SECTION EM
ENGINE MECHANICAL

CONTENTS

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PRECAUTIONS

PFP:00001

Precautions for Drain Coolant

EBS00GUD

- Drain coolant when engine is cooled.

Precautions for Disconnecting Fuel Piping

EBS00GUE

- 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

EBS00GUF

- 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

EBS00GUG

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

Precautions for Assembly and Installation

EBS00GUH

- 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

EBS00GUI

- 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

EBS00GUJ

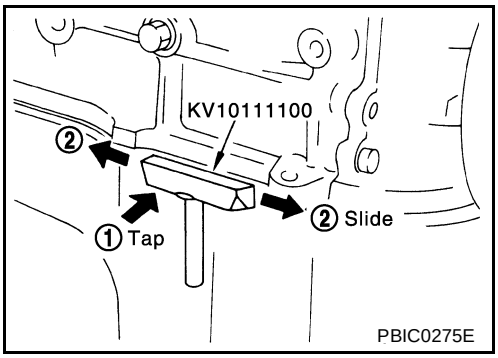
REMOVAL OF LIQUID GASKET SEALING

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

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.

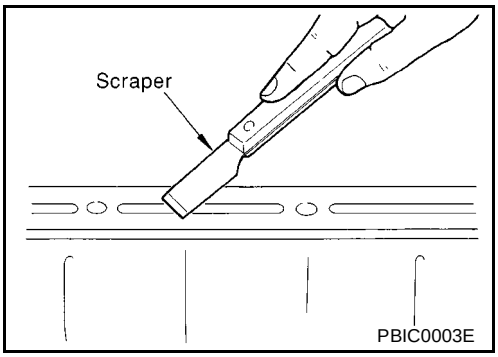


LIQUID GASKET APPLICATION PROCEDURE

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

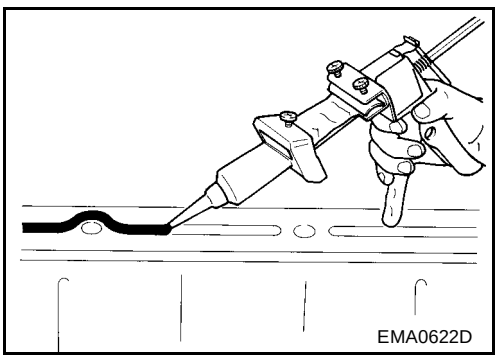
- Remove the liquid gasket completely from the groove of the gasket application surface, mounting bolts, and bolt holes.

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. If specified, it should be applied outside the holes. Make sure to read the text of 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.



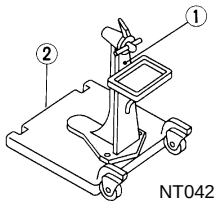
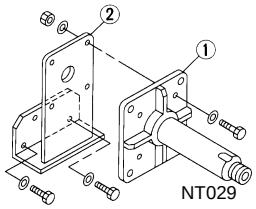
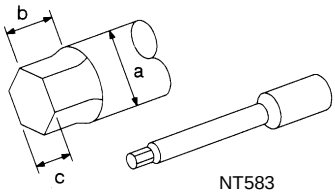
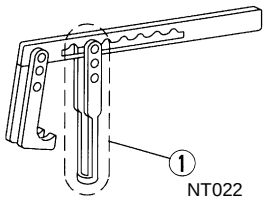
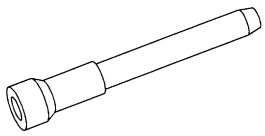
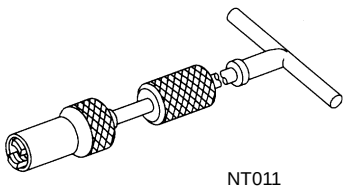
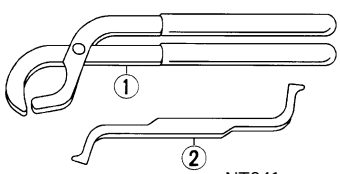
CAUTION:
If there are specific instructions in the service manual, observe them.

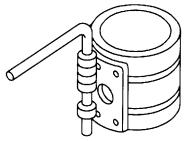
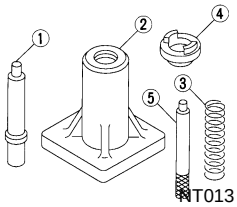
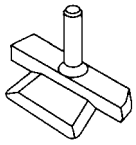
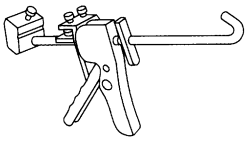
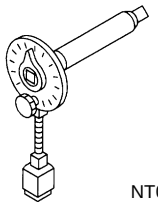
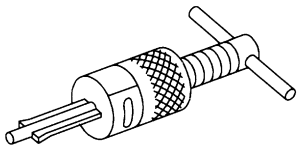
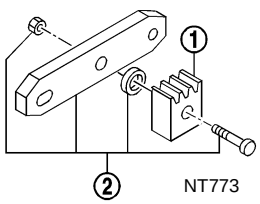
PREPARATION

PFP:00002

Special Service Tools

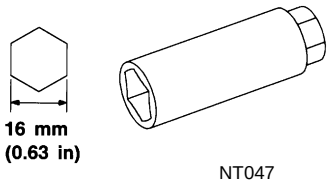
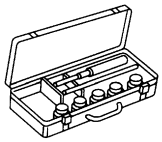
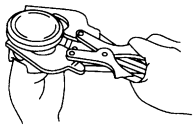
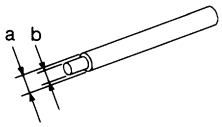
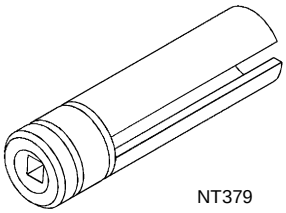
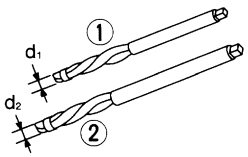
EBS00GWK

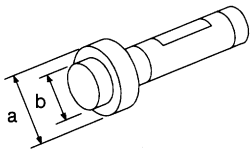
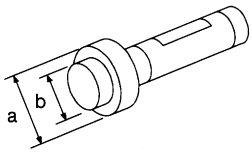
Tool number Tool name		Description
ST0501S000 Engine stand assembly 1 ST05011000 Engine stand 2 ST05012000 Base	 NT042	Disassembling and assembling
Engine attachment assembly 1 KV10106500 Engine attachment 2 KV10113300 Sub-attachment	 NT029	Overhauling engine
ST10120000 Cylinder head bolt wrench	 NT583	Loosening and tightening cylinder head bolt **a: 13 mm (0.51 in) dia.** **b: 12 mm (0.47 in)** **c: 10 mm (0.39 in)**
KV10116200 Valve spring compressor 1 KV10115900 Attachment	 NT022	Disassembling valve mechanism
KV10115600 Valve oil seal drift	 NT024	Installing valve oil seal
KV10107902 Valve oil seal puller	 NT011	Displacement valve lip seal
KV101151S0 Lifter stopper set 1 KV10115110 Camshaft pliers 2 KV10115120 Lifter stopper	 NT041	Changing shims

Tool number Tool name	Description
EM03470000 Piston ring compressor  NT044	Installing piston assembly into cylinder bore
KV10107400 Piston pin press stand 1 KV10107310 Center shaft 2 ST13040020 Stand 3 ST13040030 Spring 4 KV10107320 Cap 5 ST13040050 Drift  NT013	Disassembling and assembling piston pin
KV10111100 Seal cutter  NT046	Removing oil pan
WS39930000 Tube presser  NT052	Pressing the tube of liquid gasket
KV10112100 Angle wrench  NT014	Tightening bolts for bearing cap, cylinder head, etc.
ST16610001 Pilot bushing puller  NT045	Removing pilot bushing
KV101056S0* Rear gear stopper 1 KV10105630 Adapter 2 KV10105610 Plate assembly  NT773	Preventing crankshaft from rotating

Commercial Service Tools

EBS00GWL

Tool name	Description
Spark plug wrench  NT047	Removing and installing spark plug
Valve seat cutter set  NT048	Finishing valve seat dimensions
Piston ring expander  NT030	Removing and installing piston ring
Valve guide drift  NT015	Removing and installing valve guide **Intake & Exhaust:** **a: 9.5 mm (0.374 in) dia.** **b: 5.5 mm (0.217 in) dia.**
Front (heated) oxygen sensor wrench  NT379	Loosening or tightening heated oxygen sensor with 22 m (0.87 in) hexagon nut
Valve guide reamer  NT016	Reaming valve guide **1** or hole for oversize valve guide **2** **Intake & Exhaust:** **d_1 : 5.5 mm (0.217 in) dia.** **d_2 : 9.685 mm (0.3813 in) dia.**

