SECTION EM
ENGINE MECHANICAL

CONTENTS

QR25DE

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PRECAUTIONS

PFP:00001

Precautions for Drain Coolant

EBS00DH3

Drain coolant when engine is cooled.

Precautions for Disconnecting Fuel Piping

EBS00DH4

- Before starting work, make sure no fire or spark producing items are in the work area.
- Release fuel pressure before disassembly.
- After disconnecting pipes, plug openings to stop fuel leakage.

Precautions for Removal and Disassembly

EBS00DH5

- When instructed to use special service tools, use the specified tools. Always be careful to work safely, avoid forceful or uninstructed operations.
- Exercise maximum care to avoid damage to mating or sliding surfaces.
- Cover openings of engine system with tape or the equivalent, if necessary, to seal out foreign materials.
- Mark and arrange disassembly parts in an organized way for easy troubleshooting and re-assembly.
- When loosening nuts and bolts, as a basic rule, start with the one furthest outside, then the one diagonally opposite, and so on. If the order of loosening is specified, do exactly as specified.

Precautions for Inspection, Repair and Replacement

EBS00DH6

Before repairing or replacing, thoroughly inspect parts. Inspect new replacement parts in the same way, and replace if necessary.

Precautions for Assembly and Installation

EBS00DH7

- Use torque wrench to tighten bolts or nuts.
- When tightening nuts and bolts, as a basic rule, equally tighten in several different steps starting with the ones in center, then ones on inside and outside diagonally in this order. If the order of tightening is specified, do exactly as specified.
- Replace with new gasket, packing, oil seal or O-ring.
- Thoroughly wash, clean, and air-blow each part. Carefully check oil or coolant passages for any restriction and blockage.
- Avoid damaging sliding or mating surfaces. Completely remove foreign materials such as cloth lint or dust. Before assembly, oil sliding surfaces well.
- Release air within route after draining coolant.
- Before starting engine, apply fuel pressure to fuel lines with turning ignition switch ON. Then mark sure that there are no leaks at fuel line connections.
- After repairing, start engine and increase engine speed to check coolant, fuel, oil, and exhaust systems for leakage.

Parts Requiring Angular Tightening

EBS00DH8

- Use an angle wrench for the final tightening of the following engine parts.
  - Cylinder head bolts
  - Lower cylinder block bolts
  - Connecting rod cap bolts
  - Crankshaft pulley bolt (No angle wrench is required as the bolt flange is provided with notches for angular tightening)
- Do not use a torque value for final tightening.
- The torque value for these parts are for a preliminary step.
- Ensure thread and seat surfaces are clean and coated with engine oil.

Precautions For Liquid Gasket

EBS00EL4

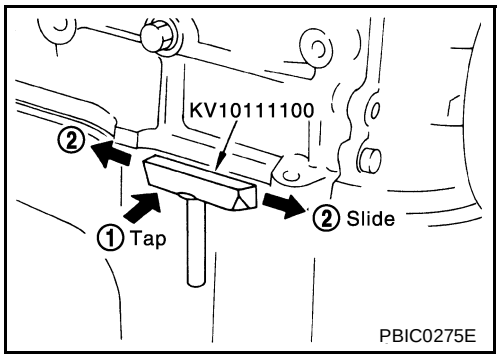
REMOVAL OF LIQUID GASKET

- After removing the mounting bolts and nuts, disconnect and remove the liquid gasket using a seal cutter.

  CAUTION:
  Be careful not to damage the mating surfaces.

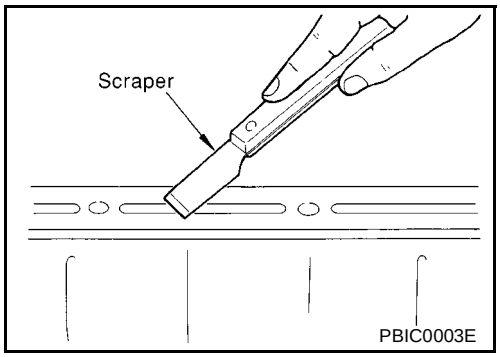
- In areas where the cutter is difficult to use, use a plastic hammer to lightly tap the gasket applied area.

  CAUTION:
  If for some unavoidable reason a tool such as a flat-blade screwdriver is used, be careful not to damage the mating surfaces.

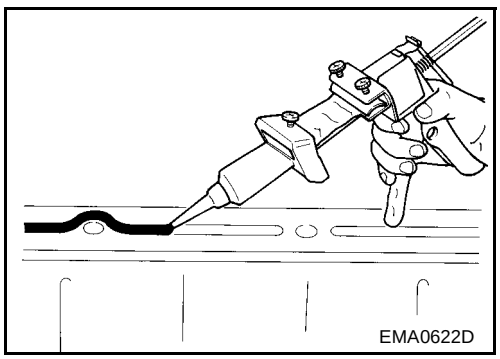


LIQUID GASKET APPLICATION PROCEDURE

1. Using a scraper, remove the old liquid gasket adhering to the gasket application surface and the mating surface.
   - Remove the liquid gasket completely from the groove of the gasket application surface, mounting bolts and bolt holes.
2. Wipe the gasket application surface and the mating surface with white gasoline (lighting and heating use) to remove adhering moisture, grease and foreign materials.
3. Attach the liquid gasket to the tube presser.
   Use Genuine Liquid Gasket or equivalent.

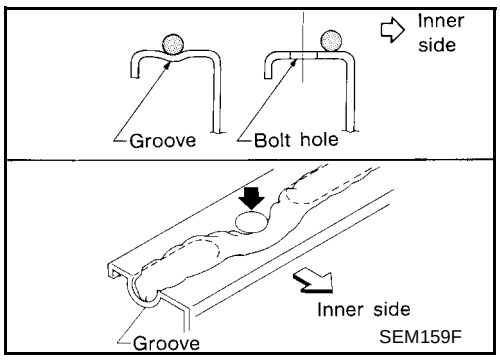


4. Apply the gasket without breaks to the specified location with the specified dimensions.
   - If there is a groove for the liquid gasket application, apply the gasket to the groove.



   - As for the bolt holes, normally apply the gasket inside the holes. If specified, it should be applied outside the holes. Make sure to read the instruction in this manual.
   - Within five minutes of gasket application, install the mating component.
   - If the liquid gasket protrudes, wipe it off immediately.
   - Do not retighten after the installation.
   - After 30 minutes or more have passed from the installation, fill the engine oil and coolant.

   CAUTION:
   If there are instructions in this manual, observe them.

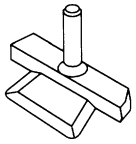
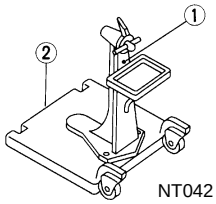
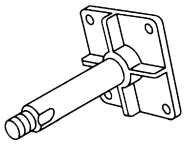
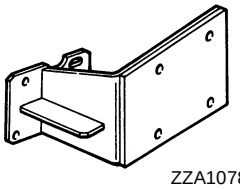
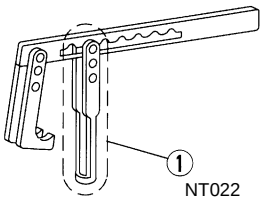
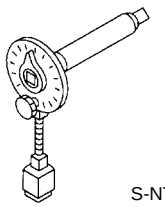
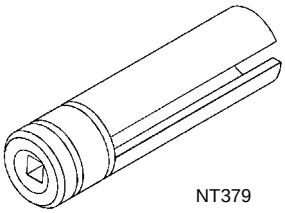


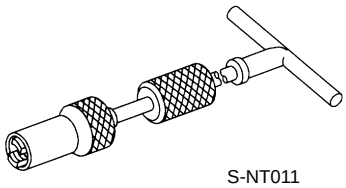
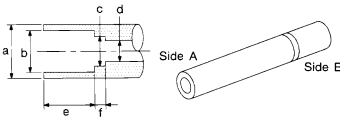
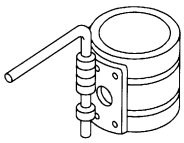
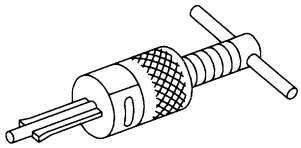
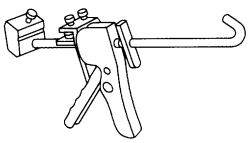
PREPARATION

PFP:00002

Special Service Tools

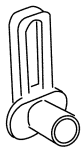
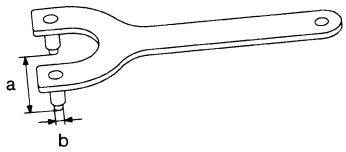
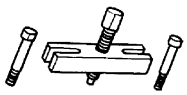
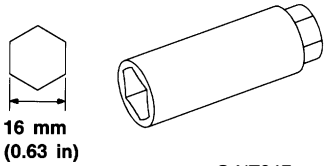
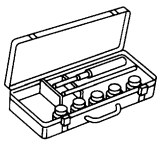
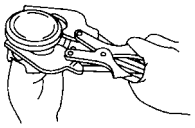
EBS00DHA

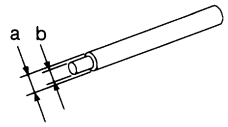
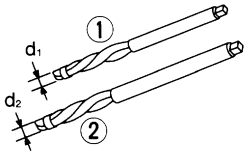
Tool number Tool name		Description
KV10111100 Seal cutter	 S-NT046	Removing oil pan and timing chain case
ST0501S000 Engine stand assembly 1, ST05011000 Engine stand 2, ST05012000 Base	 NT042	Disassembling and assembling
KV10106500 Engine stand shaft	 NT028	
KV10115300 Engine sub-attachment	 ZZA1078D	
KV10116200 Valve spring compressor 1, KV10115900 Attachment	 NT022	Disassembling valve mechanism
KV10112100 Angle wrench	 S-NT014	Tightening bolts for bearing cap, cylinder head, etc.
KV10117100 Heated oxygen sensor wrench	 NT379	Loosening or tightening heated oxygen sensors with 22 mm (80.87 in) hexagon nut

Tool number Tool name	Description
KV10107902 Valve oil seal puller  S-NT011	Removing valve oil seal
KV10115600 Valve oil seal drift  S-NT603	Installing valve oil seal **Use side A.** **a: 20 (0.79) dia.** **d: 8 (0.31) dia.** **b: 13 (0.51) dia.** **e: 10.7 (0.421) dia.** **c: 10.3 (0.406) dia.** **f: 5 (0.20) dia.** Unit: mm (in)
EM03470000 Piston ring compressor  S-NT044	Installing piston assembly into cylinder bore
ST16610001 Pilot bushing puller  S-NT045	Removing crankshaft pilot bushing
WS39930000 Tube presser  S-NT052	Pressing the tube of liquid gasket

Commercial Service Tools

EBS00DHB

Tool number Tool name	Description
Quick connector release  PBIC0198E	Removing fuel tube quick connectors in engine room (Available in SEC. 164 of PARTS CATALOG: Part No. 16441 6N210)
Pulley holder  NT628	Crankshaft pulley removing and installing **a: 68 mm (2.68 in)** **b: 8 mm (0.31 in)**
Crank puller  ZZA0010D	Crankshaft pulley removing
Spark plug wrench  S-NT047	Removing and installing spark plug
Valve seat cutter set  S-NT048	Finishing valve seat dimensions
Piston ring expander  S-NT030	Removing and installing piston ring

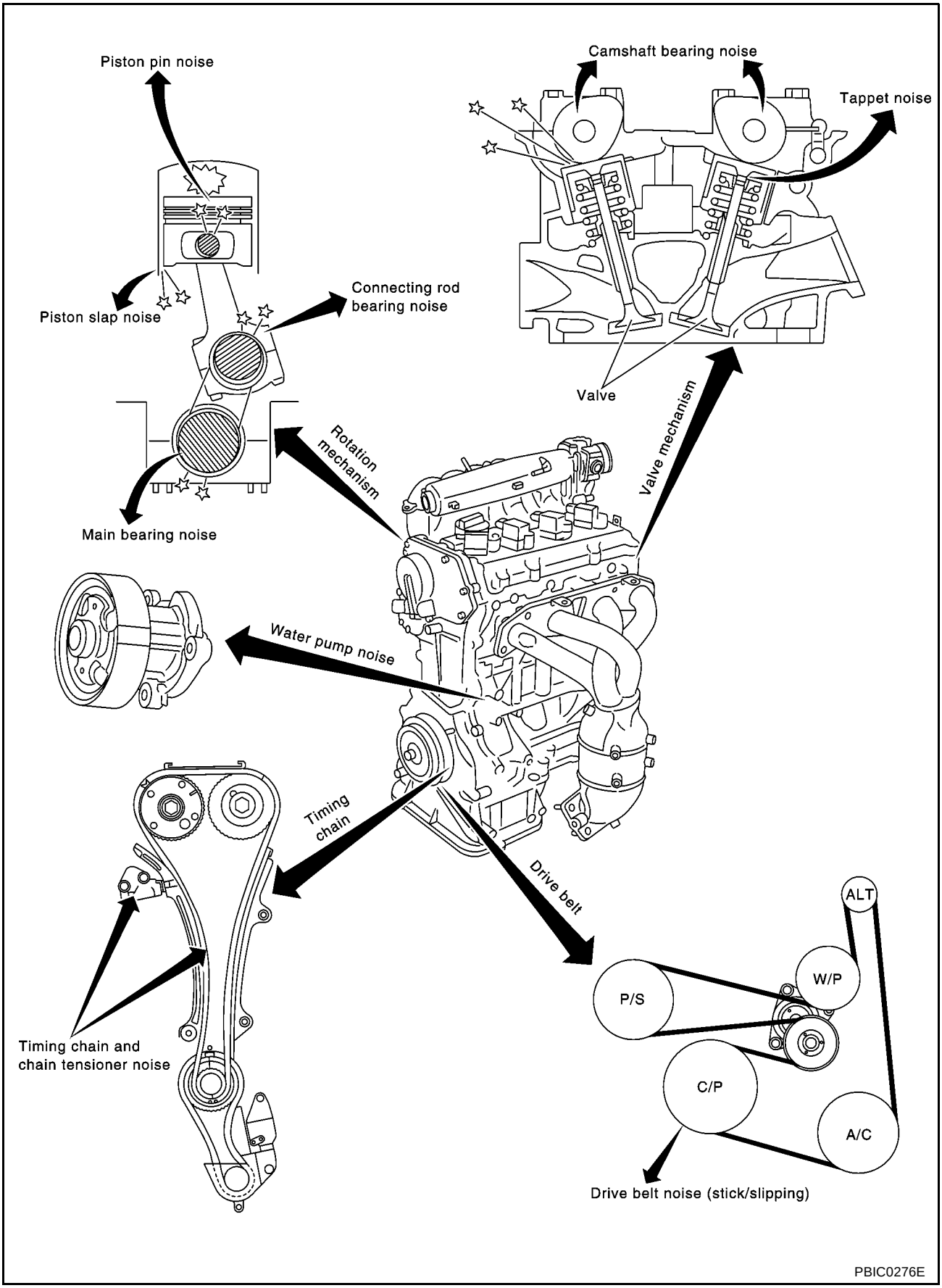
Tool number Tool name	Description
Valve guide drift  S-NT015	Removing and installing valve guide **Intake & Exhaust:** **a: 9.5 mm (0.374 in) dia.** **b: 5.5 mm (0.217 in) dia.**
Valve guide reamer  S-NT016	1: Reaming valve guide inner hole 2: Reaming hole for oversize valve guide **Intake & Exhaust:** **d1: 6.0 mm (0.236 in) dia.** **d2: 10.2 mm (0.402 in) dia.**

NOISE, VIBRATION, AND HARSHNESS (NVH) TROUBLESHOOTING

PFP:00003

Nvh Troubleshooting —Engine Noise

EBS00DHC



Use the Chart Below to Help You Find the Cause of the Symptom.

EBS00DHD

1. Locate the area where noise occurs.
2. Confirm the type of noise.
3. Specify the operating condition of engine.
4. Check specified noise source.

If necessary, repair or replace these parts.

Location of noise	Type of noise	Operating condition of engine						Source of noise	Check item	Reference page
		Before warm-up	After warm-up	When starting	When idling	When racing	While driving			
Top of engine Rocker cover Cylinder head	Ticking or clicking	C	A	—	A	B	—	Tappet noise	Valve clearance	EM-41
	Rattle	C	A	—	A	B	C	Camshaft bearing noise	Camshaft journal clearance Camshaft runout	EM-39 EM-39
Crankshaft pulley Cylinder block (Side of engine) Oil pan	Slap or knock	—	A	—	B	B	—	Piston pin noise	Piston and piston pin clearance Connecting rod bushing oil clearance (Small end)	EM-85 EM-88
	Slap or rap	A	—	—	B	B	A	Piston slap noise	Piston to cylinder bore clearance Piston ring side clearance Piston ring end gap Connecting rod bend and torsion	EM-89 EM-86 EM-86 EM-87
	Knock	A	B	C	B	B	B	Connecting rod bearing noise	Connecting rod bushing oil clearance (Small end) Connecting rod bearing clearance (Big end)	EM-88 EM-87
	Knock	A	B	—	A	B	C	Main bearing noise	Main bearing oil clearance Crankshaft runout	EM-91 EM-91
Front of engine Timing chain cover	Tapping or ticking	A	A	—	B	B	B	Timing chain and chain tensioner noise	Timing chain cracks and wear Timing chain tensioner operation	EM-44
Front of engine	Squeaking or fizzing	A	B	—	B	—	C	Drive belts (Sticking or slipping)	Drive belts deflection	EM-13
	Creaking	A	B	A	B	A	B	Drive belts (Slipping)	Idler pulley bearing operation	
	Squall Creak	A	B	—	B	A	B	Water pump noise	Water pump operation	CO-19, "WATER PUMP"

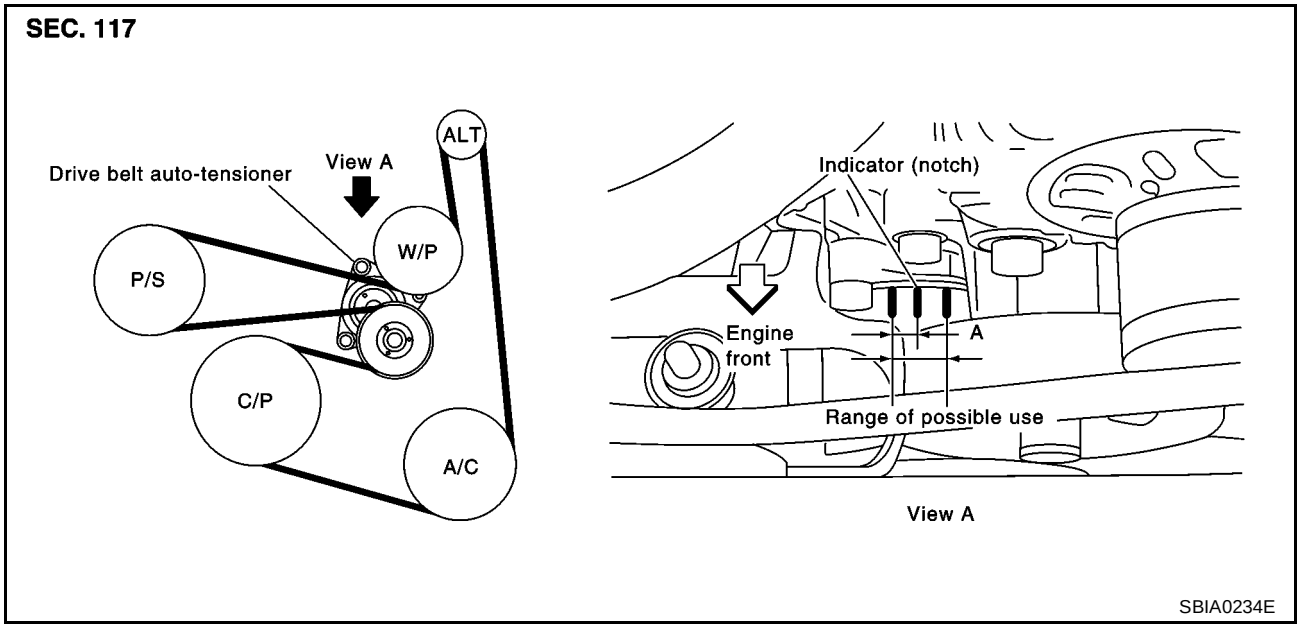
A: Closely related B: Related C: Sometimes related —: Not related

DRIVE BELTS

PFP:02117

Checking Drive Belts

EBS00DHE



WARNING:

Be sure to perform when the engine is stopped.

- Make sure that the stamp mark of auxiliary drive belt auto-tensioner is within the usable range.

  NOTE:
  - Check the drive belt auto-tensioner indication when the engine is cold.
  - When the new drive belt is installed, the range should be A.
- Visually check entire belt for wear, damage or cracks.
- If the indicator is out of allowable use range or belt is damaged, replace the belt.

Tension Adjustment

EBS00DHF

Belt tensioning is not necessary, as it is automatically adjusted by drive belt auto-tensioner.

Removal and Installation

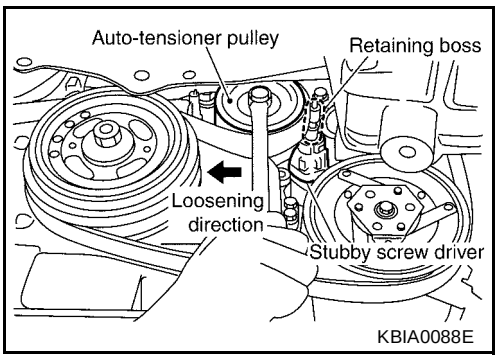
EBS00DHG

REMOVAL

1. Remove front RH engine side cover.
2. With box wrench, and while securely holding the hexagonal part in pulley center of drive belt auto-tensioner, move the wrench handle in the direction of arrow (loosening direction of tensioner).

   CAUTION:

   Avoid placing hand in a location where pinching may occur if the holding tool accidentally comes off.
3. Insert a rod approximately 6mm (0.24 in) in diameter through the rear of engine into holding boss to fix tensioner pulley.
   - Leave tensioner pulley arm locked until belt is installed again.
4. Loosen auxiliary drive belt from water pump pulley in sequence, and remove it.



INSTALLATION

1. With box wrench, and while securely holding the hexagonal part in pulley center of drive belt auto-tensioner, move the wrench handle in the direction of arrow [loosening direction of tensioner].

   CAUTION:

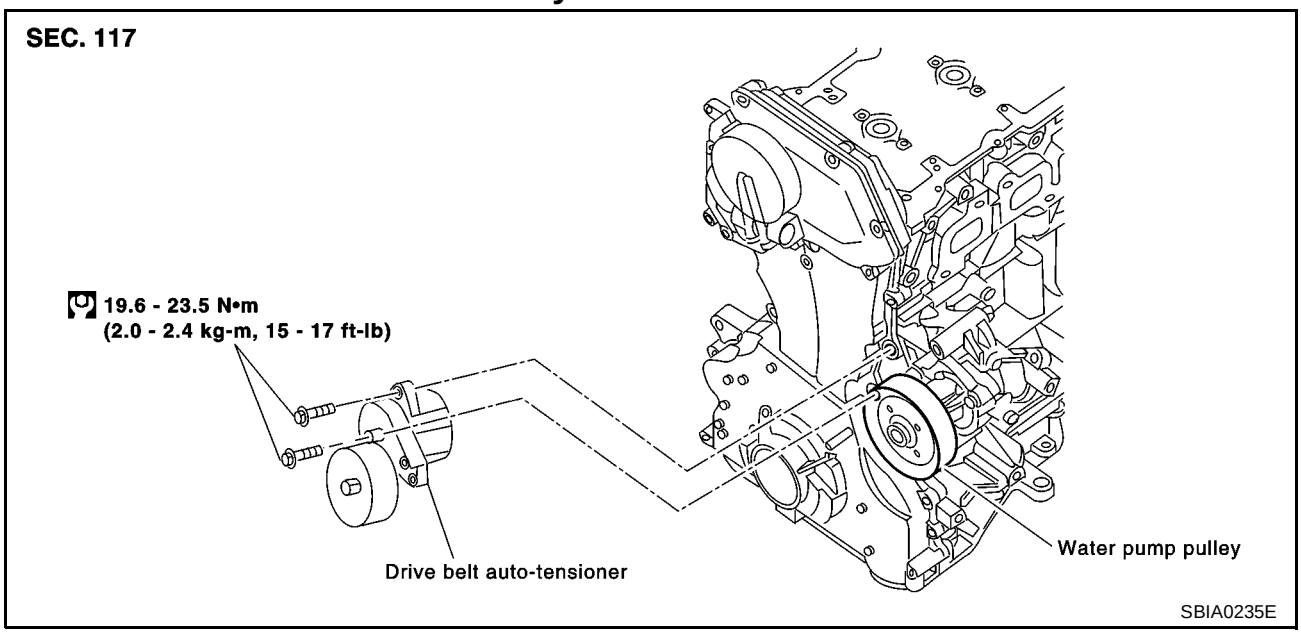
   Avoid placing hand in a location where pinching may occur if the holding tool accidentally comes off.

2. Insert a rod approximately 6 mm (0.24 in) in diameter through the rear of engine into holding boss to fix tensioner pulley.
3. Hook auxiliary drive belt onto all pulleys except for water pump. Hook belt onto water pump pulley at the end.

   CAUTION:
   Confirm belts are completely set to pulleys.
4. Release tensioner, and apply tensions to belt.
5. Turn crankshaft pulley clockwise several times to equalize tension between each pulley.
6. Confirm tensions of belt at indicator is within the allowable use range. Refer to EM-13, "Checking Drive Belts" .

Removal and Installation of Auxiliary Drive Belt Auto- Tensioner

EBS00DHH



REMOVAL

1. Remove front RH engine side cover.
2. Remove auxiliary drive belt.
   - Keep tensioner pulley fixed with a tool such as a short-length screwdriver.
3. Remove alternator and then auxiliary drive belt auto-tensioner.
   - Remove and install auxiliary drive belt auto-tensioner by fixing tension pulley.

INSTALLATION

Install in the reverse order of removal.

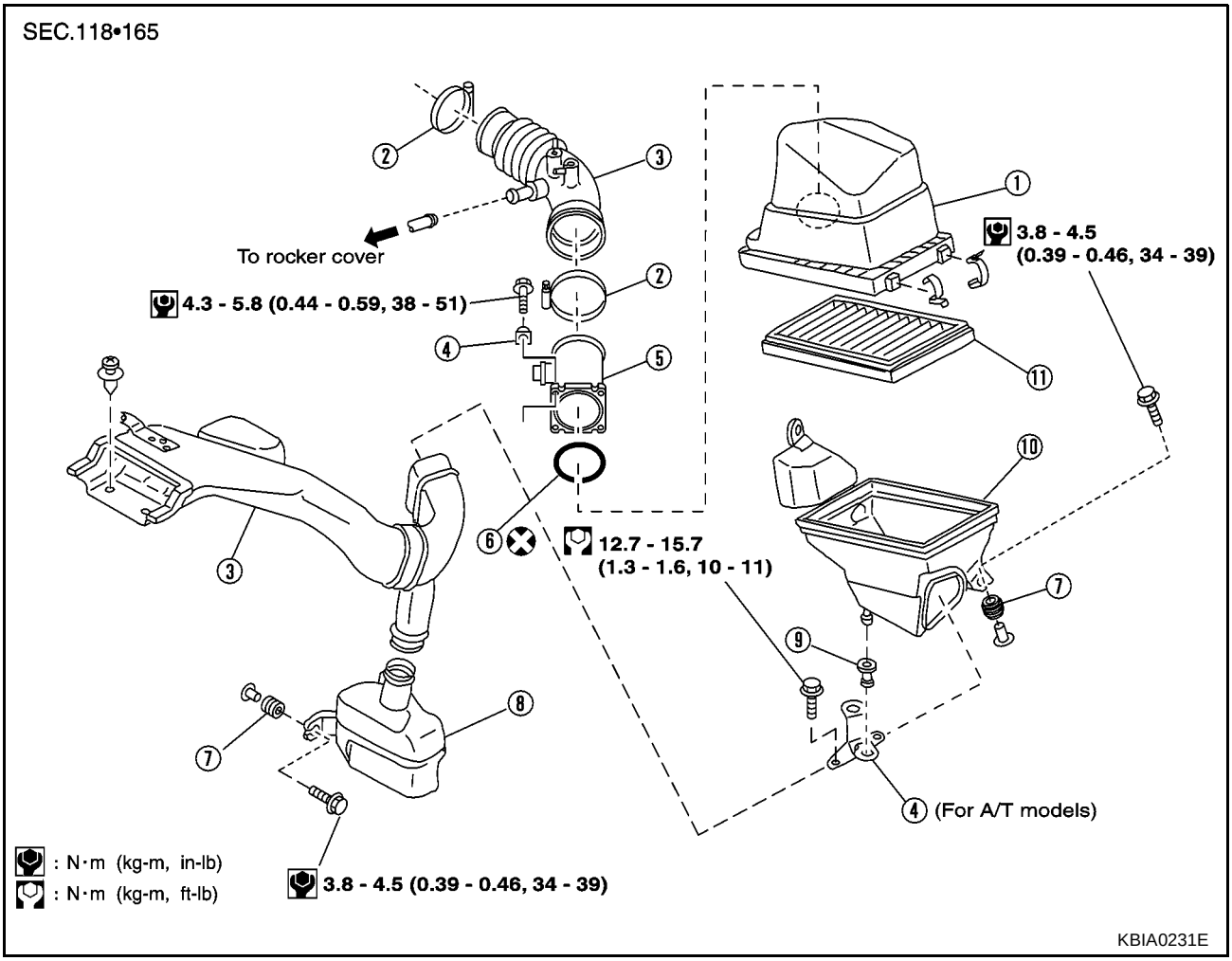
CAUTION:
Install auxiliary drive belt auto-tensioner carefully not to damage the water pump pulley.

AIR CLEANER AND AIR DUCT

PFP:16500

Removal and Installation

EBS00DHI



1	Air cleaner case upper	2	Clamp	3	Air duct
4	Bracket	5	Mass air flow sensor	6	O-ring
7	Grommet	8	Resonator	9	Mounting rubber
10	Air cleaner case lower	11	Air cleaner element		

REMOVAL

1. Remove mass air flow sensor harness clamp.
2. Remove harness connector from mass air flow sensor.
3. Remove air duct, air cleaner case/ mass air flow sensor.
   - Add marks as necessary for easier installation.
4. Remove mass air flow sensor from air cleaner case.

   CAUTION:

   Handle mass air flow sensor with following cares.
   - **Do not shock it.**
   - **Do not disassembly it.**
   - **Do not touch its sensor.**
5. Remove resonator in fender lifting left fender protector.

INSTALLATION

1. Attach each joint aligning marks put at removal. Screw clamps firmly.
2. Install in the reverse order of removal.

CHANGING AIR CLEANER ELEMENT

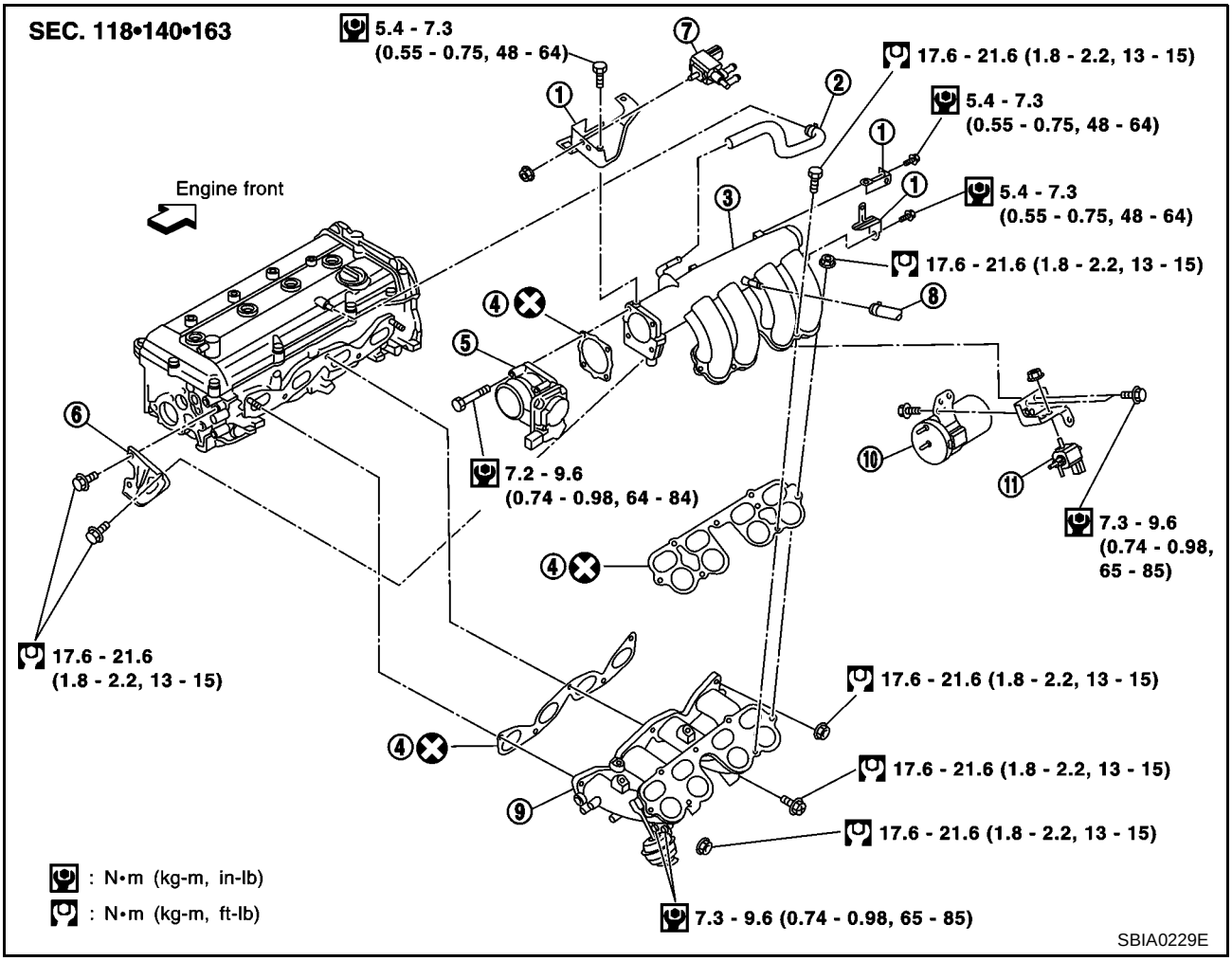
1. Remove clips and lift up air cleaner upper case.
2. Remove air cleaner element.

INTAKE MANIFOLD

PFP:14003

Removal and Installation

EBS00DHJ



1	Bracket	2	PCV hose	3	Intake manifold collector
4	Gasket	5	Electric throttle control actuator	6	Intake manifold support
7	EVAP canister purge volume control solenoid valve	8	Vacuum hose	9	Intake manifold
10	Vacuum reservoir tank	11	VIAS control solenoid valve		

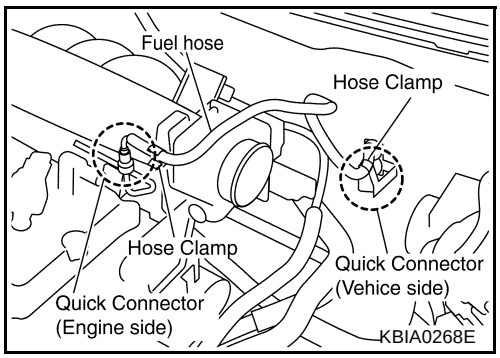
REMOVAL

WARNING:

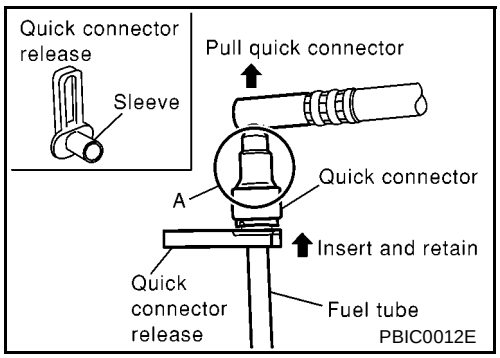
To avoid the danger of being scalded, never drain the coolant when the engine is hot.

1. Remove mass air flow sensor harness connector from mass air flow sensor and clamp.
2. Release fuel pressure. Refer to EC-31, "FUEL PRESSURE RELEASE" .
3. Remove air cleaner case and air duct assembly. Refer to EM-15, "AIR CLEANER AND AIR DUCT" .
4. Drain coolant when engine is cooled. Refer to CO-9, "DRAINING ENGINE COOLANT" .

5. Disconnect fuel hose quick connector on engine side.



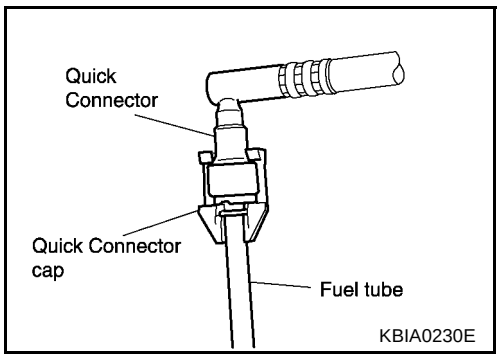
- Using tool of quick connector release (here in after “release”), perform the following steps to disconnect quick connector.



a. Remove quick connector cap.
b. With the sleeve side of release facing quick connector, install release onto fuel tube.
c. Insert release into quick connector until sleeve contacts and goes no further. Hold the release on that position.

CAUTION:
Inserting the release hard will not disconnect quick connector. Hold release where it contacts and goes no further.

d. Draw and pull out quick connector straight from fuel tube.

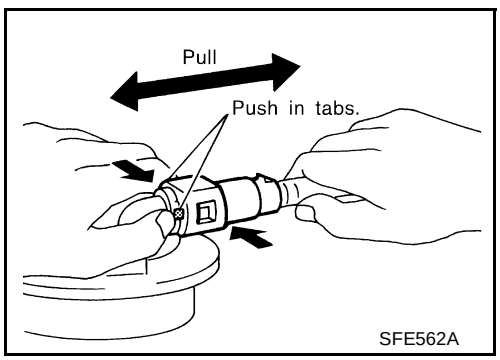


CAUTION:
- **Pull quick connector holding A position in illustration.**
- **Do not pull with lateral force applied. O-ring inside quick connector may be damaged.**
- **Prepare container and cloth beforehand as fuel will leak out.**
- **Avoid fire and sparks.**
- **Be sure to cover openings of disconnected pipes with plug or plastic bag to avoid fuel leakage and entry of foreign materials.**

6. Remove fuel hose quick connector at vehicle piping side, perform as follows.

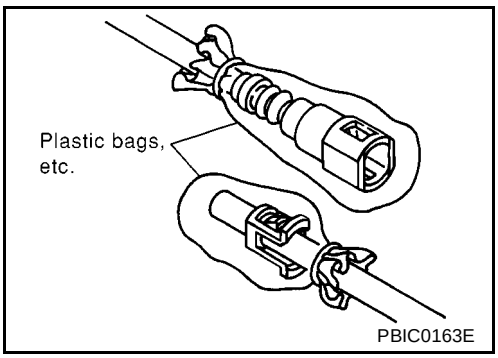
a. Remove quick connector cap.
b. Hold the sides of the connector, push in tubs and pull out the tube. (The figure is shown for reference only.)

- If the connector and the tube are stuck together, push and pull several times until they start to move. Then disconnect them by pulling.



CAUTION:
- **The tube can be removed when the tabs are completely depressed. Do not twist it more than necessary.**
- **Do not use any tools to remove the quick connector.**
- **Keep the resin tube away from heat. Be especially careful when welding near the tube.**
- **Prevent acid liquid such as battery electrolyte etc. from getting on the resin tube.**

- **Do not bend or twist the tube during installation and removal.**
- **Do not remove the remaining retainer on tube.**
- **When the tube is replaced, also replace the retainer with a new one.**
- **To keep clean the connecting portion and to avoid damage and foreign materials, cover them completely with plastic bags or something similar.**



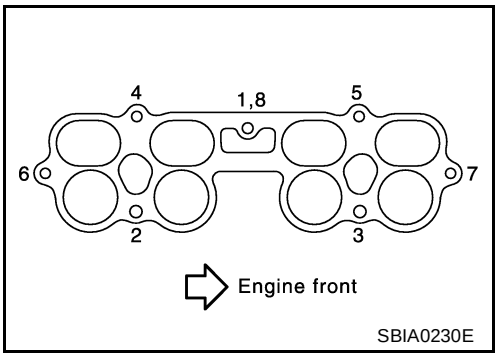
7. Loosen mounting bolts diagonally, and remove electric throttle control actuator.

CAUTION:
Handle carefully to avoid any shock.

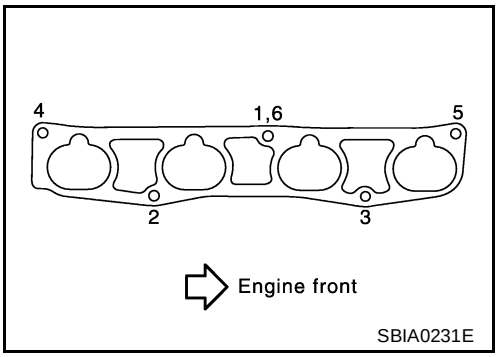
8. Disconnect intake manifold collector harness, vacuum hose, and PCV hose.

CAUTION:
Cover engine openings to avoid entry of foreign materials.

9. Remove intake manifold collector mounting bolts on the support.
10. Loosen mounting bolts and nuts in order from 7 to 1, and remove intake manifold collector.
    - Disregard 6 when loosening.
11. Disconnect harness and power steering piping from intake manifold and fuel tube assembly, and move them a side.



12. Loosen bolts in reverse order of illustration to remove intake manifold assembly.
    - Disregard No.6 when loosening.

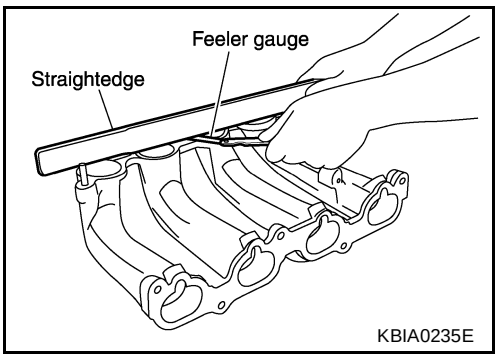


INSPECTION AFTER REMOVAL

Surface Distortion

Using straightedge and feeler gauge, inspect surface distortion of intake manifold collector and intake manifold surface.

Standard: 0.1 mm (0.004 in)



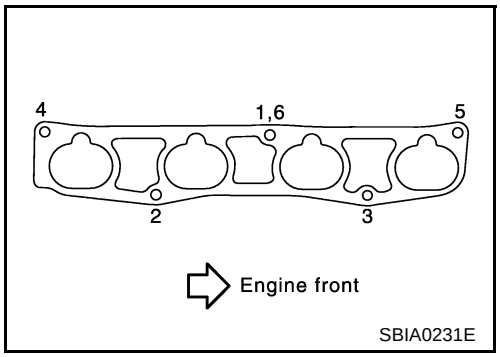
INSTALLATION

Install in the reverse order of removal paying attention to the following.

Intake Manifold Bolts and Nuts

Tighten in numerical order as shown in the figure.

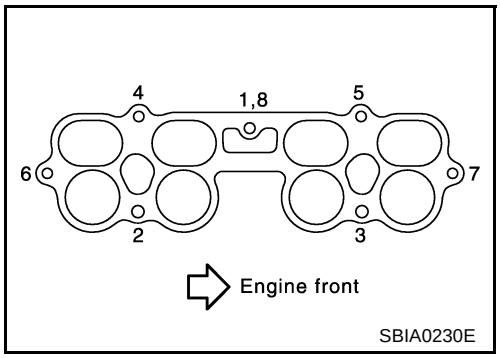
NOTE:
No.6 means double tightening of bolt 1.



Intake Manifold Collector Bolts and Nuts

Tighten in numerical order as shown in the figure.

NOTE:
No.8 means double tightening of bolts 1.



Electric Throttle Control Actuator

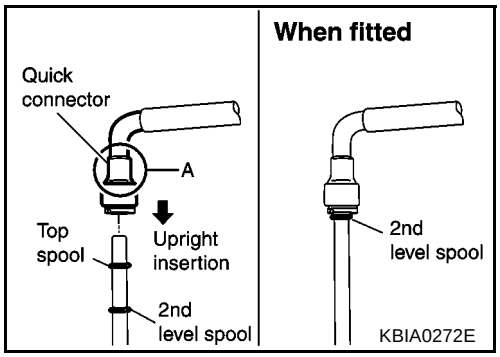
- Tighten fixing bolts of electric throttle control actuator equally and diagonally in several steps.
- After installation perform procedure, refer to EM-21, "INSPECTION AFTER INSTALLATION" .

Connecting Quick Connector of Fuel Hose (Engine side)

Install quick connector as follows.

1. Make sure no foreign substances are deposited in and around tube and quick connector and no damage on them.
2. Thinly apply new engine oil around the fuel tube tip end.
3. Align center to insert quick connector straightly into fuel tube.
   - Insert fuel tube into quick connector until the first spool on fuel tubes is inserted completely and the second one is positioned slightly below the quick connectors bottom end.

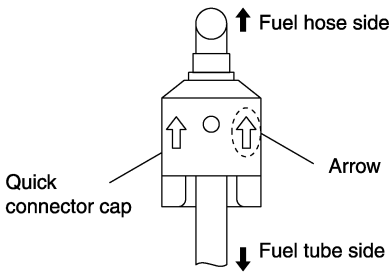
   CAUTION:
   - **Hold A position in illustration when inserting fuel tube into quick connector.**
   - **Carefully align center to avoid inclined insertion to prevent damage to O-ring inside quick connector.**
   - **Insert until you hear a “click” sound and actually feel the engagement.**
   - **To avoid misidentification of engagement with a similar sound, be sure to perform the next step.**



4. Before clamping fuel hose with hose clamps, pull quick connector hard by hand holding A position. Make sure it is completely engaged (connected) so that it does not come out from fuel tube.

   NOTE:
   Recommended pulling force is 50 N (5.1 kg, 11.2 lb).

5. Install quick connector cap on quick connector joint.
   - Direct arrow mark on quick connector cap to upper side (The figure shows quick connector cap for engine side).
6. Install fuel hose to hose clamp.



KBIA0298E

Connecting Quick Connector of Fuel Hose (Vehicle side)

Install quick connector as follows.

1. Make sure no foreign substances are deposited in and around tube and quick connector and no damage on them.
2. Align center to insert quick connector straightly into fuel tube.
   - Insert fuel tube until a click is heard.
   - Install quick connector cap on quick connector joint. Direct arrow mark on quick connector cap to upper side.
   - Install fuel hose to hose clamp.

INSPECTION AFTER INSTALLATION

Check connections for fuel leakage.

1. Start the engine, and run it for a few minutes with engine at idle.
2. Stop the engine, and check for fuel leakage both visually and by odor of gasoline.

   NOTE:
   Use mirrors for checking on invisible points.

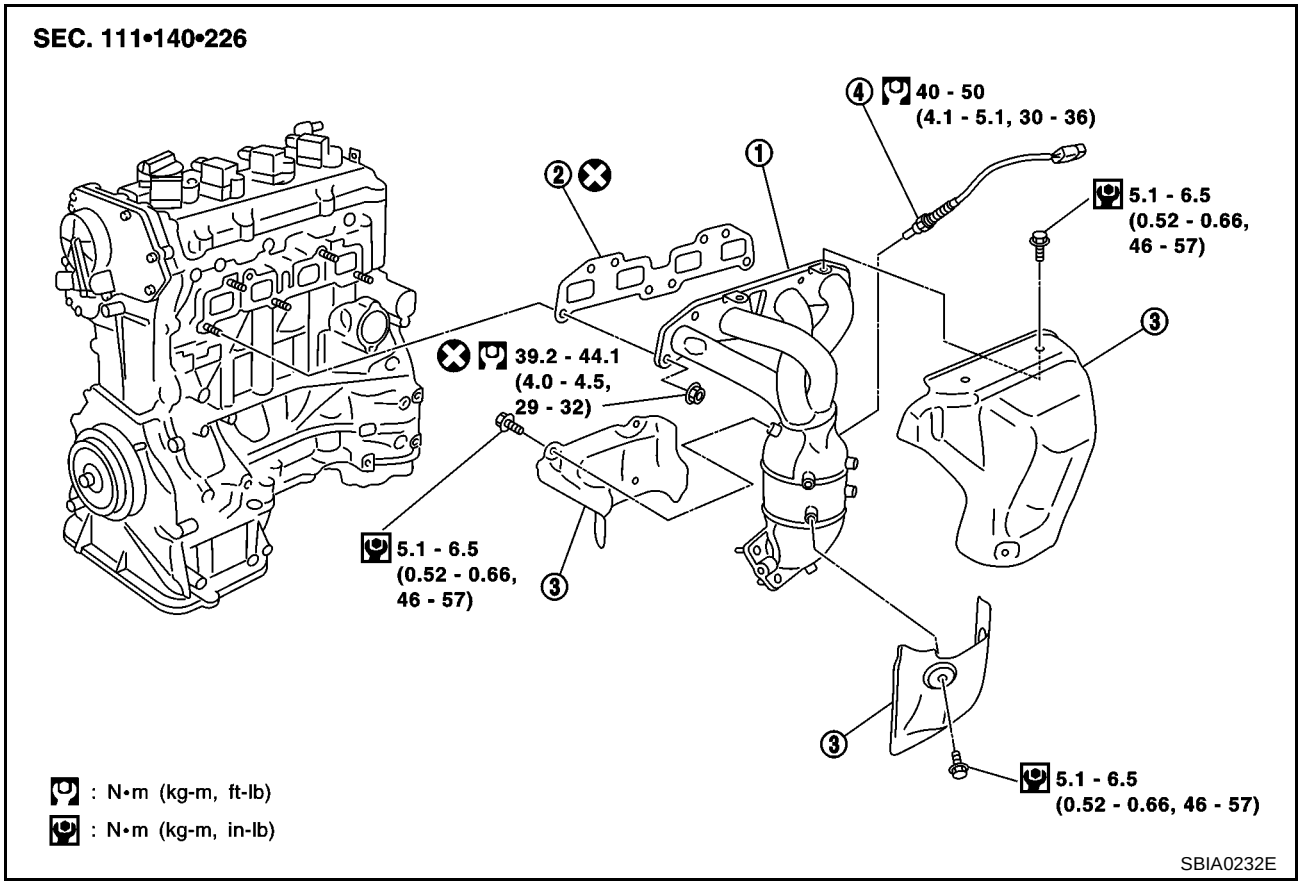
   CAUTION:
   Do not touch the engine immediately after stopped as engine becomes extremely hot.
   - Perform procedures for “Throttle Valve Closed Position Learning” after finishing repairs. Refer to EC-28, "Throttle Valve Closed Position Learning" .
   - If electric throttle control actuator is replaced, perform procedures for “Idle Air Volume Learning” after finishing repairs. Refer to EC-28, "Idle Air Volume Learning" .

EXHAUST MANIFOLD AND THREE WAY CATALYST

PFP:14004

Removal and Installation

EBS00DHK



1	Exhaust manifold and three way catalyst assembly	2	Gasket	3	Exhaust manifold cover
4	Heated oxygen sensor 1				

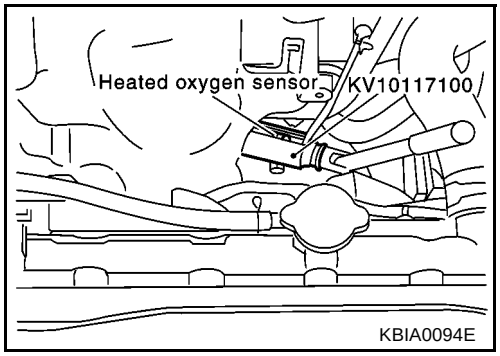
REMOVAL

1. Remove heated oxygen sensors.
   - Follow below steps to remove each heated oxygen sensor.

a. Remove engine under cover.

b. Remove harness connector of each heated oxygen sensor, and harness from bracket and middle clamp.

c. Using heated oxygen sensor wrench, remove heated oxygen sensors.



CAUTION:

- **Be careful not to damage heated oxygen sensor.**
- **Discard any heated oxygen sensor which has been dropped from a height of more than 0.5 m (19.7 in) onto a hard surface such as a concrete floor; use a new one.**

2. Remove exhaust manifold and three way catalyst assembly.

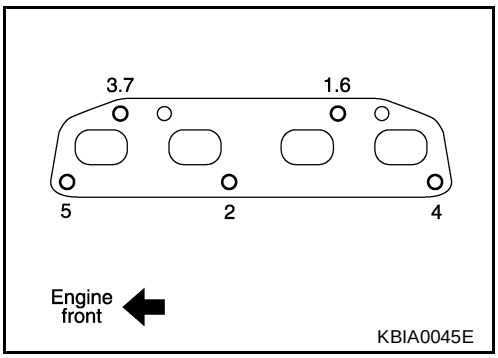
a. Remove exhaust manifold cover lower.

b. Remove exhaust front tube. Refer to EX-2, "EXHAUST SYSTEM" .

c. Remove exhaust manifold cover upper.

d. Loosen nuts in reverse order of illustration to remove exhaust manifold and catalytic converter.
   - Disregard the numerical order No.6 and 7 when loosening.

3. Remove exhaust manifold and three way catalyst loosening nuts in reverse order in the figure.

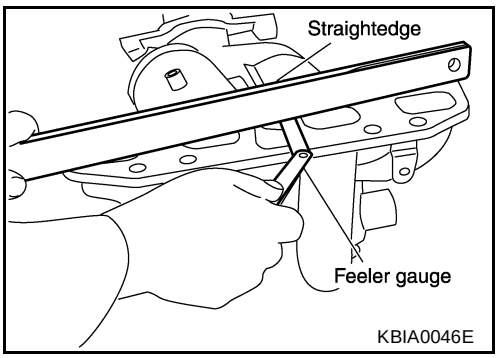


INSPECTION AFTER REMOVAL

Surface Distortion

Use a reliable straightedge and feeler gauge to check the flatness of exhaust manifold fitting surface.

Standard: 0.3mm (0.012in)

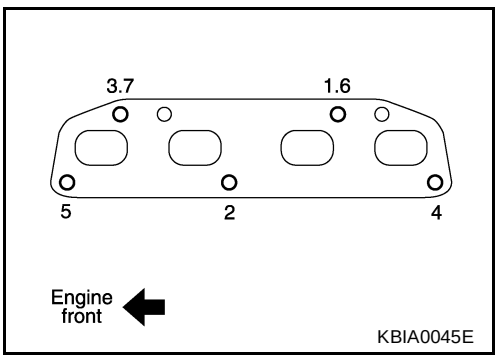


INSTALLATION

Install in the reverse order of removal paying attention to the following.

Exhaust Manifold Nuts

- Tighten nuts in the numerical order shown in the figure.
- No.6 and 7 indicate double tightening of bolts 1 and 3.



Heated Oxygen Sensor

CAUTION:

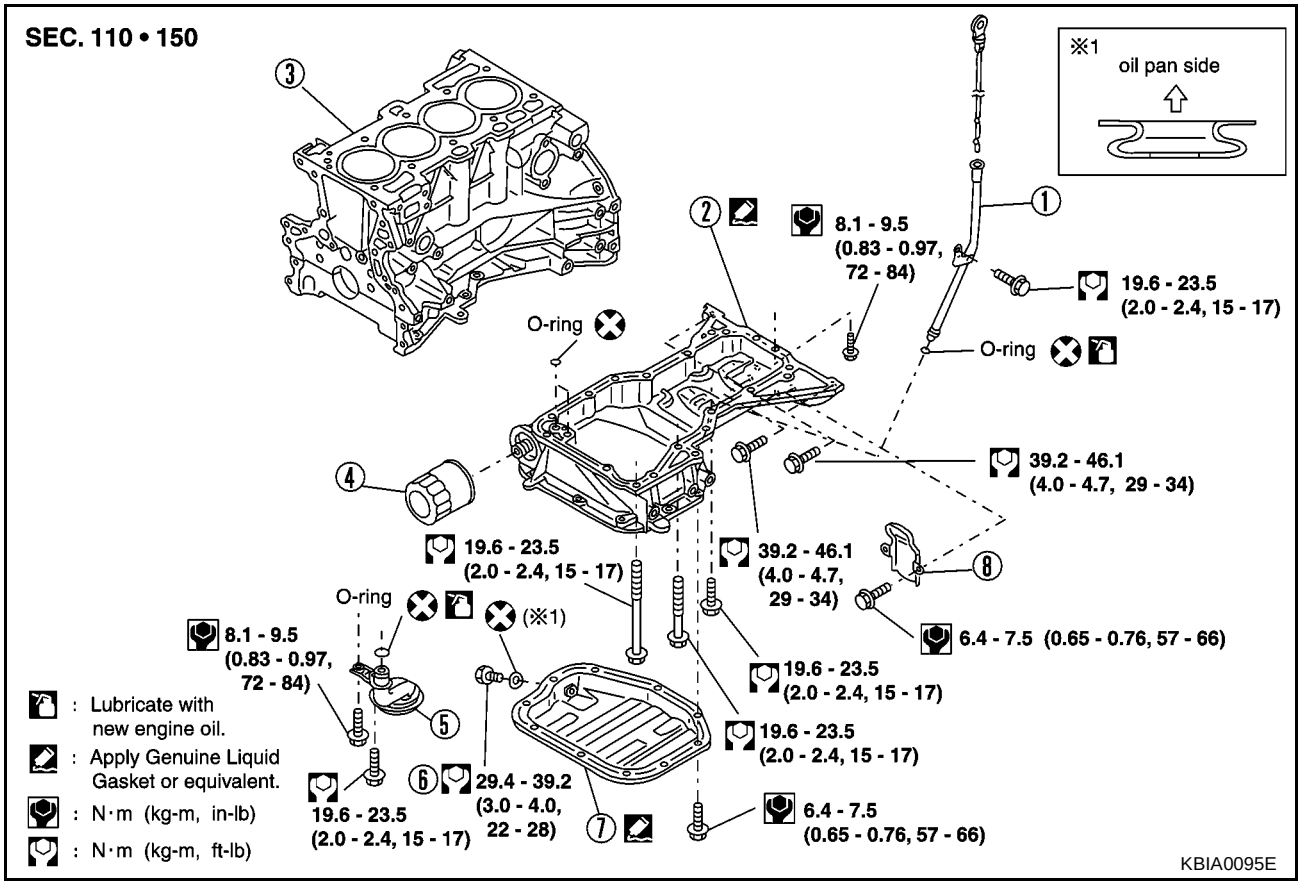
Do not over torque the heated oxygen sensor. Doing so may cause damage to the heated oxygen sensor, resulting in the MIL coming on.

OIL PAN AND OIL STRAINER

PFP:11110

Removal and Installation

EBS00DHL



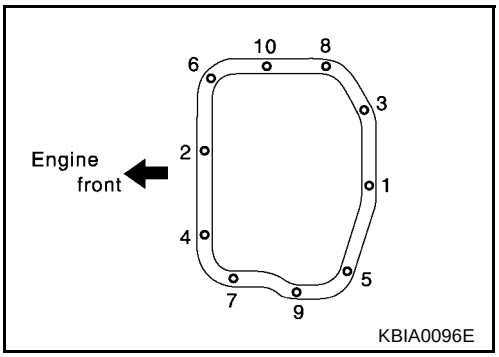
1	Oil level gauge guide	2	Oil pan upper	3	Cylinder block
4	Oil filter	5	Oil strainer	6	Drain plug
7	Oil pan lower	8	Rear plate cover		

REMOVAL

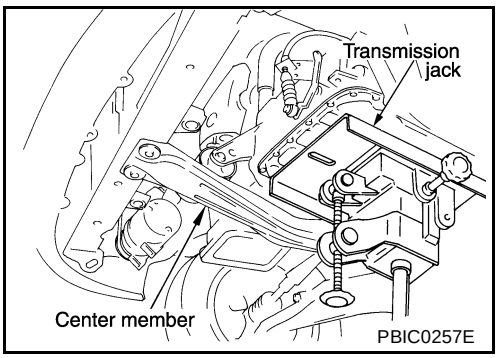
WARNING:

To avoid the danger of being scalded, never drain the engine oil when the engine is hot.

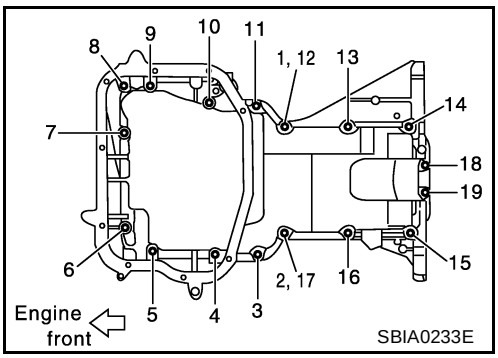
1. Remove engine under cover both side.
2. Drain engine oil. Refer to LU-9, "Changing Engine Oil" .
3. Remove lower oil pan bolts, Loosen bolts in the reverse order of that shown in the figure.
4. Insert Tool Seal cutter between lower and upper oil pan.
5. Remove lower oil pan.



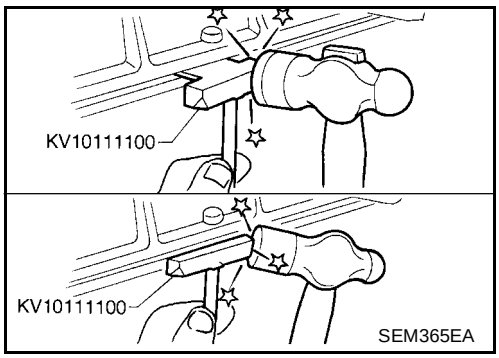
6. Remove drive belts.
7. Remove A/C compressor with piping connected.
   And locate it aside temporarily with ropes or equivalent not to disturb the following work.
8. Remove front exhaust tube and its support.
9. Set a suitable transmission jack under transaxle and hoist engine with engine slinger.
10. Remove center member.
11. Remove rear plate cover, and four engine-to transaxle bolts.



12. Loosen bolts in reverse order of illustration to remove upper oil pan.
    - Disregard No. 1, 2 and 3 when loosening.



    - Insert Tool (Seal cutter) between upper oil pan and cylinder block. Slide tool by tapping on the side of the tool with a hammer.
13. Remove oil strainer.



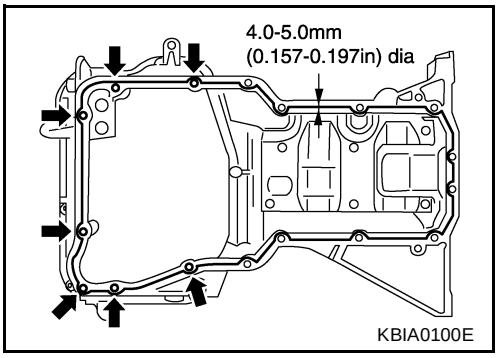
INSPECTION AFTER REMOVAL

Clean oil strainer if any object attached.

INSTALLATION

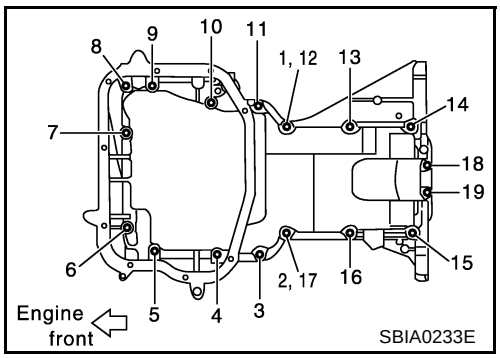
1. Install oil strainer.
2. Install upper oil pan in the order below.

a. Apply liquid gasket thoroughly as in illustration.
   Use Genuine Liquid Gasket or equivalent.
b. Install O-rings as front cover side.

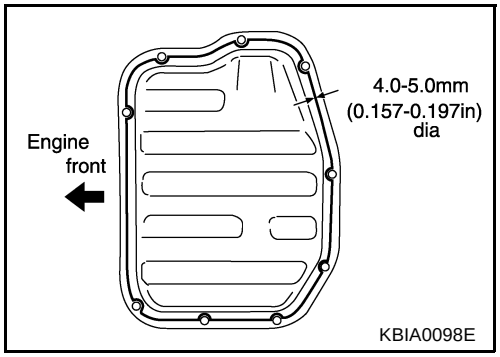


c. Tighten bolts in numerical order as shown.
   - No.10, 11and 18 indicate double tightening of bolts 1,2 and 3.

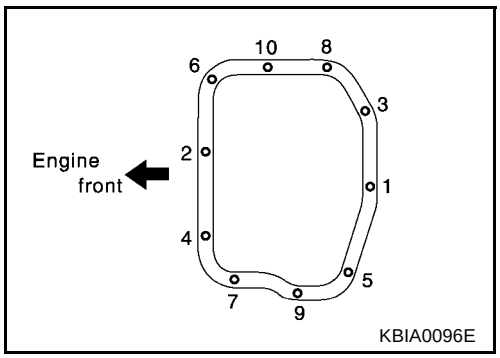
   NOTE:
   Refer to the below for locating bolts.
   M6 × 20 mm (0.79 in): No. 18, 19
   M8 × 25 mm. (0.98 in): No. 1, 2, 3, 11
   M8 x 45 mm (1.77 in): No. 4, 10, 13, 14, 15, 16
   M8 x100mm (3.97 in): No. 5, 6, 7, 8, 9



d. Tighten transmission joint bolts.
e. Install rear plate cover.
3. Install lower oil pan.
   - Use Genuine Liquid gasket or equivalent.



   - Tighten bolts in numerical order as shown.



4. Install oil pan drain plug.
   - Refer to illustration of components of former page for installation direction of washer.
5. Install in the reverse order of removal after this step.
   - Pour engine oil or start engine at least 30 minutes after oil pan is installed.

INSPECTION AFTER INSTALLATION

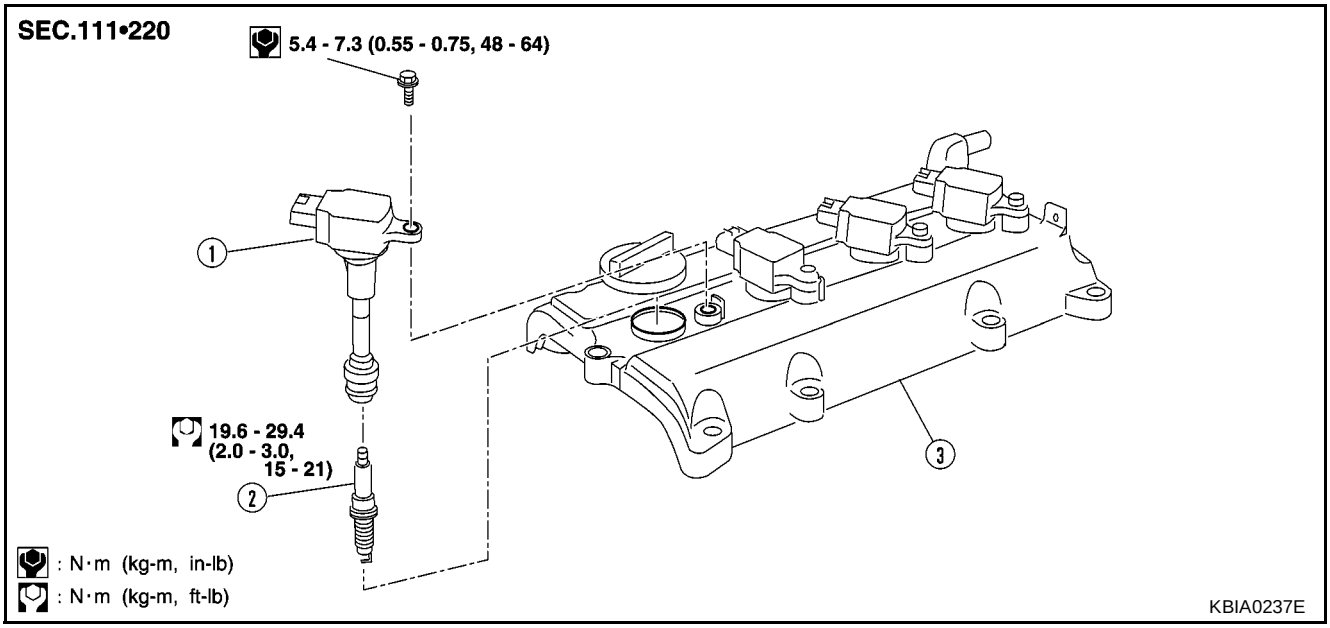
Check for leakage of engine oil when engine is warmed.

IGNITION COIL

PFP:22448

Removal and Installation

EBS00DHM



1 Ignition coil 2 Spark plug 3 Rocker cover

REMOVAL

1. Remove harness connector from ignition coil.
2. Remove ignition coil.
3. Remove spark plug.

CAUTION:
Do not shock it.

INSTALLATION

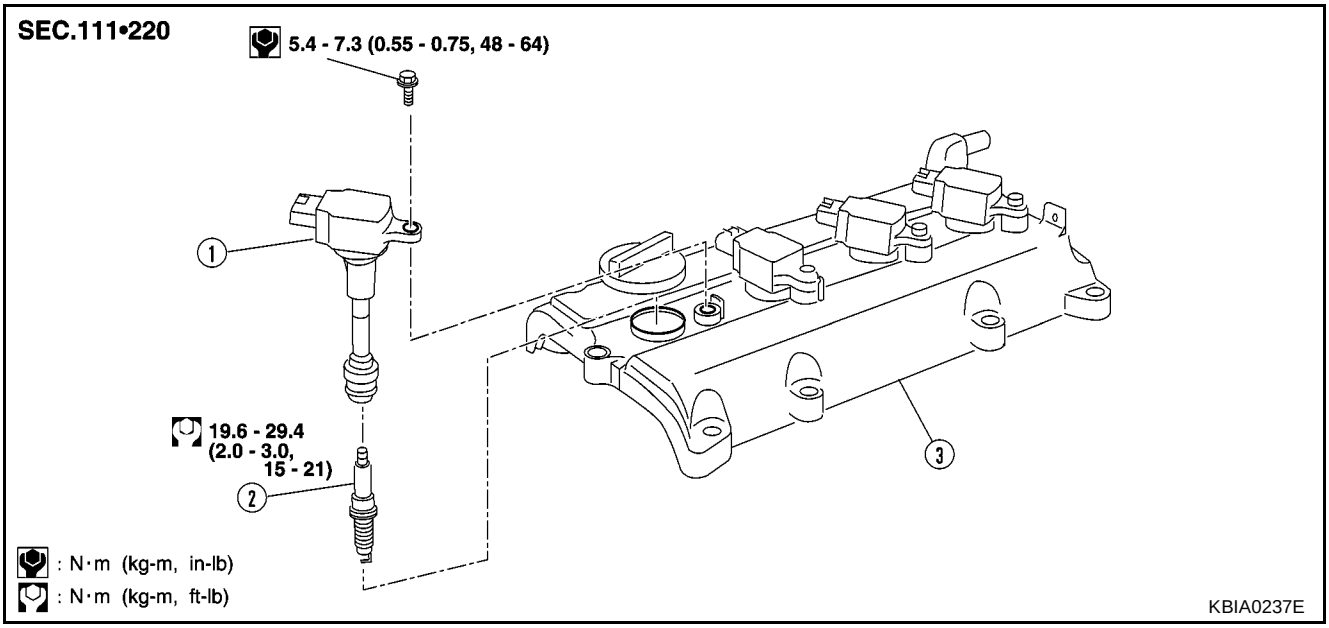
Install in the reverse order of removal.

SPARK PLUG

PFP:22401

Removal and Installation

EBS00DI2

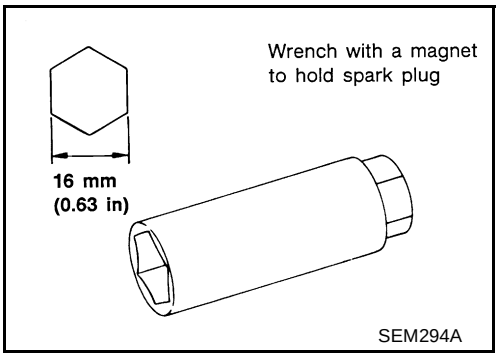


1 Ignition coil 2 Spark plug 3 Rocker cover

REMOVAL

1. Remove ignition coil. Refer to EM-27, "IGNITION COIL" .
2. Remove spark plug with suitable spark plug wrench.

Make	NGK	
Model type	With catalyst	Without catalyst
Standard type	LFR5A-11	LFR5A
Hot type	LFR4A-11	LFR4A
Cold type	LFR6A-11	LFR6A



INSPECTION AFTER REMOVAL

- **Use standard type spark plug for normal condition.**
- The hot type spark plug is suitable when fouling occurs with the standard type spark plug under conditions such as.
  - frequent engine starts.
  - low ambient temperatures.
- The cold type spark plug is suitable when spark plug knock occurs with the standard type spark plug under conditions such as.
  - extended highway driving.
  - frequent high engine revolution.

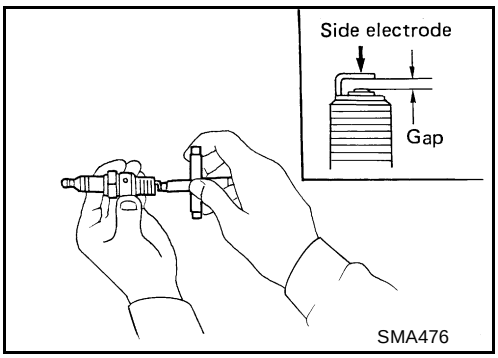
Check plug gap of each spark plug. Adjust or replace if necessary.

Spark plug gap:

With catalyst model: 1.0 - 1.1 mm (0.039 - 0.043 in)

Without catalyst model: 0.8 - 0.9 mm (0.031 - 0.035 in)

- **Use a wire brush for cleaning, if necessary.**



INSTALLATION

Install in the reverse order of removal.

Spark plug:

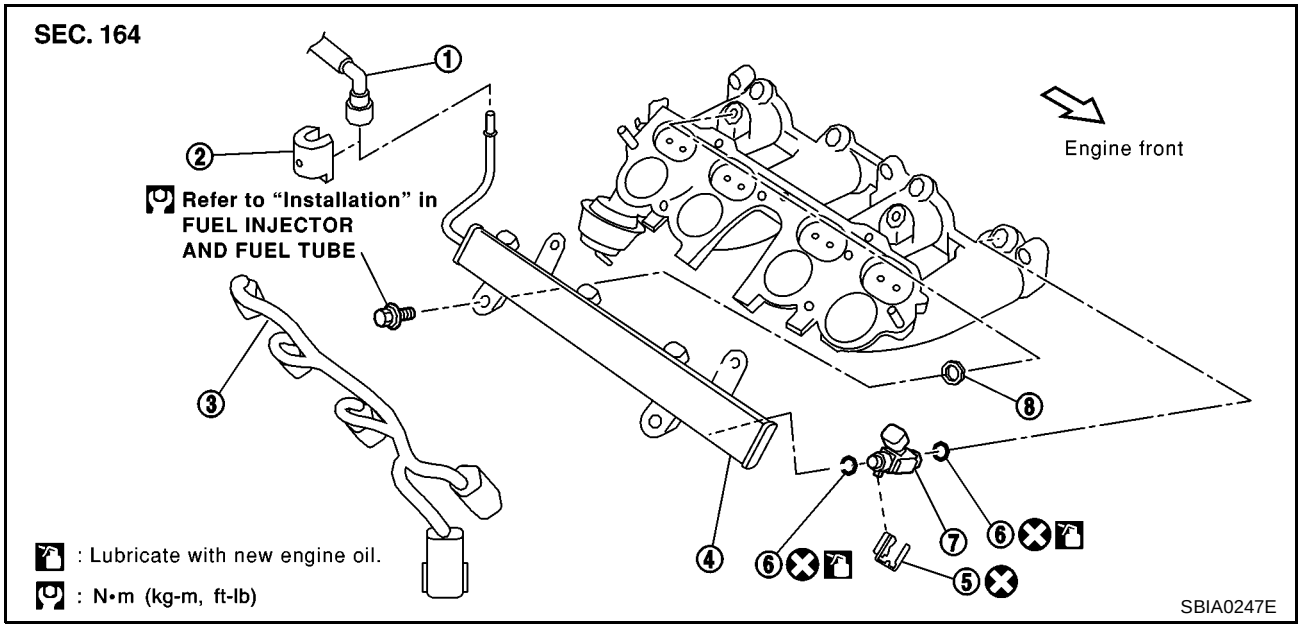
: 19.6 - 29.4 N·m (2.0 - 3.0 kg-m, 15 - 21 ft-lb)

FUEL INJECTOR AND FUEL TUBE

PFP:16600

Removal and Installation

EBS00DHN



1	Fuel hose	2	Quick connector cap	3	Sub harness
4	Fuel tube	5	Clip	6	O-ring
7	Fuel injector	8	Insulator		

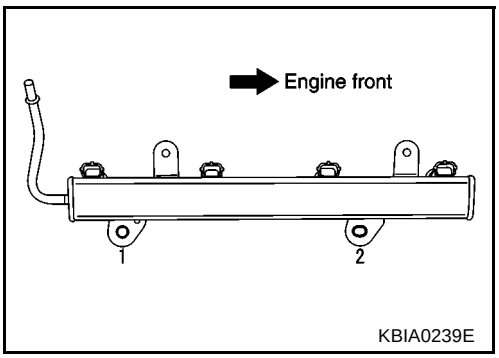
CAUTION:

- **Apply new engine oil when installing the parts that specified to do so in the figure.**
- **Do not remove or disassembly parts unless instructed as shown in the figure.**

REMOVAL

1. Release fuel pressure. refer to EC-31, "FUEL PRESSURE RELEASE"
2. Remove air duct, air cleaner case (upper) assembly.
3. Disconnect fuel hose quick connector at fuel tube side.
   - Regarding how to disconnect and connect quick connector, Refer to EM-17, "INTAKE MANIFOLD" .

   CAUTION:
   - **Prepare a container of cloth for spilled fuel.**
   - **This operation should be performed in a place where free from fire.**
   - **While hoses are disconnected seal their openings with vinyl bag or similar material to prevent foreign material from entering them.**
4. Disconnect intake manifold collector. Refer to EM-17, "INTAKE MANIFOLD" .
5. Disconnect sub-harness for injector at engine front side, and remove it from bracket.
6. Loosen mounting bolts in the reverse order in the figure, and remove fuel tube and fuel injector assembly.
7. Remove fuel injector.
   - Release clip and remove it.
   - Pull fuel injector straight out of fuel tube.
   - Be careful not to damage nozzle part.
   - Avoid any impact such as a dropping.
   - Do not disassemble or adjust it.



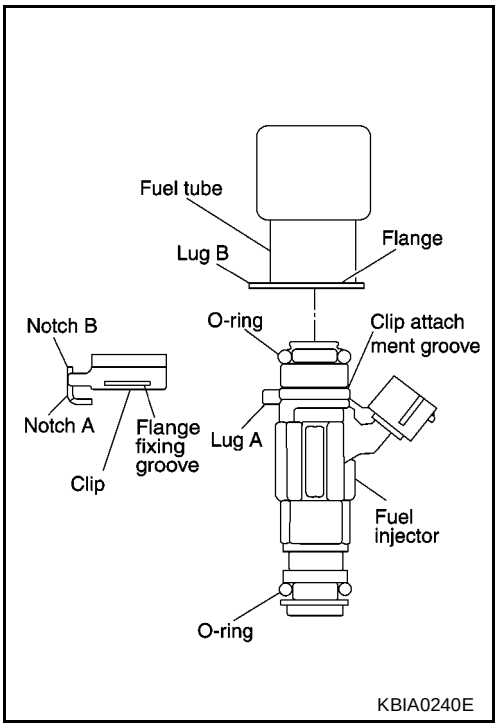
INSTALLATION

1. Install O-rings to fuel injector paying attention to the items below.

- **Lubricate O-rings by smearing new engine oil.**
- **Be careful not to scratch it with a tool or fingernails during installation. Also be careful not to twist or stretch O-ring. If O-ring was stretched while it is attached, do no insert it into fuel tube immediately.**

2. Install fuel injector to fuel tube with the following procedure.
   - Insert clip into clip mounting groove on fuel injector.
   - Insert clip so that projection A of fuel injector matches notch A of the clip.
   - Do not reuse clip. Replace it with a new one.
   - Be careful to keep clip from interfering with O-ring. If interference occurs, replace O-ring.
3. Insert fuel injector into fuel tube with clip attached.
   - Insert it while matching it to the axial center.
   - Insert fuel injector so that projection B of fuel injector matches notch B of the clip.
   - Make sure that fuel tube flange is securely fixed in flange fixing groove on clip.
   - Make sure that installation is complete by checking that fuel injector does not rotate or come off.
4. Install fuel tube assembly with the following procedure.

a. Insert the tip of each fuel injector into intake manifold.



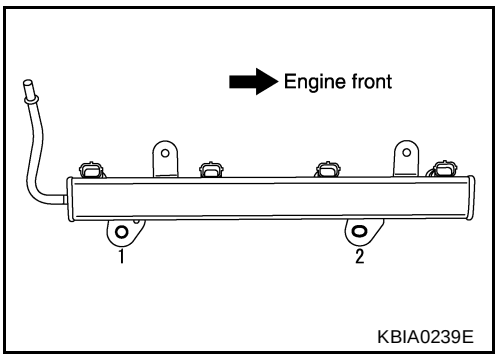
b. Tighten mounting bolts in two steps in the numerical order shown in the figure.

1st step:

: 9.3 - 10.8 N·m (0.95 - 1.1 kg-m, 0.7 - 0.8 ft-lb)

2nd step:

: 20.6 - 26.5 N·m (2.1 - 2.7 kg-m, 16 - 19 ft-lb)



5. Install intake manifold collector. Refer toEM-17, "INTAKE MANIFOLD" .
6. Connect fuel hose. Refer to EM-17, "INTAKE MANIFOLD" .
7. Install all removed parts in the reverse order of removal.

INSPECTION AFTER INSTALLATION

Check connections for fuel leakage.

1. Start the engine, and run it for a few minutes with engine at idle.
2. Stop the engine, and check for fuel leakage both visually and by odor of gasoline.

NOTE:
Use mirrors for checking on invisible points.

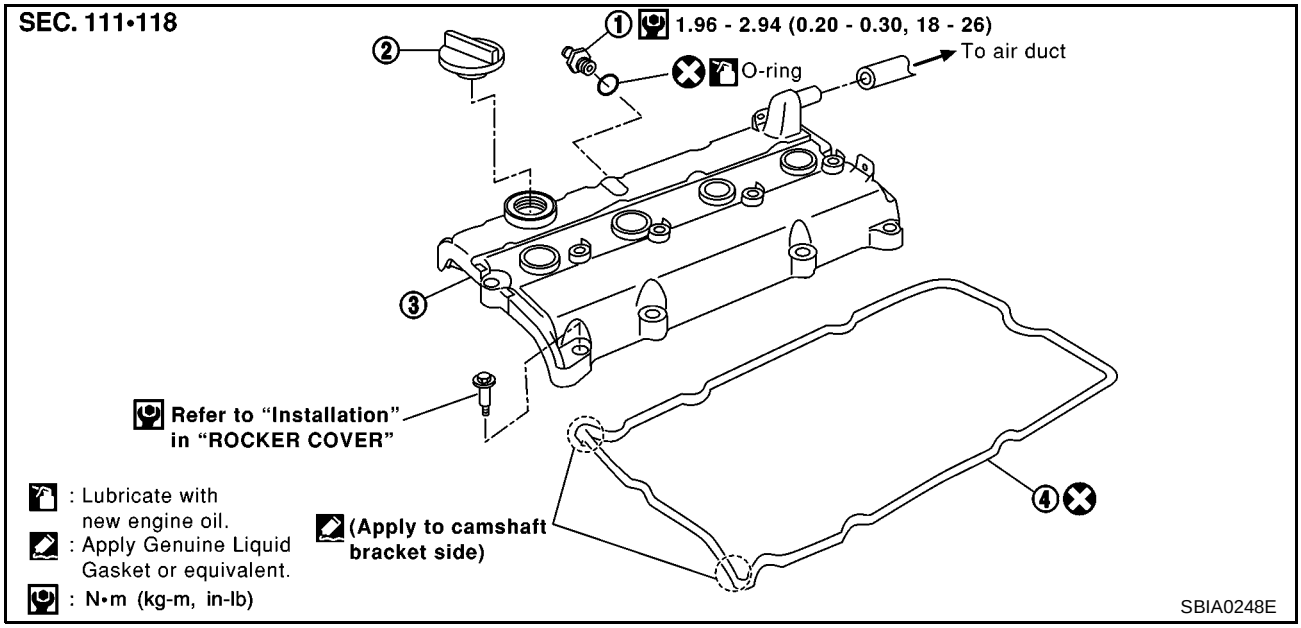
CAUTION:
Do not touch the engine immediately after stopped as engine becomes extremely hot.

ROCKER COVER

PFP:13264

Removal and Installation

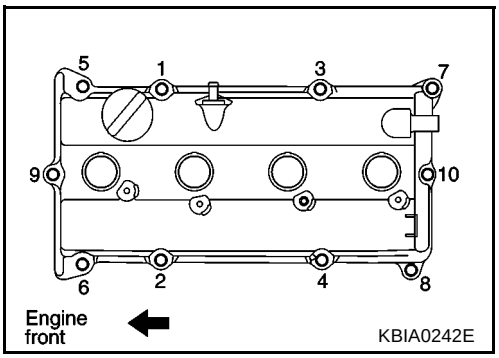
EBS00DHO



1 PCV valve 2 Oil filler cap 3 Rocker cover
4 Rocker cover gasket

REMOVAL

1. Remove PCV hose.
   - Remove ignition coil. Refer to EM-27, "IGNITION COIL" .
2. Loosen bolts in reverse order shown in the figure.



INSTALLATION

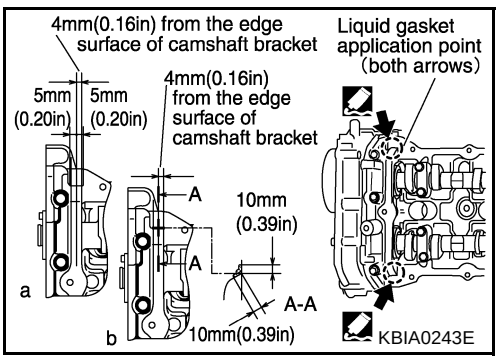
1. Apply liquid gasket to joint part of cylinder head and camshaft bracket following the below steps.

a. Refer to illustration "a" to apply liquid gasket to joint part of No.1 camshaft bracket and cylinder head.

b. Refer to illustration "b" to apply liquid gasket in 90° to illustration "a".

Use Genuine Liquid gasket or equivalent.

2. Install rocker cover.
   - Check if rocker cover gasket is dropped from installation groove of rocker cover.



3. Tighten bolts two steps separately in order numbers in illustration.

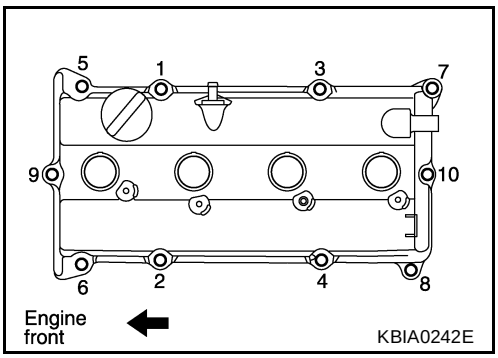
1st step:

: 0.98 - 2.9 N·m (0.1 - 0.3 kg-m, 9 - 25 in-lb)

2nd step:

: 7.4 - 9.3 N·m (0.75 - 0.95 kg-m, 66 - 82 in-lb)

4. Install in the reverse order of removal after this step.

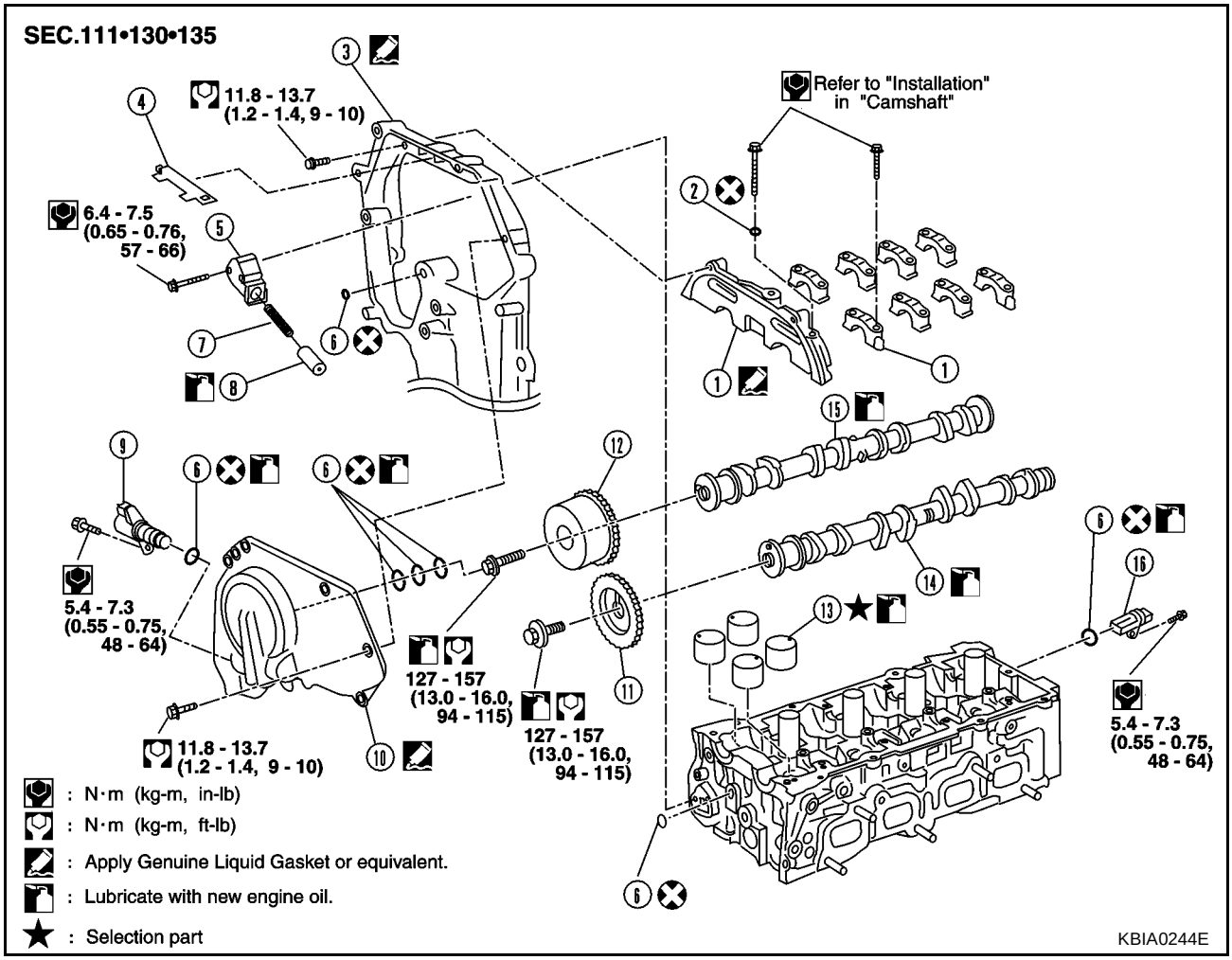


CAMSHAFT

PFP:13001

Removal and Installation

EBS00DHP



1	Camshaft bracket	2	Washer	3	Front cover
4	Chain guide	5	Chain tensioner	6	O-ring
7	Spring	8	Chain tensioner plunger	9	Intake valve timing control solenoid valve
10	Intake valve timing control cover	11	Camshaft sprocket (EXH)	12	Camshaft sprocket (INT)
13	Valve lifter	14	Camshaft (EXH)	15	Camshaft (INT)
16	Camshaft position sensor (PHASE)				

CAUTION:

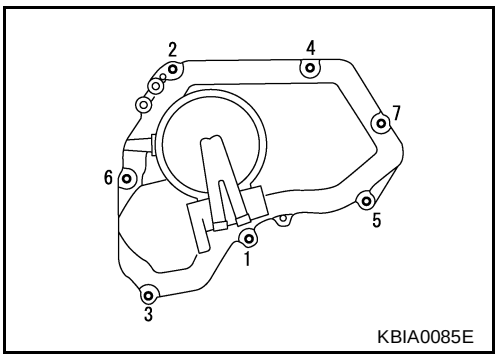
Apply new engine oil to parts marked in illustration before installation.

REMOVAL

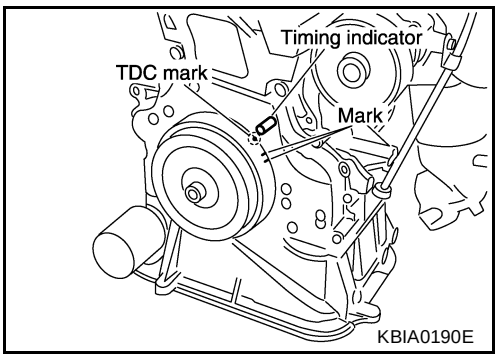
The following procedure describes removing and installing camshaft without removing front cover. If the front cover is removed or installed, removal of No.1 camshaft bracket is easier before step 8. Installation is easier after step 3. Regarding removal and installation of front cover, refer to EM-44, "TIMING CHAIN" .

1. Release fuel pressure. Refer to EC-31, "FUEL PRESSURE RELEASE" .
2. Remove parts listed below.
   - Ignition Coil; Refer to EM-27, "IGNITION COIL" .
   - Rocker cover; Refer to EM-32, "ROCKER COVER" .
3. Remove power steering reservoir tank.
4. Remove Intake valve timing control cover.

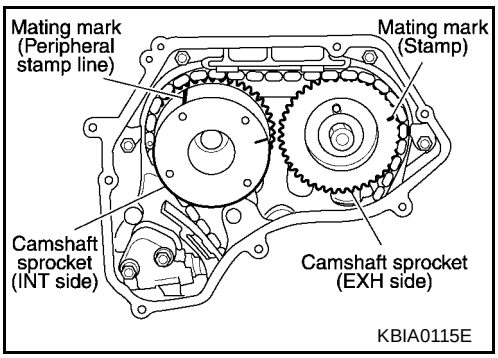
a. Loosen bolts in reverse order shown in the figure.
b. Remove the cover using Tool (Seal cutter).



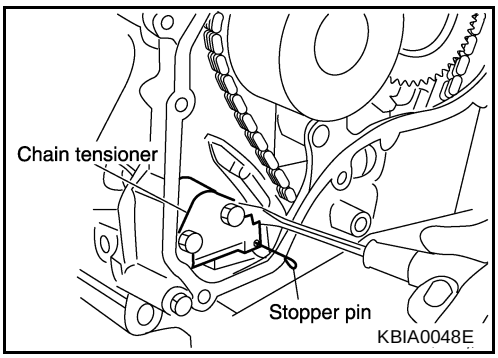
5. Set No.1cylinder at TDC on its compression stroke with the following procedure.
a. Open splash cover on RH under cover.
b. Rotate crankshaft pulley clockwise, and align mating marks for TDC with timing indicator on front cover.



c. At the same time, make sure that the mating marks on camshaft sprockets are located as shown in the figure.
   - If not, rotate crankshaft pulley one more turn to line up the mating marks to the positions in the figure.



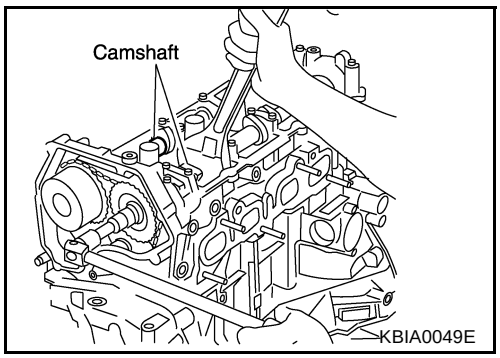
6. Pull chain guide between camshaft sprockets out through front cover.
7. Remove camshaft sprockets with the following procedure.
a. Line up the mating marks on camshaft sprockets, and paint an indelible mating mark on timing chain link plate.
b. Push in tensioner plunger. Insert a stopper pin into hole on tensioner body to fix chain tensioner and remove it.
   - Use wire of 0.5mm (0.02in) in diameter as a stopper pin.



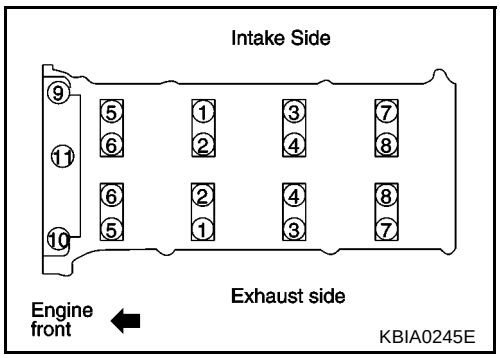
c. Secure hexagonal part of camshaft with a tool such as a spanner. Loosen camshaft sprocket mounting bolts and remove the camshaft sprockets.

CAUTION:
Do not rotate crankshaft or camshaft while timing chain is removed. It causes interference between valve and piston.

NOTE:
Chain tension holding work is not necessary. Crank sprocket and timing chain do not disconnect structurally while front cover is attached.



8. Loosen mounting bolts in the reverse order shown in the figure, and remove camshaft brackets and camshafts.
   - Remove No.1 camshaft bracket by slightly tapping it with a soft tool such as a plastic hammer.
9. Remove valve lifter.
   - Check mounting positions, and store them without mixing them up.

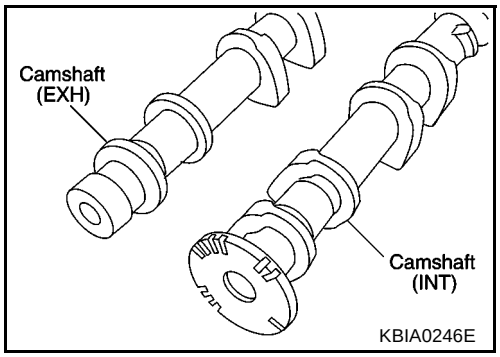


INSTALLATION

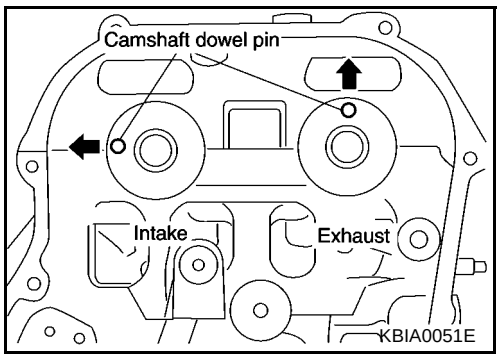
1. Install valve lifter.
   - Install them in the same positions they were in prior to removal.
2. Install camshaft.
   - Distinction between intake and exhaust camshafts is performed with a difference of shapes of rear end.

     Intake : Signal plate shape for camshaft position (PHASE) sensor.

     Exhaust : Cone end shape.

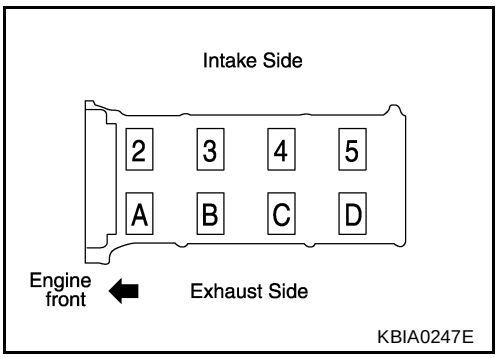


   - Install camshafts so that knock pins on the front side are positioned as shown in the figure.



3. Install camshaft brackets.

- Install by referring to identification mark on upper surface mark.
- Install so that identification mark can be correctly read when viewed from the exhaust side.



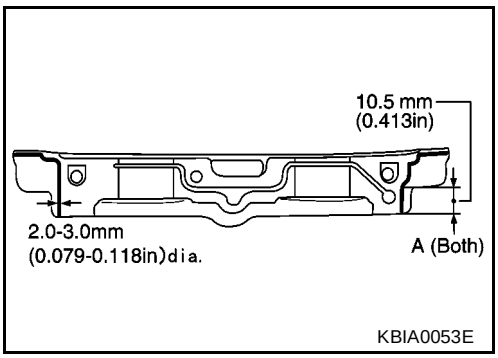
- Install No. 1 camshaft bracket as follow.

– Apply liquid gasket to No.1 camshaft bracket as in illustration.

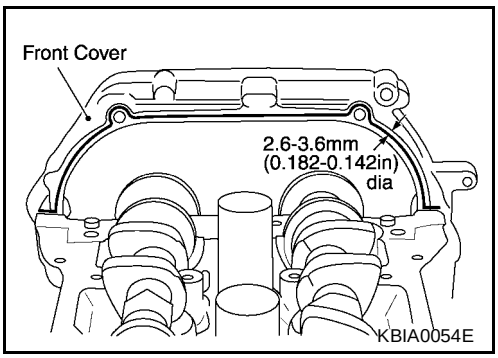
Use Genuine Liquid Gasket or equivalent.

CAUTION:

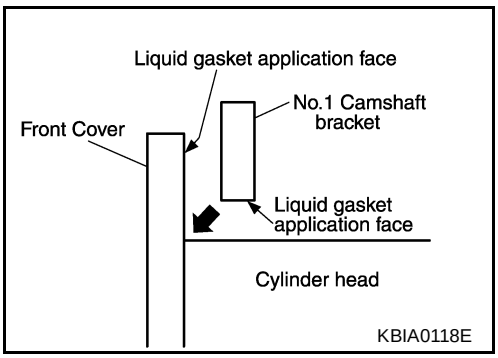
After installation, be sure to wipe off any excessive liquid gasket leaking from part "A" (both on right and left sides).



- Apply liquid gasket to camshaft bracket contact surface on the front cover backside.
- Apply liquid gasket to the outside of bolt hole on front cover.



- For No.1 camshaft bracket near mounting position, and install it without disturbing the liquid gasket applied to the surfaces.



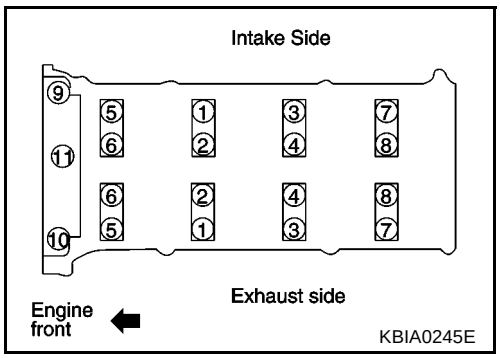
4. Tighten fixing bolts of camshaft brackets as follows.

a. Tighten in the order from 9 to 11 with tightening torque 2. 0 N·m (0.2 kg-m, 17 in-lb).

b. Tighten in the order from 1 to 8 with tightening torque 2.0 N·m (0.2 kg-m, 17 in-lb).

c. Tighten all bolts in the specified order with tightening torque 5.9 N·m (0.6 kg-m, 52 in-lb).

d. Tighten in the order from 1 to 11 with tightening torque 9.0 to 11.8 N·m (0.92 to 1.20 kg-m, 80 to 104 in-lb).

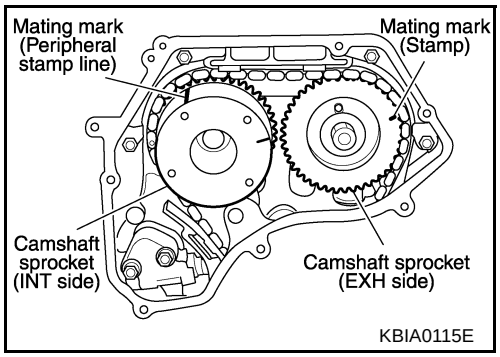


CAUTION:

After tightening fixing bolts of camshaft brackets, be sure to wipe off excessive liquid gasket from the parts listed below.

- Mating surface of rocker cover.
- Mating surface of front cover. (When installed without front cover)

5. Install camshaft sprockets.
   - Install them by lining up the mating marks on each camshaft sprocket with the ones painted on the timing chain during removal.
   - Before installation of chain tensioner, it is possible to re-match the marks on timing chain with the ones on each sprocket.



CAUTION:

- **Aligned mating marks could slip. Therefore, after matching them, hold the timing chain in place by hand.**
- **Before and after installing chain tensioner, check again to make sure that mating marks have not slipped.**

6. Install chain tensioner.

CAUTION:

After installation, pull the stopper pin off completely, and make sure that tensioner is released.

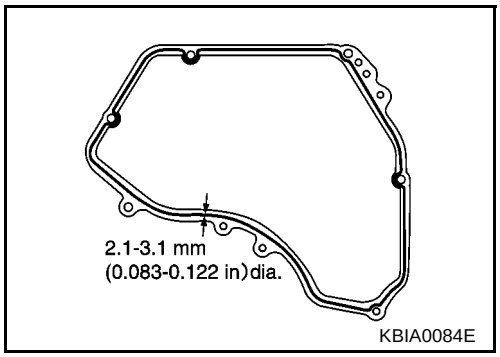
7. Install chain guide.

8. Install Intake valve timing control cover with the following procedure.

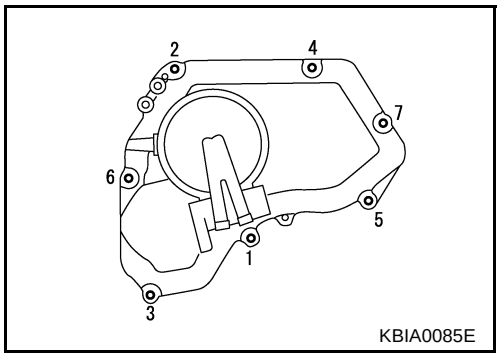
a. Install Intake valve timing control solenoid valve to intake valve timing control cover.

b. Install O-ring to front cover side.

c. Apply liquid gasket to the positions shown in the figure.
   - Use Genuine Liquid Gasket or equivalent.



d. Install Intake valve timing control cover.
   - Tighten bolts in numerical order shown in the figure.



9. Check and adjust valve clearances. Refer to EM-41, "Valve Clearance" .

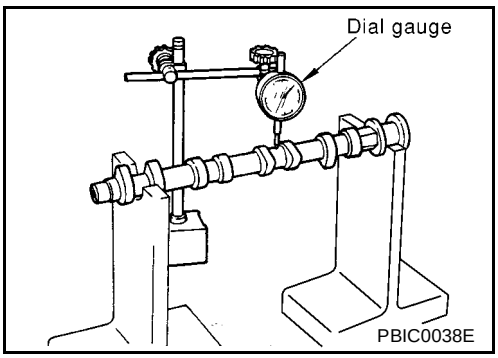
10. For the following operations, perform steps in the reverse order of removal.

INSPECTION AFTER REMOVAL

Camshaft Runout

- Put V block on, and support No.2 and No.5 journal of camshaft.
- Set dial gauge vertically to No.3 journal.
- Turn camshaft to one direction with hands, and measure camshaft runout on dial gauge. (Total indicator reading)

Standard: Less than 0.04 mm (0.0016 in).



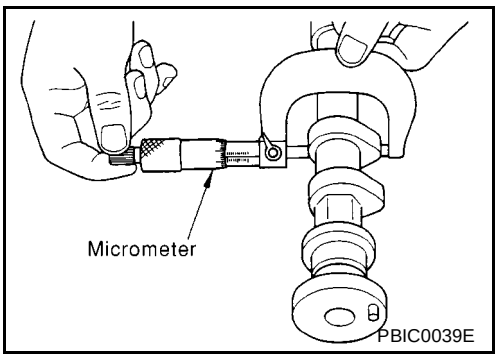
Camshaft Cam Height

1. Measure camshaft cam height.

Standard cam height:

Intake : 45.665 - 45.855 mm (1.7978 - 1.8053 in)
Exhaust : 43.975 - 44.165 mm (1.7313 - 1.7388 in)

2. If wear is beyond the limit, replace camshaft.



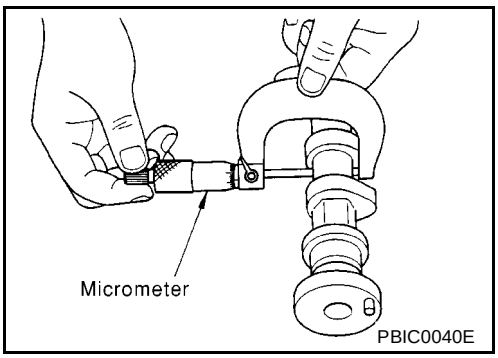
Camshaft Journal Clearance

Outer Diameter of Camshaft Journal

Measure outer diameter of camshaft journal.

Standard outer diameter:

No.1 : 27.935 - 27.955 mm (1.0998 - 1.1006 in)
No.2, 3, 4, 5 : 23.435 - 23.455 mm (0.9226 - 0.9234 in)

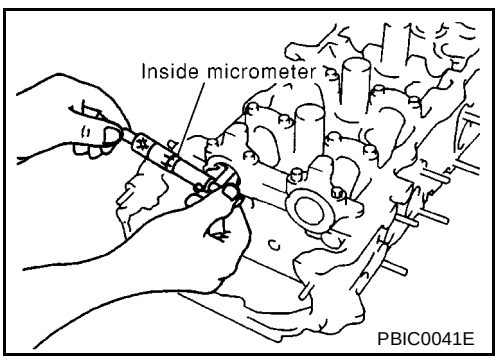


Inner Diameter of Camshaft Bracket

- Tighten camshaft bracket bolt with specified torque.
- Using inside micrometer, measure inner diameter of camshaft bracket.

Standard:

No.1 : 28.000 - 28.021 mm (1.1024 - 1.1032in)
No.2, 3, 4, 5 : 23.500 - 23.521 mm (0.9252 - 0.9260 in)



Calculation of Camshaft Journal Clearance

(Journal clearance) = (inner diameter of camshaft bracket) – (outer diameter of camshaft journal).

Standard: 0.045 - 0.086 mm (0.0018 - 0.0034 in)

- When out of the specified range above, replace either or both camshaft and cylinder head.

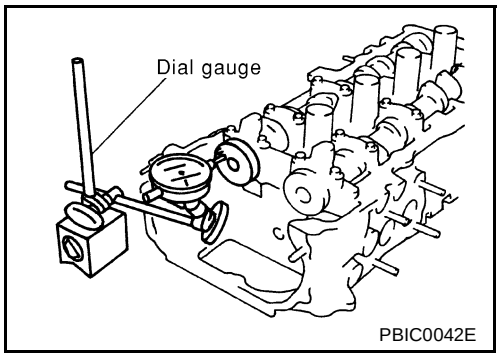
NOTICE:
Inner diameter of camshaft bracket is manufactured together with cylinder head. Replace the whole cylinder head assembly.

Camshaft End Play

- Install dial gauge in thrust direction on front end of camshaft. Measure end play of dial gauge when camshaft is moved forward/backward (in direction to axis).

Standard: 0.115 - 0.188 mm (0.0045 - 0.0074 in)

- When out of the specified range, replace with new camshaft and measure again.
- When out of the specified range again, replace with new cylinder head.

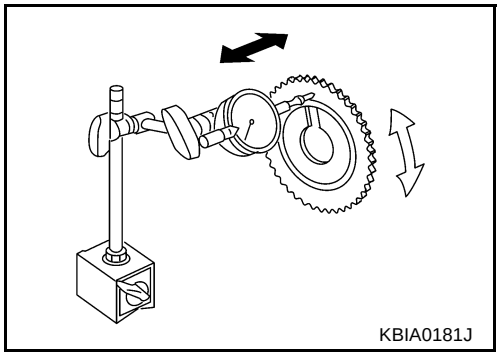


Camshaft Sprocket Runout

1. Install camshaft in cylinder head.
2. Install camshaft sprocket to camshaft.
3. Measure camshaft sprocket runout.

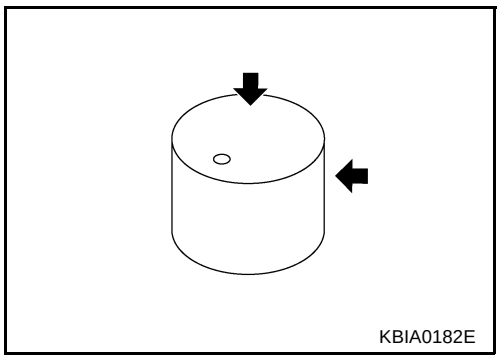
Runout: Less than 0.15 mm (0.0059 in)

4. If it exceeds the limit, replace camshaft sprocket.



Valve Lifter

Check if surface of valve lifter has any wear or cracks.



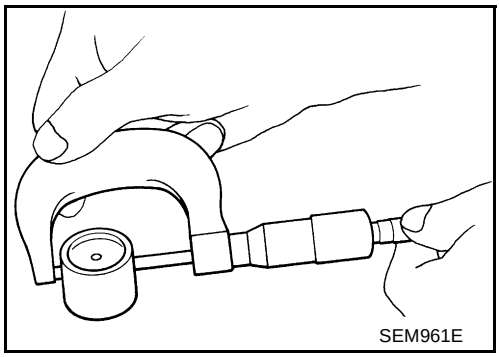
Valve Lifter Clearance

Outer Diameter of Valve Lifter

Measure outer diameter of valve lifter.

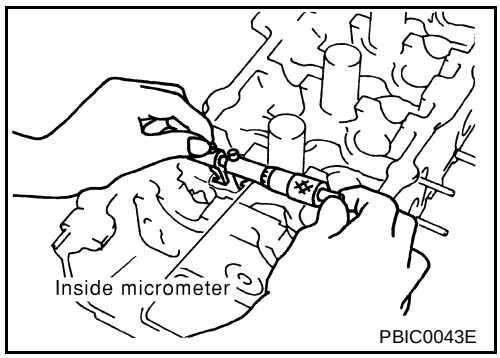
Valve lifter outer diameter:

33.965 - 33.980mm (1.3372 - 1.3378 in)



Valve Lifter Hole Diameter
Using inside micrometer, measure diameter of valve lifter hole of cylinder head.

Standard: 34.000 - 34.021 mm (1.3386 - 1.3394 in)



Calculation of Valve Lifter Clearance
(Valve lifter clearance) = (hole diameter of valve lifter) – (outer diameter of valve lifter).

Standard: 0.020 - 0.056 mm (0.0008 - 0.0022 in)

- When out of specified range, referring to each specification of outer and inner diameter, replace either or both valve lifter and cylinder head.

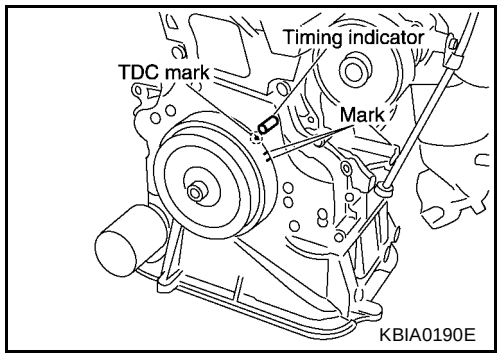
Valve Clearance

EBS00DHQ

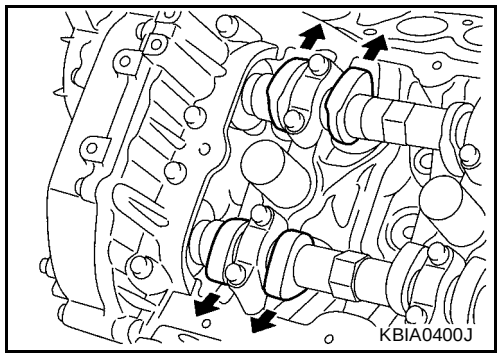
INSPECTION

Perform inspection as follows after removal, installation or replacement of camshaft or valve-related parts, or if there is unusual engine conditions due to changes in valve clearance over time (starting, idling, and/or noise).

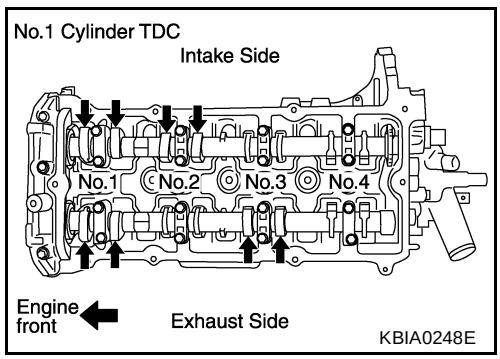
1. Warm up engine. Then stop it.
2. Remove front RH engine side cover.
3. Remove rocker cover. Refer to EM-32, "ROCKER COVER" .
4. Turn crankshaft pulley in normal direction (clockwise when viewed from front) to align TDC identification notch (without paint mark) with timing indicator.



5. At this time, check that the both intake and exhaust cam noses of No. 1 cylinder face outside.
   - If they do not face outside, turn crankshaft pulley once more.

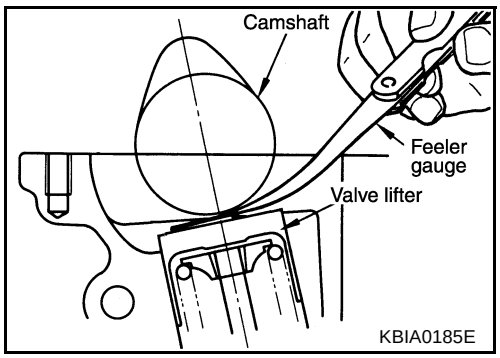


6. By referring to the figure, measure valve clearances at locations marked X as shown in the table below (locations indicated with black arrow in figure) with a feeler gauge.



- No.1 cylinder compression TDC.

Cylinder	No.1		No.2		No.3		No.4	
Valve	INT	EXH	INT	EXH	INT	EXH	INT	EXH
Measurable	×	×	×			x		



- Use a feeler gauge, measure clearance between valve and camshaft.

Valve clearance standard:

Hot	**Intake**	**: 0.32 - 0.40 mm (0.013 - 0.016 in)**
	Exhaust	**: 0.33 - 0.41 mm (0.013 - 0.016 in)**
Cold*	**Intake**	**: 0.24 - 0.32 mm (0.009 - 0.013 in)**
	Exhaust	**: 0.26 - 0.34 mm (0.010 - 0.013 in)**

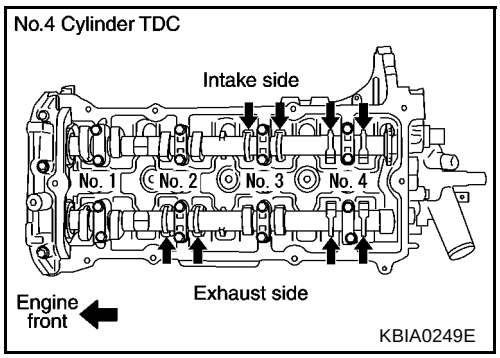
***: Reference data at approximately 20°C (68°F)**

CAUTION:

If inspection was carried out with cold engine, check that values with fully warmed up engine are still within specifications.

7. Turn crankshaft one revolution (360°) and align mark on crankshaft pulley with pointer.
8. By referring to the figure, measure valve clearances at locations marked X as shown in the table below (locations indicated with black arrow in figure).
   - No.4 cylinder compression TDC.

Cylinder	No.1		No.2		No.3		No.4	
Valve	INT	EXH	INT	EXH	INT	EXH	INT	EXH
Measurable				x	×		x	×

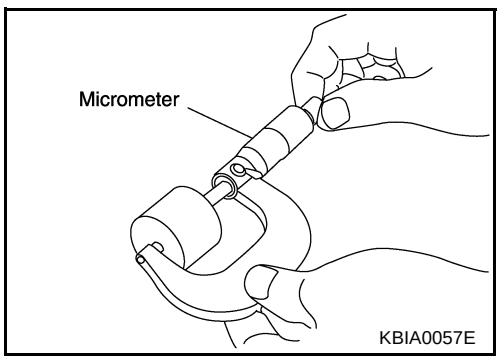


9. If out of specifications, adjust as follows.

ADJUSTMENT

- Perform adjustment depending on selected head thickness of valve lifter.
- The specified valve lifter thickness is the dimension at normal temperatures. Ignore dimensional differences caused by temperature. Use the specifications for hot engine condition to adjust.

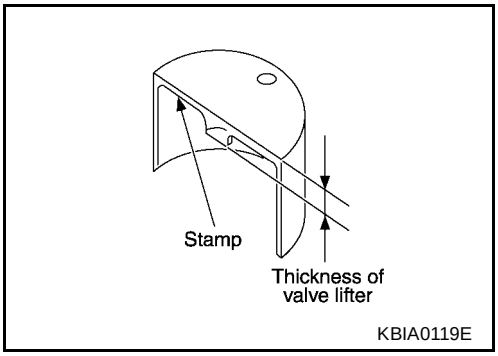
1. Remove camshaft. Refer to EM-34, "REMOVAL" .
2. Remove the valve lifters at the locations that are outside the standard.
3. Measure the center thickness of the removed valve lifters with a micrometer.



4. Use the equation below to calculate valve lifter thickness for replacement.
   - Valve lifter thickness calculation.
     t = t1 + (C1 – C2)
     t = Thickness of replacement valve lifter
     t1 = Thickness of removed valve lifter.
     C1 = Measured valve clearance.
     C2 = Standard valve clearance.

     Intake : 0.36 mm (0.0142 in)
     Exhaust : 0.37 mm (0.0146 in)

   - Thickness of a new valve lifter can be identified by stamp marks on the reverse side (inside the cylinder).
     Stamp mark 696 indicates 6.96mm (0.2740in) in thickness.



Available thickness of valve lifter: 26 sizes with range 6.96 to 7.46 mm (0.2740 to 0.2937 in) in steps of 0.02 mm (0.0008 in) (when manufactured at factory).

5. Install the selected valve lifter.
6. Install camshaft.
7. Manually turn crankshaft pulley a few turns.
8. Check that valve clearances for cold engine are within specifications by referring to the specified values.
9. After completing the repair, check valve clearances again with the specifications for warmed engine. Make sure the values are within specifications.

Valve clearance standard:

Hot	**Intake**	**: 0.32 - 0.40 mm (0.013 - 0.016 in)**
	Exhaust	**: 0.33 - 0.41 mm (0.013 - 0.016 in)**
Cold*	**Intake**	**: 0.24 - 0.32 mm (0.009 - 0.013 in)**
	Exhaust	**: 0.26 - 0.34 mm (0.010 - 0.013 in)**

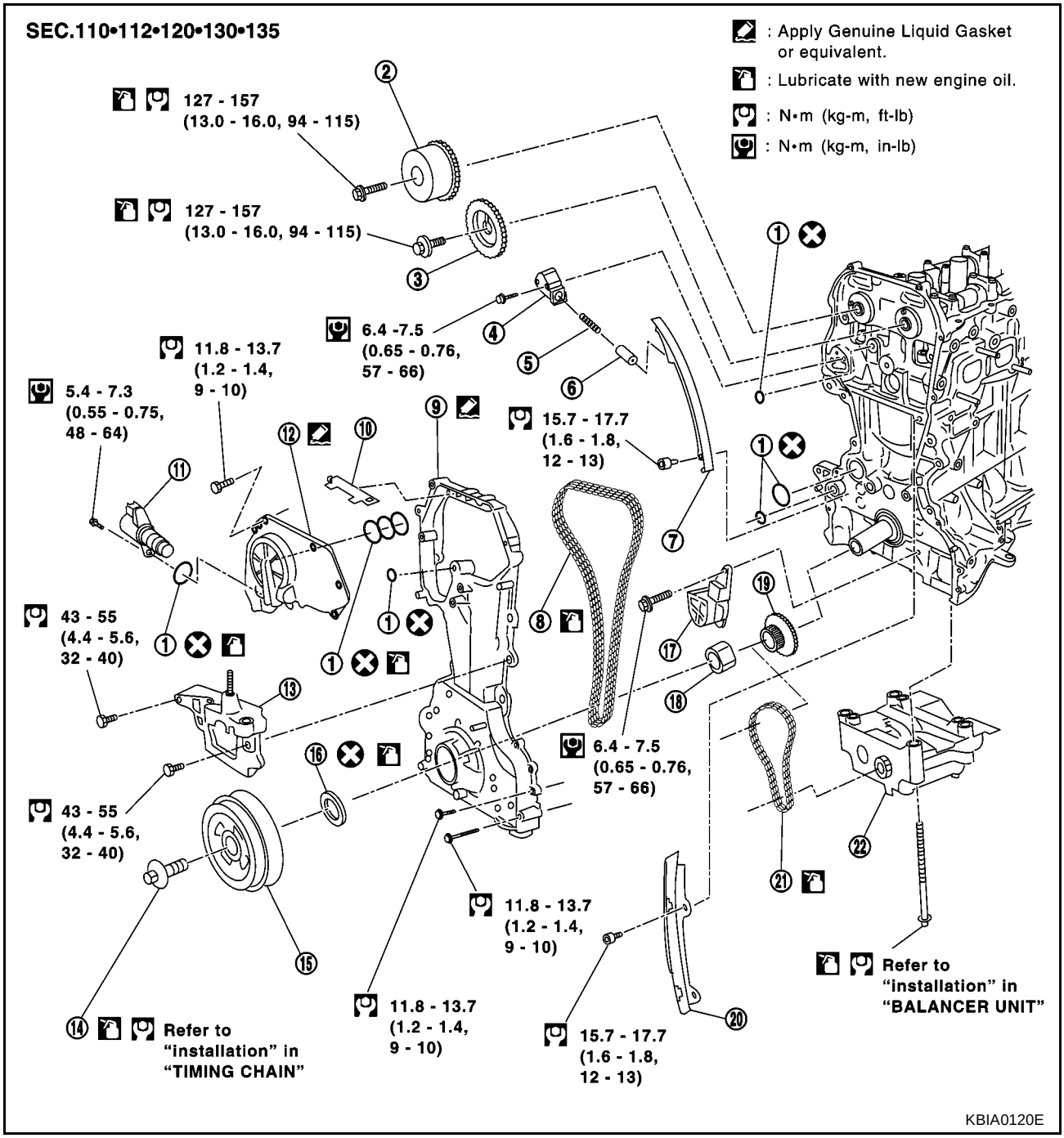
***: Reference data at approximately 20°C (68°F)**

TIMING CHAIN

PFP:13028

Removal and Installation

EBS00DHR



1	Oil rings	2	Camshaft sprocket (INT)	3	Camshaft sprocket (EXH)
4	Chain tensioner	5	Spring	6	Chain tensioner plunger
7	Timing chain slack guide	8	Timing chain	9	Front cover
10	Chain guide	11	Intake valve timing control solenoid valve	12	Intake valve timing control cover
13	Engine mounting bracket	14	Crankshaft pulley bolt	15	Crankshaft pulley
16	Front oil seal	17	Balancer unit timing chain tensioner	18	Oil pump drive spacer
19	Crankshaft sprocket	20	Timing chain tension guide	21	Balancer unit timing chain
22	Balancer unit				

CAUTION:
Apply new engine oil to parts marked in illustration before installation.

REMOVAL

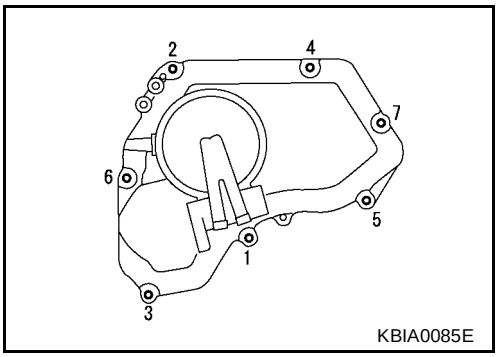
1. Remove the parts listed below.
   - Engine hood
   - Undercover
   - PCV hose
   - Ignition coil; Refer to EM-27, "IGNITION COIL" .
   - Rocker cover; Refer to EM-32, "ROCKER COVER" .
   - Engine coolant reservoir tank
   - Auxiliary drive belt; Refer to EM-13, "REMOVAL" .
   - Alternator
   - Auxiliary drive belt auto-tensioner; Refer to EM-14, "REMOVAL" .
   - Exhaust front tube; Refer to EX-2, "EXHAUST SYSTEM" .
2. Remove A/C compressor from engine. Temporarily secure A/C compressor to vehicle side with a rope to avoid putting a load on them.
3. Remove bracket mounting bolts for fixing A/C piping on right strut housing and exhaust manifold cover. Doing so simplifies moving.
4. Move power steering pump with piping connected, and secure it to vehicle side temporarily.
5. Pull power steering reservoir tank out of brackets to move power steering piping.

   CAUTION:
   To avoid power steering fluid leakage, temporarily fix reservoir tank vertically.
6. Suspend engine with a hoist, and support the engine posture.
   For installation of engine slingers, refer to EM-62, "ENGINE ASSEMBLY" .
7. Remove RH engine mount insulator.
8. Remove center member and rear engine mounting bracket.
9. Drain engine oil.
10. Remove oil pan upper and lower, and oil strainer. Refer to EM-24, "OIL PAN AND OIL STRAINER" .
11. Remove Intake valve timing control cover.

a. Loosen bolts in reverse order shown in the figure.

b. Remove the cover using Tool (Seal cutter).

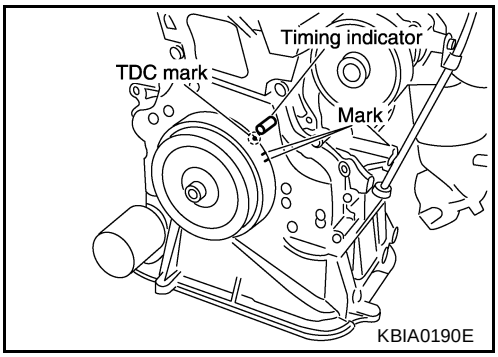
12. Pull chain guide between camshaft sprockets out through front cover.



KBIA0085E

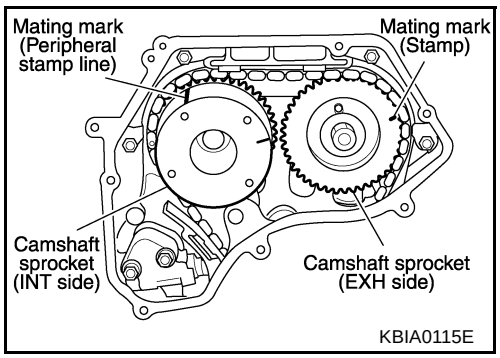
13. Set No.1 cylinder at TDC on its compression stroke with the following procedure.

a. Rotate crankshaft pulley clockwise and align mating marks to timid indicator on front cover.



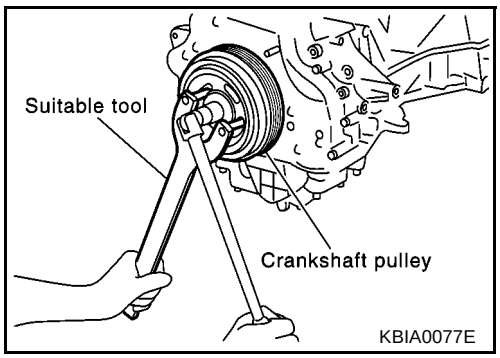
KBIA0190E

b. At the same time, make sure that the mating marks on camshaft sprockets are located as shown in the figure.
   - If not, rotate crankshaft pulley one more turn to line up mating marks to the positions in the figure.

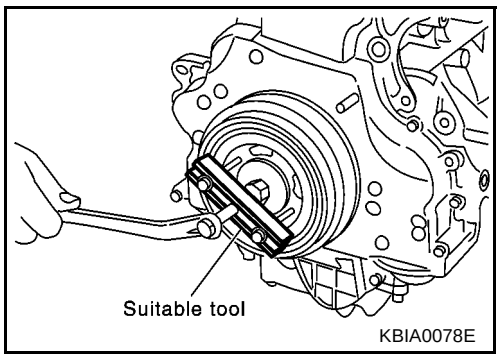


14. Remove crankshaft pulley with the following procedure.

a. Fix crankshaft pulley with a pulley holder, loosen crankshaft pulley mounting bolts, and pull the pulley out by 10mm (0.3937in).



b. Attach a pulley puller in the M 6 (0.24 in dia) thread hole on crankshaft pulley, and remove crankshaft pulley.



15. Remove front cover with following procedure.

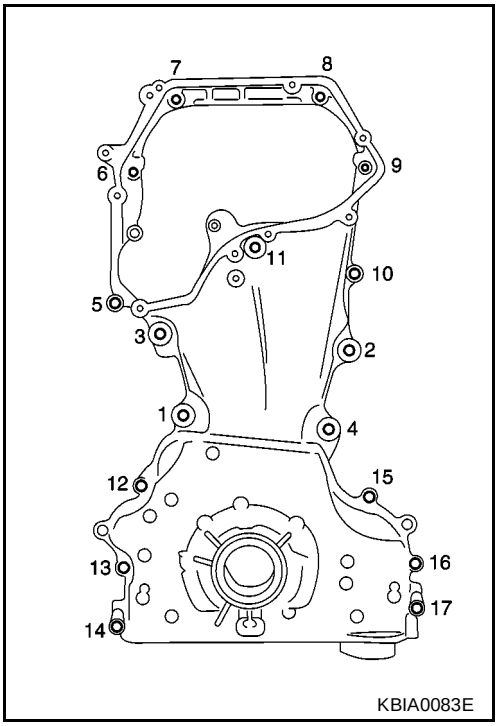
a. Loosen mounting bolts in the reverse order shown in the figure, and remove them.

b. Using a seal cutter, remove front cover.

CAUTION:

Be careful not to damage mounting surface.

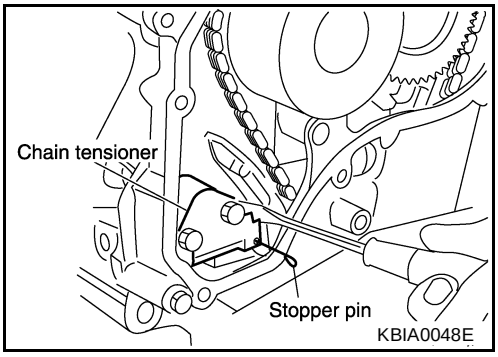
16. If front oil seal needs to be replaced, lift it with a screwdriver, and remove it.



17. Remove timing chain with the following procedure.

a. Push in tensioner plunger. reinsert a stopper pin into hole on tensioner body to fix chain tensioner and remove it.

- Use wire of 0.5mm (0.02in) in diameter as a stopper pin.

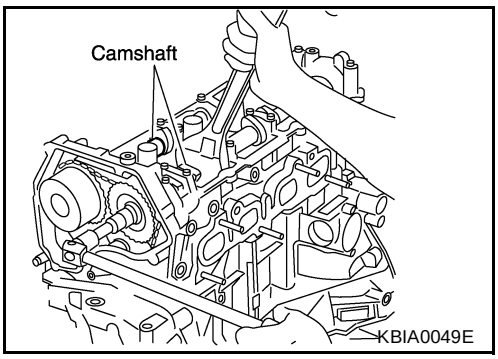


b. Secure hexagonal part of camshaft with a tool such as a spanner. Loosen camshaft sprocket mounting bolts and remove the camshaft sprockets.

CAUTION:

Do not rotate crankshaft or camshaft while timing chain is removed. It causes interference between valve and piston.

18. Remove chain slack guide, tension guide, timing chain and oil pump drive spacer.



19. Remove timing chain tensioner for balancer unit with the following procedure.

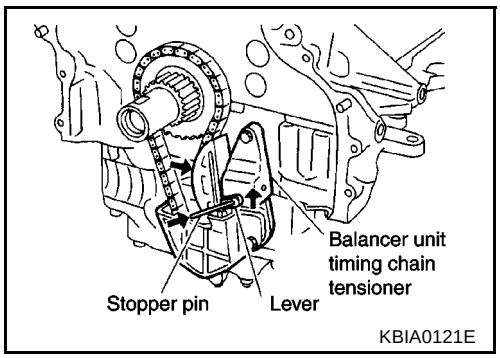
a. Lift tensioner lever up, and release ratchet claw for return proof.

b. Push tensioner sleeve in, and hold it.

c. Matching the hole on lever with the one on body, insert a stopper pin to secure tensioner sleeve.

d. Remove timing chain tensioner for balancer unit.

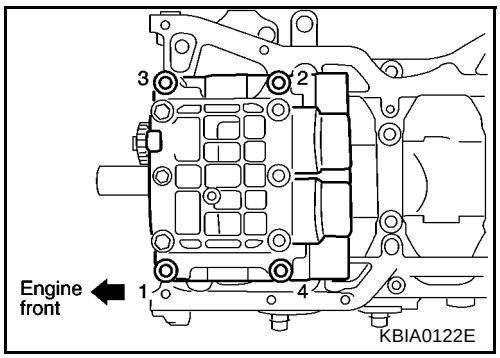
20. Remove timing chain for balancer unit and crankshaft sprockets.



21. Loosen mounting bolts in reverse order shown in the figure, and remove balancer unit.

- Use Torx socket (size E14)

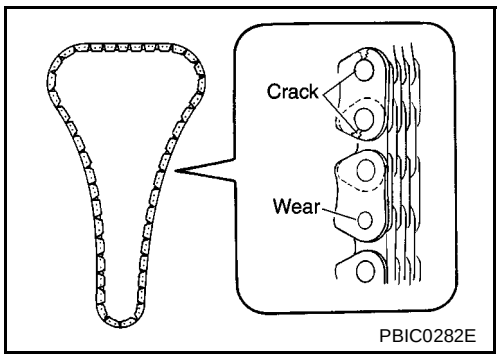
CAUTION:
Do not disassemble balancer unit.



INSPECTION AFTER REMOVAL

Timing Chain

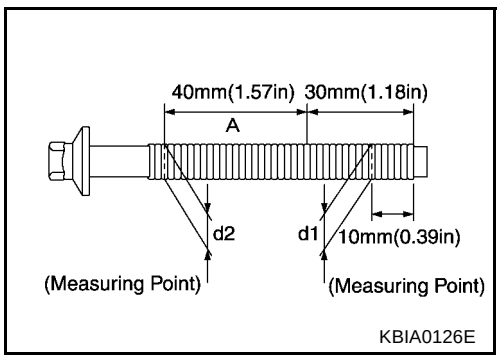
Check timing chain for cracks or serious wear. If a malfunction is detected, replace it.



Balancer Unit Mounting Bolt Outer Diameter.

- Measure outer diameters (d1, d2) at the two positions shown in the figure.
- Measure d2 within the range A.
- If the value difference (d1 – d2) exceeds the limit (a dimension difference is large), replace it with a new one.

Limit: 0.15 mm (0. 0059in) or more.

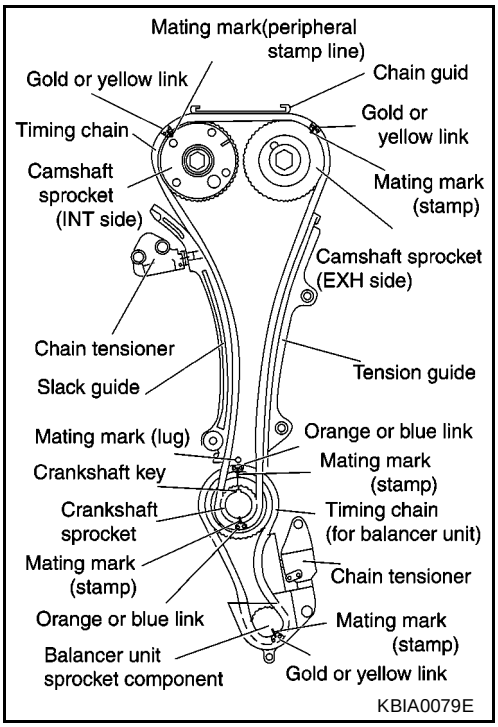


INSTALLATION

NOTE:

- The figure shows the relationship between the mating mark on each timing chain and that on the corresponding sprocket, with the components installed.
- Because of parallel manufacture, there are two types of mark (link colors) for timing chain.

1. Make suer that crankshaft key points straight up.

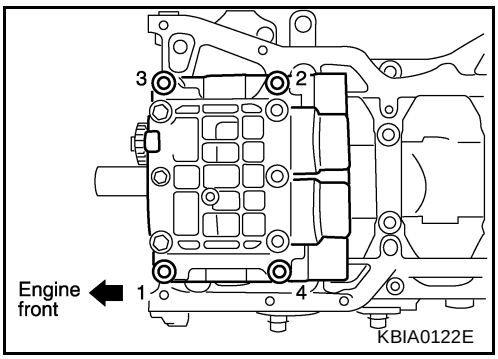


2. Tighten mounting bolt in the numerical order shown in the figure with the following procedure, and install balancer unit.

CAUTION:

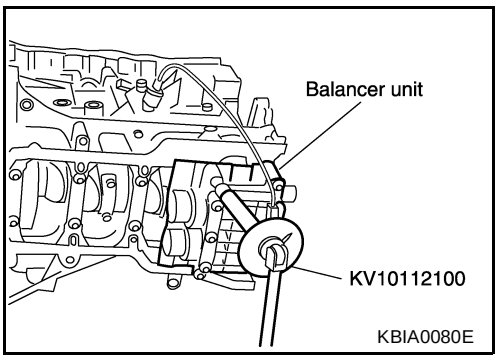
When reusing a mounting bolt, check its outer diameter before installation, Refer to EM-48, "INSPECTION AFTER REMOVAL" .

a. Apply new engine oil to threads and seat surfaces of mounting bolts.
b. Tighten them to 45.2 to 51.0 N·m (4.6 to 5.2 kg-m, 34 to 37 ft-lb).
c. Turn them another 90 to 95° (Target: 90°).
d. Fully loosen to 0 N·m (0 kg-m, 0 ft-lb).
   - Loosen in the reverse order of tightening.
e. Tighten them to 45.2 to 51.0 N·m (4.6 to 5.2 kg-m, 34 to 37 ft-lb).
f. Turn them another 90 to 95° (Target: 90°).

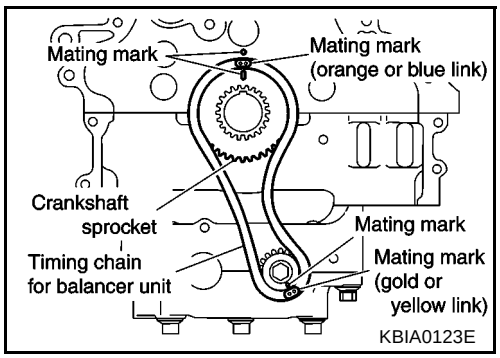


CAUTION:

Check tightening angle with an angle wrench or a protractor. Do not make judgment by visual check alone.

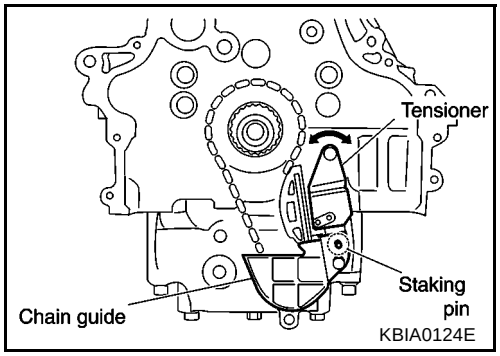


3. Install crankshaft sprocket and timing chain for balancer unit.
   - Make sure that crankshaft sprocket is positioned with mating marks on block and sprocket meeting at the top.
   - Install it by lining up mating marks on each sprocket and timing chain.



4. Install timing chain tensioner for balancer unit.

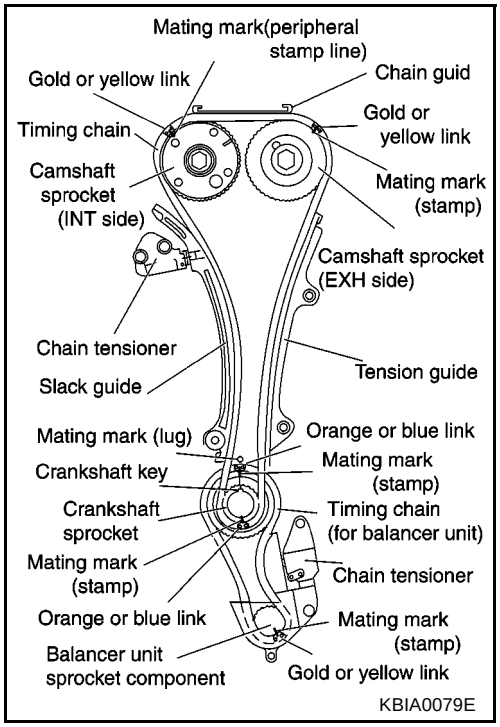
   NOTE:
   Chain guide and tensioner move freely with the caulking pin as the axle. Therefore, bolt hole position of the three points could be changed during removal. If points change, temporarily fix the two mounting bolts on the chain guide, and move the tensioner to mate the bolt holes.
   - Be careful not to let mating marks of each sprocket and timing chain slip.
   - After installation, make sure the mating marks have not slipped, then remove stopper pin and release tensioner.



5. Install timing chain and related parts.
   - Install by lining up mating marks on each sprocket and timing chain.

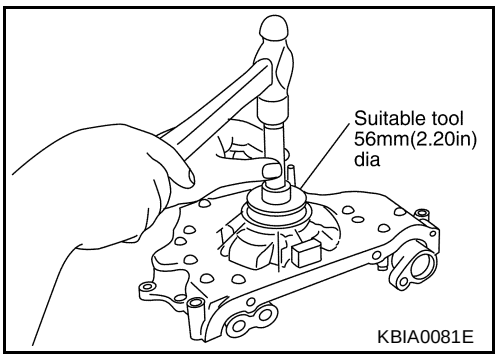
   NOTE:
   Before installing chain tensioner, it is possible to change the position of mating mark on timing chain for that on each sprocket for alignment.

   CAUTION:
   For the above reason, after the mating marks are aligned, keep them aligned by holding them with a hand.
   - Before and after installing chain tensioner, check again to make sure that mating marks have not slipped.
   - After installing chain tensioner, remove stopper pin, and make sure that tensioner moves freely.
   - To avoid skipped teeth, do not move crankshaft and camshaft until front cover is installed.



6. Install front oil seal to front cover.
   - Using a drift of 56 mm (2.20in) dia, press oil seal in until it is flush with front end surface of front cover.

   CAUTION:
   Be careful not to cause damage or burr to circumference of oil seal.



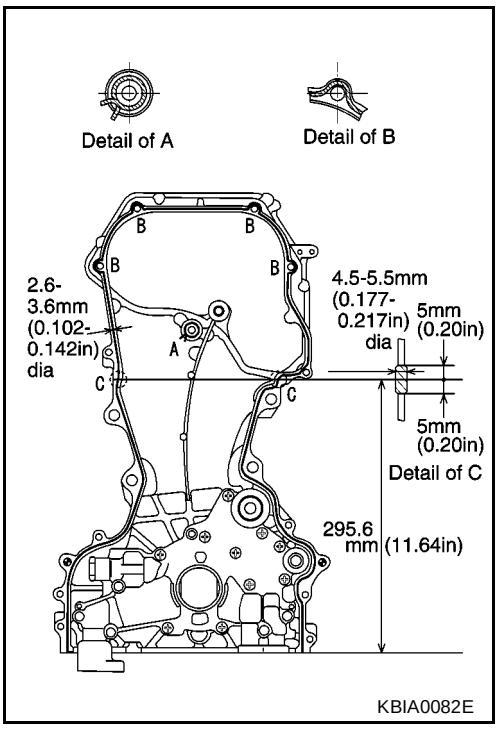
7. Install front cover with the following procedure.

a. Install O-rings to cylinder head and cylinder block.

b. Apply liquid gasket to positions specified in the figure.
   - Application instruction differs depending on the part.

c. Make sure that mating marks of timing chain and each sprocket are still aligned. Then install front cover.

   CAUTION:
   - **Do not let air conditioning and power steering piping interfere with upper part of front cover.**
   - **Be careful not to damage front oil seal by interference with front end of crankshaft.**

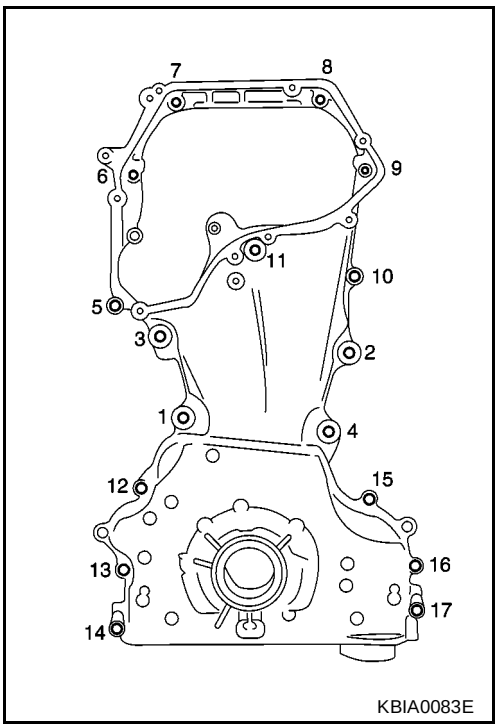


d. Tighten mounting bolts in the numerical order shown in the figure.

e. After all bolts are tightened, retighten them to specified torque.

   CAUTION:
   Be sure to wipe off any excessive liquid gasket leaking to surface for fitting oil pan.

8. Install chain guide between camshaft sprockets.



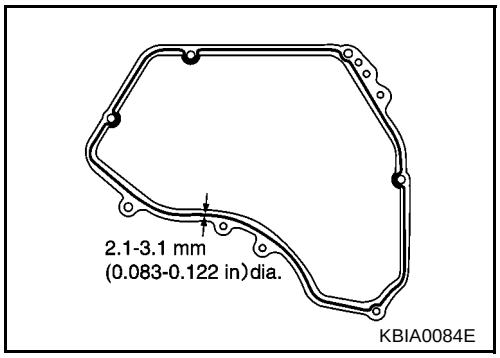
9. Install Intake valve timing control cover with the following procedure.

a. Install Intake valve timing control solenoid valves to Intake valve timing control cover.

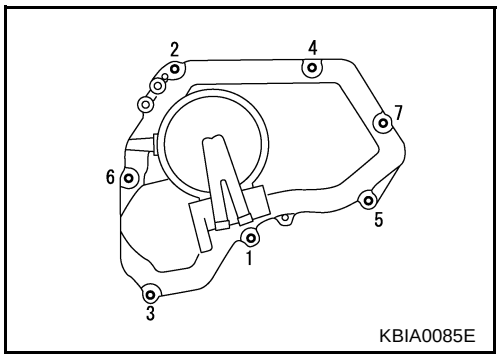
b. Install Oil rings to the intake camshaft sprocket insertion points on Intake valve timing control backside cover.

c. Install O-ring to front cover.

d. Apply liquid gasket to the positions in the figure.



e. Tighten mounting bolts in the numerical order shown in the figure.



10. Insert crankshaft pulley by aligning with crankshaft key.
    - Tap its center with a plastic hammer to insert.
    - Do not tap belt hook.
11. Tighten crankshaft pulley mounting bolts.
    - Secure crankshaft pulley with a pulley holder, and tighten the bolts.
    - Perform angle tightening with the following procedure.

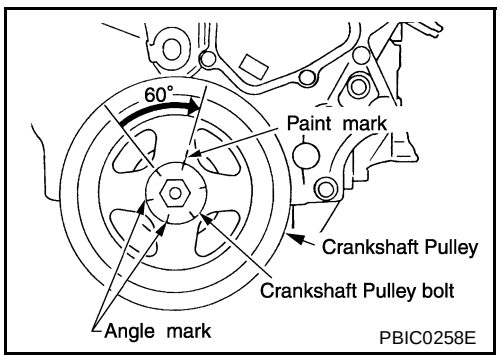
a. Apply new engine oil to threads and seat surfaces of mounting bolts.

b. Tighten to 37.3 to 47.1 N·m (3.8 to 4.8 kg-m, 28 to 34 ft-lb).

c. put a paint mark on front cover, mating with any one of six easy to recognize stamp marks on bolt flange.

d. Turn another 60° to 66° [Target: 60°].
    - Check vertical mounting angle with movement of one stamp mark.

12. Install remaining parts in reverse order of removal.



CYLINDER HEAD

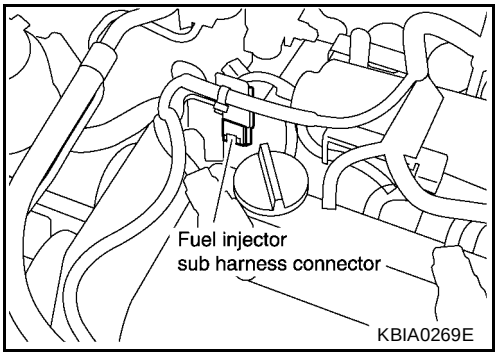
PFP:11041

On-Vehicle Service

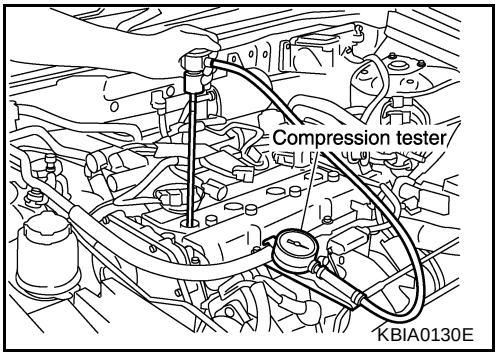
EBS00DHS

CHECKING COMPRESSION PRESSURE

1. Warm up engine thoroughly. Then, stop it.
2. Release fuel pressure. Refer to EC-31, "FUEL PRESSURE RELEASE" .
3. Remove ignition coil and spark plug from each cylinder. Refer to EM-27, "IGNITION COIL" and EM-28, "SPARK PLUG" .
4. Connect engine tachometer (not required in use of CONSULT-II).
5. Disconnect fuel injector sub-harness to avoid fuel injection during measurement.

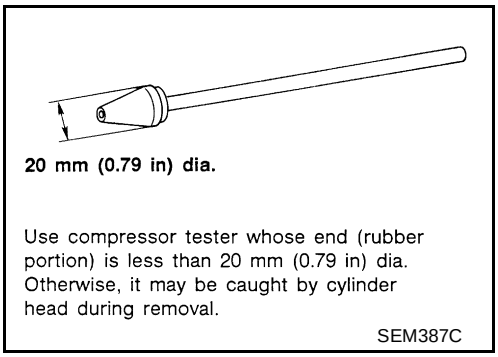


6. Install compression tester with adapter onto spark plug hole.



- Use compression gauge whose picking up end inserted to spark plug hole is smaller than 20 mm (0.79 in) in diameter. Otherwise, it may be caught by cylinder head during removal.

7. With accelerator pedal fully depressed, turn ignition switch to “START” for cranking. When the gauge pointer stabilizes, read the compression pressure and engine rpm. Perform these steps to check each cylinder.



Compression pressure

Unit: kPa (bar, kg/cm^2 , psi) /rpm

Standard	Minimum	Deference limit between cylinders
1,250 (12.5,12.8, 181.3) / 250	1,060 (10.6, 10.8, 153.7) / 250	0.1 (1.0, 1.0, 14) / 250

CAUTION:

Always use a fully changed battery to obtain specified engine speed.

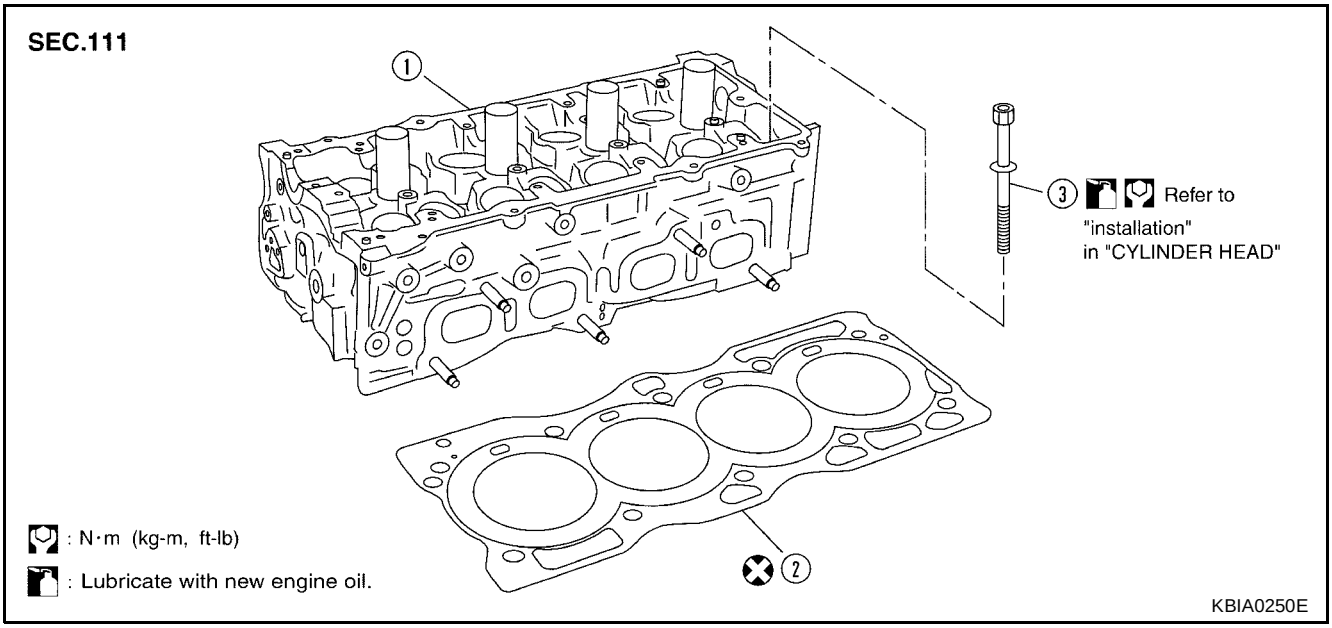
- If the engine speed is out of specified range, check battery liquid for proper gravity. Check engine speed again with normal battery gravity.
- If compression pressure is below minimum value, check valve clearances and parts associated with combustion chamber (Valve, valve seat, piston, piston ring, cylinder bore, cylinder head, cylinder head gasket). After the checking, measure compression pressure again.

- If some cylinders have low compression pressure, pour small amount of engine oil into the spark plug hole of the cylinder to re-check it for compression.
  - If the added engine oil improves the compression, the piston rings may be worn out or damaged. Check the piston rings and replace if necessary.
  - If the compression pressure remains at low level despite the addition of engine oil, the valves may be malfunctioning. Check the valves for damage. Replace the valve or valve seat accordingly.
- If two adjacent cylinders have respectively low compression pressure and their compression remains low even after the addition of engine oil, the gaskets are leaking. In such a case, replace the cylinder head gaskets.

8. Install spark plug, ignition coil and harness connectors.

Removal and Installation

EBS00DHT

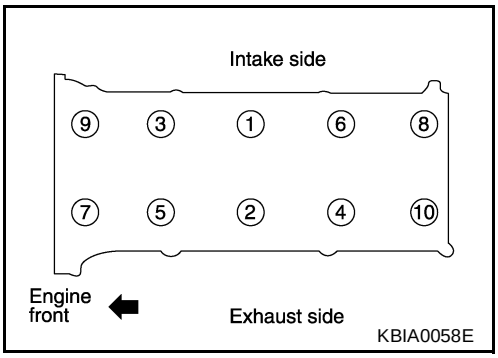


1 Cylinder head assembly 2 Cylinder head gasket 3 Cylinder head bolt

REMOVAL

1. Release fuel pressure. Refer to EC-31, "FUEL PRESSURE RELEASE" .
2. Drain engine coolant and engine oil.
3. Remove the following components and related parts.
   - Engine hood and engine under cover.
   - Air cleaner case and air duct assembly; Refer to EM-15, "AIR CLEANER AND AIR DUCT" .
   - Ignition coils; Refer to EM-27, "IGNITION COIL" .
   - Rocker cover; Refer to EM-32, "ROCKER COVER" .
   - Engine Coolant reservoir tank
   - Auxiliary drive belt; Refer to EM-13, "REMOVAL" .
   - Alternator
   - Auxiliary drive belt auto -tensioner; Refer to EM-14, "REMOVAL" .
   - Exhaust front tube; Refer to EX-2, "EXHAUST SYSTEM" .
   - Exhaust manifold; Refer to EM-22, "EXHAUST MANIFOLD AND THREE WAY CATALYST" .
   - Intake manifold collector, intake manifold and fuel tube assembly; Refer to EM-17, "INTAKE MANIFOLD" .
   - Water control valve and housing; Refer to CO-21, "THERMOSTAT AND WATER CONTROL VALVE" .
4. Remove front cover and timing chain. Refer to EM-44, "TIMING CHAIN" .
5. Remove camshaft. Refer to EM-34, "CAMSHAFT" .

6. Securely support bottom of cylinder block with a jack or equivalent tool, and remove the hoist that was supporting it.
7. Remove cylinder head loosening bolts in reverse order shown in the figure.



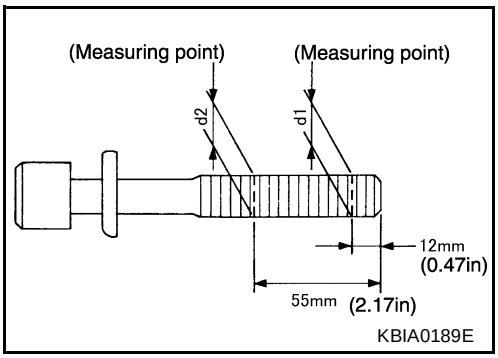
INSPECTION AFTER REMOVAL

Outer Diameter of Cylinder Head Bolts

- Cylinder head bolts are tightened by plastic zone tightening method. Whenever the size difference between d1 and d2 exceeds the limit, replace them with new one.

  Limit (d1 – d2): More than 0.23 mm (0.0091 in).

- If reduction of outer diameter appears in a position other than d2, use it as d2 point.

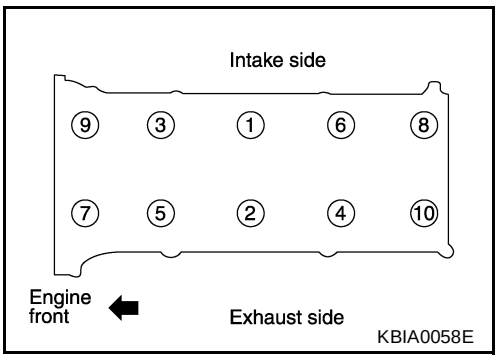


INSTALLATION

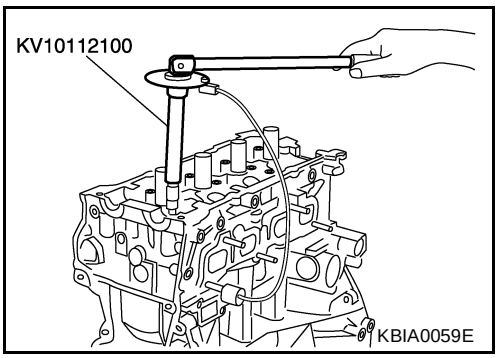
1. Install cylinder head gasket.
2. Follow the steps below to tighten fixing bolts in the order shown in figure to install cylinder head.

   CAUTION:
   - **If cylinder head bolts are re-used, check their outer diameters before installation. Refer to EM-55, "Outer Diameter of Cylinder Head Bolts" .**
   - **In step “c”, loosen bolts in the reverse order of that indicated in figure.**

a. Apply new engine oil to threads and seating surface of mounting bolts.
b. Tighten all bolts to 98.1 N·m (10 kg-m, 72 ft-lb).
c. Completely loosen to 0 N·m (0 kg-m, 0 ft-lb).
d. Tighten all bolts to 34.3 to 44.1 N·m (3.5 to 4.4 kg-m, 26 to 32 ft-lb).
e. Turn all bolts 75° to 80° (target: 75°) degrees clockwise.
f. Turn all bolts 75° to 80° (target: 75°) degrees clockwise again.



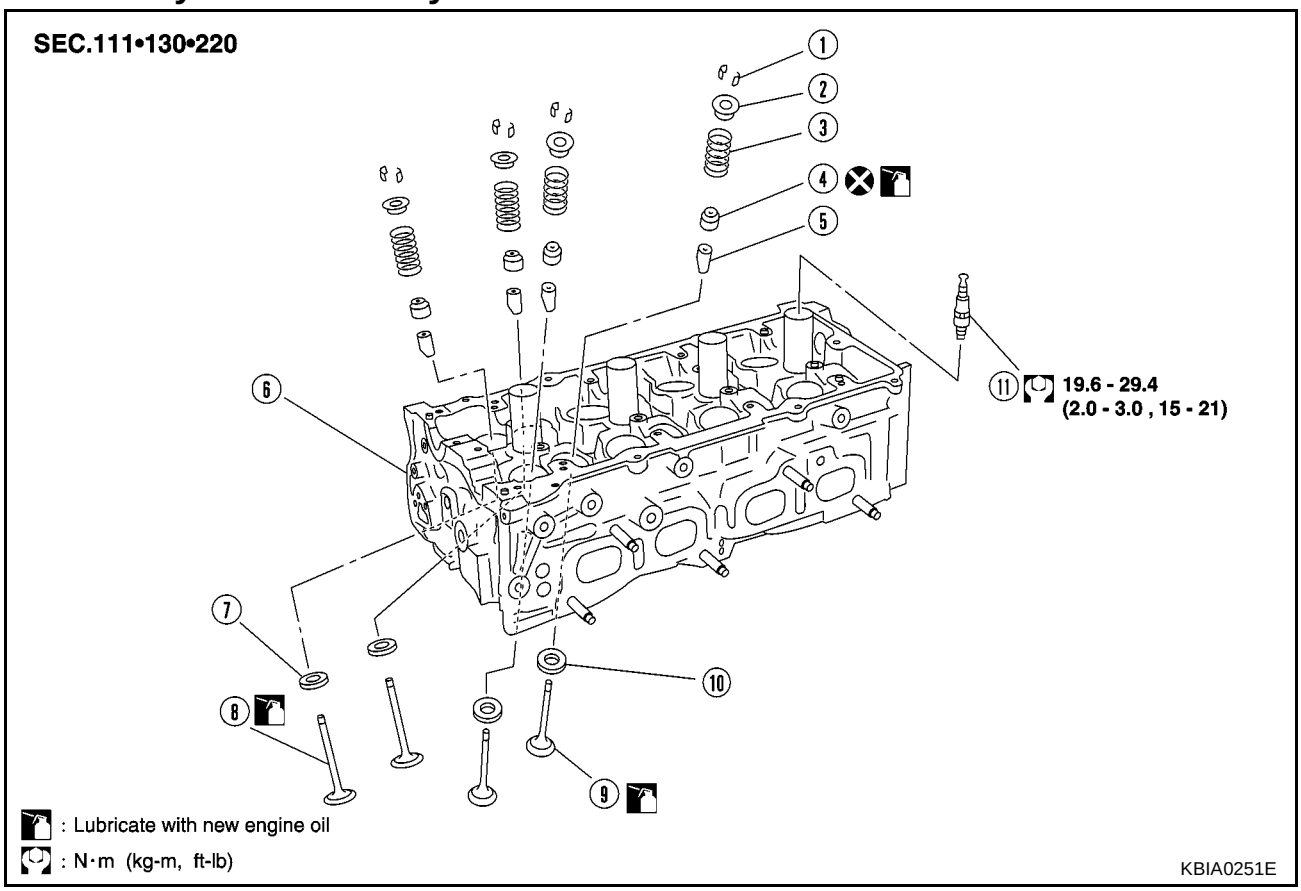
CAUTION:
Check and confirm the tightening angle by using angle wrench or protractor. Avoid judgment by visual inspection without the tool.



3. Install followings in reverse order of removal.

Disassembly and Assembly

EBS00DHU



1	Valve Collet	2	Valve spring retainer	3	Valve spring (with valve spring seat)
4	Valve oil seal	5	Valve guide	6	Cylinder head
7	Valve seat (INT)	8	Valve (INT)	9	Valve (EXH)
10	Valve seat (EXH)	11	Spark plug		

CAUTION:

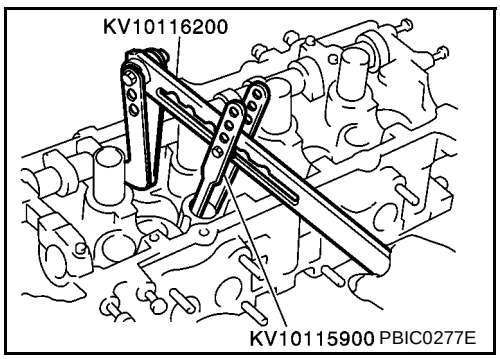
- **When installing camshafts, chain tensioners, oil seals or other sliding parts, lubricate contacting surface with new engine oil.**
- **Apply new engine oil to threads and seat surface when installing cylinder head, camshaft sprocket, crankshaft pulley and camshaft bracket.**
- **Attach tags to valve lifters so as not to mix them up.**

DISASSEMBLY

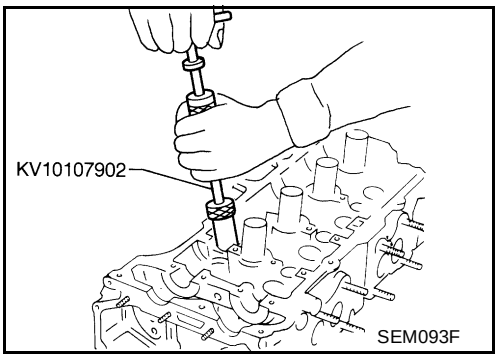
1. Remove valve lifter.
   - Confirm installation point.
2. Remove valve collet.
   - Compress valve spring with valve spring compressor. Remove valve collet with magnet driver.
3. Remove valve spring retainer and valve spring.

   CAUTION:

   Do not remove valve spring seat from valve spring.
4. Push valve stem to combustion chamber side, and remove valve.
   - Inspect valve guide clearance before removal. Refer to EM-58, "VALVE GUIDE CLEARANCE" .
   - Confirm installation point.

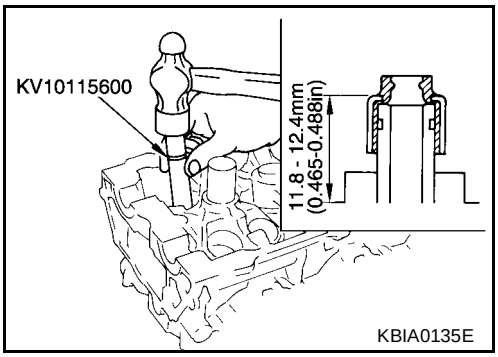


5. Remove valve oil seal with valve oil seal puller.
6. When valve seat must be replaced, refer to EM-59, "VALVE SEAT REPLACEMENT" to removal.
7. When valve guide must be replaced, refer to EM-58, "VALVE GUIDE REPLACEMENT" to removal.
8. Remove spark plug with spark plug wrench.



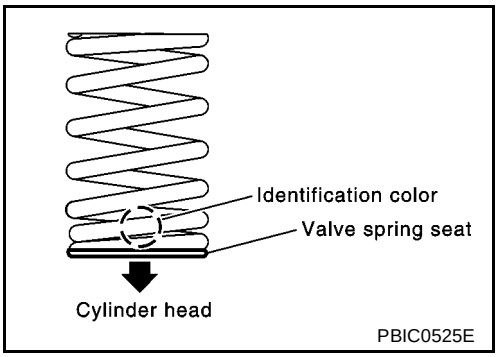
ASSEMBLY

1. Install valve guide. Refer to EM-58, "VALVE GUIDE REPLACEMENT" .
2. Install valve seat. Refer to EM-59, "VALVE SEAT REPLACEMENT" .
3. Install valve oil seal.
   - Install with valve oil seal drift to match dimension in illustration.
4. Install valve.
   - Install larger diameter to intake side.



5. Install valve spring.
   - Install smaller pitch (valve spring seat side) to cylinder head side.
   - Confirm identification color of valve spring.

   Intake : Blue
   Exhaust : Yellow
6. Install valve spring retainer.
7. Install valve collet.
   - Compress valve spring with valve spring compressor. Install valve collet with magnet hand.
   - Tap stem edge lightly with plastic hammer after installation to check its installed condition.
8. Install valve lifter.
9. Install spark plug with spark plug wrench.



Inspection After Disassembly

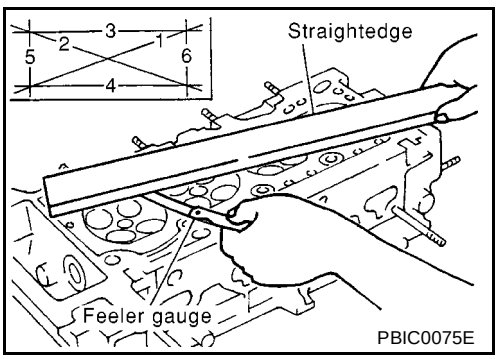
EBS00DHV

CYLINDER HEAD DISTORTION

1. Wipe off oil and remove water scale (like deposit), gasket, sealer, carbon, etc with scraper.

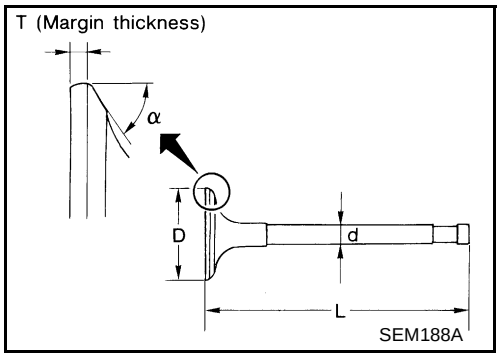
   CAUTION:
   Use utmost care not to allow gasket debris to enter passages for oil or water.
2. At each of several locations on bottom surface of cylinder head, measure distortion in six directions.

   Standard: 0.1mm (0.004 in)



VALVE DIMENSIONS

Check dimensions of each valve. For dimensions, refer to SDS, EM-95, "Valve Dimensions" .



VALVE GUIDE CLEARANCE

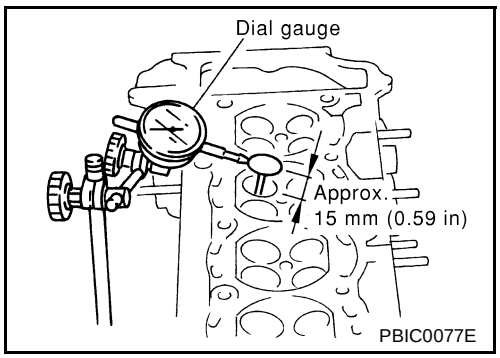
Perform this inspection before removing valve guide.

1. Make sure that the valve stem diameter is within the specification.
2. Push the valve out by approx. 15 mm (0.59 in) toward the combustion chamber side to measure the valve's run-out volume (in the direction of dial gauge) with dial gauge.
3. The half of the run-out volume accounts for the valve guide clearance.

Standard

Intake : 0.020 - 0.053 mm (0.0008 - 0.0021 in)

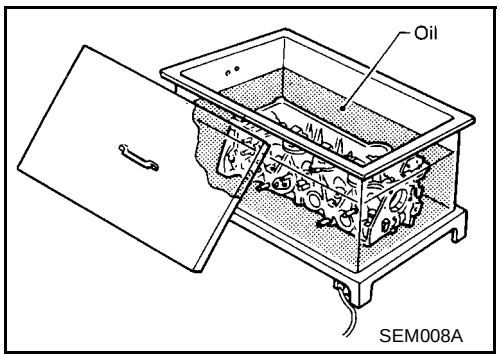
Exhaust : 0.030 - 0.063 mm (0.0012 - 0.0025 in)



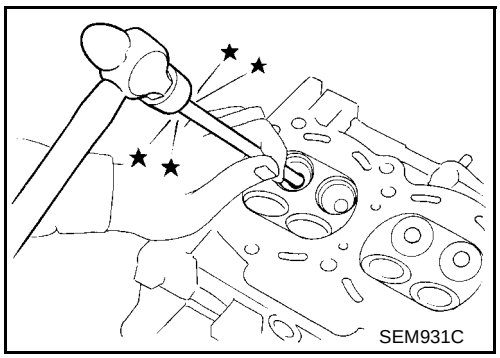
VALVE GUIDE REPLACEMENT

When valve guide is removed, replace with oversized (0.2 mm, 0.008 in) valve guide.

1. To remove valve guide, heat cylinder head to 110 to 130°C (230 to 266°F) by soaking in heated oil.



2. Drive out valve guide with a press [under a 20 kN (2 ton, 2.2 US ton, 2.0 lmp ton) pressure] or hammer and suitable tool.

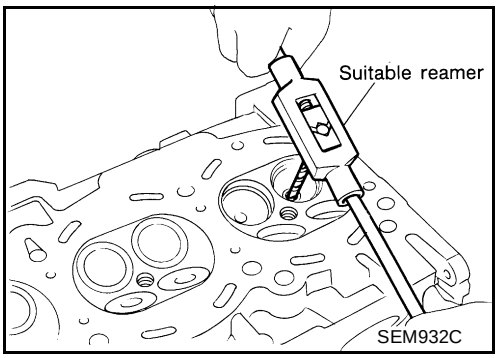


3. Ream cylinder head valve guide hole.

Valve guide hole diameter (for service parts)

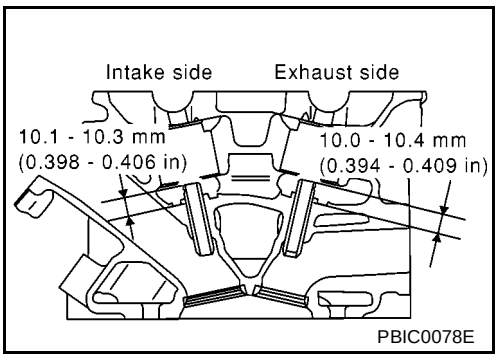
Intake and exhaust:

10.175 - 10.196 mm (0.4006 - 0.4014 in)



4. Heat cylinder head to 110 to 130°C (230 to 266°F) by soaking in heated oil.

5. Press valve guide from camshaft side to dimensions as in illustration.

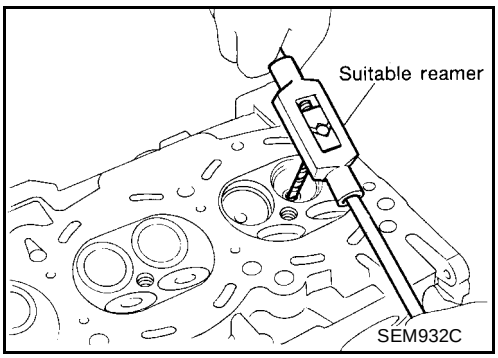


6. Using valve guide reamer, apply reamer finish to valve guide.

Standard

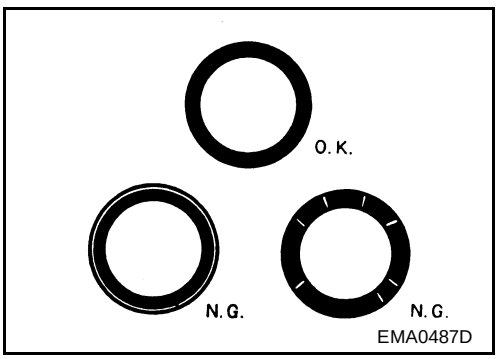
Intake and exhaust:

6.000 - 6.018 mm (0.2362 - 0.2369 in)



VALVE SEAT CONTACT

- After confirming that the dimensions of valve guides and valves are within specifications, perform this procedure.
- Apply prussian blue (or white lead) onto contacting surface of valve seat to check the condition of the valve contact on the surface.
- Check if the contact area band is continuous all around the circumference.
- If not, grind to adjust valve fitting and check again. If the contacting surface still has N.G conditions even after the re-check, replace valve seat.