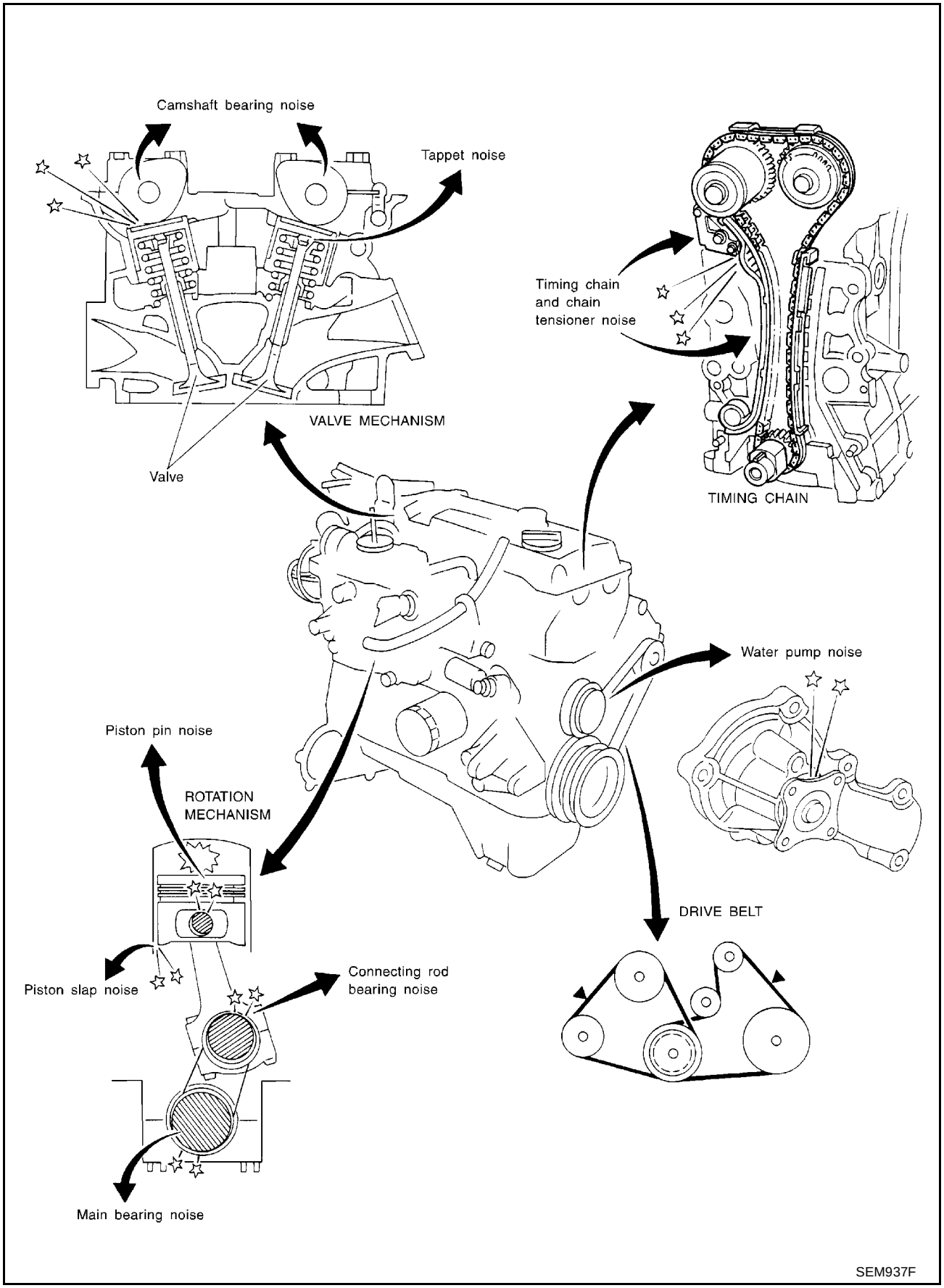
Tool name	Description
Front oil seal drift  NT049	Installing front oil seal **a: 52 mm (2.05 in) dia.** **b: 40 mm (1.57 in) dia.**
Rear oil seal drift  NT049	Installing rear oil seal **a: 103 mm (4.06 in) dia.** **b: 84 mm (3.31 in) dia.**

NOISE, VIBRATION, AND HARSHNESS (NVH) TROUBLESHOOTING

PFP:00003

NVH Troubleshooting —Engine Noise

EBS00GX9



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

EBS00GXA

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-140
	Rattle	C	A	—	A	B	C	Camshaft bearing noise	Camshaft journal clearance Camshaft runout	EM-42 EM-42
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 clearance	EM-85 EM-88
	Slap or rap	A	—	—	B	B	A	Piston slap noise	Piston-to-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 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-92 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-53 EM-49
Front of engine	Squeaking or fizzing	A	B	—	B	—	C	Drive belts (Sticking or slipping)	Drive belts deflection	EM-14
	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-18, "WATER PUMP"

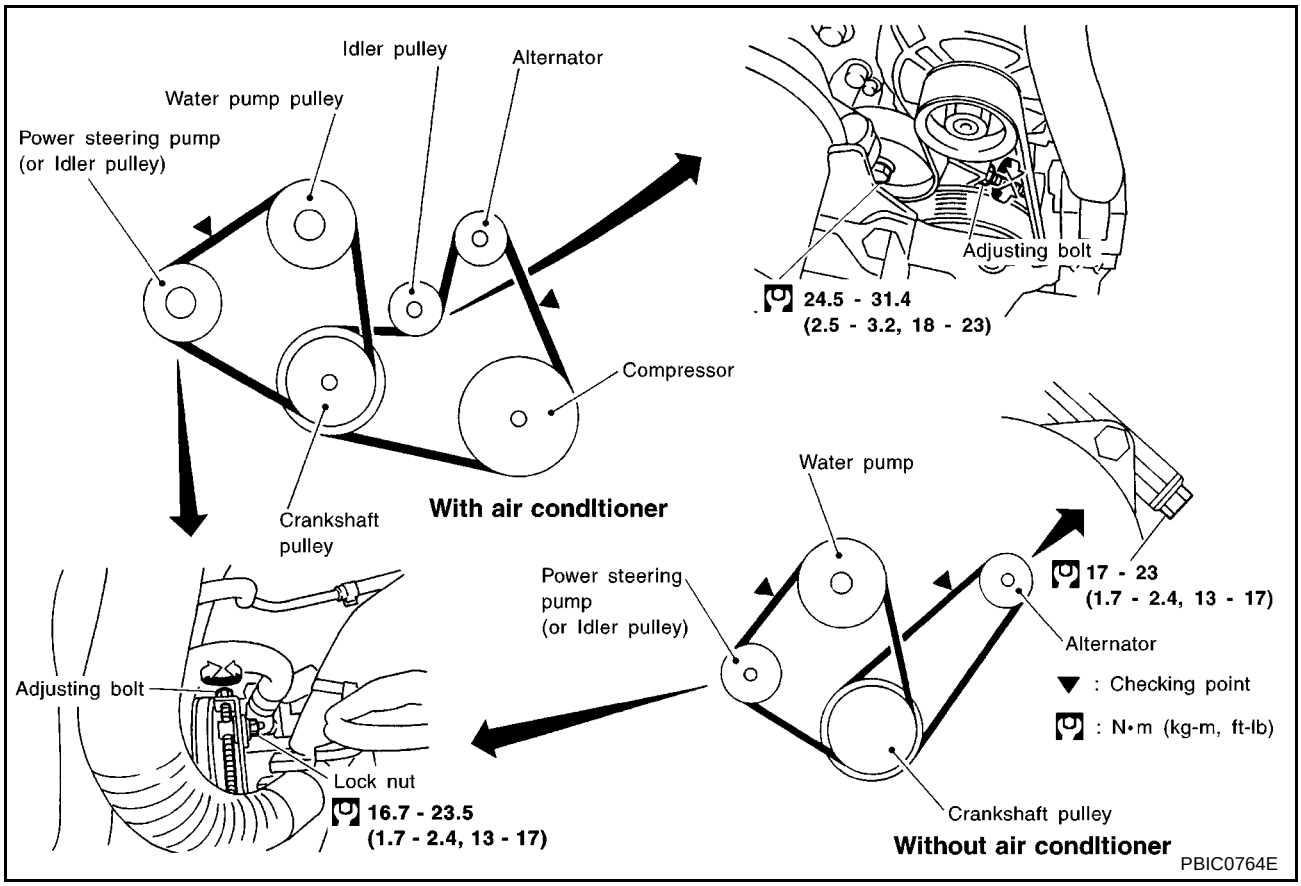
A: Closely related B: Related C: Sometimes related —: Not related

DRIVE BELTS

PFP:02117

Checking Drive Belts

EBS00GWM



- 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:

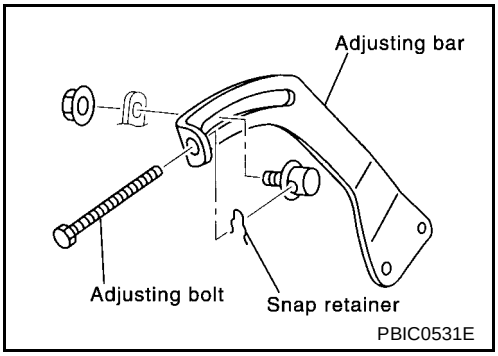
When measuring belt tension immediately after belt is installed, first set the tension to the standard. Then, rotate crankshaft for more than two turns in order to eliminate variance in belt deflection between the pulleys. Re-measure and adjust the tension to the standard.

		Deflection adjustment Unit: mm (in)		
		Used belt		New belt
		Limit	After adjustment	
Alternator	Without air conditioner compressor	10.2 (0.402)	6.5 - 7.0 (0.256 - 0.276)	5.5 - 6.1 (0.217 - 0.240)
	With air conditioner compressor	8.1 (0.319)	5.3 - 5.7 (0.209 - 0.224)	4.5 - 5.0 (0.177 - 0.197)
Power steering oil pump		10.8 (0.425)	6.6 - 7.5 (0.260 - 0.295)	6.0 - 6.6 (0.236 - 0.260)
Applied pushing force		98 N (10 kg, 22 lb)		

Tension Adjustment

EBS00GWN

Portion	Belt tightening method for adjustment
Power steering pump and water pump belt	Adjusting bolt on power steering pump
Alternator and air conditioner compressor belt	Adjusting bolt on idler pulley



CAUTION:

- **When belt is replaced with a new one, tighten it a little stronger than current one to accommodate for insufficient adaptability with pulley grooves.**
- **When tension of belt being used exceeds "Retightening limit", adjust it to value for "Used belt".**
- **When installing belt, make sure that it is correctly engaged with pulley groove.**
- **Keep oil and water away from belt.**
- **Do not twist or bend belt excessively.**
- When adjusting belt, remove snap retainer from adjusting bolt thread (to prevent the retainer from becoming pinched or missing).
- After adjustment, be sure to install snap retainer to adjusting bolt thread.

NOTE:
Snap retainer can prevent adjusting bolt from dropping due to vibration during driving.

POWER STEERING PUMP AND WATER PUMP BELT

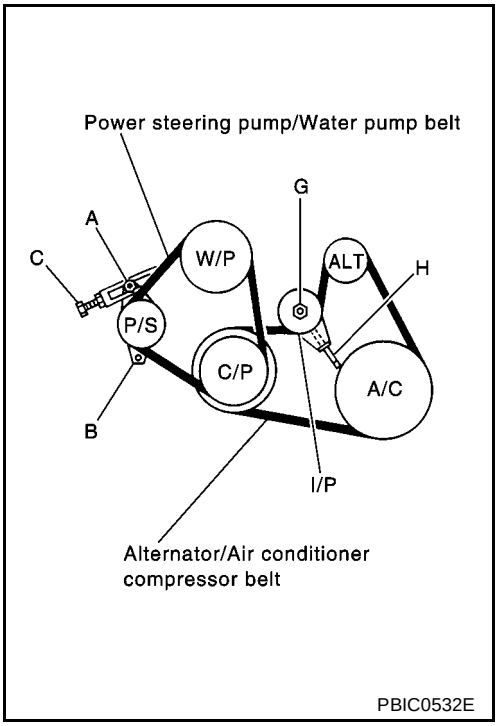
1. Loosen lock nut (A) and power steering pump mounting nut (B).
2. Turn adjusting bolt (C) to adjust. Refer to EM-14, "Checking Drive Belts" .
3. Tighten lock nut (A) and power steering pump mounting nut (B) in this order.