VALVE SEAT REPLACEMENT

When valve seat is removed, replace with oversized (0.5 mm, 0.020 in) valve seat.

1. Bore out old seat until it collapses. Boring should not continue beyond the bottom face of the seat recess in cylinder head. Set the machine depth stop to ensure this.

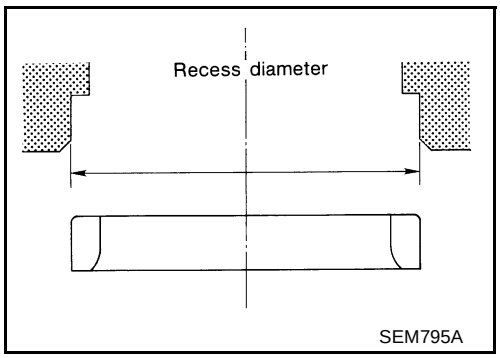
2. Ream cylinder head recess diameter for service valve seat.

Oversize [0.5 mm (0.020 in)]

Intake : 37.000 - 37.016 mm (1.4567 - 1.4573 in)

Exhaust : 32.000 - 32.016 mm (1.2598 - 1.2605 in)

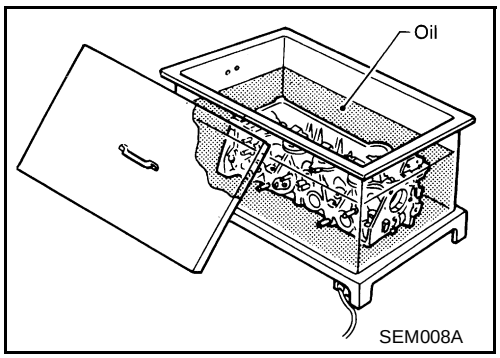
- Be sure to ream in circles concentric to the valve guide center.
- This will enable valve seat to fit correctly.



3. Heat cylinder head to 110 to 130°C (230 to 266°F) by soaking in heated oil.
4. Provide valve seats cooled well with dry ice. Force fit valve seat into cylinder head.

CAUTION:

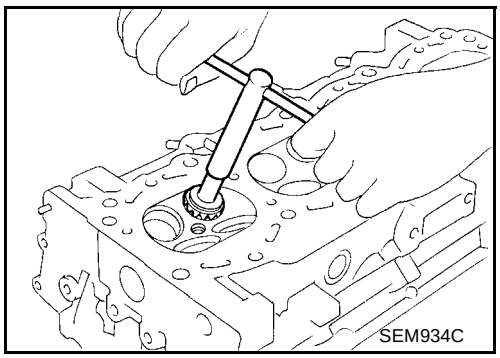
Avoid directly to touching cold valve seats.



5. Using valve seat cutter set or valve seat grinder, finish the seat to the specified dimensions.

CAUTION:

When using valve seat cutter, firmly grip the cutter handle with both hands. Then, press on the contacting surface all around the circumference to cut in a single drive. Improper pressure on with the cutter or cutting many different times may result in stage valve seat.



- Grind to obtain the dimensions indicated in figure.

Standard

D1 dia. : 33.5 mm (1.3189 in)

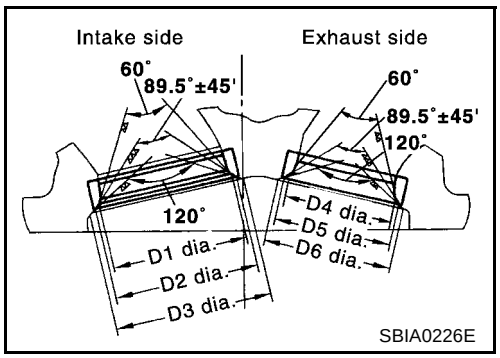
D2 dia. : 35.1 - 35.3 mm (1.382 - 1.390 in)

D3 dia. : 39.0 - 39.2 mm (1.535 - 1.543 in)

D4 dia. : 28 mm (1.10 in)

D5 dia. : 29.9 - 30.1 mm (1.177 - 1.185 in)

D6 dia. : 33.5 - 33.7mm (1.319 - 1.327 in)

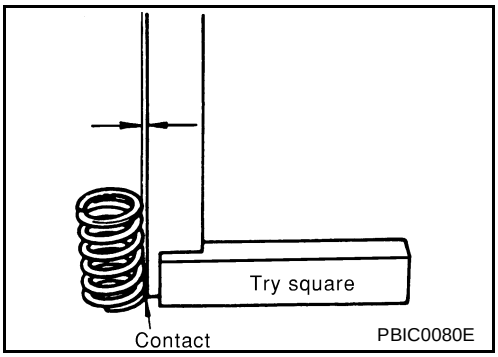


6. Using compound, grind to adjust valve fitting.
7. Check again for normal contact.

VALVE SPRING SQUARENESS

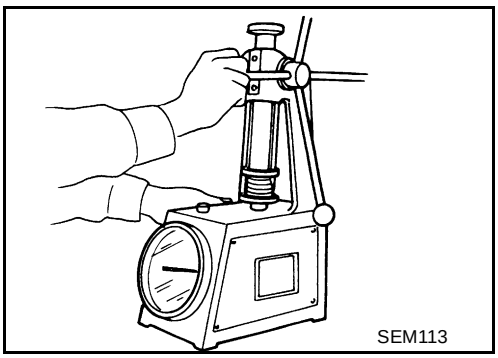
Set try square along the side of valve spring and rotate the spring. Measure the maximum clearance between the top face of spring and try square.

Limit: More than 1.9 mm (0.0748 in).



VALVE SPRING DIMENSIONS AND VALVE SPRING PRESSURE LOAD

Check valve spring pressure with valve spring seat installed at specified spring height.



CAUTION:
Do not remove valve spring seat.

Standard:	INTAKE	EXHAUST
Free height	: 44.84 - 45.34 mm (1.7654 - 1.7850 in)	: 45.28 - 45.78 mm (1.7827 - 1.8024 in)
Installation height	: 35.30 mm (1.390 in)	: 35.30 mm (1.390 in)
Installation load	: 151 - 175 N (15.4 - 17.8 kg, 34 - 39 lb)	: 151 - 175 N (15.4 - 17.8 kg, 34 - 39 lb)
Height during valve open	: 24.94 mm (0.9819 in)	: 26.39 mm (1.0390 in)
Load with valve open	: 358 - 408 N (36.5 - 41.6 kg, 80 - 92 lb)	: 325 - 371 N (33.1 - 37.8 kg, 73 - 83 lb)
Identification color	: Blue	: Yellow

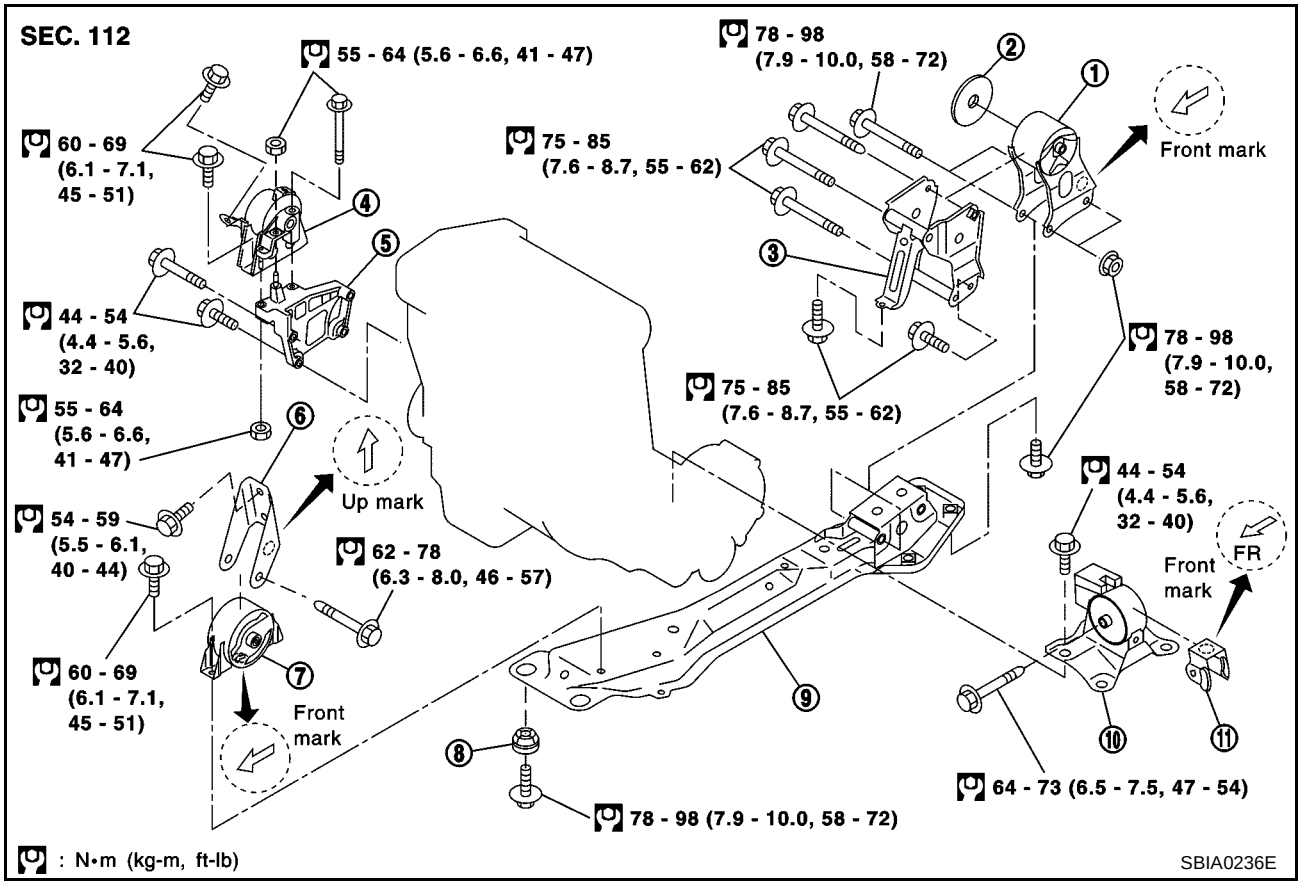
ENGINE ASSEMBLY

PFP:10001

Removal and Installation

EBS00DLO

2WD MODEL



1	Rear engine mounting insulator	2	Rubber seat	3	Rear engine mounting bracket
4	RH engine mounting insulator	5	RH engine mounting bracket	6	Front engine mounting bracket
7	Front engine mounting insulator	8	Grommet (2pcs)	9	Center member
10	LH engine mounting insulator	11	Stopper		

WARNING:

- **Situate vehicle on a flat and solid surface.**
- **Place chocks at front and back of rear wheels.**
- **For engines not equipped with engine slingers, attach proper slingers and bolts described in PARTS CATALOG.**

CAUTION:

- **Always be careful to work safely, avoid forceful or uninstructed operations.**
- **Do not start working until exhaust system and coolant are cool enough.**
- **If items or work required are not covered by the engine main body section, refer to the applicable sections.**
- **Always use the support point specified for lifting.**
- **Use either 2-pole lift type or separate type lift as best you can. If board-on type is used for unavoidable reasons, support at the rear axle jacking point with transmission jack or similar tool before starting work, in preparation for the backward shift of center of gravity.**
- **For supporting points for lifting and jacking point at rear axle, refer to GI-31, "Garage Jack and Safety Stand" .**

REMOVAL

Description of work

Remove engine and transaxle assembly from vehicle down ward. Separate engine and transaxle.

Preparation

1. Release fuel pressure. Refer to EC-31, "FUEL PRESSURE RELEASE" .
2. Remove engine hood.
3. Drain coolant from radiator drain plug.
4. Remove the following parts.
   - LH/RH under cover
   - LH/RH Front wheel
   - Battery
   - Auxiliary drive belt; Refer to EM-14, "REMOVAL" .
   - Air duct and air cleaner case assembly; Refer to EM-15, "AIR CLEANER AND AIR DUCT" .
   - Alternator
   - Radiator and radiator fan assembly; Refer to CO-12, "RADIATOR" .
5. Disconnect engine room harness from the engine side and set it aside for easier work.
6. Disconnect all the body-side vacuum hoses and air hoses at engine side.

Engine room LH

7. Disconnect fuel hose, and plug it to prevent fuel from draining. Refer to EM-17, "INTAKE MANIFOLD"
8. Disconnect heater hose, and install plug it to prevent engine coolant from draining.
9. Disconnect select cable from transaxle (A/T models).
10. Remove clutch operating cylinder from transaxle, and move it aside (M/T models).
11. Disconnect shift cable from transaxle (M/T models).

Engine room RH

12. Remove engine coolant reservoir tank.
13. Remove air conditioner compressor with piping connected from engine. Temporarily secure it on body with a rope to avoid putting load on it.
14. Remove brake caliper from steering knuckle. Temporarily secure it on body with a rope to avoid putting load on it.

Vehicle underbody

15. Remove exhaust front tube.
16. Remove ABS sensor from brake caliper.
17. Remove brake caliper with piping connected from steering knuckle. Temporarily secure it on body with a rope to avoid load on it.
18. Remove LH/RH drive shaft from steering knuckle.

Removal

19. Install engine slingers into front left of cylinder head and rear right of cylinder head.
    - Use alternator bracket mounting bolt holes for the front side.

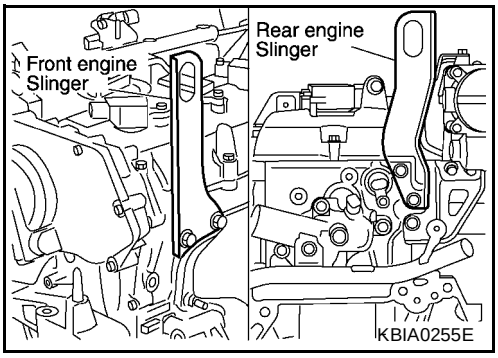
    Slinger bolts:

    Front

    : 51.0 - 64.7 N·m (5.2 - 6.6 kg-m, 38 - 47 ft-lb)

    Rear

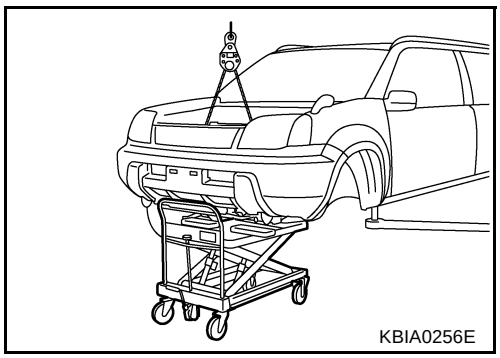
    : 24.5 - 31.4 N·m (2.5 - 3.2 kg-m, 18 - 23 ft-lb)



20. Lift with hoist and secure the engine in position.

- Use a manual lift table caddy or equivalently rigid tool such as a jack or trestle. Securely support bottom of engine and transaxle, and simultaneously adjust hoist tension.

CAUTION:
Put a piece of wood or something similar as the supporting surface, secure a completely stable condition.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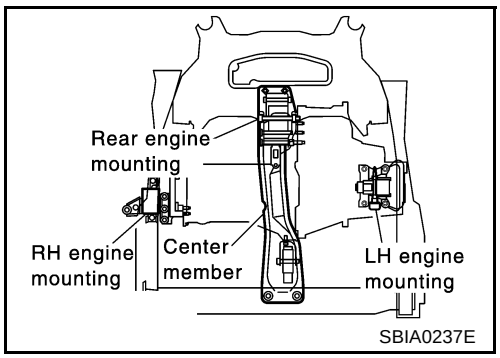
21. Remove RH engine mounting insulator.
22. Pull LH engine mounting through-bolt out.
23. Remove center member.



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24. Remove engine and transaxle assembly with suspension member from vehicle downward by carefully operating supporting tools.

CAUTION:
- **During the operation, make sure that no part interferes with body side.**
- **Before and during this lifting, always check if any harnesses are left connected.**
- **During the removal operation, always be careful to prevent vehicle from falling off the lift due to changes in the center of gravity.**
- **If necessary, support vehicle by setting a jack or equivalent tool at the rear.**

25. Remove starter motor.
26. Remove rear engine mounting bracket.
27. Separate engine and transaxle.

INSTALLATION

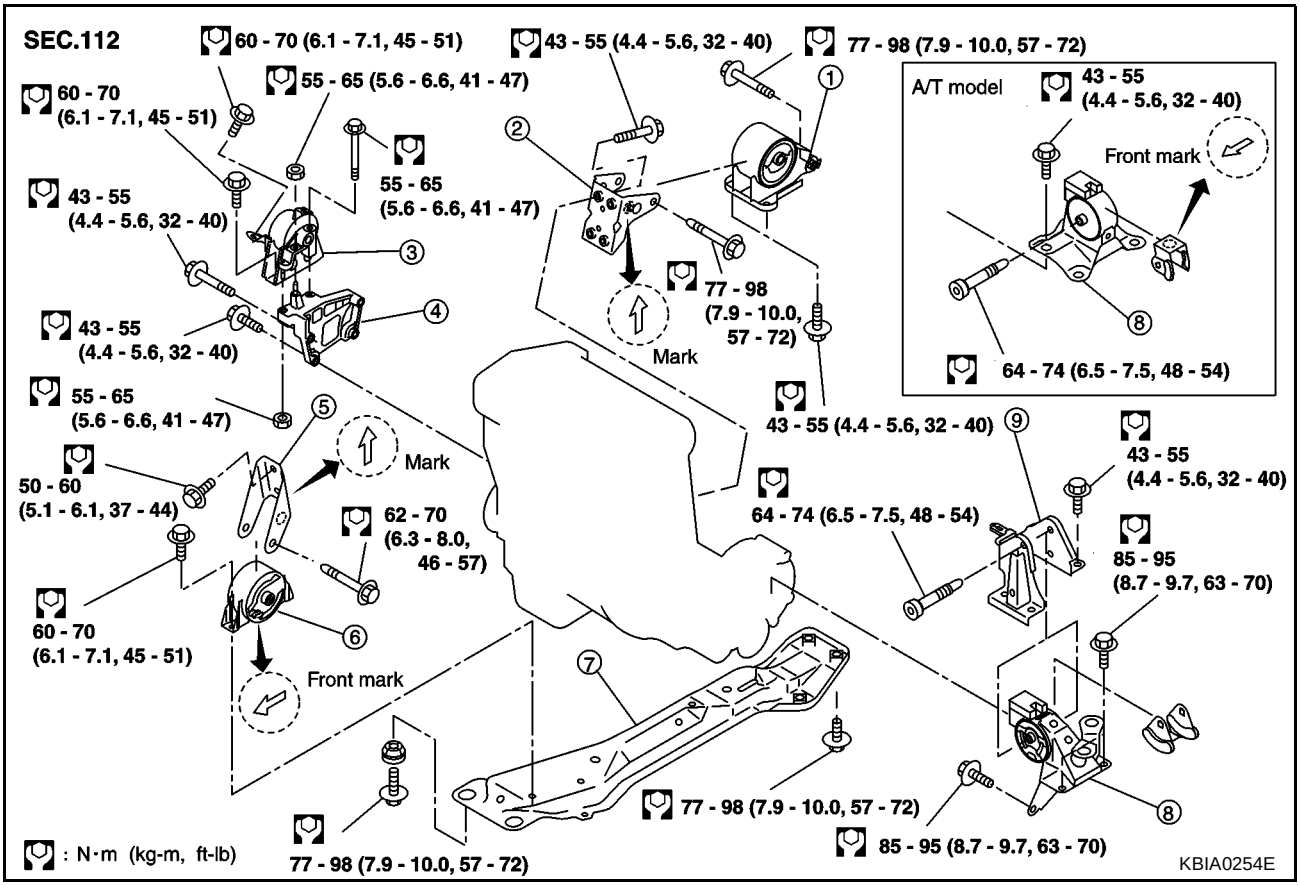
Install in the reverse order of removal.

- Do not allow oil to get on mounting insulator. Be careful not to damage mounting insulator.
- When installation directions are specified, install parts according to the direction marks on them referring to components illustration.
- Make sure that each mounting insulator is seated properly, and tighten mounting bolts and nuts.

INSPECTION AFTER INSTALLATION

- Before starting engine check the levels of coolant, lubrications and working oils. If less than required quantity, fill to the specified level.
- Run engine to check for unusual noise and vibration.
- Warm up engine thoroughly to make sure there is no leakage of coolant, lubricants, working oil, fuel and exhaust gas.
- Bleed air from passages in pipes and tubes of applicable lines.

4WD MODEL



1	Rear engine mounting insulator	2	Rear engine mounting bracket	3	RH engine mounting insulator
4	RH engine mounting bracket	5	Front engine mounting bracket	6	Front engine mounting insulator
7	Center member	8	LH engine mounting insulator	9	LH engine mounting bracket

WARNING:

- **Situate vehicle on a flat and solid surface.**
- **Place chocks at front and back of rear wheels.**
- **For engines not equipped with engine slingers, attach proper slingers and bolts described in PARTS CATALOG.**

CAUTION:

- **Always be careful to work safely, avoid forceful or uninstructed operations.**
- **Do not start working until exhaust system and coolant are cool enough.**
- **If items or work required are not covered by the engine main body section, refer to the applicable sections.**
- **Always use the support point specified for lifting.**
- **Use either 2-pole lift type or separate type lift as best you can. If board-on type is used for unavoidable reasons, support at the rear axle jacking point with transmission jack or similar tool before starting work, in preparation for the backward shift of center of gravity.**
- **For supporting points for lifting and jacking point at rear axle, refer to GI-31, "Garage Jack and Safety Stand" .**

REMOVAL

Description of work

Remove engine, transaxle and transfer assembly with front suspension member from vehicle down ward. Separate suspension member, and then separate engine and transaxle.

Preparation

1. Release fuel pressure. Refer to EC-31, "FUEL PRESSURE RELEASE" .
2. Remove engine hood.

3. Drain coolant from radiator drain plug.
4. Remove the following parts.
   - LH/RH under cover
   - LH/RH Front wheel
   - Battery
   - Auxiliary drive belt; Refer to EM-14, "REMOVAL" .
   - Air duct and air cleaner case assembly; Refer to EM-15, "AIR CLEANER AND AIR DUCT" .
   - Alternator
   - Radiator and radiator fan assembly; Refer to CO-12, "RADIATOR" .
5. Disconnect engine room harness from the engine side and set it aside for easier work.
6. Disconnect all the body-side vacuum hoses and air hoses at engine side.

Engine room LH

7. Disconnect fuel hose, and plug it to prevent fuel from draining. Refer to EM-17, "INTAKE MANIFOLD"
8. Disconnect heater hose, and install plug it to prevent engine coolant from draining.
9. Disconnect select cable from transaxle (A/T models).
10. Remove clutch operating cylinder from transaxle, and move it aside (M/T models).
11. Disconnect shift cable from transaxle (M/T models).

Engine room RH

12. Remove engine coolant reservoir tank.
13. Remove air conditioner compressor with piping connected from engine. Temporarily secure it on body with a rope to avoid putting load on it.

Vehicle underbody

14. Remove exhaust front tube.
15. Remove propeller shaft.
16. Remove steering shaft from steering gear.
17. Disconnect power steering fluid cooler piping at a point between body and engine.
18. Remove ABS sensor from brake caliper.
19. Remove brake caliper with piping connected from steering knuckle. Temporarily secure it on body with a rope to avoid load on it.
20. Remove LH/RH suspension from steering knuckle under strut.

Removal

21. Install engine slingers into front left of cylinder head and rear right of cylinder head.
    - Use alternator bracket mounting bolt holes for the front side.

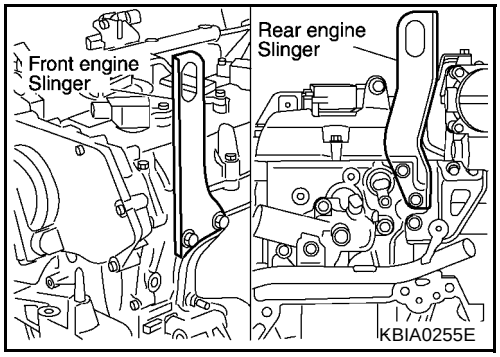
    Slinger bolts:

    Front

    : 51.0 - 64.7 N·m (5.2 - 6.6 kg-m, 38 - 47 ft-lb)

    Rear

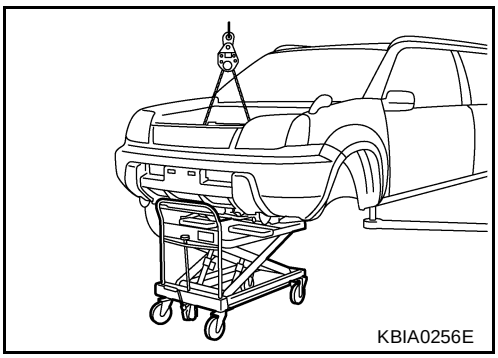
    : 24.5 - 31.4 N·m (2.5 - 3.2 kg-m, 18 - 23 ft-lb)



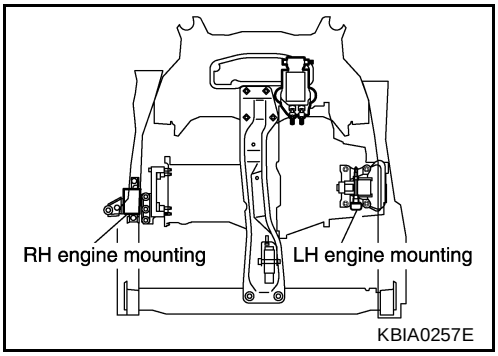
22. Lift with hoist and secure the engine in position.

- Use a manual lift table caddy or equivalently rigid tool such as a jack or trestle. Securely support bottom of engine and transaxle, and simultaneously adjust hoist tension.

CAUTION:
Put a piece of wood or something similar as the supporting surface, secure a completely stable condition.


KBIA0256E

23. Remove RH engine mounting insulator.
24. Pull LH engine mounting through-bolt out.



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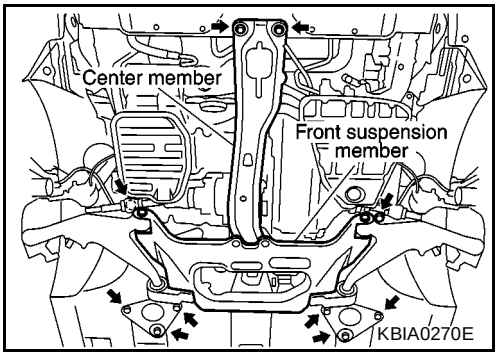
25. Remove mounting bolts at front end of center member.
26. Remove front suspension member mounting bolts and nuts.
27. Remove engine, transaxle and transfer assembly with suspension member from vehicle downward by carefully operating supporting tools.

CAUTION:
- **During the operation, make sure that no part interferes with body side.**
- **Before and during this lifting, always check if any harnesses are left connected.**
- **During the removal operation, always be careful to prevent vehicle from falling off the lift due to changes in the center of gravity.**
- **If necessary, support vehicle by setting a jack or equivalent tool at the rear.**



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28. Remove power steering pump with piping connected from engine. Move it aside on suspension member.
29. Remove front engine mounting and rear engine mounting through-bolts to remove suspension member.
30. Remove starter motor.
31. Separate engine and transaxle.

INSTALLATION

Install in the reverse order of removal.

- Do not allow oil to get on mounting insulator. Be careful not to damage mounting insulator.
- When installation directions are specified, install parts according to the direction marks on them referring to components illustration.
- Make sure that each mounting insulator is seated properly, and tighten mounting bolts and nuts.

INSPECTION AFTER INSTALLATION

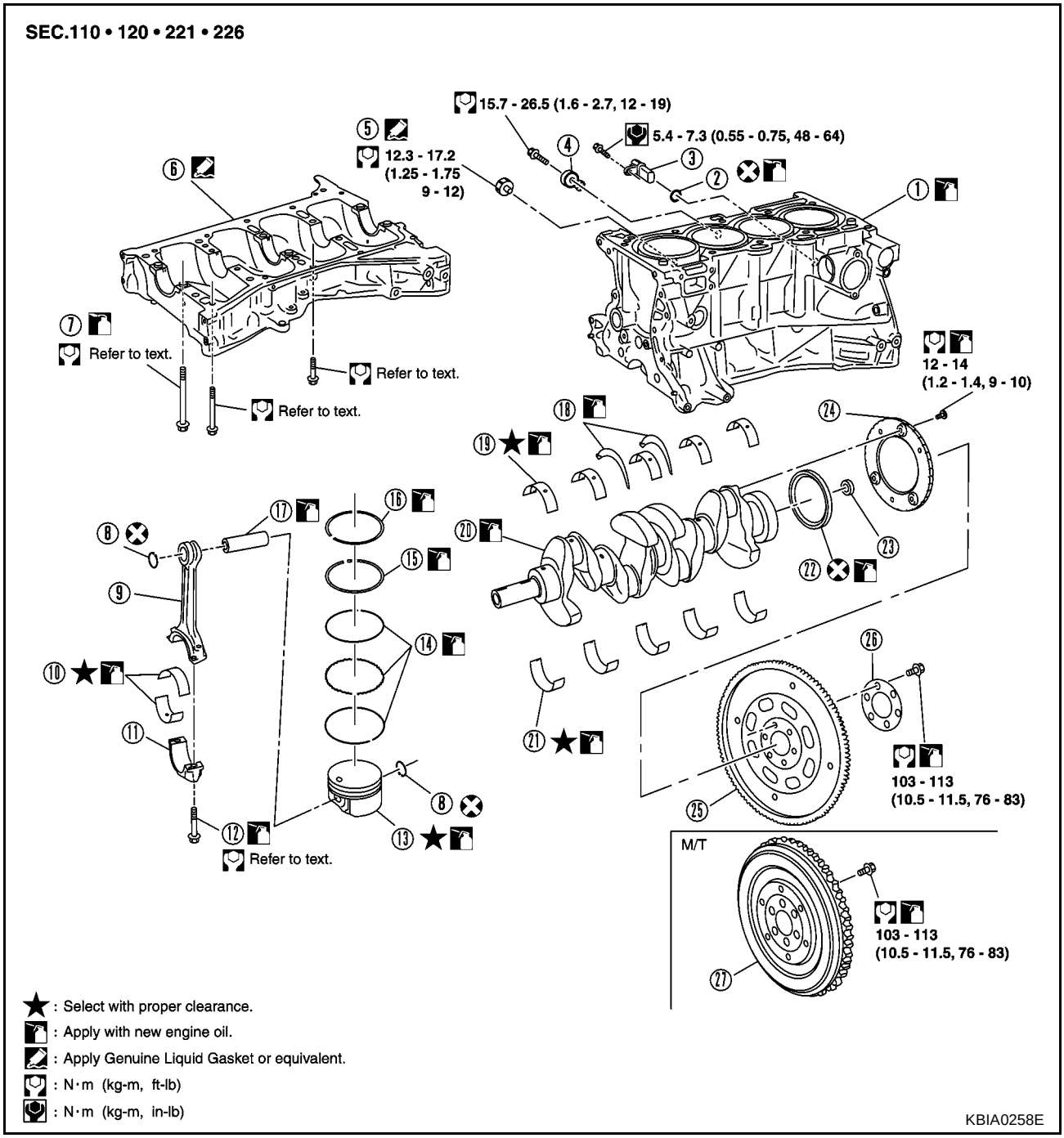
- Before starting engine check the levels of coolant, lubrications and working oils. If less than required quantity, fill to the specified level.
- Run engine to check for unusual noise and vibration.
- Warm up engine thoroughly to make sure there is no leakage of coolant, lubricants, working oil, fuel and exhaust gas.
- Bleed air from passages in pipes and tubes of applicable lines.

CYLINDER BLOCK

PFP:11010

Disassembly and Assembly

EBS00DHX



1	Cylinder block	2	O-ring	3	Crankshaft position sensor (POS)
4	Knock sensor	5	Oil pressure switch	6	Lower cylinder block
7	Lower cylinder block bolt	8	Snap ring	9	Connecting rod
10	Connecting rod bearing	11	Connecting rod bearing cap	12	Connecting rod bolt
13	Piston	14	Oil ring	15	Second ring
16	Top ring	17	Piston pin	18	Thrust bearing
19	Main bearing upper	20	Crankshaft	21	Main bearing lower
22	Rear oil seal	23	Pilot convertor (A/T model)	24	Signal plate
25	Drive plate (A/T model)	26	Reinforce plate (A/T model)	27	Flywheel (M/T model)

CAUTION:
Apply new engine oil to parts marked in illustration before installation.

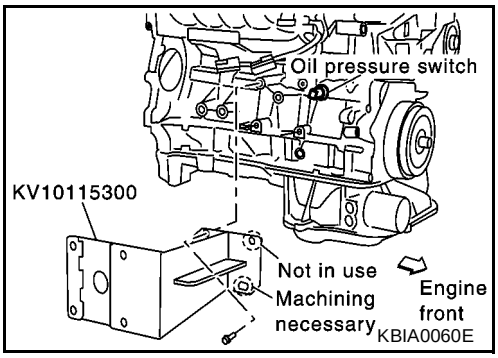
DISASSEMBLY

1. Remove engine and transaxle assembly from vehicle, and separate transaxle from engine. Refer to EM-62, "ENGINE ASSEMBLY" .
2. Mount engine on an engine stand with the following procedure.

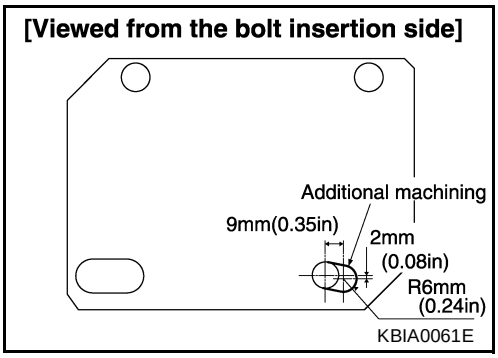
a. Remove oil cooler on right side of cylinder block.

b. Install engine sub-attachment to right side of cylinder block.

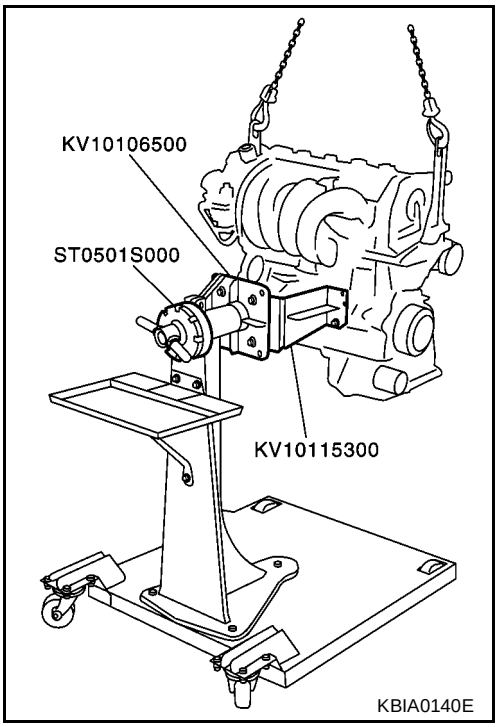
- Do not use bolt hole at the upper right looking from bolt insertion side.



- Machine a bolt hole at the lower right of the engine sub-attachment looking from bolt insertion side shown in the figure.

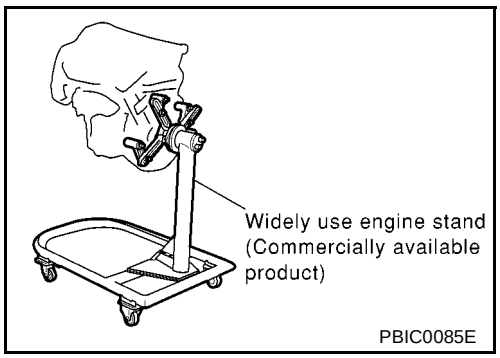


c. Lift engine, and mount it onto the engine stand.



- A commercial engine stand can be used.

NOTE:
This example is an engine stand for holding at transaxle mounting side with the flywheel or drive plate removed.

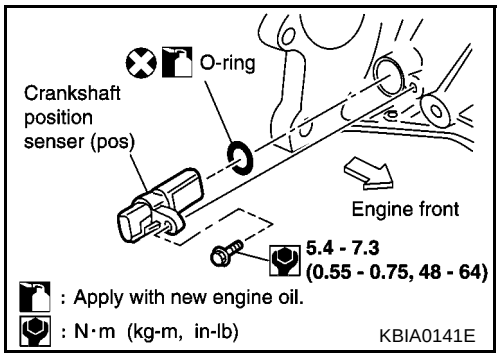


3. Drain engine oil and coolant from inside of engine.
4. Remove the following components and associated parts.
   - Exhaust manifold and three way catalyst assembly; Refer to EM-22, "EXHAUST MANIFOLD AND THREE WAY CATALYST" .
   - Intake manifold collector; Refer to EM-17, "INTAKE MANIFOLD" .
   - Intake manifold and fuel tube assembly; Refer to EM-17, "INTAKE MANIFOLD" .
   - Ignition coil; Refer to EM-27, "IGNITION COIL" .
   - Rocker cover; Refer to EM-32, "ROCKER COVER" .
   - Oil pan and oil strainer; Refer to EM-24, "OIL PAN AND OIL STRAINER" .
   - Front cover, timing chain and balancer unit; Refer to EM-44, "TIMING CHAIN" .
   - Camshaft; Refer to EM-34, "CAMSHAFT" .
   - Cylinder head; Refer toEM-53, "CYLINDER HEAD" .
5. Remove knock sensor.

CAUTION:
Carefully handle the sensor avoiding shocks.

6. Remove crankshaft position sensor (POS).

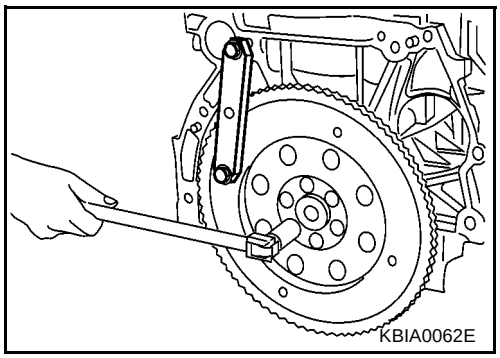
CAUTION:
- **Avoid impacts such as a dropping.**
- **Do not disassemble.**
- **Keep it away from metal particles.**
- **Do not place sensor close to magnetic materials.**



7. Remove flywheel (M/T model) or drive plate (A/T model). Fix crankshaft with a stopper plate, and remove mounting bolts.
   Torx bit (size T55): Flywheel (M/T model)
   Torx socket (size T55): Drive plate (A/T model)

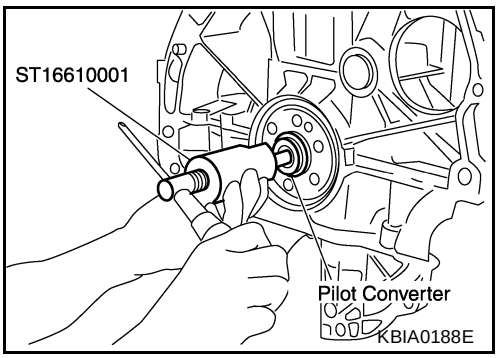
CAUTION:
Be careful not to damage contact surface for the clutch disc of the flywheel.

NOTE:
The flywheels, two block construction, allows movement in response to transmission side pressure, or when twisted in its rotational direction. Therefore, some amount of noise is normal.



8. Remove pilot converter using Tool or suitable tool. (A/T model)

NOTE:
M/T models have no pilot push.



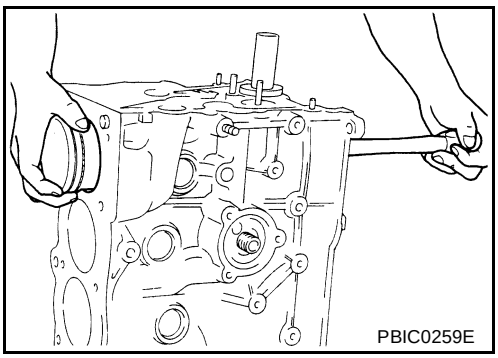
9. Remove the piston and connecting rod assembly.

a. Position the crankshaft pin corresponding to the connecting rod to be removed onto the bottom dead center.

b. Remove the connecting rod cap.

c. Using a hammer handle or similar tool, push the piston and connecting rod assembly out to the cylinder head side.

- Before removing the piston and connecting rod assembly, check the connecting rod side clearance. Refer to EM-85, "CONNECTING ROD SIDE CLEARANCE" .



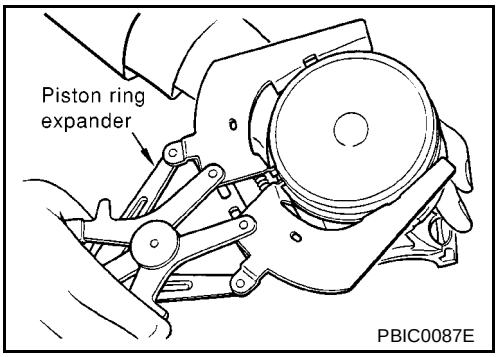
10. Remove the connecting rod bearings.

CAUTION:
When removing them, note the installation position. Keep them in the correct order.

11. Remove the piston rings form the piston.

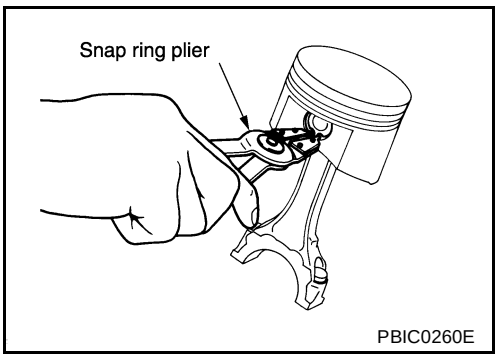
- Use a piston ring expander.

CAUTION:
- **When removing the piston rings, be careful not to damage the piston.**
- **Be careful not to damage piston rings by expanding them excessively.**
- **Before removing the piston rings, check the piston ring side clearance. Refer to EM-86, "PISTON RING SIDE CLEARANCE" .**

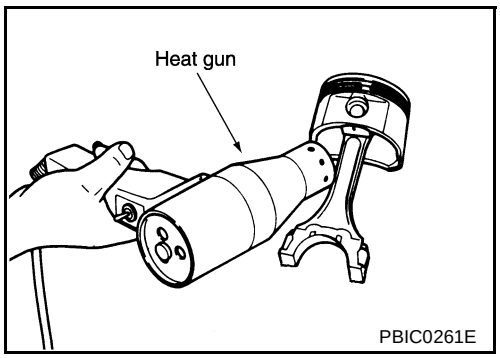


12. Remove the piston from the connecting rod as follows.

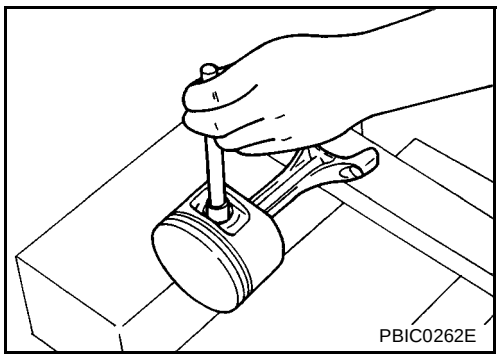
a. Using a snap ring pliers, remove the snap ring.



b. Heat piston to 60 to 70°C (140 to 158°F) with drier or equivalent.

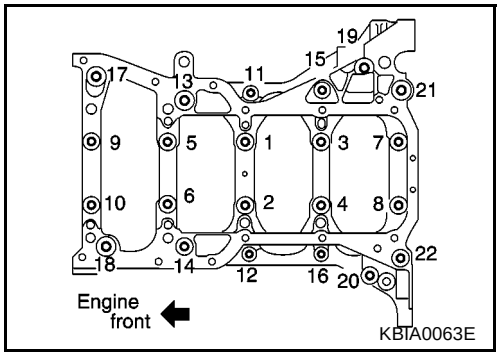


c. Push out piston pin with stick of outer diameter approximately 19 mm (0.75in).



13. Remove lower cylinder block mounting bolts.
    - Loosen them in the reverse order shown in the figure, and remove them.
    - Use Torx socket (size E14) for bolts 1 to 10.
    - Before loosening lower cylinder block mounting bolts, measure crankshaft side clearance. Refer to EM-84, "CRANKSHAFT SIDE CLEARANCE" .
14. Remove lower cylinder block.
    - Using Tool (Seal cutter), cut liquid gasket off, and remove it from cylinder block.

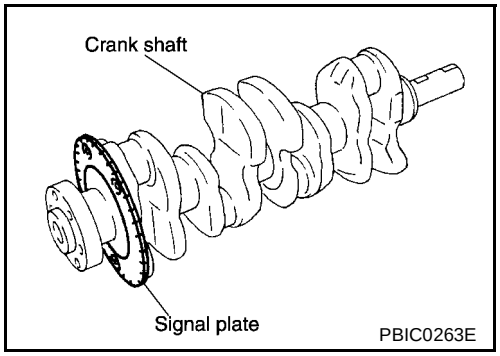
    CAUTION:
    Be careful not to damage the mounting surface.



15. Remove crankshaft.

    CAUTION:
    - **Be careful not damage or deform the signal plate mounted on the crankshaft.**
    - **When setting crankshaft on a flat floor surface, use a block of wood to avoid interference between the signal plate and the floor surface.**
    - **Do not remove signal plate unless it is necessary to do so.**

    NOTE:
    When removing or installing signal plate, use Torx bit size T30.



16. Pull rear oil seal out from rear end of crankshaft.

    NOTE:
    When replacing rear oil seal without removing cylinder block, use a screwdriver to pull it out from between crankshaft and block.

    CAUTION:
    Be careful not to damage the crankshaft and cylinder block.
17. Remove main bearings and thrust bearings from cylinder block and lower cylinder block.

CAUTION:
Identify installation positions, and store them without mixing them up.

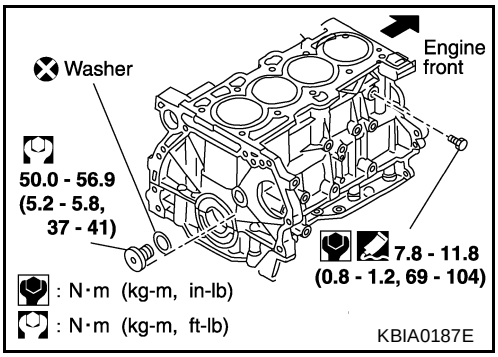
ASSEMBLY

1. Fully air-blow the coolant and oil passages in the cylinder block, the cylinder bore and the crankcase to remove any foreign material.

CAUTION:
Use a goggles to protect your eye.

2. Install each plug to the cylinder block.
   - Apply liquid gasket.

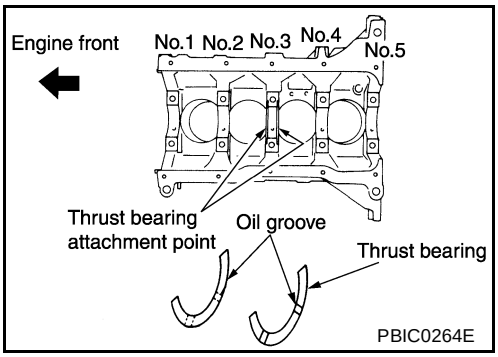
   Use Genuine Liquid Gasket or equivalent.
   - Replace the copper washers with new ones.



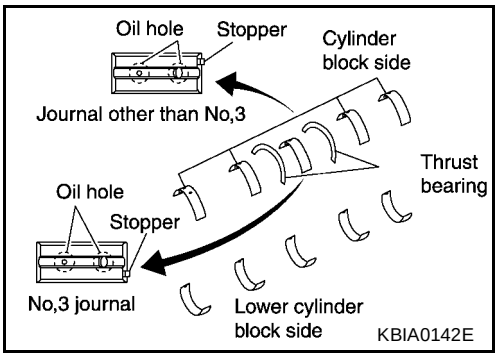
3. Install the main bearings and the thrust bearings.

a. Remove dust, dirt, and oil on the bearing mating surfaces of the cylinder block and the lower cylinder block.

b. Install the thrust bearings to the both sides of the No. 3 journal housing on the cylinder block.
   - Install the thrust bearings with the oil groove facing the crankshaft arm (outside).



c. Install the main bearings paying attention to the direction.
   - The main bearing with an oil hole and groove goes on the cylinder block. The one without them goes on the lower cylinder block.
   - Only the main bearing (on the cylinder block) for No. 3 journal has different specifications.
   - Before installing the bearings, apply engine oil to the bearing surface (inside). Do not apply oil to the back surface, but thoroughly clean it.
   - When installing, align the bearing stopper to the notch.
   - Ensure the oil holes on cylinder block and those on the corresponding bearing are aligned.



4. Install the signal plate to the crankshaft.

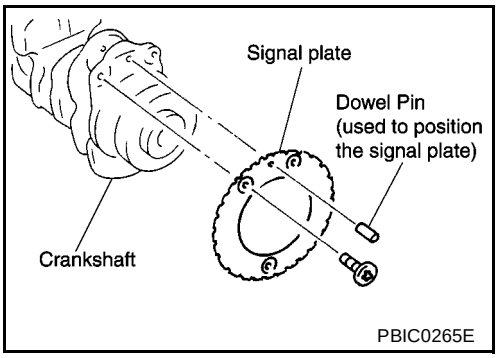
a. Position crankshaft and signal plate using a positioning dowel pin, and tighten mounting bolts.

b. Remove dowel pin.

CAUTION:
Be sure to remove dowel pin.

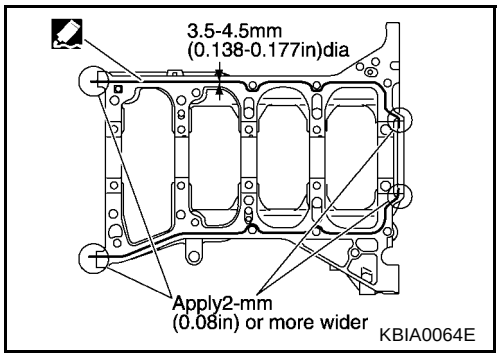
NOTE:
Dowel pins of crankshaft and signal plate are provided as a set for each.

5. Install the crankshaft to the cylinder block.



- While turning the crankshaft by hand, check that it turns smoothly.

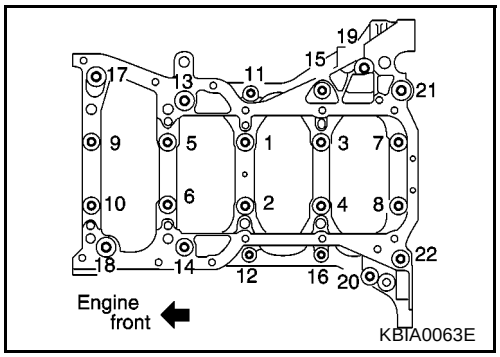
6. Install the lower cylinder block.
   - Apply genuine liquid gasket or equivalent to positions shown in the figure.



NOTE:
Cylinder block and lower cylinder block are machined together. Neither of them can be replaced as a single unit.

CAUTION:
After liquid gasket is applied, rear oil seal installation must be finished within 5 minutes. Therefore, the following procedure must be performed quickly.

7. Tighten lower cylinder block mounting bolts in the numerical order in the figure by following the procedure below.



a. Apply new engine oil to threads and seat surfaces of mounting bolts.

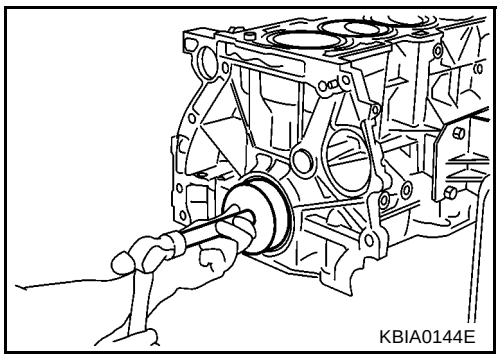
b. Tighten M10 (0.39 in) bolts in order from 1 to 10 with tightening torque 36.3 to 42.2 N·m (3.7 to 4.3 kg-m, 27 to 31 ft-lb).

NOTE:
There are two more processes to complete the tightening of mounting bolts (See step 9). However stop procesure here to install rear oil seal.

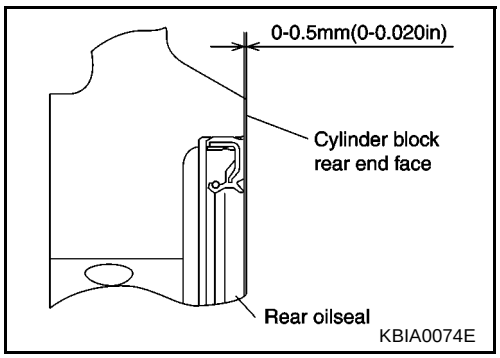
8. Install rear oil seal.

CAUTION:
Complete this step within approximately 5 minutes after liquid gasket is applied to the lower cylinder block.

- Press oil seal between cylinder block and crankshaft with a suitable drift.
- Be careful not to touch the grease on the oil seal lip.
- Be careful not to cause scratches or burrs when pressing in the oil seal.



- Press in rear oil seal to the position shown in the figure.



9. Restart tightening of lower cylinder block bolts with the following procedure.

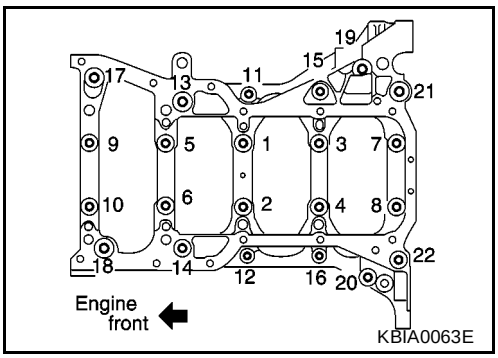
NOTE:
Step “a ”and “b” have been completed before installation of rear oil seal (step 7).

a. Step “a” has been completed before installation of rear oil seal.

b. Step “b” has been completed before installation of rear oil seal.

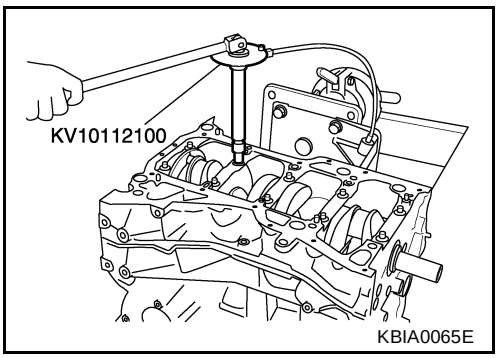
c. Tighten M10 (0.39 in) bolts to 60 to 65° (target: 60°) in order from 1to 10.

d. Tighten M8 (0.31 in) bolts to 19.6 to 24.5 N·m (2.0 to 2.5 kg-m, 15 to 18 ft-lb) in order from 11 to 22.



CAUTION:
In step “c”, use an angle wrench (special service tool) or protractor to check tightening angle. Do not make judgment by visual inspection.

- After installing mounting bolts, make sure that crankshaft can be rotated smoothly by hand.
- Wipe off completely any protruding liquid gasket on front side of engine.
- Check crankshaft side clearance. Refer toEM-84, "CRANK-SHAFT SIDE CLEARANCE" .



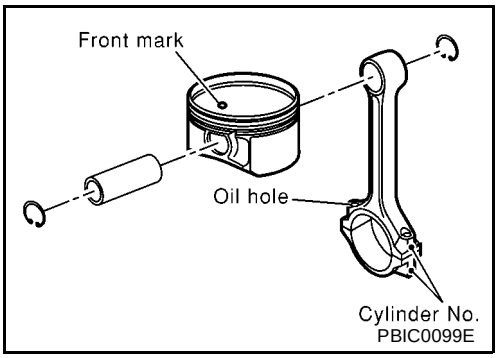
10. Install the piston to the connecting rod.

a. Using a snap ring pliers, install the snap ring to the grooves of the piston rear side.

- Insert it fully into groove to install.

b. Install the piston to the connecting rod.

- Using an industrial drier or similar tool, heat the piston until the piston pin can be pushed in by hand without excess force [approx. 60 to 70 C° (140 to 158 °F)]. From the front to the rear, insert the piston pin into the piston and the connecting rod.
- Assemble so that the front mark on the piston crown and the oil holes and the cylinder No. on the connecting rod are positioned as shown in the figure.



c. Install the snap rings to the front of the piston.

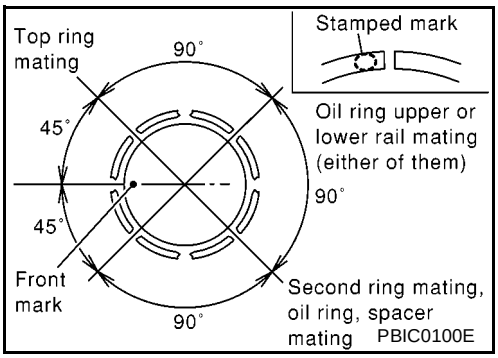
- After installing, check that the connecting rod moves smoothly.

11. Using a piston ring expander, install the piston rings.

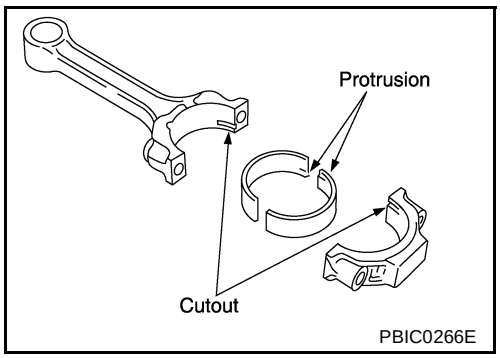
CAUTION:
Be careful not to damage the piston.

- Position each ring with the gap as shown in the figure referring to the piston front mark.
- Install the top ring and the second ring with the stamped surface facing upward.

Stamped mark : 1A (top ring)
: 2A (second ring)

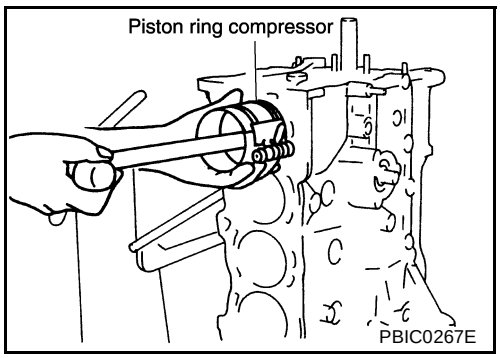


12. Install the connecting rod bearings to the connecting rod and the connecting rod cap.
    - When installing the connecting rod bearings, apply engine oil to the bearing surface (inside). Do not apply oil to the back surface, but thoroughly clean it.
    - When installing, align the connecting rod bearing stopper protrusion with the notch of the connecting rod to install.
    - Check the oil holes on the connecting rod and those on the corresponding bearing are aligned.

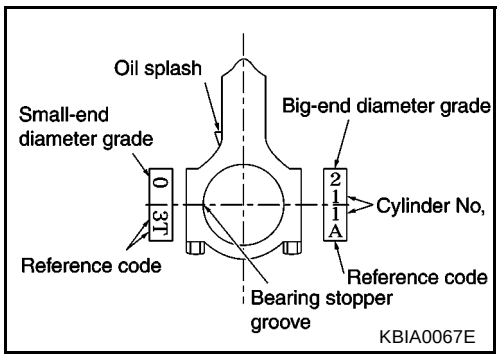


13. Install the piston and connecting rod assembly to the crankshaft.
    - Position the crankshaft pin corresponding to the connecting rod to be installed onto the bottom dead center.
    - Apply engine oil sufficiently to the cylinder bore, piston and crankshaft pin.
    - Match the cylinder position with the cylinder No. on the connecting rod to install.
    - Using a piston ring compressor, install the piston with the front mark on the piston crown facing the front of the engine.

    CAUTION:
    Be careful not to damage the crankshaft pin, resulting from an interference of the connecting rod big end.



14. Install the connecting rod cap.
    - Match the stamped cylinder number marks on the connecting rod with those on the cap to install.



15. Tighten the connecting rod bolt as follows.

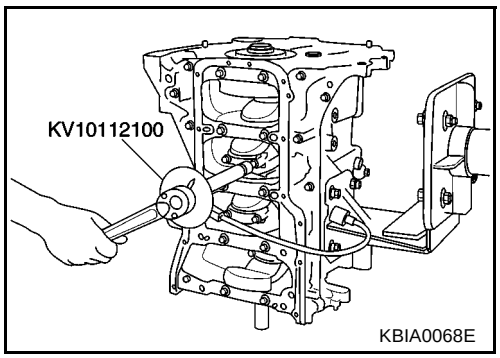
a. Apply engine oil to the threads and seats of the connecting rod bolts.

b. Tighten bolts to 18.6 to 20.6 N·m (1.9 to 2.1 kg-m, 14 to 15 ft-lb).

c. Put mating (with paint) on each bolt and connecting rod cap, all in the same direction (when using a protractor).

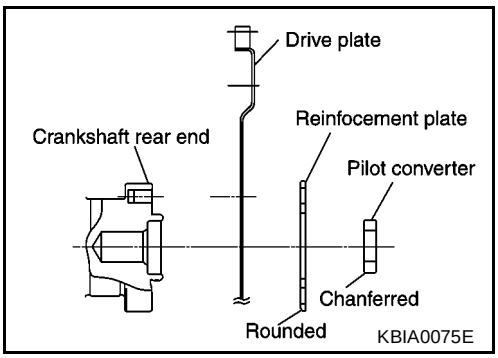
d. Then tighten all bolts 90 to 95 degrees clockwise (target: 90 degrees) (Angle tightening).

    CAUTION:
    Always use either an angle wrench or protractor. Avoid tightening based on visual check alone.



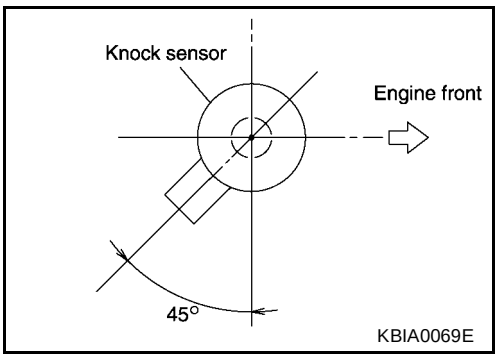
- After tightening the bolt, make sure that the crankshaft rotates smoothly.
- Check the connecting rod side clearance. Refer to EM-85, "CONNECTING ROD SIDE CLEARANCE" .

16. Install flywheel (M/T model) or drive plate (A/T model).
    - Install drive plate, reinforcement plate and pilot converter as shown in figure.
    - Using drift of 33 mm (1.30 in) in diameter, push pilot converter into the end of crankshaft.



17. Install knock sensor.
    - Make sure that there is no foreign material on the cylinder block mating surface and the back surface of the knock sensor.
    - Install sensor with connector facing lower left by 45° as show.
    - Do not tighten the mounting bolts while holding the connector.
    - Make sure that the knock sensor does not interfere with other-parts.

    CAUTION:
    If any impact by dropping is applied to the knock sensor, replace it with new one.



18. Install crankshaft position (POS) sensor.
19. Install followings in reverse order of removal.

How to Select Piston and Bearing

EBS00DHY

DESCRIPTION

Selection points	Selection parts	Selection items	Selection methods
Between cylinder block to crankshaft	Main bearing	Main bearing grade (bearing thickness)	Determined by match of cylinder block bearing housing grade (inner diameter of housing) and crankshaft journal grade (outer diameter of journal)
Between crankshaft to connecting rod	Connecting rod bearing	Connecting rod bearing grade (bearing thickness)	Combining service grades for connecting rod big end inner diameter and crankshaft pin outer diameter determine connecting rod bearing selection.
Between cylinder block to piston	Piston and piston pin assembly The piston is available together with piston pin as an assembly.	Piston grade (piston outer diameter)	Piston grade = cylinder bore grade (inner diameter of bore)
*Between piston to connecting rod	—	—	—

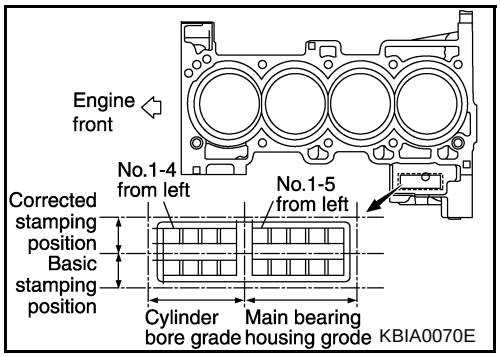
*For the service parts, the grade for fitting cannot be selected between a piston pin and a connecting rod. (Only 0 grade is available.) The information at the shipment from the plant is described as a reference.

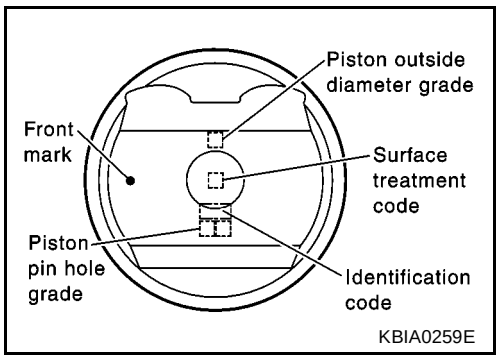
- The identification grade stamped on each part is the grade for the dimension measured in new condition. This grade cannot apply to reused parts.
- For reused or repaired parts, measure the dimension accurately. Determine the grade by comparing the measurement with the values of each selection table.
- For details of the measurement method of each part, the reuse standards and the selection method of the selective fitting parts, refer to the text.

HOW TO SELECT PISTON

When New Cylinder Block is Used:

- Check the cylinder bore grade on rear left side of cylinder block, and select a piston of the same grade.
- If there is a corrected stamp mark on the cylinder block, use it as a correct reference.





When Cylinder Block is Reused:

1. Measure the cylinder block bore inner diameter.
2. Determine the bore grade by comparing the measurement with the values under the cylinder bore inner diameter of the “Piston Selection Table”. Select the piston of the same grade.

Piston Selection Table

Unit: mm (in)

Grade number (Mark)	1	2 (or no mark)	3
Inner diameter of cylinder bore	89.000-89.010 (3.5039-3.5043)	89.010-89.020 (3.5043-3.5047)	89.020-89.030 (3.5047-3.5051)
Outer diameter of piston	88.980-88.990 (3.5031-3.5035)	88.990-89.000 (3.5035-3.5039)	89.000-89.010 (3.5039-3.5043)

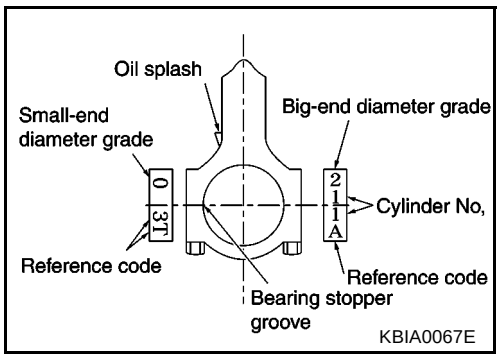
NOTE:

- The piston is available together with piston pin as an assembly.
- The piston pin (piston pin bore) grade is provided only for the parts installed at the plant. For service parts, no grades can be selected. (Only 0 grade is available.)

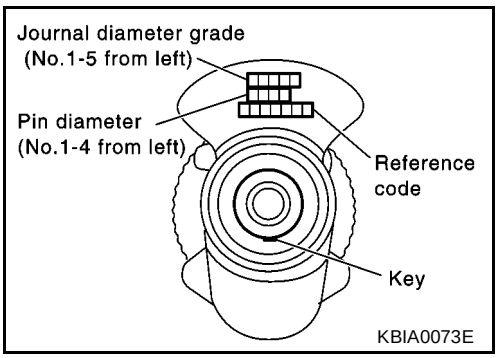
HOW TO SELECT CONNCTING ROD BEARING

When New Connecting Rod and Crankshaft are Used:

1. Apply big end inside diameter grade stamped on connecting rod side face to the row in the “Connecting Rod Bearing Selection Table”.



2. Apply pin diameter grade stamped on crankshaft front side to the column in the “Connecting Rod Bearing Selection Table”.
3. Read the symbol at the cross point of selected row and column in the “Connecting Rod Bearing Selection Table”. selective-fit service parts table.
4. Apply the symbol obtained to connecting rod bearing grade table to select.



When Crankshaft and Connecting Rod are Reused:

1. Measure dimensions of the big end inner diameter of connecting rod and outer diameter of crankshaft pin individually.
2. Apply the measured dimension to the “Connecting Rod Bearing Selection Table”selective-fit service parts table.
3. The following steps are same as in Step 3 or later in “When New Connecting Rod and Crankshaft are Used”.

Connecting “Rod Bearing Selection Table”.

Crankshaft pin outer diameter Mark	Crankshaft pin outer diameter Outer diameter Unit: mm (in)	Connecting rod big end. inner diameter Mark	0	1	2	3	4	5	6	7	8	9	A	B	C
		Inner diameter Unit: mm (in)	48.000 – 48.001 (1.8898 – 1.8898)	48.001 – 48.002 (1.8898 – 1.8898)	48.002 – 48.003 (1.8898 – 1.8899)	48.003 – 48.004 (1.8899 – 1.8899)	48.004 – 48.005 (1.8899 – 1.8900)	48.005 – 48.006 (1.8900 – 1.8900)	48.006 – 48.007 (1.8900 – 1.8900)	48.007 – 48.008 (1.8900 – 1.8901)	48.008 – 48.009 (1.8901 – 1.8901)	48.009 – 48.010 (1.8901 – 1.8902)	48.010 – 48.011 (1.8902 – 1.8902)	48.011 – 48.012 (1.8902 – 1.8902)	48.012 – 48.013 (1.8902 – 1.8903)
A	44.974 – 44.973 (1.7706 – 1.7706)		0	0	0	0	0	0	0	0	1	1	1	1	1
B	44.973 – 44.972 (1.7706 – 1.7705)		0	0	0	0	0	0	0	1	1	1	1	1	1
C	44.972 – 44.971 (1.7705 – 1.7705)		0	0	0	0	0	0	1	1	1	1	1	1	1
D	44.971 – 44.970 (1.7705 – 1.7705)		0	0	0	0	0	1	1	1	1	1	1	1	1
E	44.970 – 44.969 (1.7705 – 1.7704)		0	0	0	0	1	1	1	1	1	1	1	1	2
F	44.969 – 44.968 (1.7704 – 1.7704)		0	0	0	1	1	1	1	1	1	1	1	2	2
G	44.968 – 44.967 (1.7704 – 1.7704)		0	0	1	1	1	1	1	1	1	1	2	2	2
H	44.967 – 44.966 (1.7704 – 1.7703)		0	1	1	1	1	1	1	1	1	2	2	2	2
J	44.966 – 44.965 (1.7703 – 1.7703)		1	1	1	1	1	1	1	1	2	2	2	2	2
K	44.965 – 44.964 (1.7703 – 1.7702)		1	1	1	1	1	1	1	2	2	2	2	2	2
L	44.964 – 44.963 (1.7702 – 1.7702)		1	1	1	1	1	1	2	2	2	2	2	2	2
M	44.963 – 44.962 (1.7702 – 1.7702)		1	1	1	1	1	2	2	2	2	2	2	2	2
N	44.962 – 44.961 (1.7702 – 1.7701)		1	1	1	1	2	2	2	2	2	2	2	2	3
P	44.961 – 44.960 (1.7701 – 1.7701)		1	1	1	2	2	2	2	2	2	2	2	3	3
R	44.960 – 44.959 (1.7701 – 1.7700)		1	1	2	2	2	2	2	2	2	2	3	3	3
S	44.959 – 44.958 (1.7700 – 1.7700)		1	2	2	2	2	2	2	2	2	3	3	3	3
T	44.958 – 44.957 (1.7700 – 1.7700)		2	2	2	2	2	2	2	2	3	3	3	3	3
U	44.957 – 44.956 (1.7700 – 1.7699)		2	2	2	2	2	2	2	3	3	3	3	3	3

KBIA0147E

Connecting “Rod Bearing Grade Table”.

Grade	0	1	2	3
Upper / Lower thickness mm (in)	1.499 / 1.495 (0.0590 / 0.0589)	1.503 / 1.499 (0.0592 / 0.0590)	1.507 / 1.503 (0.0593 / 0.0592)	1.511 / 1.507 (0.0595 / 0.0593)
Identification color	Black	Brown	Green	Yellow

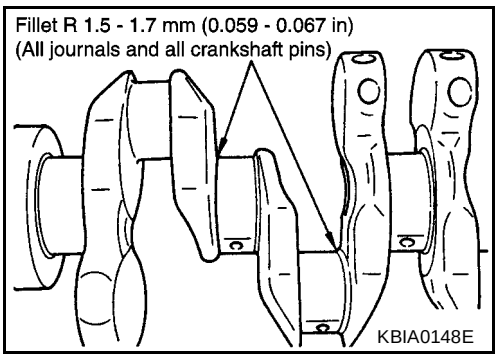
Under size Bearings Usage Guide

- When the specified oil clearance is not obtained with standard size connecting rod bearings, use under size (US) bearings.
- When using under size bearing, measure the bearing inner diameter with bearing installed, and grind the crankshaft pin so that the oil clearance satisfies the standard.

Bearing under size table

Unit: mm (in)

Size		Thickness
US	0.25 (0.0098)	1.624 - 1.632 (0.0639 - 0.0643)

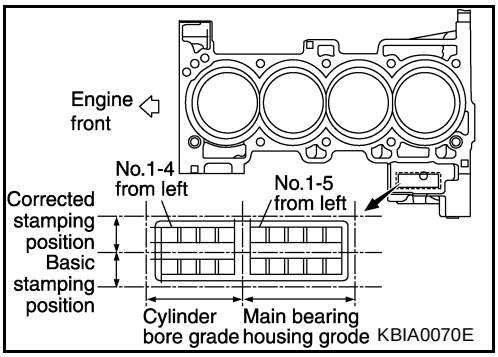


CAUTION:
In grinding the crankshaft pin to use under size bearings, keep the fillet R (All crankshaft pins).

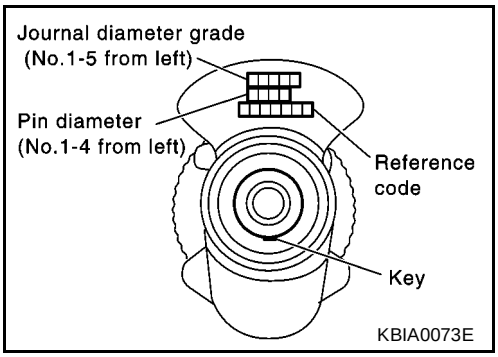
HOW TO SELECT MAIN BEARING

When New Cylinder Block and Crankshaft are Used:

1. "Main Bearing Selection Table" rows correspond to bearing housing grade on rear left side of cylinder block.
   - If there is a corrected stamp mark on the cylinder block, use it as a correct reference.



2. Apply journal diameter grade stamped on crankshaft front side to column in "Main Bearing Selection Table".



3. Find sign at crossing of row and column in "Main Bearing Selection Table".

   CAUTION:
   There are two main bearing selection tables. One is for odd-numbered journals (1, 3 and 5) and the other is for even-numbered journals (2 and 4). Make certain to use the appropriate table. This is due to differences in the specified clearances.

4. Apply the symbol obtained to "Main Bearing Grade Table" to select.

   NOTE:
   Service parts is available as a set of both upper and lower.

When Cylinder Block and Crankshaft are Reused:

1. Measure inner diameter of cylinder block main bearing housing and outer diameter of crankshaft journal.
2. Apply measurement in above step 1 to "Main Bearing Selection Table".
3. Follow step 3 and later in "When new cylinder block and crankshaft are used".

Main Bearing Selection Table (No.1,3 and No.5 journals)

Cylinder block main bearing housing inner diameter / Crankshaft journal outer diameter		Mark	A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	S	T	U	V	W	X	Y	4	7
		Inner diameter Unit: mm (in)	58.944 – 58.945 (2.3206 – 2.3207)	58.945 – 58.946 (2.3207 – 2.3207)	58.946 – 58.947 (2.3207 – 2.3207)	58.947 – 58.948 (2.3207 – 2.3208)	58.948 – 58.949 (2.3208 – 2.3208)	58.949 – 58.950 (2.3208 – 2.3209)	58.950 – 58.951 (2.3209 – 2.3209)	58.951 – 58.952 (2.3209 – 2.3209)	58.952 – 58.953 (2.3209 – 2.3210)	58.953 – 58.954 (2.3210 – 2.3210)	58.954 – 58.955 (2.3210 – 2.3211)	58.955 – 58.956 (2.3211 – 2.3211)	58.956 – 58.957 (2.3211 – 2.3211)	58.957 – 58.958 (2.3211 – 2.3212)	58.958 – 58.959 (2.3212 – 2.3212)	58.959 – 58.960 (2.3212 – 2.3213)	58.960 – 58.961 (2.3213 – 2.3213)	58.961 – 58.962 (2.3213 – 2.3213)	58.962 – 58.963 (2.3213 – 2.3214)	58.963 – 58.964 (2.3214 – 2.3214)	58.964 – 58.965 (2.3214 – 2.3215)	58.965 – 58.966 (2.3215 – 2.3215)	58.966 – 58.967 (2.3215 – 2.3215)	58.967 – 58.968 (2.3215 – 2.3216)
Mark	Outer diameter Unit: mm (in)																									
A	54.979 – 54.978 (2.1645 – 2.1645)		0	0	01	01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4
B	54.978 – 54.977 (2.1645 – 2.1644)		0	01	01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4
C	54.977 – 54.976 (2.1644 – 2.1644)		01	01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4
D	54.976 – 54.975 (2.1644 – 2.1644)		01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45
E	54.975 – 54.974 (2.1644 – 2.1643)		01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45
F	54.974 – 54.973 (2.1643 – 2.1643)		1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45
G	54.973 – 54.972 (2.1643 – 2.1642)		1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5
H	54.972 – 54.971 (2.1642 – 2.1642)		1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5
J	54.971 – 54.970 (2.1642 – 2.1642)		12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5
K	54.970 – 54.969 (2.1642 – 2.1641)		12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56
L	54.969 – 54.968 (2.1641 – 2.1641)		12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56
M	54.968 – 54.967 (2.1641 – 2.1641)		2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56
N	54.967 – 54.966 (2.1641 – 2.1640)		2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6
P	54.966 – 54.965 (2.1640 – 2.1640)		2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6
R	54.965 – 54.964 (2.1640 – 2.1639)		23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6
S	54.964 – 54.963 (2.1639 – 2.1639)		23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67
T	54.963 – 54.962 (2.1639 – 2.1639)		23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67
U	54.962 – 54.961 (2.1639 – 2.1638)		3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67
V	54.961 – 54.960 (2.1638 – 2.1638)		3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7
W	54.960 – 54.959 (2.1638 – 2.1637)		3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7
X	54.959 – 54.958 (2.1637 – 2.1637)		34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7
Y	54.958 – 54.957 (2.1637 – 2.1637)		34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	7
4	54.957 – 54.956 (2.1637 – 2.1636)		34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	7	7
7	54.956 – 54.955 (2.1636 – 2.1636)		4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	7	7	7

KBIA0149E

Main Bearing Selection Table (No.2 and 4 journals)

Crankshaft journal outer diameter / Cylinder block main bearing housing inner diameter		Mark	A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	S	T	U	V	W	X	Y	4	7
		Inner diameter Unit: mm (in)	58.944 – 58.945 (2.3206 – 2.3207)	58.945 – 58.946 (2.3207 – 2.3207)	58.946 – 58.947 (2.3207 – 2.3207)	58.947 – 58.948 (2.3207 – 2.3208)	58.948 – 58.949 (2.3208 – 2.3208)	58.949 – 58.950 (2.3208 – 2.3209)	58.950 – 58.951 (2.3209 – 2.3209)	58.951 – 58.952 (2.3209 – 2.3209)	58.952 – 58.953 (2.3209 – 2.3210)	58.953 – 58.954 (2.3210 – 2.3210)	58.954 – 58.955 (2.3210 – 2.3211)	58.955 – 58.956 (2.3211 – 2.3211)	58.956 – 58.957 (2.3211 – 2.3211)	58.957 – 58.958 (2.3211 – 2.3212)	58.958 – 58.959 (2.3212 – 2.3212)	58.959 – 58.960 (2.3212 – 2.3213)	58.960 – 58.961 (2.3213 – 2.3213)	58.961 – 58.962 (2.3213 – 2.3213)	58.962 – 58.963 (2.3213 – 2.3214)	58.963 – 58.964 (2.3214 – 2.3214)	58.964 – 58.965 (2.3214 – 2.3215)	58.965 – 58.966 (2.3215 – 2.3215)	58.966 – 58.967 (2.3215 – 2.3215)	58.967 – 58.968 (2.3215 – 2.3216)
Mark	Outer diameter Unit: mm (in)																									
A	54.979 – 54.978 (2.1645 – 2.1645)		0	0	0	0	0	0	0	0	01	01	01	1	1	1	12	12	12	2	2	2	23	23	23	3
B	54.978 – 54.977 (2.1645 – 2.1644)		0	0	0	0	0	0	0	01	01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3
C	54.977 – 54.976 (2.1644 – 2.1644)		0	0	0	0	0	0	01	01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3
D	54.976 – 54.975 (2.1644 – 2.1644)		0	0	0	0	0	01	01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34
E	54.975 – 54.974 (2.1644 – 2.1643)		0	0	0	0	01	01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34
F	54.974 – 54.973 (2.1643 – 2.1643)		0	0	0	01	01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34
G	54.973 – 54.972 (2.1643 – 2.1642)		0	0	01	01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4
H	54.972 – 54.971 (2.1642 – 2.1642)		0	01	01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4
J	54.971 – 54.970 (2.1642 – 2.1642)		01	01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4
K	54.970 – 54.969 (2.1642 – 2.1641)		01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45
L	54.969 – 54.968 (2.1641 – 2.1641)		01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45
M	54.968 – 54.967 (2.1641 – 2.1641)		1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45
N	54.967 – 54.966 (2.1641 – 2.1640)		1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5
P	54.966 – 54.965 (2.1640 – 2.1640)		1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5
R	54.965 – 54.964 (2.1640 – 2.1639)		12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5
S	54.964 – 54.963 (2.1639 – 2.1639)		12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56
T	54.963 – 54.962 (2.1639 – 2.1639)		12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56
U	54.962 – 54.961 (2.1639 – 2.1638)		2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56
V	54.961 – 54.960 (2.1638 – 2.1638)		2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6
W	54.960 – 54.959 (2.1638 – 2.1637)		2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6
X	54.959 – 54.958 (2.1637 – 2.1637)		23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6
Y	54.958 – 54.957 (2.1637 – 2.1637)		23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67
4	54.957 – 54.956 (2.1637 – 2.1636)		23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67
7	54.956 – 54.955 (2.1636 – 2.1636)		3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67

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Main Bearing Grade Table (All Journals)

Unit: mm (in)

Grade number	Thickness	Identification color (UPR / LWR)	Remarks
0	1.973 - 1.976 (0.0777 - 0.0778)	Black	Grade and color are the same for upper and lower bearings.
1	1.976 - 1.979 (0.0778 - 0.0779)	Brown	
2	1.979 - 1.982 (0.0779- 0.0780)	Green	
3	1.982 - 1.985 (0.0780 - 0.0781)	Yellow	
4	1.985 - 1.988 (0.0781 - 0.0783)	Blue	
5	1.988 - 1.991 (0.0783 - 0.0784)	Pink	
6	1.991 - 1.994 (0.0784 - 0.0785)	Purple	
7	1.994 - 1.997 (0.0785 - 0.0786)	White	

Grade number		Thickness	Identification color (UPR / LWR)	Remarks
01	UPR	1.973 - 1.976 (0.0777 - 0.0778)	Black / Brown	Grade and color are different for upper and lower bearings.
	LWR	1.976 - 1.979 (0.0778 - 0.0779)		
12	UPR	1.976 - 1.979 (0.0778 - 0.0779)	Brown / Green	
	LWR	1.979 - 1.982 (0.0779 - 0.0780)		
23	UPR	1.979 - 1.982 (0.0779- 0.0780)	Green / Yellow	
	LWR	1.982 - 1.985 (0.0780 - 0.0781)		
34	UPR	1.982 - 1.985 (0.0780 - 0.0781)	Yellow / Blue	
	LWR	1.985 - 1.988 (0.0781 - 0.0783)		
45	UPR	1.985 - 1.988 (0.0781 - 0.0783)	Blue / Pink	
	LWR	1.988 - 1.991 (0.0783 - 0.0784)		
56	UPR	1.988 - 1.991 (0.0783 - 0.0784)	Pink / Purple	
	LWR	1.991 - 1.994 (0.0784 - 0.0785)		
67	UPR	1.991 - 1.994 (0.0784 - 0.0785)	Purple / White	
	LWR	1.994 - 1.997 (0.0785 - 0.0786)		

Use Undersize Bearing Usage Guide

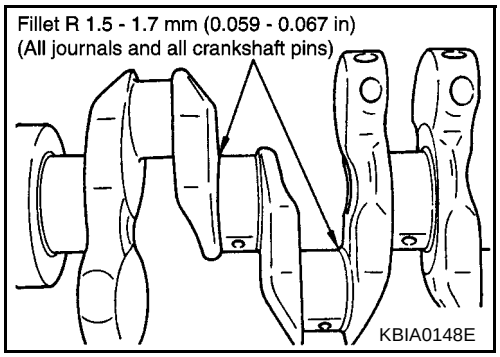
- Use undersize (US) bearing when oil clearance with standard size main bearing is not within specification.
- When using undersize (US) bearing, measure the bearing inner diameter with bearing installed, and grind journal until oil clearance falls within specification.

Bearing undersize table

Unit: mm (in)

Size		Thickness
US	0.25 (0.0098)	2.106 - 2.114 (0.0829 - 0.0832)

CAUTION:
Keep fillet R when grinding crankshaft journal in order to use undersize bearing (All journals).



Inspection After Disassembly

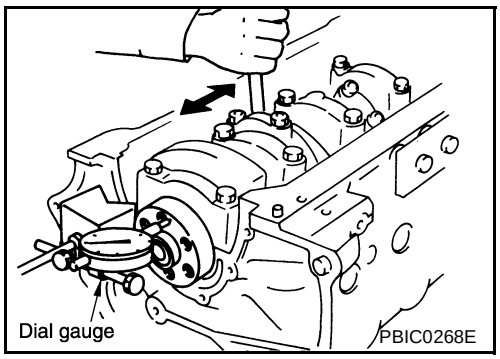
EBS00DHZ

CRANKSHAFT SIDE CLEARANCE

- Using a dial gauge, measure the clearance between the thrust bearings and the crankshaft arm when the crankshaft is moved fully forward or backward.

  Standard : 0.10 - 0.26 mm (0.0039 - 0.0102 in)
  Limit : 0.30 mm (0.0118 in)

- If the measured value exceeds the limit, replace the thrust bearings, and measure again. If it still exceeds the limit, replace the crankshaft also.



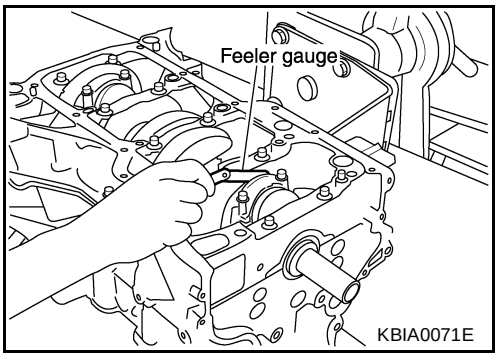
CONNECTING ROD SIDE CLEARANCE

- Measure side clearance between connecting rod and crankshaft arm with feeler gauge.

  Standard : 0.20 - 0.35 mm (0.0079 - 0.0138 in)

  Limit : 0.50 mm (0.0197 in)

- If the measured value exceeds the limit, replace the connecting rod bearings, and measure again. If it still exceeds the limit, replace the crankshaft also.

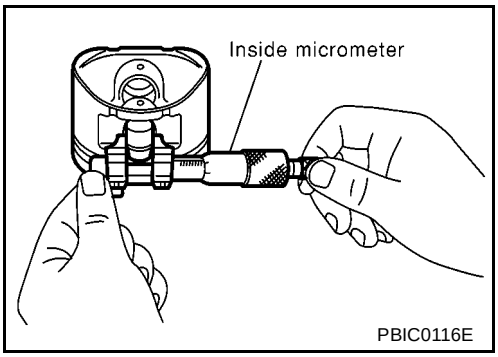


PISTON AND PISTON PIN CLEARANCE

Inner Diameter of Piston Pin

Measure the inner diameter of piston pin bore with an inside micrometer.

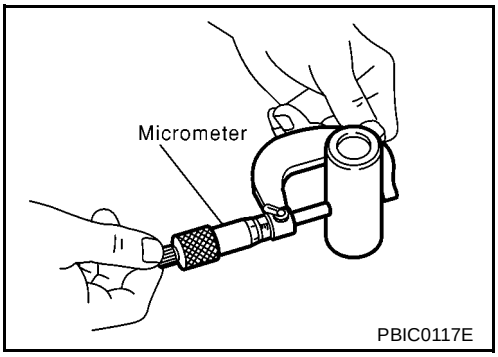
Standard: 19.993 - 20.005 mm (0.7871 - 0.7876 in)



Outer Diameter of Piston Pin

Measure outer diameter of piston pin with a micrometer.