Nut A :

: 16.7 - 23.5 N·m (1.7 - 2.3 kg-m, 13 - 17 ft-lb)

Nut B :

: 26.5 - 36.3 N·m (2.7 - 3.7 kg-m, 20 - 26 ft-lb)



ALTERNATOR AND AIR CONDITIONER COMPRESSOR BELT

1. Remove RH splash cover (with undercover attached).
2. Loosen lock nut (G).
3. Turn adjusting bolt (H) to adjust.
   Refer to EM-14, "Checking Drive Belts" .
4. Tighten lock nut (G).

Nut G :

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

Removal and Installation

EBS00GWO

REMOVAL

- Loosen each belt while referring to “Tension Adjustment”, and remove them one by one starting from the one in front.

INSTALLATION

1. Install belts to pulley in reverse order of removal.
2. Adjust belt tension.

   CAUTION:

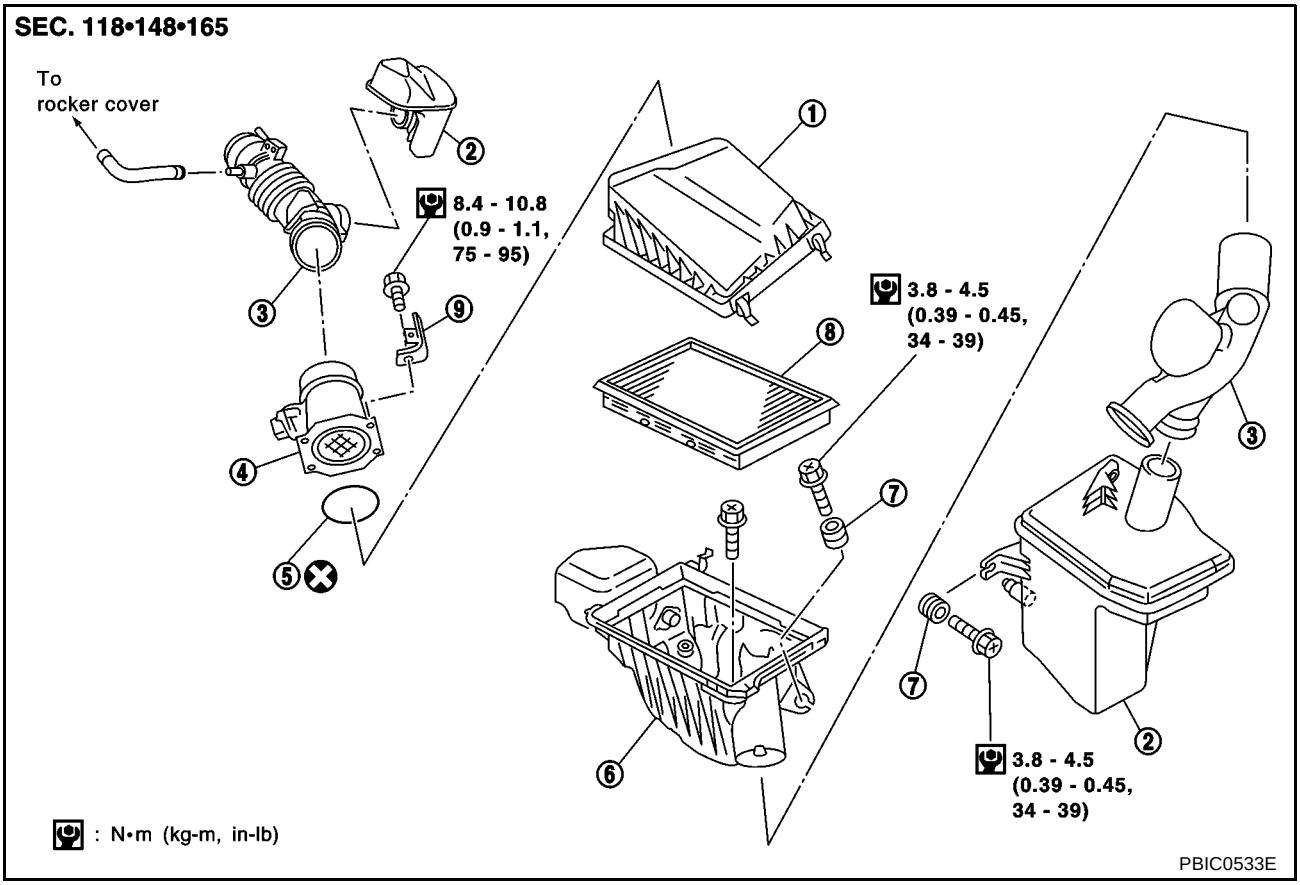
   - **When checking belt tension immediately after installation, first, adjust to specified value. Then, after turning crankshaft more than two turns, re-adjust to specified value to avoid variation in deflection between pulleys.**
   - **Tighten idler pulley lock nut by hand and measure tension without looseness.**
3. Tighten each adjusting bolt and nut to the specified torque.
4. Make sure that tension of each belt is within the standard.

AIR CLEANER AND AIR DUCT

PFP:16500

Removal and Installation

EBS00GUS



1	Air cleaner case (upper)	2	Resonator	3	Air duct
4	Mass air flow sensor	5	O-ring	6	Air cleaner case (lower)
7	Grommet	8	Air cleaner element	9	Bracket

REMOVAL

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

   CAUTION:

   Handle mass air flow sensor with following cares.
   - **Do not shock it.**
   - **Do not disassembly it.**
   - **Do not touch its sensor.**
   - **Do not deform mass air flow sensor's wire mesh.**
4. Remove left fender protector and resonator.

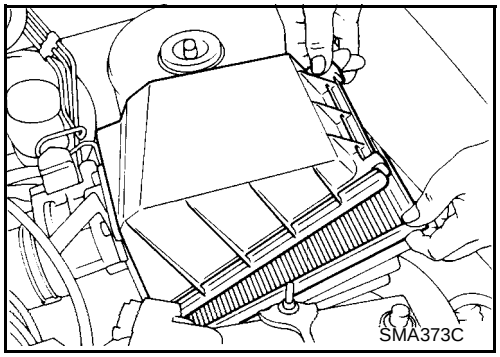
INSTALLATION

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

Changing Air Cleaner Element

EBS00GV2

The viscous paper type filter does not need cleaning between renewals.

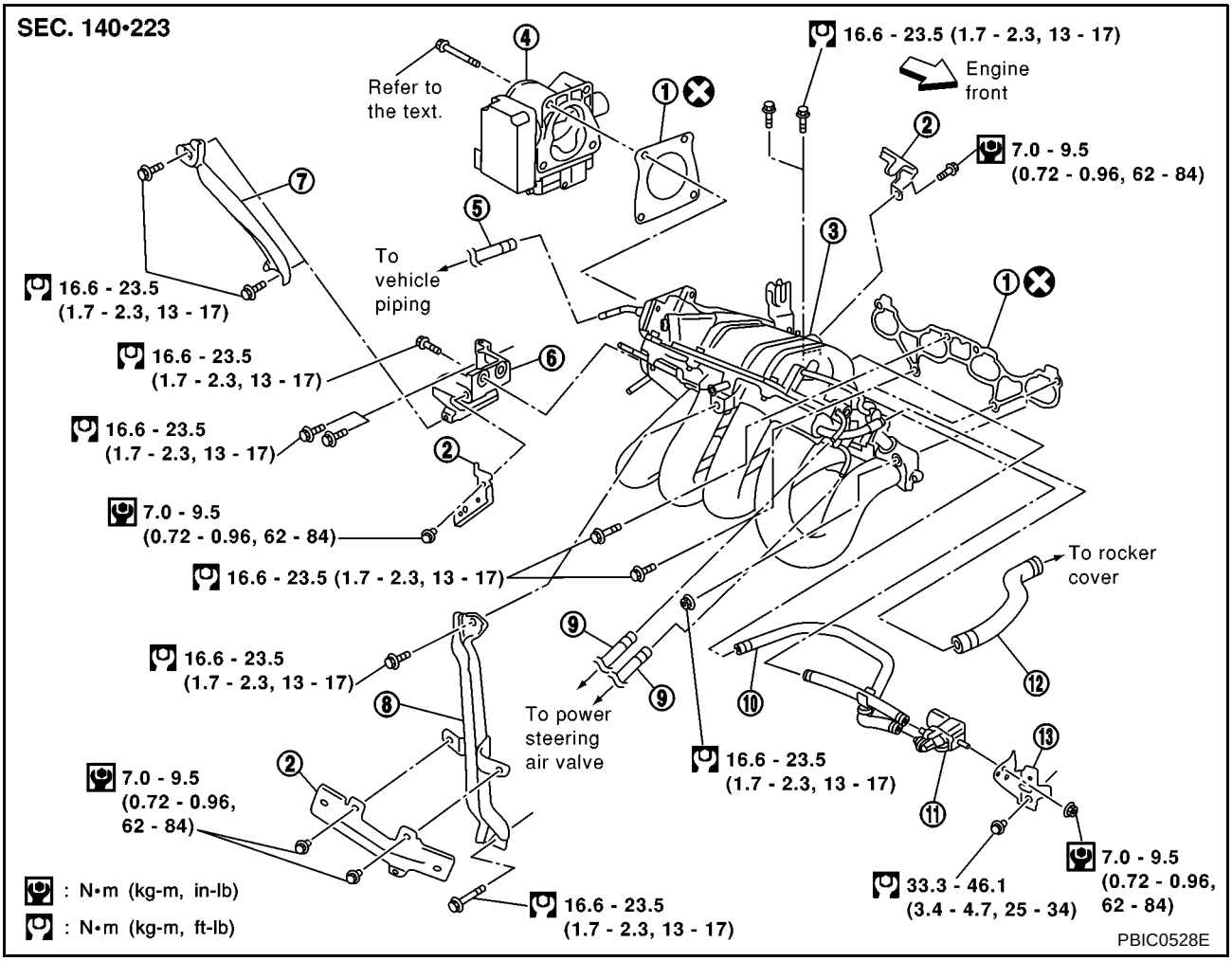


INTAKE MANIFOLD

PFP:14003

Removal and Installation

EBS00GWP



1	Gasket	2	Harness bracket	3	Intake manifold
4	Electric throttle control actuator	5	Fuel feed hose	6	Intake manifold support (engine rear)
7	Intake manifold support (rear)	8	Intake manifold support (front)	9	Air hose
10	Vacuum hose	11	EVAP canister purge volume control solenoid valve	12	PCV hose
13	Bracket				

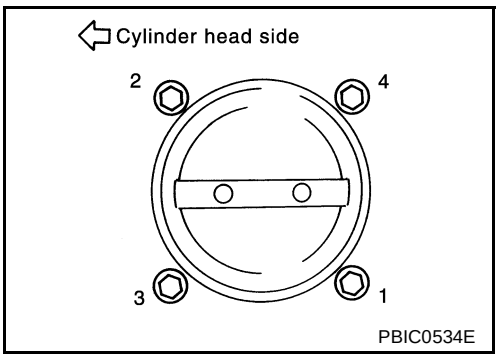
REMOVAL

WARNING:

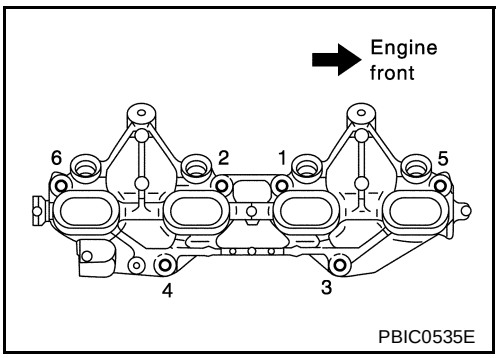
To avoid the danger of being scalded, never drain the coolant when the engine is hot.

1. Release fuel pressure.
   Refer to EC-58, "FUEL PRESSURE RELEASE" (WITH EURO-OBD), EC-591, "FUEL PRESSURE RELEASE" (WITHOUT EURO-OBD).
2. Remove air duct and air cleaner case.
   Refer to EM-17, "Removal and Installation" .
3. Remove fuel hose.
4. Separate harness and pipings from intake manifold.
5. Remove mounting nuts from canister purge control valve to make it movable.

6. Loosen mounting bolts in reverse order shown in figure to remove electric throttle control actuator.
7. Remove all intake manifold supports (front, rear, engine mount, engine rear).
8. Remove mounting bolts from support on cylinder head side of intake manifold assembly.



9. Loosen mounting nuts and bolts in reverse order shown in figure to remove intake manifold assembly.

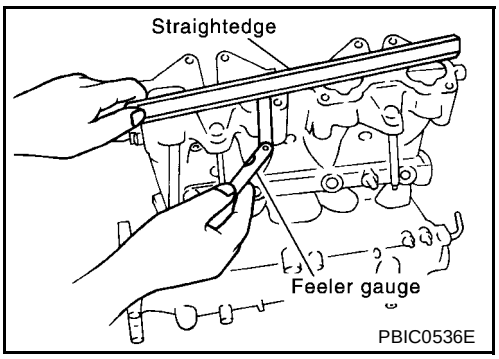


INSPECTION AFTER REMOVAL

Surface Distortion

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

Limit : 0.1 mm (0.004 in)



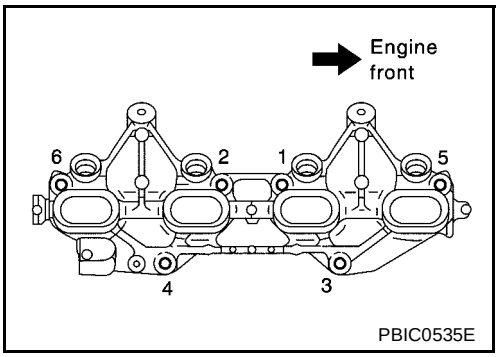
INSTALLATION

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

Tightening Intake Manifold Bolts and Nuts

- Tighten in numerical order as shown in the figure.

NOTE:
Installation direction (fore and aft) for gasket is not specified (symmetrical).



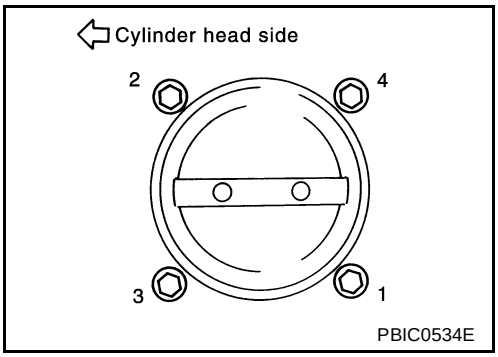
Installation of Electric Throttle Control Actuator

- Tighten mounting bolts for electric throttle control actuator in two steps in order shown in figure.

  1st step : 8.8 - 10.8 N·m (0.9 - 1.1 kg-m, 6.5 - 7.9 ft-lb)

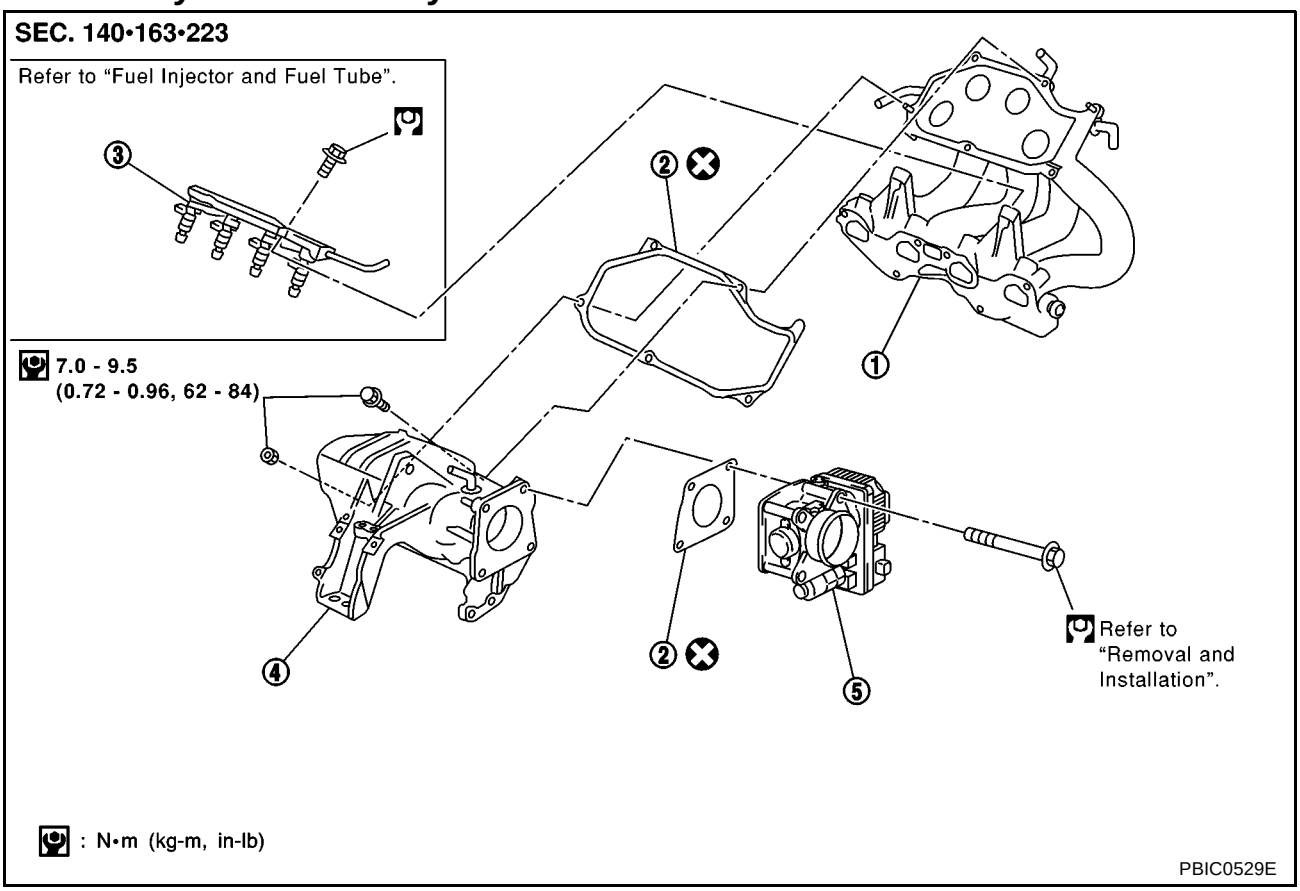
  2nd step : 17.7 - 21.6 N·m (1.8 - 2.2 kg-m, 13 - 15 ft-lb)

  CAUTION:
  When electric throttle control actuator is replaced, perform idle air volume learning.
- Refer to BASIC SERVICE PROCEDURE, EC-55, "Idle Air Volume Learning" (WITH EURO-OBD), EC-589, "Idle Air Volume Learning" (WITHOUT EURO-OBD).



Disassembly and Assembly

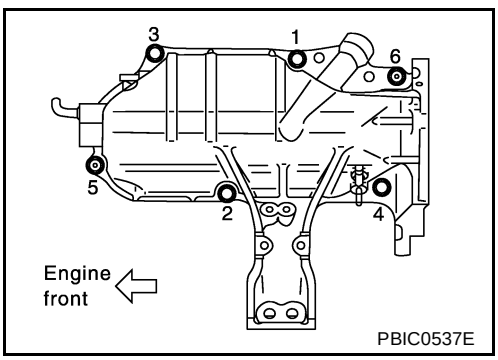
EBS00GWQ



1	Intake manifold	2	Gasket	3	Fuel tube and injectors
4	Intake manifold collector	5	Electric throttle control actuator		

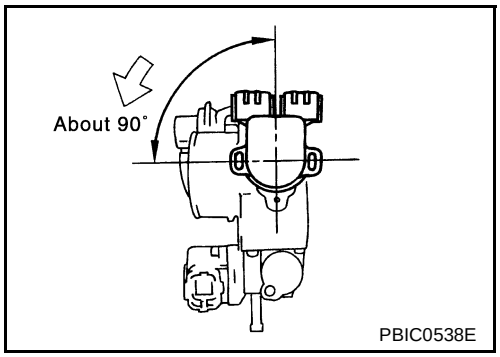
INTAKE MANIFOLD COLLECTOR

- Loosen and remove mounting nuts and bolts in reverse order shown in figure.
- Tighten mounting nuts and bolts in order shown in figure.