Standard: 19.989 - 20.001 mm (0.7870 - 0.7874 in)

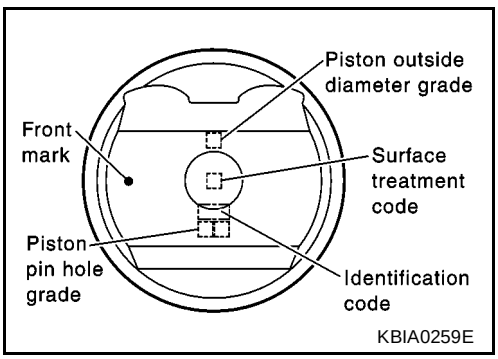


Piston and Piston Pin Clearance

(Piston pin clearance) = (Piston pin bore diameter) – (Outer diameter of piston pin)

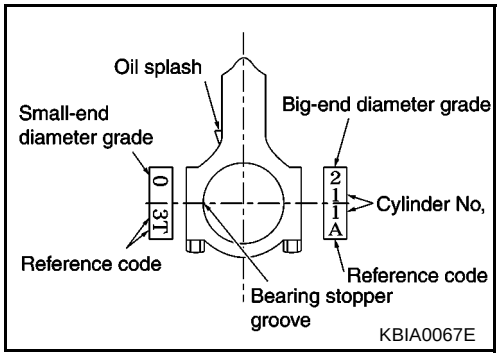
Standard: 0.002 - 0.006 mm (0.0001 - 0.0002 in)

- If clearance exceeds specification, replace either or both of piston/piston pin assembly and connecting rod assembly with reference to specification of each parts.
- Refer to piston selection table to replace piston/piston pin assembly. Refer to EM-78, "HOW TO SELECT PISTON" .
- Refer to connecting rod bearing selection table to replace connecting rod. Refer to EM-78, "HOW TO SELECT CONNCTING ROD BEARING" .



NOTE:

- The connecting rod small end grade and piston pin hole (piston pin) grade are provided only for the parts installed at the plant. For service parts, no grades can be selected. (Only 0 grade is available.)
- Refer to EM-87, "CONNECTING ROD BUSHING OIL CLEARANCE (SMALL END)" for the values for each grade at the plant.
- Regarding marks on piston head, Refer to EM-78, "HOW TO SELECT PISTON" .



PISTON RING SIDE CLEARANCE

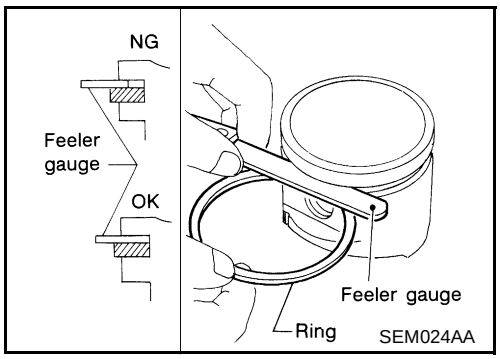
- Measure side clearance of piston ring and piston ring groove with feeler gauge.

Standard:

Top ring	**: 0.045 - 0.080 mm (0.0018 - 0.0031 in)**
2nd ring	**: 0.030 - 0.070 mm (0.0012 - 0.0028 in)**
Oil ring	**: 0.065 - 0.135 mm (0.0026 - 0.0053 in)**

Limit:

Top ring	**: 0.11 mm (0.0043 in)**
2nd ring	**: 0.10 mm (0.0039 in)**



- If out of specification, replace piston and/or piston ring assembly.

PISTON RING END GAP

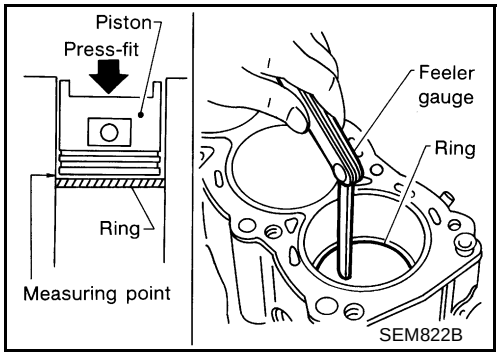
- Check if inner diameter of cylinder bore is within specification. Refer to EM-89, "PISTON TO CYLINDER BORE CLEARANCE" .
- Insert piston ring until middle of cylinder with piston, and measure gap.

Standard:

Top ring	**: 0.21 - 0.31 mm (0.0083 - 0.0122 in)**
2nd ring	**: 0.32 - 0.47 mm (0.0126 - 0.0185 in)**
Oil ring	**: 0.20 - 0.60 mm (0.0079 - 0.0236 in)**

Limit:

Top ring	**: 0.54 mm (0.0213 in)**
2nd ring	**: 0.67 mm (0.0264 in)**
Oil ring	**: 0.95 mm (0.0374 in)**



- If out of specification, replace piston ring. If gap still exceeds the limit even with a new ring, re-bore cylinder and use oversized piston and piston ring.

CONNECTING ROD BEND AND TORSION

- Check with connecting rod aligner.

Bend

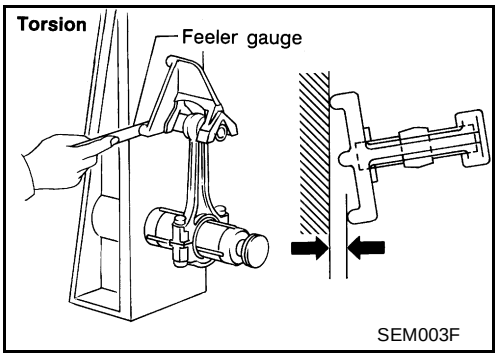
Limit:

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

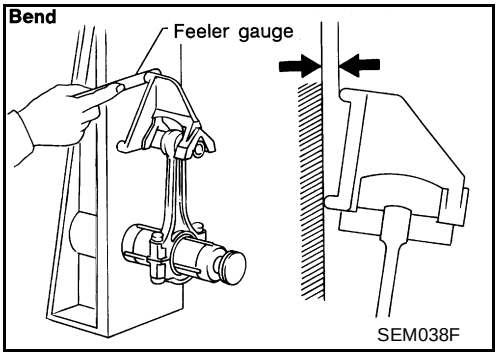
Torsion

Limit:

0.30 mm (0.0118 in) per 100 mm (3.94 in) length.



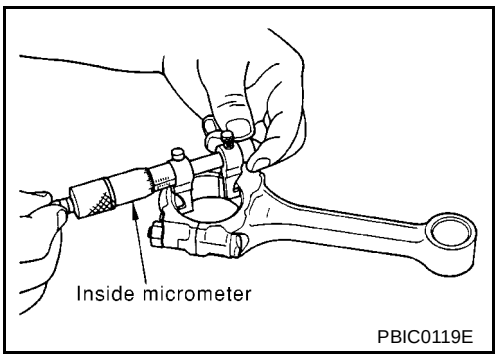
- If it exceeds the limit, replace connecting rod assembly.



CONNECTING ROD BEARING (BIG END)

Install the connecting rod cap without the connecting rod bearing installed. After tightening the connecting rod bolt to the specified torque, measure the connecting rod big end inner diameter using an inside micrometer.

Standard: 48.000 - 48.013 mm (1.8898 - 1.8903 in)

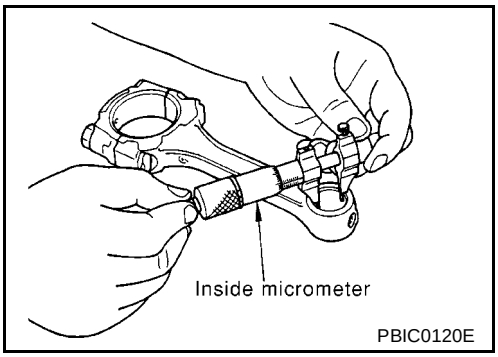


CONNECTING ROD BUSHING OIL CLEARANCE (SMALL END)

Inner Diameter of Connecting Rod (Small End)

Measure inner diameter of bushing.

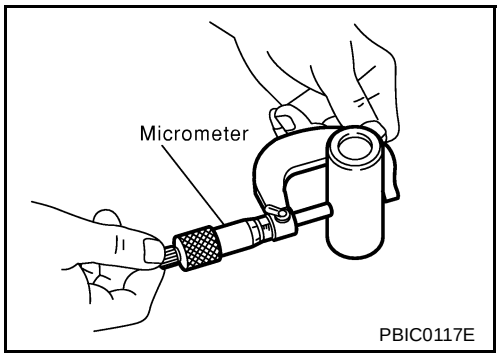
Standard: 20.000 - 20.012 mm (0.7874 - 0.7879 in)



Outer Diameter of Piston Pin

Measure outer diameter of piston pin.

Standard: 19.989 - 20.001 mm (0.7870 - 0.7874 in)

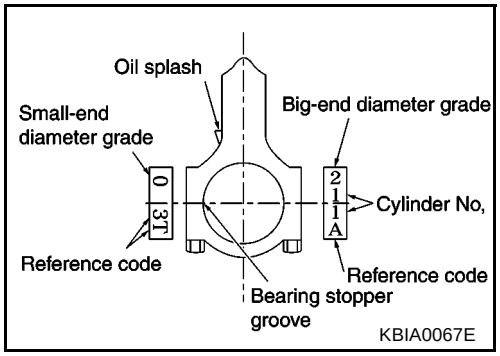


Connecting Rod Bushing Oil Clearance (Small End)

(Connecting rod small end oil clearance) = (Inner diameter of connecting rod small end) – (Outer diameter of piston pin)

Standard: 0.005 - 0.017 mm (0.0002 - 0.0007 in)

- If the measured value exceeds the standard, replace the connecting rod assembly and/or piston and piston pin assembly.
- If replacing the piston and piston pin assembly, refer to the “Piston Selection Table” to select the piston corresponding to the applicable bore grade of the cylinder block to be used. Refer to EM-78, "HOW TO SELECT PISTON" .

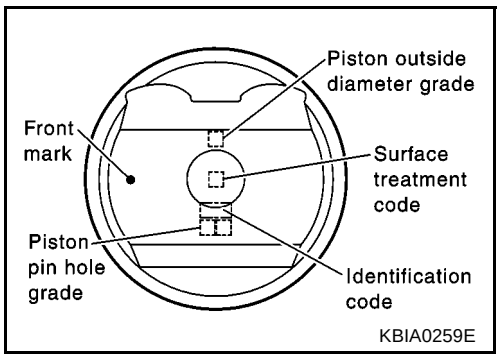


Factory installed parts grading:

Service parts apply only to grade 0.

Unit: mm (in)

Grade	0	1
Connecting rod small end inner diameter	20.000 - 20.006 (0.7874 - 0.7876)	20.006 - 20.012 (0.7876 - 0.7879)
Piston pin outer diameter	19.989 - 19.995 (0.7870 - 0.7872)	19.995 - 20. 001 (0.7872 - 0.7874)
Piston pin bore diameter	19.993 - 19.999 (0.7871- 0.7874)	19.999 - 20.005 (0.7874 - 0.7876)

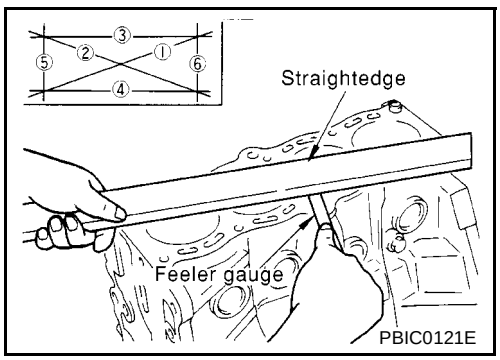


CYLINDER BLOCK DISTORTION

- Using a scraper, remove gasket on the cylinder block surface, and also remove oil, scale, carbon, or other contamination.

  CAUTION:
  Be careful not to allow gasket flakes to enter the oil or coolant passages.
- Measure the distortion on the block upper face at some different points in 6 directions.

  Limit: 0.1 mm (0.004 in)
- If out of the distortion limit, replace the cylinder block.



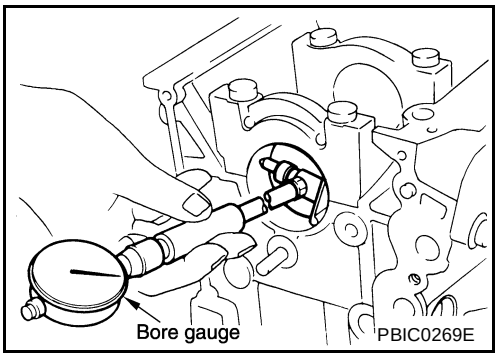
INNER DIAMETER OF MAIN BEARING HOUSING

- Install the main bearing caps with the main bearings removed, and tighten the mounting bolts to the specified torque.
- Using a bore gauge, measure the inner diameter of the main bearing housing.

Standard: 58.944 - 58.967 mm (2.3206 - 2.3215 in)

- If out of the standard, replace the cylinder block and lower cylinder block assembly.

NOTE:
These components cannot be replaced as a single unit because they were processed together.



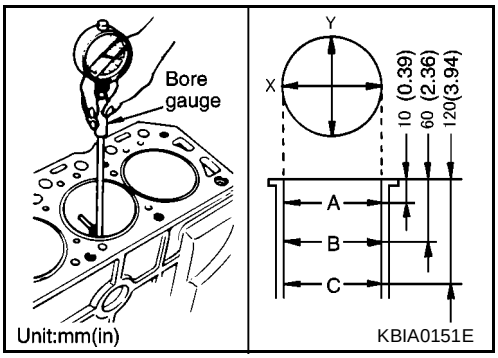
PISTON TO CYLINDER BORE CLEARANCE

Inner Diameter of Cylinder Bore

- Using a bore gauge, measure cylinder bore for wear, out-of-round and taper at 6 different points on each cylinder. (X and Y directions at A, B and C)(Y is in longitudinal direction of engine)

NOTE:
When determining cylinder bore grade, measure cylinder bore at B position.

Standard inner diameter:
89.000 - 89.030 mm (3.5039 - 3.5051 in)
Wear limit:
0.2 mm (0.008 in)
Out-of-round (Difference between X and Y):
0.015 mm (0.0006 in)
Taper limit (Difference between A and C):
0.01 mm (0.0004 in)



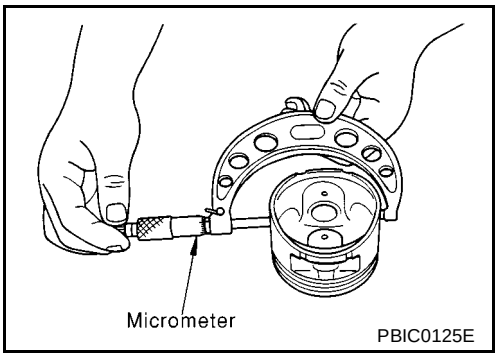
- If the measured value exceeds the limit, or if there are scratches and/or seizure on the cylinder inner wall, hone or re-bore the inner wall.
- An oversize piston is provided. When using an oversize piston, re-bore the cylinder so that the clearance of the piston cylinder satisfies the standard.

Over size (OS): 0.2 mm (0.008 in)

Outer Diameter of Piston

- Measure piston skirt diameter.

Standard: 88.980 - 89.010 mm (3.5031 - 3.5043 in)



- Measure point (Distance from the top): 42 mm (1.65 in)

Piston to Cylinder Bore Clearance

- Calculate by outer diameter of piston skirt and inner diameter of cylinder (direction X, position B).
(Clearance) = (Inner diameter of cylinder) – (Outer diameter of piston skirt).

Standard : 0.010 - 0.030 mm (0.0004 - 0.0012 in)
Limit : 0.08 mm (0.0031 in)

- If it exceeds the limit, replace piston/piston pin assembly.

Re-boring Cylinder Bore

1. Cylinder bore size is determined by adding piston-to-bore clearance to piston diameter “A”.

   Re-bored size calculation: D = A + B - C
   where,
   D: Bored diameter
   A: Piston diameter as measured
   B: Piston - to - bore clearance (standard value)
   C: Honing allowance 0.02 mm (0.0008 in)

2. Install main bearing caps, and tighten to the specified torque. Otherwise, cylinder bores may be distorted in final assembly.
3. Cut cylinder bores.
   - **When any cylinder needs boring, all other cylinders must also be bored.**
   - **Do not cut too much out of cylinder bore at a time. Cut only 0.05 mm (0.0020 in) or so in diameter at a time.**
4. Hone cylinders to obtain specified piston-to-bore clearance.
5. Measure finished cylinder bore for out-of-round and taper.
   - **Measurement should be done after cylinder bore cools down.**

OUTER DIAMETER OF CRANKSHAFT JOURNAL

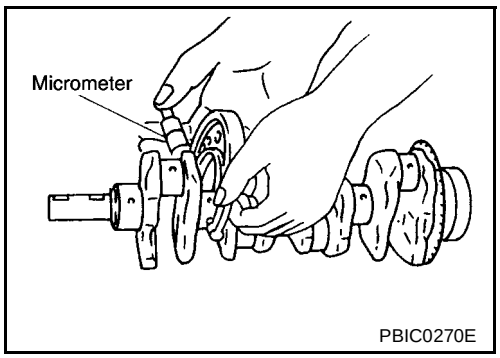
Measure outer diameter of crankshaft journals.

Standard: 54.955 - 54.979 mm (2.1636 - 2.1645 in)

OUTER DIAMETER OF CRANKSHAFT PIN

Measure outer diameter of crankshaft pin.

Standard: 44.956 - 44.974 mm (1.7699-1.7706 in)

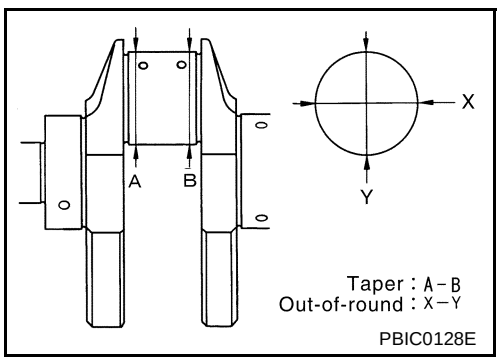


OUT-OF-ROUND AND TAPER OF CRANKSHAFT

- Using a micrometer, measure the dimensions at 4 different points shown in the figure on each journal and pin.
- Out-of-round is indicated by the difference in dimensions between X and Y at A and B.
- Taper is indicated by the difference in dimension between A and B at X and Y.

Limit:

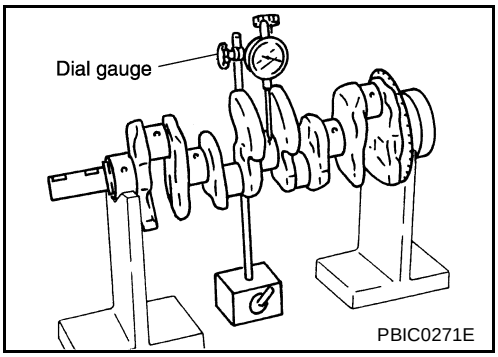
Out-of-round (X– Y) : 0.005 mm (0.0002 in)
Taper (A – B) : 0.005 mm (0.0002 in)



CRANKSHAFT RUNOUT

- Place a V-block on a precise flat table to support the journals on the both end of the crankshaft.
- Place a dial gauge straight up on the No. 3 journal.
- While rotating the crankshaft, read the movement of the pointer on the dial gauge. (Total indicator reading)

Limit: 0.10 mm (0.004 in)

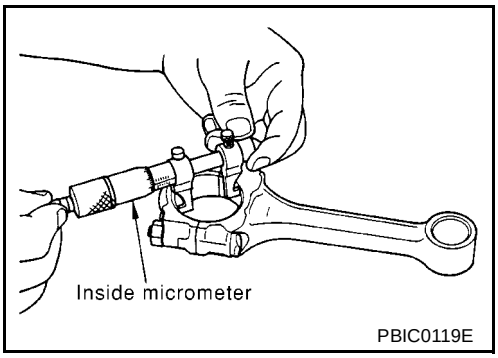


OIL CLEARANCE OF CONNECTING ROD BEARING

Method of Measurement

- Install the connecting rod bearings to the connecting rod and the cap, and tighten the connecting rod bolts to the specified torque. Using a inside micrometer measure the inner diameter of connecting rod bearing.
(Oil clearance) = (Inner diameter of connecting rod bearing) – (Outer diameter of crankshaft pin)

Standard : 0.028 - 0.045 mm (0.0011 - 0.0018 in)
Limit : 0.10 mm (0.0039 in)



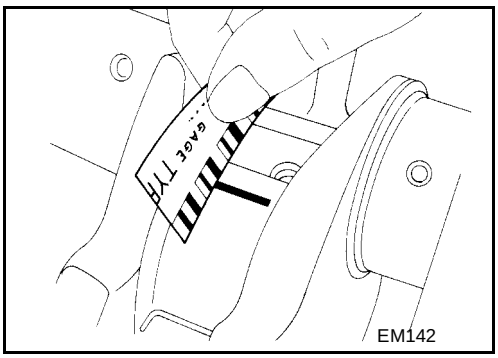
- If clearance cannot be adjusted within the standard, grind crankshaft pin and use undersized bearing. Refer to EM-78, "HOW TO SELECT CONNCTING ROD BEARING" .

Method of Using Plastigauge

- Remove oil and dust on the crankshaft pin and the surfaces of each bearing completely.
- Cut a plastigauge slightly shorter than the bearing width, and place it in crankshaft axial direction, avoiding oil holes.
- Install the connecting rod bearings to the connecting rod cap, and tighten the connecting rod bolts to the specified torque.

CAUTION:
Never rotate the crankshaft.

- Remove the connecting rod cap and bearings, and using the scale on the plastigauge bag, measure the plastigauge width.



NOTE:
The procedure when the measured value exceeds the limit is same as that described in the method by calculation.

OIL CLEARANCE OF MAIN BEARING

Method of Measurement

- Install the main bearings to the cylinder block and bearing cap. Measure the main bearing inner diameter with the bearing cap bolt tightened to the specified torque.
(Oil clearance) = (Inner diameter of main bearing) – (Outer diameter of crankshaft journal)

Standard
No. 1, 3 and 5 journals : 0.012 - 0.022 mm (0.0005 - 0.0009 in)
No. 2 and 4 journals : 0.018 - 0.028 mm (0.0007 - 0.0011 in)
Limit : 0.1 mm (0.004 in)

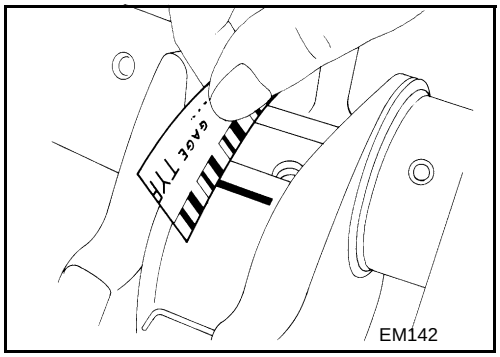
- If the measured value exceeds the limit, select main bearings referring to the main bearing inner diameter and crankshaft journal outer diameter, so that the oil clearance satisfies the standard. Refer to EM-81, "HOW TO SELECT MAIN BEARING" .

Method of Using Plastigauge

- Remove oil and dust on the crankshaft journal and the surfaces of each bearing completely.
- Cut a plastigauge slightly shorter than the bearing width, and place it in crankshaft axial direction, avoiding oil holes.
- Tighten the main bearing bolts to the specified torque.

  CAUTION:
  Never rotate the crankshaft.
- Remove the bearing cap and bearings, and using the scale on the plastigauge bag, measure the plastigauge width.

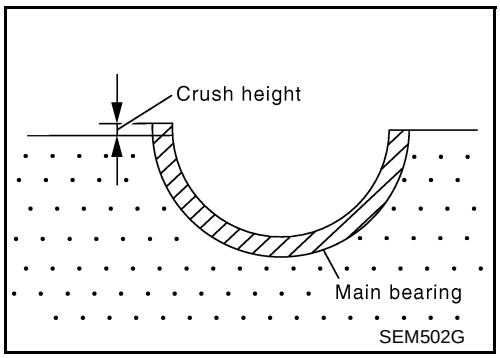
  NOTE:
  The procedure when the measured value exceeds the limit is same as that described in “the method by calculation.”



CRUSH HEIGH OF MAIN BEARING

- When the bearing cap is removed after being tightened to the specified torque with main bearings installed, the tip end of bearing must protrude.

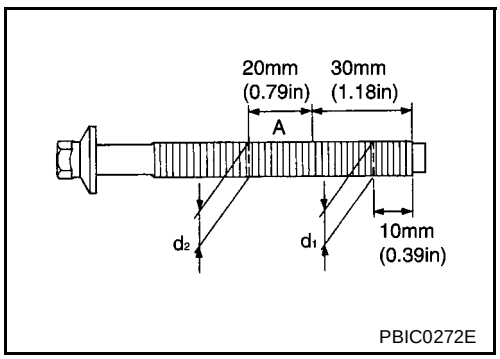
  Standard: There must be crush height.
- If the standard is not met, replace main bearings.



OUTER DIAMETER OF LOWER CYLINDER BLOCK MOUNTING BOLT

- Perform only with M10 (0.39 in) bolts.
- Measure outer diameters (d1, d2) at two positions shown in the figure.
- Measure d2 at a point within block A.
- When the value of d1- d2 exceeds the limit (a large difference in dimensions), replace the bolt with a new one.

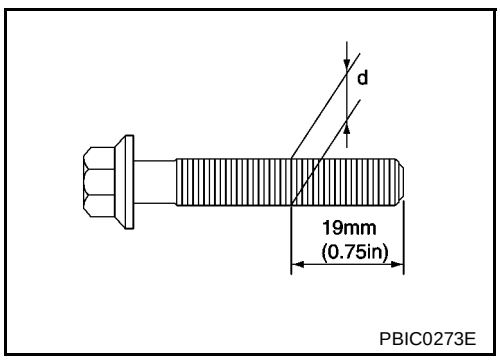
  Limit: 0.13 mm (0.0051 in) or more.



OUTER DIAMETER OF CONNECTING ROD BOLT

- Measure outer diameter (d) at position shown in the figure.
- When “d ” exceeds the limit (when it becomes thinner), replace the bolt with a new one.

  Limit: 7.75 mm (0.3051 in) or less.



MOVEMENT AMOUNT OF FLYWHEEL (M/T MODELS)

NOTE:

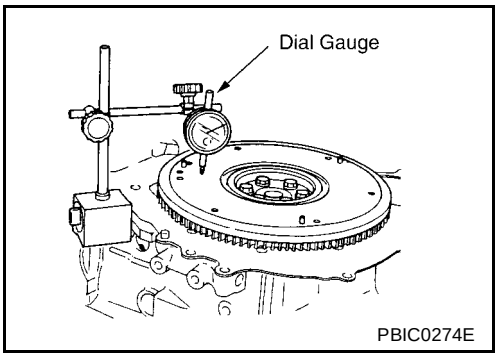
- Inspection for double mass flywheel only.
- Do not disassembly double mass flywheel.

Flywheel Deflection

- Measure deflection of flywheel contact surface to the clutch with a dial gauge.
- Measure deflection at 210 mm (8.27 in) dia.

  Standard : 0.45 mm (0.0177 in) or less.
  Limit : 1.3 mm (0.051 in) or less.

- When measured value exceeds the limit, replace it with a new one.



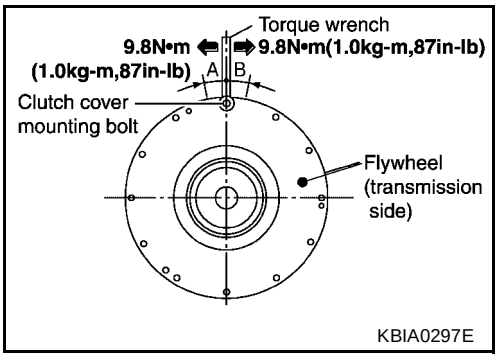
Movement Amount in Radial (rotation) Direction

Check the movement amount in the following procedure.

1. Install a bolt to clutch cover mounting hole, and place a torque wrench on the extended line of the flywheel center line.
   - Tighten bolt at a force of 9.8 N·m (1kg-m, 87 in-lb) to keep it from loosening.
2. Put a mating mark on circumferences of the two flywheel masses without applying any load (Measurement standard points).
3. Apply a force of 9.8 N·m (1kg-m, 87 in-lb) in each direction, and mark the movement amount on the mass on the transmission side.
4. Measure dimensions of movement amounts A and B on circumference of the flywheel on the transmission side.

   Standard: 28.3 mm (1.114 in) or less.

   - When measured value is outside the standard, replace flywheel.



SERVICE DATA AND SPECIFICATIONS (SDS)

PFP:00030

Standard and Limit

EBS00DI0

GENERAL SPECIFICATIONS

Cylinder arrangement		4.in-line
Displacement	cm^3 (cu in)	2,488 (151.82)
Bore and stroke	mm (in)	89.0 x 100.0 (3.504 x 3.937)
Valve arrangement		DOHC
Firing order		1-3-4-2
Number of piston rings	Compression	2
	Oil	1
Compression ratio		9.5
Compression pressure kPa (bar, kg/cm^2 , psi) / 250 rpm	Standard	1,250 (12.5, 12.8, 181.3)
	Minimum	1,060 (10.6, 10.8, 153.7)
	Differential limit between cylinders	0.1 (1.0, 1.0, 14)

DRIVE BELTS

Tension of drive belts	Auto adjustment by auto-tensioner

INTAKE MANIFOLD AND EXHAUST MANIFOLD

Unit: mm (in)

Item		Limit
Surface distortion	Intake manifold collector	0.1 (0.004)
	Intake manifold	0.1 (0.004)
	Exhaust manifold	0.3 (0.012)

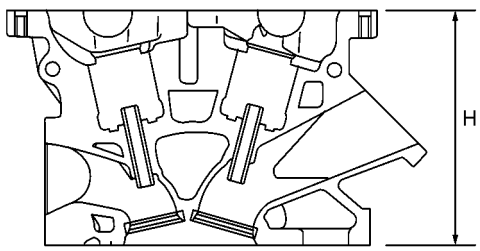
SPARK PLUG

Make		NGK	
Model type		With catalyst	Without catalyst
Standard type		LFR5A-11	LFR5A
Hot type		LFR4A-11	LFR4A
Cold type		LFR6A-11	LFR6A
Spark plug gap	mm(in)	1.0 - 1.1 (0.039 - 0.043)	0.8 - 0.9 (0.031 - 0.035)

CYLINDER HEAD

Unit: mm (in)

Item	Limit
Head surface distortion	0.1 (0.004)

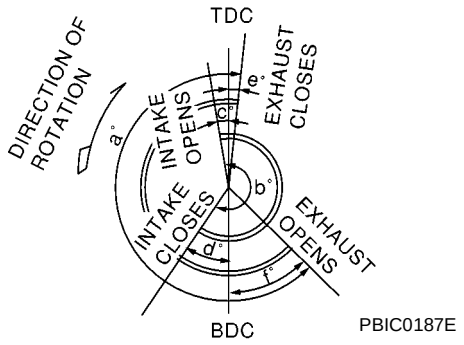


Nominal cylinder head height:
H = 129.4 mm (5.09 in) PBIC0283E

VALVE

Valve timing

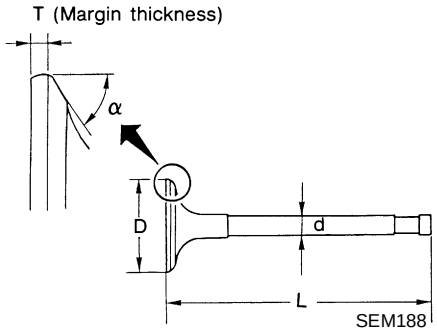
Unit: degree

Valve timing	 PBIC0187E

a	b	c	d	e	f
224	244	0	64	3	41

Valve Dimensions

Unit: mm (in)



Valve head diameter “D”	Intake	35.5 - 35.8 (1.398 - 1.409)
	Exhaust	30.5 - 30.8 (1.201 - 1.213)
Valve length “L”	Intake	97.16 (3.8252)
	Exhaust	98.82 (3.8905)
Valve stem diameter “d”	Intake	5.965 - 5.980 (0.2348 - 0.2354)
	Exhaust	5.955 - 5.970 (0.2344 - 0.2350)
Valve seat angle “α”	Intake	45°15′ - 45°45′
	Exhaust	
Valve margin “T”	Intake	1.1 (0.043)
	Exhaust	1.3 (0.051)

Valve Clearance

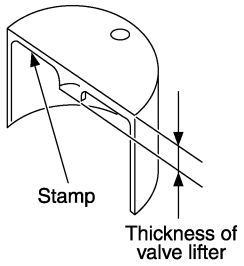
Unit: mm (in)

Item	Cold* (reference data)	Hot
Intake	0.24 - 0.32 (0.009 - 0.013)	0.32 - 0.40 (0.013 - 0.016)
Exhaust	0.26 - 0.34 (0.010 - 0.013)	0.33 - 0.41 (0.013 - 0.016)

*: Reference data at approximately 20°C (68°F)

Available Valve Lifter

Thickness mm (in)	Identification mark



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6.96 (0.2740)	696
6.98 (0.2748)	698
7.00 (0.2756)	700
7.02 (0.2764)	702
7.04 (0.2772)	704
7.06 (0.2780)	706
7.08 (0.2787)	708
7.10 (0.2795)	710
7.12 (0.2803)	712
7.14 (0.2811)	714
7.16 (0.2819)	716
7.18 (0.2827)	718
7.20 (0.2835)	720
7.22 (0.2843)	722
7.24 (0.2850)	724
7.26 (0.2858)	726
7.28 (0.2866)	728
7.30 (0.2874)	730
7.32 (0.2882)	732
7.34 (0.2890)	734
7.36 (0.2898)	736
7.38 (0.2906)	738
7.40 (0.2913)	740
7.42 (0.2921)	742
744 (0.2929)	744
7.46 (0.2937)	746

Valve Spring

Free height mm (in)	Standard	Intake	44.84 - 45.34 (1.7654 - 1.7850)
		Exhaust	45.28 - 45.78 (1.7827 - 1.8024)
Pressure N (kg, lb) at height mm (in)	Standard	Intake and exhaust	151 - 175 (15.4 - 17.8, 34 - 39) at 35.30 (1.390)
Out-of-square mm (in)			Less than 1.9 (0.0748)

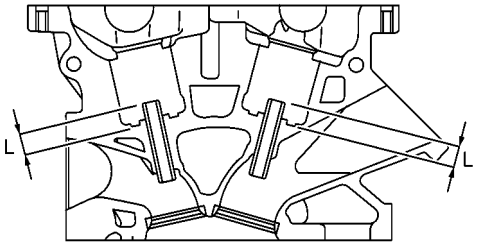
Valve Lifter

Unit: mm (in)

Item	Standard
Valve lifter outer diameter	33.965 - 33.980 (1.3372 - 1.3378)
Lifter guide inner diameter	34.000 - 34.021 (1.3386 - 1.3394)
Clearance between lifter and lifter guide	0.020 - 0.056 (0.0008 - 0.0022)

Valve Guide

Unit: mm (in)

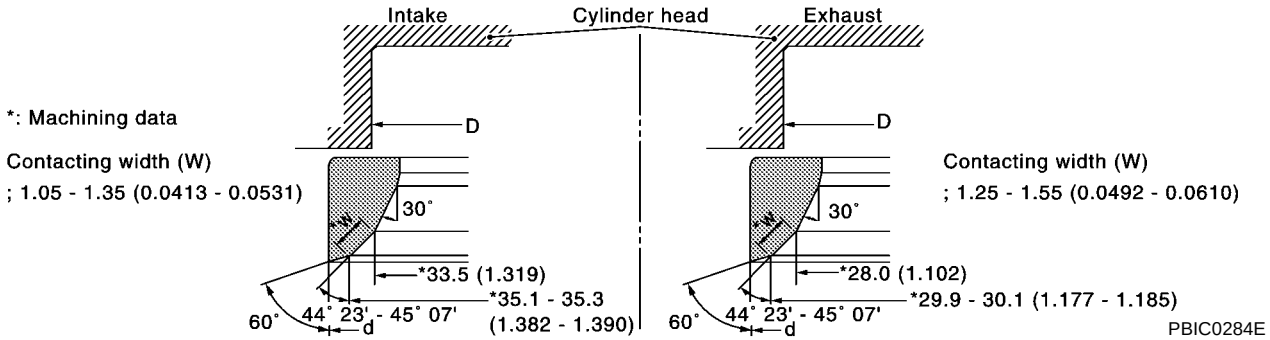


PBIC0184E

Item		Standard part	Service part
Valve guide	Outer diameter	10.023 - 10.034 (0.3946 - 0.3950)	10.223 - 10.234 (0.4025 - 0.4029)
	Inner diameter (Finished size)	6.000 - 6.018 (0.2362 - 0.2369)	
Cylinder head valve guide hole diameter		9.975 - 9.996 (0.3927 - 0.3935)	10.175 - 10.196 (0.4006 - 0.4014)
Interference fit of valve guide		0.027 - 0.059 (0.0011 - 0.0023)	
Stem to guide clearance	Intake	0.020 - 0.053 (0.0008 - 0.0021)	
	Exhaust	0.030 - 0.063 (0.0012 - 0.0025)	
Projection length “L”	Intake	10.1 - 10.3 (0.398 - 0.406)	
	Exhaust	10.0 - 10.4 (0.394 - 0.409)	

Valve Seat

Unit: mm (in)



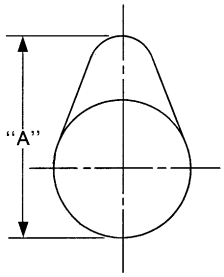
PBIC0284E

Item		Standard part	Service part
Cylinder head seat recess diameter (D)	Intake	36.500 - 36.516 (1.4370 - 1.4376)	37.000 - 37.016 (1.4567 - 1.4573)
	Exhaust	31.500 - 31.516 (1.2402 - 1.2408)	32.000 - 32.016(1.2598 - 1.2605)
Valve seat interference fit	Intake	0.081 - 0.113 (0.0032 - 0.0044)	
	Exhaust	0.084 - 0.116 (0.0033 - 0.0046)	
Valve seat outer diameter (d)	Intake	36.597 - 36.613 (1.4408 - 1.4415)	37.097 - 37.113 (1.4605 - 1.4611)
	Exhaust	31.600 - 31.616 (1.2441 - 1.2447)	32.100 - 32.116 (1.2638 - 1.2644)

CAMSHAFT AND CAMSHAFT BEARING

Unit: mm (in)

Item	Standard
Camshaft runout [TIR] (Total indicator reading)	Less than 0.04 (0.0016)



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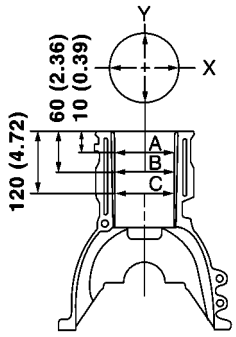
Cam height "A"	Intake	45.665 - 45.855 (1.7978 - 1.8053)
	Exhaust	43.975 - 44.165 (1.7313 - 1.7388)
Outer diameter of camshaft journal	No.1	27.935 - 27.955 (1.0998 - 1.1006)
	No. 2, 3, 4 and 5	23.435 - 23.455 (0.9226 - 0.9234)
Inner diameter of camshaft bracket	No.1	28.000 - 28.021 (1.1024 - 1.1032)
	No. 2, 3, 4 and 5	23.500 - 23.521 (0.9252 - 0.9260)
Camshaft journal clearance		0.045 - 0.086 (0.0018 - 0.0034)
Camshaft end play		0.115 - 0.188 (0.0045 - 0.0074)
Camshaft sprocket runout [TIR] (Total indicator reading)		Less than 0.15 (0.0059)

CYLINDER BLOCK

Unit: mm (in)



PBIC0281E

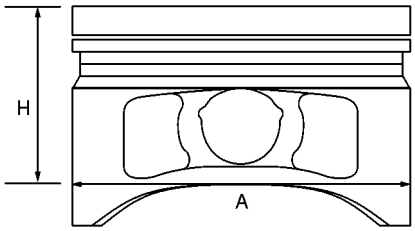
Surface flatness		Limit		0.1 (0.004)
Cylinder bore	Inner diameter	Standard	Grade No. 1	89.000 - 89.010 (3.5039 - 3.5043)
			Grade No. 2	89.010 - 89.020 (3.5043 - 3.5047)
			Grade No. 3	89.020 - 89.030 (3.5047 - 3.5051)
		Wear limit		0.2 (0.008)
	Out-of-round (X – Y)			Less than 0.015 (0.0006)
	Taper (C– A)			Less than 0.01 (0.0004)

Main journal inner diameter grade (Without bearing)		Grade No. A	58.944 - 58.945 (2.3206 - 2.3207)
		Grade No. B	58.945 - 58.946 (2.3207 - 2.3207)
		Grade No. C	58.946 - 58.947 (2.3207 - 2.3207)
		Grade No. D	58.947 - 58.948 (2.3207 - 2.3208)
		Grade No. E	58.948 - 58.949 (2.3208 - 2.3208)
		Grade No. F	58.949 - 58.950 (2.3208 - 2.3209)
		Grade No. G	58.950 - 58.951 (2.3209 - 2.3209)
		Grade No. H	58.951 - 58.952 (2.3209 - 2.3209)
		Grade No. J	58.952 - 58.953 (2.3209 - 2.3210)
		Grade No. K	58.953 - 58.954 (2.3210 - 2.3210)
		Grade No. L	58.954 - 58.955 (2.3210 - 2.3211)
		Grade No. M	58.955 - 58.956 (2.3211 - 2.3211)
		Grade No. N	58.956 - 58.957 (2.3211 - 2.3211)
		Grade No. P	58.957 - 58.958 (2.3211 - 2.3212)
		Grade No. R	58.958 - 58.959 (2.3212 - 2.3212)
		Grade No. S	58.959 - 58.960 (2.3212 - 2.3213)
		Grade No. T	58.960 - 58.961 (2.3213 - 2.3213)
		Grade No. U	58.961 - 58.962 (2.3213 - 2.3213)
		Grade No. V	58.962 - 58.963 (2.3213 - 2.3214)
		Grade No. W	58.963 - 58.964 (2.3214 - 2.3214)
		Grade No. X	58.964 - 58.965 (2.3214 - 2.3215)
		Grade No. Y	58.965 - 58.966 (2.3215 - 2.3215)
		Grade No. 4	58.966 - 58.967 (2.3215 - 2.3215)
		Grade No. 7	58.967 - 58.968 (2.3215 - 2.3216)
Difference in inner diameter between cylinders	Standard		Less than 0.03 (0.0012)

PISTON, PISTON RING AND PISTON PIN

Available Piston

Unit: mm (in)



PBIC0188E

Piston skirt diameter “A”	Standard	Grade No. 1	88.980 - 88.990 (3.5031- 3.5035)
		Grade No. 2	88.990 - 89.000 (3.5035 - 3.5039)
		Grade No. 3	89.000 - 89.010 (3.5039 - 3.5043)
		0.20 (0.0079) oversize (Service)	89.180 - 89.210 (3.5110 - 3.5122)
Piston height “H” dimension			42 (1.65)
Piston pin bore diameter		Grade No.0	19.993 - 19.999 (0.7871 - 0.7874)
		Grade No.1	19.999 - 20.005 (0.7874 - 0.7876)
Piston clearance to cylinder block		Standard	0.010 - 0.030 (0.0004 - 0.0012)
		Limit	0.08 (0.0031)

Piston Ring

Unit: mm (in)

Item		Standard	Limit
Side clearance	Top	0.045 - 0.080 (0.0018 - 0.0031)	0.11 (0.0043)
	2nd	0.030 - 0.070 (0.0012 - 0.0028)	0.10 (0.004)
	Oil ring	0.065 - 0.135 (0.0026 - 0.0053)	—

End gap	Top	0.21- 0.31 (0.0083 - 0.0122)	0.54 (0.0213)
	2nd	0.32 - 0.47 (0.0126 - 0.0185)	0.67 (0.0264)
	Oil (rail ring)	0.20 - 0.60 (0.0079 - 0.0236)	0.95 (0.0374)

Piston Pin

Unit: mm (in)

Piston pin outer diameter	Grade No.0	19.989 - 19.995 (0.7870 - 0.7872)
	Grade No.1	19.995 - 20.001 (0.7872 - 0.7874)
Interference fit of piston pin to piston		0.002 - 0.006 (0.0001 - 0.0002)
Piston pin to connecting rod bushing clearance	Standard	0.005 - 0.017 (0.0002 - 0.0007)

CONNECTING ROD

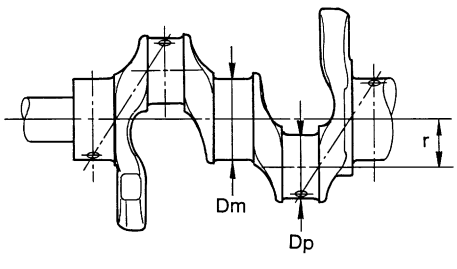
Unit: mm (in)

Center distance		143.0 - 143.10 (5.63 - 5.63)
Bend [per 100 (3.94)]	Limit	0.15 (0.0059)
Torsion [per 100 (3.94)]	Limit	0.30 (0.0118)
Connecting rod small end inner diameter		22.000 - 22.020 (0.8661 - 0.8669)
Piston pin bushing inner diameter*	Grade No. 0	20.000 - 20.006 (0.7874 - 0.7876)
	Grade No. 1	20.006 - 20.012 (0.7876 - 0.7879)
Connecting rod big end inner diameter		48.000 - 48.013 (1.8898 - 1.8903)
Side clearance	Standard	0.20 - 0.35 (0.0079 - 0.0138)
	Limit	0.50 (0.0197)
Connecting rod bearing housing	Grade No. 0 Grade No. 1 Grade No. 2 Grade No. 3 Grade No. 4 Grade No. 5 Grade No. 6 Grade No. 7 Grade No. 8 Grade No. 9 Grade No. A Grade No. B Grade No. C	48.000- 48.001 (1.8898 - 1.8898) 48.001- 48.002 (1.8898 - 1.8898) 48.002- 48.003 (1.8898 - 1.8899) 48.003 - 48.004 (1.8899 - 1.8899) 48.004 - 48.005 (1.8899 - 1.8900) 48.005 - 48.006 (1.8900 - 1.8900) 48.006 - 48.007 (1.8900 - 1.8900) 48.007 - 48.008 (1.8900 - 1.8901) 48.008 - 48.009 (1.8901- 1.8901) 48.009 - 48.010 (1.8901- 1.8902) 48.010 - 48.011 (1.8902 - 1.8902) 48.011 - 48.012 (1.8902 - 1.8902) 48.012 - 48.013 (1.8902 - 1.8903)

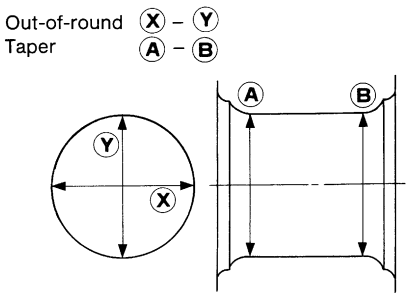
*: After installing in connecting rod

CRANKSHAFT

Unit: mm (in)



SEM645



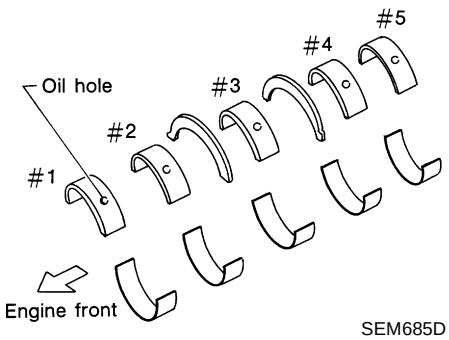
SEM715

Center distance “r”		49.60 - 50.04 (1.9528 - 1.9701)
Out-of-round (X – Y)	Standard	Less than 0.005 (0.0002)
Taper (A – B)	Standard	Less than 0.005 (0.0002)
Runout [TIR] (Total indicator reading)	Limit	Less than 0.10 (0.004)

Free end play	Standard	0.10 - 0.26 (0.0039 - 0.0102)
	Limit	0.30 (0.0118)
Pin journal grade. “DP”	Grade No. A	44.974 - 44.973 (1.7706 - 1.7706)
	Grade No. B	44.973 - 44.972 (1.7706 - 1.7705)
	Grade No. C	44.972 - 44.971 (1.7705 - 1.7705)
	Grade No. D	44.971 - 44.970 (1.7705 - 1.7705)
	Grade No. E	44.970 - 44.969 (1.7705 - 1.7704)
	Grade No. F	44.969 - 44.968 (1.7704 - 1.7704)
	Grade No. G	44.968 - 44.967 (1.7704 - 1.7704)
	Grade No. H	44.967 - 44.966 (1.7704 - 1.7703)
	Grade No. J	44.966 - 44.965 (1.7703 - 1.7703)
	Grade No. K	44.965 - 44.964 (1.7703 - 1.7702)
	Grade No. L	44.964 - 44.963 (1.7702 - 1.7702)
	Grade No. M	44.963 - 44.962 (1.7702 - 1.7702)
	Grade No. N	44.962 - 44.961 (1.7702 - 1.7701)
	Grade No. P	44.961 - 44.960 (1.7701 - 1.7701)
	Grade No. R	44.960 - 44.959 (1.7701 - 1.7700)
	Grade No. S	44.959 - 44.958 (1.7700 - 1.7700)
	Grade No. T	44.958 - 44.957 (1.7700 - 1.7700)
	Grade No. U	44.957- 44.956 (1.7700 - 1.7699)
Main journal grade. “Dm”	Grade No. A	54.979 - 54.978 (2.1645 - 2.1645)
	Grade No. B	54.978 - 54.977 (2.1645 - 2.1644)
	Grade No. C	54.977 - 54.976 (2.1644 - 2.1644)
	Grade No. D	54.976 - 54.975 (2.1644 - 2.1644)
	Grade No. E	54.975 - 54.974 (2.1644 - 2.1643)
	Grade No. F	54.974 - 54.973 (2.1643 - 2.1643)
	Grade No. G	54.973 - 54.972 (2.1643 - 2.1642)
	Grade No. H	54.972 - 54.971 (2.1642 - 2.1642)
	Grade No. J	54.971 - 54.970 (2.1642 - 2.1642)
	Grade No. K	54.970 - 54.969 (2.1642 - 2.1641)
	Grade No. L	54.969 - 54.968 (2.1641 - 2.1641)
	Grade No. M	54.968 - 54.967 (2.1641 - 2.1641)
	Grade No. N	54.967 - 54.966 (2.1641 - 2.1640)
	Grade No. P	54.966 - 54.965 (2.1640 - 2.1640)
	Grade No. R	54.965 - 54.964 (2.1640 - 2.1639)
	Grade No. S	54.964 - 54.963 (2.1639 - 2.1639)
	Grade No. T	54.963 - 54.962 (2.1639 - 2.1639)
	Grade No. U	54.962 - 54.961 (2.1639 - 2.1638)
	Grade No. V	54.961 - 54.960 (2.1638 - 2.1638)
	Grade No. W	54.960 - 54.959 (2.1638 - 2.1637)
	Grade No. X	54.959 - 54.958 (2.1637 - 2.1637)
	Grade No. Y	54.958 - 54.957 (2.1637 - 2.1637)
	Grade No. 4	54.957 - 54.956 (2.1637 - 2.1636)
	Grade No. 7	54.956 - 54.955 (2.1636 - 2.1636)

MAIN BEARING

Unit: mm (in)



SEM685D

Grade number	Thickness	Identification color (UPR / LWR)	Remarks

0		1.973 - 1.976 (0.0777 - 0.0778)	Black	Grade and color are the same for upper and lower bearings.
1		1.976 - 1.979 (0.0778 - 0.0779)	Brown	
2		1.979 - 1.982 (0.0779 - 0.0780)	Green	
3		1.982 - 1.985 (0.0780 - 0.0781)	Yellow	
4		1.985 - 1.988 (0.0781 - 0.0783)	Blue	
5		1.988 - 1.991 (0.0783 - 0.0784)	Pink	
6		1.991 - 1.994 (0.0784 - 0.0785)	Purple	
7		1.994 - 1.997 (0.0785 - 0.0786)	White	
01	UPR	1.973 - 1.976 (0.0777 - 0.0778)	Black / Brown	Grade and color are different for upper and lower bearings.
	LWR	1.976 - 1.979 (0.0778 - 0.0779)		
12	UPR	1.976 - 1.979 (0.0778 - 0.0779)	Brown / Green	
	LWR	1.979 - 1.982 (0.0779 - 0.0780)		
23	UPR	1.979 - 1.982 (0.0779 - 0.0780)	Green / Yellow	
	LWR	1.982 - 1.985 (0.0780 - 0.0781)		
34	UPR	1.982 - 1.985 (0.0780 - 0.0781)	Yellow / Blue	
	LWR	1.985 - 1.988 (0.0781 - 0.0783)		
45	UPR	1.985 - 1.988 (0.0781 - 0.0783)	Blue / Pink	
	LWR	1.988 - 1.991 (0.0783 - 0.0784)		
56	UPR	1.988 - 1.991 (0.0783 - 0.0784)	Pink / Purple	
	LWR	1.991 - 1.994 (0.0784 - 0.0785)		
67	UPR	1.991 - 1.994 (0.0784 - 0.0785)	Purple / White	
	LWR	1.994 - 1.997 (0.0785 - 0.0786)		

Undersize

Unit: mm (in)

Item	Thickness	Main journal diameter
US 0.25 (0.0098)	2.106 - 2.114 (0.0829 - 0.0832)	Grind so that bearing clearance is the specified value.

Bearing Clearance

Unit: mm (in)

Main bearing clearance	Standard	No.1, 3 and 5	0.012 - 0.022 (0.0005 - 0.0009)
		No.2 and 4	0.018 - 0.028 (0.0007 - 0.0011)
	Limit		0.1(0.004)

CONNECTING ROD BEARING

Grade number	Thickness mm (in)	Identification color (mark)
0	1.499 - 1.495 (0.0590 - 0.0589)	Black
1	1.503 - 1.499 (0.0592 - 0.0590)	Brown
2	1.507 - 1.503 (0.0593 - 0.0592)	Green
3	1.511 - 1.507 (0.0595 - 0.0593)	Yellow

Undersize

Unit: mm (in)

Item	Thickness	Crank pin journal diameter
US 0.25 (0.0098)	1.624 - 1.632 (0.0639 - 0.0643)	Grind so that bearing clearance is the specified value.

Bearing Clearance

Unit: mm (in)

Connecting rod bearing clearance	Standard	0.028 - 0.045 (0.0011 - 0.0018)
	Limit	0.10 (0.0039)

Tightening Torque

EBS00DI1

Unit: N·m (kg-m, ft-lb) N·m (kg-m, in-lb)*2

*1: Parts to be tightened in particular orders.

1)-: Order of tightening when tightening two or more times separately.

	Auto-tensioner		19.6 - 23.5 (2.0 - 2.4, 15 - 17)
	Mass air flowsensor		4.3 - 5.8 (0.44 - 0.59, 38 - 51) *2
	Resonetor		3.8 - 4.5 (0.39 - 0.46, 34 - 39)*2
	Air cleaner case lower		3.8 - 4.5 (0.39 - 0.46, 34 - 39)*2
	Air cleaner case lower bracket (For A/T models)	For the Middle East models	3.8 - 4.5 (0.39 - 0.46, 34 - 39)*2
		Except for the Middle East models	6.3 - 7.5 (0.65 - 0.76, 56 - 76))*2
*1	Intake manifold		17.6 - 21.6 (1.8 - 2.2, 13 - 15)
	Intake manifold collector		17.6 - 21.6 (1.8 - 2.2, 13 - 15)
	Intake manifold support		17.6 - 21.6 (1.8 - 2.2, 13 - 15)
	Electric throttle control actuator		7.2 - 9.6 (0.74 - 0.98, 64 - 84) *2
	EVAP canister purge volume control solenoid valve		4.3 - 5.8 (0.44 - 0.59, 38 - 51) *2
*1	Exhaust manifold		39.2 - 44.1 (4.0 - 4.5, 29 - 32)
	Exhaust manifold cover		5.1 - 6.5 (0.52 - 0.66, 46 - 57) *2
	Heated oxygen sensor		40 - 50(4.1 - 5.1, 30 - 36)
*1	Oil pan upper	M6 bolt	8.1 - 9.5 (0.83 - 0.97, 72 - 84) *2
		M8 bolt	19.6 - 23.5 (2.0 - 2.4, 15 - 17)
	Oil pan upper to transmission joint bolts		39.2 - 46.1 (4.0 - 4.7, 29 - 34)
*1	Oil pan lower		6.4 - 7.5 (0.65 - 0.76, 57 - 66) *2
	Oil pan drain plug		29.4 - 39.2 (3.0 - 4.0, 22 - 28)
	Rear plate cover		6.4 - 7.5 (0.65 - 0.76, 57 - 66) *2
	Oil strainer	M6 bolt	8.1 - 9.5 (0.83 - 0.97, 72 - 84) *2
		M8 bolt	19.6 - 23.5 (2.0 - 2.4, 15 - 17)
	Oil level gauge guide		19.6 - 23.5 (2.0 - 2.4, 15 - 17)
	Ignition coil		5.4 - 7.3 (0.55 - 0.75, 48 - 64) *2
	Spark plug		19.6 - 29.4 (2.0 - 3.0, 15 - 21)
*1	Fuel tube		1) 9.3 - 10.8 (0.95 - 1.1, 0.7 - 0.8) *2 2) 20.6 - 26.5 (2.1 - 2.7, 16 - 19)
*1	Rocker cover		1) 0.98 - 2.9 (0.1 - 0.3, 9 - 25) *2 2) 7.4 - 9.3 (0.75 - 0.95, 66 - 82) *2
	PCV valve		1.96 - 2.94 (0.20 - 0.30, 18 - 26) *2
	Intake valve timing control solenoid valve		5.4 - 7.3 (0.55 - 0.75, 48 - 64) *2
*1	Intake valve timing control cover		11.8 - 13.7 (1.2 - 1.4, 9 - 10)
	Camshaft position sensor (PHASE)		5.4 - 7.3 (0.55 - 0.75, 48 - 64) *2
	Camshaft sprocket (Intake and Exhaust)		127- 157 (13.0 - 16.0, 94 - 115)
	Chain tensioner		6.4 - 7.5 (0.65 - 0.76, 57 - 66) *2

*1	Camshaft bracket		1) 2) 3) 4)	2.0 (0.2, 17) *2 2.0 (0.2, 17) *2 5.9 (0.6, 52) *2 9.0 - 11.8 (0.92 - 1.20, 80 - 104) *2
	Crankshaft pulley		1) 2)	37.3 - 47.1 (3.8 - 4.8, 28 - 34) 60° - 66° (Angle tightening)
*1	Front cover			11.8 - 13.7 (1.2 - 1.4, 9 - 10)
	Timing chain slack guide			15.7 - 17.7 (1.6 - 1.8, 12 - 13)
	Timing chain tension guide			15.7 - 17.7 (1.6 - 1.8, 12 - 13)
	Balancer unit timing chain tensioner			6.4 - 7.5 (0.65 - 0.76, 57 - 66) *2
*1	Balancer unit		1) 2) 3) 4) 5)	45.2 - 51.0 (4.6 - 5.2, 34 - 37) 90° - 95° (Angle tightening) 0 (0.0, 0) 45.2 - 51.0 (4.6 - 5.2, 34 - 37) 90° - 95° (Angle tightening)
*1	Cylinder head		1) 2) 3) 4) 5)	98.1 (10.0, 72) 0 (0.0, 0) 34.3 - 44.1 (3.54.5, 26 - 32) 75° - 80° (Angle tightening) 75° - 80° (Angle tightening)
	Flywheel (M/T)			103 - 113 (10.5 - 11.5, 76 - 83)
	Drive plate (A/T)			103 - 113 (10.5 - 11.5, 76 - 83)
	Connecting rod bearing cap		1) 2)	18.6 - 20.6 (1.9 - 2.1, 14 - 15) 90° - 95° (Angle tightening)
*1	Lower cylinder block	M10 bolt M10 bolt M8 bolt	1) 2) 3)	36.3 - 42.2 (3.7 - 4.3, 27 - 31) 60° - 65° (Angle tightening) 19.6 - 24.5 (2.0 - 2.5, 15 - 18)
	Knock sensor			15.7 - 26.5 (1.6 - 2.7, 12 - 19)
	Oil pressure switch			12.3 - 17.2 (1.25 -1.75, 9 - 12)
	Signal plate			12 - 14 (1.2 - 1.4, 9 - 10)
	Crankshaft position sensor (POS)			5.4 - 7.3 (0.55 - 0.75, 48 - 64) *2

PRECAUTIONS

PFP:00001

Precautions for Drain Coolant

EBS00DI3

- Drain coolant when engine is cooled.

Precautions for Disconnecting Fuel Piping

EBS00DI4

- Before starting work, make sure no fire or spark producing items are in the work area.
- Release fuel pressure before disassembly.
- After disconnecting pipes, plug openings to stop fuel leakage.

Precautions for Removal and Disassembly

EBS00DI5

- When instructed to use special service tools, use the specified tools. Always be careful to work safely, avoid forceful or uninstructed operations.
- Exercise maximum care to avoid damage to mating or sliding surfaces.
- Cover openings of engine system with tape or the equivalent, if necessary, to seal out foreign materials.
- Mark and arrange disassembly parts in an organized way for easy troubleshooting and re-assembly.
- When loosening nuts and bolts, as a basic rule, start with the one furthest outside, then the one diagonally opposite, and so on. If the order of loosening is specified, do exactly as specified.

Precautions for Inspection, Repair and Replacement

EBS00DI6

- Before repairing or replacing, thoroughly inspect parts. Inspect new replacement parts in the same way, and replace if necessary.

Precautions for Assembly and Installation

EBS00DI7

- Use torque wrench to tighten bolts or nuts.
- When tightening nuts and bolts, as a basic rule, equally tighten in several different steps starting with the ones in center, then ones on inside and outside diagonally in this order. If the order of tightening is specified, do exactly as specified.
- Replace with new gasket, packing, oil seal or O-ring.
- Thoroughly wash, clean, and air-blow each part. Carefully check oil or coolant passages for any restriction and blockage.
- Avoid damaging sliding or mating surfaces. Completely remove foreign materials such as cloth lint or dust. Before assembly, oil sliding surfaces well.
- Release air within route after draining coolant.
- After repairing, start engine and increase engine speed to check coolant, fuel, oil, and exhaust systems for leakage.

Parts Requiring Angular Tightening

EBS00DI8

- Use an angle wrench for the final tightening of the following engine parts:
  - Cylinder head bolts
  - Main bearing cap bolts
  - Connecting rod cap nuts
  - Crankshaft pulley bolt (No angle wrench is required as the bolt flange is provided with notches for angular tightening)
- Do not use a torque value for final tightening.
- The torque value for these parts are for a preliminary step.
- Ensure thread and seat surfaces are clean and coated with engine oil.

Precautions for Liquid Gasket

EBS00DI9

REMOVAL OF LIQUID GASKET SEALING

- After removing the mounting bolts and nuts, disconnect and remove the liquid gasket sealing using a seal cutter.

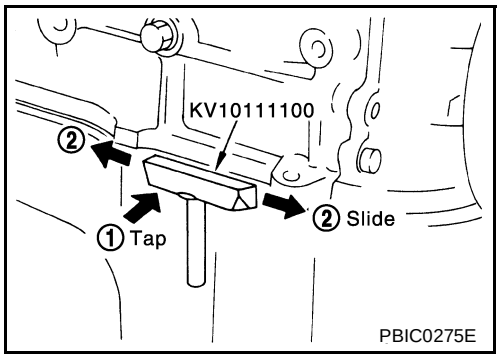
CAUTION:

Be careful not to damage the mating surfaces.

- In areas where the cutter is difficult to use, use a plastic hammer to lightly tap the areas where the liquid gasket is applied.

CAUTION:

If for some unavoidable reason a tool such as a flat-bladed screwdriver is used, be careful not to damage the mating surfaces.

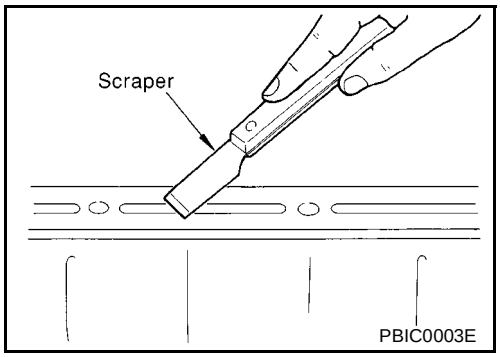


LIQUID GASKET APPLICATION PROCEDURE

1. Using a scraper, remove the old liquid gasket adhering to the gasket application surface and the mating surface.

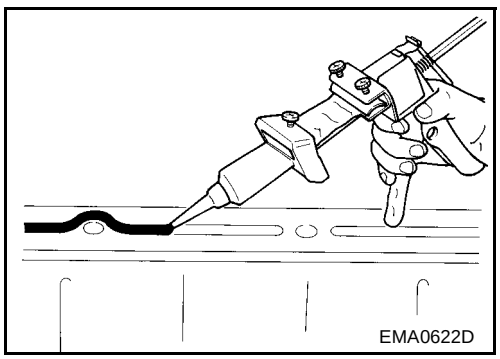
- Remove the liquid gasket completely from the groove of the gasket application surface, mounting bolts, and bolt holes.

2. Wipe the gasket application surface and the mating surface with white gasoline (lighting and heating use) to remove adhering moisture, grease and foreign materials.
3. Attach the liquid gasket to the tube presser.
   Use Genuine Liquid Gasket or equivalent.



4. Apply the gasket without breaks to the specified location with the specified dimensions.

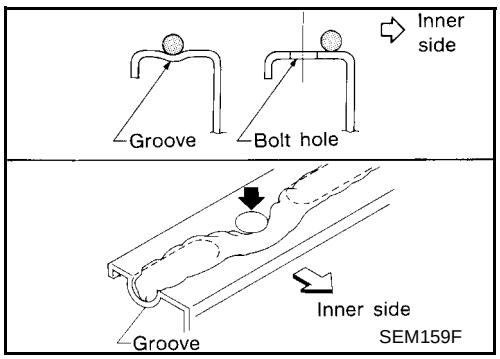
- If there is a groove for the liquid gasket application, apply the gasket to the groove.



- As for the bolt holes, normally apply the gasket inside the holes. Occasionally, it should be applied outside the holes. Make sure to read the this service manual.
- Within five minutes of gasket application, install the mating component.
- If the liquid gasket protrudes, wipe it off immediately.
- Do not retighten after the installation.
- After 30 minutes or more have passed from the installation, fill the engine oil and coolant.

CAUTION:

If there are specific instructions in this service manual, observe them.

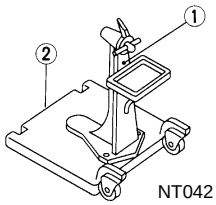
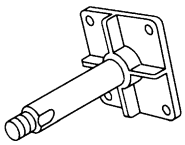
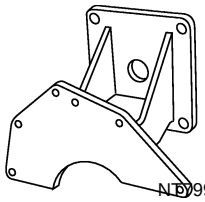
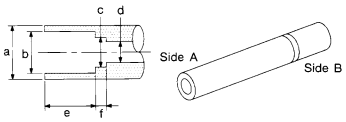
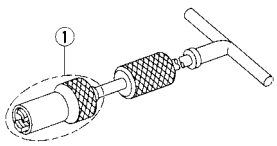
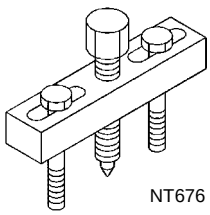


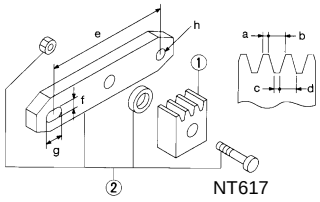
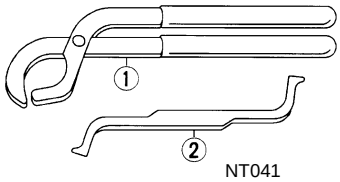
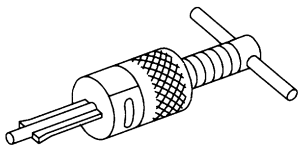
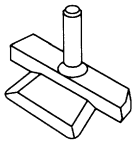
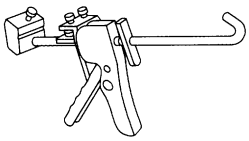
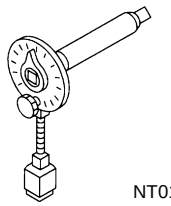
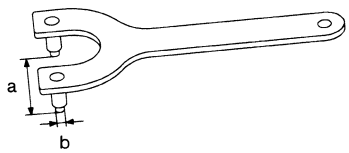
PREPARATION

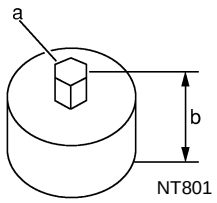
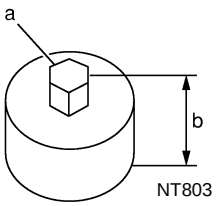
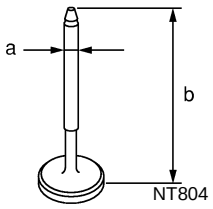
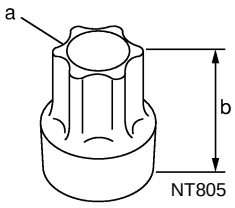
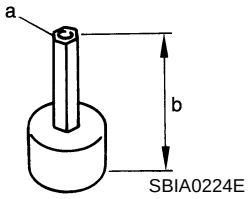
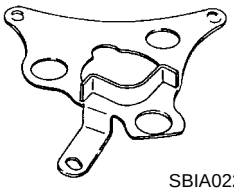
PFP:00002

Special Service Tools

EBS00DIA

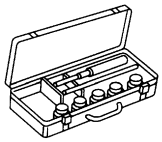
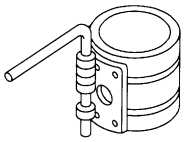
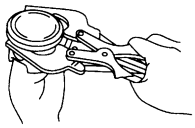
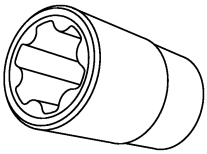
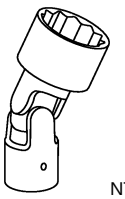
Tool number Tool name		Description
ST0501S000 Engine stand assembly 1 ST05011000 Engine stand 2 ST05012000 Base	 NT042	Disassembling and assembling
KV10106500 Engine stand shaft	 NT028	
KV11105900 Engine sub-attachment	 NT099	Used with KV10106500
KV10115600 Valve oil seal drift	 NT603	Installing valve oil seal **Use side A.** **Side A** **a: 20 (0.79) dia.** **b: 13 (0.51) dia.** **c: 10.3 (0.406) dia.** **d: 8 (0.31) dia.** **e: 10.7 (0.421)** **f: 5 (0.20)** Unit: mm (in)
KV10107902 Valve oil seal puller 1 KV10116100 Valve oil seal puller adapter	 NT605	Removing valve oil seal
KV11103000 Injection pump drive gear puller	 NT676	Removing crankshaft pulley

Tool number Tool name		Description
KV101056S0 Ring gear stopper 1 KV10105630 Adapter 2 KV10105610 Plate	 NT617	Preventing crankshaft from rotating **a: 3 (0.12)** **b: 6.4 (0.252)** **c: 2.8 (0.110)** **d: 6.6 (0.260)** **e: 107 (4.21)** **f: 14 (0.55)** **g: 20 (0.79)** **h: 14 (0.55) dia.** Unit: mm (in)
KV101151S0 Lifter stopper set 1 KV10115110 Camshaft pliers 2 KV10115120 Lifter stopper	 NT041	Changing valve lifter shims
ST16610001 Pilot bushing puller	 NT045	Removing crankshaft pilot bushing
KV10111100 Seal cutter	 NT046	Removing steel oil pan and rear timing chain case
WS39930000 Tube presser	 NT052	Pressing the tube of liquid gasket
KV10112100 Angle wrench	 NT014	Tightening bolts for bearing cap, cylinder head, etc.
KV10109300 Pulley holder	 NT628	**a: 68 mm (2.68 in)** **b: 8 mm (0.31 in) dia.**

Tool number Tool name		Description
KV11106010 Hexagon wrench	 NT801	**a: 5 mm (0.20 in) (Face to face)** **b: 20 mm (0.79 in)**
KV11106020 Hexagon wrench	 NT803	**a: 6 mm (0.24 in) (Face to face)** **b: 20 mm (0.79 in)**
KV11106030 Positioning stopper pin	 NT804	**a: 6 mm (0.24 in) dia.** **b: 80 mm (3.15 in)**
KV11106040 TORX wrench	 NT805	**a: T70** **b: 26 mm (1.02 in)**
KV11106050 Hexagonal wrench	 SBIA0224E	**a: 6 mm (0.24 in) (Face to face)** **b: 42 mm (1.65 in)** Removing and installing mountingbolts of fuel injection pump sprocket
KV11106060 Sprocket holder	 SBIA0225E	Holding fuel injection pump sprocket

Commercial Service Tools

EBS00DIB

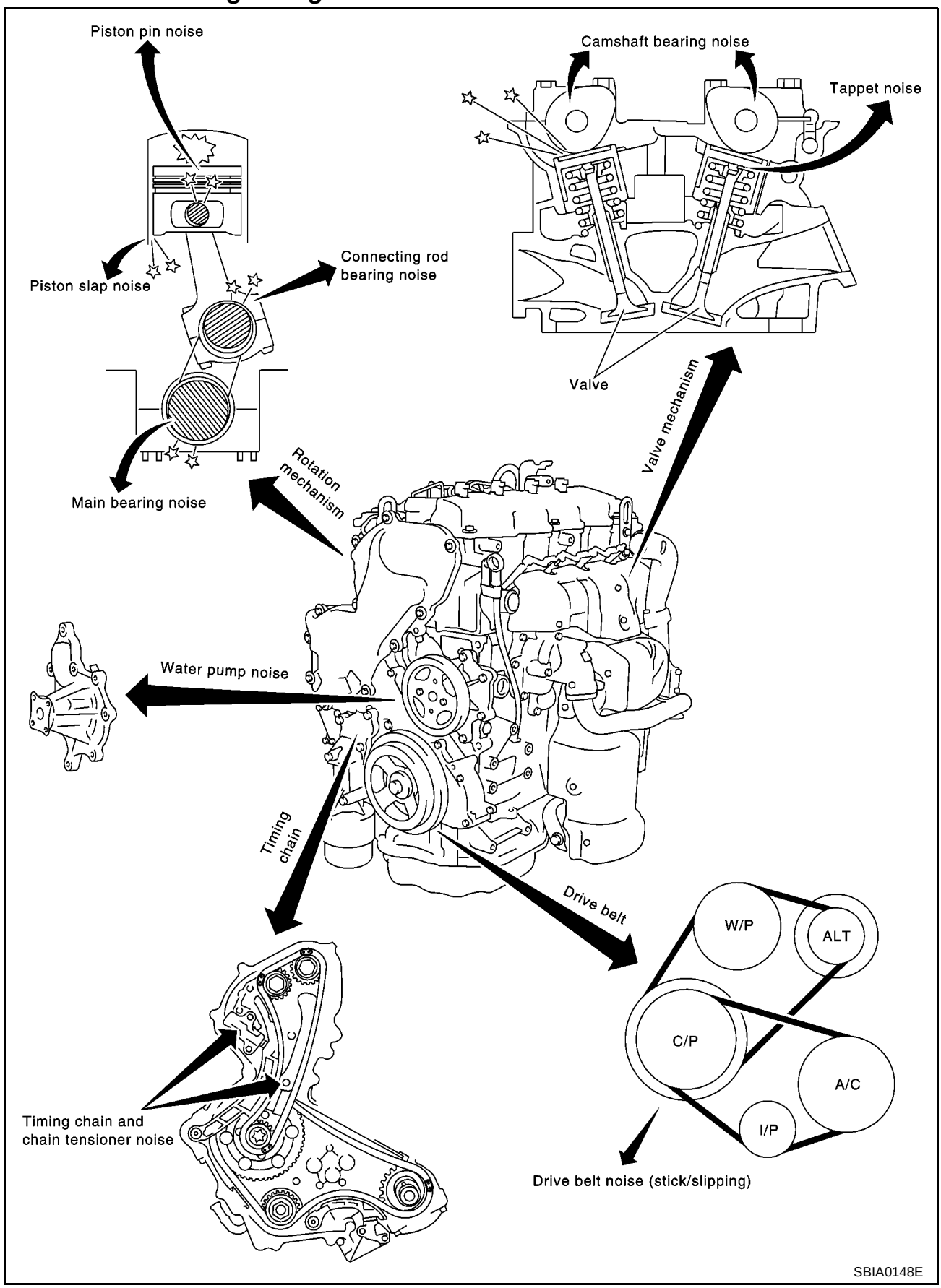
Tool name	Description
Valve seat cutter set  NT048	Finishing valve seat dimensions
Piston ring compressor  NT044	Installing piston assembly into cylinder bore
Piston ring expander  NT030	Removing and installing piston ring
TORX socket  NT807	
Standard Universal  NT808	

NOISE, VIBRATION, AND HARSHNESS (NVH) TROUBLESHOOTING

PFP:00003

Nvh Troubleshooting —Engine Noise

EBS00DIC



Use the Chart Below to Help You Find the Cause of the Symptom.

EBS00DID

1. Locate the area where noise occurs.
2. Confirm the type of noise.
3. Specify the operating condition of engine.
4. Check specified noise source.

If necessary, repair or replace these parts.

Location of noise	Type of noise	Operating condition of engine						Source of noise	Check item	Reference page
		Before warm-up	After warm-up	When starting	When idling	When racing	While driving			
Top of engine Rocker cover Cylinder head	Ticking or clicking	C	A	—	A	B	—	Tappet noise	Valve clearance	EM-157
	Rattle	C	A	—	A	B	C	Camshaft bearing noise	Camshaft oil clearance Camshaft runout	EM-154 EM-153
Crankshaft pulley Cylinder block (Side of engine) Oil pan	Slap or knock	—	A	—	B	B	—	Piston pin noise	Piston to piston pin clearance Connecting rod bushing oil clearance (Small end)	EM-204 EM-206
	Slap or rap	A	—	—	B	B	A	Piston slap noise	Piston to cylinder bore clearance Piston ring side clearance Piston ring end gap Connecting rod bend and torsion	EM-207 EM-204 EM-205 EM-205
	Knock	A	B	C	B	B	B	Connecting rod bearing noise	Connecting rod bushing oil clearance (Small end) Connecting rod bearing oil clearance (Big end)	EM-206 EM-209
	Knock	A	B	—	A	B	C	Main bearing noise	Main bearing oil clearance Crankshaft runout	EM-209 EM-209
Front of engine Timing chain cover	Tapping or ticking	A	A	—	B	B	B	Timing chain and chain tensioner noise	Timing chain cracks and wear Timing chain tensioner operation	EM-161 EM-166
Front of engine	Squeaking or fizzing	A	B	—	B	—	C	Drive belts (Sticking or slipping)	Drive belts deflection	EM-113
	Creaking	A	B	A	B	A	B	Drive belts (Slipping)	Idler pulley bearing operation	
	Squall Creak	A	B	—	B	A	B	Water pump noise	Water pump operation	CO-40, "WATER PUMP"

A: Closely related B: Related C: Sometimes related —: Not related

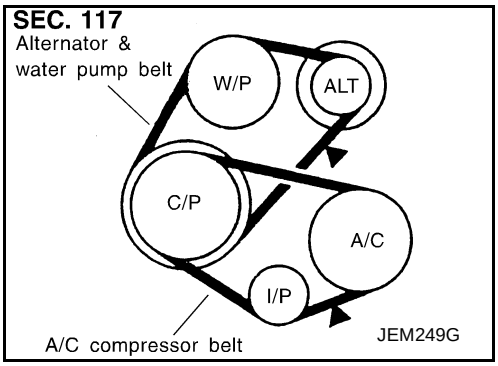
DRIVE BELTS

PFP:02117

Checking Drive Belts

EBS00DIE

- Before inspecting the engine, make sure the engine has cooled down; wait approximately 30 minutes after the engine has been stopped.
- Visually inspect all belts for wear, damage or cracks on contacting surfaces and edge areas.
- When measuring deflection, apply 98 N (10 kg, 22 lb) at the marked point (▲).



CAUTION:

- **When checking belt deflection immediately after installation, first adjust it to the specified value. Then, after turning the crankshaft two turns or more, re-adjust to the specified value to avoid variation in deflection between pulleys.**
- **Tighten idler pulley lock nut by hand and measure deflection without looseness.**

Belt Deflection:

Applied belt	Belt deflection with 98 N (10 kg, 22 lb) force applied* mm (in)		
	New	Adjusted	Limit for re-adjusting
Air conditioner compressor belt	4 - 5 (0.16 - 0.20)	6 - 7 (0.24 - 0.28)	8.5 (0.335)
Alternator and water pump belt	9.0 - 10.5 (0.354 - 0.413)	11.0 - 12.5 (0.433 - 0.492)	16.5 (0.650)

*: When engine is cold.

Tension Adjustment

EBS00DIF

- Adjust belts with the parts shown below.

Applied belt	Belt adjustment method
Air conditioner compressor belt	Adjusting bolt on idler pulley
Alternator water pump belt	Adjusting bolt on alternator

CAUTION:

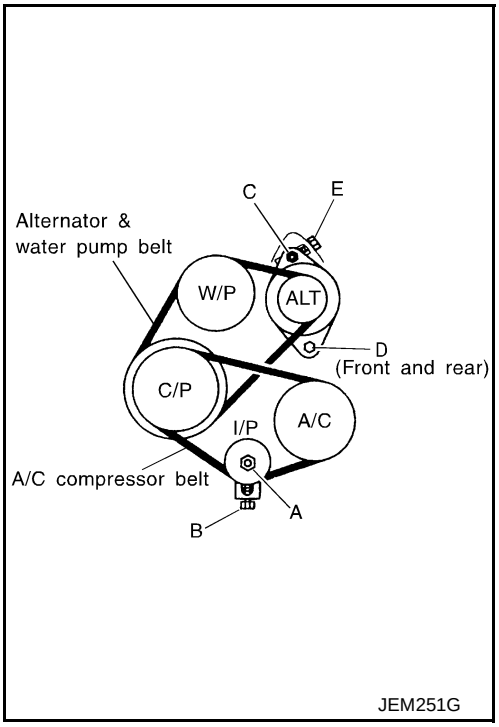
- **When a new belt is installed as a replacement, adjust it to the value specified under “New” value because of insufficient adaptability with pulley grooves.**
- **If the belt deflection of the current belt is out of the “Limit for re-adjusting”, adjust to the “Adjusted” value.**
- **When checking belt deflection immediately after installation, first adjust it to the specified value. Then, after turning crankshaft two turns or more, re-adjust it to the specified value to avoid variation in deflection between pulleys.**
- **Make sure the belts are fully fitted into the pulley grooves during installation.**
- **Handle with care to avoid smearing the belts with oil or cooling water etc.**
- **Do not twist or bend the belts with strong force.**

AIR CONDITIONER COMPRESSOR BELT

1. Remove RH splash cover (with undercover attached).
2. Loosen idler pulley lock nut (A).
3. Turn adjusting bolt (B) to adjust.
   - Refer to EM-113, "Checking Drive Belts" .
4. Tighten lock nut (A).

Nut A:

: 31 - 39 N-m (3.1 - 4.0 kg-m, 23 - 28 ft-lb)



ALTERNATOR AND WATER PUMP BELT

1. Loosen adjusting lock nut (C).
2. Loosen alternator fixing bolts (D) (each on front and rear).
3. Turn adjusting bolt (E) to adjust.
   - Refer to EM-113, "Tension Adjustment" .
4. Tighten nut (C) and bolt (D) in this order.

Nut C:

: 19 - 24 N-m (1.9 - 2.5 kg-m, 14 - 18 ft-lb)

Bolt D:

: 44 - 57 N-m (4.4 - 5.9 kg-m, 32 - 42 ft-lb)

Removal and Installation

EBS00DIG

REMOVAL

1. Loosen each belt. Refer to EM-113, "Tension Adjustment" .
2. Remove air conditioner compressor belt.
3. Remove alternator and water pump belt.

INSTALLATION

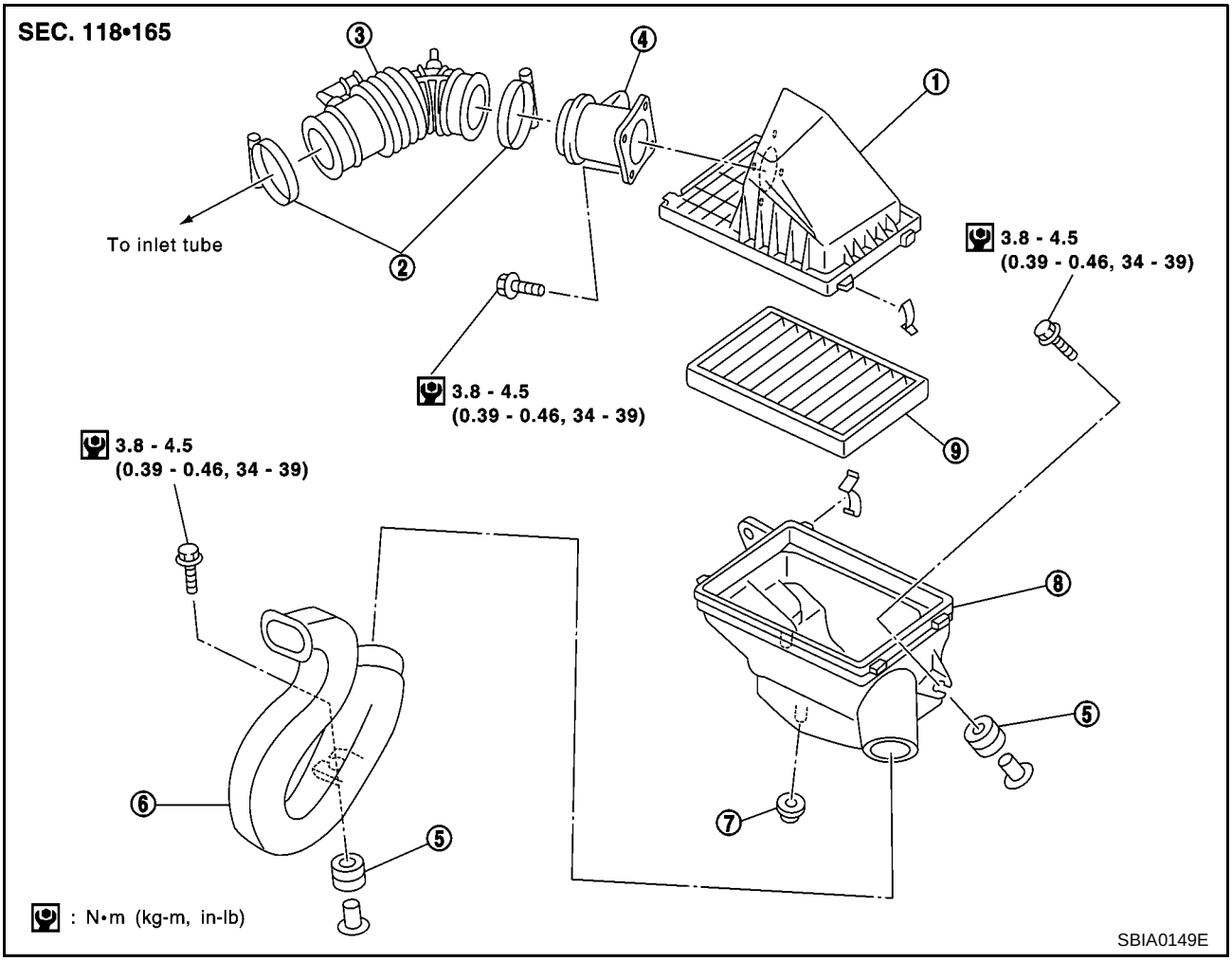
1. Install each belt on pulley in reverse order of removal.
2. Adjust belt tension. Refer to EM-113, "Tension Adjustment" .
3. Tighten nuts and bolts provided for adjustment to the specified torque.
4. Check again that each belt tension is as specified.

AIR CLEANER AND AIR DUCT

PFP:16500

Removal and Installation

EBS00DIH



1. Air cleaner case (upper)
2. Clamp
3. Air duct
4. Mass air flow sensor
5. Grommet
6. Air duct side
7. Mounting rubber
8. Air cleaner case (lower)
9. Air cleaner element

REMOVAL

1. Remove mass air flow sensor harness clamp.
2. Remove harness connector from mass air flow sensor.
3. Remove air duct, air cleaner case/ mass air flow sensor.

- Add marks as necessary for easier installation.

4. Remove mass air flow sensor from air cleaner case.

CAUTION:
Handle mass air flow sensor with following cares.