THROTTLE POSITION SENSOR

- When installing throttle position sensor, insert connector into electric throttle control actuator facing direction shown in figure. Rotate it to the direction shown by arrow, and temporarily tighten mounting screws.
- After the repair, adjust it on vehicle.



CAUTION:

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

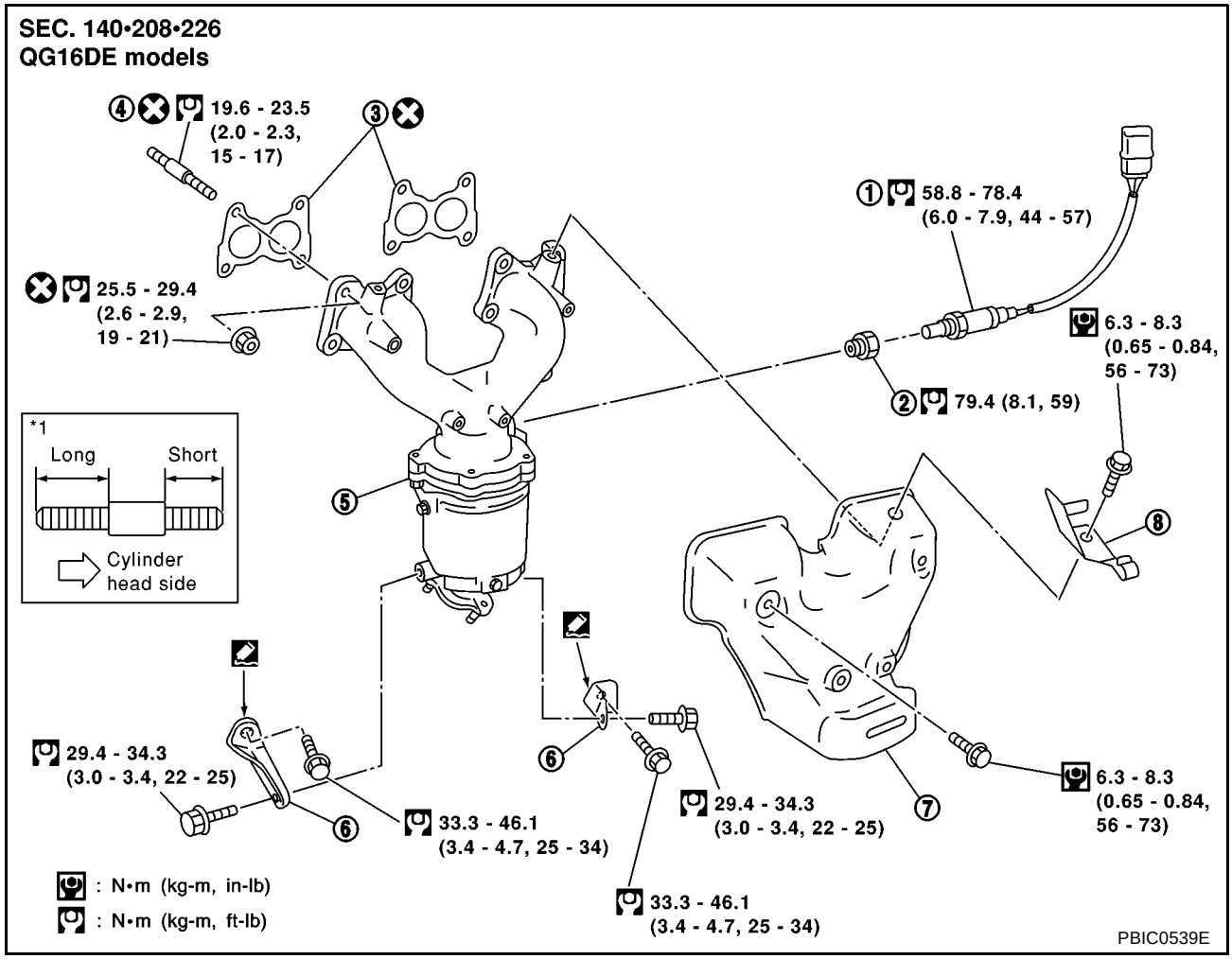
- Perform procedures for “Throttle Valve Closed Position Learning” after finishing repairs. Refer to BASIC SERVICE PROCEDURE, EC-55, "Throttle Valve Closed Position Learning" (WITH EURO-OBD), EC-589, "Throttle Valve Closed Position Learning" (WITHOUT EURO-OBD).
- If electric throttle control actuator is replaced, perform procedures for “Idle Air Volume Learning” after finishing repairs. Refer to BASIC SERVICE PROCEDURE, EC-55, "Idle Air Volume Learning" (WITH EURO-OBD), EC-589, "Idle Air Volume Learning" (WITHOUT EURO-OBD).

EXHAUST MANIFOLD AND CATALYTIC CONVERTER

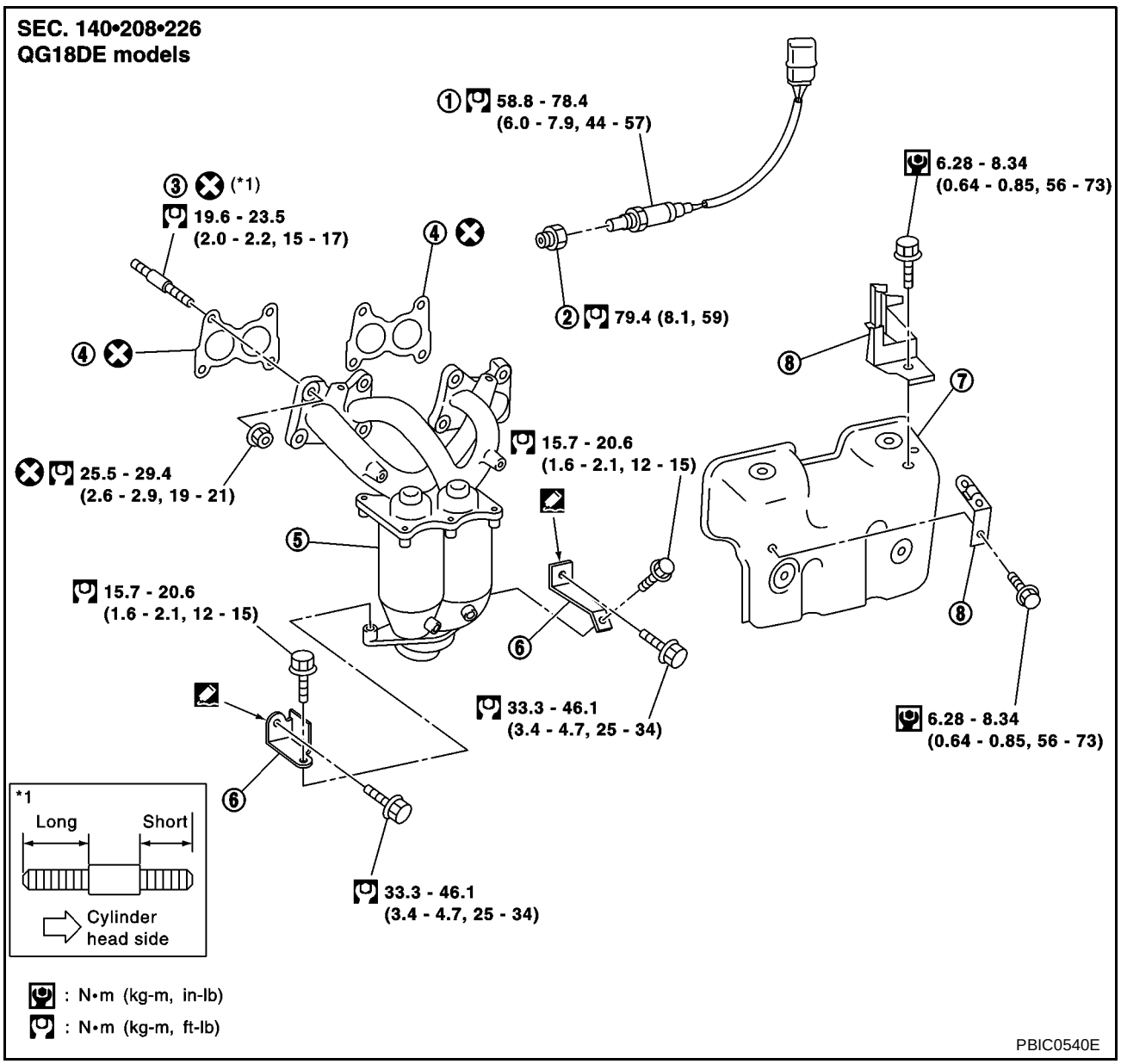
PFP:14004

Removal and Installation

EBS00GWR



1	Heated oxygen sensor 1	2	Ground nut	3	Gasket
4	Stud bolt	5	Exhaust manifold and catalytic converter assembly	6	Support
7	Exhaust manifold cover	8	Heated oxygen sensor harness bracket		



1	Heated oxygen sensor 1	2	Ground nut	3	Stud bolt
4	Gasket	5	Exhaust manifold and catalytic converter assembly	6	Support
7	Exhaust manifold cover	8	Heated oxygen sensor harness bracket		

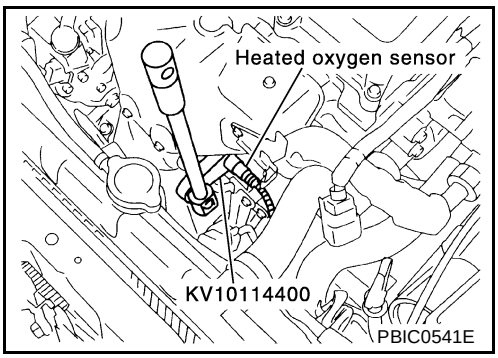
REMOVAL

1. Remove RH undercover.
2. Disconnect exhaust front tube from catalytic converter.
3. Remove exhaust manifold support from both sides of catalytic converter.
4. Disconnect heated oxygen sensor harness connector.
5. Remove heated oxygen sensors.
   - Follow below steps to remove each heated oxygen sensor.