- **Do not shock it.**
- **Do not disassemble it.**
- **Do not touch its sensor.**

INSTALLATION

1. Attach each joint aligning marks put at removal. Screw clamps firmly.
2. Install in the reverse order of removal.

CHANGING AIR CLEANER ELEMENT

1. Remove air cleaner case.

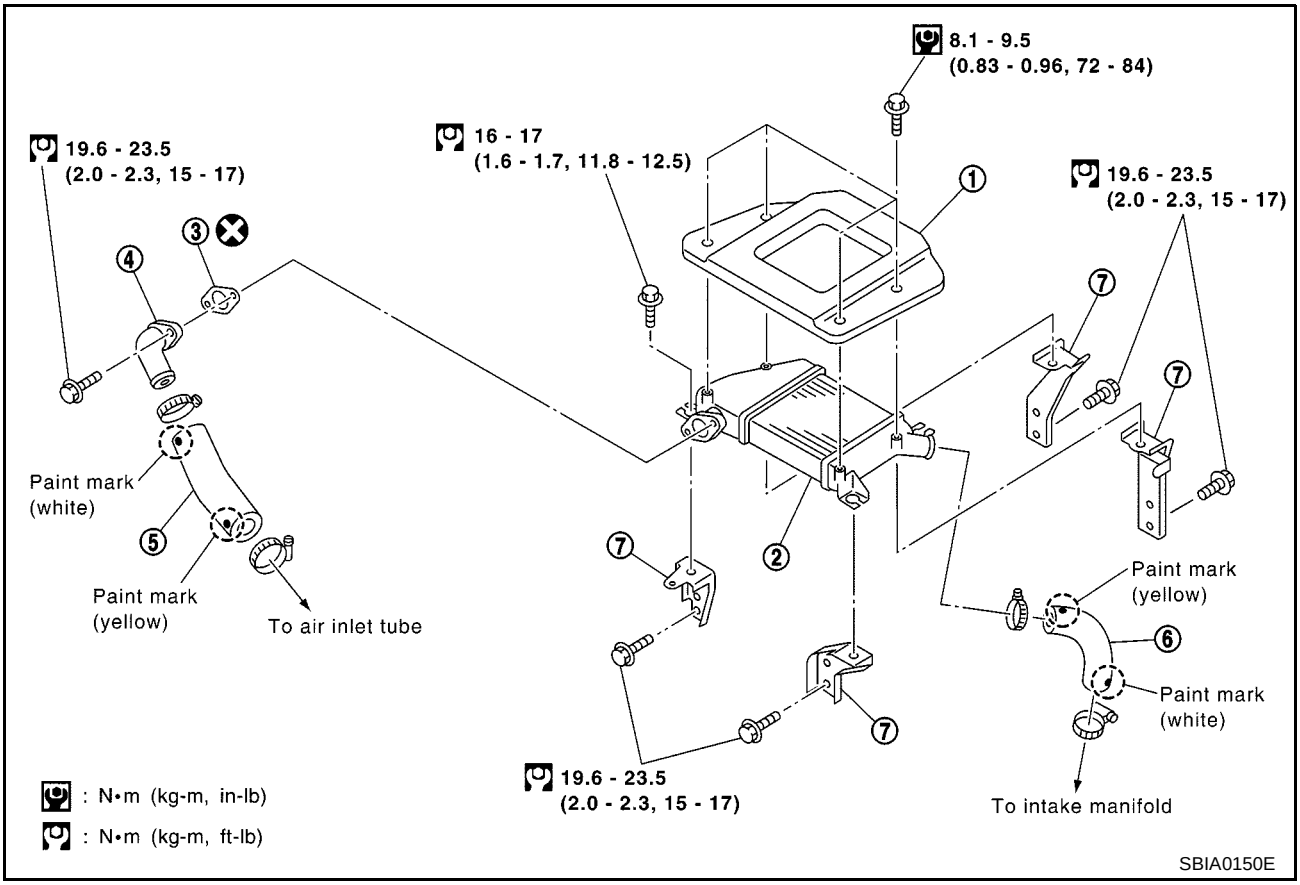
2. Remove clips and lift up air cleaner upper case.
3. Remove air cleaner element.

CHARGE AIR COOLER

PFP:14461

Removal and Installation

EBS00DII



1. Charge air cooler cover
2. Charge air cooler
3. Gasket
4. Air inlet tube
5. Air inlet hose
6. Air inlet hose
7. Bracket

REMOVAL

Remove and install with bottom bracket as an assembly

CAUTION:

When removing charge air cooler, close opening on turbocharger and on intake manifold with shop cloth or other suitable material.

INSPECTION AFTER REMOVAL

Check air passages of charge air cooler core and fins for clogging, leaks or deformation. Clean or replace charge air cooler if necessary.

- **Be careful not to deform core fins.**
- **For cleaning procedure of charge air cooler core, refer to CO-35, "Checking Radiator".**

INSTALLATION

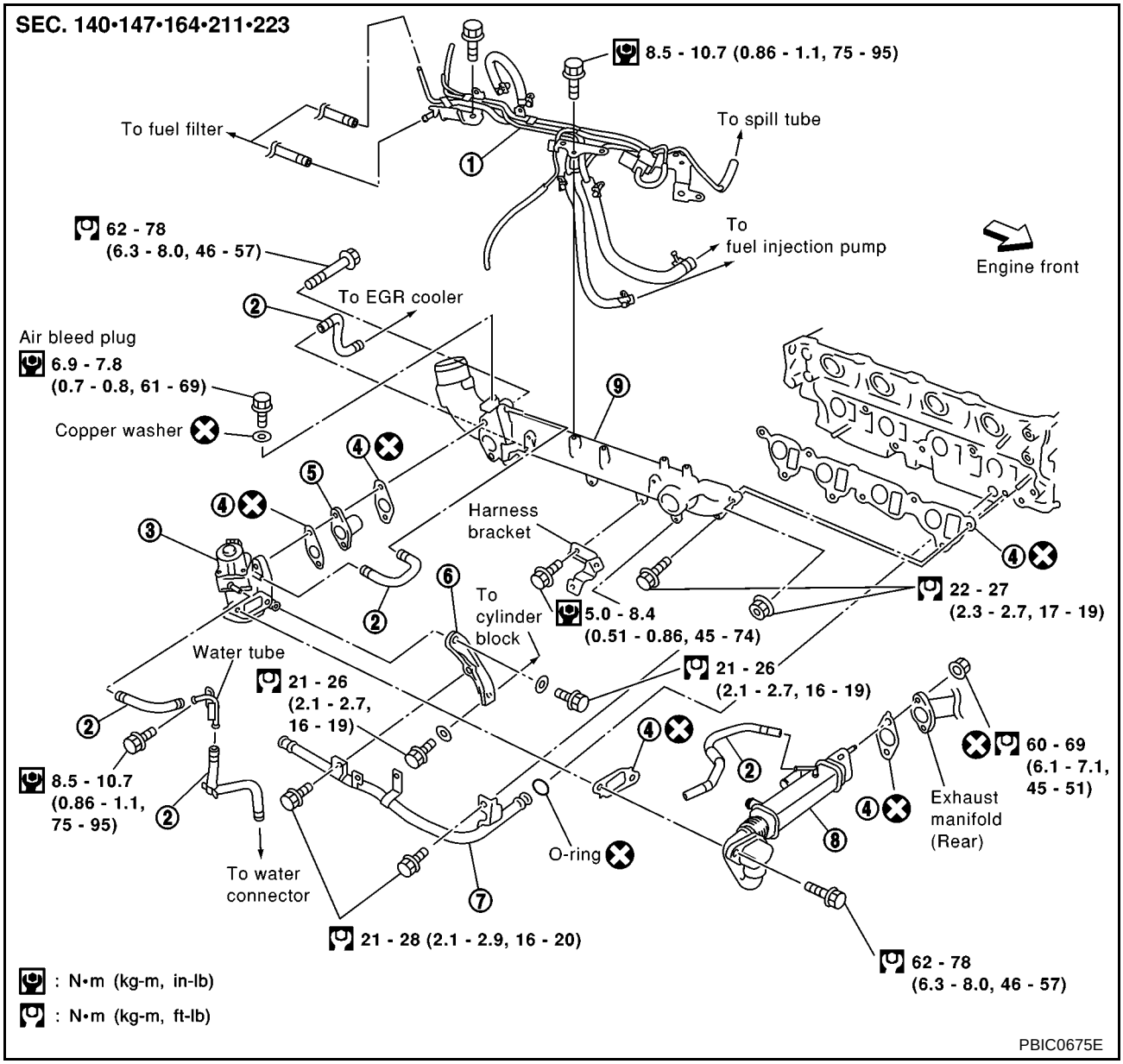
Pay attention to identification mark color and direction when installing air inlet hoses. Refer to EM-117, "Removal and Installation" .

INTAKE MANIFOLD

PFP:14003

Removal and Installation

EBS00DIJ



1. Vacuum & fuel gallery
2. Water hose
3. Electronic EGR volume control valve
4. Gasket
5. EGR passage
6. EGR support
7. Water pipe
8. EGR Cooler
9. Intake manifold

REMOVAL

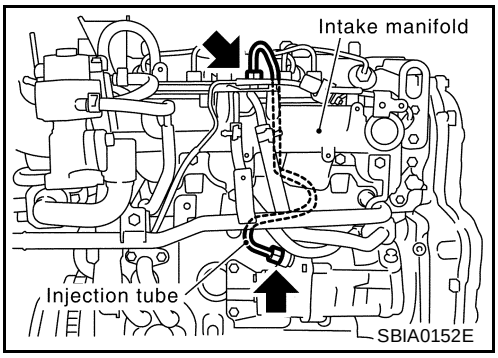
WARNING:

To avoid the danger of being scalded, never drain the coolant when the engine is hot.

1. Drain engine coolant. Refer to CO-30, "Changing Engine Coolant" .
2. Remove air duct. Refer to EM-115, "Removal and Installation" .
3. Remove charge air cooler and bracket. Refer to EM-117, "Removal and Installation" .
4. Remove air inlet pipes. Refer to EM-122, "Removal and Installation"
5. Remove exhaust manifold cover.
6. Disconnect electronic EGR control valve water hoses and harness.
7. Disconnect heater hose.

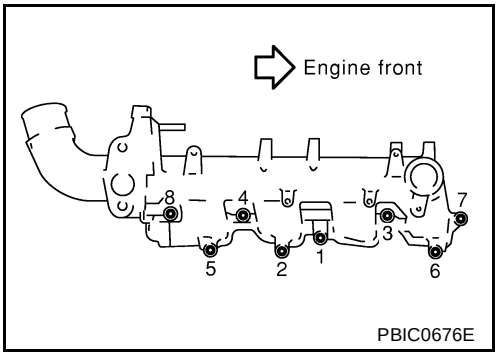
8. Remove EGR Cooler.
9. Remove vacuum hose.
10. Remove injection tube. Refer to EM-138, "Removal and Installation" .
11. Remove water pipe.
12. Remove fuel hose.
    - To prevent fuel from flowing out, plug the opening of the hose with a blind plug after disconnection.

    CAUTION:
    Be careful not to spill fuel in the engine component.



13. Loosen bolts and nuts in the reverse order of that shown in the figure.

    CAUTION:
    Do not disassemble or adjust swirl control valve.
14. Remove electronic EGR volume control valve from intake manifold.

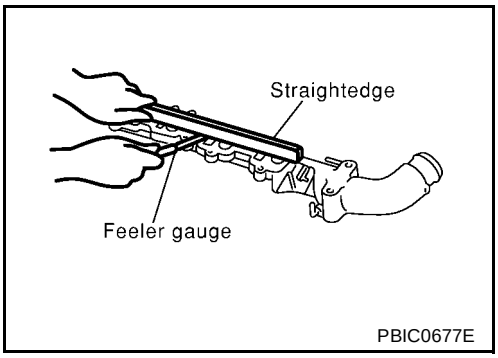


INSPECTION AFTER REMOVAL

Surface Distortion

- Check distortion on the mounting surface with a straightedge and feeler gauge.

  Limit : 0.1 mm (0.004 in)



INSTALLATION

Following instructions below, install in reverse order of removal.

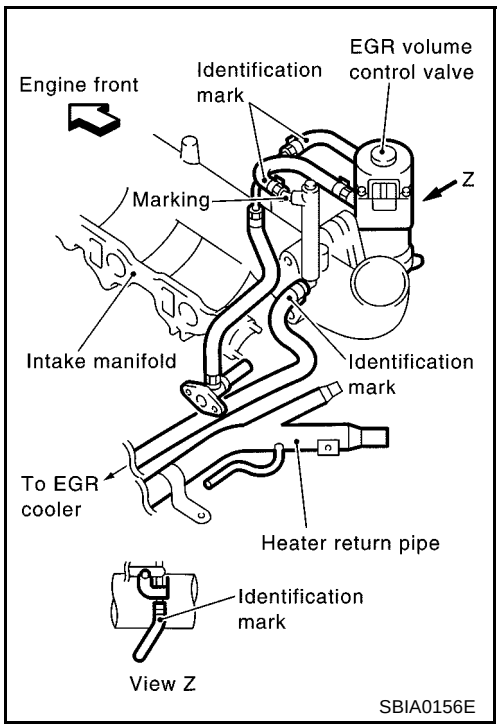
1. Install electronic EGR volume control valve.
   - **Handle with care avoiding any shocks.**
   - **Do not disassemble or adjust.**
2. Install intake manifold.
   - Tighten fixing bolts and nuts in numerical order as shown in the figure.
   - When stud bolts come off, install with the following torque..

     : 10 - 11 N·m (1.0 - 1.2 kg-m, 87 - 104 in-lb)

3. Install water hose.
   - Install water hose by referring to identification marks avoiding twisting.
   - When an insert stopper is not provided with the pipe, insert the hose up to dimension A. When the pipe is shorter than dimension A, insert hose fully until it reaches the end.

     Dimension A : 25 - 30 mm (0.984 - 1.181 in)

   - When an insert stopper is provided on the pipe side, insert the hose until it reaches the bulge.
   - When marking is provided on the pipe, insert hose until it covers half of the marking.
4. Install remaining parts in reverse order of removal.
5. Before starting engine, bleed air from fuel piping. Refer to FL-16, "Air Bleeding" .



INSPECTION AFTER INSTALLATION

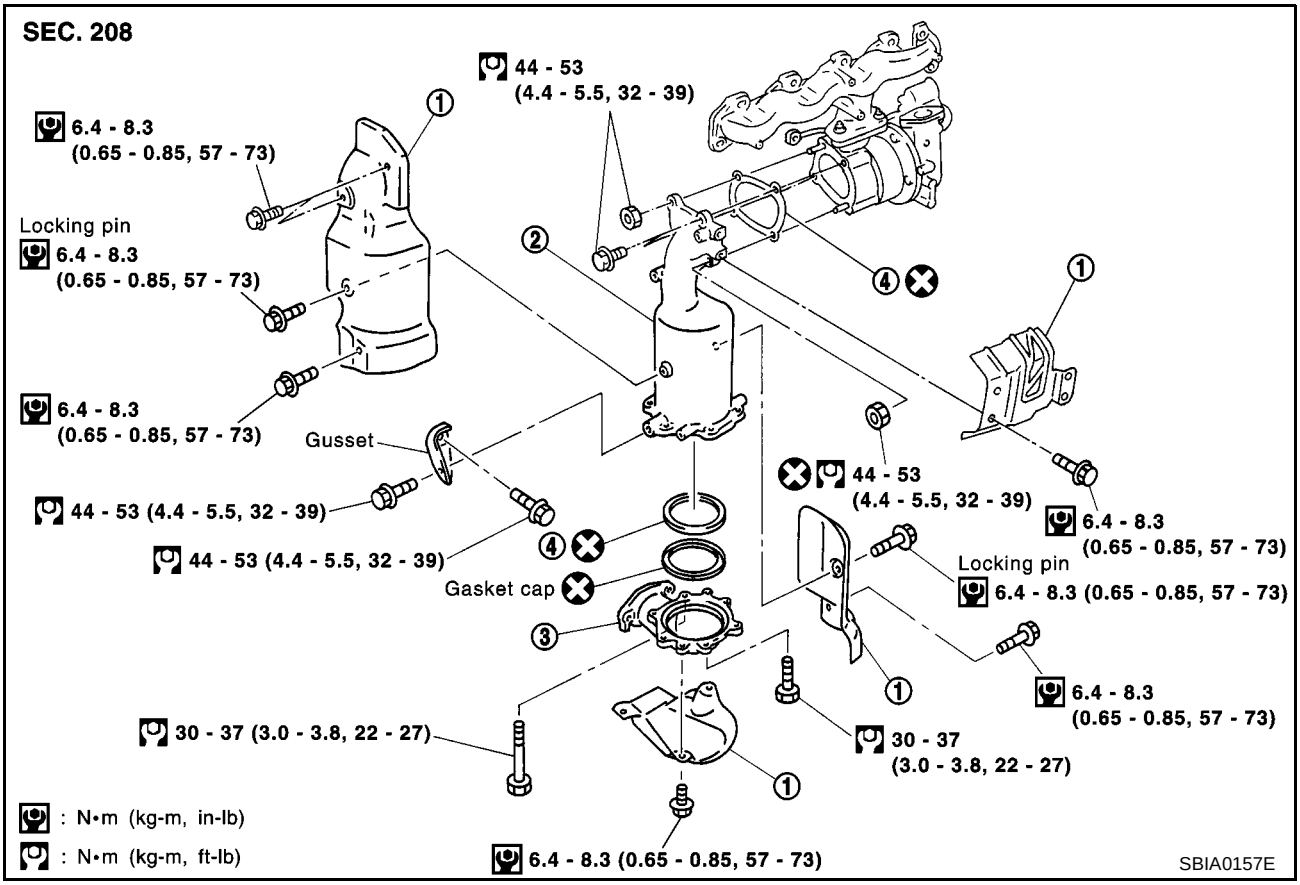
Start engine and increase engine speed to check for fuel leak.

CATALYST

PFP:20905

Removal and Installation

EBS00DIK



1. Insulator
2. Catalyst
3. Catalyst rear diffuser
4. Gasket

REMOVAL

1. Remove engine under cover.
2. Drain engine coolant. Refer to CO-30, "Changing Engine Coolant" .
3. Remove radiator upper and lower hoses.
4. Remove radiator fan. Refer to CO-33, "Removal and Installation" .
5. Remove radiator mount bracket and radiator.
6. Remove water inlet pipe.
7. Remove insulators.
8. Disconnect exhaust front tube. Refer to EX-2, "EXHAUST SYSTEM" .
9. Remove catalyst.

CAUTION:

Do not disassemble.

Install two locking pins into both sides of the catalyst. Be careful not to confuse locking pins with insulator mounting bolts.

Catalyst locking pin	**: Flange bolt (black)**
Insulator mounting bolt	**: Washer bolt (silver or yellow)**

INSTALLATION

Install in reverse order of removal.

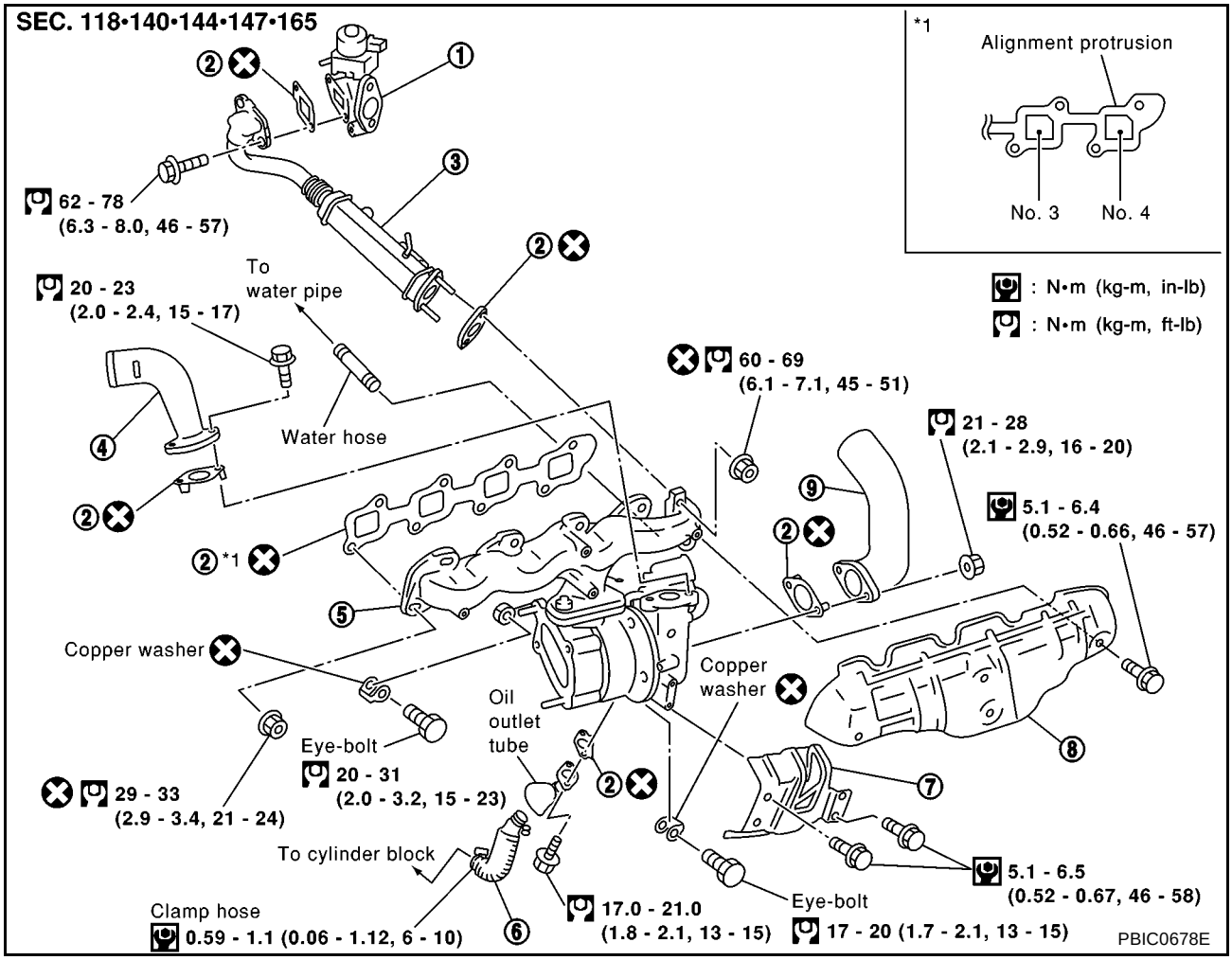
- Pushing gussets against the oil pan and the catalyst, temporarily tighten the mounting bolt. And then tighten it to the specified torque.

EXHAUST MANIFOLD AND TURBOCHARGER

PFP:14004

Removal and Installation

EBS00DIL

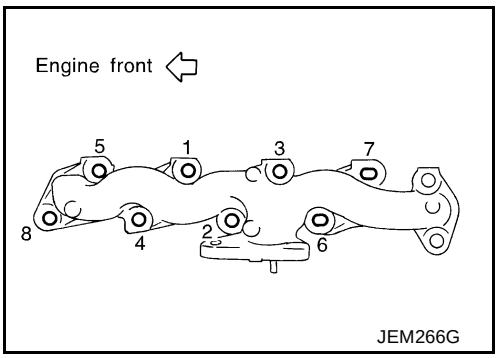


1.	Electronic EGR volume control valve	2.	Gasket	3.	EGR Cooler
4.	Air inlet pipe	5.	Exhaust manifold & turbocharger assembly	6.	Oil return hose
7.	Turbo insulator	8.	Exhaust manifold insulator	9.	Air inlet pipe

REMOVAL

1. Drain engine coolant. Refer to CO-30, "Changing Engine Coolant" .
2. Remove charge air cooler. Refer to EM-117, "Removal and Installation" .
3. Remove air duct and air inlet pipe. Refer to EM-115, "Removal and Installation" .
4. Remove engine under cover.
5. Remove radiator upper and lower hoses.
6. Remove radiator fan. Refer to CO-34, "Disassembly and Assembly Radiator Fan" .
7. Remove radiator mount bracket and radiator. Refer to CO-33, "Removal and Installation" .
8. Remove water inlet pipe.
9. Disconnect exhaust front tube. Refer to EX-2, "EXHAUST SYSTEM" .
10. Remove catalyst. Refer to EM-121, "Removal and Installation" .
11. Remove exhaust manifold cover.
12. Remove insulator.
13. Each wiring and piping (disconnect/move)

14. Loosen exhaust manifold mounting nuts in the reverse order specified in the figure.
15. Rotate the exhaust manifold and turbocharger assembly so that the rear side (EGR cooler mounting side) faces upward. And then pull out the assembly from between the engine and the air conditioning piping.



CAUTION:
Be careful not to deform each turbocharger piping when pulling out the assembly.

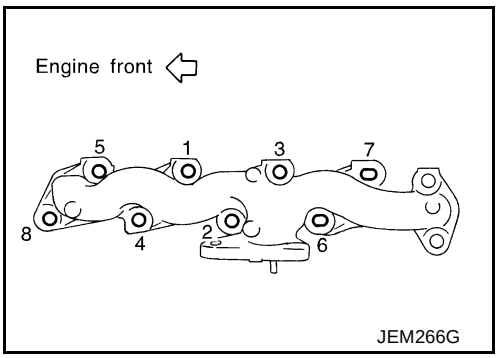
INSTALLATION

- When a stud bolt is pulled out, tighten it to the following torque:

: 18 - 21 N·m (1.8 - 2.2 kg-m, 13 - 15 ft-lb)

- Tighten the exhaust manifold mounting nuts in the following procedure:

1. Tighten the nuts in the order specified in the figure.
2. Re-tighten the nuts 1 to 4.
3. Install the gasket so that the alignment protrusion faces the No. 4 port.
4. Install in reverse order of removal.

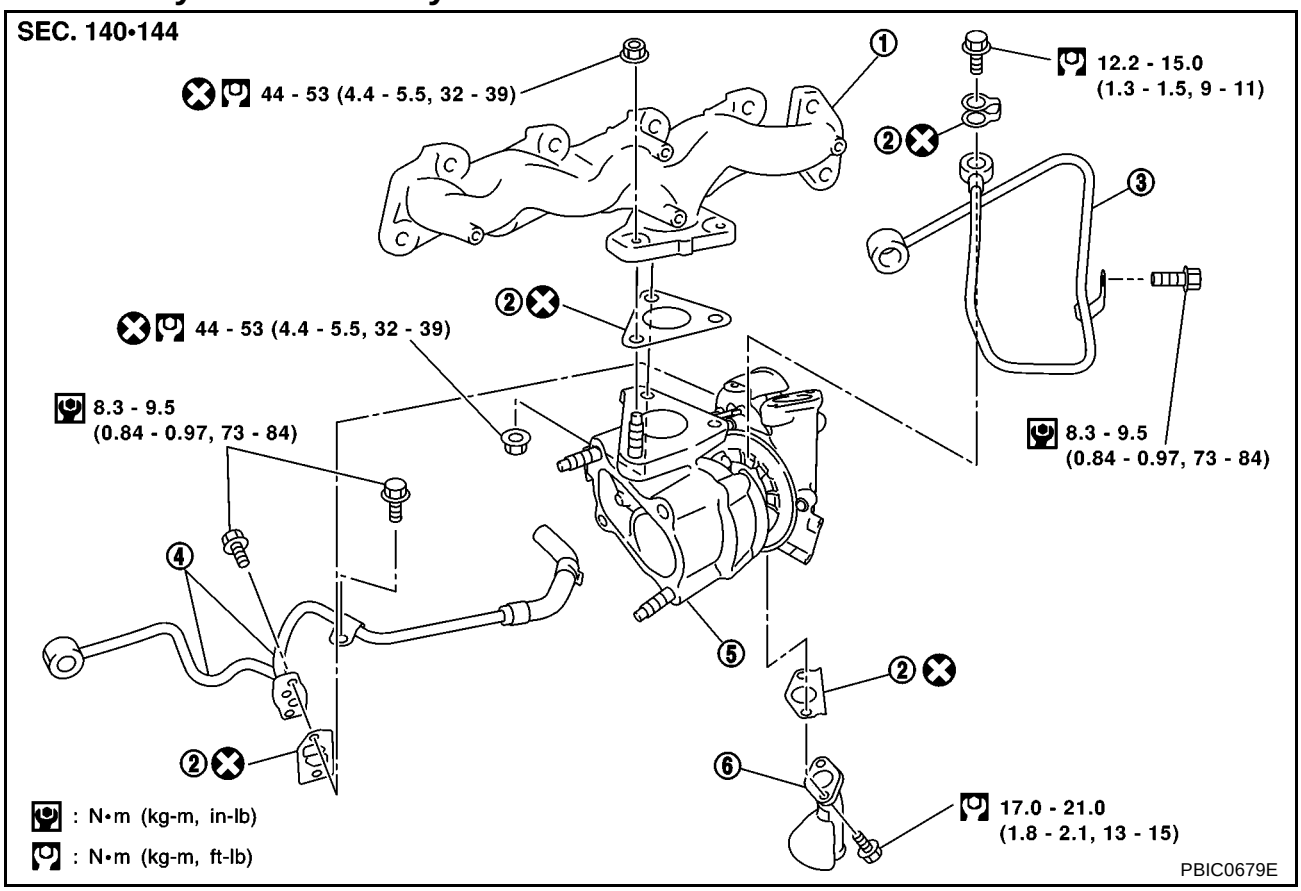


INSPECTION AFTER INSTALLATION

Start engine and raise engine speed to check no exhaust emission leaks.

Disassembly and Assembly

EBS00DIM



1. Exhaust manifold
2. Gasket
3. Oil inlet tube
4. Water tube
5. Turbocharger
6. Oil outlet tube

REMOVAL

1. After applying penetrative lubricant to the mounting nuts, check for the penetration of the lubricant, and then loosen the nuts to remove.

   CAUTION:

   Do not disassemble or adjust the turbocharger body.

2. When a stud bolt is pulled out, tighten it to the following torque:

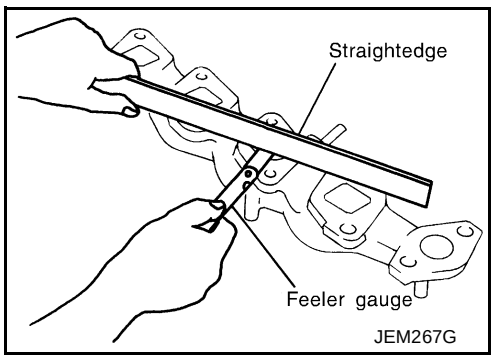
   : 24 - 27 N·m (2.4 - 2.8 kg-m, 18 - 20 ft-lb)

INSPECTION AFTER REMOVAL

Surface Distortion

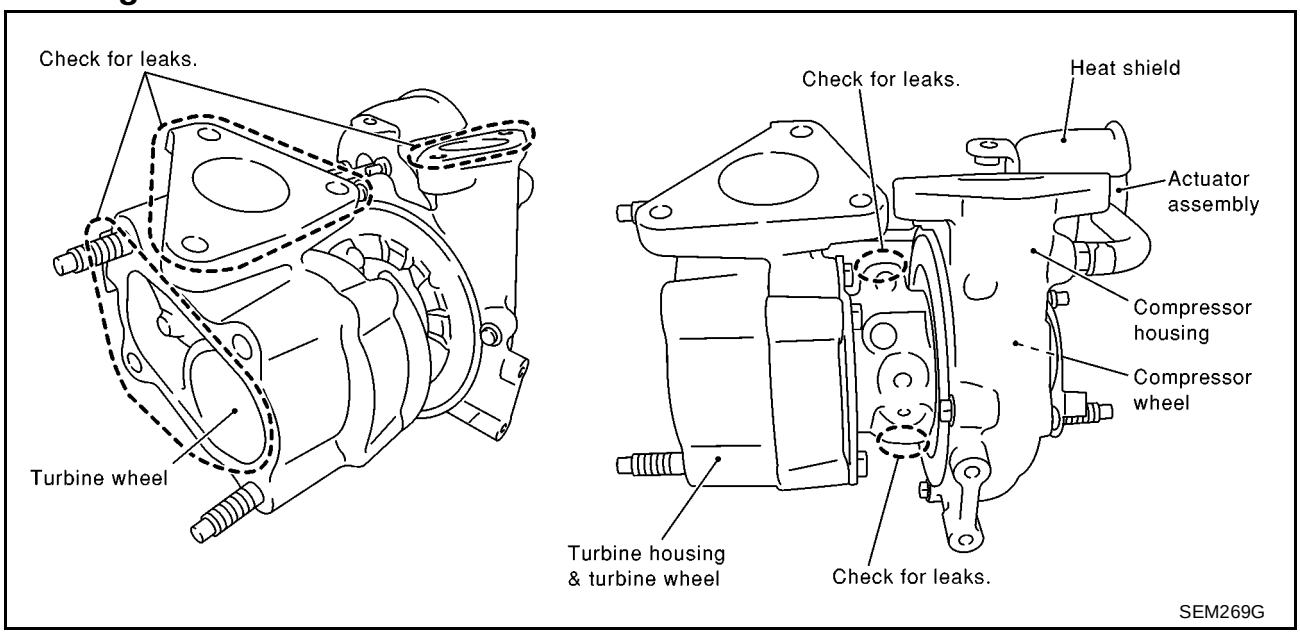
Check the distortion on the mounting surface in the six directions using a straightedge and a feeler gauge.

Limit : 0.3 mm (0.012 in)



Turbocharger

EBS00DIN



CAUTION:

When the compressor wheel turbine wheel or rotor shaft is damaged, remove all the fragments and foreign matter left in the following passages in order to prevent a secondary failure:

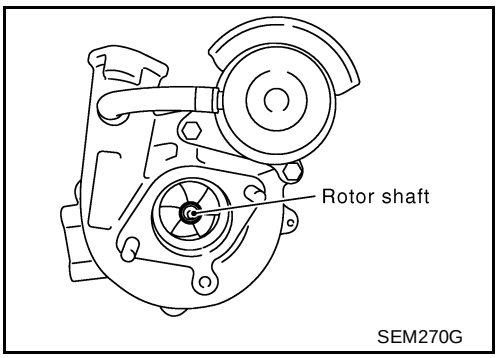
Suction side : Between turbocharger and air cleaner

Exhaust side : Between turbocharger and catalyst

ROTOR SHAFT CLEARANCE

- Check that the rotor shaft rotates smoothly without any resistance when it is rotated by your fingertips.
- Check that the rotor shaft is not loose when it is moved vertically or horizontally.

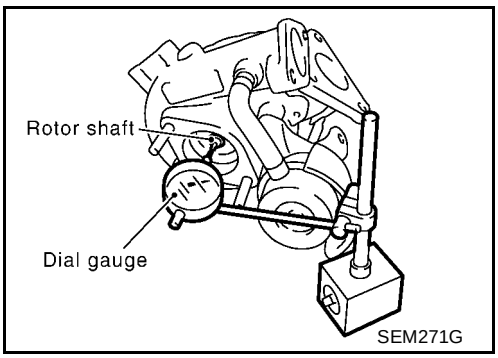
Standard : 0.068 - 0.096 mm (0.0027 - 0.0038 in)



ROTOR SHAFT END PLAY

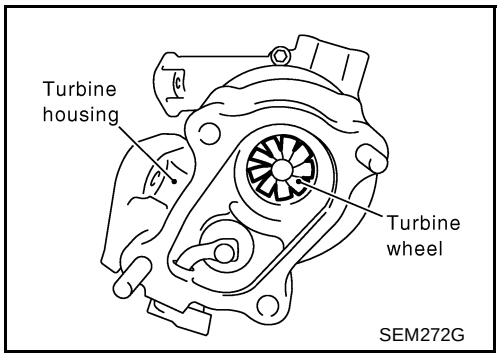
Place a dial gauge at the rotor shaft end in the axial direction to measure the end play.

Standard : 0.026 - 0.084 mm (0.0010 - 0.0033 in)



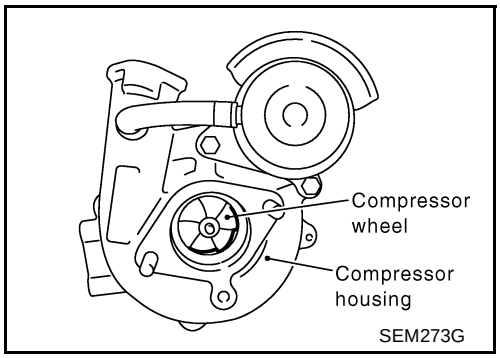
TURBINE WHEEL

- Check that there is no oil adhesion.
- Check that there is no carbon accumulation.
- Check that blades of the turbine wheel are not bent or broken.
- Check that the turbine wheel does not interfere with the turbine housing.



COMPRESSOR WHEEL

- Check that there is no oil adhesion inside the air inlet.
- Check that the compressor wheel does not interfere with the compressor housing.
- Check that the wheel is not bent or broken.



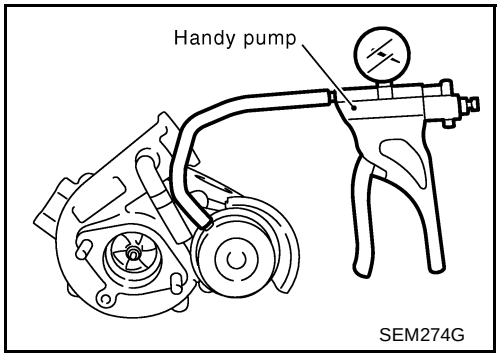
WASTEGATE VALVE ACTUATOR

- Connect the handy pump to the actuator, and check that the rod strokes smoothly in compliance with the following pressure.
- Pressure to be applied at actuator part to move rod end as follows:

Standard (Pressure/rod stroke amount):

: 150.80 - 156.20 kPa (1,508 - 1,562 mbar, 1,131 - 1,172 mmHg, 44.0 - 46.2 inHg)/0.38 mm (0.0150 in)

: 176.50 - 185.90 kPa (1,765 - 1,859 mbar, 1,324 - 1,394 mmHg, 52.2 - 54.9 inHg)/4.0 mm (0.157 in)



TROUBLE DIAGNOSIS OF TURBOCHARGER

Preliminary check:

- Check that the engine oil level is between MIN and MAX of the dipstick. (When the engine oil amount is more than MAX, the oil flows into the inlet duct through the blow-by gas passage, and the turbocharger is misjudged failure.)
- Ask the customer if he/she always runs the vehicle in idle engine speed to cool the oil down after driving.
- Replace the turbocharger assembly when any malfunction is found after unit inspections specified in the table below.
- If no malfunction is found after the unit inspections, judge that the turbocharger body has no failure. Check the other parts again.

Inspection item	Inspection result	Symptom (when each inspection item meets each inspection result)			
		Oil leakage	Smoke	Noise	Insufficient power/ acceleration failure

Turbine wheel	Oil leaks	C	A	C	C
	Carbon is accumulated	C	A	B	B
	Friction with housing	C	B	A	B
	Blades are bent or broken			A	A
Compressor wheel	Inside the air inlet is seriously contaminated by oil.	B	B		
	Friction with housing	C	B	A	B
	Blades are bent or broken			A	A
After checking both turbine and compressor, inspect rotor shaft end play.	There is resistance when the rotor shaft is rotated by your fingertips.		C	C	B
	The rotor shaft sometimes does not rotate by your fingertips.				A
	There is too much play in the bearing.	C	C	B	C
Oil return port	Carbon or sludge is accumulated in the waste oil hole.	C	A	C	C

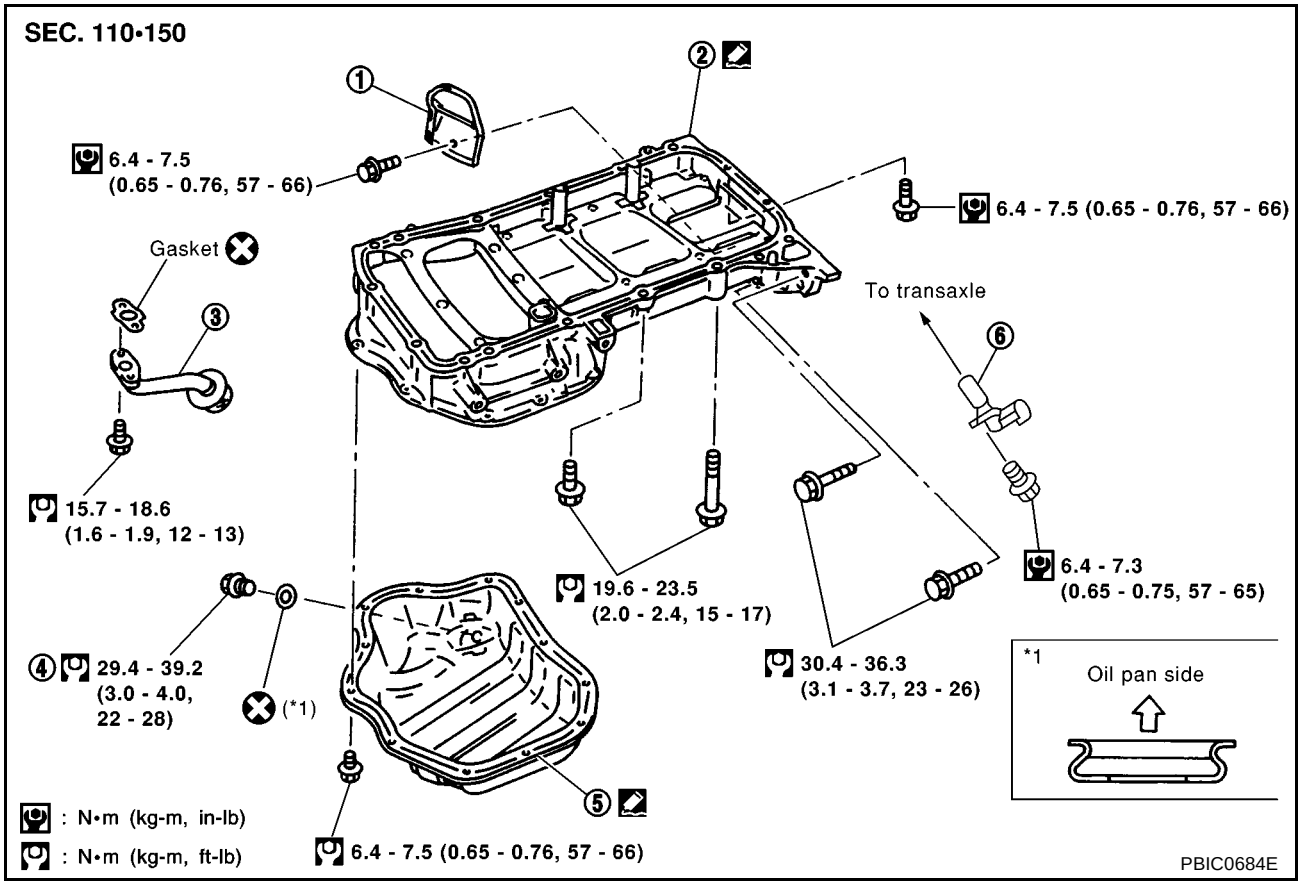
A: Large possibility
B: Medium possibility
C: Small possibility

OIL PAN AND OIL STRAINER

PFP:11110

Removal and Installation

EBS00DIO



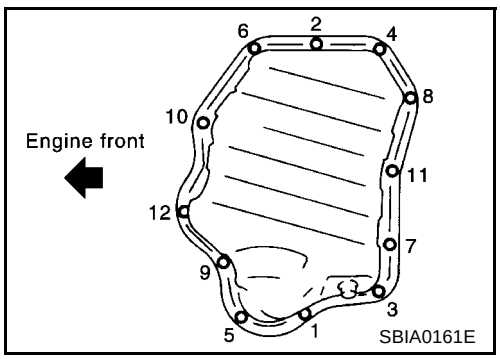
1. Rear plate cover
2. Oil pan upper
3. Oil strainer
4. Drain plug
5. Oil pan lower
6 Crankshaft position sensor (TDC)

REMOVAL

WARNING:

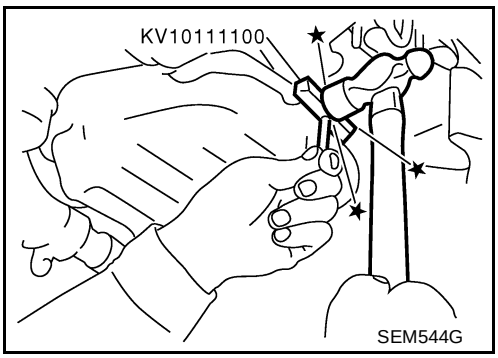
To avoid the danger of being scalded, never drain the engine oil when the engine is hot.

1. Remove engine under cover at both side.
2. Drain engine oil. Refer to LU-20, "Changing Engine Oil" .
3. Remove lower oil pan bolts, Loosen bolts in the reverse order of that shown in the figure.

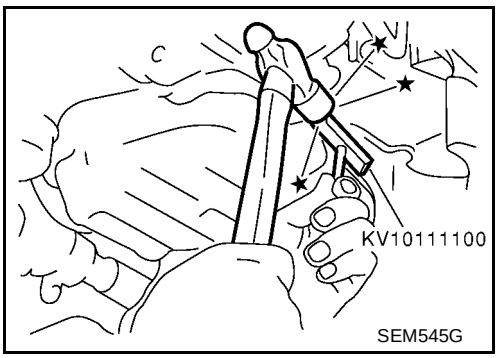


4. Remove lower oil pan.

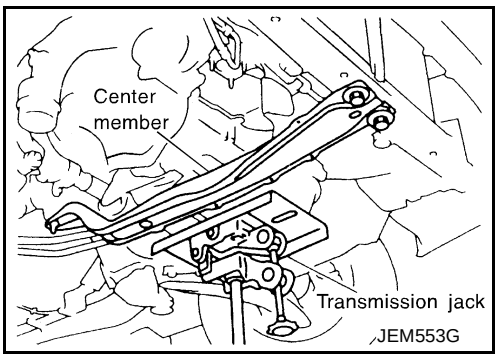
a. Insert Tool between upper oil pan and lower oil pan.
   - **Be careful not to damage aluminum mating surface.**
   - **Do not insert screwdriver, or oil pan flange will be deformed.**



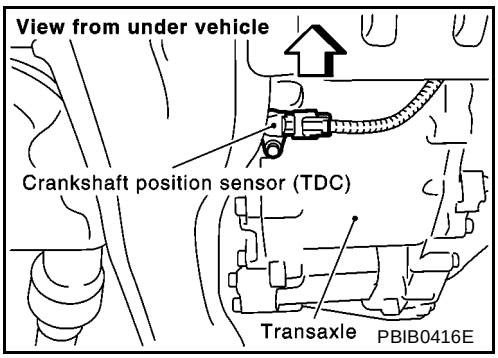
b. Slide Tool by tapping on the side of the Tool with a hammer.
c. Remove lower oil pan.



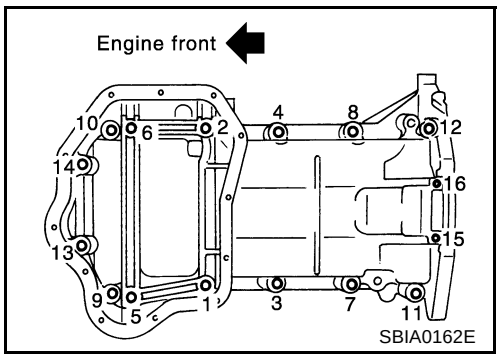
5. Remove drive belts.
6. Remove A/C compressor and bracket.
7. Remove front exhaust tube and its support.
8. Set a suitable transmission jack under transaxle and hoist engine with engine slinger. Refer to EM-187, "Removal and Installation" .
9. Remove center member.



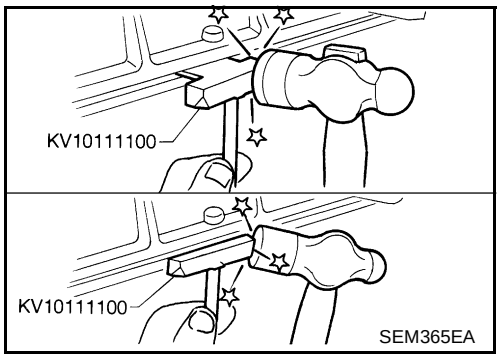
10. Remove crankshaft position sensor (TDC) from transaxle.
11. Remove rear plate cover and four engine-to transaxle bolts.
12. Remove catalyst and rear diffuser. Refer to EM-121, "Removal and Installation" .



13. Loosen bolts in reverse order of illustration to remove upper oil pan.

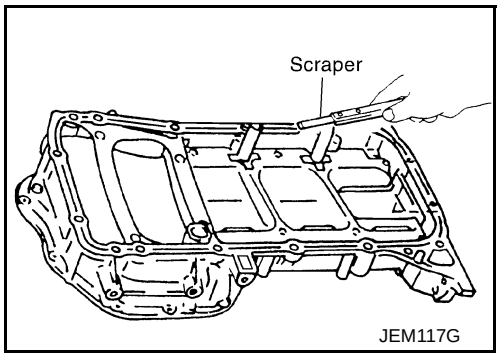


14. Remove upper oil pan.
    - Insert Tool (Seal cutter) between upper oil pan and cylinder block. Slide tool by tapping on the side of the tool with a hammer. Remove oil pan.
    - **Be careful not to damage aluminum mating surface.**
    - **Do not insert screwdriver, or oil pan flange will be deformed.**
15. Remove oil strainer.



INSPECTION AFTER REMOVAL

Clean oil strainer if any object attached.

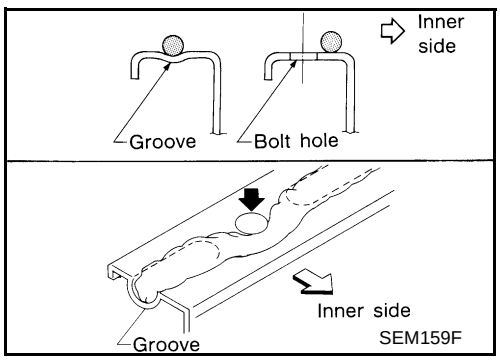


INSTALLATION

1. Install oil strainer.
2. Install upper oil pan in the order below.

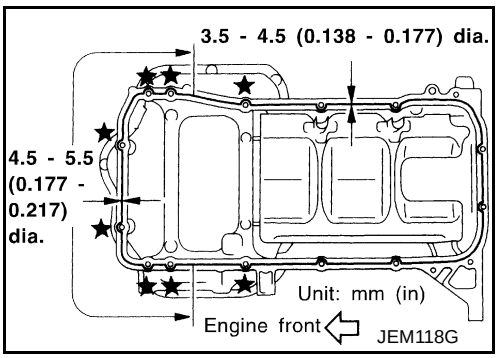
a. Use a scraper to remove old liquid gasket from mating surfaces.
    - **Also remove old liquid gasket from mating surface of cylinder block, front cover and lower oil pan.**
    - **Remove old liquid gasket from the bolt hole and thread.**

b. Apply a continuous bead of liquid gasket to mating surface of aluminum oil pan.
    - **Use Genuine Liquid Gasket or equivalent.**



c. Apply Genuine Liquid Gasket or equivalent, to areas shown in the figure.

- **At the 8 bolt holes marked ★, liquid gasket should be applied on the rims of the holes.**
- **Be sure liquid gasket is 3.5 to 4.5 mm (0.138 to 0.177 in) or 4.5 to 5.5 mm (0.177 to 0.217 in) wide. (Be careful that the diameter of the silicon bead is different around the front.)**
- **Attaching should be done within 5 minutes after coating.**

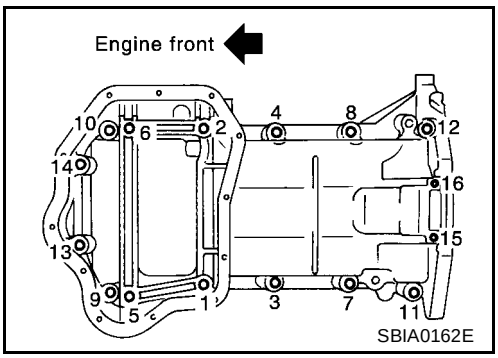


d. Install upper oil pan.

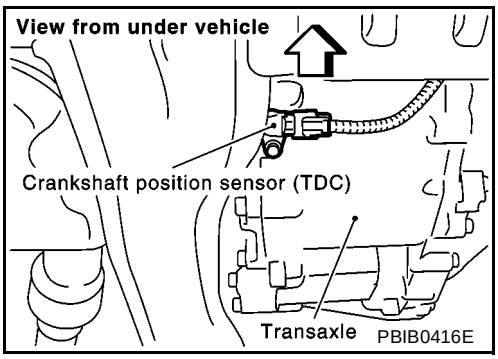
- Tighten bolts in numerical order to specified torque.
- Bolt dimensions vary depending on the installation location. Refer to the following and use appropriate bolts.

M6 x 30 mm (1.18 in) : Bolt No. 15, 16
M8 x 25 mm (0.98 in) : Bolt No. 3, 4, 9, 10
M8 x 60 mm (2.36 in) : Bolt No. 1, 2, 5, 6, 7, 8, 11, 12, 13, 14

- The shank length under the bolt neck above is the length of the threaded part (pilot portion not included).



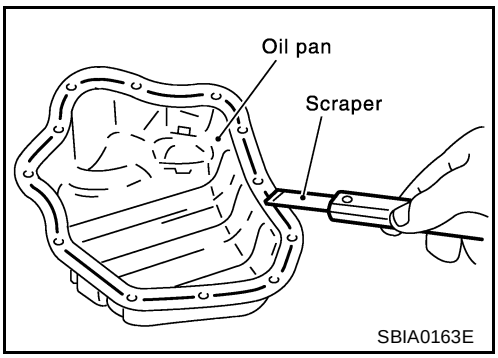
3. Tighten transaxle joint bolts.
4. Install rear plate cover.
5. Install center member.
6. Install crankshaft position sensor (TDC).



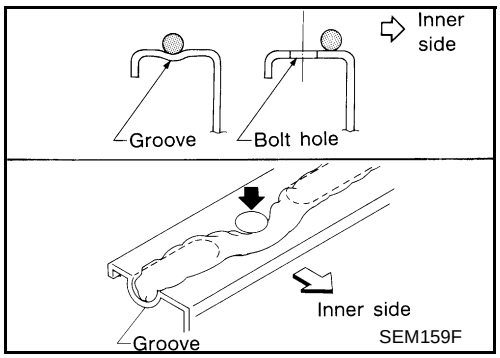
7. Install lower oil pan.

a. Use a scraper to remove old liquid gasket from mating surfaces.

- **Also remove old liquid gasket from mating surface of upper oil pan.**

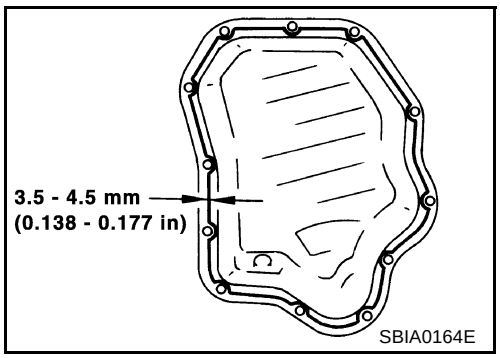


b. Apply a continuous bead of liquid gasket to mating surface of lower oil pan.
   - **Use Genuine Liquid Gasket or equivalent.**

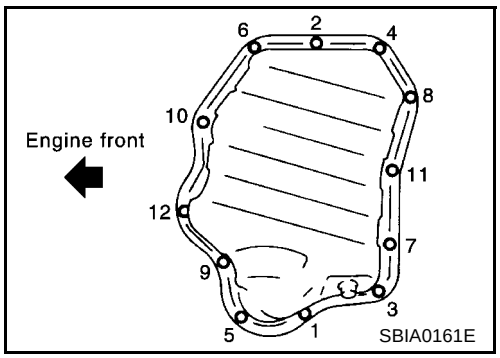


   - **Be sure liquid gasket is 3.5 to 4.5 mm (0.138 to 0.177 in) wide.**
   - **Attaching should be done within 5 minutes after coating.**

8. Install oil pan drain plug.
   - Refer to illustration of components parts for installation direction of washer.



9. Install in the reverse order of removal after this step.
   - **Pour engine oil or start engine at least 30 minutes after oil pan is installed.**



INSPECTION AFTER INSTALLATION

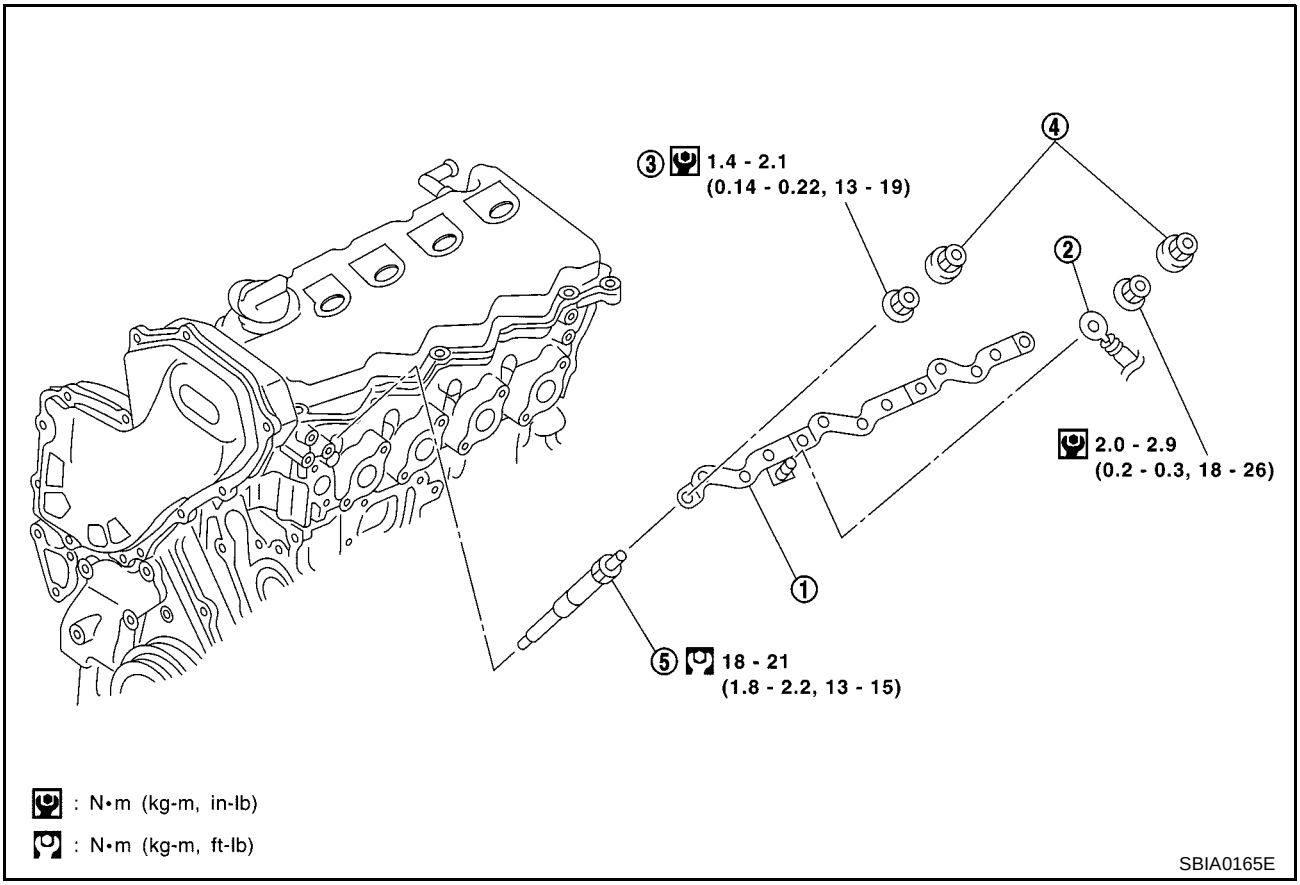
Check for leakage of engine oil when engine is warmed.

GLOW PLUG

PFP:22401

Removal and Installation

EBS00DIP



1. Glow plate
2. Glow harness
3. Glow nut
4. Cap
5. Glow plug

REMOVAL

CAUTION:

Remove glow plug only if necessary. If carbon adheres, it may be stuck and broken.

1. Remove chage air cooler cover. Refer to EM-117, "Removal and Installation" .
2. Remove charg air cooler and bracket.
3. Disconnect harness connector from glow plate.
4. Remove glow nut to remove glow plate.
5. Remove glow plug.

CAUTION:

- **When removing or installing, do not use such tools as an air impact wrench.**
- **Handle it carefully without giving any impact, even after removal. [As a guide, if it drops from height of 10 cm (3.94 in) or higher, always replace it.]**

INSTALLATION

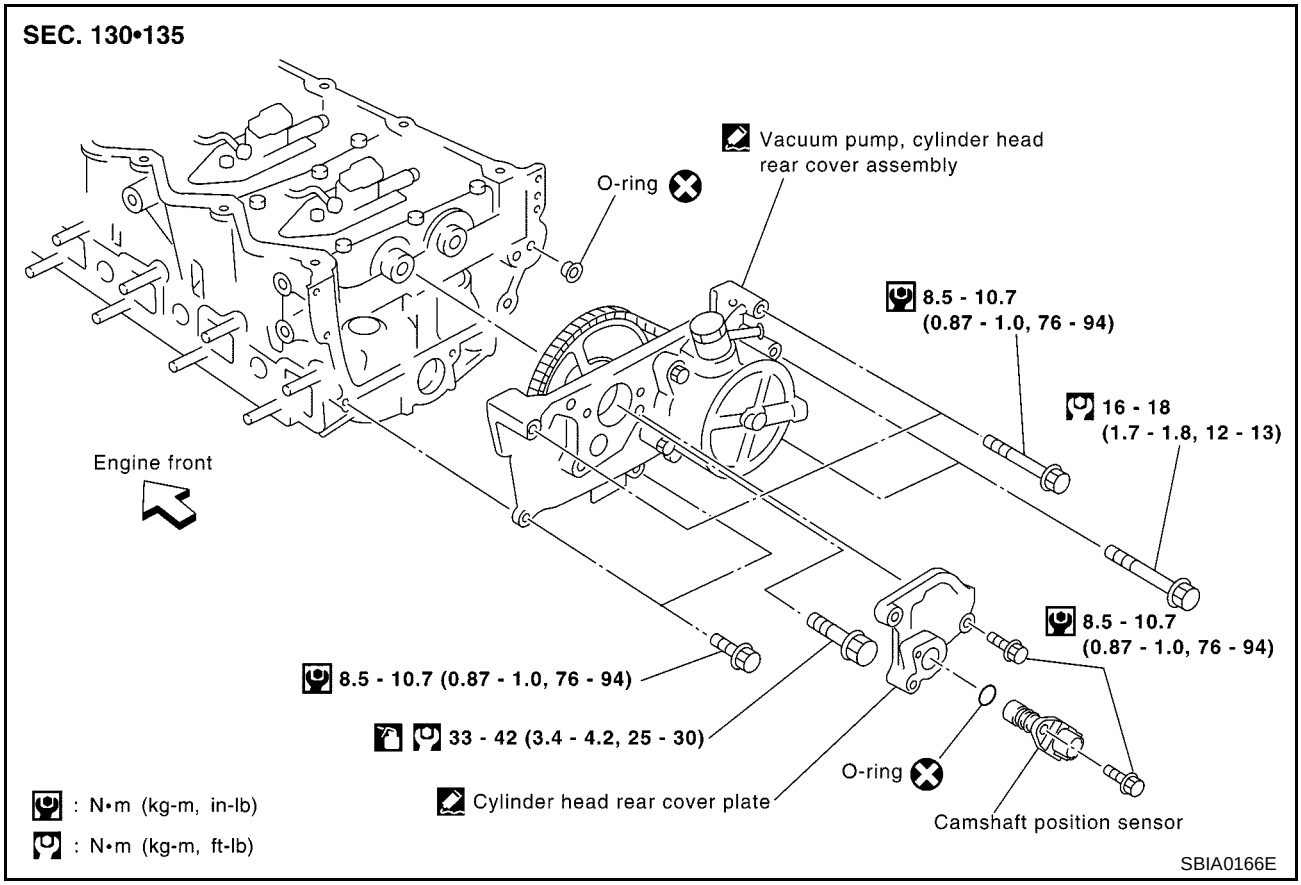
1. Remove adhered carbon from glow plug installation hole with a reamer.
2. Install glow plug.
3. Install remaining parts in reverse order of removal.

VACUUM PUMP

PFP:41920

Removal and Installation

EBS00DIQ



INSPECTION BEFORE REMOVAL

1. Disconnect vacuum hose, and connect a vacuum gauge via 3-way connector.
   - Disconnect point where vacuum from vacuum pump can be measured directly and install 3-way connector.
2. Start engine and measure generated vacuum at idle speed.

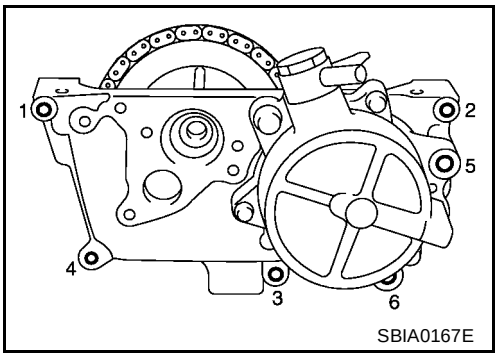
Standard : – 86.6 to – 101.3 kPa (– 866 to – 1,013 mbar, – 650 to – 760 mmHg, – 25.59 to – 29.92 inHg)

- If out of standard, check for air suction in vacuum route, and measure again.
- If still outside of standard, replace vacuum pump.

REMOVAL

1. Drain engine coolant. Refer to CO-30, "Changing Engine Coolant" .
2. Remove air duct and air cleaner case. Refer to EM-115, "Removal and Installation" .
3. Remove charge air cooler and bracket. Refer to EM-117, "Removal and Installation" .
4. Disconnect harness connector from fuel injector.
5. Remove injection tube. Refer to EM-138, "Removal and Installation" .
6. Remove fuel injector oil seal.
7. Remove rocker cover. Refer to EM-150, "Removal and Installation" .
8. Remove spill tube. Refer to EM-138, "Removal and Installation" .
9. Remove nozzle support from NO.2 cylinder and fuel injector. Refer to EM-138, "Removal and Installation" .
10. Remove air inlet pipes. Refer to EM-122, "Removal and Installation" .
11. Remove exhaust manifold cover.

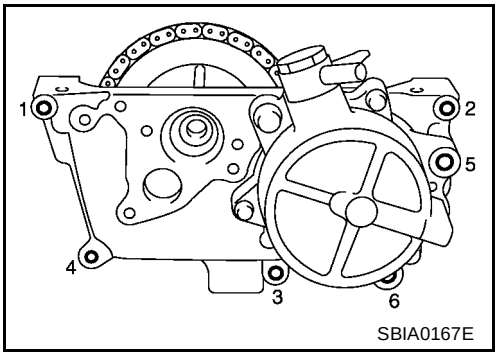
12. Disconnect electronic EGR volume control valve water hose and harness.
13. Disconnect heater hose.
14. Remove EGR cooler.
15. Disconnect vacuum hose from vacuum pump side.
16. Remove camshaft position sensor.
17. Remove cylinder head rear cover plate.
18. Loosen and remove the installation bolts in rear cam sprocket.
    - Loosen rear cam sprocket installation bolts by fixing the hexagonal portion of the camshaft.
19. Remove vacuum pump and cylinder head rear cover assembly.
    - Remove and install vacuum pump, sprocket, drive chain and chain guide as an assembly.
    - Loosen mounting bolts in reverse order shown in figure.
    - Do not remove any bolts not shown in figure. (Especially never remove M6 bolts on vacuum pump.)
    - Use seal cutter (special service tool) or other suitable tool to remove.



SBIA0167E

INSTALLATION

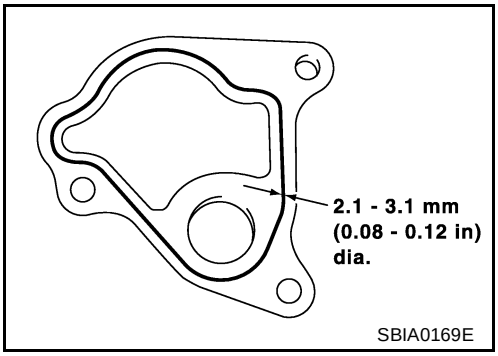
1. Install vacuum pump and cylinder head rear cover assembly onto cylinder head. Refer to EM-136, "ASSEMBLY" .
    - Apply Genuine Liquid Gasket or equivalent (Refer to EM-106, "Precautions for Liquid Gasket" .) to area shown in the figure.
    - **Attaching should be done with in 5 minutes after coating.**
2. Tighten mounting bolts in order shown in the figure.
3. Install rear cam sprocket mounting bolts by fixing the hexagonal portion of the camshaft. .
4. Tighten rear cam sprocket mounting bolts.



SBIA0167E

5. Install cylinder head rear cover plate.
    - Apply Genuine Liquid Gasket or equivalent (Refer to EM-106, "Precautions for Liquid Gasket" .) to area shown in the figure.
    - **Attaching should be done with in 5 minutes after coating.**

    CAUTION:
    Never start engine with vacuum circuit being open. If engine is started and vehicle is running while vacuum pump is open (with vacuum hose disconnected), blow-by flow rate will increase and engine may be damaged.
6. Install in reverse order of removal after this step.
    - When vacuum hose is connected, insert it securely by at least 15 mm (0.59 in).



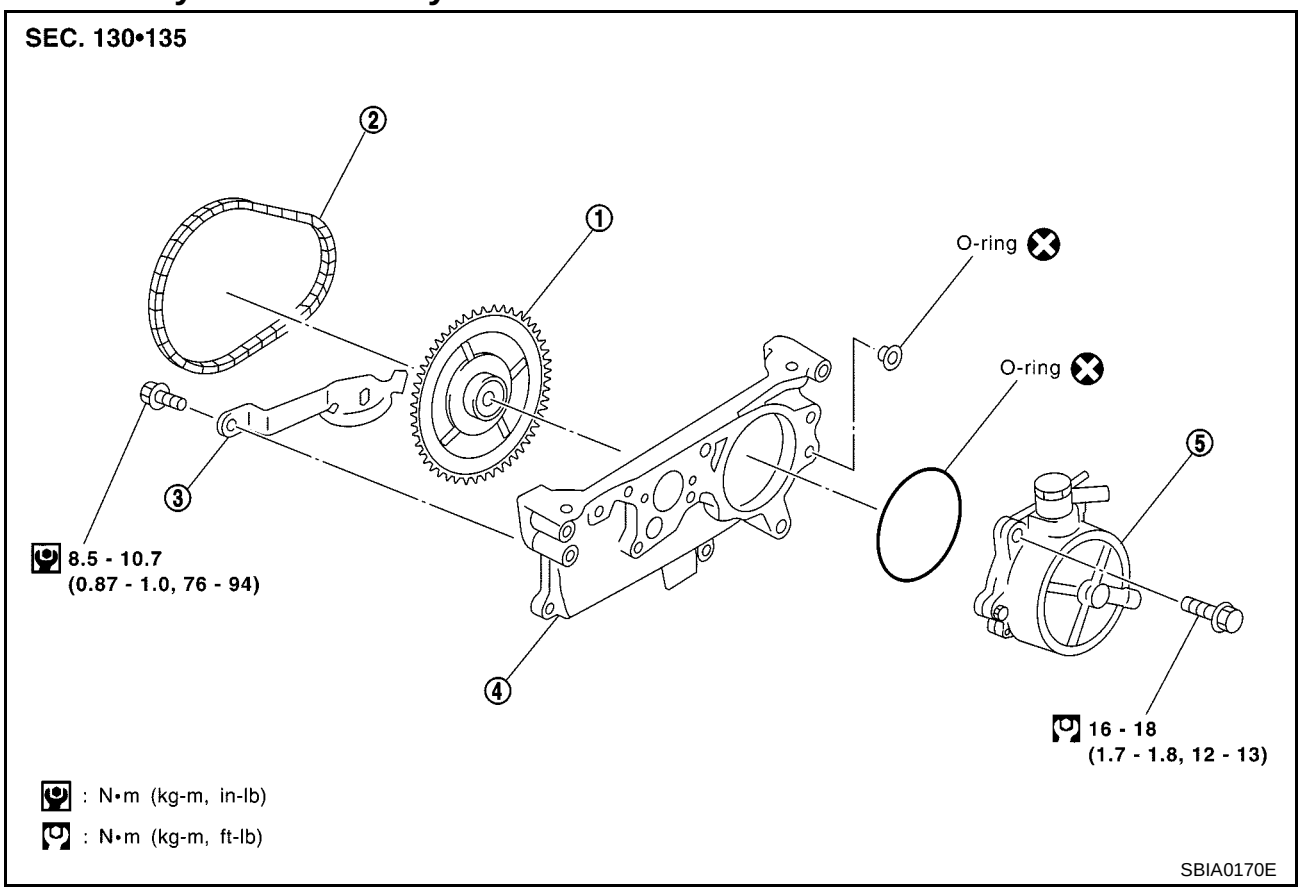
SBIA0169E

INSPECTION AFTER INSTALLATION

Check generated vacuum satisfies the specification at idle speed. Refer to EM-134, "INSPECTION BEFORE REMOVAL" .

Disassembly and Assembly

EBS00DIR



1. Rear cam sprocket
2. Drive chain
3. Chain guide
4. Cylinder head rear cover
5. Vacuum pump

DISASSEMBLY

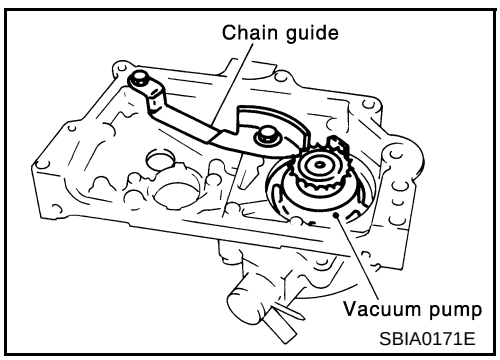
1. Push on chain guide lightly so that clearance between chain and chain guide part reaches 0 mm (0 in). Then loosen chain guide mounting bolts.
2. Remove chain from rear cam sprocket and vacuum pump sprocket.
3. Remove rear cam sprocket.
4. Remove vacuum pump.

CAUTION:
Do not disassemble vacuum pump.

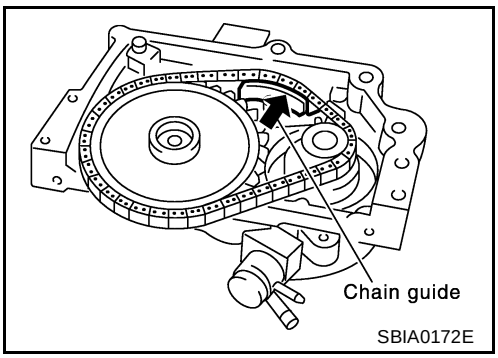
ASSEMBLY

Follow procedure below to install each part onto cylinder head rear cover.

1. Install vacuum pump.
2. Temporarily fit chain guide.



3. Install rear cam sprocket.
   - Sprocket can be installed in any direction.
4. Fit drive chain onto rear cam sprocket and vacuum pump sprocket.
5. Push on chain guide lightly so that clearance between chain and chain guide sliding part reaches 0 mm (0 in). Then tighten chain guide mounting bolts.

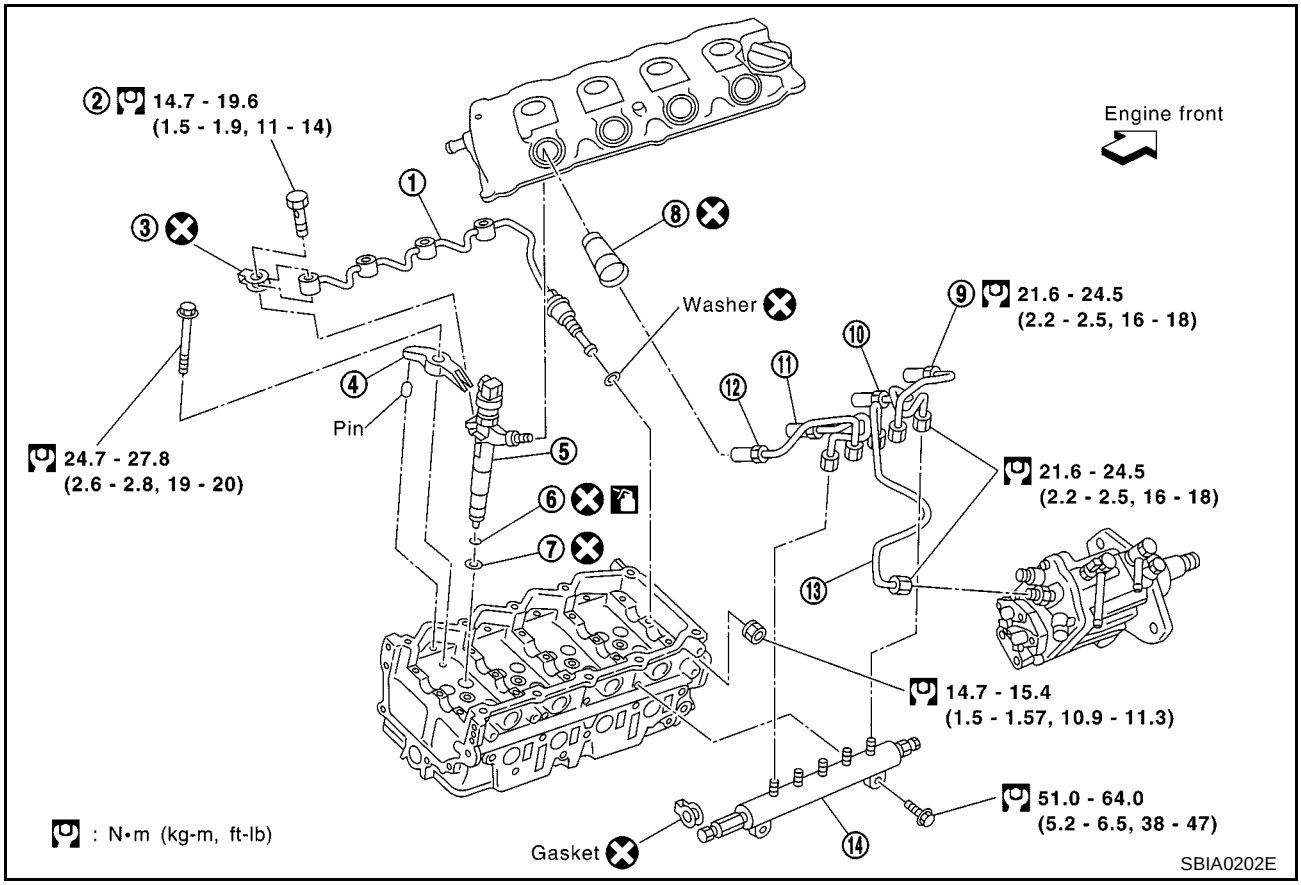


INJECTION TUBE AND FUEL INJECTOR

PFP:00018

Removal and Installation

EBS00DIS



1. Spill tube
2. Eye-bolt
3. Spill tube gasket
4. Nozzle support
5. Fuel injector
6. O-ring
7. Nozzle gasket
8. Nozzle oil seal
9. Injection tube No.1
10. Injection tube No.2
11. Injection tube No.3
12. Injection tube No.4
13. Injection tube center
14. Common rail assembly

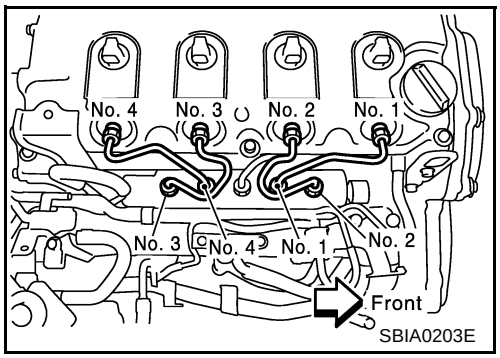
CAUTION:
Apply new engine oil to parts marked in illustration before installation.

REMOVAL

1. Remove charge air cooler. Refer to EM-117, "Removal and Installation" .
2. Remove harness connector from fuel injector.
3. Remove spill hose.
4. Following steps below, remove injection tubes.

a. Put a paint mark or tag on injection tubes to identify each cylinder.
   - Use a fuel-resistant method.

b. Remove injection tubes in order of 2-1-4-3 individually.

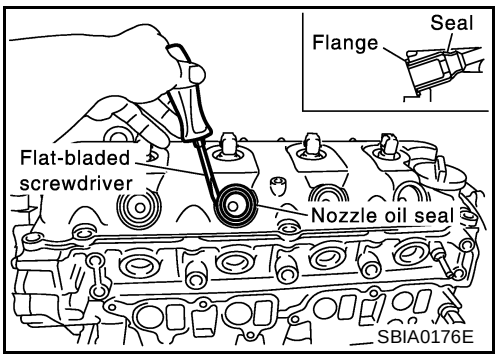


CAUTION:
Be careful not to allow leaked fuel to contaminate engine compartment. Especially, ensure to keep engine mount insulator clear of fuel.

NOTE:
Removal procedure of fuel injector is shown below.

5. Remove nozzle oil seal.
   - Using a slotted screwdriver, pry flange to remove oil seal.

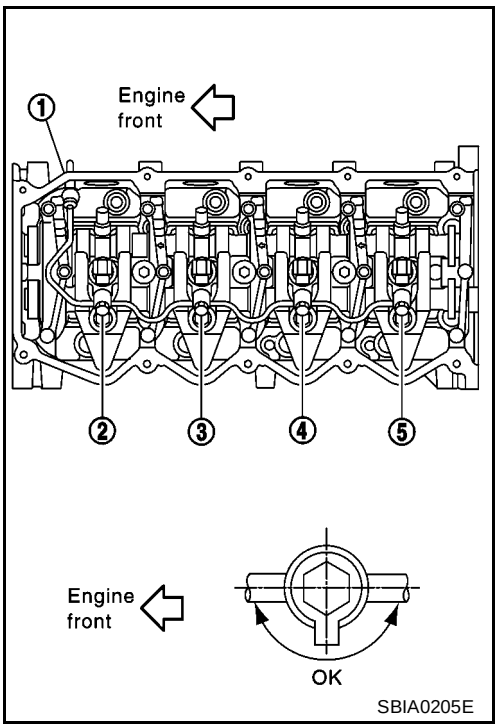
   NOTE:
   Nozzle oil seal seals between fuel injector and rocker cover. If only injection tube shall be removed and installed, nozzle oil seal replacement is not required.
6. Remove rocker cover. Refer to EM-150, "Removal and Installation" .



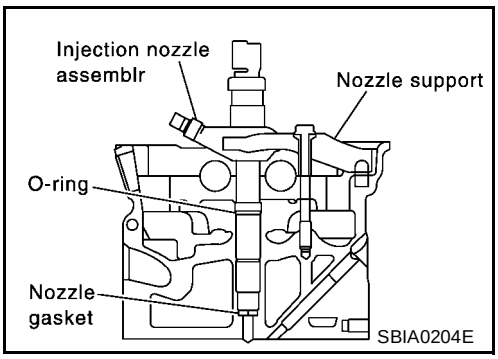
7. Remove spill tube mounting bolts and nut.
   - Loosen bolts and nut to the reverse order of the shown in the figure and remove then.
8. Following steps below, remove fuel injector.

a. Remove nozzle support.
b. Remove fuel injector. While rotating it to left and right, raise it to remove.

   CAUTION:
   - **Handle fuel injector carefully without giving any impact.**
   - **Do not disassemble fuel injector.**



c. If nozzle gasket remains in cylinder head, hook it with tip of a slotted screwdriver and pull it out.



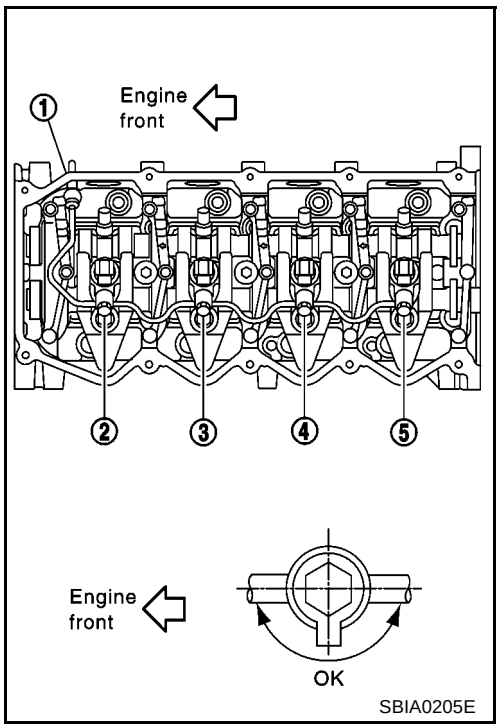
INSTALLATION

1. Following steps below, install fuel injector.

a. Install O-ring and nozzle gasket to fuel injector, and insert them into cylinder head.
b. Tighten injection tubes temporarily in the order of 3-4-1 and 2.
c. Be sure to fit nozzle support without looseness.
d. Tighten nozzle support bolts.
e. Loosen injection tubes in the order of 2-1- 4 and 3.

2. Connect spill tube.
   - Tighten fixing bolts and nut in the numerical order shown in the figure.

   NOTE:
   Connection of spill tube gasket may be broken, even if it is tighten to specified torque. It does not affect performance.

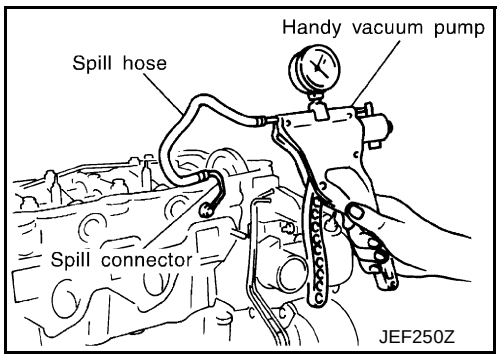


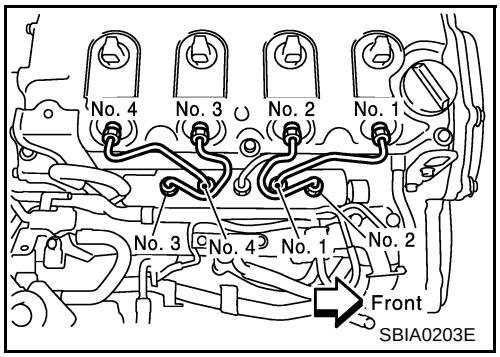
3. Carry out air tightness test for spill tube.
   - Connect a vacuum handy pump to spill connector. Check that vacuum is retained while applying following vacuum.

     Standard : – 53.3 to – 66.7 kPa (– 533 to – 667 mbar, – 400 to – 500 mmHg, –15.75 to –19.69 inHg)

   - If outside of standard, reconnect spill tube. (Replace gasket in this case.)
4. Install rocker cover. Refer to EM-150, "Removal and Installation".
5. Install nozzle oil seal.
   - Insert it straight until its flange fully contacts rocker cover.

   CAUTION:
   - **Check gutter spring in seal on fuel injector for missing.**
6. Connect injection tubes individually to each cylinder in order of 3-4-1-2.
7. Connect spill hose.
8. Install remaining parts in reverse order of removal.





INSPECTION AFTER INSTALLATION

CONSULT-II service support has a force rail pressure increase function and can increase rail pressure to any given pressure. Check for fuel leaks visually by increasing internal pressure using this function.

FUEL SUPPLY PUMP

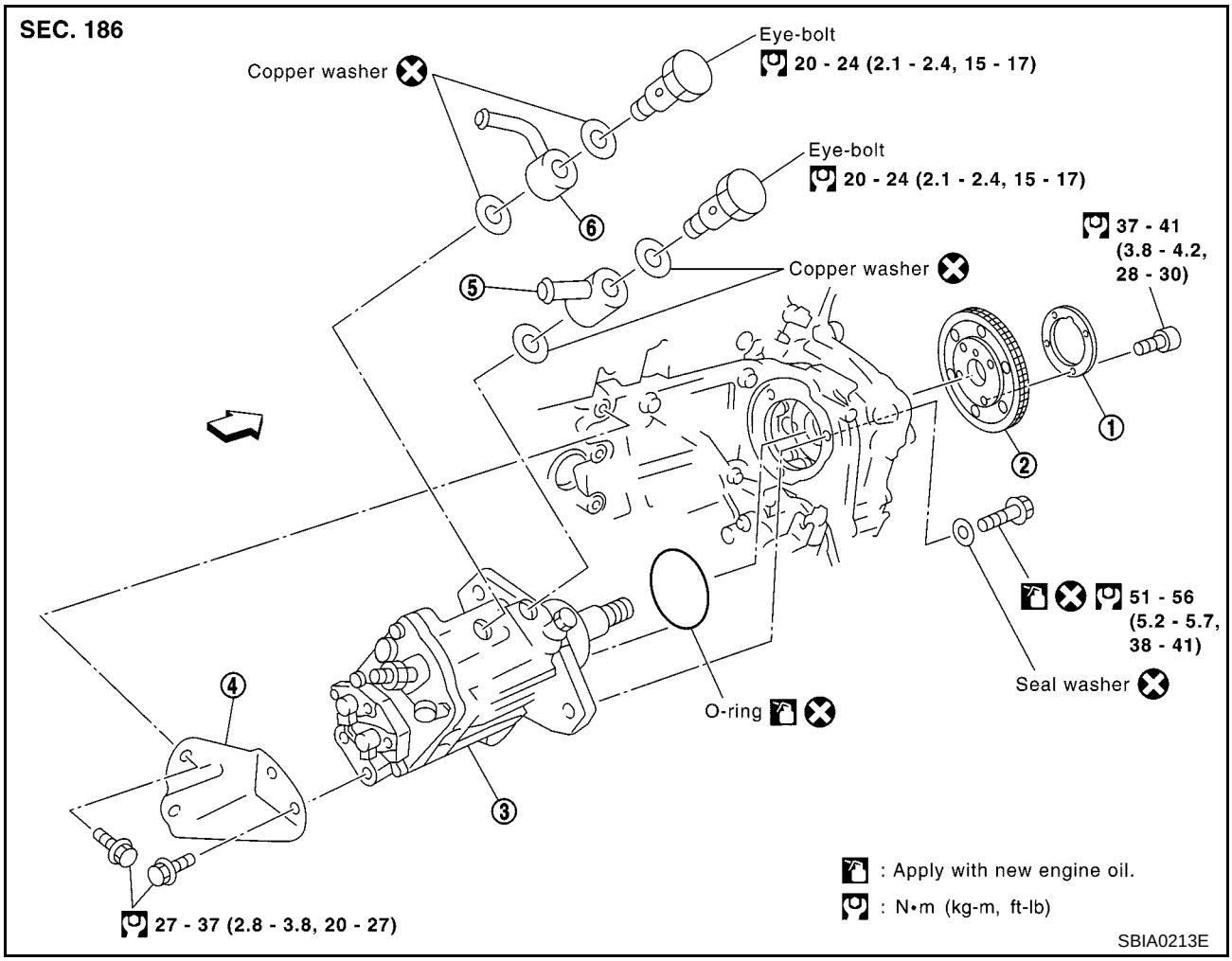
PFP:00018

Removal and Installation

EBS00DIT

CAUTION:

- **Before removing and installing fuel supply pump, be sure to remove sprocket. Do not loosen or remove installation nut in the center of fuel supply pump. If loosened or removed, replace fuel supply pump.**
- **After removing timing chain, do not turn crankshaft and camshaft separately, or valves will strike piston heads.**
- **When installing camshafts, chain tensioners, oil seals, or other sliding parts, lubricate contacting surfaces with new engine oil.**
- **Apply new engine oil to parts marked in illustration before installation.**



1. Washer
2. Fuel supply pump sprocket
3. Fuel supply pump
4. Fuel supply pump rear bracket
5. Fuel connector (Feed side)
6. Fuel connector (Return side)

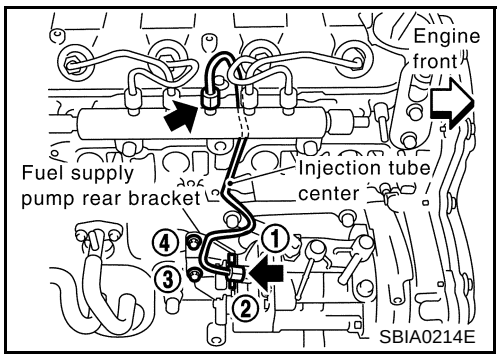
REMOVAL

1. Remove coolant reservoir tank.
2. Remove charge air cooler. Refer to EM-117, "Removal and Installation" .
3. Remove RH engine mount insulator and bracket. Refer to EM-187, "Removal and Installation" .
4. Pull power steering reservoir tank out of brackets to move power steering piping.

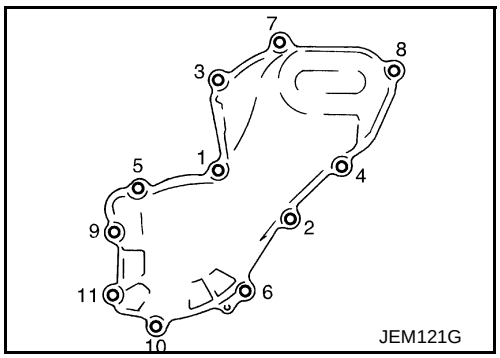
   CAUTION:

   To avoid removing power steering reservoir tank out of brackets move it with power steering piping aside.

5. Remove RH front wheel.
6. Remove RH splash cover (combined with under cover)
7. Remove front exhaust tube.
8. Remove fuel hose from fuel supply pump.
9. Remove the harness connector from the fuel supply pump.
10. Remove the fuel supply pump rear bracket.
    - Loosen the fuel bolts in the reverse order of that show in the figure and remove them.
11. Remove injection tube center.



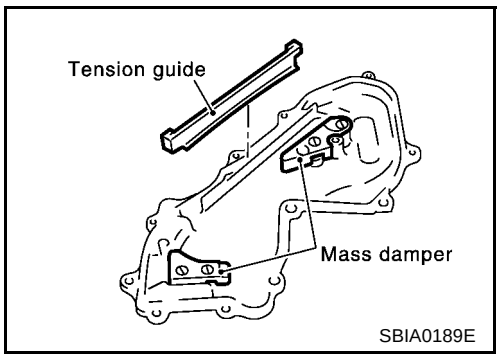
12. Remove front chain case.
    - Loosen fixing bolts in the reverse order of that shown in the figure and remove them.



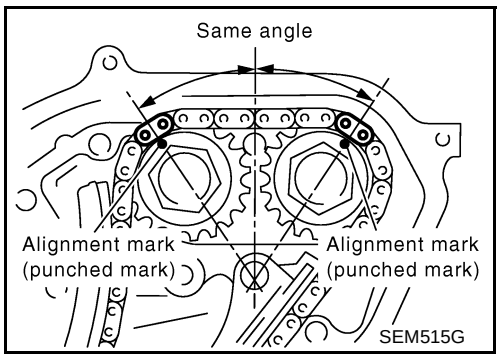
    - Remove No. 6, 10 and 11 bolts with the rubber washer as space is limited for pulling them out.

CAUTION:

- **While front chain case is removed, cover openings to prevent entry of foreign material into engine.**
- **Do not remove two mass dampers on the back of cover.**

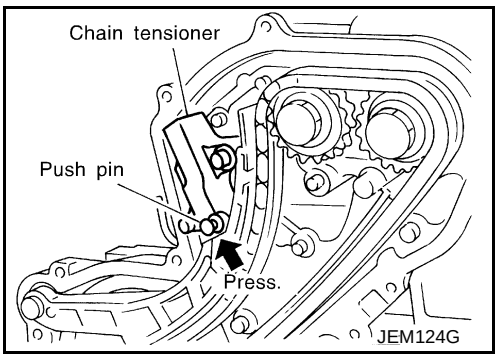


13. Set the No. 1 piston to TDC on its compression stroke.
    - Turn crankshaft pulley clockwise so that the alignment mark (punched mark) on each camshaft sprocket is positioned as shown in the figure.
    - **No position indicator is provided on the crankshaft pulley.**
    - **When installing, color coded links on the secondary timing chain can be used as alignment marks. Marking may not be necessary for removal; however, make alignment marks as required because the alignment mark on fuel supply pump sprocket may not be easy to see.**

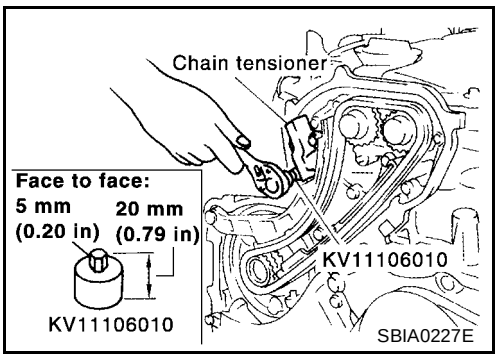


14. Remove chain tensioner.

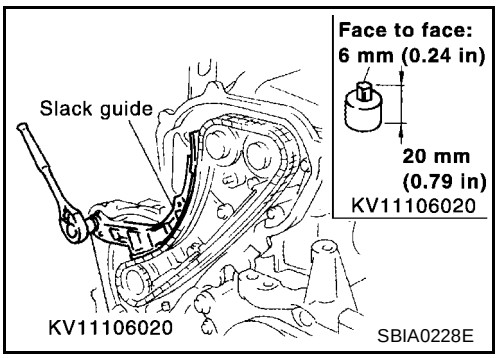
a. Push the plunger of chain tensioner and keep it pressed with a push pin.



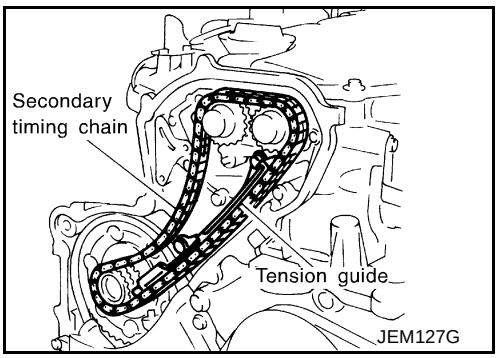
b. Using a hexagon-head wrench [face to face: 5 mm (0.20 in), SST], remove bolts to remove chain tensioner.



15. Remove timing chain slack guide.
    - Using a hexagon-head wrench [face to face: 6 mm (0.24 in), SST], remove bolt to remove timing chain slack guide.



16. Remove timing chain tension guide.
17. Remove secondary timing chain.
    - Timing chain alone can be removed without removing sprockets.

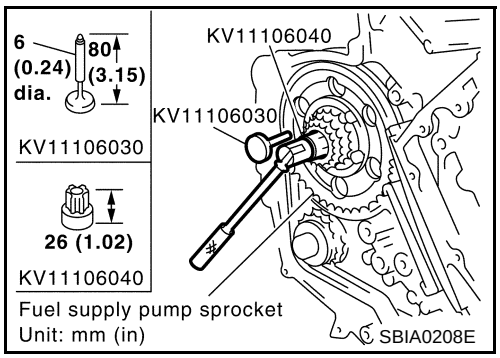


18. Hold fuel supply pump sprocket and remove bolt.

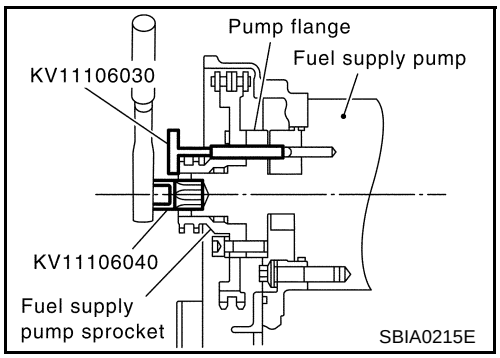
a. Insert positioning stopper pin (SST) into the hole 6 mm (0.24 in) in the diameter on the fuel supply pump sprocket.

b. Using a TORX wrench (SST), turn pump shaft little by little to adjust the position of fuel supply pump sprocket so that the holes align.

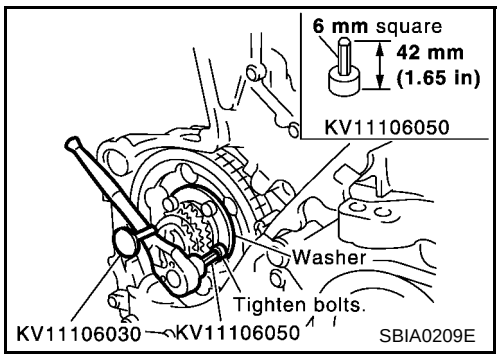
c. Push positioning stopper pin (SST) through pump sprocket to fuel supply pump body to hold pump sprocket.

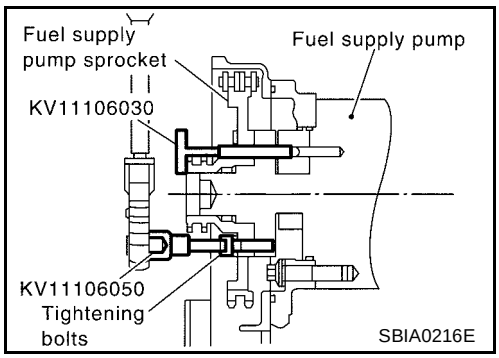


- Insert the positioning stopper pin until its flange contacts the fuel supply pump sprocket.
- Remove the TORX wrench (SST).

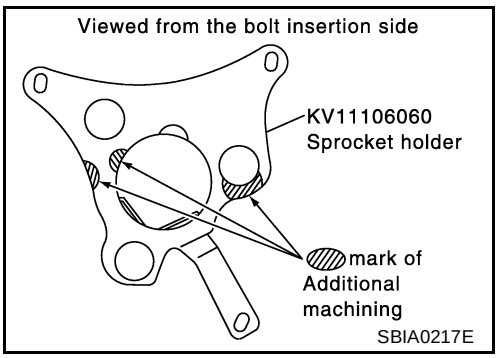


19. Using a hexagon-head wrench [face to face 6 mm (0.24 in) SST] remove bolts to fuel supply pump sprocket.

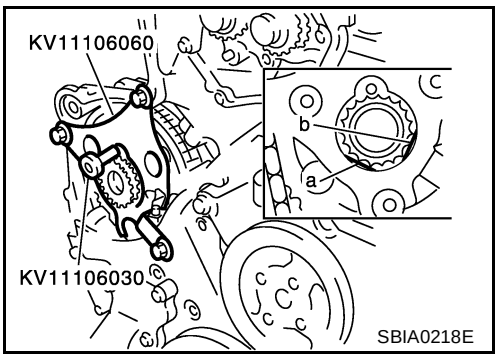




20. Using the sprocket holder (SST), hold the fuel supply pump sprocket to prevent falling.

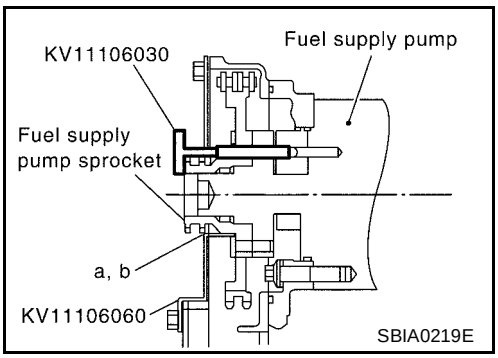


- As for the sprocket holder, install fuel supply pump mounting bolt through hole of KV11106060 as shown in figure.
- When the sprocket holder is installed, if the positioning stopper pin interferes, pull out the stopper pin approximately 10 mm (0.39 in), then install it.
- After the sprocket holder is installed temporarily, insert the extension bar (SST) and TORX socket in the three holes A. After positioning the holes, tighten the holder mounting bolts.



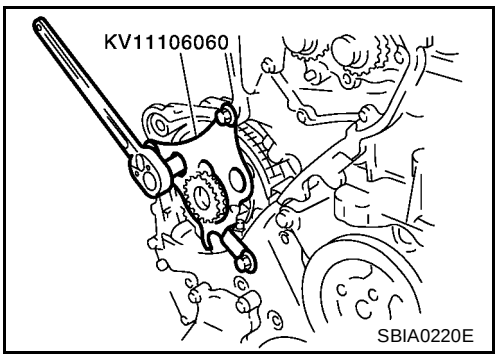
- The length of the sprocket holder mounting bolts should be approximately 15 mm (0.59 in) (M6 thread length).
- Make sure that the a- and b-faces of the sprocket holder contact the bottom side of the sprocket (small diameter side).

  CAUTION:
  Do not remove the sprocket holder until the fuel supply pump is installed.
- After the sprocket holder is installed, pull out the positioning stopper pin (SST) from the fuel supply pump sprocket.



21. Using the extension bar [SST: whole length 43 mm (1.69 in)] and the TORX socket (Q6-E12: commercially available), remove the mounting bolts, them remove the fuel supply pump toward the rear of the engine

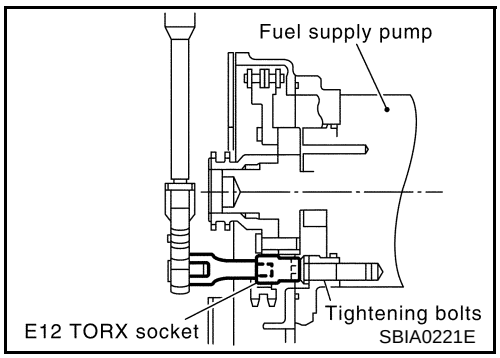
    CAUTION:
    Do not disassemble or adjust the fuel supply pump.



22. Remove the fuel supply pump mounting bolts.

NOTE:
The seal washer of the mounting bolts cannot be reused.

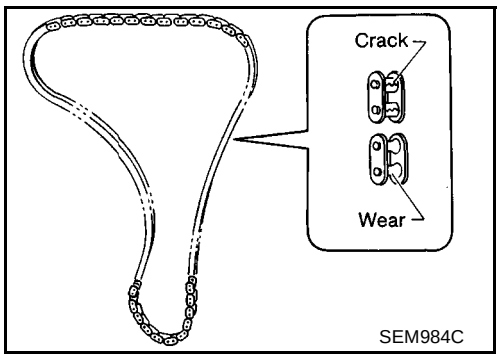
CAUTION:
For removal, be careful not to drop the seal washer into the engine.



INSPECTION AFTER REMOVAL

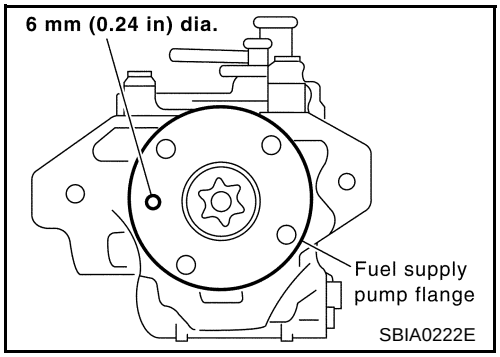
Timing Chain

Check for cracks and excessive wear at roller links. Replace chain if necessary.

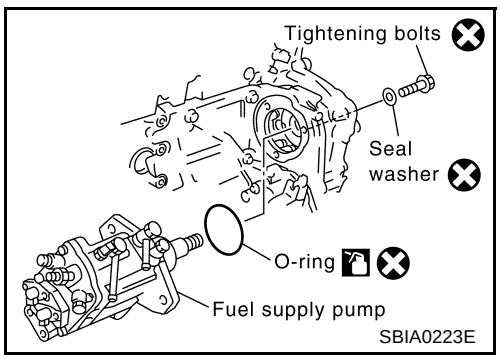


INSTALLATION

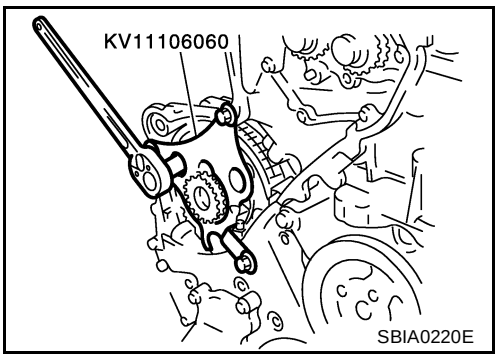
1. Before the fuel supply pump is installed, check that the notch of its flange and the 6 mm (0.24 in) dia. hole on the body are aligned.



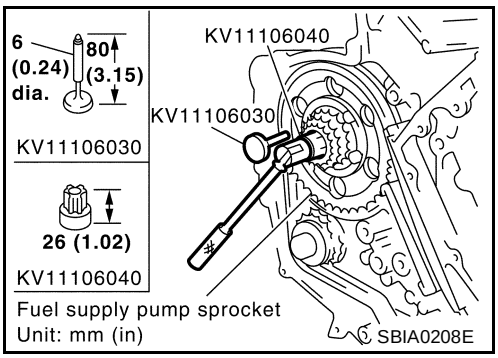
2. Insert the fuel supply pump to the mounting position from the rear side of the engine.



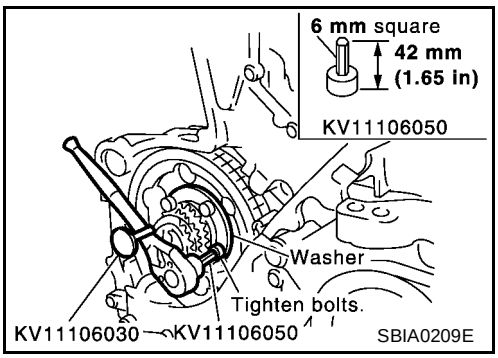
3. Using the extension bar (SST) and the TORX socket, tighten the mounting bolts of the fuel supply pump.
4. Remove the sprocket holder (SST).



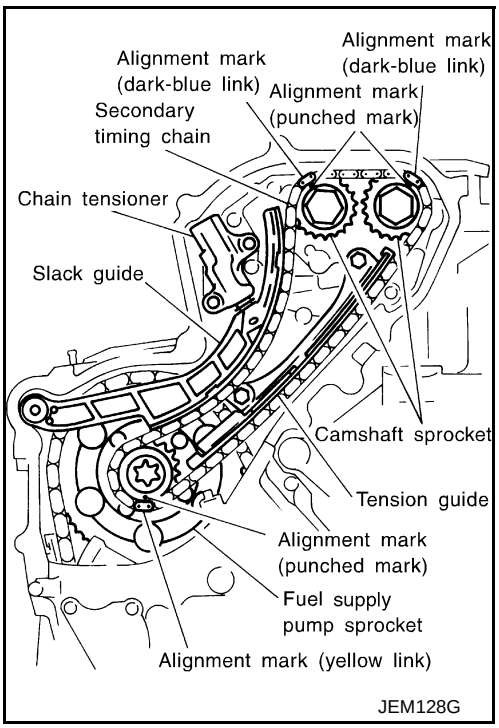
5. Using the TORX wrench (SST), turn the pump shaft gradually to adjust the position of the flange. Then, insert the positioning stopper pin (SST) to the 6 mm (0.24 in) dia. hole of the fuel supply pump sprocket through the pump flange and the pump body.
6. Remove the TORX wrench (SST)



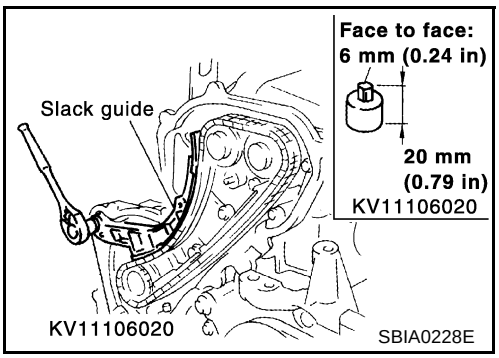
7. Using the hexagon wrench [face to face: 6 mm (0.24 in), long-type](SST), tighten the sprocket mounting bolt.
   - When the washer of the fuel supply pump sprocket is removed, install it with the marking “F” (front) facing the front of the engine.
8. Pull out the positioning stopper pin (SST).



9. Install secondary timing chain.
   - When installing, match the alignment marks on sprockets with color coded alignment marks (colored links) on the chain.
10. Install timing chain tension guide.
   - The upper bolt has a longer shank than the lower bolt.

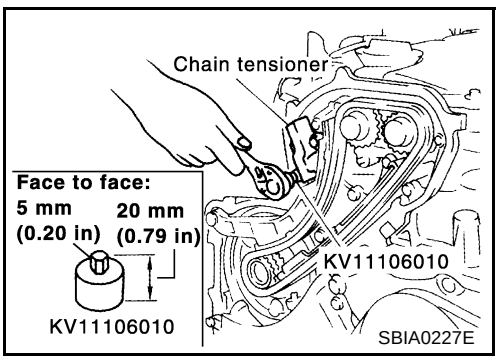


11. Using a hexagon-head wrench [face to face: 6 mm (0.24 in), SST], install timing chain slack guide.



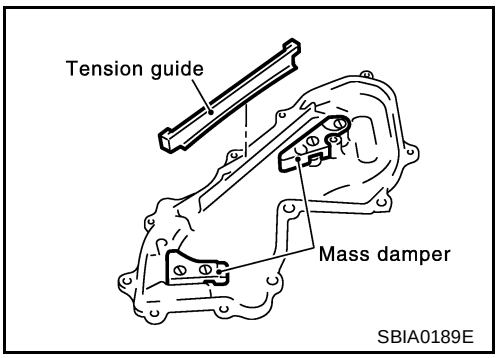
12. Install chain tensioner.

a. Push the plunger of the chain tensioner. While holding it with a push pin, install the chain tensioner.
b. Using a hexagon-head wrench [face to face: 5 mm (0.20 in), SST], tighten bolts.
c. Pull out the push pin, etc. holding the plunger.
   - **Check again that the alignment marks on the sprockets and the colored alignment marks on the timing chain are aligned.**



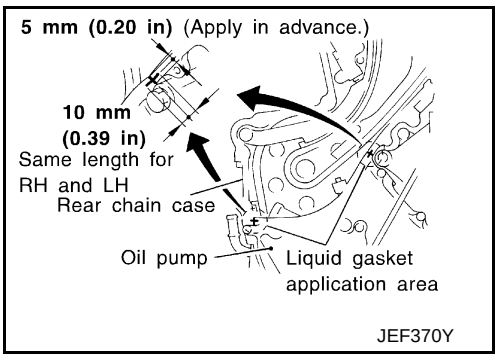
13. Install front chain case.

a. Install tension guide on the back surface of front chain case.
   - Hold front chain case vertically when installing. Tension guide may come off if front chain case is tilted.



b. Apply Genuine Liquid Gasket or equivalent (Refer to EM-106, "Precautions for Liquid Gasket" .) on both ends of arched area (locations where rear chain case is adjoined) as shown in the figure.

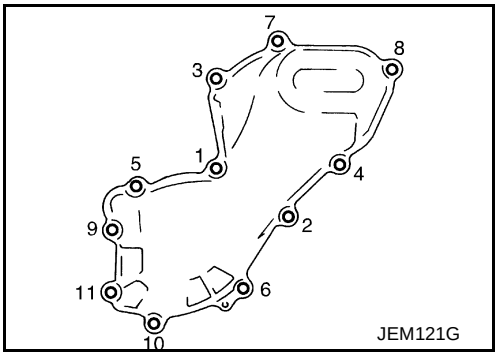
c. Install front chain case.
   - When installing, align dowel pin on oil pump case with the pin hole.



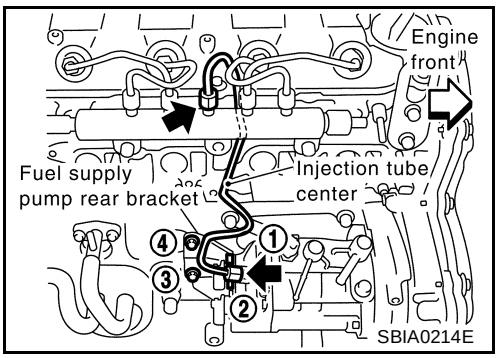
   - Install No. 6, 10 and 11 bolts with the rubber washer to the front chain case.

d. Tighten fixing bolts in the numerical order shown in the figure.

e. After tightening all the bolts, re-tighten in the same order.



14. Install the fuel supply pump rear bracket.
   - Tighten fixing bolts in the numerical order shown in the figure.
15. Install the harness connector from fuel supply pump.
16. Install fuel hoses.
17. Hereafter, install in the reverse order of removal.

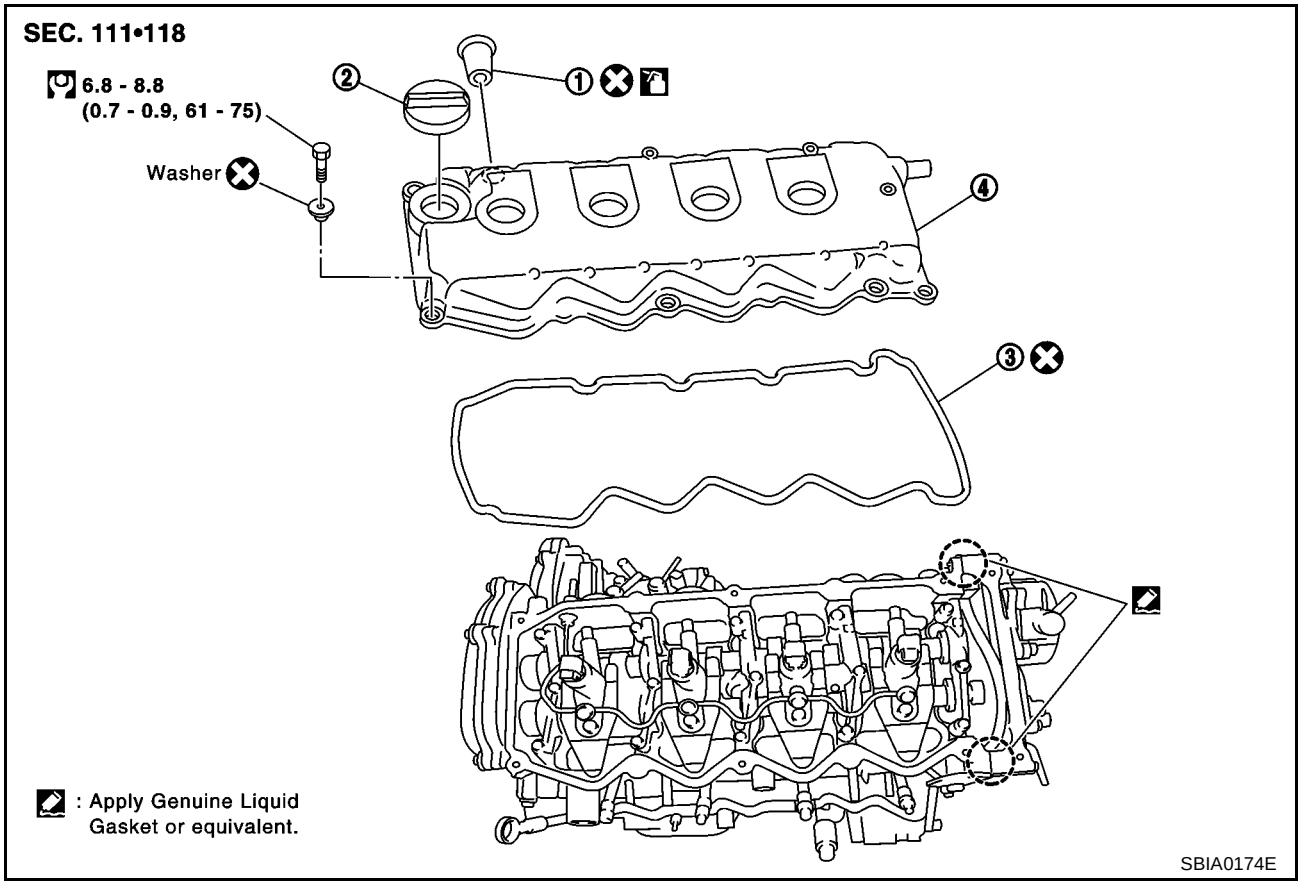


ROCKER COVER

PFP:13264

Removal and Installation

EBS00DIU



1. Nozzle oil seal
2. Oil filler cap
3. Gasket
4. Rocker cover

REMOVAL

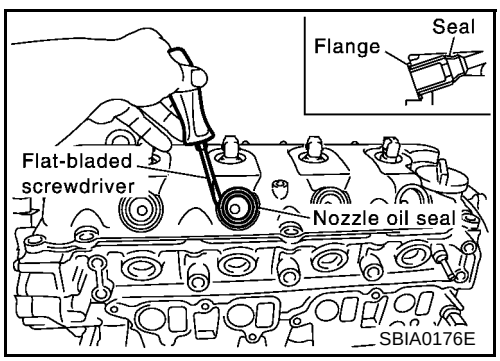
1. Remove charge air cooler cover. Refer to EM-117, "Removal and Installation" .
2. Remove charge air cooler and bracket.
3. Remove harness connector from injection nozzle. Refer to EM-138, "Removal and Installation" .
4. Following steps below, remove injection tube.

a. Put a paint mark or tag on injection tubes to identify each cylinder.
   - Use a fuel-resistant method.

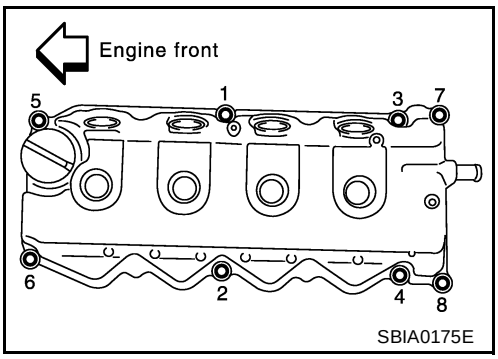
b. Remove injection tubes in order of 2-1-4-3 individually.

CAUTION:
Be careful not to allow leaked fuel to contaminate engine compartment. Especially, ensure to keep engine mount insulator clear of fuel.

5. Remove injection nozzle oil seal.
   - Using a slotted screwdriver, pry flange to remove oil seal.

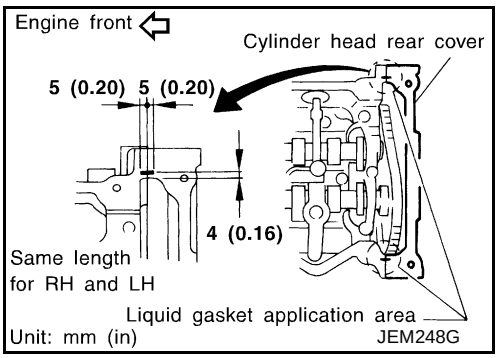


6. Remove rocker cover.
   - Loosen holding bolts in the reverse order of that shown in the figure and remove.

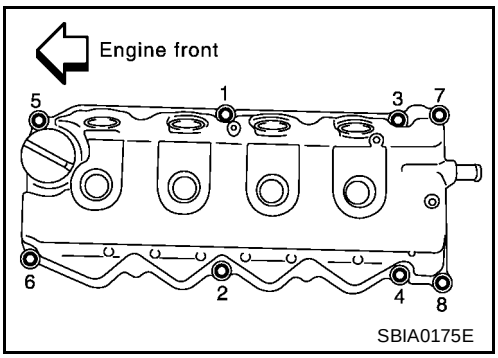


INSTALLATION

1. Apply 3.0 mm (0.118 in) dia. of Genuine Liquid Gasket or equivalent (Refer to EM-106, "Precautions for Liquid Gasket" .) on locactions shown in the figure.



2. Tighten holding bolts in the numerical order shown in the figure.
   - Re-tighten to the same torque in the same order as above.
3. Install nozzle oil seal.
   - Insert it straight until flange fully contacts cylinder head.
4. Install remaining parts in reverse order removal.
5. Before starting engine, bleed air from fuel piping. Refer FL-16, "Air Bleeding" .



INSPECTION AFTER INSTALLATION

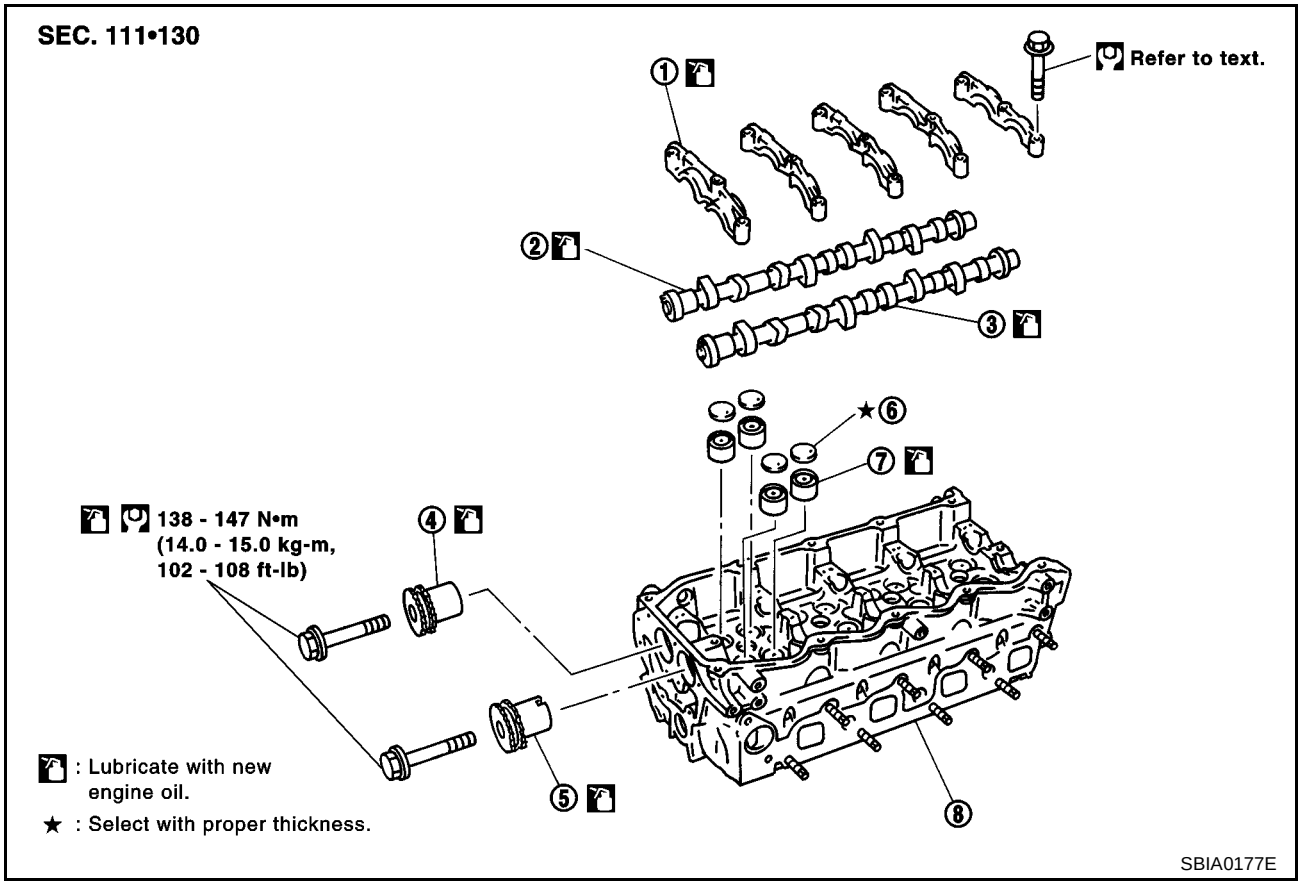
Start engine and increase engine speed to check for fuel leak.

CAMSHAFT

PFP:13001

Removal and Installation

EBS00DIV



1. Camshaft bracket
2. Camshaft (right side)
3. Camshaft (left side)
4. Camshaft sprocket (right side)
5. Camshaft sprocket (left side)
6. Adjusting shim
7. Valve lifter
8. Cylinder head

.

CAUTION:

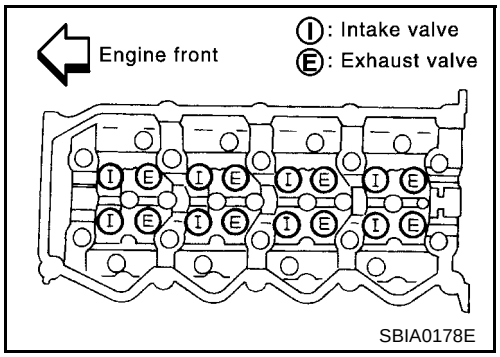
Apply new engine oil to parts marked in illustration before installation.

- This engine will have a different valve arrangement from normal DOHC 4-valve type engines. As both camshafts on this engine have intake and exhaust camshafts, in this chapter they are named as follows:

  Camshaft (Right side) : Intake manifold side

  Camshaft (Left side) : Exhaust manifold side

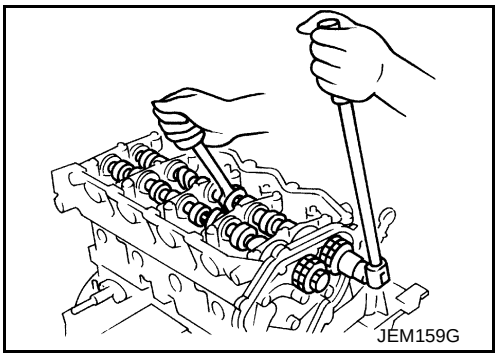
- Refer to the figure for intake and exhaust valve arrangement. (The camshafts have, alternately, either an intake valve or an exhaust valve.)



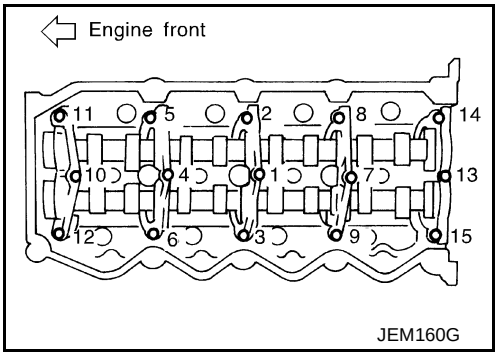
REMOVAL

1. Drain engine coolant. Refer to CO-30, "Changing Engine Coolant" .
2. Remove charge air cooler. Refer to EM-117, "Removal and Installation" .
3. Remove air duct and air inlet pipe. Refer to EM-115, "Removal and Installation" .
4. Remove rocker cover. Refer to EM-150, "Removal and Installation" .
5. Remove vacuum pump. Refer to EM-134, "Removal and Installation" .

6. Remove injection tube and fuel injector. Refer to EM-138, "Removal and Installation" .
7. Remove secondary timing chain. Refer to EM-161, "Removal and Installation" .
8. Set the No. 1 cylinder at TDC on its compression stroke.
9. Remove the camshaft stroke.
   - Loosen the camshaft gear installation bolt by fixing the hexagonal portion of the camshaft.


JEM159G

10. Remove the camshaft.
    - Place distinguishing marks on the right and left sides with paint.
    - Loosen and remove the installation bolt in reverse order shown in the figure.
11. Remove the adjusting shim and valve lifter.
    - Remove by taking notice of the installation position, and place outside engine in order to prevent confusion.



JEM160G

INSPECTION AFTER REMOVAL

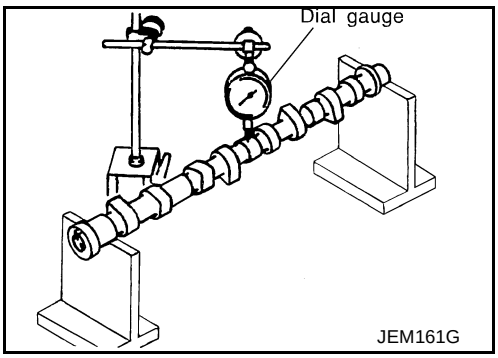
Visual Check of Camshaft

- Check the camshaft for one sided wear or scratches.
- Replace the camshaft if there are abnormalities.

Camshaft Runout

- Prepare V-block on a flat surface and secure camshaft journals No. 1 and No. 5.
- Set the dial gauge vertically on journal No. 3.
- Rotate camshaft in one direction by hand, then read needle movement on dial indicator. (Total indicator reading)

Limit : 0.04 mm (0.0016 in)



JEM161G

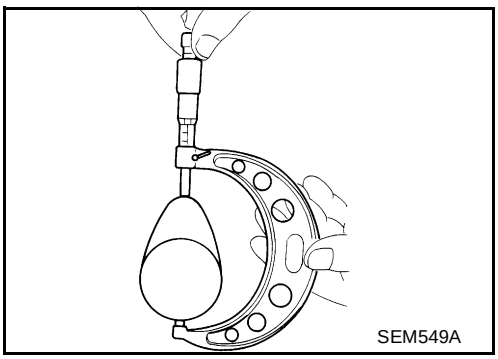
Height of Cam Nose

Measure by using a micrometer.

Standard:

Intake : 39.505 - 39.695 mm (1.5553 - 1.5628 in

Exhaust : 39.905 - 40.095 mm (1.5711 - 1.5785 in)


SEM549A

Camshaft Oil Clearance

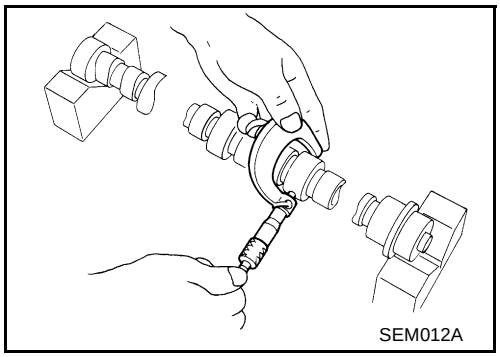
Measure by using a micrometer.

Camshaft journal outer diameter:

Standard:

NO. 1 : 30.435 - 30.455 mm (1.1982 - 1.1990 in) dia.

NO. 2, 3, 4, 5 : 23.935 - 23.955 mm (0.9423 - 0.9431 in) dia.



Camshaft Bracket Inner Diameter

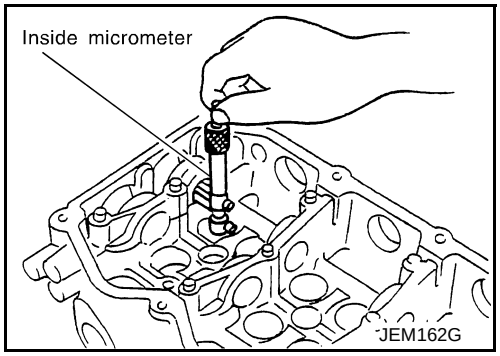
- Install camshaft bracket and tighten bolts to the specified torque.
- Measure inner diameter of camshaft bracket using an inside micrometer.

Camshaft bracket inner diameter:

Standard:

NO. 1 : 30.500 - 30.521 mm (1.2008 - 1.2016 in) dia.

NO. 2, 3, 4, 5 : 24.000 - 24.021 mm (0.9449 - 0.9457 in) dia.



Camshaft Oil Clearance Calculations

(Oil clearance) = (Camshaft bracket inner diameter) – (Camshaft journal outer diameter)

Standard : 0.045 - 0.086 mm (0.0018 - 0.0034 in) dia.

- If it exceeds the standard value, refer to the standard value of each unit, then replace the camshaft and/or cylinder head.

NOTE:

As the camshaft bracket is manufactured with the cylinder head, it is impossible to replace only the camshaft bracket.

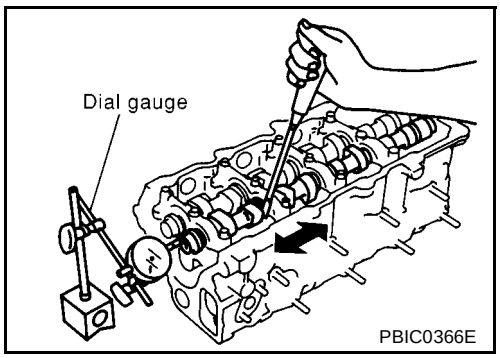
Camshaft End Play

- Set the dial gauge to the front end of the camshaft. Measure the end play by moving the camshaft in the direction of the axle.

Standard : 0.070 - 0.148 mm (0.0028 - 0.0058 in)

Limit : 0.24 mm (0.0094 in)

- If end play exceeds the limit, replace camshaft and measure camshaft end play again.
- If end play still exceeds the limit after replacing camshaft, replace cylinder head.

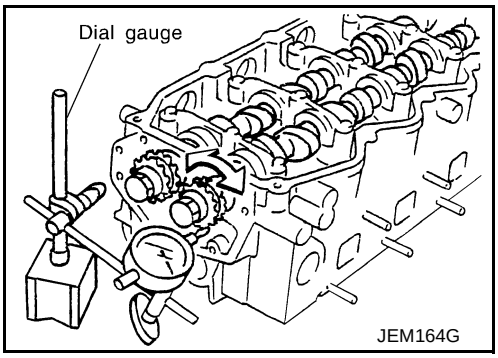


Camshaft Sprocket Runout

1. Install sprocket on camshaft.
2. Measure camshaft sprocket runout.

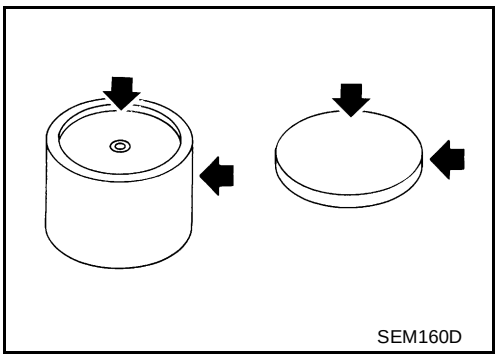
Runout (Total indicator reading):
: Less than 0.15 mm (0.0059 in)

3. If it exceeds the limit, replace camshaft sprocket.



Visual Inspection of Valve Lifter and Adjusting Shim

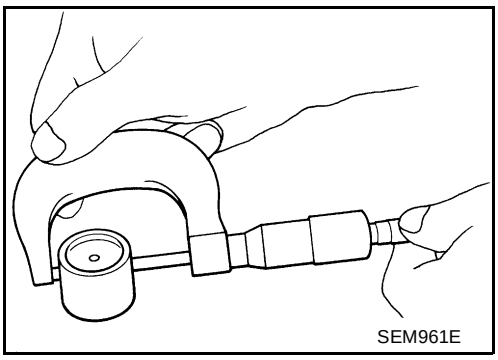
- Check lifter side for any signs of wear or damage. Replace if there are any abnormalities.
- Check cam nose contact and sliding surfaces for wear and scratches. Replace if there are any abnormalities.



Valve Lifter Bore Diameter

Measure the outer diameter of the valve lifter with a micrometer.

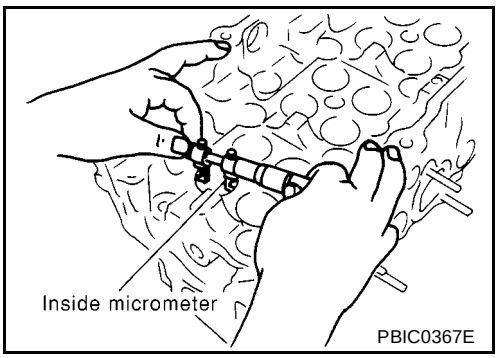
Standard : 29.960 - 29.975 mm (1.1795 - 1.1801 in) dia.



Valve Lifter Inner Diameter

Measure the bore diameter of the cylinder head valve lifter with an inside micrometer.

Standard : 30.000 - 30.021 mm (1.1811 - 1.1819 in) dia.



Valve Lifter Clearance Calculations

(Clearance) = (Valve lifter bore diameter) – (Valve lifter outer diameter)

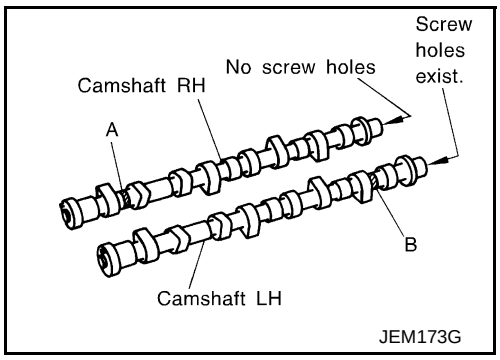
Standard : 0.025 - 0.061 mm (0.0010 - 0.0024 in)

If it exceeds the standard value, refer to the outer diameter and bore diameter standard values and replace valve lifter and/or cylinder head.

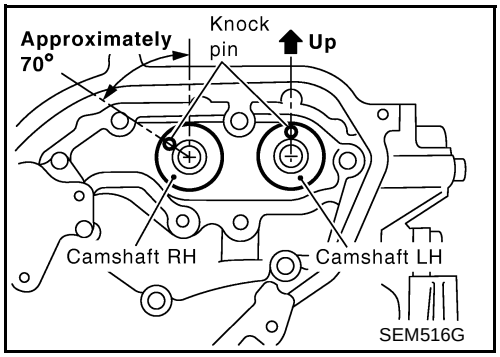
INSTALLATION

1. Install the valve lifter and adjusting shim.
   - Make sure that these are installed in the same position as before the removal process.
2. Install the camshaft.
   - Identify camshafts by the paint position and screw hole at the rear end.

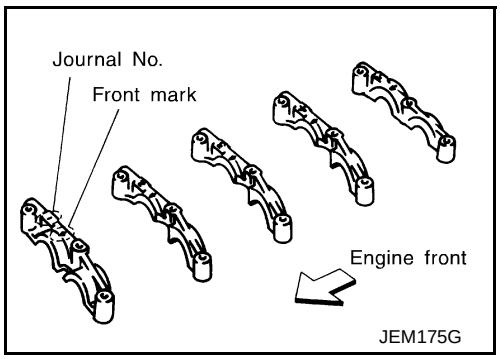
     Camshaft RH : Paint is at position A without screw hole.
     Camshaft LH : Paint is at position B with screw hole.



   - Install so that knock pins are positioned in the directions shown in the figure.



3. Install camshaft brackets.
   - Install correctly, identifying brackets by the journal No. and front mark on top surface.



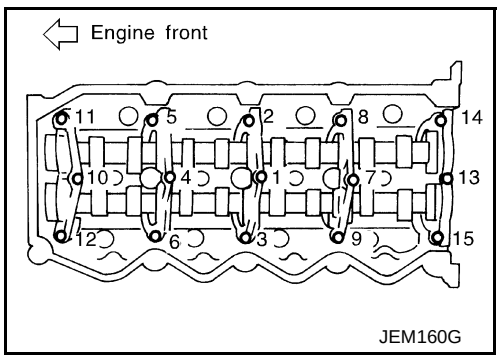
4. Tighten bolts in the order shown in the figure according to the following procedure:

a. Tighten to 2.0 N·m (0.2 kg-m, 17 in-lb).
   - Make sure camshaft thrusting parts (on rear side) securely fit in their mating parts on the cylinder head.

b. Tighten to 6 N·m (0.6 kg-m, 52 in-lb).

c. Tighten to 12 to 13 N·m (1.2 to 1.4 kg-m, 9 to 10 ft-lb).

5. Install camshaft sprockets.
   - Camshaft sprockets are commonly used for RH and LH.
   - Align camshaft sprocket and dowel pin on camshaft, and install.
   - Holding the hexagonal part of camshaft with a wrench, tighten bolt securing camshaft sprocket.



6. Before installing spill tube after installing secondary timing chain, check and adjust valve clearance. Refer to EM-157, "Valve Clearance" .
7. Hereafter, install in the reverse order of removal.

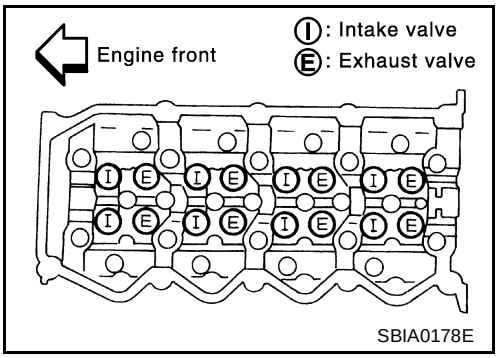
Valve Clearance

EBS00DIW

INSPECTION

- When the camshaft or parts in connection with valves are removed or replaced, and a malfunction has occurred (poor starting, idling, or other malfunction) due to the mis adjustment of the valve clearance, inspect as follows.
- Inspect and adjust when the engine is cool (at normal temperature).
- Be careful of the intake and exhaust valve arrangement. The valve arrangement is different from that in a normal engine.

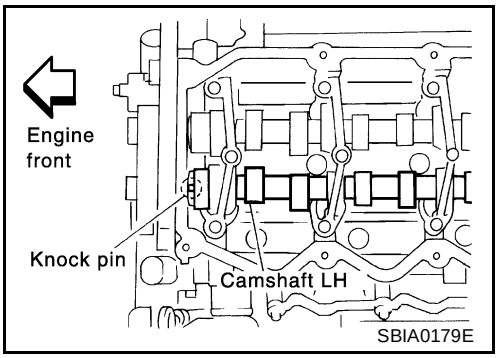
  NOTE:
  The camshafts have, alternately, either an intake valve or an exhaust valve.(Refer to illustration)



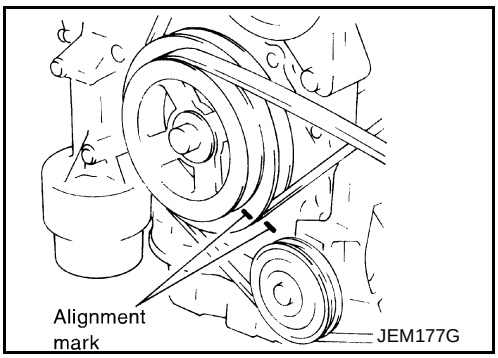
1. Drain engine coolant. Refer to CO-30, "Changing Engine Coolant" .
2. Remove charge air cooler. Refer to EM-117, "Removal and Installation" .
3. Remove air duct and air inlet pipe. Refer to EM-115, "Removal and Installation" .
4. Remove rocker cover. Refer to EM-150, "Removal and Installation" .
5. Remove vacuum pump. Refer to EM-134, "Removal and Installation" .
6. Remove injection tube and fuel injector. Refer to EM-138, "Removal and Installation" .
7. Remove secondary timing chain. Refer to EM-161, "Removal and Installation"

Check valve clearance while engine is cold and not running.

8. Set the No. 1 piston to TDC on its compression stroke.
   - Turn crankshaft pulley clockwise so that the knock pin on camshaft LH faces straight above. (No position indicator, etc. is provided on the crankshaft pulley.)

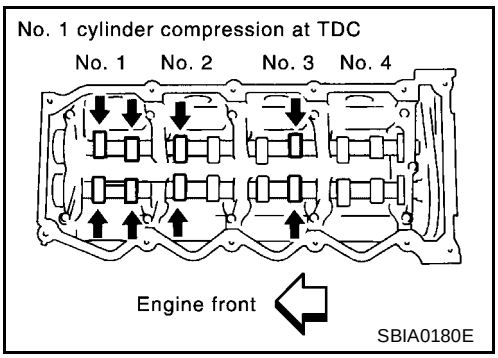


9. Put an alignment mark with paint, etc. on the crankshaft pulley and on the oil pump as an angle indicator.



10. While referring to the figure, measure the valve clearance marked in the table below.

Measuring point	No. 1		No. 2		No. 3		No. 4	
	INT	EXH	INT	EXH	INT	EXH	INT	EXH
When the No. 4 cylinder is in the TDC	X	X	X			X		



- The injection order is 1-3-4-2.

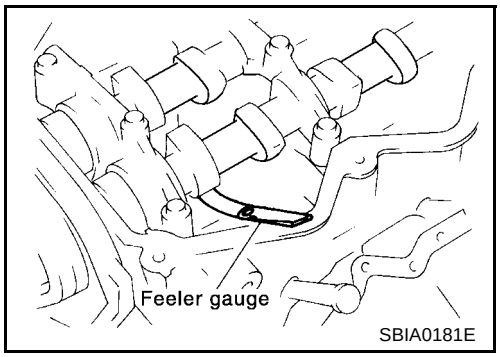
- Measure the valve clearance using a fine feeler gauge when the engine is cool (at normal temperature).

Valve clearance (Cold):

Standard:

Intake : 0.24 - 0.32 mm (0.0094 - 0.0126 in)

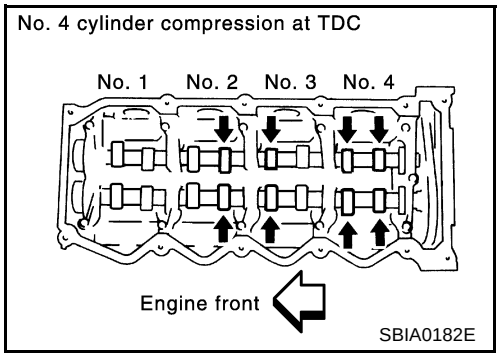
Exhaust : 0.26 - 0.34 mm (0.0102 - 0.0134 in)



11. Set the No. 4 cylinder at TDC by rotating the crankshaft clockwise once.

12. While referring to the figure, measure the valve clearance marked in the table below.

Measuring point	No. 1		No. 2		No. 3		No. 4	
	INT	EXH	INT	EXH	INT	EXH	INT	EXH
When the No. 4 cylinder is in the TDC				X	X		X	X

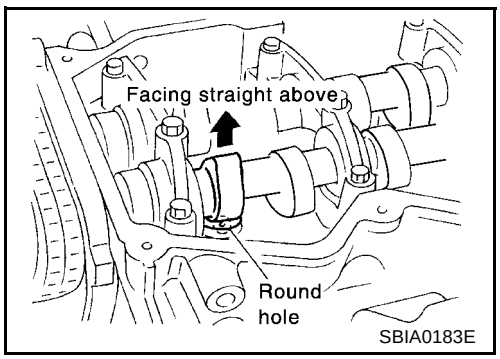


13. If the valve clearance is outside the specification, adjust as follows.

ADJUSTMENTS

- Remove the adjusting shim for parts which are outside the specified valve clearance.

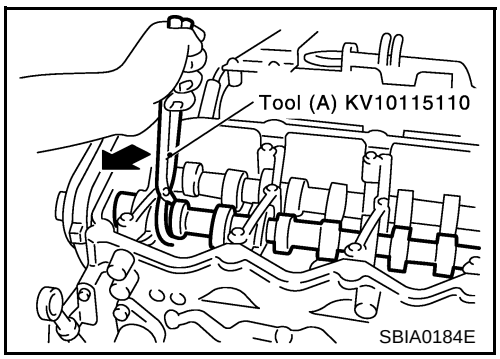
1. Remove the spill tube. Refer to EM-138, "Removal and Installation" .
2. Extract the engine oil on the upper side of the cylinder head (for the air blowing in step 7).
3. Rotate the crankshaft to face the camshaft for adjusting shims that are to be removed upward.



4. Grip the camshaft with camshaft pliers, them using the camshaft as a support point, push the adjusting shim downward to compress the valve spring.

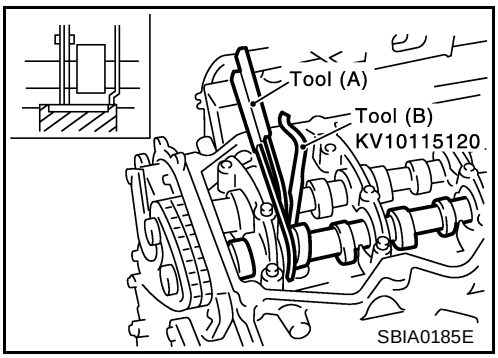
CAUTION:

Do not damage the camshaft, cylinder head and the outer circumference of the valve lifter.



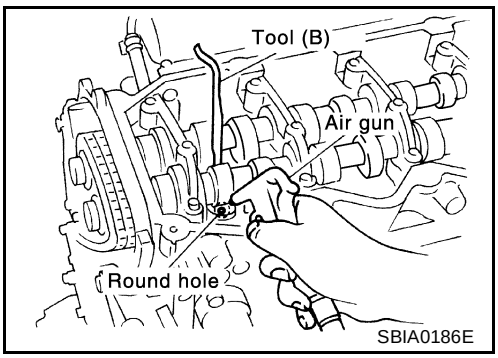
5. With the valve spring in a compressed state, remove the camshaft pliers by securely setting the outer circumference of the valve lifter with the end of the lifter stopper.
   - Hold the lifter stopper by hand until the shim is removed.

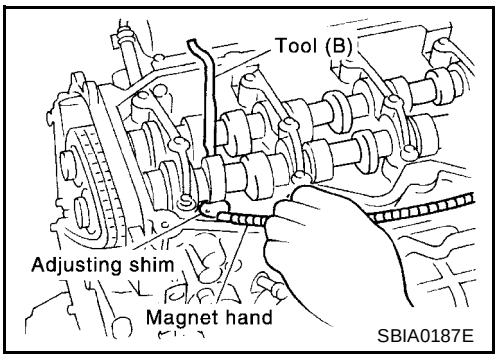
   CAUTION:
   Do not retrieve the camshaft pliers forcefully, as the camshaft will be damaged.



6. Move the rounded hole of the adjusting shim to the front with a very thin screwdriver or like that.
   - When the adjusting shim on the valve lifter will not rotate smoothly, restart from step 4 to release the end of the lifter stopper from touching the adjusting shim.
7. Remove the adjusting shim from the valve lifter by blowing air through the rounded hole of the shim with an air gun.

   CAUTION:
   To prevent any remaining oil from being blown around, thoroughly wipe the area clean and wear protective goggles.
8. Remove the adjusting shim by using a magnetic hand.





9. Measure the thickness of the adjusting shim using a micrometer.
   - Measure near the center of the shim (the part that touches the camshaft).
10. Select the new adjusting shim from the following methods.

    Calculation method of the adjusting shim thickness:

    R = Thickness of removed shim

    N = Thickness of new shim

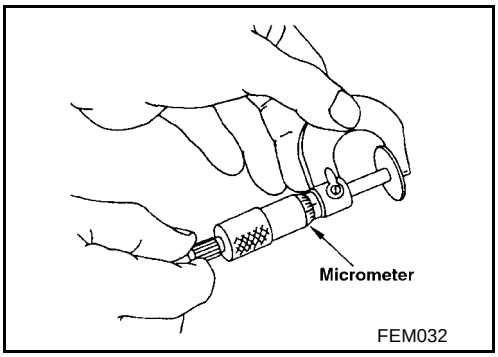
    M = Measured valve clearance

    Intake

    N = R + [M - 0.28 mm (0.0010 in)]

    Exhaust

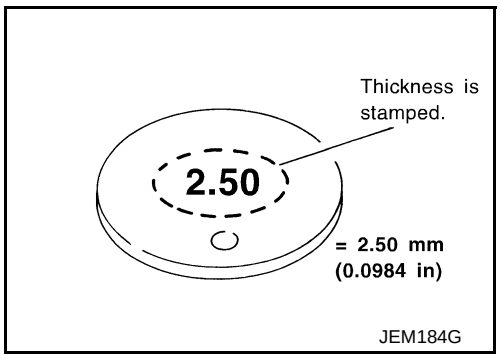
    N = R + [M - 0.30 mm (0.0118 in)]



- New adjusting shims have the thickness stamped on the rear side.

Stamped mark	Shim thickness mm (in)
2.10	2.10 (0.0827)
2.12	2.12 (0.0835)
.	.
.	.
.	.
2.74	2.74 (0.1079)

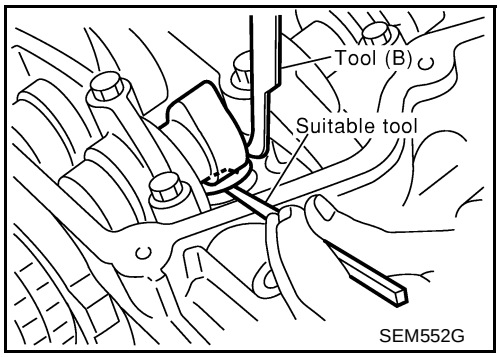
- **Shims are available in 33 size from 2.10 mm (0.0827 in) to 2.74 mm (0.1079 in), in steps of 0.02 mm (0.0008 in).**



11. Fit the selected adjusting shim to the valve lifter.

CAUTION:
Place the stamped side of the adjusting shim to the valve lifter.

12. Compress the valve spring using the camshaft pliers and remove the lifter stopper.
13. Rotate the crankshaft 2 to 3 turns by hand.
14. Confirm that the valve clearance is within the specification.



Valve clearance:

Item	Cold	Hot* (Reference data)
Intake	0.24 -0.32 (0.0094 - 0.0126)	0.274 - 0.386 (0.0108 - 0.0152)
Exhaust	0.26 - 0.34 (0.0102 - 0.0134)	0.308 - 0.432 (0.0121 - 0.0170)

*: Approximately 80°C (176°F)

15. Install remaining parts in reverse order of removal.

SECONDARY TIMING CHAIN

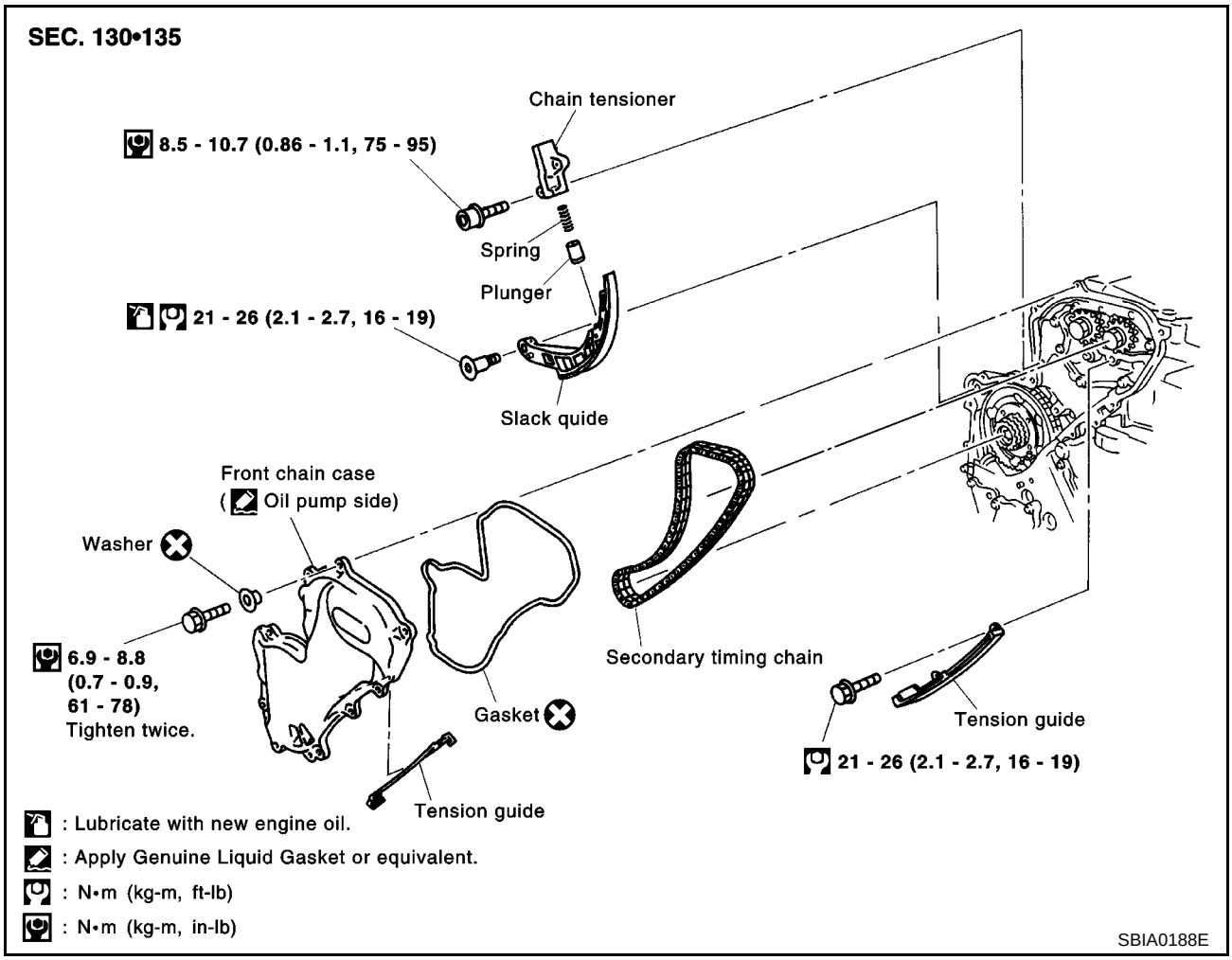
PFP:13028

Removal and Installation

EBS00DIX

CAUTION:

- **After removing timing chain, do not turn crankshaft and camshaft separately, or valves will strike piston heads.**
- **When installing camshafts, chain tensioners, oil seals or other sliding parts, lubricate contacting surfaces with new engine oil.**
- **Apply new engine oil to parts marked in illustration before installation.**



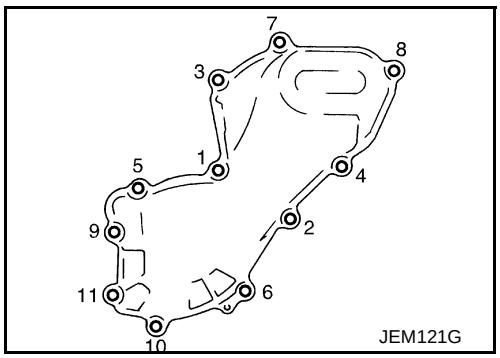
REMOVAL

- For preparative work for removing/installing secondary timing chain to remove/install electronic fuel supply pump. Refer to EM-141, "FUEL SUPPLY PUMP" .
- To prepare for removing/installing secondary timing chain to remove/install camshaft. Refer to EM-152, "Removal and Installation" .

1. Remove coolant reservior tank.
2. Remove RH engine mount insulator and bracket. Refer to EM-187, "Removal and Installation" .
3. Pull power steering reservoir tank out of brackets to move power steering piping.

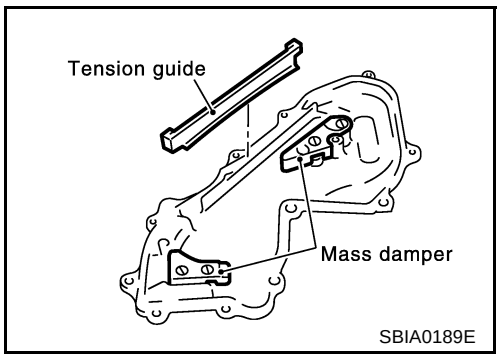
   CAUTION:
   To avoid removing power steering reservoir tank out of brackets move it with power steering piping aside.

4. Remove front chain case.
   - Loosen fixing bolts in the reverse order of that shown in the figure and remove them.

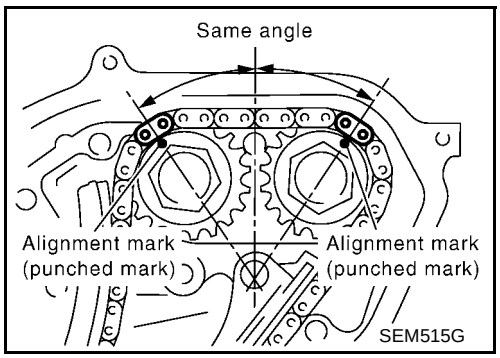


   - Remove No. 6, 10 and 11 bolts with the rubber washer as space is limited for pulling them out.

CAUTION:
- **While front chain case is removed, cover openings to prevent entry of foreign material into engine.**
- **Do not remove two mass dampers on the back of cover.**

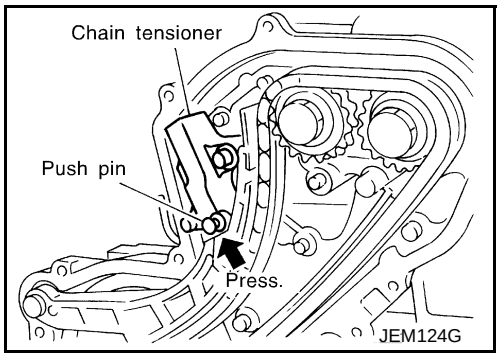


5. Set the No. 1 piston to TDC on its compression stroke.
   - Turn crankshaft pulley clockwise so that the alignment mark (punched mark) on each camshaft sprocket is positioned as shown in the figure.
   - **No position indicator is provided on the crankshaft pulley.**
   - **When installing, color coded links on the secondary timing chain can be used as alignment marks. Marking may not be necessary for removal; however, make alignment marks as required because the alignment mark on fuel supply pump sprocket may not be easy to see.**

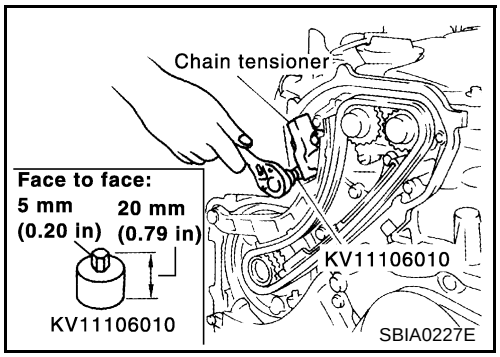


6. Remove chain tensioner.

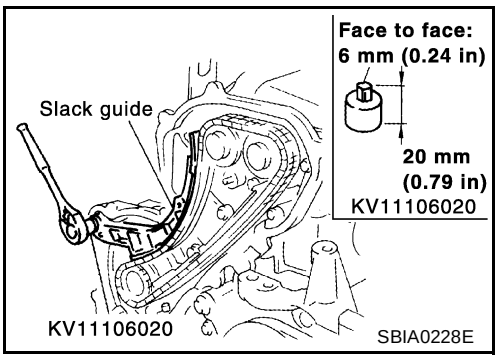
a. Push the plunger of chain tensioner and keep it pressed with a push pin.



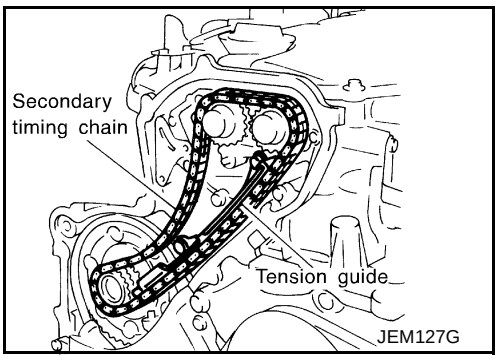
b. Using a hexagon-head wrench [face to face: 5 mm, (0.20 in) SST], remove bolts to remove chain tensioner.



7. Remove timing chain slack guide.
   - Using a hexagon-head wrench [face to face: 6 mm (0.24 in), SST], remove bolt to remove timing chain slack guide.



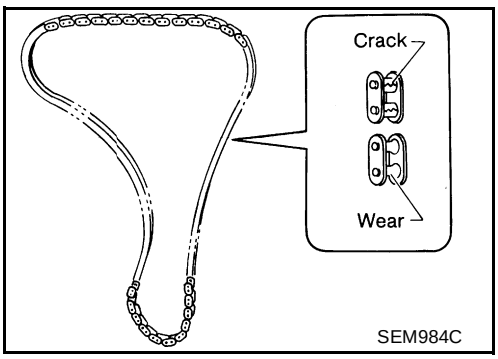
8. Remove timing chain tension guide.
9. Remove secondary timing chain.
   - Timing chain alone can be removed without removing sprockets.



INSPECTION AFTER REMOVAL

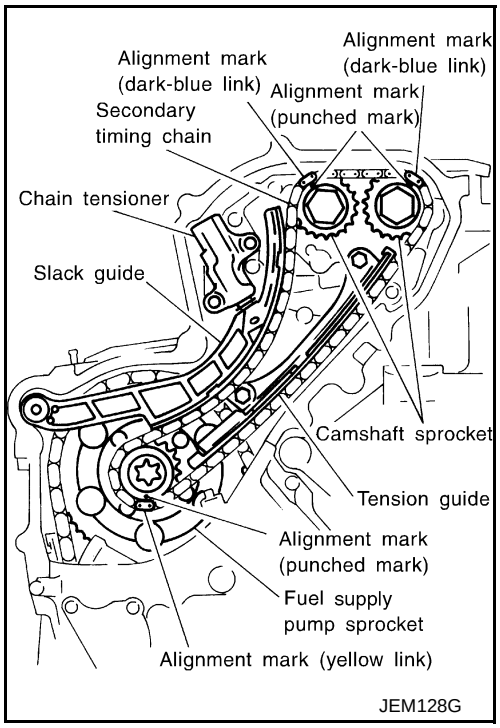
Timing Chain

Check for cracks and excessive wear at roller links. Replace chain if necessary.

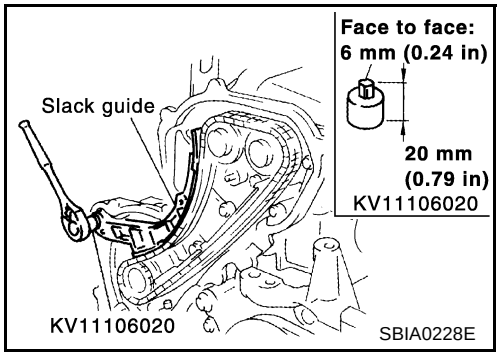


INSTALLATION

1. Install secondary timing chain.
   - When installing, match the alignment marks on sprockets with color coded alignment marks (colored links) on the chain.
2. Install timing chain tension guide.
   - The upper bolt has a longer shank than the lower bolt.



3. Using a hexagon-head wrench [face to face: 6 mm (0.24 in), SST], install timing chain slack guide.

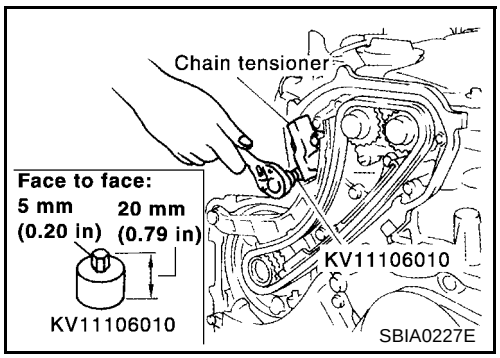


4. Install chain tensioner.

a. Push the plunger of the chain tensioner. While holding it with a push pin, install the chain tensioner.

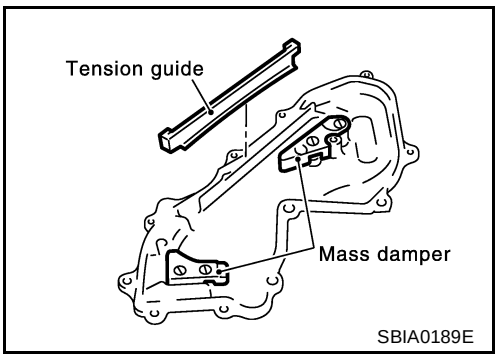
b. Using a hexagon-head wrench [face to face: 5 mm (0.20 in), SST], tighten bolts.

c. Pull out the push pin, etc. holding the plunger.
   - **Check again that the alignment marks on the sprockets and the colored alignment marks on the timing chain are aligned.**



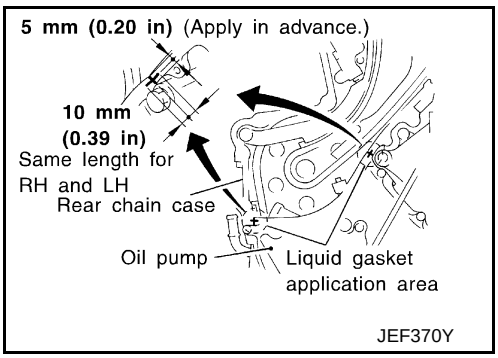
5. Install front chain case.

a. Install tension guide on the back surface of front chain case.
   - Hold front chain case vertically when installing. Tension guide may come off if front chain case is tilted.



b. Apply Genuine Liquid Gasket or equivalent (Refer to EM-106, "Precautions for Liquid Gasket" .) on both ends of arched area (locations where rear chain case is adjoined) as shown in the figure.

c. Install front chain case.
   - When installing, align dowel pin on oil pump case with the pin hole.

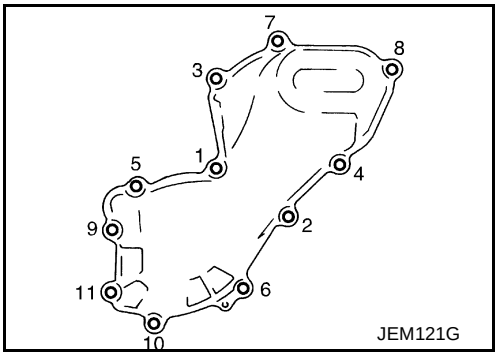


   - Install No. 6, 10 and 11 bolts with the rubber washer to the front chain case.

d. Tighten fixing bolts in the numerical order shown in the figure.

e. After tightening all the bolts, re-tighten in the same order.

6. Hereafter, install in the reverse order of removal.



PRIMARY TIMING CHAIN

PFP:13028

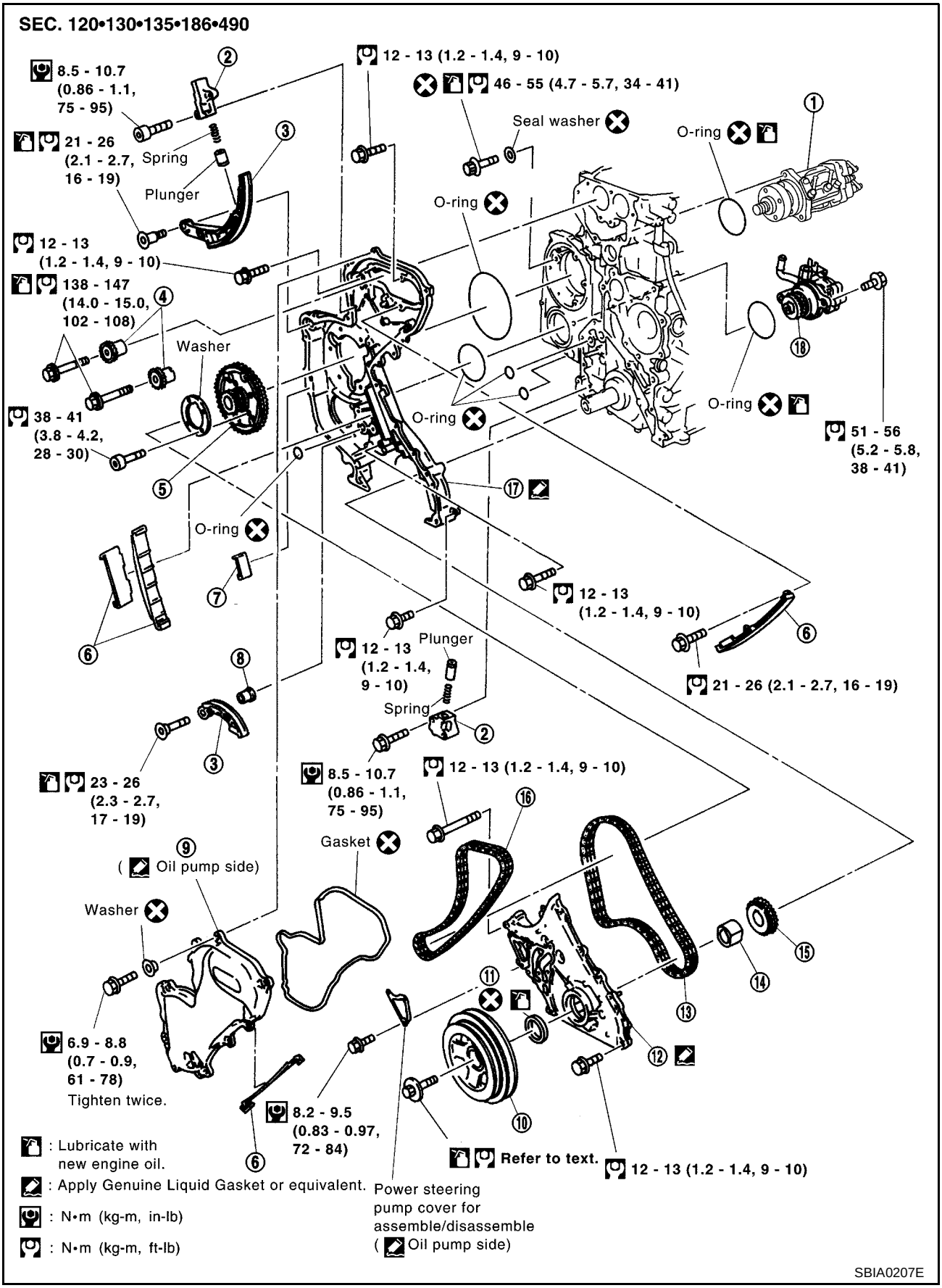
Removal and Installation

EBS00DIY

CAUTION:

- **After removing timing chain, do not turn crankshaft and camshaft separately, or valves will strike piston heads.**
- **When installing camshafts, chain tensioners, oil seals or other sliding parts, lubricate contacting surfaces with new engine oil.**
- **Apply new engine oil to parts marked in illustration before installation.**

SEC. 120•130•135•186•490



1. Fuel supply pump
2. Chain tensioner
3. Slack guide
4. Camshaft sprocket
5. Fuel supply pump sprocket
6. Tension guide

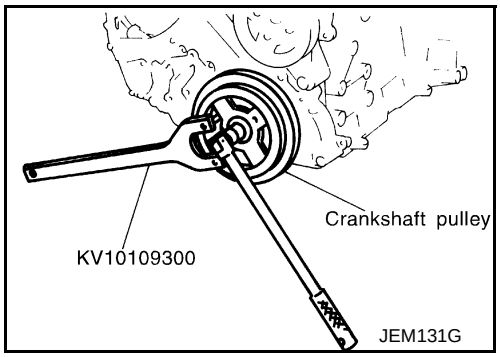
7. Chain guide
8. Spacer
9. Front chain case
10. Crankshaft pully
11. Front oil seal
12. Oil pump
13. Primary timing chain
14. Oil pump drive sprocket
15. Crankshaft sprocket
16. Secondary timing chain
17. Rear chain case
18. Power steering pump

REMOVAL

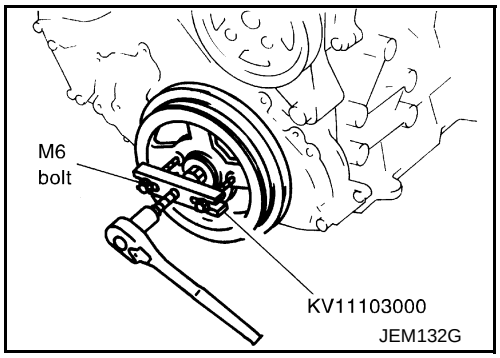
1. Remove coolant reservior tank.
2. Remove charge air cooler and bracket. Refer to EM-117, "Removal and Installation" .
3. Remove air cleaner and air duct. Refer to EM-115, "Removal and Installation" .
4. Remove rocker cover. Refer to EM-150, "Removal and Installation" .
5. Remove RH engine mount insulator and bracket. Refer to EM-187, "Removal and Installation" .
6. Pull power steering reservoir tank out of brackets to move power steering piping.

   CAUTION:
   To avoid removing power steering reservoir tank out of brackets move it with power steering piping aside.
7. Remove oil pan. Refer to EM-128, "Removal and Installation" .
8. Remove oil filter bracket. Refer to LU-23, "Removal and Installation" .
9. Remove injection tube and fuel injector. Refer to EM-138, "Removal and Installation" .
10. Remove secondary timing chain and associated parts. Refer to EM-161, "Removal and Installation" .
11. When removing rear chain case, remove camshaft sprockets. Refer to EM-152, "Removal and Installation" .
12. Remove crankshaft pulley.

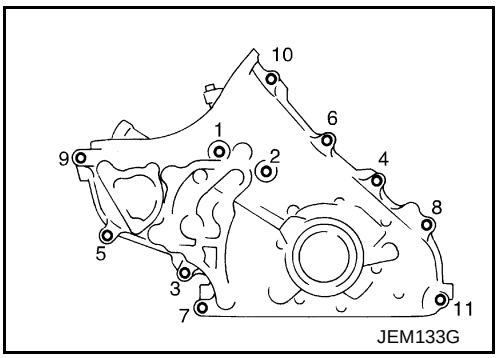
a. Hold crankshaft pulley with the pulley holder (SST).
b. Loosen crankshaft pulley fixing bolt and pull out the bolt approximately 10 mm (0.39 in).