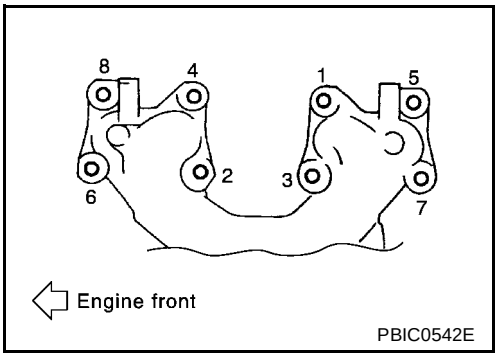
- Using heated oxygen sensor wrench, remove heated oxygen sensor.

CAUTION:

- **Be careful not to damage heated oxygen sensor.**
- **When using heated oxygen sensor wrench, tighten to the middle of specified torque because length of tool may induce sight indication increase. (Do not tighten to the maximum specified torque)**
- **Do not over torque the heated oxygen sensor. Doing so may cause damage to the heated oxygen sensor, resulting in the MI coming on.**



6. Remove exhaust manifold cover.
7. Loosen mounting nuts in reverse order shown in figure to remove exhaust manifold and catalytic converter assembly.

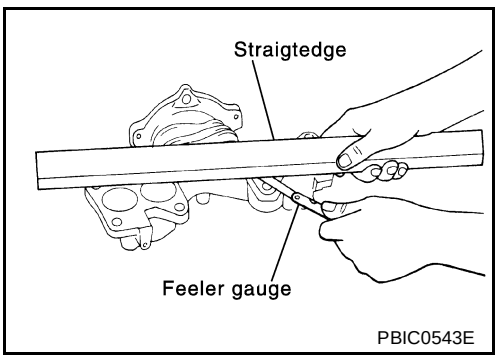


INSPECTION AFTER REMOVAL

Surface Distortion

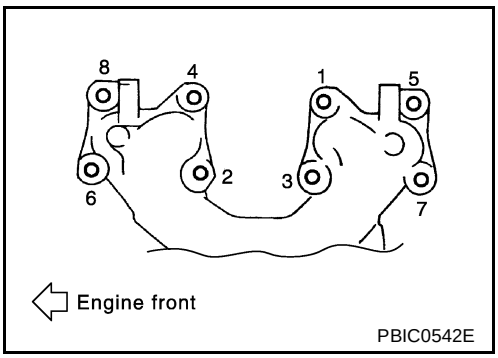
- Use a reliable straightedge and feeler gauge to check the flatness of exhaust manifold fitting surface.

Limit : 0.3 mm (0.012 in)



INSTALLATION

- Install in the reverse order of removal after this step.
- Tighten mounting nuts for exhaust manifold and catalytic converter assembly in order shown in figure.
- Before installing exhaust manifold support, apply liquid gasket to contact surface on engine side.
  Use Genuine Liquid Gasket or equivalent.



Installation of Heated Oxygen Sensor

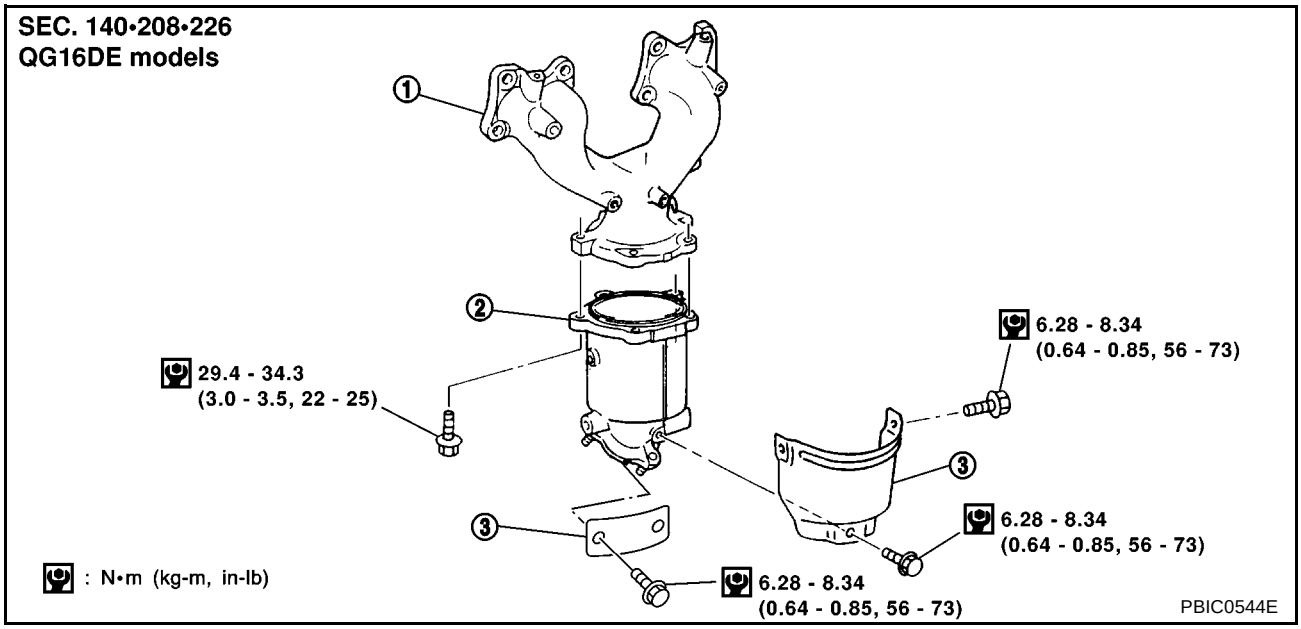
CAUTION:

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

Disassembly and Assembly

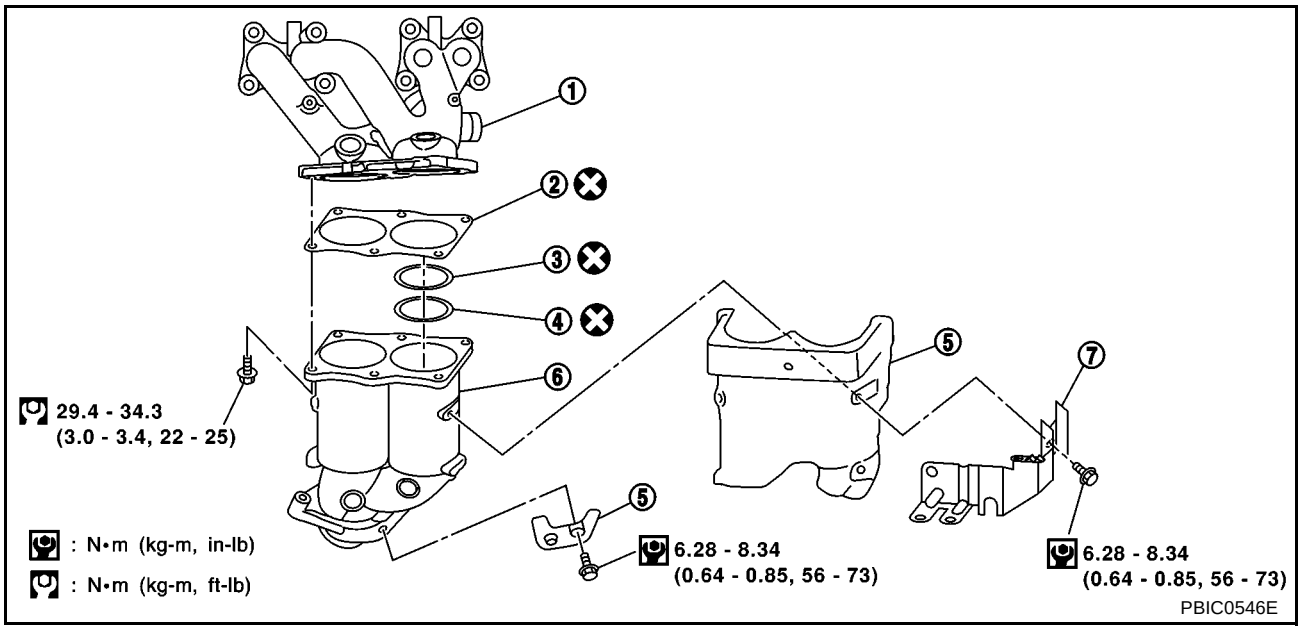
EBS00GWS

QG16DE ENGINE MODELS



1 Exhaust manifold 2 Catalytic converter 3 Catalytic converter cover

QG18DE ENGINE MODELS



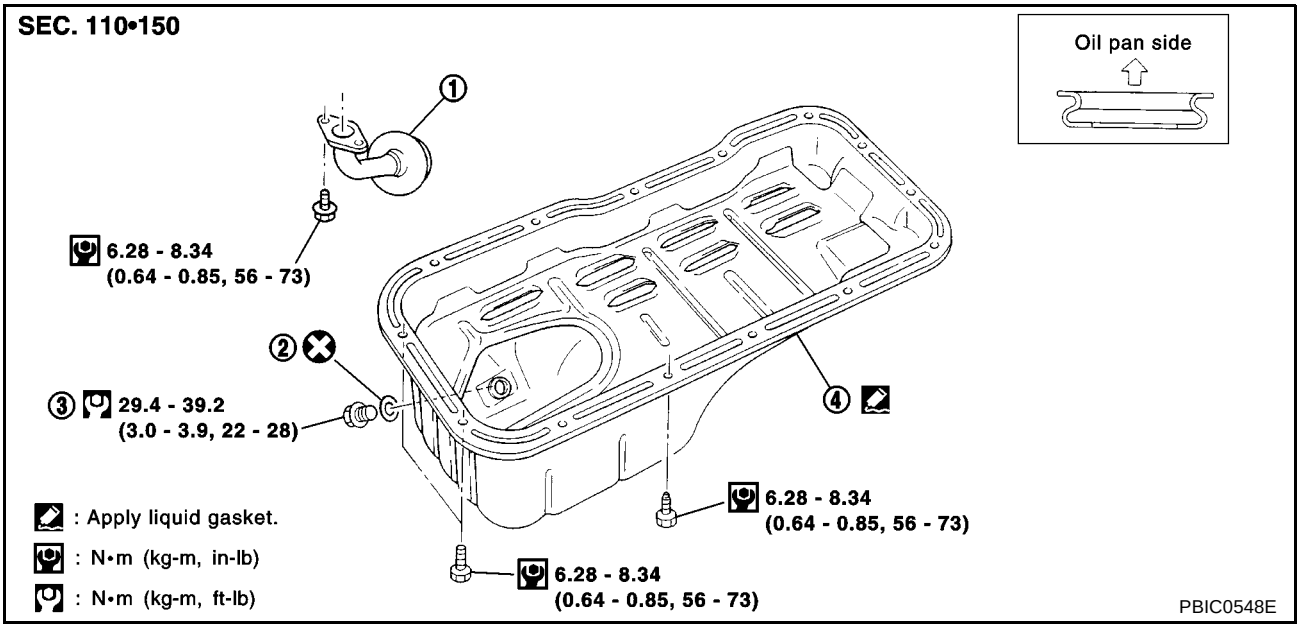
1 Exhaust manifold 2 Gasket 3 Converter cap
4 Wire mesh washer 5 Catalytic converter cover 6 Catalytic converter
7 Heated oxygen sensor harness bracket

OIL PAN AND OIL STRAINER

PFP:11110

Removal and Installation

EBS00GWT



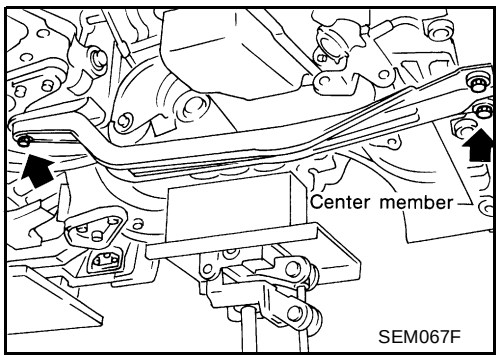
1 Oil strainer 2 Washer 3 Drain plug
4 Oil pan

REMOVAL

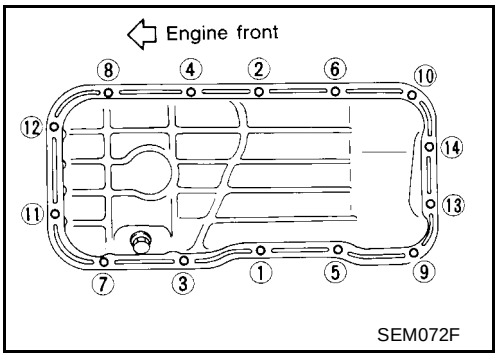
WARNING:

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

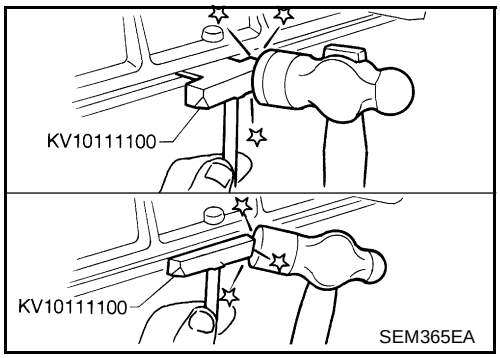
1. Remove engine RH undercover.
2. Drain engine oil. Refer to LU-7, "Changing Engine Oil" .
3. Remove exhaust front tube.
4. Using a transmission jack, be sure to support the bottom of transaxle oil pan, and remove center member.
5. Remove gusset and engine rear plate (lower) [A/T vehicle].



6. Loosen and remove mounting nuts and bolts in reverse order shown in figure.



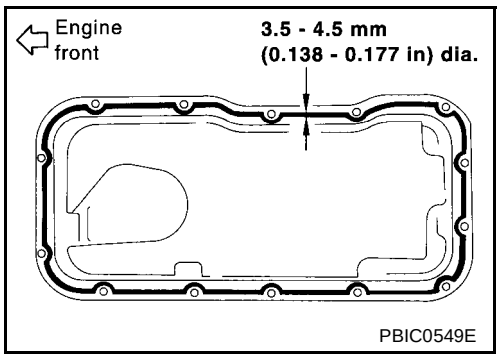
7. Insert Tool (Seal cutter) between oil pan and cylinder block. Slide tool by tapping on the side of the tool with a hammer. Remove oil pan.
8. Remove oil strainer.



INSTALLATION

1. Install oil strainer.

   NOTE:
   Gasket and O-ring are not used for sealed area with oil pump.
2. Install oil pan drain plug.
   - Referring to “Components”, install drain plug washer.
3. Apply a continuous bead of liquid gasket to position shown in figure.

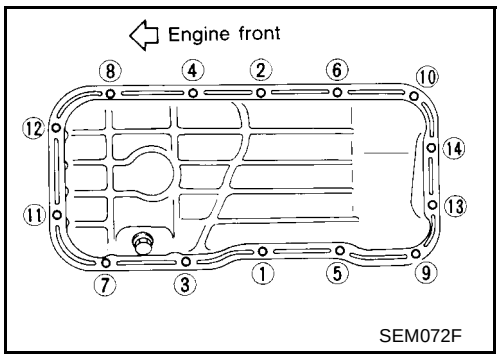


4. Tighten mounting nuts and bolts in order shown in figure.
   - Install mounting nuts and bolts as follows.

   Mounting bolt:

   [Shank length under head 10 mm (0.39 in)] : Nos. 1 - 10, 13, 14

   [Shank length under head 12 mm (0.47 in)] : Nos. 11, 12



5. Install center member.
   Refer to ENGINE ASSEMBLY, EM-66, "Removal and Installation" .
6. Install remaining parts in the reverse order of removal.

INSPECTION AFTER INSTALLATION

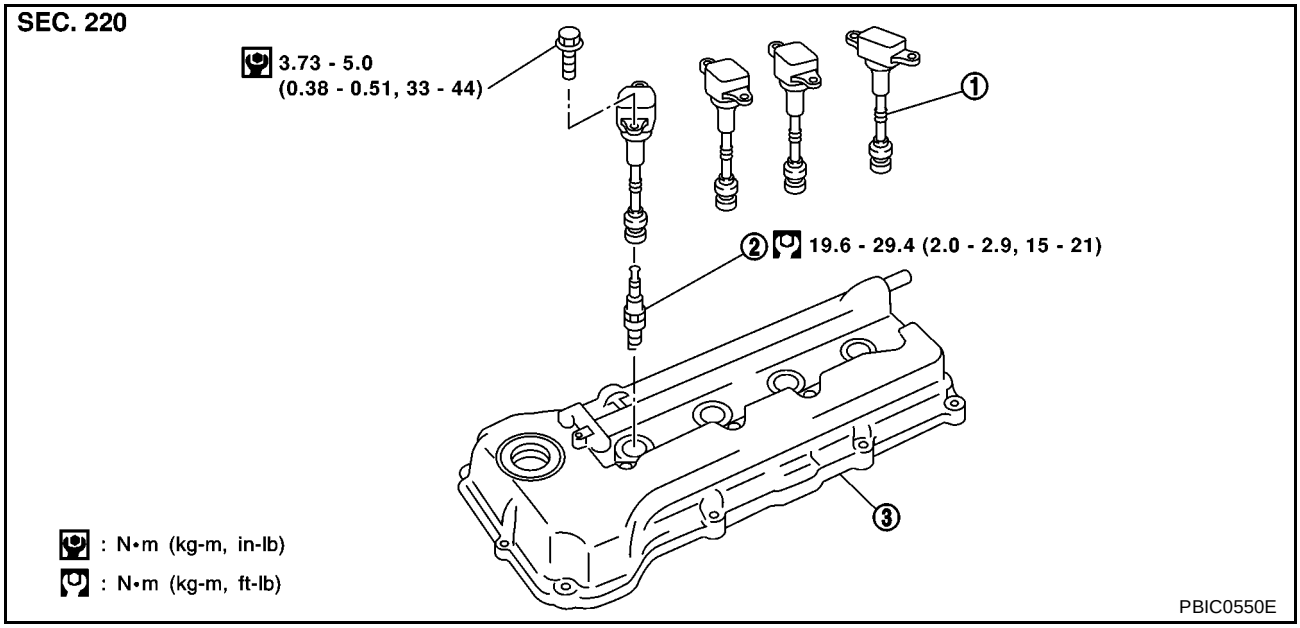
- Check for leakage of engine oil when engine is warmed.
- Pour engine oil or start engine at least 30 minutes after oil pan is installed.

IGNITION COIL

PFP:22448

Removal and Installation

EBS00GUW



1 Ignition coil 2 Spark plug 3 Rocker cover

REMOVAL

1. Remove ignition coil harness connector from ignition coil.
2. Remove ignition coil.

CAUTION:
Do not shock it.

INSTALLATION

- Install in the reverse order of removal.

SPARK PLUG (CONVENTIONAL)

PFP:22401

Removal and Installation

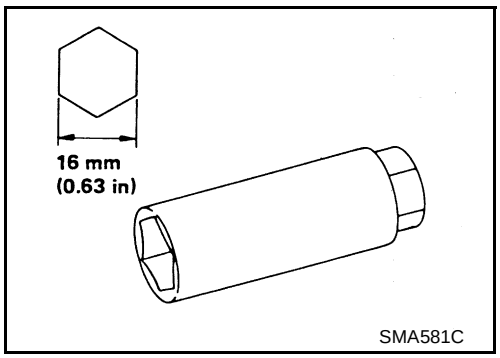
EBS00GWU

REMOVAL

1. Disconnect ignition coil harness connector from ignition coil.
2. Remove ignition coil.
3. Remove spark plugs with a spark plug wrench (commercial service tool).

Spark plug

Make	NGK	Champion
Standard type	LFR5A-11	REC10YC4
Hot type	LFR4A-11	—
Cold type	LFR6A-11	—

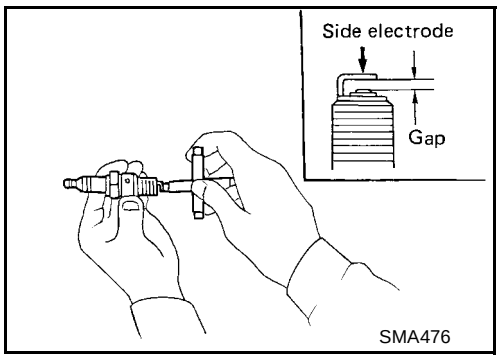


INSPECTION AFTER REMOVAL

Check spark plug gap. Adjust or replace if necessary.