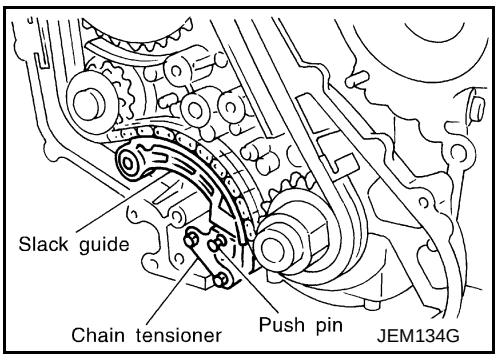
c. Using pulley puller (SST), remove crankshaft pulley.
   - Use two M6 bolts with approx. 60 mm (2.36 in) shank length for securing crankshaft pulley.



13. Remove oil pump.
    - Loosen bolts in the reverse order of that shown in the figure and remove them.
    - Use seal cutter (SST) etc. for removal.
14. Remove front oil seal from oil pump.
    - Punch out the seal off from the back surface of the oil pump using a flat-bladed screwdriver.
    - **Be careful not to damage the oil pump.**



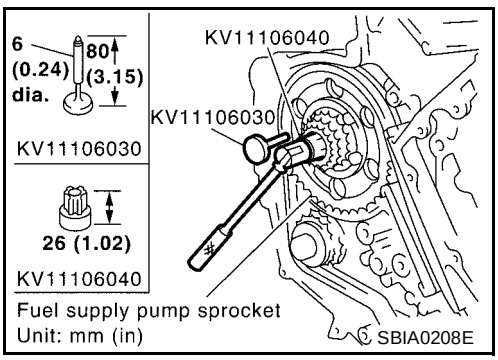
15. Remove chain tensioner.
    - When removing chain tensioner, push the sleeve of chain tensioner and keep it pressed with a push pin, etc.
16. Remove timing chain slack guide.



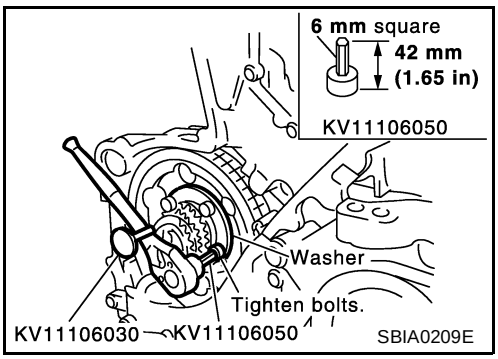
17. Hold fuel supply pump sprocket and remove bolt.

a. Insert positioning stopper pin (SST) into the hole 6 mm (0.24 in) in the diameter on the fuel supply pump sprocket.

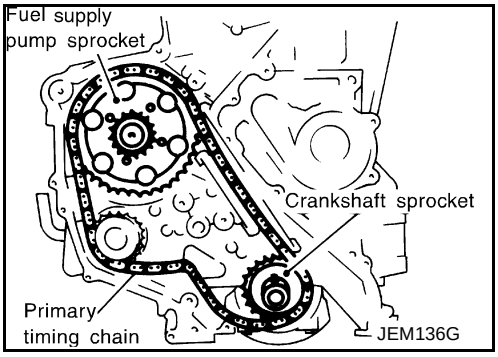
b. Using a TORX wrench (SST), turn pump shaft little by little to adjust the position of fuel supply pump sprocket so that the holes align.



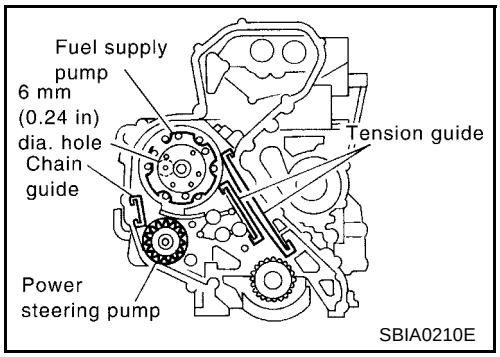
c. Push positioning stopper pin (SST) through fuel supply pump sprocket to fuel supply pump body to hold pump sprocket, and remove bolt.



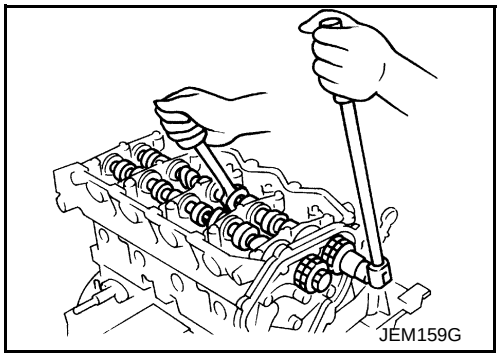
18. Remove primary timing chain with fuel supply pump sprocket and crankshaft sprocket.



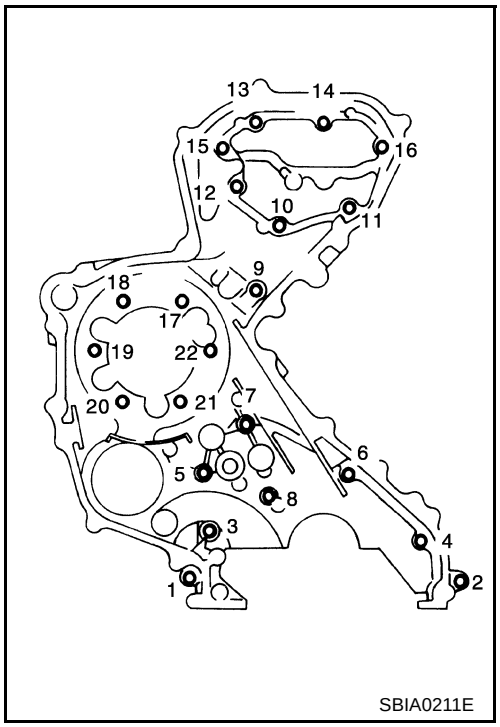
19. Remove chain guide and tension guides.
20. Remove fuel supply pump.
21. Remove power steering pump.



22. Remove camshaft sprockets.
    - Loosen the camshaft sprockets installation bolts by fixing the hexagonal portion of the camshaft.



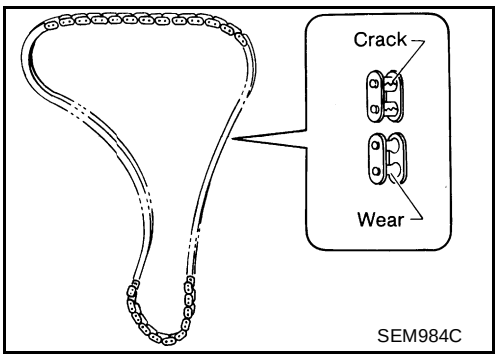
23. Remove rear chain case.
    - Loosen fixing bolts in the reverse order of that shown in the figure and remove them.
    - Use seal cutter (SST) for removal.



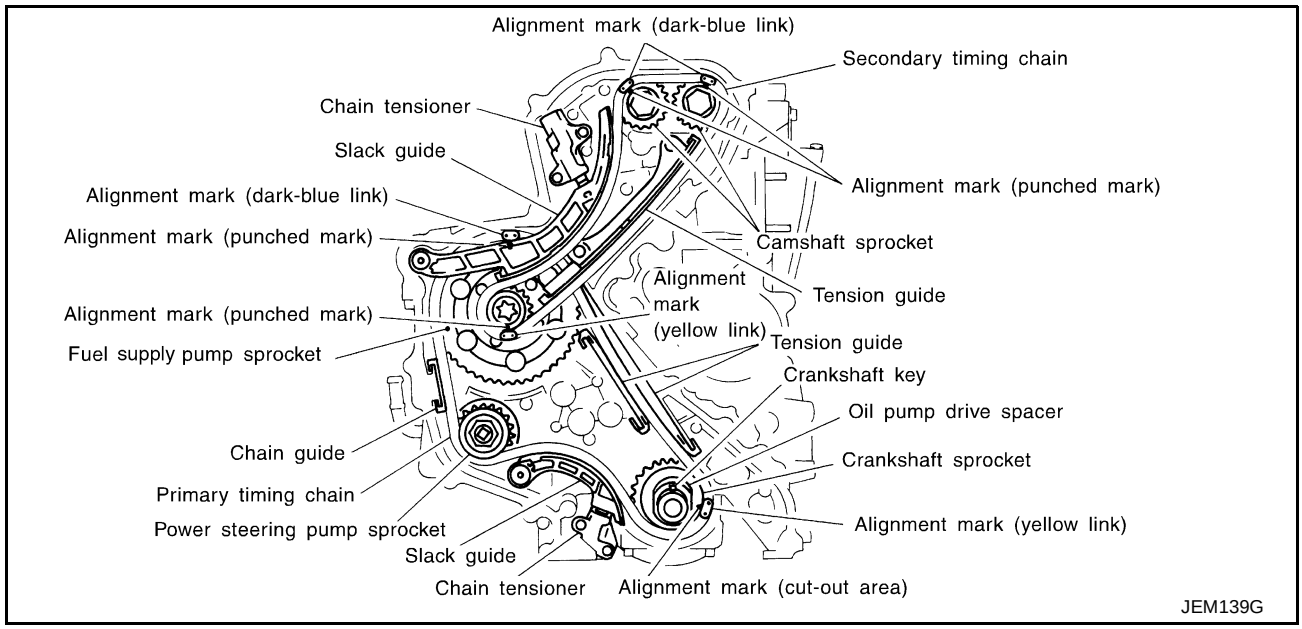
INSPECTION AFTER REMOVAL

Timing Chain

Check for cracks and excessive wear at roller links. Replace chain if necessary.

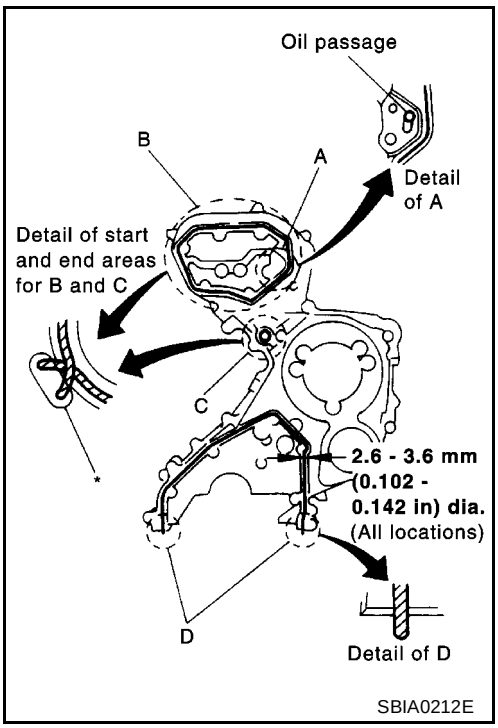


INSTALLATION

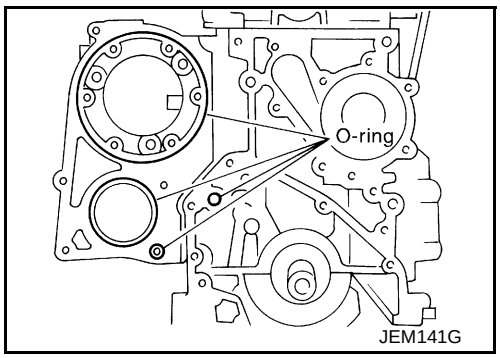


1. Install rear chain case.

a. Apply a continuous bead of Genuine Liquid Gasket or eqivalent on locations shown in the figure. Refer to EM-106, "Precautions for Liquid Gasket" .
A: Apply bead so that it does not protrude into the oil passage.
B, C: Minimize overlapping area of bead, by starting and ending at areas of bead as shown in the figure. Apply so that the portion marked * comes at an external location but cannot be viewed externally after engine assembly.
D: Leave the start and end areas of the bead slightly protruding from the case surface.



b. Install four O-rings to the grooves of the cylinder block and fuel supply pump bracket.



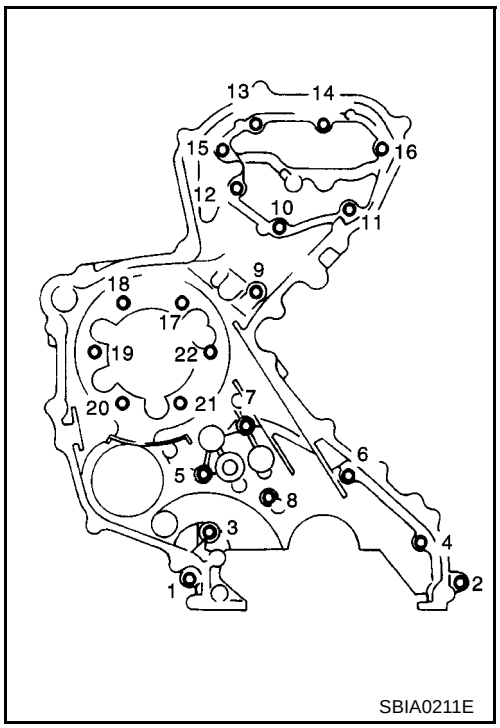
c. Install rear chain case.
   - When installing, align the dowel pin with the pin hole.

d. Tighten bolts in the numerical order shown in the figure.
   - Install the following four types of bolts, referring to the figure.

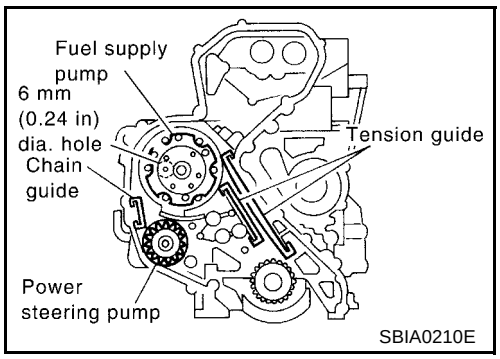
     16 mm (0.63 in) : Bolt No. 1, 2, 16, 17, 18, 19, 20, 21, 22
     20 mm (0.79 in) : Bolt No. 3, 4, 6, 9, 10, 11, 13, 14
     25 mm (0.98 in) : Bolt No. 12, 15
     35 mm (1.38 in) : Bolt No. 5, 7, 8

   - The shank length under the bolt neck above is the length of threaded part (pilot portion not included).

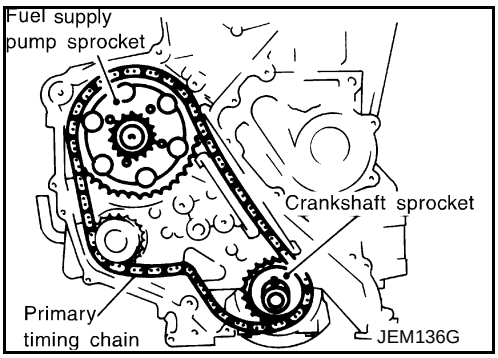
e. After tightening all the bolts, re-tighten in the same order.



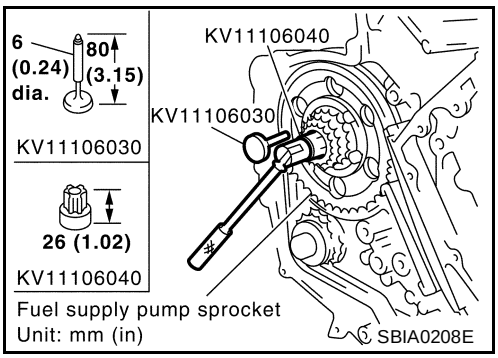
2. Install power steering pump.
3. Install fuel supply pump.
   - Before installing, make sure the notch on the fuel supply pump flange and the hole 6 mm (0.24 in) in diameter on the pump body are aligned.
4. Install chain guide and tension guides.
5. Install crankshaft sprocket, aligning it with the crankshaft key on the far side.

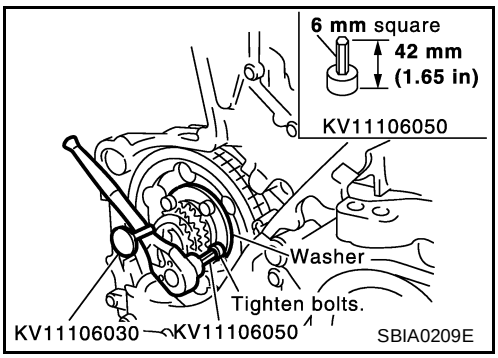


6. Install primary timing chain with fuel supply pump sprocket.
   - When installing, match the alignment marks on sprockets with color coded alignment marks (colored links) on the chain.
   - Install fuel supply pump sprocket washer with the surface marked “F” (front mark) facing the front of the engine.
7. Install timing chain onto power steering pump sprocket and through chain guide.

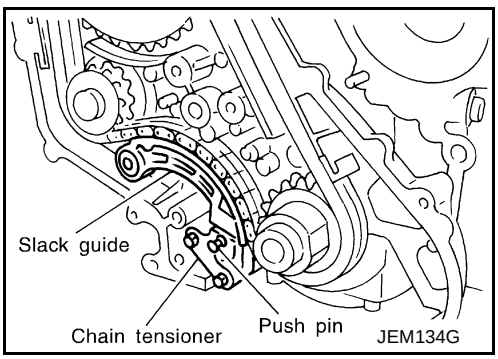


8. Use the positioning stopper pin (SST) to hold the fuel supply pump sprocket and install the bolt.
   - Using a TORX wrench (SST), turn the pump shaft little by little to adjust the position of the pump flange. Insert positioning stopper pin (SST) into the hole 6 mm (0.24 in) in diameter on the fuel supply pump sprocket so that the stopper pin goes through the pump flange to the pump body. While the stopper pin is in place, install the bolt.

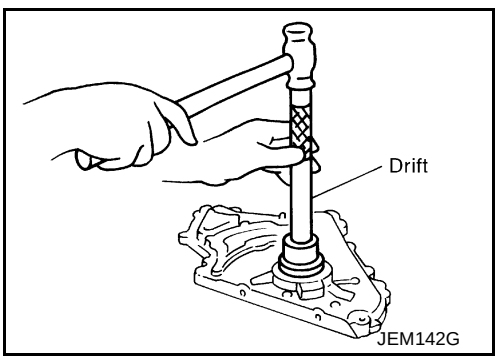




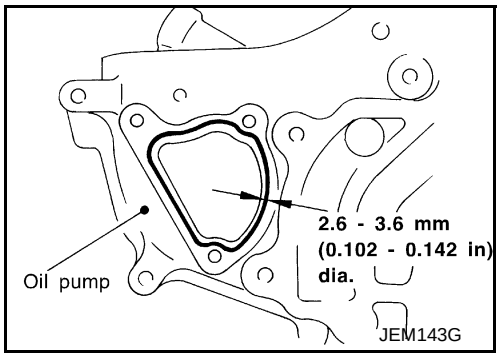
9. Install timing chain slack guide.
10. Install chain tensioner.
    - Push the plunger of the chain tensioner. While keeping plunger pressed down with a push pin, etc., install the chain tensioner.
    - After installation, pull out the push pin holding the plunger.
    - **Check again that the alignment marks on the sprockets and the colored alignment marks on timing chain are aligned.**



11. Install front oil seal to oil pump.
    - Using a suitable drift [62 mm (2.44 in) dia.], force fit the seal until it hits the bottom.
    - **Do not touch lips of oil seal. Make sure seal surfaces are free of foreign materials.**

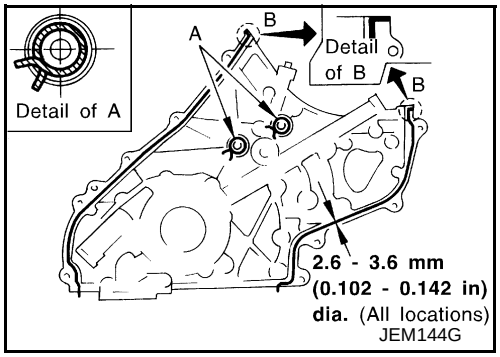


12. Install chain case cover (for opening for power steering pump removal/installation) to oil pump.
    - Apply a continuous bead of Genuine Liquid Gasket or equivalent as shown in the figure. Refer to EM-106, "Precautions for Liquid Gasket" .
    - Apply liquid gasket on oil pump-side surface.



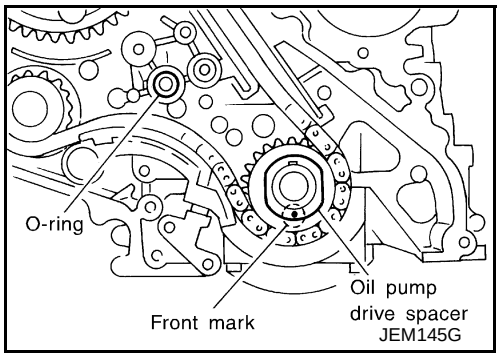
13. Install oil pump.

a. Apply a continuous bead of Genuine Liquid Gasket or equivalent on locations shown in the figure. Refer to EM-106, "Precautions for Liquid Gasket" .
   A: Leave the start and end areas of the bead slightly protruding from the surface.
   B: Apply liquid gasket along upper end surface of oil pump.



b. Install oil pump drive spacer to crankshaft.
   - Install with the front mark (punched mark) facing the front of the engine.

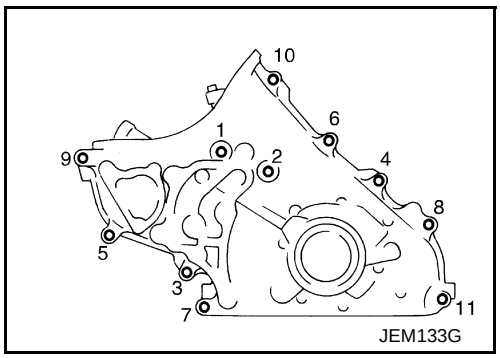
c. Install O-ring into the groove of rear chain case.



d. Install oil pump.
   - When installing, align the inner rotor in the direction of the two facing flats of the oil pump drive spacer.
   - When installing, align the dowel pin with the pin hole.

e. Tighten fixing bolts in the numerical order shown in the figure.

f. After tightening all the bolts, re-tighten in the same order.



14. Check gaps on upper oil pan mounting surface.
    - Using straightedge and feeler gauge, measure gaps between the locations of the following parts:

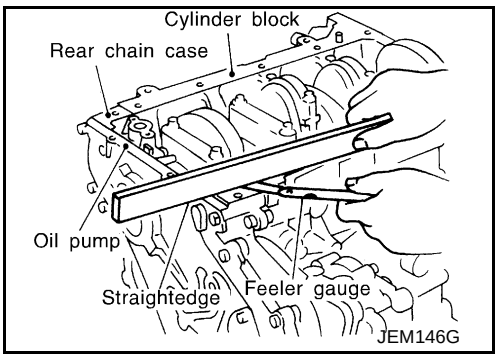
      Oil pump and rear chain case:

      Standard : – 0.14 to 0.14 mm (– 0.0055 to 0.0055 in)

      Rear chain case and cylinder block:

      Standard : – 0.25 to 0.13 mm (– 0.0098 to 0.0051 in)

    - If the measured value is out of the above range, install again.



15. Install crankshaft pulley.

a. Install crankshaft pulley to crankshaft.

b. Hold crankshaft pulley with the pulley holder (SST).

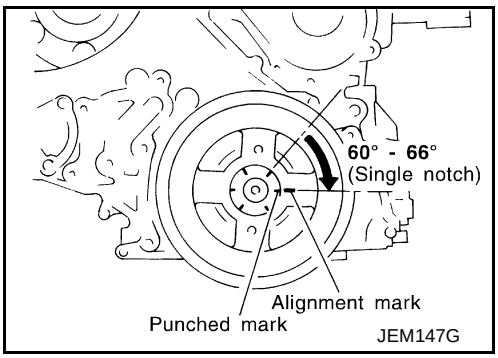
c. Tighten bolt to 20 to 29 N·m (2.0 to 3.0 kg-m, 15 to 21 ft-lb).

d. Put an alignment mark on crankshaft pulley that aligns with one of the punched marks on the bolt.

e. Tighten fixing bolt another 60° - 66° [target: 60° (turn by one notch)].

16. Install secondary timing chain and the associated parts. Refer to EM-164, "INSTALLATION" .

17. Install in the reverse order of removal hereafter.



CYLINDER HEAD

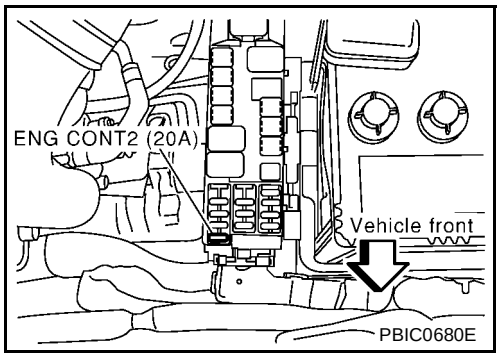
PFP:11041

On-Vehicle Service

EBS00DIZ

CHECKING COMPRESSION PRESSURE

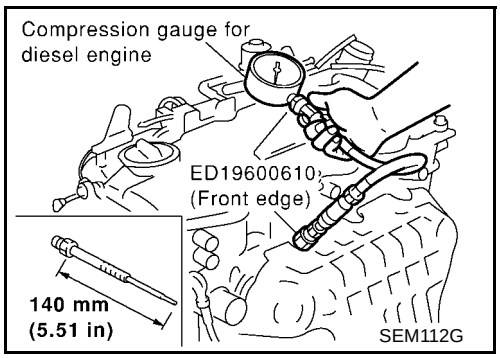
1. Warm up engine thoroughly. Then, stop it.
2. Using CONSULT-II, make sure no error codes are indicated for self-diagnosis items. Refer to EC-407, "Basic Inspection" .
   - Do not disconnect CONSULT-II until the end of this operation; it will be used to check engine rpm and for error detection at the end of this operation.
3. Disconnect the negative battery terminal.
4. Remove the following parts.
   - Charge air cooler (Refer to EM-117, "Removal and Installation" .)
5. To prevent fuel from being injected during inspection, remove fuel supply pump fuse [ENG CONT (20A)] from fuse box on the left side of engine compartment.
   - Among marks on fuse box, [ENG CONT 2 (20A)] is for fuel supply pump fuse.



6. Remove glow plugs from all the cylinders. Refer to EM-133, "Removal and Installation" .

   CAUTION:
   - **Before removal, clean the surrounding area to prevent entry of any foreign materials into the engine.**
   - **Carefully remove glow plugs to prevent any damage or breakage.**
   - **Handle with care to avoid applying any shock to glow plugs.**

7. Install adapter to installation holes of glow plugs and connect compression gauge for diesel engine.



   : 18 - 21 N·m (1.8 - 2.2 kg-m, 13 - 15 ft-lb)

8. Connect battery negative terminal.
9. Set the ignition switch to “START” and crank. When gauge pointer stabilizes, read compression pressure and engine rpm. Repeat the above steps for each cylinder.
   - Always use a fully-charged battery to obtain specified engine speed.

Unit: kPa (bar, kg/cm^2 , psi)/rpm

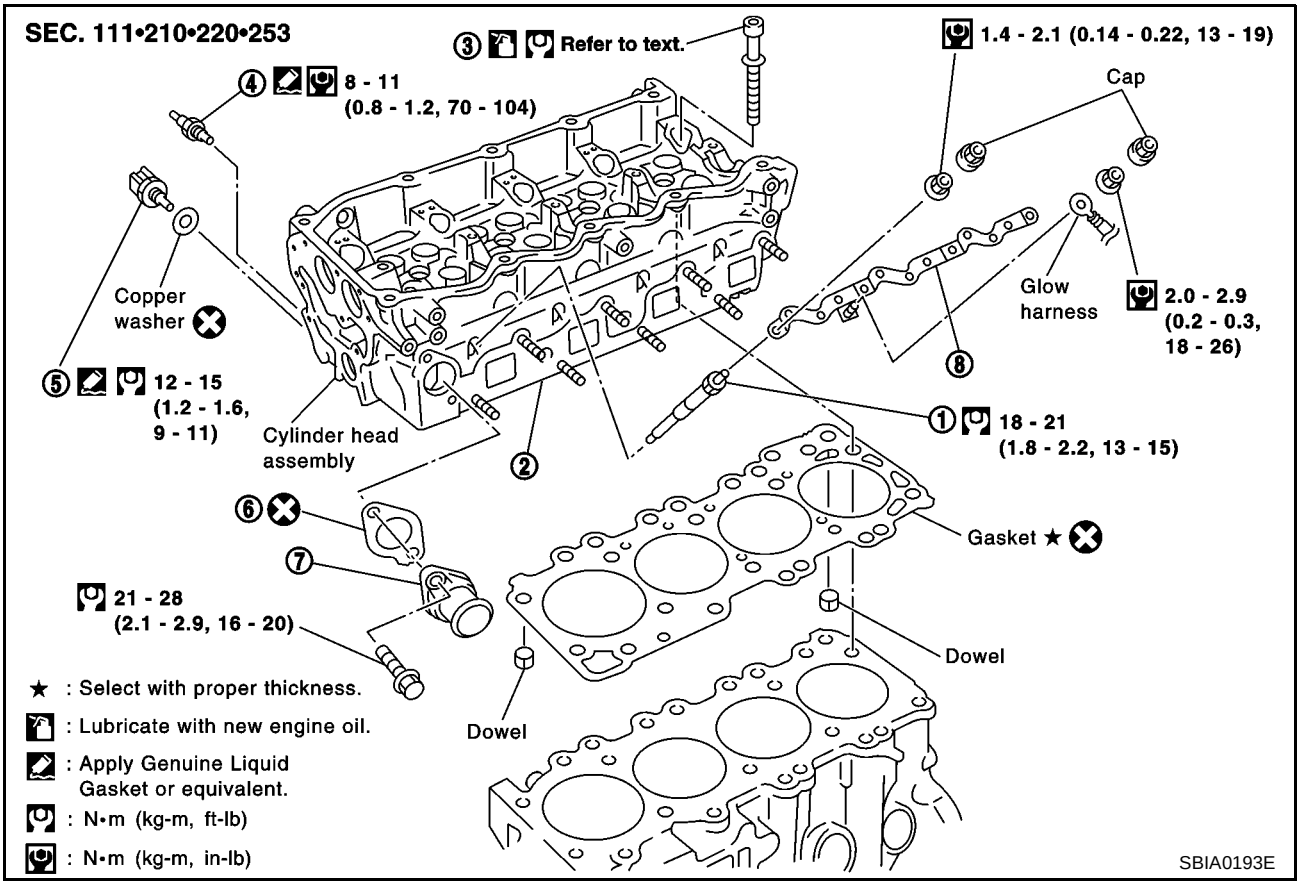
Standard	Minimum	Difference limit between cylinders
2,893 (28.9, 29.5, 419)/ 200	2,452 (24.52, 25.0, 356)/ 200	490 (4.90, 5.0, 71)/200

- When engine rpm is out of the specified range, check the specific gravity of battery liquid. Measure again under corrected conditions.
- If engine rpm exceeds the limit, check valve clearance and combustion chamber components (valves, valve seats, cylinder head gaskets, piston rings, pistons, cylinder bores, cylinder block upper and lower surfaces) and measure again.
- If compression pressure is low in some cylinders, apply engine oil from glow plug installation hole. Then check pressure again.
  - If compression pressure becomes normal after applying oil, piston ring may be worn or damaged. Check piston ring for malfunction. If any, replace piston ring.
  - If compression pressure is still low after applying oil, valve may be malfunctioning. Check valve for malfunction. If contact malfunction is found, replace valve or valve seat.
- If compression pressure in adjacent two cylinders is low after applying oil, pressure may be leaking from gasket. In this case, replace cylinder head gasket.

10. Complete this operation as follows:
a. Turn the ignition switch to “OFF”.
b. Disconnect battery negative terminal.
c. Install glow plug and install all the parts removed in step 4.
d. Install fuel supply pump fuse [ENG CONT (20A)].
e. Connect battery negative terminal.
f. Using CONSULT-II make sure no error code is indicated for items of self-diagnosis.

Removal and Installation

EBS00DJ0



1. Glow plug
2. Cylinder head assembly
3. Cylinder head bolt
4. Thermal transmitter
5. Engine coolant temperature sensor
6. Gasket
7. Water outlet
8. Glow plate

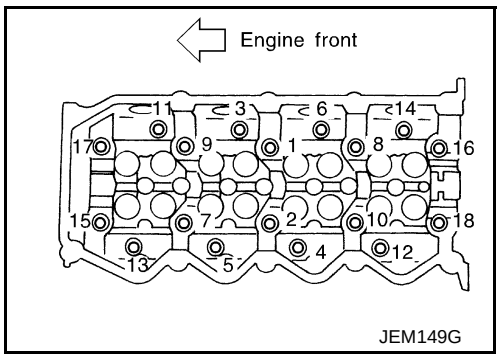
CAUTION:
Apply new engine oil to parts marked in illustration before installation.

REMOVAL

1. Remove drain coolant. Refer to CO-30, "Changing Engine Coolant" .
2. Remove the following parts:
   - Charge air cooler (Refer to EM-117, "Removal and Installation" .)
   - Rocker cover (Refer to EM-150, "Removal and Installation" .)
   - Air cleaner and air duct (Refer to EM-115, "Removal and Installation" .)
   - Vacuum pump (Refer to EM-134, "Removal and Installation" .)
   - Injection tube, spill tube and fuel injector (Refer to EM-138, "Removal and Installation" .)
   - Intake manifold (Refer to EM-118, "Removal and Installation" .)
   - Exhaust manifold (Refer to EM-122, "Removal and Installation" .)
   - Secondary timing chain (Refer to EM-161, "Removal and Installation" .)
   - Camshaft (Refer to EM-152, "Removal and Installation" .)

3. Remove cylinder head assembly.
   - Loosen and remove mounting bolts in the reverse order shown in the figure.
   - Lift up the cylinder head assembly to avoid interference with dowel pins located between the block and head, and remove cylinder head assembly.

     CAUTION:
     Remove glow plug in advance to avoid damage as the tip of the glow plug projects from the bottom of the cylinder head, or, place wood blocks beneath both ends of the cylinder head to keep the cylinder bottom from any contact.



   - For glow plug removal, the following shall be noted.

     CAUTION:
     - **To avoid breakage, do not remove glow plug unless necessary.**
     - **Perform continuity test with glow plug installed.**
     - **Keep glow plug from any impact. (Replace if dropped from a height 10 cm (3.94 in) or higher.)**
     - **Do not use air impact wrench.**

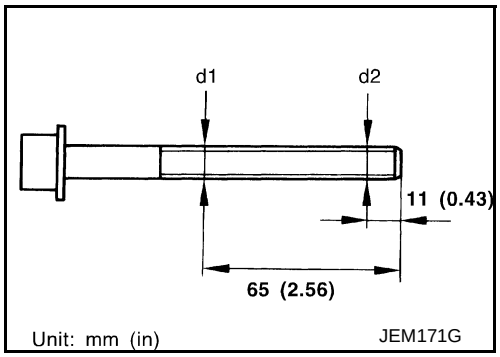
INSPECTION AFTER REMOVAL

Cylinder Head Bolt Deformation

- Using micrometer, measure the outer diameters d1 and d2 of bolt thread as shown in the figure.
- If the necking point can be identified, set it as measuring point d2.
- Calculate the difference between d1 and d2.

  Limit : 0.15 mm (0.0059 in)

- If out of the limit, replace cylinder head bolt.

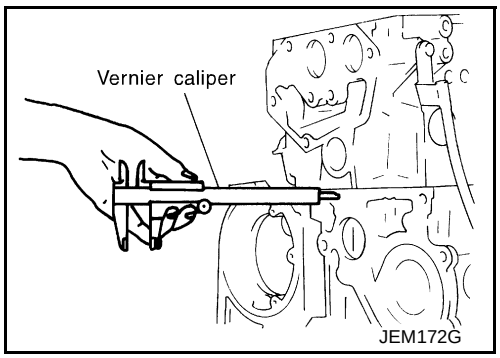


Cylinder Head-to-block Difference Check

- After installing cylinder head, measure dimension from the front end surface of cylinder block to that of cylinder head.

  Standard : 23.53 - 24.07 mm (0.9264 - 0.9476 in)

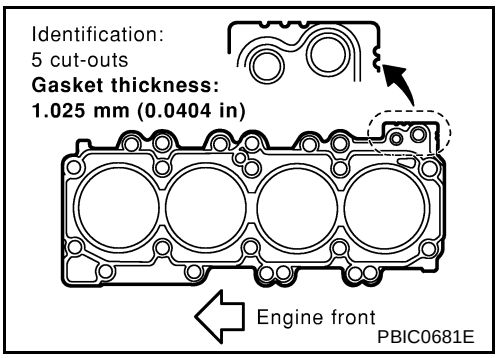
- If the difference is out of the range, check fitting of dowel pins and cylinder head.



INSTALLATION

Before installation, remove old liquid gasket from mating surface of all liquid gasket applied parts.

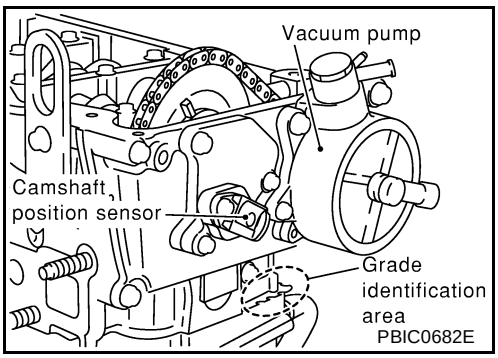
1. Install cylinder head gasket.
   - Cylinder head gasket to be installed is selected by its thickness through the following procedure.
   - **When replacing gasket alone**
   - Install a gasket with same thickness as that of the one removed.
   - Identify the thickness of gasket by the number of cut-outs on the RH side.

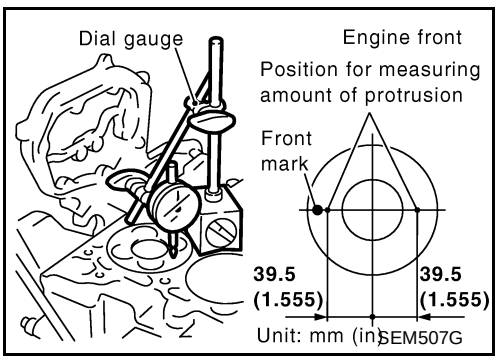


Gasket thickness* mm (in)	Number of grade	Number of cut-outs
0.900 (0.0354)	1	0
0.925 (0.0364)	2	1
0.950 (0.0374)	3	2
0.975 (0.0384)	4	3
1.000 (0.0394)	5	4
1.025 (0.0404)	6	5

*: Measured with head bolts tightened

   - Gasket thickness can be identified at the location shown in the figure by the numbers of cut-outs before removal.





   - **When the following parts have been repaired/replaced:**
   - With cylinder block upper surface and/or crankshaft pin journal ground
   - With cylinder block, pistons, connecting rods, and/or crankshaft replaced

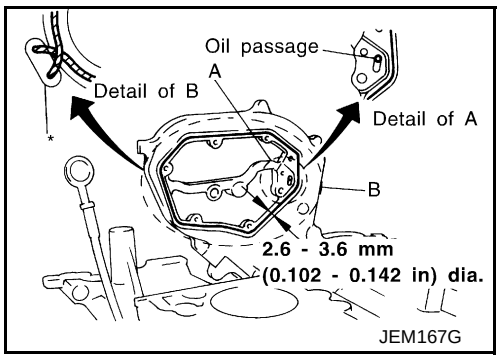
a. Set piston at a point close to TDC.
b. Set a dial gauge at the location as shown in the figure. Turning crankshaft gradually, set the gauge scale to “0” where the piston protrusion is maximized.
c. Move the dial gauge stand so that the tip of dial gauge can contact the cylinder block. Read the difference.
d. Measure at two locations per cylinder, that is eight locations for four cylinders. Select gasket based on the maximum protrusion of eight measurements.

Piston protrusion mm (in)	Gasket thickness* mm (in)	Identification	
		Number of cut-outs	
Less than 0.255 (0.0100)	0.900 (0.0354)	0	

Less than 0.255 - 0.280 (0.0100 - 0.0110)	0.925 (0.0364)	1	
Less than 0.280 - 0.305 (0.0110 - 0.0120)	0.950 (0.0374)	2	
Less than 0.305 - 0.330 (0.0120 - 0.0130)	0.975 (0.0384)	3	
Less than 0.330 - 0.355 (0.0130 - 0.0140)	1.000 (0.0394)	4	
More than 0.355 (0.0140)	1.025 (0.0404)	5	

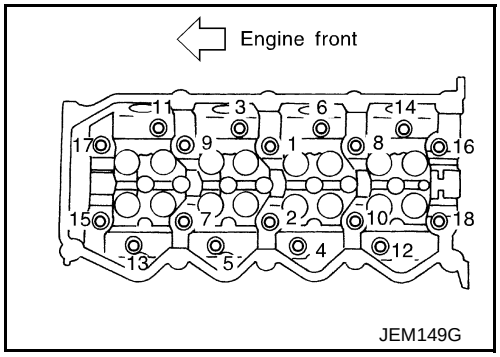
*: Measured with head bolts tightened

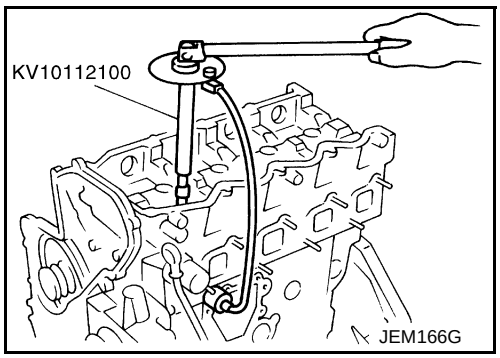
2. Apply a continuous bead of Genuine Liquid Gasket or equivalent on the surface shown in the figure.
A: Apply bead so that it does not protrude into oil passage. Refer to EM-106, "Precautions for Liquid Gasket" .
B: Miniimize the overlapping area of the bead, with start and end areas of bead as shown in the figure.
Apply so that the portion marked * comes at an external location but cannot be viewed externally after engine is assembled.



3. Install cylinder head assembly.
   - Tighten bolts in numerical order as shown in the figure according to the following procedure:

a. Apply engine oil to bolt threads and seat surfaces.
b. Tighten bolts to 29 to 38 N·m (2.9 to 3.9 kg-m, 21 to 28 ft-lb).
c. Tighten 180° to 185° [target: 180°] (angular tightening).
d. Loosen completely to 0 N·m (0 kg-m, 0 in-lb) in the reverse order of that shown in the figure.
e. Tighten bolts to 35 to 44 N·m (3.5 to 4.5 kg-m, 26 to 32 ft-lb).
f. Tighten 90° to 95° [target: 90°] (angular tightening)
g. Tighten another 90° to 95° [target: 90°] (angular tightening).
   - **When an angle wrench is not used, paint an alignment mark on the head of cylinder head bolt and cylinder head surface before tightening. Check the angle with a protractor.**

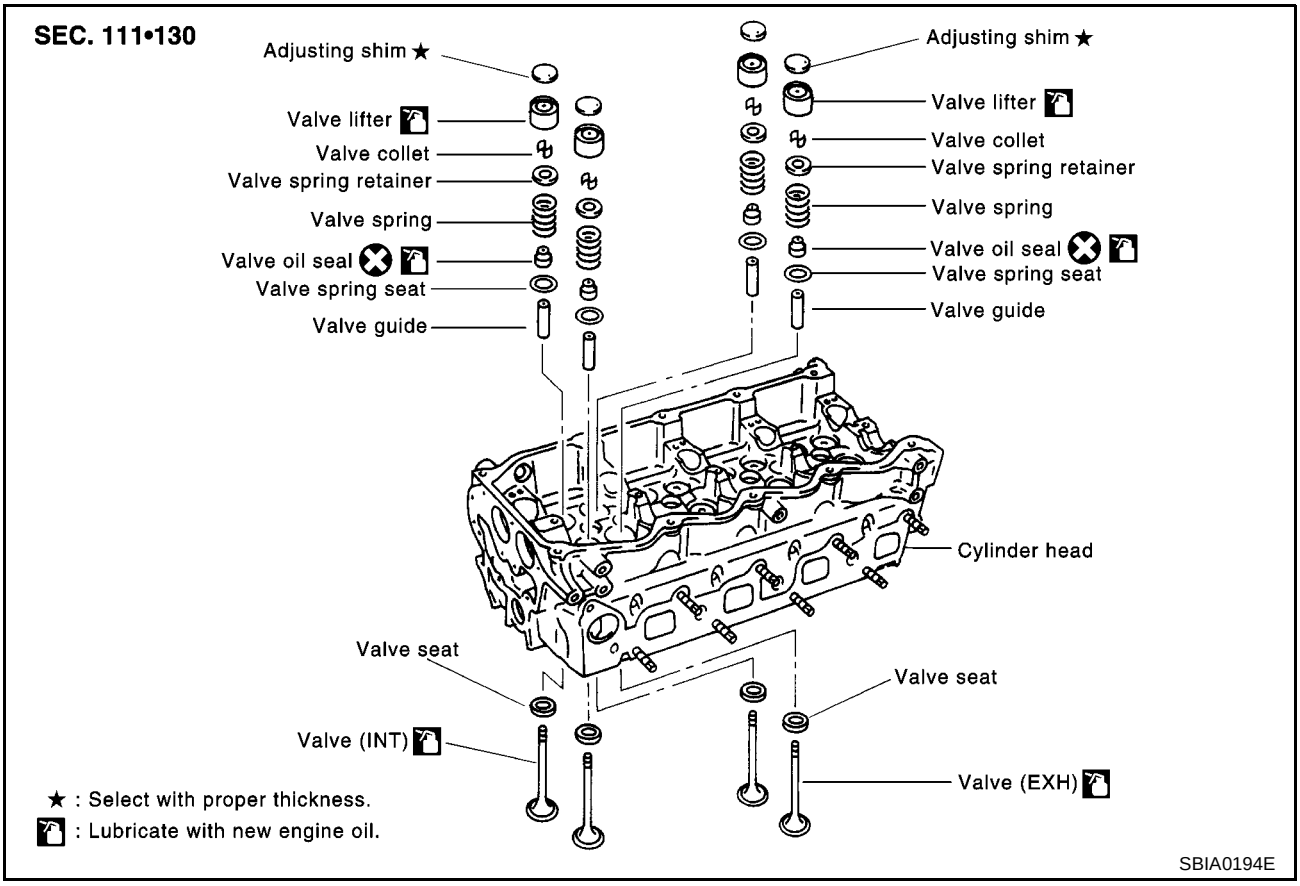




4. Install glow plug.
   - **To avoid damage, glow plugs should be removed only when required.**
   - **Handle with care to avoid applying shock. When dropped from approx. 100 mm (3.94 in) or higher, always replace with a new one.**
   - Before installing, remove carbon depositing on mounting hole of glow plug with a reamer.
5. Install engine coolant temperature sensor and thermal transmitter.

Disassembly and Assembly

EBS00DJ1

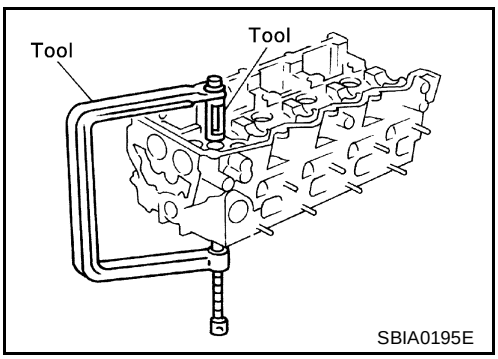


CAUTION:

Apply new engine oil to parts marked in illustration before installation.

DISASSEMBLY

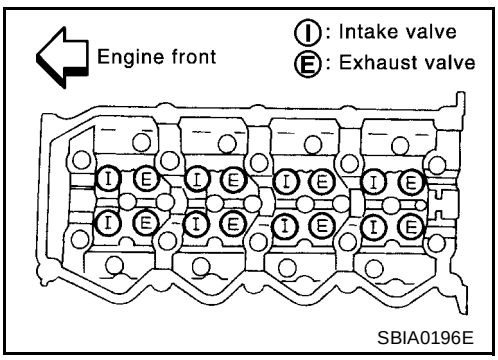
1. Remove adjusting shims and valve lifters.
   - Check the installation positions, and keep them to avoid being confused.
2. Remove valve.
   - Using valve spring compressor, compress valve spring. Using magnetic hand, remove valve collets.
3. Remove valve spring retainers and valve springs.
4. Remove valves as pressing valve stems toward combustion chamber.



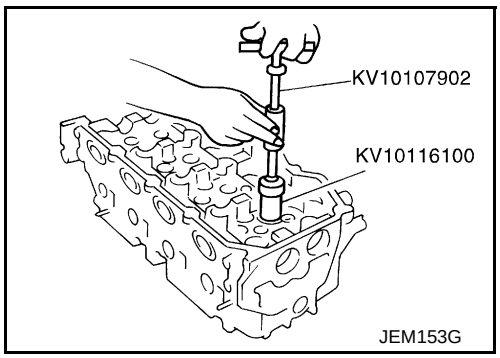
- Before removing the valve, check the valve guide clearance. Refer to EM-183, "Valve Guide Clearance" .
- Check installation positions, and keep them to avoid being confused.

  NOTE:

  Refer to the figure for intake and exhaust valve positions. Intake and exhaust valve driving cams are provided alternately for each camshaft.

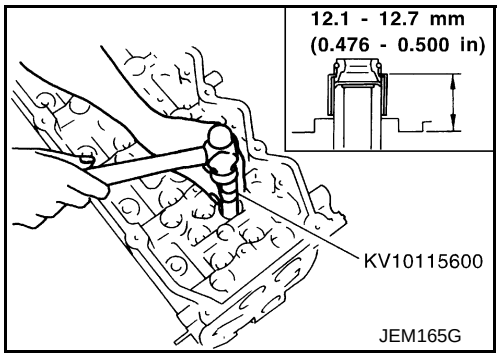


5. Remove valve oil seals using valve oil seal puller.
6. Remove valve spring seats.
7. Before removing valve spring seats, perform valve seat contact check. Refer to EM-184, "Valve Seat Contact" .
8. Before removing valve guides, perform valve guide clearance check. Refer to EM-183, "Valve Guide Clearance" .



ASEMBLY

1. Install valve guides. Refer to EM-183, "Valve Guide Clearance" .
2. Install valve seats. Refer to EM-184, "Valve Seat Replacement" .
3. Using valve oil seal drift, install valve oil seals referring to the dimension shown in the figure.
4. Install valve spring seats.
5. Install valves.
   - Install the valves with bigger outer diameter to intake valve side.
   - Note that valve layout here is different from that of conventional engine.



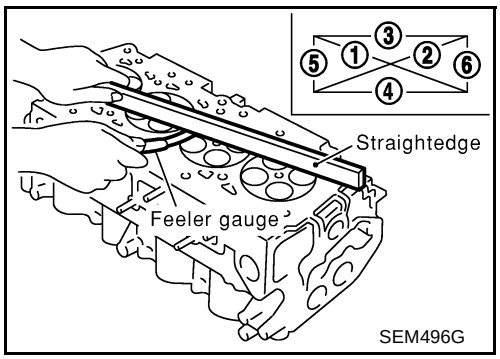
6. Install valve spring.
7. Install valve spring retainers.
8. Using valve spring compressor, compress valve springs.
   Then install valve collets using magnetic hand.
   - After installing valve collets, tap the stem end using a plastic hammer, and check the installation status.
9. Install valve lifters and adjusting shims to the same positions as before.

INSPECTION AFTER DISASSEMBLY

Cylinder Head Distortion

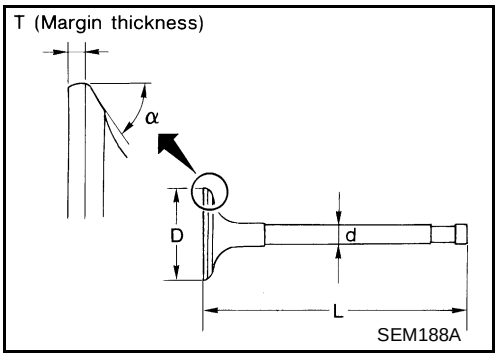
Using straightedge and feeler gauge, check the bottom of the cylinder head for distortion.

Limit : 0.04 mm (0.0016 in)



Valve Dimension

Check dimensions of each valve. For dimensions, refer to SDS, EM-214, "Valve" .
When valve head has been worn down to 1 mm (0.039 in) in margin thickness, replace valve.
Grinding allowance for valve stem tip is 0.2 mm (0.008 in) or less.



Valve Guide Clearance

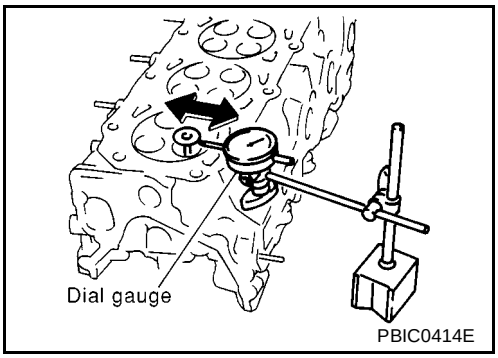
- Perform the inspection before removing valve guides.
- Check that the valve stem diameter is within specifications.
- Push valve approximately 25 mm (0.98 in) toward combustion chamber, move valve toward dial indicator to measure valve movement.
- Valve guide clearance is 1/2 of movement on dial indicator.

Standard:

Intake	**: 0.020 - 0.053 mm (0.0008 - 0.0021 in)**
Exhaust	**: 0.040 - 0.073 mm (0.0016 - 0.0029 in)**

Limit:

Intake	**: 0.08 mm (0.0031 in)**
Exhaust	**: 0.10 mm (0.0039 in)**

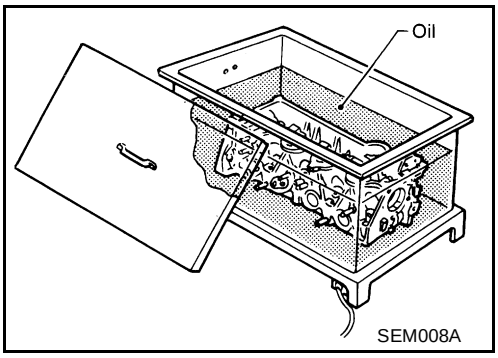


- If the measured value exceeds the limit, replace valve guide.

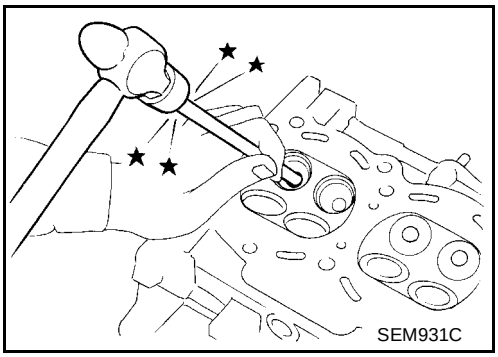
Valve Guide Replacement

- When removing valve guide, replace it with oversized [0.2 mm (0.0008 in)] valve guide.

1. Heat cylinder head to 110 to 130°C (230 to 266°F) in oil bath.

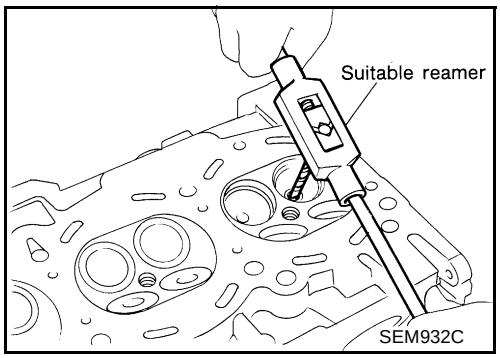


2. Using valve guide drift, tap valve guides out from the combustion chamber side.



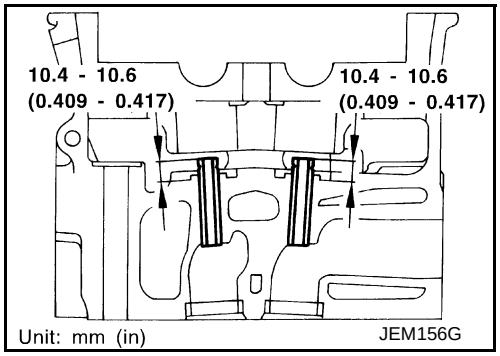
3. Remove cylinder head valve guide hole.

Valve guide hole diameter (for service parts):
: 10.175 - 10.196 mm (0.4006 - 0.4014 in)



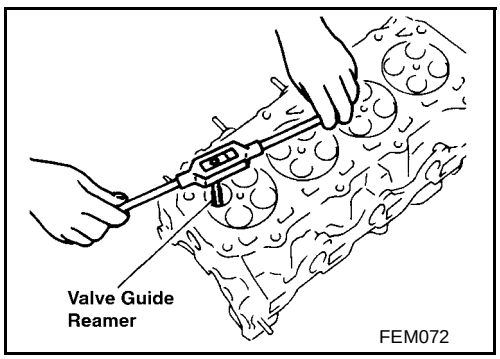
4. Heat cylinder head to 110 to 130°C (230 to 266°F) in oil bath.
5. Using valve guide drift, press fit valve guides from camshaft side, referring to the dimension shown in the figure.

Projection "L" : 10.4 - 10.6 mm (0.409 - 0.417 in)



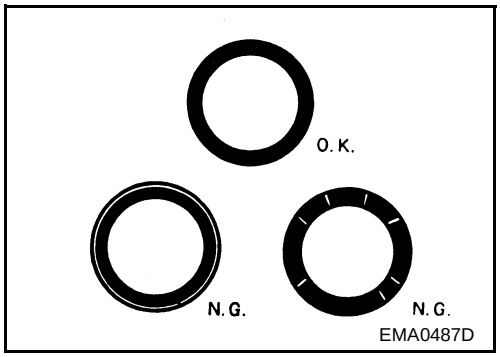
6. Using valve guide reamer, perform reaming to the press-fitted valve guides.

Reaming specifications:
Intake and Exhaust
6.000 - 6.018 mm (0.2362 - 0.2369 in)



Valve Seat Contact

- Before starting this check, confirm that the dimension of valve guide and valves are as specified.
- Apply red lead primer on contacting surfaces of valves seat and of valve face to examine the conditions of contacting surfaces.
- Check that the paint on contacting surfaces is continuous along the entire circumference.
- If there are abnormal indications, grind the valve and check the contact again. If abnormal indications still persist, replace valve seat.



Valve Seat Replacement

- When removing valve seat, replace it with oversized [0.5 mm (0.0020 in)] valve seat.

1. Cut valve seat to make it thin, and pull it out.

2. Machine cylinder head inner diameter at valve seat installation position.

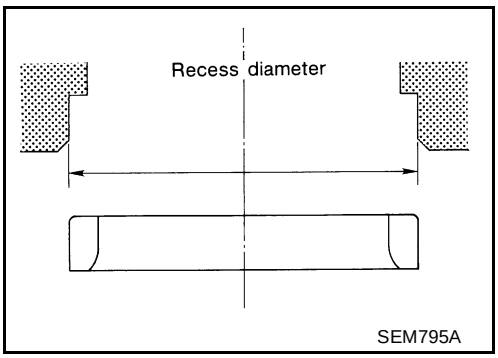
Machining dimension:

Intake

30.500 - 30.516 mm (1.2008 - 1.2014 in) dia.

Exhaust

29.500 - 29.516 mm (1.1614 - 1.1620 in) dia.



3. Heat cylinder head to approximately 110 to 130°C (230 to 266°F) in oil bath.
4. After cooling valve seats sufficiently with dry ice, press fit it to cylinder head.

CAUTION:

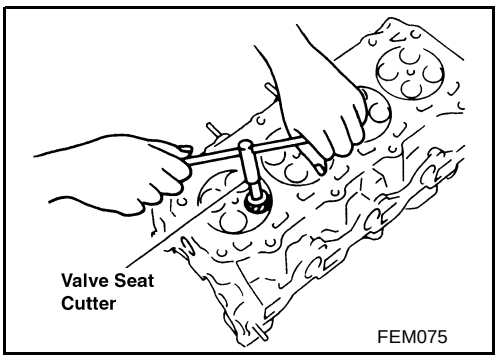
Do not touch the cooled valve seats directly by hand.

5. Using valve seat cutter, finish processing referring to the dimensions shown in the figure.

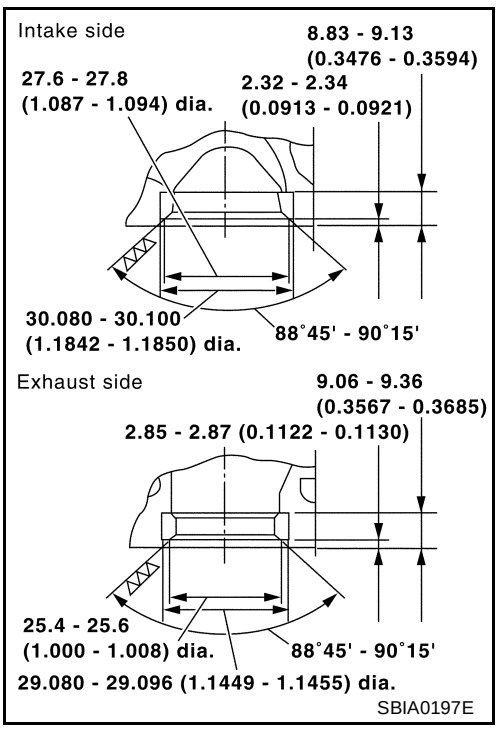
CAUTION:

When using valve seat cutter, grasp cutter handle with both hands, press cutter onto contacting face all around, and cut thoroughly. If cutter is pressed unevenly or repeatedly, the valve seat surface may be damaged.

6. Using compound, perform valve fitting.



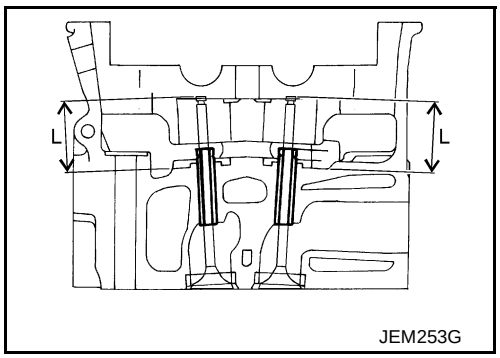
7. Check again to make sure that contacting status is satisfactory. For details, Refer to EM-184, "Valve Seat Contact" .



8. Use a depth gauge to measure the distance between the mounting surface of the cylinder head spring seat and the valve stem end. If the distance is shorter than specified, repeat step 5 above to adjust it. If it is longer, replace the valve seat with a new one.

Valve seat resurface limit "L":

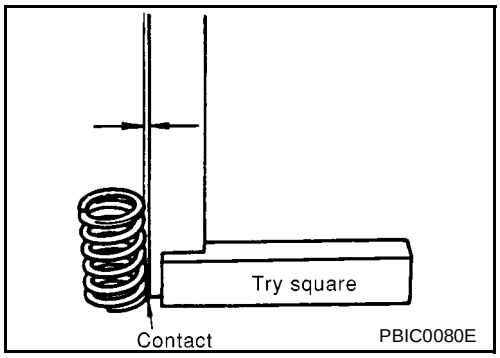
Intake	**: 36.53 - 36.98 mm (1.4382 - 1.4559 in)**
Exhaust	**: 36.53 - 37.01 mm (1.4382 - 1.4571 in)**



Valve Spring Sequences

Position a straightedge to valve spring, turn the spring, and measure the maximum clearance value between top surface of spring and the straightedge.

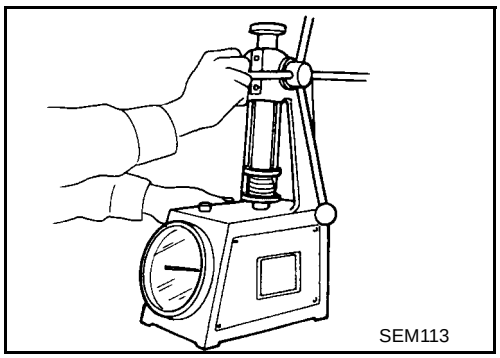
Limit : 1.9 mm (0.075 in)



Valve Spring Dimensions and Valve Spring Pressure Load

Using valve spring tester, check the following.

Free length	**: 43.7 mm (1.720 in)**
Installation height	**: 32.82 mm (1.2921 in)**
Installation load	**: 184 - 208 N (18.77 - 21.22 kg, 41.4 - 46.8 lb)**
Height during valve open	**: 24.82 mm (0.9772 in)**
Load with valve open	**: 320 - 360 N (32.65 - 36.73 kg, 71.9 - 80.9 lb)**

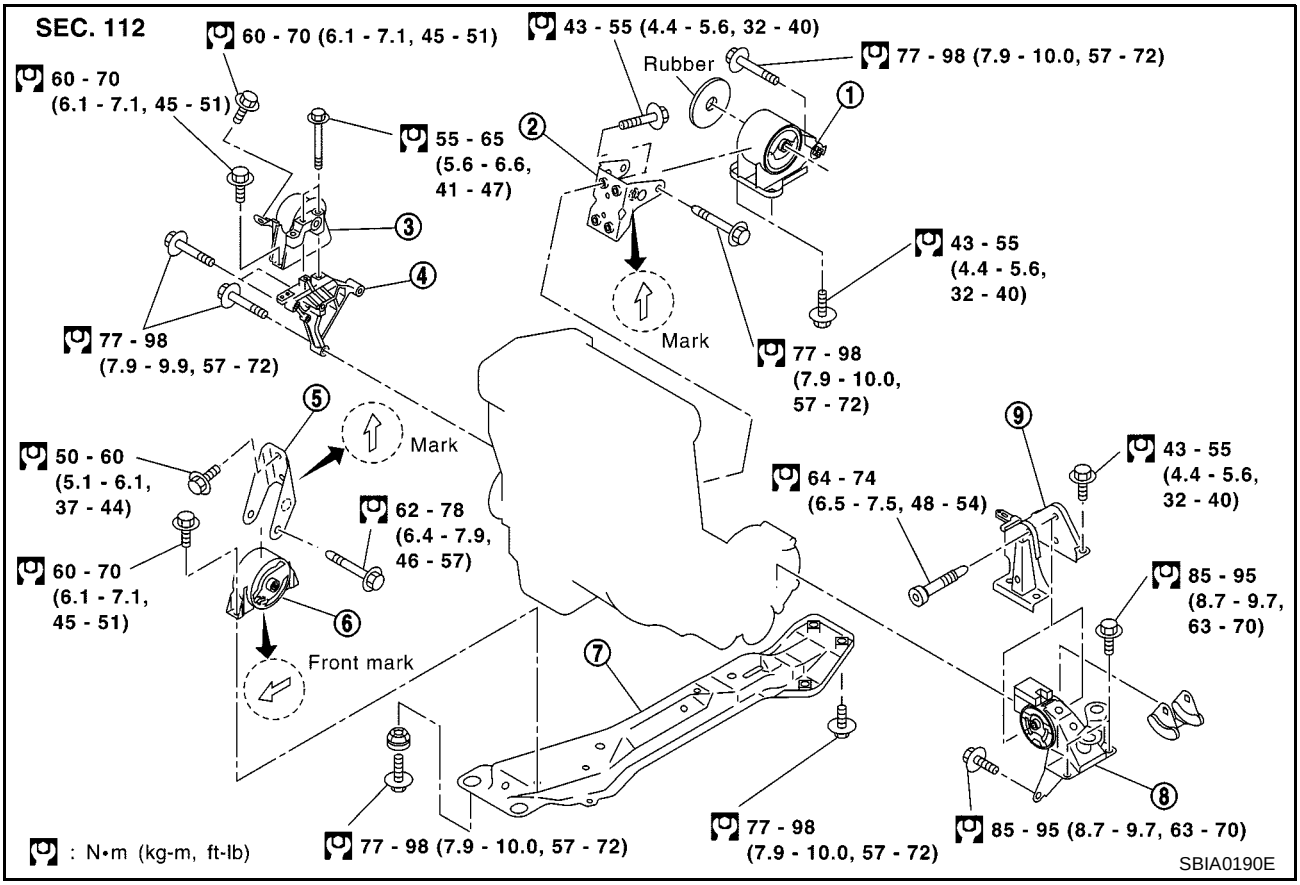


ENGINE ASSEMBLY

PFP:10001

Removal and Installation

EBS00DJ2



1. Rear engine mounting insulator
2. Rear engine mounting bracket
3. RH engine mounting insulator
4. RH engine mounting bracket
5. Front engine mounting bracket
6. Front engine mounting insulator
7. Center member
8. LH engine mounting insulator
9. LH engine mounting bracket

WARNING:

- **Situate vehicle on a flat and solid surface.**
- **Place chocks at front and back of rear wheels.**
- **For engines not equipped with engine slingers, attach proper slingers and bolts described in PARTS CATALOG.**

CAUTION:

- **Always be careful to work safely, avoid forceful or uninstructed operations.**
- **Do not start working until exhaust system and coolant are cool enough.**
- **If items or work required are not covered by the engine main body section, refer to the applicable sections.**
- **Always use the support point specified for lifting.**
- **Use either 2-pole lift type or separate type lift as best you can. If board-on type is used for unavoidable reasons, support at the rear axle jacking point with transmission jack or similar tool before starting work, in preparation for the backward shift of center of gravity.**
- **For supporting points for lifting and jacking point at rear axle, refer to GI-31, "Garage Jack and Safety Stand" .**

REMOVAL

Description of work

Remove engine, transaxle and transfer assembly with front suspension member from vehicle down ward. Separate suspension member, and then separate engine and transaxle.

Preparation

1. Remove engine hood.
2. Drain coolant from radiator drain plug.
3. Remove the following parts.
   - LH/RH under cover
   - LH/RH front wheel
   - Battery
   - Auxiliary drive belt; Refer toEM-114, "Removal and Installation" .
   - Air duct and air cleaner case assembly; Refer to EM-115, "Removal and Installation" .
   - Alternator
   - Radiator and radiator fan assembly; Refer to CO-33, "Removal and Installation" .
   - Charge air cooler
4. Disconnect engine room harness from the engine side and set it aside for easier work.
5. Disconnect all the body-side vacuum hoses and air hoses at engine side.

Engine room LH

6. Disconnect fuel feed and return hoses, and plug it to prevent fuel from draining.
7. Disconnect heater hose, and install plug it to prevent engine coolant from draining.
8. Remove clutch operating cylinder from transaxle, and move it aside.
9. Disconnect shift cable from transaxle.

Engine room RH

10. Remove engine coolant reservoir tank.
11. Remove air conditioner compressor with piping connected from engine. Temporarily secure it on body with a rope to avoid putting load on it.

Vehicle underbody

12. Remove exhaust front tube.
13. Remove propeller shaft.
14. Remove steering shaft from steering gear.
15. Disconnect power steering fluid cooler piping at a point between body and engine.
16. Remove ABS sensor from brake caliper.
17. Remove brake caliper with piping connected from steering knuckle. Temporarily secure it on body with a rope to avoid load on it.
18. Remove LH/RH suspension from steering knuckle under strut.

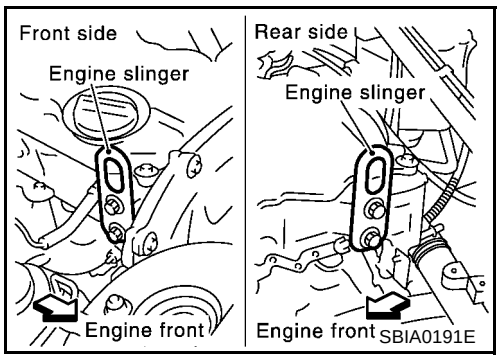
Removal

19. Install engine slingers into front right of cylinder head and rear left of cylinder head.

    Slinger bolts:

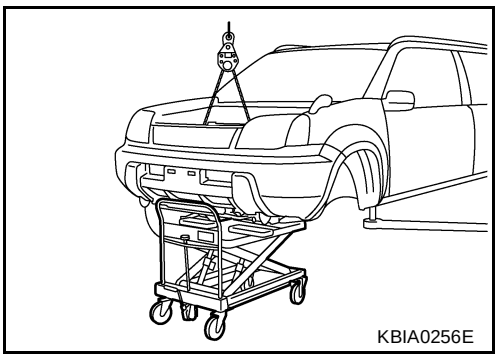
    : 30 - 37 N·m (3.0 - 3.8 kg-m, 22 - 27 ft-lb)

20. Lift with hoist and secure the engine in position.

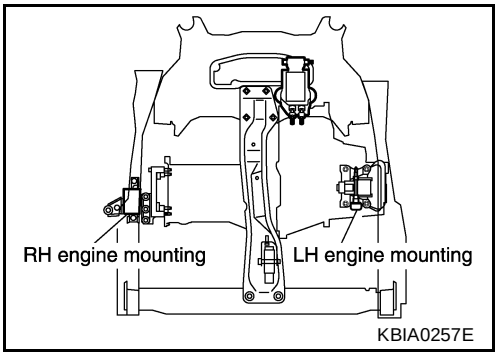


- Use a manual lift table caddy or equivalently rigid tool such as a jack or trestle. Securely support bottom of engine and transaxle, and simultaneously adjust hoist tension.

  CAUTION:
  Put a piece of wood or something similar as the supporting surface, secure a completely stable condition.


KBIA0256E

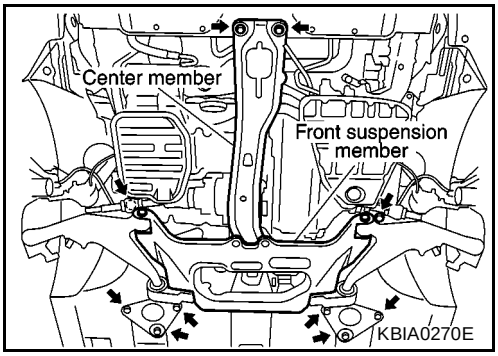
21. Remove RH engine mounting insulator.
22. Pull LH engine mounting through-bolt out.



KBIA0257E

23. Remove mounting bolts at front end of center member.
24. Remove front suspension member mounting bolts and nuts.
25. Remove engine, transaxle and transfer assembly with suspension member from vehicle downward by carefully operating supporting tools.

    CAUTION:
    - **During the operation, make sure that no part interferes with body side.**
    - **Before and during this lifting, always check if any harnesses are left connected.**
    - **During the removal operation, always be careful to prevent vehicle from falling off the lift due to changes in the center of gravity.**
    - **If necessary, support vehicle by setting a jack or equivalent tool at the rear.**



KBIA0270E

26. Remove power steering pump with piping connected from engine. Move it aside on suspension member.
27. Remove front engine mounting and rear engine mounting through-bolts to remove suspension member.
28. Remove starter motor.
29. Separate engine and transaxle.

INSTALLATION

Install in the reverse order of removal.

- Do not allow oil to get on mounting insulator. Be careful not to damage mounting insulator.
- When installation directions are specified, install parts according to the direction marks on them referring to components illustration.
- Make sure that each mounting insulator is seated properly, and tighten mounting bolts and nuts.

INSPECTION AFTER INSTALLATION

- Before starting engine check the levels of coolant, lubrications and working oils. If less than required quantity, fill to the specified level.
- Before starting engine, bleed air from fuel piping. Refer to FL-16, "Air Bleeding" .
- Run engine to check for unusual noise and vibration.
- Warm up engine thoroughly to make sure there is no leakage of coolant, lubricants, working oil, fuel and exhaust gas.

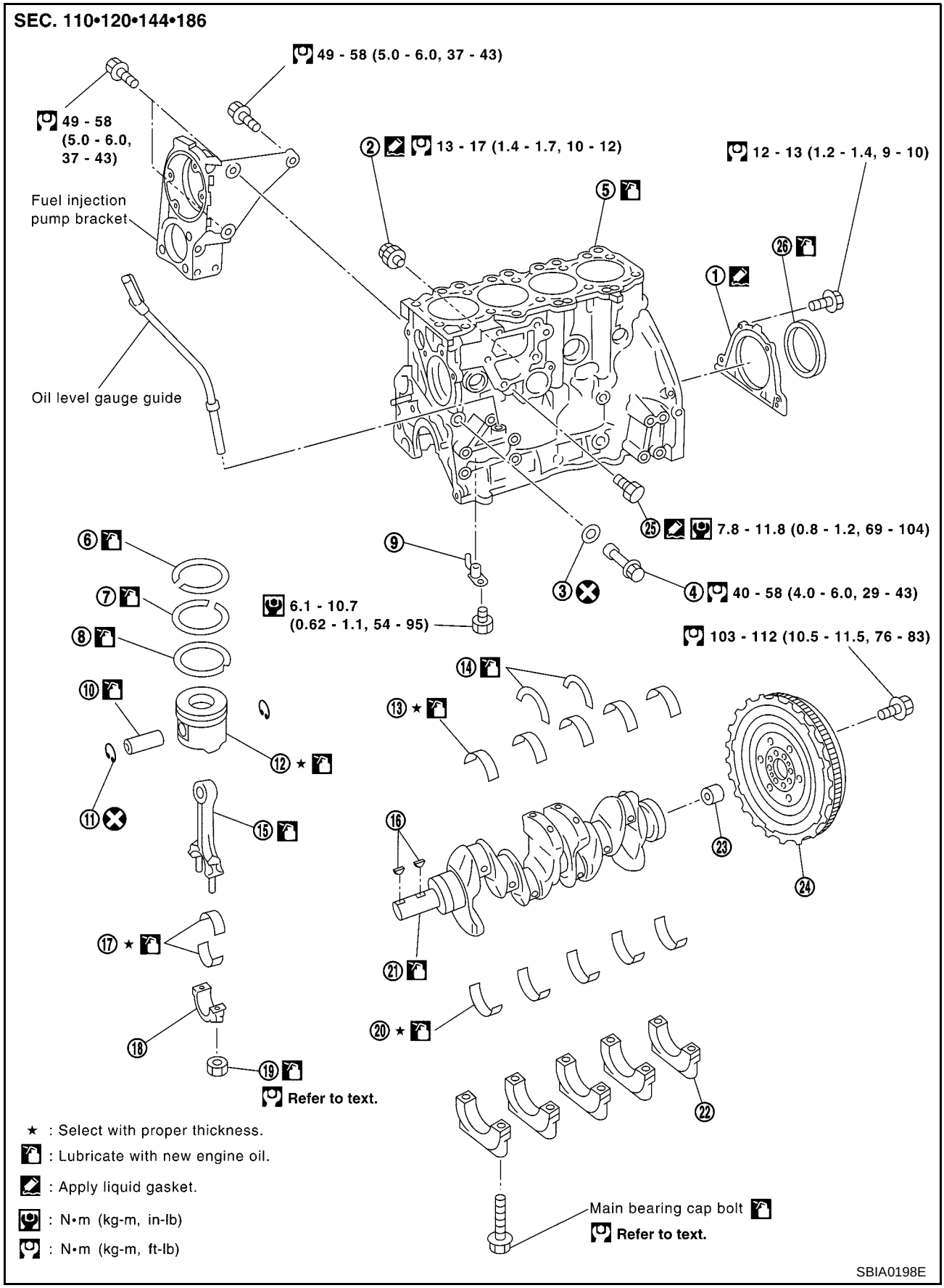
- Bleed air from passages in pipes and tubes of applicable lines.

CYLINDER BLOCK

PFP:11010

Disassembly and Assembly

EBS00DJ3

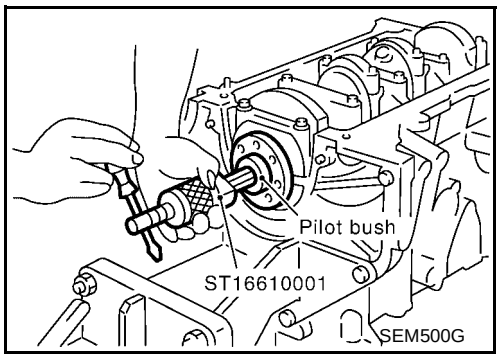


1. Rear oil seal retainer
2. Oil pressure switch
3. Coppet washer
4. Oil jet relief valve
5. Cylinder block
6. Top ring
7. Second ring
8. Oil ring
9. Oil jet
10. Piston pin
11. Snap ring
12. Piston
13. Main bearing
14. Thrust bearing
15. Connecting rod
16. Key
17. Connecting rod bearing
18. Connecting rod cap
19. Connecting rod nut
20. Main bearing
21. Crankshaft
22. Main bearing cap
23. Pilot bush
24. Flywheel
25. Drain plug
26. Rear oil seal

CAUTION:
Apply new engine oil to parts marked in illustration before installation.

DISASSEMBLY

1. Remove engine assembly from the vehicle, then separate engine and transaxle. Refer to EM-187, "ENGINE ASSEMBLY" .
2. Remove clutch cover and disk. Refer to CL-15, "CLUTCH DISC, CLUTCH COVER AND FLYWHEEL" .
3. If they need to be replaced, replace pilot bushing.
   - Using pilot bushing puller, remove the bushing from rear edge of crankshaft.

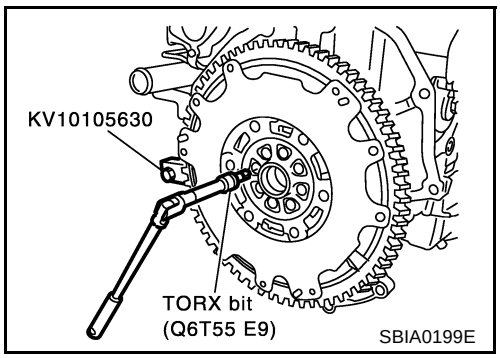


4. Install engine to engine stand as follows.

a. Remove flywheel.

b. Secure ring gear with ring gear stopper, then loosen mounting bolts with TORX bit (size: Q6T55 E9, Commercial Service Tools) and remove them. As an alternative method hold the crankshaft pulley with a pulley holder (SST) to remove the flywheel.

CAUTION:
Do not disassemble flywheel.

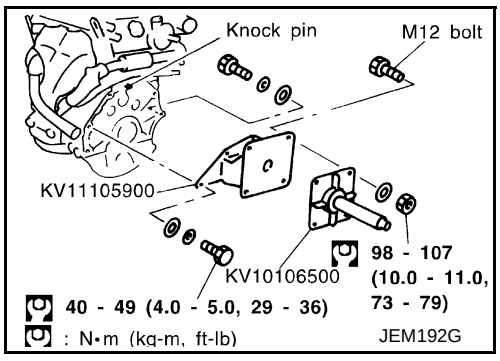


c. Install engine sub-attachment to the rear side of cylinder block.
   - Align knock pins on cylinder block with pin holes on attachment to install.

NOTE:
Installation bolts are part of engine sub-attachment.

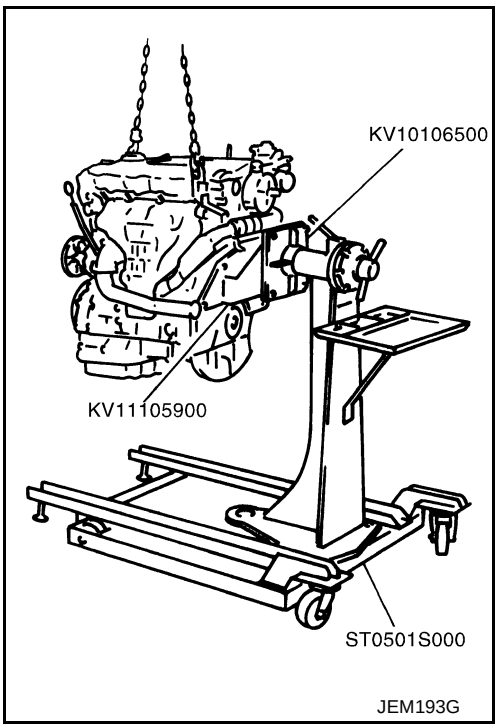
d. Install engine attachment.

NOTE:
Use commercially available M12 (0.47 in) mounting bolts and nuts (4 sets) with strength grade of 9T (minimum).



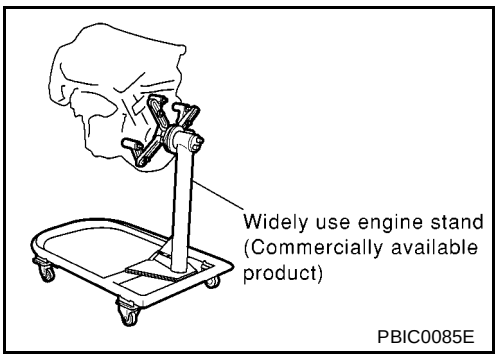
e. Hoist engine and install it to the engine stand.

NOTE:
It is possible to set engine sub-attachment and engine attachment to engine stand at first, then install engine later.



- Commercial engine stand can be used.

NOTE:
The figure shows an example of general-purpose engine stand that can hold mating surface of transmission with drive plate and rear plate removed.

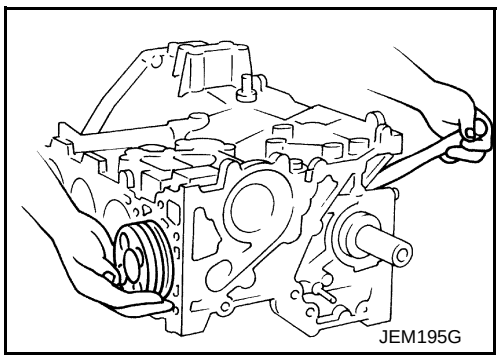


5. Drain engine oil and coolant from inside engine.
6. Remove the following parts and related parts. (Only major parts are listed.)
   - Intake manifold collector and intake manifold (Refer to EM-118, "Removal and Installation" .)
   - Exhaust manifold (Refer to EM-122, "Removal and Installation" .)
   - Rocker cover (Refer to EM-150, "Removal and Installation").
   - Injection tube and fuel injector (Refer to EM-138, "Removal and Installation" .)
   - Oil pan and oil strainer (Refer to EM-128, "Removal and Installation" .)
   - Water pump (Refer to CO-40, "Removal and Installation" .)
   - Thermostat and water piping (Refer to CO-42, "Removal and Installation" .)
   - Vacuum pump and vacuum pipe (Refer to EM-134, "Removal and Installation" .)
   - Secondary timing chain (Refer to EM-161, "Removal and Installation")
   - Primary timing chain (Refer to EM-166, "Removal and Installation" .)
   - Electronic control fuel supply pump (Refer to EM-141, "Removal and Installation" .)
   - Camshaft (Refer to EM-152, "Removal and Installation" .)
   - Cylinder head (Refer to EM-177, "Removal and Installation" .)
   - Oil cooler (Refer to LU-26, "Removal and Installation" .)
   - Accessory, accessory bracket and mount brackets
7. Remove fuel supply pump bracket.
8. Remove rear oil seal retainer.

- Insert a flat-bladed screwdriver between main bearing cap and rear oil seal retainer to remove retainer.

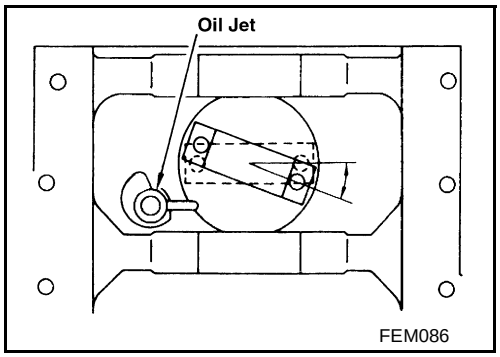
9. Remove rear oil seal from rear oil seal retainer.
   - Punch out with a flat-bladed screwdriver.
   - **Be careful not to damage rear oil seal retainer.**
10. Remove piston and connecting rod assembly.
    - Before removing piston and connecting rod assembly, check connecting rod side clearance.
      Refer to EM-203, "CONNECTING ROD SIDE CLEARANCE" .

a. Move crankshaft pin to be removed to approximately BDC.
b. Remove connecting rod caps.
c. Using the grip of a hammer, press the piston and connecting rod assembly out to cylinder head side.


JEM195G

CAUTION:
When removing the piston and connecting rod assembly, prevent the big end of the connecting rod from interfering with the oil jet.

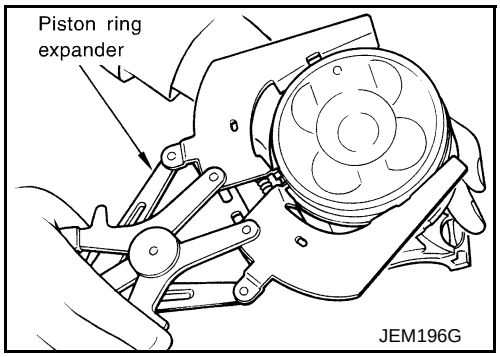
11. Remove connecting rod bearings from connecting rods and caps.
    - Keep them by cylinder to avoid confusion.



FEM086

12. Remove piston rings from pistons using piston ring expander.

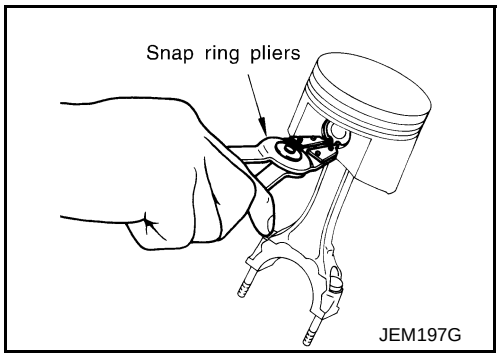
CAUTION:
- **When removing, prevent pistons from being damaged.**
- **Do not expand piston rings excessively. This may damage the piston rings.**



JEM196G

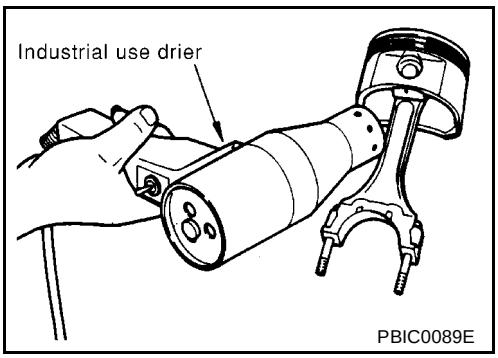
13. Remove pistons from connecting rods.

a. Using long nose pliers, remove snap rings.

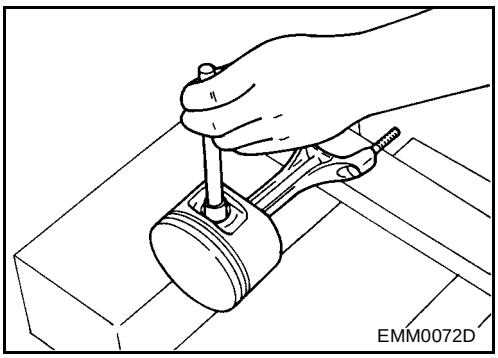


JEM197G

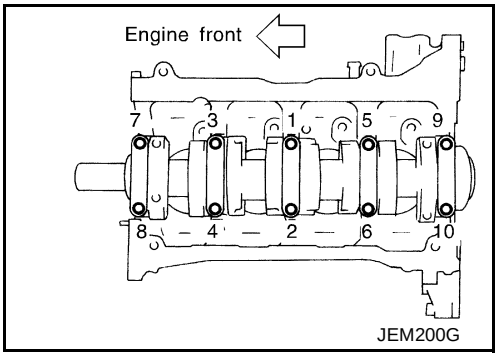
b. Using industrial dryer, heat pistons up to 60 to 70°C (140 to 158°F).



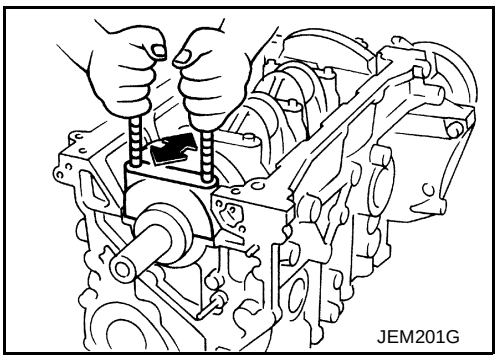
c. Using rod with outer diameter of 26 mm (1.02 in), press piston pins out.



14. Remove main bearing cap bolts.
    - With a TORX socket (size: E-14, Commercial Service Tool), loosen main bearing cap bolts in several stages in the reverse order of that shown in the figure and remove them.
    - Before loosening main bearing cap bolts, measure crankshaft side clearance. Refer to EM-203, "CRANKSHAFT SIDE CLEARANCE" .

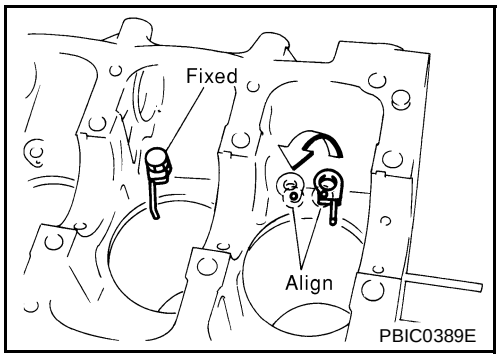


15. Remove main bearing caps.
    - Using main bearing cap bolts, remove by rocking bearing cap back and forth.
16. Remove crankshaft.
17. Remove main bearings and thrust bearings from cylinder block and main bearing caps.
    - **Check the correct installation locations of removed parts. Store them so they do not get mixed up.**
18. Remove oil jet.
19. Remove oil jet relief valve.



ASSEMBLY

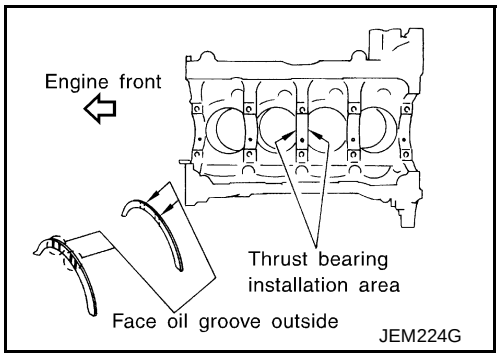
1. Blow air sufficiently to inside coolant passage, oil passage, crankcase and cylinder bore to remove foreign matter.
2. Install oil jet relief valve.
3. Install oil jet.
   - Align knock pin on back of oil jet with hole on block when installing oil jet.



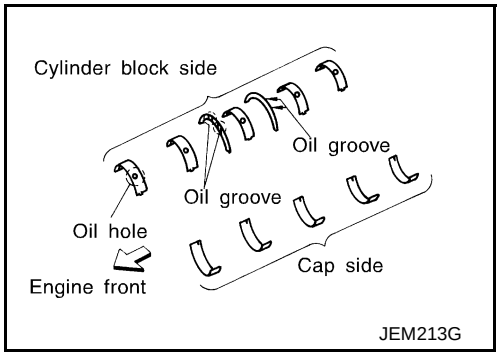
4. Install main bearings and thrust bearings.

a. Remove contamination, dust and oil from bearing mounting positions on cylinder block and main bearing caps.

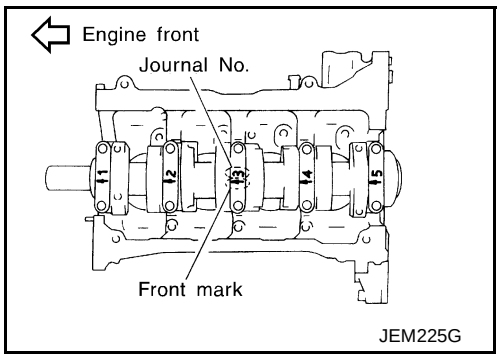
b. Install thrust bearings on both sides of No. 3 housing on cylinder block.
   - Install thrust bearings with oil groove facing to crankshaft arm (outside).



c. Being careful with the direction, install main bearings.
   - Install main bearings with the oil holes and grooves onto the cylinder block side, and those without oil holes and grooves onto the main cap side.
   - While installing bearings, apply engine oil to bearing surfaces (inside). Do not apply oil to rear surfaces, but clean them completely.
   - Align stopper notches on bearings to install them.
   - Check that the oil holes on the cylinder block body are mated with the oil hole positions on the bearings.



5. Install crankshaft to cylinder block.
   - Make sure crankshaft rotates smoothly by hand.
6. Install main bearing caps.
   - Identify main bearing caps by the punched mark. Install correctly matching the journal No. on the bearing cap and the journal with the front mark facing forward.
   - Main bearing caps are commonly processed with the cylinder block. Therefore, caps and cylinder block should be replaced as a set.
7. Check the main bearing cap bolts for deformation.
   Refer to EM-210, "MAIN BEARING CAP BOLT DEFORMATION" .

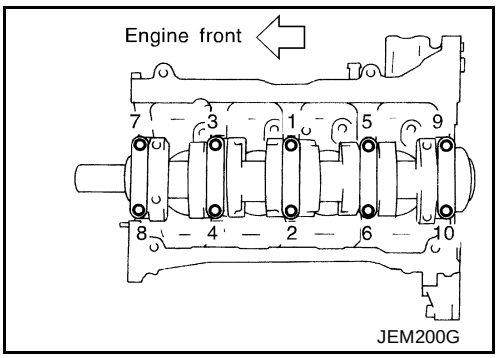


8. Tighten the main bearing cap bolts according to the following procedure:

a. Apply engine oil to the threaded part and seat surface of each bolt.

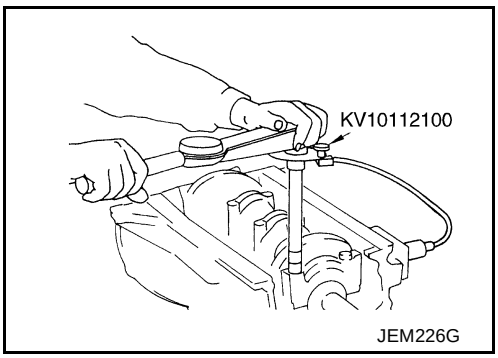
b. Tighten to 25 to 30 N·m (2.5 to 3.1 kg-m, 18 to 22 ft-lb) in the numerical order shown in the figure.

c. Put alignment marks (with paint) on each bolt and the main bearing cap, all in the same direction. (When using a protractor)



d. Then, tighten 90° to 95° [target: 90°].

- **Always use either an angle wrench (SST) or protractor during angular tightening. Avoid tightening based on visual checks alone.**
- After tightening bolts to specified torque, make sure that crankshaft rotates smoothly.
- Check crankshaft end side clearance. Refer to EM-203, "CRANKSHAFT SIDE CLEARANCE" .



9. Check the outer diameter of connecting rod bolts. Refer to EM-210, "CONNECTING ROD BOLT DEFORMATION" .

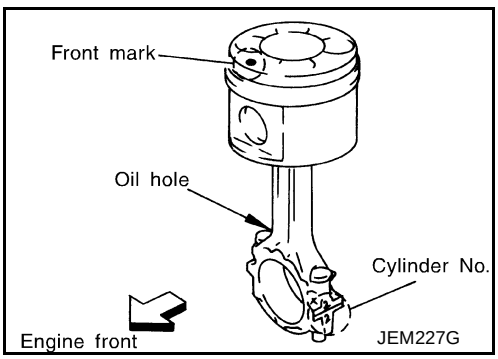
10. Install pistons to connecting rod.

a. Using long nose pliers, install snap rings to grooves on piston rear side.

- Fit snap rings correctly into grooves.

b. Install pistons to connecting rods.

- Using industrial dryer, heat pistons up to approx. 60 to 70°C (140 to 158°F) until piston pin can be pressed down by finger touch. Then insert piston pins into piston and connecting rod from front side of piston toward rear.
- Assemble piston and connecting rod with front mark of piston crown and cylinder No. stamped on connecting rod being positioned as shown in the figure.



c. Install snap rings to front side of pistons.

- Refer to above step a for precaution on snap ring installation.
- After installation, check connecting rods for smooth movement.

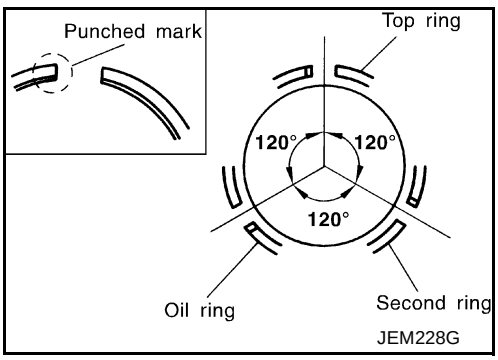
11. Use piston ring expander to install piston rings.

CAUTION:
When installing, prevent piston from being damaged.

- Install top ring and second ring with stamped surfaces facing upward.

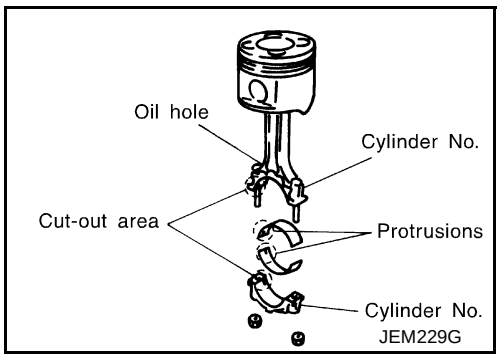
Identification stamp:

Top ring : R Top
Second ring : R 2nd



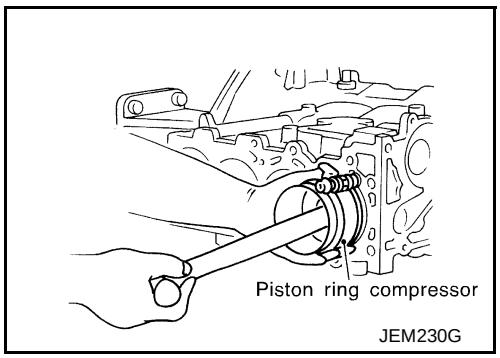
- Install rings so that three closed gap position 120° apart one another.
- Closed gaps do not need to face in a specific directions, as long as each are positioned 120° apart.

12. Install connecting rod bearings to connecting rods and caps.
    - While installing connecting rod bearings, apply engine oil to bearing surfaces (inside). Do not apply oil to rear surfaces, but clean them completely.
    - Align stoppers on connecting rod bearings with connecting rod stopper notches to install connecting rod bearings.

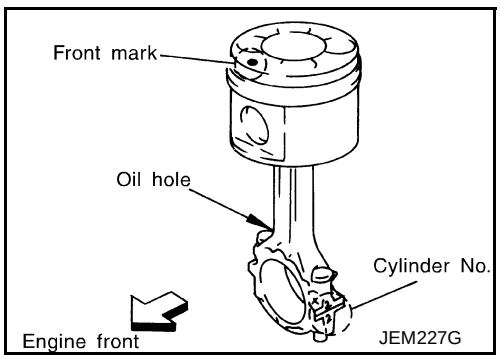


13. Install piston and connecting rod assembly to crankshaft.
    - Move crankshaft pin to be assembled to BDC.
    - Align cylinder position with cylinder No. on connecting rod to install piston and connecting rod assembly.
    - Using piston ring compressor, install piston and connecting rod assembly with front mark on piston crown facing toward the front side of engine.

    CAUTION:
    When installing piston and connecting rod assembly, prevent the big end of connecting rod from interfering with oil jet.

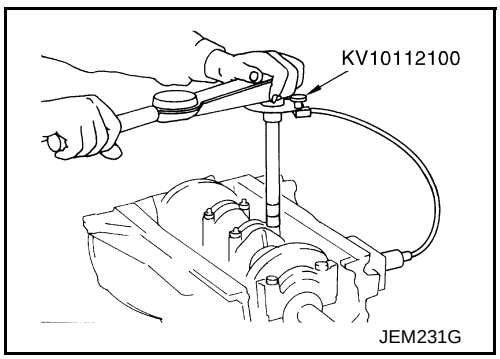


14. Install connecting rod caps and mounting nuts.
    - Align cylinder No. stamped on connecting rod with that on cap to install connecting rod cap.
    - Make sure that the front mark on connecting rod cap faces towards the front of the engine.



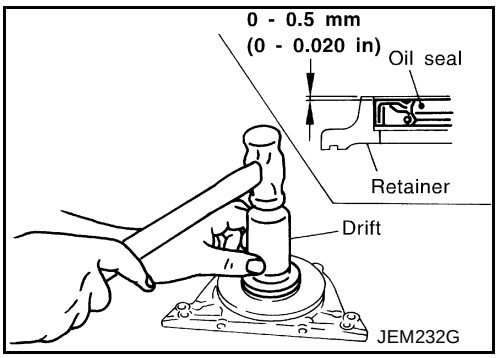
15. Tighten connecting rod nuts according to the following procedure:

a. Apply engine oil on bolt threads and seat surface of nuts.
b. Tighten to 29 to 30 N·m (2.9 to 3.1 kg-m, 21 to 22 ft-lb).
c. Loosen completely to 0 N·m (0 kg-m, 0 in-lb).
d. Tighten to 19 to 20 N·m (1.9 to 2.1 kg-m, 14 to 15 ft-lb).
e. Tighten 120° to 125° [target: 120°]. (angular tightening)
    - **Always use either an angle wrench (SST) or protractor during angular tightening. Avoid tightening based on visual checks alone.**
    - After tightening nuts, check that crankshaft rotates smoothly.

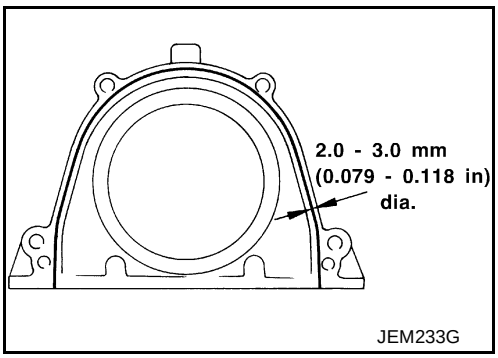


- Check connecting rod side clearance. Refer to EM-203, "CONNECTING ROD SIDE CLEARANCE" .

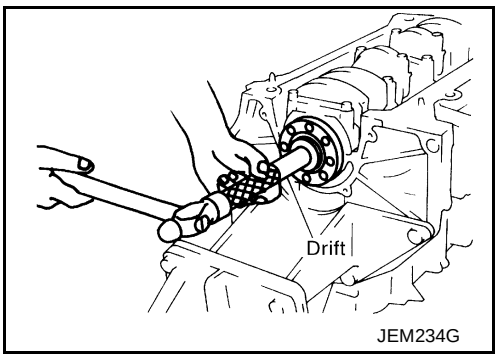
16. Force fit rear oil seal into rear oil seal retainer.
    - Using a drift [105 mm (4.13 in) dia.], force fit so that the dimension is as specified in the figure.
    - Avoid inclined fitting. Force fit perpendicularly.



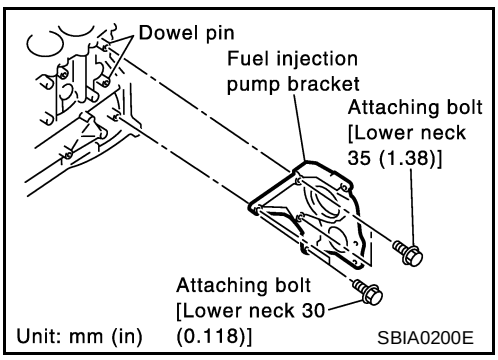
17. Install rear oil seal and retainer assembly.
    - Apply a continuous bead of liquid gasket to rear oil seal and retainer assembly as shown in the figure.



18. Press fit pilot bushing into flywheel.
    - Using drift with outer diameter of 19 mm (0.75 in), press fit pilot bushing until it stops.



19. Install fuel supplypump bracket.
    - Align the bracket with the dowel pins on the block to install.
    - The two bolts used for dowel pins have a longer shanks than the other two.
20. Install parts to the engine in the reverse order of disassembly.
21. Remove engine from engine stand in the reverse order of assembly.
22. Install flywheel.
    - Holding ring gear with ring stopper (SST), tighten securing bolts with TORX bit (size: Q6T55 E9, Commercial Service Tool).
    - Tighten bolts uniformly in a crisscross manner.



How to Select Piston and Bearing

EBS00DJ4

DESCRIPTION

Selection points	Selection parts	Selection items	Selection methods
Between cylinder block to crankshaft	Main bearing	Main bearing grade (bearing thickness)	Determined by match of cylinder block bearing housing grade (inner diameter of housing) and crankshaft journal grade (outer diameter of journal)
Between crankshaft to connecting rod	Connecting rod bearing	Connecting rod bearing grade (bearing thickness)	Combining service grades for connecting rod bearing and crankshaft pin outer diameter determine connecting rod bearing selection.
Between cylinder block to piston	Piston and piston pin assembly The piston is available together with piston pin as an assembly.	Piston grade (piston outer diameter)	Piston grade = cylinder bore grade (inner diameter of bore)

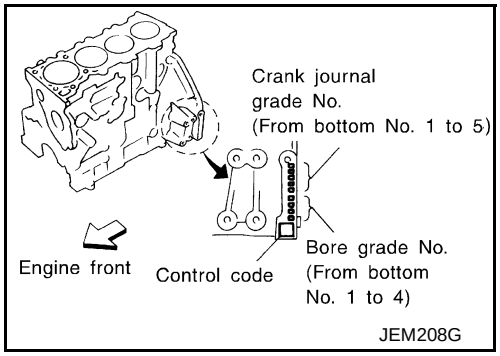
- The identification grade stamped on each part is the grade for the dimension measured in new condition. This grade cannot apply to reused parts.
- For reused or repaired parts, measure the dimension accurately. Determine the grade by comparing the measurement with the values of each selection table.
- For details of the measurement method of each part, the reuse standards and the selection method of the selective fitting parts, refer to the text.

HOW TO SELECT PISTON

When Using New Cylinder Block

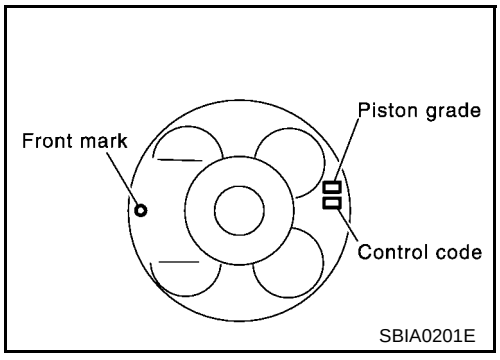
1. Identify the cylinder bore grade (No. 1, 2, or 3) on LH surface at the rear of cylinder block.
2. Select the piston of the same grade.

- The part No. of piston is specified together with the piston pin as an assembly.



When Re-using an Old Cylinder Block

1. Measure cylinder block bore inner diameter.
2. Referring to “Cylinder block bore inner diameter” in “Piston Selection Table”, determine the bore grade.
3. Select the piston of the same grade.



Piston Selection Table

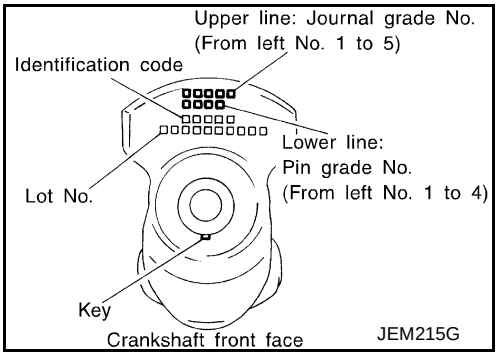
Unit: mm (in)

Grade (punched)	1	2	3
Cylinder bore inner diameter	86.000 - 86.010(3.3858 - 3.3862)	86.010 - 86.020(3.3862 - 3.3866)	86.020 - 86.030(3.3866 - 3.3870)
Piston outer diameter	85.925 - 85.935(3.3829 - 3.3833)	85.935 - 85.945(3.3833 - 3.3837)	85.945 - 85.955(3.3837 - 3.3841)

HOW TO SELECT CONNECTING ROD BEARING

When Using a New Crankshaft and Connecting Rod

1. Identify the pin diameter grade (No. 0, 1, or 2) on front surface of crankshaft.
2. Select the connecting rod bearings of the same grade.
   - There is no grading for the inner diameter of the big end of the connecting rod.



When Re-using the Removed Crankshaft and Connecting Rod

1. Measure the inner diameter of the big end of the connecting rod and make sure it is within the specified range.
2. Measure the outer diameter of the crankshaft pin.
3. Determine the crankshaft pin grade by comparing the measurement with the values under the column “Crankshaft pin outer diameter” of the table below.
4. Choose the bearings of the same grade.

Selection Table of connecting Rod BearinC

Unit: mm (in)

Connecting rod big end inner diameter		55.000 - 55.013 (2.1654 - 2.1659)	
Crankshaft pin outer diameter	Grade (punched)	0 (no punching)	
51.968 - 51.974 (2.0460 - 2.0462)	0	● Bearing grade No. ● Bearing thickness ● Oil clearance ● Identification color	STD 0 1.492 - 1.496 (0.0587 - 0.0589) 0.031 - 0.061 (0.0012 - 0.0024) Black
51.961 - 51.968 (2.0457 - 2.0460)	1	● Bearing grade No. ● Bearing thickness ● Oil clearance ● Identification color	STD 1 1.496 - 1.500 (0.0589 - 0.0591) 0.031 - 0.061 (0.0012 - 0.0024) Brown
51.954 - 51.961 (2.0454 - 2.0457)	2	● Bearing grade No. ● Bearing thickness ● Oil clearance ● Identification color	STD 2 1.500 - 1.504 (0.0591 - 0.0592) 0.031 - 0.061 (0.0012 - 0.0024) Green

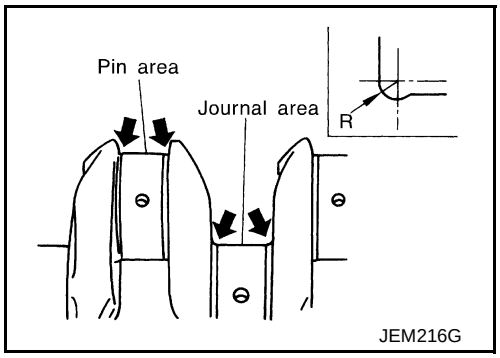
Under Size Bearing Usage

- If bearing clearance is out of specifications for connecting rod bearings in standard size, use under size bearings.
- When using under size bearings, measure bearing inner diameter with bearing installed, and grind crankshaft pins to adjust clearance to specification.

Connecting Rod Bearing Under Size lLst

Unit: mm (in)

Size	Thickness
US 0.08 (0.0031)	1.536 - 1.540 (0.0605 - 0.0606)
US 0.12 (0.0047)	1.556 - 1.560 (0.0613 - 0.0614)
US 0.25 (0.0098)	1.621 - 1.625 (0.0638 - 0.0640)



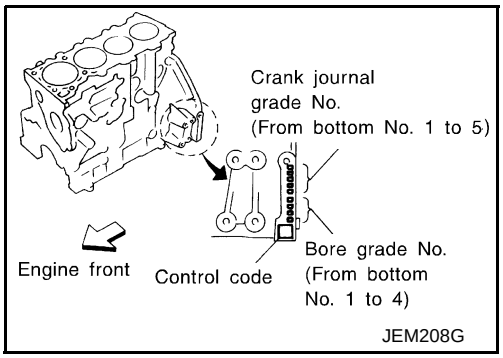
CAUTION:
When grinding the crankshaft journal to use an under size bearing, avoid damaging the fillet R.

Standard dimension R : 1.5 - 1.7 mm (0.0591 - 0.0669 in)

HOW TO SELECT MAIN BEARING

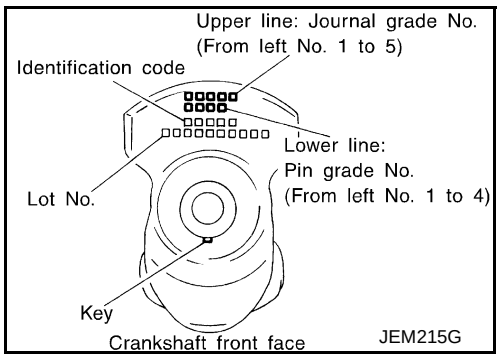
When Using a New Cylinder Block and Crankshaft

1. Identify the bearing housing grade (No. 0, 1, or 2) on LH surface at the rear of the cylinder block, and locate the applicable grade on the “Grade” row in the table below.
2. Identify the journal grade (No. 0, 1, or 2) on the front surface of the crankshaft, and locate the applicable grade under the “Grade” column on the table.
3. The main bearing to be used (STD 0 to STD 4) can be located in the cell where the row and column cross.



When Re-using Removed Cylinder Block and Crankshaft

1. Measure the inner diameter of cylinder block main bearing housing.
2. Locate the applicable cell where the measurement falls, on “Inner diameter of Cylinder block main bearing housing” row on the table.
3. Measure the outer diameter of the crankshaft journal.
4. Locate the applicable cell where the measurement falls, under “Crankshaft journal outer diameter” column on the table.
5. The main bearing to be used (STD 0 to STD 4) can be located in the cell where the row and column cross.



Main Bearing Grade Table

Unit: mm (in)

Inner diameter of Cylinder block main bearing housing			66.654 - 66.663 (2.6242 - 2.6245)	66.663 - 66.672 (2.6245 - 2.6249)	66.672 - 66.681 (2.6249 - 2.6252)
Crankshaft journal outer diameter	Grade (punched)		0	1	2
62.967 - 62.975 (2.4790 - 2.4793)	0	● Bearing grade No. ● Bearing thickness ● Oil clearance ● Identification color	STD 0 1.816 - 1.820 (0.0715 - 0.0717) 0.039 - 0.066 (0.0015 - 0.0026) Black	STD 1 1.820 - 1.824 (0.0717 - 0.0718) 0.039 - 0.066 (0.0015 - 0.0026) Red or Brown	STD 2 1.824 - 1.828 (0.0718 - 0.0720) 0.039 - 0.066 (0.0015 - 0.0026) Green

62.959 - 62.967 (2.4787 - 2.6790)	1	● Bearing grade No. ● Bearing thickness ● Oil clearance ● Identification color	STD 1 1.820 - 1.824 (0.0717 - 0.0718) 0.039 - 0.066 (0.0015 - 0.0026) Brown	STD 2 1.824 - 1.828 (0.0718 - 0.0720) 0.039 - 0.066 (0.0015 - 0.0026) Green	STD 3 1.828 - 1.832 (0.0720 - 0.0721) 0.039 - 0.066 (0.0015 - 0.0026) Yellow
62.951 - 62.959 (2.4784 - 2.4787)	2	● Bearing grade No. ● Bearing thickness ● Oil clearance ● Identification color	STD 2 1.824 - 1.828 (0.0718 - 0.0720) 0.039 - 0.066 (0.0015 - 0.0026) Green	STD 3 1.828 - 1.832 (0.0720 - 0.0721) 0.039 - 0.066 (0.0015 - 0.0026) Yellow	STD 4 1.832 - 1.836 (0.0721 - 0.0723) 0.039 - 0.066 (0.0015 - 0.0026) Blue

Under Size Bearing Usage

- If bearing clearance is out of specifications for connecting rod bearings in standard size, use under size bearings.
- When using under size bearings, measure bearing inner diameter with bearing installed, and grind crankshaft journals to adjust clearance to specification.

Main Bearing Under Size List

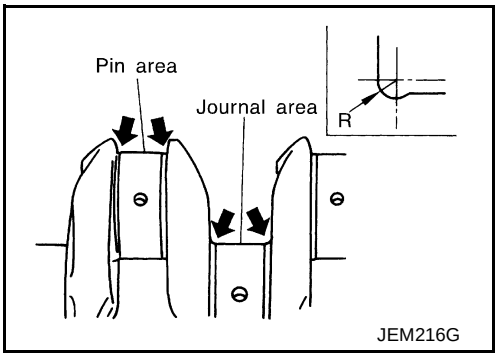
Unit: mm (in)

Size	Thickness
US 0.25(0.0098)	1.949 - 1.953 (0.0767 - 0.0769)

CAUTION:

When grinding crank journals to use undersize bearings, keep corners radius of fillet. (All journals)

Standard dimension R : 1.5 - 1.7 mm (0.0591 - 0.0669 in)



Inspection After Disassembly

EBS00DJ5

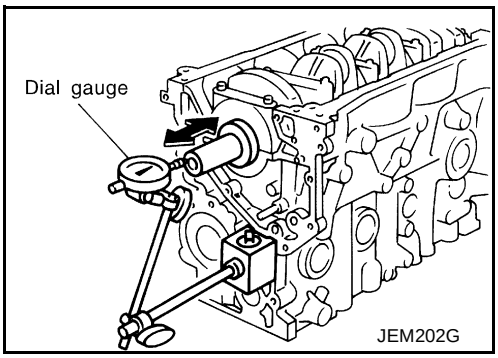
CRANKSHAFT SIDE CLEARANCE

- Using dial indicator, measure crankshaft travel amount by moving the crankshaft forward or backward.

Standard : 0.10 - 0.25 mm (0.0039 - 0.0098 in)

Limit : 0.30 mm (0.0118 in)

- If the value exceeds the limit, replace thrust bearings with new ones and measure again.
If the measurement exceeds the limit again, replace crankshaft with a new one.



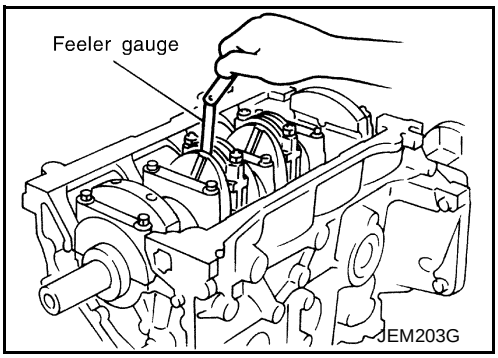
CONNECTING ROD SIDE CLEARANCE

- Using feeler gauge, measure side clearance between connecting rod and crankshaft arm.

Standard : 0.200 - 0.350(0.0079 - 0.0138 in)

Limit : 0.4 mm (0.0157 in)

- If measured value exceeds the limit, replace connecting rod and repeat measurement.
If measured value still exceeds the limit, replace crankshaft.

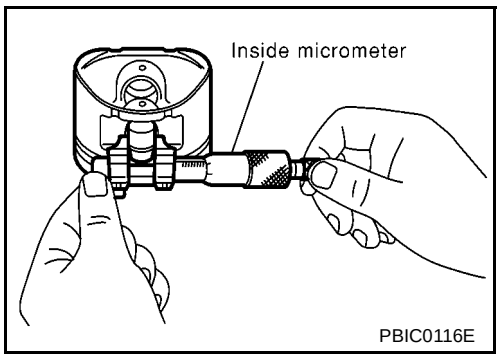


PISTON TO PISTON PIN CLEARANCE

Piston Pin Hole Inner Diameter

Using inside micrometer, measure piston pin hole inner diameter.

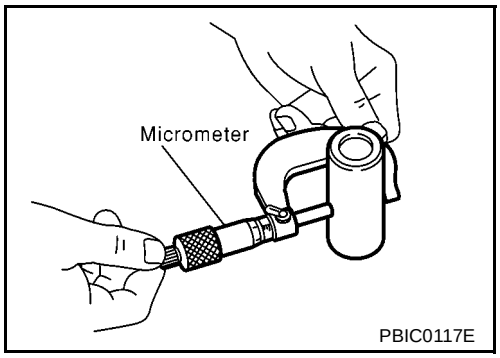
Standard : 27.997 - 28.005 mm (1.1022 - 1.1026 in) dia.



Piston Pin Outer Diameter

Using micrometer, measure piston pin outer diameter.

Standard : 27.994 - 28.000 mm (1.1021 - 1.1024 in)dia .



Calculation of Piston to Piston Pin Clearance

(Piston pin clearance) = (Piston pin hole inner diameter) – (Piston pin outer diameter)

Standard : 0.002 - 0.006 mm (0.0001 - 0.0002 in)

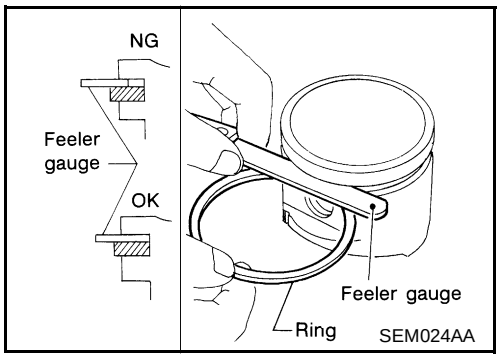
- If clearance is exceeds specification, replace either or both piston/piston pin assembly.

PISTON RING SIDE CLEARANCE

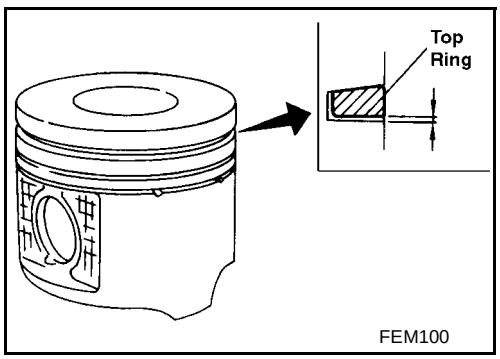
- Using feeler gauge, measure clearance between piston ring and piston ring groove.

Unit: mm (in)

Item	Standard	Limit
Top ring	0.120 - 0.180 (0.0047 - 0.0071)	0.2 (0.008)
2nd ring	0.050 - 0.090 (0.0020 - 0.0035)	0.1 (0.004)
Oil ring	0.030 - 0.070 (0.0012 - 0.0028)	—



- Align top ring and external surface of piston. Measure lower side clearance of top ring with top ring pressed onto upper side of ring groove.
- If side clearance exceeds the limit, replace piston ring.
- Check clearance again. If side clearance still exceeds the limit, replace piston.

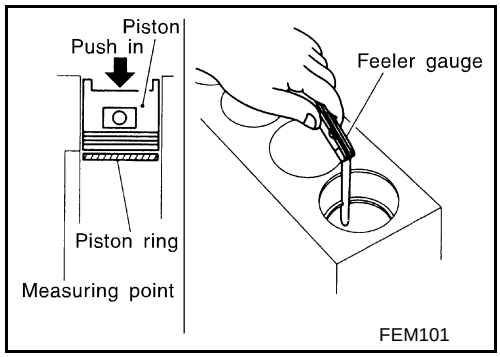


PISTON RING END GAP

- Check that cylinder bore diameter is within specifications. Refer to EM-207, "PISTON TO CYLINDER BORE CLEARANCE" .
- Using piston, press piston ring to cylinder mid point, and measure end gap.

Unit: mm (in)

Item	Standard	Limit
Top ring	0.20 - 0.35 (0.0079 - 0.0138)	1.0 (0.039)
2nd ring	0.39 - 0.54 (0.0154 - 0.0213)	
Oil ring	0.25 - 0.50 (0.0098 - 0.0197)	

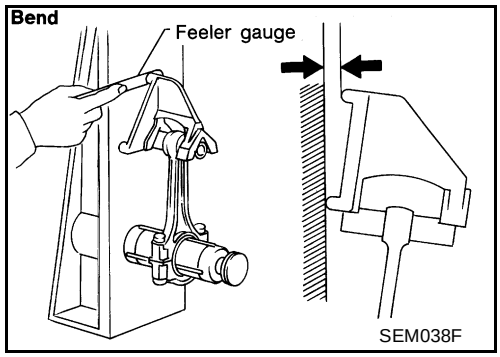


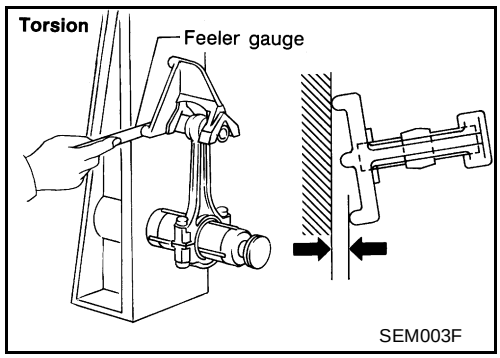
CONNECTING ROD BEND AND TORSION

Use connecting rod aligner to check bend and torsion.

Bend limit : 0.12 mm (0.0047 in)/100 mm (3.94 in)

Torsion limit : 0.12 mm (0.0047 in)/100 mm (3.94 in)

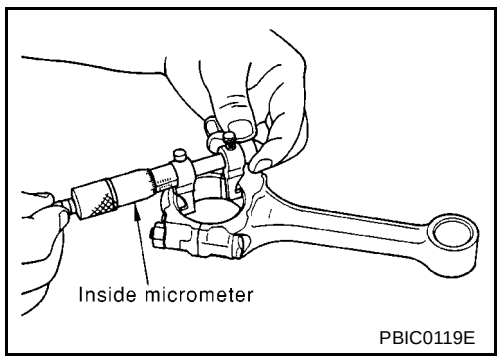




CONNECTING ROD BIG END INNER DIAMETER

- Install connecting rod caps without connecting rod bearings and tighten connecting rod nuts to the specified torque. Using inside micrometer, measure connecting rod big end inner diameter.

Standard : 55.000 - 55.013 mm (2.1654 - 2.1659 in) dia.

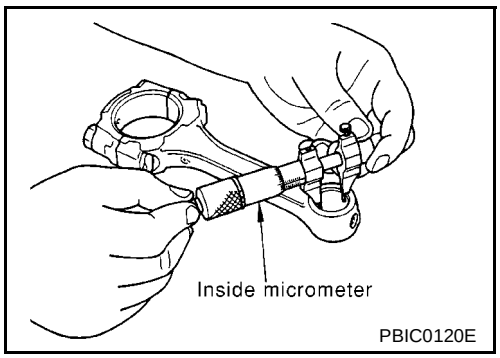


CONNECTING ROD BUSHING OIL CLEARANCE (SMALL END)

Connecting Rod Small End Inner Diameter

Use inside micrometer to measure small end inner diameter.

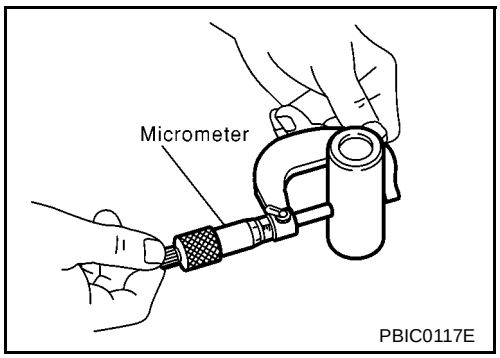
Standard : 28.026 - 28.038 mm (1.1034 - 1.1039 in) dia.



Piston Pin Outer Diameter

Use micrometer to measure piston pin outer diameter.

Standard : 27.994 - 28.000 mm (1.1021 - 1.1024 in) dia.



Calculation of Connecting Rod Bushing Clearance

(Connecting rod small end bushing clearance) = (Connecting rod small end inner diameter) – (Piston pin outer diameter)

Standard : 0.026 - 0.044 mm (0.0010 - 0.0017 in)

Limit : 0.057 mm (0.0022 in)

- If out of specifications, replace connecting rod and/or piston and piston pin assembly. Refer to EM-201, "HOW TO SELECT CONNECTING ROD BEARING" .

CYLINDER BLOCK TOP SURFACE DISTORTION

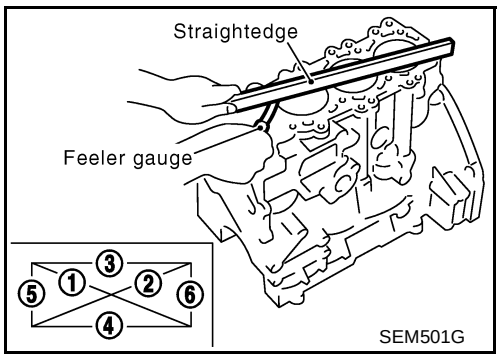
- Using scraper, remove gasket installed onto cylinder block surface. Remove contamination such as oil, scale, and carbon.

  CAUTION:

  Keep broken pieces of gasket clear of oil and coolant passages.

- Use straightedge and feeler gauge to check block upper surface for distortion.

  Limit : 0.04 mm (0.0016 in)

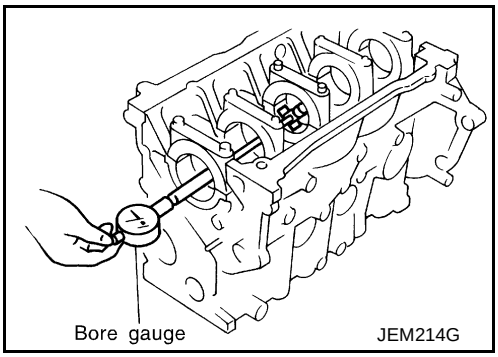


MAIN BEARING HOUSING INNER DIAMETER

- Without installing main bearings, install main bearing caps, and tighten bolts to the specified torque.
- Measure the inner diameter of main bearing housing with a bore gauge.

Standard : 66.654 - 66.681 mm (2.6242 - 2.6252 in) dia.

- If the measurement is out of the specified range, replace cylinder block and main bearing caps.



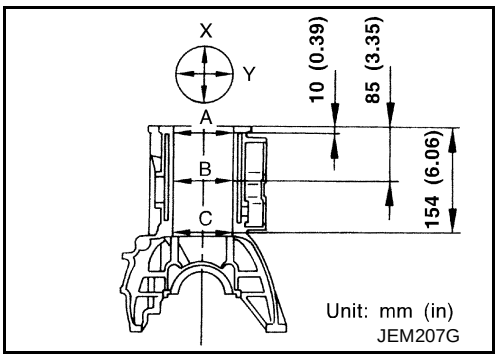
PISTON TO CYLINDER BORE CLEARANCE

Cylinder Bore Inner Diameter

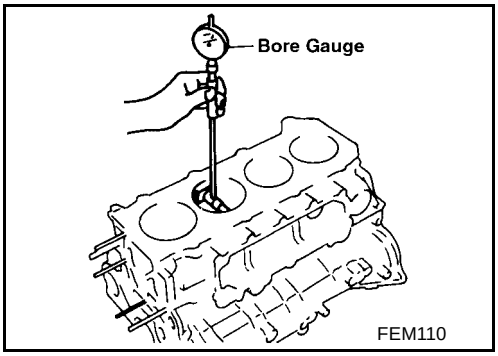
- Using bore gauge, measure cylinder inner diameters at 6 positions; top, middle, and bottom (A, B, C) in 2 directions (X, Y).

Cylinder inner diameter:

Standard	**: 86.000 - 86.030 mm (3.3858 - 3.5870 in) dia.**
Wear limit	**: 0.07 mm (0.0028 in)**
Out-of-round limit (X - Y)	**: 0.015 mm (0.0006 in)**
Taper limit (A - B - C)	**: 0.010 mm (0.0004 in)**



- If clearance exceeds the limit, or any flaws or seizures are found on inner surface of cylinder, horn or bore the applicable cylinder or redore all cylinder.

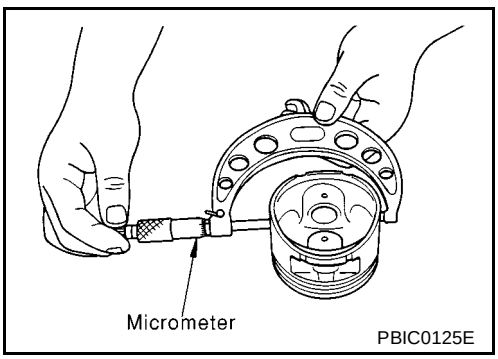


Piston Outer Diameter

Use micrometer to measure piston skirt outer diameter.

Piston skirt diameter:

Measurement position	**: 48.83 mm (1.9224 in) Distance from the top**
Standard	**: 85.925 - 85.955 mm (3.3829 - 3.3841 in) dia.**
0.25 (0.0098) O/S	**: 86.175 - 86.205 (3.3927 - 3.3939)**
0.50 (0.0197) O/S	**: 86.425 - 86.455 (3.4026 - 3.4036)**



Calculation of Piston to Piston Bore Clearance

- Calculate using piston skirt outer diameter and cylinder inner diameter (direction X, position B).
(Clearance) = (Cylinder inner diameter) – (Piston skirt outer diameter)

Specifications at room temperature [20°C (68°F)]:

0.065 - 0.085 mm (0.0026 - 0.0033 in)

- If out of specification, replace piston and piston pin assembly. Refer to EM-200, "HOW TO SELECT PISTON" .

Reboring cylinder

1. Determine cylinder bore size by adding piston-to-cylinder bore clearance to piston diameter.

   Rebore size calculation:

   D = A + B – C

   Where,

   D: Bored diameter

   A: Piston diameter as measured

   B: Piston-to-bore clearance

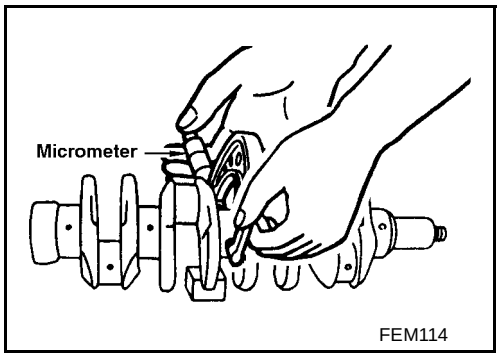
   C: Honing allowance 0.02 mm (0.0008 in)

2. install main bearing caps and tighten bolts to specified torque. This will prevent distortion of cylinder bores.
3. Cut cylinder bore.
   - When any cylinder needs boring, all other cylinders must also be bored.
   - Do not cut too much out of cylinder bore at a time. Cut only 0.05 mm (0.0020 in) or so at a time.
4. Hone cylinders to obtain specified piston-to-bore clearance.
5. Measure finished cylinder bore for out- of-round and taper.
   - Measurement should be done after cylinder bore cools down.

CRANKSHAFT JOURNAL OUTER DIAMETER

Use micrometer to measure journal outer diameter.

Standard : 62.951 - 62.975 mm (2.4784 - 2.4793 in) dia.



CRANKSHAFT PIN OUTER DIAMETER

Use micrometer to measure pin outer diameter.

Standard : 51.954 - 51.974 mm (2.0454 - 2.0462 in) dia.

CRANKSHAFT OUT-OF-ROUND AND TAPER

- Using micrometer, measure each journal and pin at 4 points shown in the figure.
- Out-of-round value is indicated by difference in dimensions between directions X and Y at points A and B.
- Taper value is indicated by difference in dimensions between points A and B in directions X and Y.

Out-of-round:

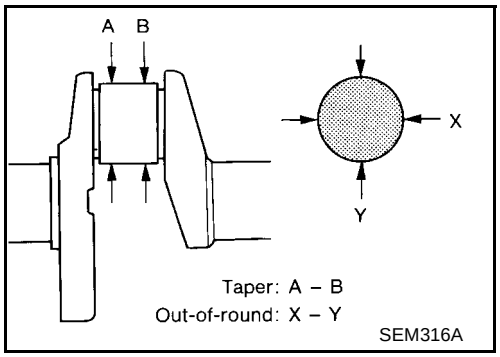
Standard : 0.003 mm (0.0001 in)

Limit : 0.005 mm (0.0002 in)

Taper:

Standard : 0.003 mm (0.0001 in)

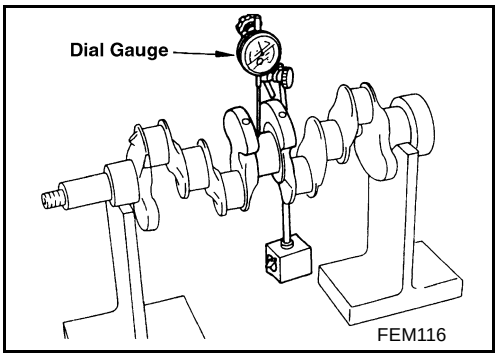
Limit : 0.005 mm (0.0002 in)



CRANKSHAFT RUNOUT

- Place V-block onto surface plate to support journals at both ends of crankshaft.
- Position dial indicator vertically onto No. 3 journal.
- Rotate crankshaft to read needle movement on dial indicator. (Total indicator reading)

Standard : 0.05 mm (0.0020 in)
Limit : 0.10 mm (0.0039 in)



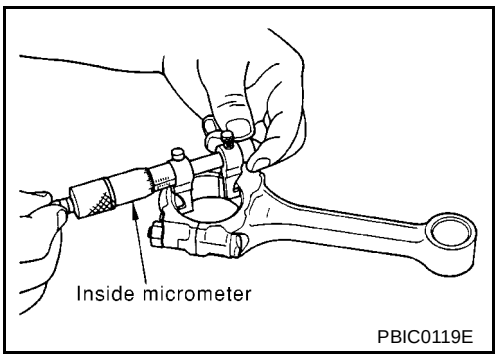
CONNECTING ROD BEARING OIL CLEARANCE

Method by measurement

- Install connecting rod bearings to connecting rods and caps, and tighten connecting nuts to the specified torque. Use inside micrometer to measure connecting rod bearing inner diameter.
(Bearing clearance) = (Connecting rod bearing inner diameter) – (Crankshaft pin outer diameter)

Standard : 0.031 - 0.061 mm (0.0012 - 0.0024 in)

- If out of specifications, check connecting rod big end inner diameter and crankshaft pin outer diameter, and select appropriate connecting rod bearing to adjust clearance to specifications.
Refer to EM-201, "HOW TO SELECT CONNECTING ROD BEARING" .



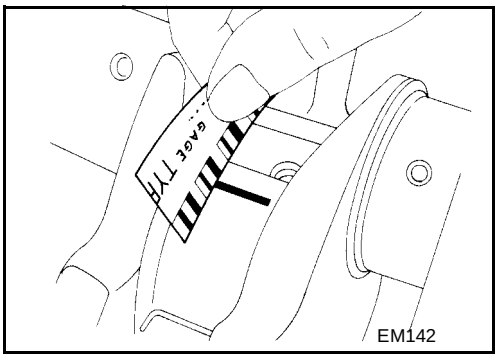
Method using plastigage

- Remove contamination such as oil, dust completely from crankshaft pins and each bearing surface.
- Cut plastigage slightly shorter than bearing width, place it in crankshaft direction, avoiding oil holes.
- Install connecting rod bearings to caps, and tighten connecting rod nuts to the specified torque.

CAUTION:
Never rotate crankshaft.

- Remove connecting rod caps and bearings, and measure plastigage width using scale on plastigage bag.

CAUTION:
If out of specification, take same action mentioned in “Method by measurement”.



MAIN BEARING OIL CLEARANCE

Method by measurement

- Install main bearings to the cylinder block and bearing cap, and tighten the bolts to the specified torque. Then, measure the inner diameter of the main bearings.
(Bearing clearance) = (Bearing inner diameter) – (Crankshaft journal outer diameter)

Standard : 0.039 - 0.066 mm (0.0015 - 0.0026 in)

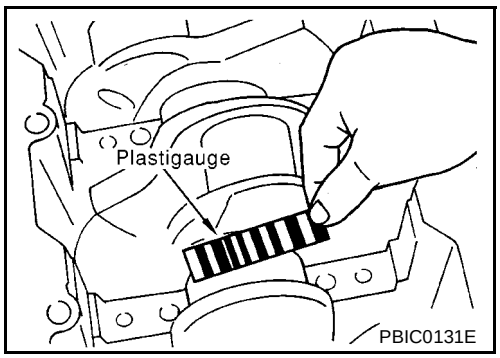
- If out of specification, check main bearing housing inner diameter and crankshaft journal outer diameter, and select appropriate main bearing to adjust clearance to specifications. Refer to EM-202, "HOW TO SELECT MAIN BEARING" .

Method using plastigage

- Remove contamination such as oil and dust completely from crankshaft journals and each bearing surface.
- Cut plastigage slightly shorter than bearing width. place it in crankshaft turning direction, avoiding oil holes.
- Install main bearings and bearing cap and tighten to the specified torque.

  CAUTION:
  Never rotate crankshaft.
- Remove main bearings and bearings, and measure plastigage width using scale on plastigage bag.

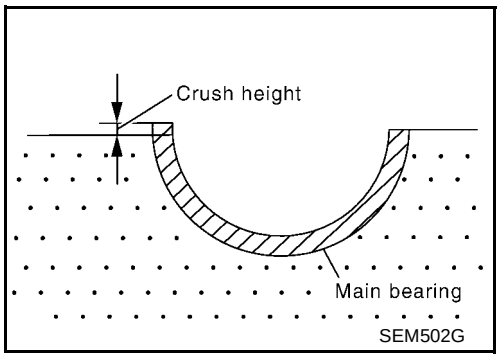
  CAUTION:
  If out of specification, take same action mentioned in "Method by measurement".
- Install main bearings to the cylinder block and bearing cap, and tighten the bolts to the specified torque. Then, measure the inner diameter of the main bearings.



MAIN BEARING CRUSH HETIGH

- When the bearing cap is removed after being tightened to the specified torque with main bearings installed, the tip end of bearing must protrude.

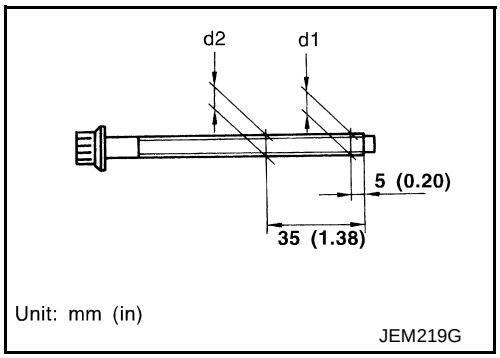
  Standard : Crush height must exist.
- If out of specification, replace main bearings.



MAIN BEARING CAP BOLT DEFORMATION

- Measure the outer diameter of threaded area, d1 and d2, at the points specified in the figure.
- When the necked point is identified at a point other than where specified, measure at the point as d2.
- Calculate the difference between d1 and d2.

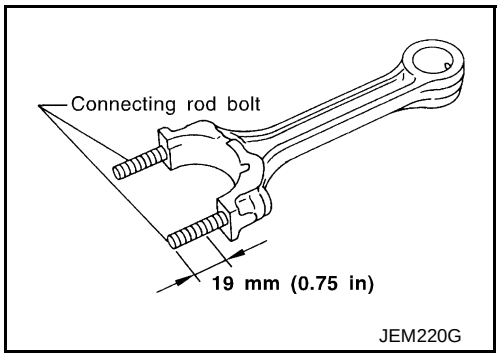
  Limit : 0.13 mm (0.0051 in)



CONNECTING ROD BOLT DEFORMATION

- Install nuts to connecting rod bolts. Check that the nut can be screwed smoothly on bolt threads by hand to the last thread on the bolt.
- If the nut does not screw in smoothly, measure the outer diameter of the bolt thread at the point specified in the figure.
- If a necked point is identified, measure at that point.

  Standard : 8.90 - 9.00 mm (0.3504 - 0.3543 in) dia.
  Limit : 8.75 mm (0. 3445 in) dia.
- If the measurement exceeds the limit, replace connecting rod bolts and nuts.

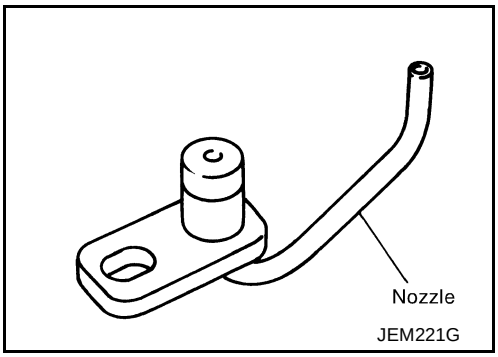


OIL JET

- Check nozzle for deformation and damage.
- Blow compressed air from nozzle, and check for clogs.

Standard : Deformation and damage.

- If it out of the standard, replace oil jet.

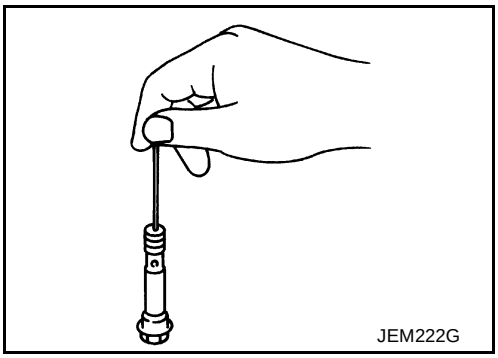


OIL JET RELIEF VALVE

- Using a clean plastic stick, press check valve in oil jet relief valve. Make sure that valve moves smoothly with proper reaction force.

Standard
: Valve moves smoothly with proper reaction force.

- If it is out of the standard, replace oil jet relief valve.



MOVEMENT AMOUNT OF FLYWHEEL

NOTE:

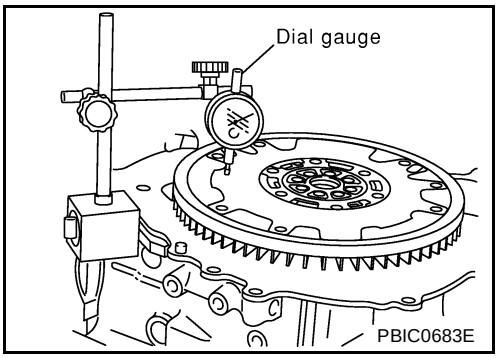
- Inspection for double mass flywheel only.
- Do not disassembly double mass flywheel.

Flywheel Deflection

- Measure deflection of flywheel contact surface to the clutch with a dial gauge.
- Measure deflection at 210 mm (8.27 in) dia.

Standard : 0.45mm (0.0177 in) or less
Limit : 1.3mm (0.051 in)

- When measured value exceeds the limit, replace flywheel with a new one.



Movement Amount in Radial (rotation) Direction

- Check the movement amount in the following procedure.

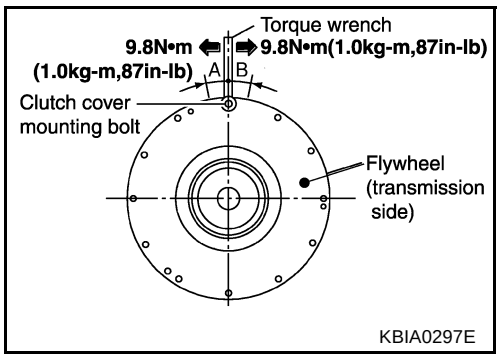
1. Install a bolt to clutch cover mounting hole, and place a torque wrench on the extended line of the flywheel center line.

- Tighten bolt at a force of 9.8 N·m (1kg-m, 87 in-lb) to keep it from loosening.

2. Put a mating mark on circumferences of the two flywheel masses without applying any load (Measurement standard points).
3. Apply a force of 9.8 N·m (1kg-m, 87 in-lb) in each direction, and mark the movement amount on the mass on the transmission side.
4. Measure dimensions of movement amounts A and B on circumference of the flywheel on the transmission side.

Standard : 26.2 mm (1.031 in) or less

- When measured value is outside the standard, replace flywheel.



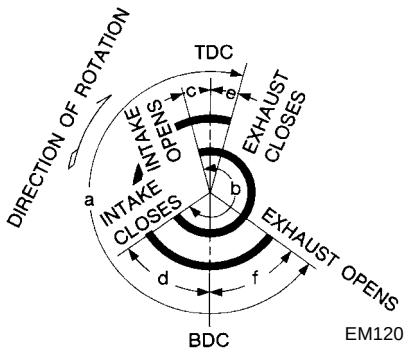
SERVICE DATA AND SPECIFICATIONS (SDS)

PFP:00030

Standard and Limit

EBS00DJ6

GENERAL SPECIFICATIONS

Cylinder arrangement		In-line 4
Displacement	Unit: cm^3 (cu in)	2,184 (133.27)
Bore and stroke	Unit: mm (in)	86 x 94 (3.39 x 3.70)
Valve arrangement		DOHC
Firing order		1-3-4-2
Number of piston rings	Compression	2
	Oil	1
Number of main bearings		5
Compression ratio		16.0
Compression pressure Unit: kPa (bar, kg/cm^2 , psi)/200 rpm	Standard	2,893 (28.9, 29.5, 419)
	Minimum	2,452 (24.5, 25.0, 356)
	Differential limit between cylinders	490 (4.9, 5.0, 71)
Valve timing	 EM120	

Unit: degree

a	b	c	d	e	f
224	212	2	30	-2	46

INTAKE MANIFOLD AND EXHAUST MANIFOLD

Unit: mm (in)

Item		Limit
Surface distortion	Intake manifold	0.1 (0.004)
	Exhaust manifold	0.3 (0.012)

DRIVE BELTS

Belt Deflection:

Unit: mm (in)

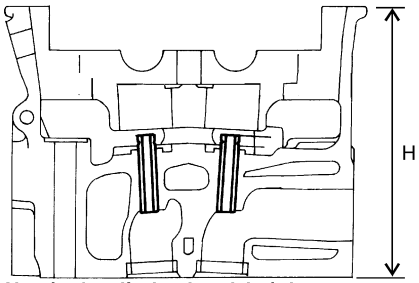
Applied belt	Belt deflection with 98 N (10 kg, 22 lb) force applied*		
	New	Adjusted	Limit for re-adjusting
Air conditioner compressor belt	4 - 5 (0.16 - 0.20)	6 - 7 (0.24 - 0.28)	8.5 (0.335)
Alternator & water pump belt	9.0 - 10.5 (0.354 - 0.413)	11.0 - 12.5 (0.433 - 0.492)	16.5 (0.650)

*: When engine is cold.

CYLINDER HEAD

Unit: mm (in)

Item	Standard	Limit
Head surface distortion	Less than 0.03 (0.0012)	0.04 (0.0016)

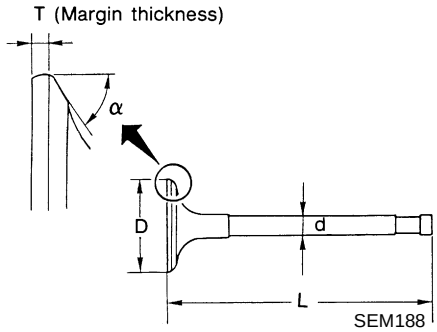


Nominal cylinder head height:
H = 153.9 - 154.1 mm (6.059 - 6.067 in)
JEM204G

VALVE

Valve

Unit: mm (in)



SEM188

Valve head diameter “D”	Intake	28.0 - 28.3 (1.102 - 1.114)
	Exhaust	26.0 - 26.3 (1.024 - 1.035)
Valve length “L”	Intake	106.72 (4.2016)
	Exhaust	106.36 (4.1874)
Valve stem diameter “d”	Intake	5.965 - 5.980 (0.2348 - 0.2354)
	Exhaust	5.945 - 5.960 (0.2341 - 0.2346)
Valve seat angle “α”	Intake	45°15′ - 45°45′
	Exhaust	
Valve margin “T”	Intake	1.38 (0.0543)
	Exhaust	1.48 (0.0583)
Valve margin “T” limit		More than 1.0 (0.039)
Valve stem end surface grinding limit		Less than 0.2 (0.008)

Valve Clearance

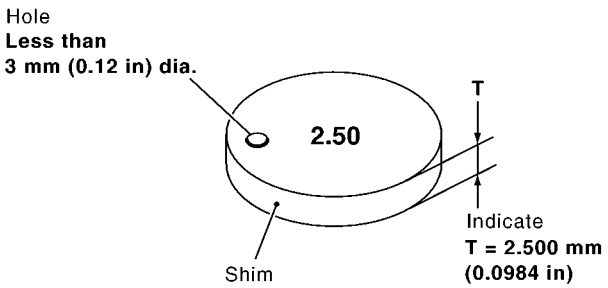
Unit: mm (in)

Item	Cold*1	Hot*2 (referance data)
Intake	0.24 - 0.32 (0.0094 - 0.0126)	0.274 - 0.386 (0.011 - 0.015)
Exhaust	0.26 - 0.34 (0.0102 - 0.0134)	0.308 - 0.432 (0.012 - 0.017)

*1: Approximately 20°C (68°F)
*2: Approximately 80°C (176°F)

Available Shims

Stamped mark	Thickness mm (in)
2.10	2.10 (0.0827)
2.12	2.12 (0.0835)
2.14	2.14 (0.0843)
2.16	2.16 (0.0850)
2.18	2.18 (0.0858)
2.20	2.20 (0.0866)
2.22	2.22 (0.0874)
2.24	2.24 (0.0882)
2.26	2.26 (0.0890)
2.28	2.28 (0.0898)
2.30	2.30 (0.0906)
2.32	2.32 (0.0913)
2.34	2.34 (0.0921)
2.36	2.36 (0.0929)
2.38	2.38 (0.0937)
2.40	2.40 (0.0954)
2.42	2.42 (0.0953)
2.44	2.44 (0.0961)
2.46	2.46 (0.0969)
2.48	2.48 (0.0976)
2.50	2.50 (0.0984)
2.52	2.52 (0.0992)
2.54	2.54 (0.1000)
2.56	2.56 (0.1008)
2.58	2.58 (0.1016)
2.60	2.60 (0.1024)
2.62	2.62 (0.1031)
2.64	2.64 (0.1039)
2.66	2.66 (0.1047)
2.68	2.68 (0.1055)
2.70	2.70 (0.1063)
2.72	2.72 (0.1071)
2.74	2.74 (0.1079)



SEM512G

Valve Spring

Free height	mm (in)	43.7 (1.720)
Pressure	N (kg, lb) at height mm (in)	184 - 208 (18.77 - 21.22, 41.4 - 46.8) at 32.82 (1.2921)
Out-of-square	mm (in)	1.9 (0.075)
Heigh during valve open	mm (in)	24.82 (0.9772)
Load with valve open	N (kg, ib)	320 - 360 (32.65 - 36.73, 71.9 - 80.9)

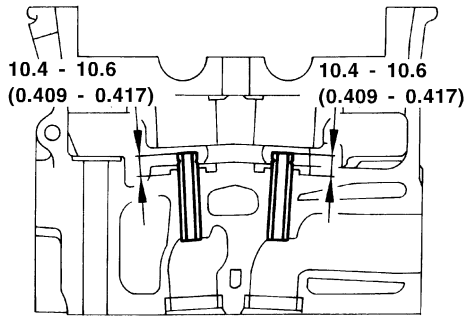
Valve Lifter

Unit: mm (in)

Item	Standard
Valve lifter outer diameter	29.960 - 29.975 (1.1795 - 1.1801)
Lifter guide inner diameter	30.000 - 30.021 (1.1811 - 1.1819)
Clearance between lifter and lifter guide	0.025 - 0.061 (0.0010 - 0.0024)

Valve Guide

Unit: mm (in)

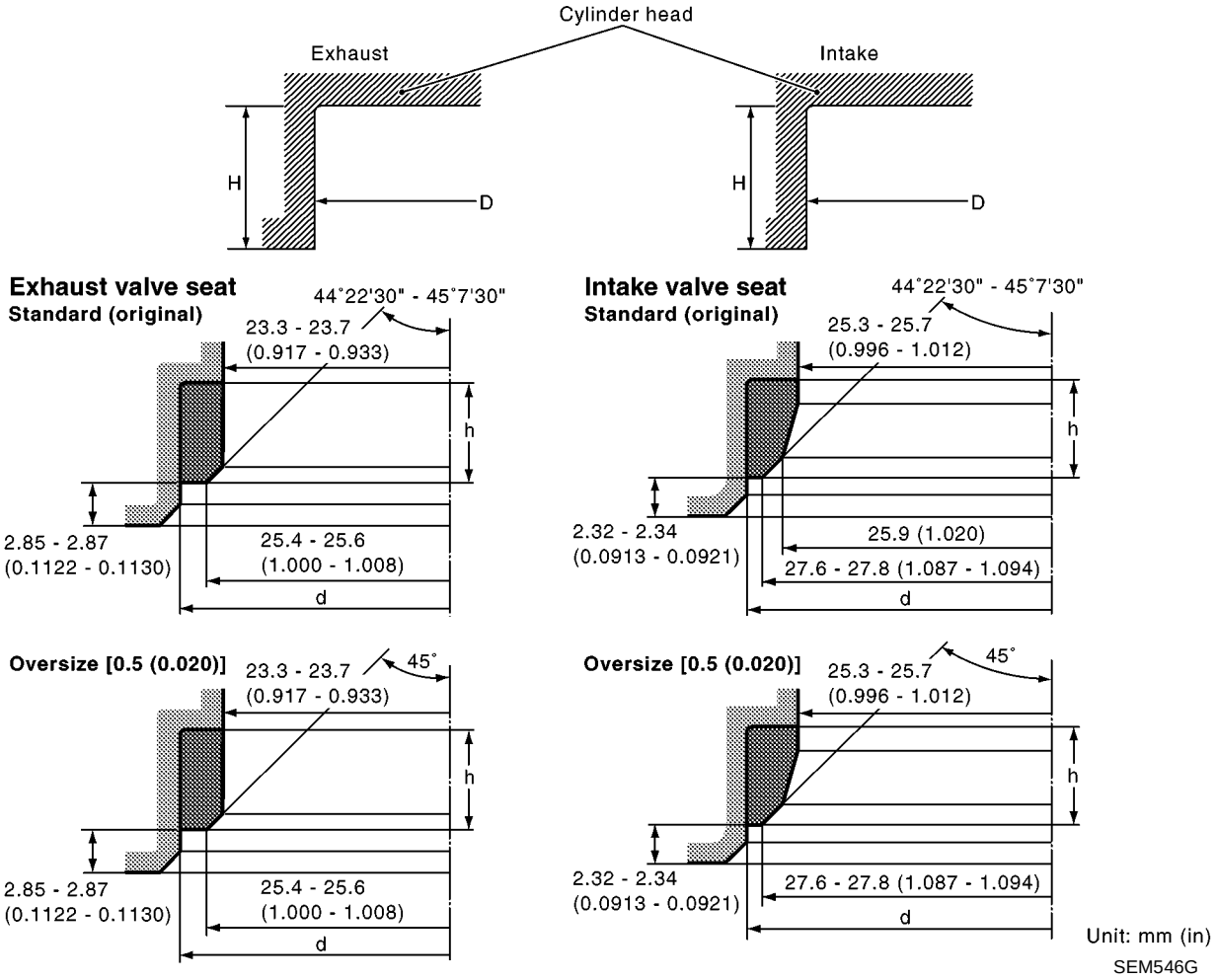


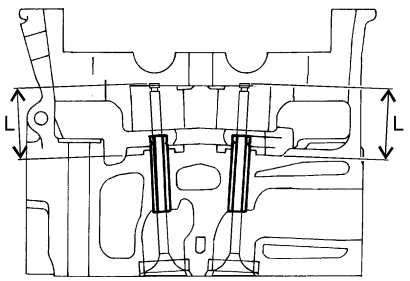
Unit: mm (in) JEM156G

Item		Standard	Service
Valve guide	Outer diameter	10.023 - 10.034 (0.3946 - 0.3950)	10.223 - 10.234 (0.4025 - 0.4029)
Valve guide	Inner diameter (Finished size)	6.000 - 6.018 (0.2362 - 0.2369)	
Cylinder head valve guide hole diameter		9.975 - 9.996 (0.3927 - 0.3935)	10.175 - 10.196 (0.4006 - 0.4014)
Interference fit of valve guide		0.027 - 0.059 (0.0011 - 0.0023)	
Item		Standard	Limit
Stem to guide clearance	Intake	0.020 - 0.053 (0.0008 - 0.0021)	0.08 (0.0031)
	Exhaust	0.040 - 0.073 (0.0016 - 0.0029)	0.1 (0.004)
Valve deflection limit		0.15 (0.0059)	
Projection length		10.4 - 10.6 (0.4094 - 0.4173)	

Valve Seat

Unit: mm (in)





JEM253G

Item		Standard	Service
Cylinder head seat recess diameter (D)	Intake	30.000 - 30.016 (1.1181 - 1.1817)	30.500 - 30.516 (1.2008 - 1.2014)
	Exhaust	29.000 - 29.016 (1.1417 - 1.1424)	29.500 - 29.516 (1.1614 - 1.1620)
Valve seat interference fit	Intake	0.064 - 0.100 (0.0025 - 0.0039)	
	Exhaust	0.064 - 0.096 (0.0025 - 0.0038)	
Valve seat outer diameter (d)	Intake	30.080 - 30.100 (1.1842 - 1.1850)	30.580 - 30.600 (1.2039 - 1.2047)
	Exhaust	29.080 - 29.096 (1.1449 - 1.1455)	29.580 - 29.596 (1.1646 - 1.1652)
Height (h)	Intake	7.0 - 7.1 (0.276 - 0.280)	6.60 - 6.70 (0.2598 - 0.2638)
	Exhaust	6.7 - 6.8 (0.264 - 0.268)	6.3 - 6.4 (0.248 - 0.252)

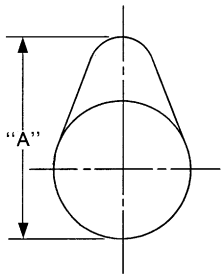
Depth (H)	Intake	8.83 - 9.13 (0.3476 - 0.3594)
	Exhaust	9.06 - 9.36 (0.3567 - 0.3685)
Projection (L)	Intake	36.53 - 36.98 (1.4382 - 1.4559)
	Exhaust	36.53 - 37.01 (1.4382 - 1.4571)

CAMSHAFT AND CAMSHAFT BEARING

Unit: mm (in)

Item		Standard	Limit
Camshaft oill clearance		0.045 - 0.086 (0.0018 - 0.0034)	
Camshaft brackt inner diameter	No.1	30.500 - 30.521 (1.2008 - 1.2016)	—
	No. 2, 3, 4, 5	24.000 - 24.021 (0.9449 - 0.9457)	
Camshaft journal outer diameter	No. 1	30.435 - 30.455 (1.1982 - 1.1990)	
	No. 2, 3, 4, 5	23.935 - 23.955 (0.9423 - 0.9431)	
Camshaft runout [TIR*]		—	0.04 (0.0016)
Camshaft sprocket runout [TIR*]		Less than 0.15 (0.0059)	—
Camshaft end play		0.070 - 0.148 (0.002 8 - 0.0058)	0.24 (0.0094)

*: Total indicator reading

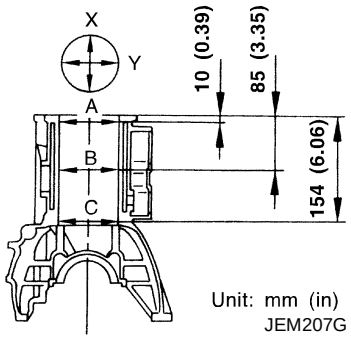


SEM671

Cam height "A"	Intake	39.505 - 39.695 (1.5553 - 1.5628)
	Exhaust	39.905 - 40.095 (1.5711 - 1.5785)
Wear limit of cam height		0.15 (0.0059)

CYLINDER BLOCK

Unit: mm (in)



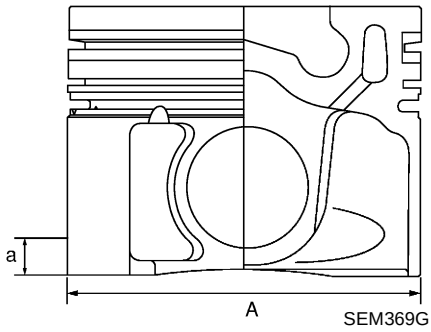
Surface flatness	Standard			Less than 0.03 (0.0012)
	Limit			0.04 (0.0016)
Cylinder bore	Inner diameter	Standard	Grade No. 1	86.000 - 86.010 (3.3858 - 3.3862)
			Grade No. 2	86.010 - 86.020 (3.3862 - 3.3866)
			Grade No. 3	86.020 - 86.030 (3.3866 - 3.3870)
		Wear limit		0.07 (0.0028)

Out-of-round (X – Y)		Less than 0.015 (0.0006)
Taper (A – B – C)		Less than 0.010 (0.0004)
Main journal inner diameter (Without bearing)		66.654 - 66.681 (2.6242 - 2.6252)
Difference in inner diameter between cylinders	Limit	Less than 0.05 (0.0020)

PISTON, PISTON RING AND PISTON PIN

Available Piston

Unit: mm (in)



Piston skirt diameter “A”	Standard	Grade No. 1	85.925 - 85.935 (3.3829 - 3.3833)
		Grade No. 2	85.935 - 85.945 (3.3833 - 3.3837)
		Grade No. 3	85.945 - 85.955 (3.3837 - 3.3841)
		0.25 (0.0098) O/S (Service)	86.175 - 86.205 (3.3927 - 3.3939)
		0.50 (0.0197) O/S (Service)	86.425 - 86.455 (3.4026 - 3.4036)
“a” dimension			48.83 (1.9224)
Piston pin bore diameter			27.997 - 28.005 (1.1022 - 1.1026)
Piston clearance to cylinder block			0.065 - 0.085 (0.0026 - 0.0033)

Piston Ring

Unit: mm (in)

Item		Standard	Limit
Side clearance	Top	0.120 - 0.180 (0.0047 - 0.0071)	0.2 (0.008)
	2nd	0.050 - 0.090 (0.0020 - 0.0035)	0.1 (0.004)
	Oil ring	0.030 - 0.070 (0.0012 - 0.0028)	—
End gap	Top	0.20 - 0.35 (0.0079 - 0.0138)	1.0 (0.039)
	2nd	0.39 - 0.54 (0.0154 - 0.0213)	1.0 (0.039)
	Oil (rail ring)	0.25 - 0.50 (0.0098 - 0.0197)	1.0 (0.039)

Piston Pin

Unit: mm (in)

Piston pin outer diameter		27.994 - 28.000 (1.1021 - 1.1024)
Interference fit of piston pin to piston		0.002 - 0.006 (0.0001 - 0.0002)
Piston pin to connecting rod bushing clearance	Standard	0.026 - 0.044 (0.0010 - 0.0017)
	Limit	0.057 (0.0022)

*: Values measured at ambient temperature of 20°C (68°F)

CONNCTING ROD

Unit: mm (in)

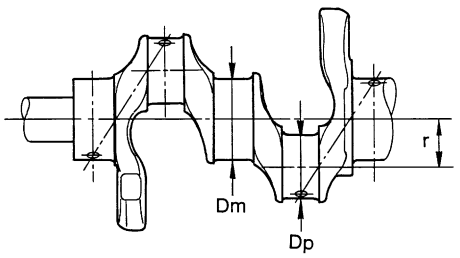
Center distance		157.5 (6.201)
Bend [per 100 (3.94)]	Limit	0.12 (0.0047)
Torsion [per 100 (3.94)]	Limit	0.12 (0.0047)
Connecting rod small end inner diameter		30.080 - 31.000 (1.1842 - 1.2205)
Piston pin bushing inner diameter*		28.026 - 28.038 (1.1034 - 1.1039)
Connecting rod big end inner diameter*		55.000 - 55.013 (2.1654 - 2.1659)
Side clearance	Standard	0.200 - 0.350 (0.0079 - 0.0138)
	Limit	0.4 (0.0157)

*: After installing in connecting rod

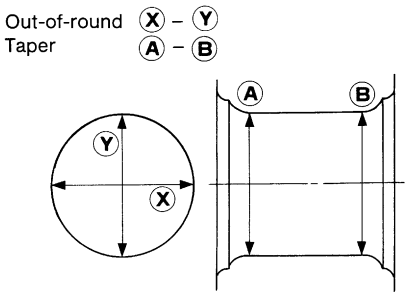
CRANKSHAFT

Unit: mm (in)

Main journal dia. “Dm”		62.951 - 62.975 (2.4784 - 2.4793)
Pin journal dia. “Dp”		51.954 - 51.974 (2.0454 - 2.0462)
Center distance “r”		46.97 - 47.03 (1.8492 - 1.8516)
Out-of-round (X – Y)	Standard	Less than 0.003 (0.0001)
	Limit	0.005 (0.0002)
Taper (A – B)	Standard	Less than 0.003 (0.0001)
	Limit	0.005 (0.0002)
Runout [TIR*]	Standard	0.05 (0.002.)
	Limit	0.10 (0.0039)
Side clearance	Standard	0.10 - 0.25 (0.0039 - 0.0098)
	Limit	0.30 (0.0118)



SEM645



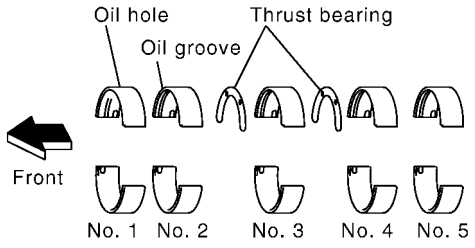
SEM715

*: Total indicator reading

AVAILABLE MAIN BEARING

Main bearing

Unit: mm (in)



SEM255G

Grade number	Thickness "T"	Width "W"	Identification color
0	1.816 - 1.820 (0.0715 - 0.0717)	19.9 - 20.1 (0.783 - 0.791)	Black
1	1.820 - 1.824 (0.0717 - 0.0718)		Brown
2	1.824 - 1.828 (0.0718 - 0.0720)		Green
3	1.828 - 1.832 (0.0720 - 0.0721)		Yellow
4	1.832 - 1.836 (0.0721 - 0.0723)		Blue

Under size

Unit: mm (in)

Sise	Thickness	Main journal diameter "Dm"
0.25 (0.0098)	1.949 - 1.953 (0.0767 - 0.0769)	Grind so that bearing clearance is the specified value.

AVAILABLE CONNECTING ROD BEARING

Connecting Rod Bearing

Unit: mm (in)

Grade number	Thickness "T"	Width "W"	Identification color (mark)
0	1.492 - 1.496 (0.0587 - 0.0589)	22.9 - 23.1 (0.902 - 0.909)	Black
1	1.496 - 1.500 (0.0589 - 0.0591)		Brown
2	1.500 - 1.504 (0.0591 - 0.0592)		Green

Under size

Unit: mm (in)

Size	Thickness	Crank pin journal diameter "Dp"
0.08 (0.0031)	1.536 - 1.540 (0.0605 - 0.0606)	Grind so that bearing clearance is the specified value.
0.12 (0.0047)	1.556 - 1.560 (0.0613 - 0.0614)	
0.25 (0.0098)	1.621 - 1.625 (0.0638 - 0.0640)	

MISCELLANEOUS COMPONENTS

Flywheel

Unit: mm (in)

Flywheel runout [TIR]*	Standard	0.45 (0.0177) or less
	Limit	1.3 (0.051) or less

*: Total indicator reading

Bearing Clearance

Unit: mm (in)

Main bearing clearance	Standard	0.039 - 0.066 (0.0015 - 0.0026)
	Limit	0.10 (0.0039)

Connecting rod bearing clearance	Standard	0.031 - 0.061 (0.0012 - 0.0024)
	Limit	0.09 (0.0035)

Tightening Torque

EBS00DJ7

*1: Parts to be tightened in particular orders.
1)-: Order of tightening when tightening two or more times separately.

Unit: N·m (kg-m, ft-lb)
Unit: N·m (kg-m, in-lb)*2

	Alternator	Nut C		19 - 24 (1.9 - 2.5, 14 - 18)
		Nut D		44 - 57 (4.4 - 5.9, 32 - 42)
	Idler pulely	Nut A		31 - 39 (3.1 - 4.0, 23 - 28)
	Catalyst			44 - 53 (4.4 - 5.5 , 32 - 39)
	Catalyst rear diffuser			30 - 37 (3.0 - 3.8 , 22 - 27)
	Catalyst insulator			6.4 - 8.3 (0.65 - 0.85, 57 - 73)*2
	Turbocharger			44.0 - 53.0 (4.4 - 5.5, 32 -39)
	Charge air cooler Bracket			19.6 - 23.5 (2.0 - 2.3,15 - 17)
	Charge air cooler cover			8.1 - 9.5 (0.83 - 0.96 , 72- 84)*2
	EGR volume control valve			62.0 - 78.0 (6.3 - 8.0, 46 - 57)
	EGR cooler			60.0 - 69.0 (6.1 - 7.1, 45 - 51)
	EGR support			21.0 - 26.0 (2.1 - 2.7, 16 - 19)
	Exhaust manifold insulator			5.1 - 6.4 (0.52 - 0.66, 46 - 57)*2
*1	Exhaust manifold			29.0 - 33.0 (2.9 - 3.4, 21 - 24)
*1	Rocker cover		1)	6.8 - 8.8 (0.7 - 0.9, 61 - 75)*2
			2)	6.8 - 8.8 (0.7 - 0.9, 61 - 75) *2
	Oil pan lower			6.4 - 7.5 (0.65 - 0.76, 57 - 66)*2
	Oil pan drain plug			29 - 39 (3.0 - 4.0, 22 - 28)
	Oil strainer			16 - 18 (1.7 - 1.8, 12 - 13)
*1	Oil pan upper	M6 bolt		6.4 - 7.5 (0.65 - 0.76 ,57 - 66)*2
		M8 bolt		20 - 23 (2.1 - 2.3, 15 - 16)
		M10 bolt		31 - 36 (3.2 - 3.6, 23 - 26)
	Vacuum pump			33.0 - 42.0 (3.3 - 4.3, 24 - 30)
	Cylinder head rear cover	M6 bolt		8.5 - 10.7 (0.86 - 1.1, 75 - 97) *2
		M8 bolt		16.0 - 18.0 (1.7 - 1.8, 12 - 13)
	Injection tube	Nozzle side		21.6 - 24.5 (2.2 - 2.5, 16 - 18)
		Pump side		21.6 - 24.5 (2.2 - 2.5, 16 - 18)
	Nozzle support			24.7 - 27.8 (2.6 - 2.8, 19 - 20)
	Spill tube	Nozzle side		14.7 - 19.6 (1.5 - 1.9, 11 - 14)
		Cylinder head side		14.7 - 15.4 (1.5 - 1.57, 10.9 - 11.3)
	Common rail			51.0 - 64.0 (5.2 - 6.5, 38 - 47)
	Fuel supply pump			51.0 - 56.0 (5.2 - 5.7, 38 - 41)
	Fuel supply pump sprocket			37.0 - 41.0 (3.8 - 4.2, 28 - 30)
	Fuel supply pump rear bracket			27.0 - 37.0 (2.8 - 3.8, 20 - 27)

	Front chain case		6.9 - 8.8 (0.7 - 0.9, 61 - 78)*2
	Chain tensioner		8.5 - 10.7 (0.86 - 1.1, 75 - 95)*2
	Tension guide		21.0 - 26.0 (2.1 - 2.7, 16 - 19)
	Slack guide		21.0 - 26.0 (2.1 - 2.7, 16 - 19)
	Camshaft sprocket		138 - 147 (14.0 - 15.0, 102 - 108)
	Fuel supply pump sprocket		38.0 - 41.0 (3.8 - 4.2, 28 - 30)
	Oil pump		12.0 - 13.0 (1.3 - 1.4, 9 - 10)
	Power steering pump		51.0 - 56.0 (5.2 - 5.8, 38 - 41)
	Rear chain case		12.0 - 13.0 (1.2 - 1.4, 19 - 10)
	Engine coolant temperature sensor		12.0 - 15.0 (1.2 - 1.6, 9 - 11)
*1	Cylinder head	1)	29 - 38 (2.9 - 3.9, 21 - 28)
		2)	180° to 185°
		3)	0 (0, 0)
		4)	35 to 44 (3.5 - 4.5, 26 - 32)
		5)	90° to 95°(angle tightening)
		6)	90° to 95° (angle tightening)
	Water outlet		21 - 28 (2.1 - 2.9, 16 - 20)
	Glow plug		18.0 - 21.0 (1.8 - 2.2, 13 - 15)
*1	Flywheel		103 - 112 (10.5 - 11.5, 76 - 83)
	Oil pressure switch		13.0 - 17.0 (1.25 - 1.75, 9 - 12)
	Oil jet		6.1 - 10.7(0.62 - 1.1, 54 - 95)
	Oil jet relief valve		40 - 58 (4.0 - 6.0, 29 - 43)
	Rear oil seal retainer		12.0 - 13.0 (1.2 - 1.4, 9 - 10)