Standard : 1.0 - 1.1 mm (0.039 - 0.043 in)

- Use a wire brush for cleaning, if necessary.



INSTALLATION

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

Spark plug:

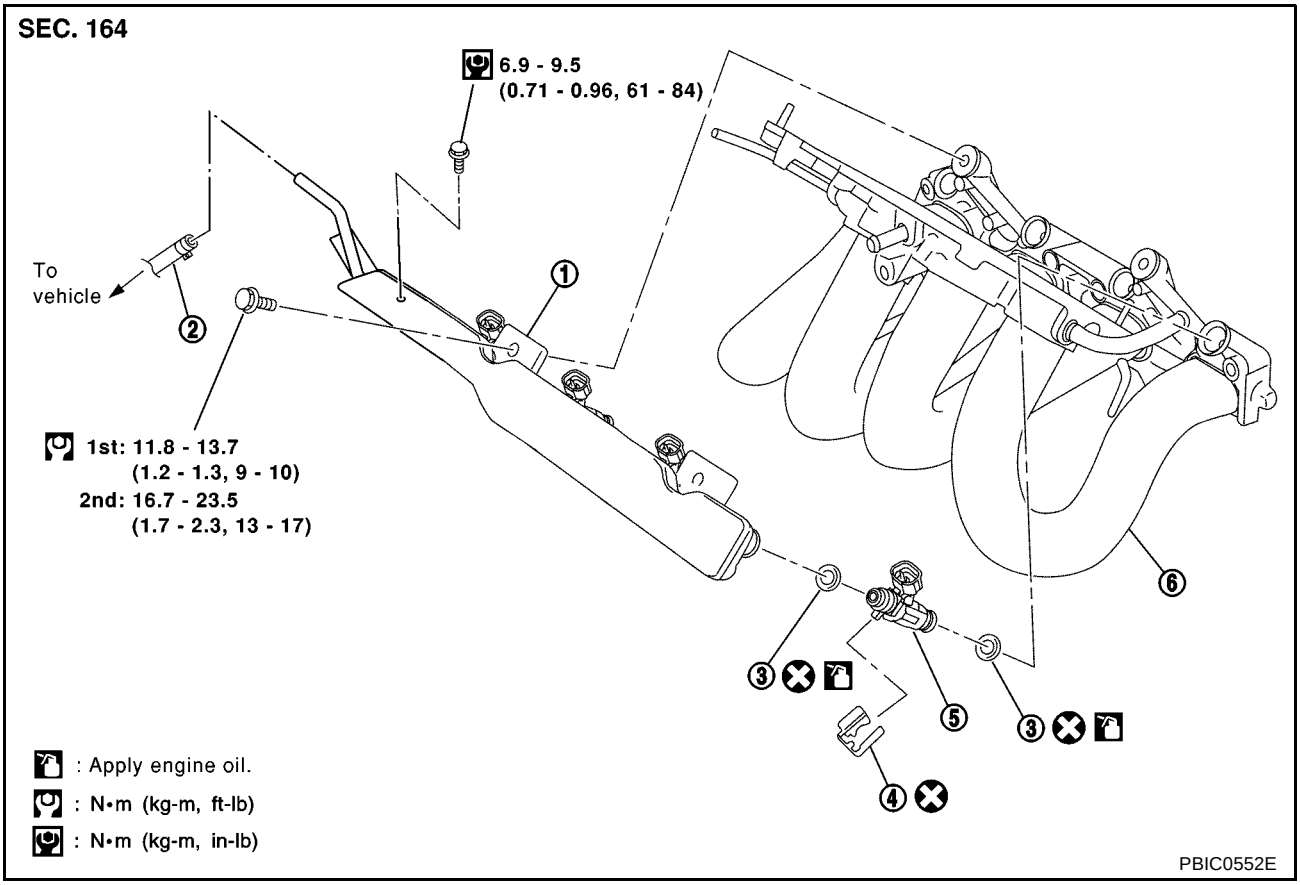
: 19.6 - 29.4 N·m (2.0 - 3.0 kg-m, 15 - 21 ft-lb)

FUEL INJECTOR AND FUEL TUBE

PFP:16600

Removal and Installation

EBS00GWV



1	Fuel tube	2	Fuel feed hose	3	O-ring
4	Clip	5	Fuel injector	6	Intake manifold

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

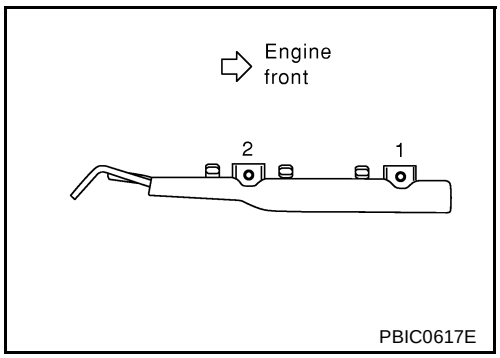
1. Release fuel pressure. Refer to EC-58, "FUEL PRESSURE RELEASE" (WITH EURO-OBD), EC-591, "FUEL PRESSURE RELEASE" (WITHOUT EURO-OBD).
2. Remove air duct between air cleaner case and electric throttle control actuator.
3. Move electric throttle control actuator.
4. Remove PCV hose and vacuum hose.
5. Disconnect harness connector from fuel injector.
6. Remove fuel hose.

CAUTION:

After removal, install blind plug to fuel hose to prevent the fuel from draining.

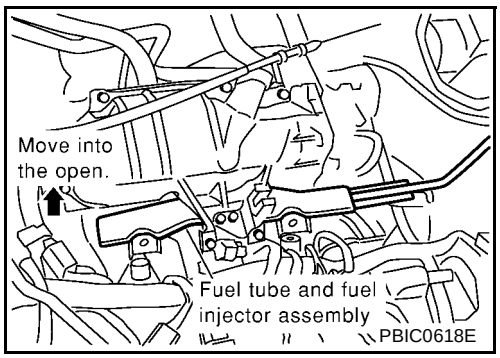
7. Remove fuel tube and injector assembly with the following procedure:

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



b. Lift fuel tube and injector assembly. With fuel injector nozzle facing rear side of vehicle, move it to port bend area of intake manifold.

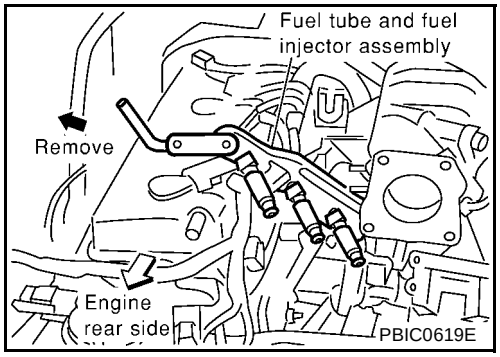
CAUTION:
Fuel remaining in tube leaks during operation. This operation should be done in a place free from fire.



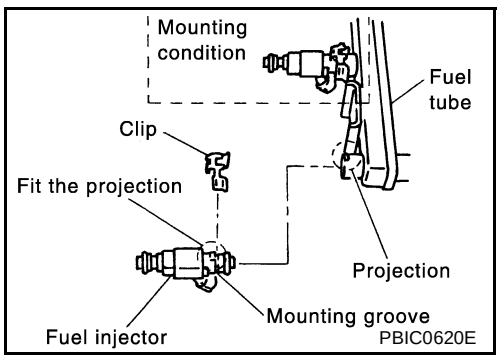
c. Frequently changing direction of fuel tube and injector assembly, take it out toward rear side of vehicle.

- If fuel hose clamp interferes with engine, tilt it to prevent contact with engine.

CAUTION:
When removing, be careful to keep fuel injector nozzle from interfering with intake manifold.



8. 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.
9. Remove pressure regulator.



INSTALLATION

1. When installing O-ring to fuel injector, follow instructions described below.

CAUTION:
- **Handle O-ring with bare hands. Never wear gloves.**
- **Lubricate O-ring with new engine oil.**
- **Do not clean O-ring with solvent.**
- **Make sure that O-ring and its mating part are free of foreign material.**
- **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 is stretched while being attached, do not insert it into fuel tube immediately.**

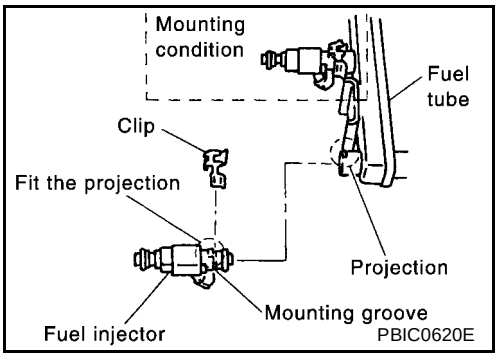
- **Insert O-ring straight into fuel tube. Do not angle or twist it.**

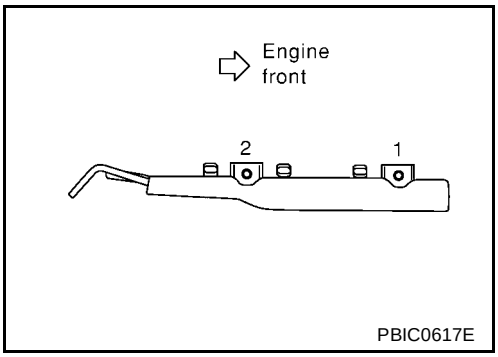
2. Insert clip into groove on injector.
   - Insert clip so that projection of injector matches notch of clip.
3. With the clip attached, insert fuel injector straight into fuel tube with all projections properly aligned.
4. When fuel injector is completely inserted, make sure that projections on fuel tube and fuel injector, and fuel tube flange are all engaged with clip.

   CAUTION:
   Do not reuse clips. Always replace clip with new one.
5. Install fuel tube to intake manifold in reverse order (c → b) of step 7.
6. Tighten mounting bolts in two steps in numerical order shown in figure.

   1st step : 11.8 - 13.7 N·m (1.2 - 1.3 kg-m, 9 - 10 ft-lb)

   2nd step : 16.7 - 23.5 N·m (1.7 - 2.3 kg-m, 13 - 17 ft-lb)
7. Install fuel hose.
   - Insert hose until its end touches bulge on fuel tube. Install a clamp avoiding the bulge, and securely tighten it.
8. Install remaining parts in the reverse order of removal.





INSPECTION AFTER INSTALLATION

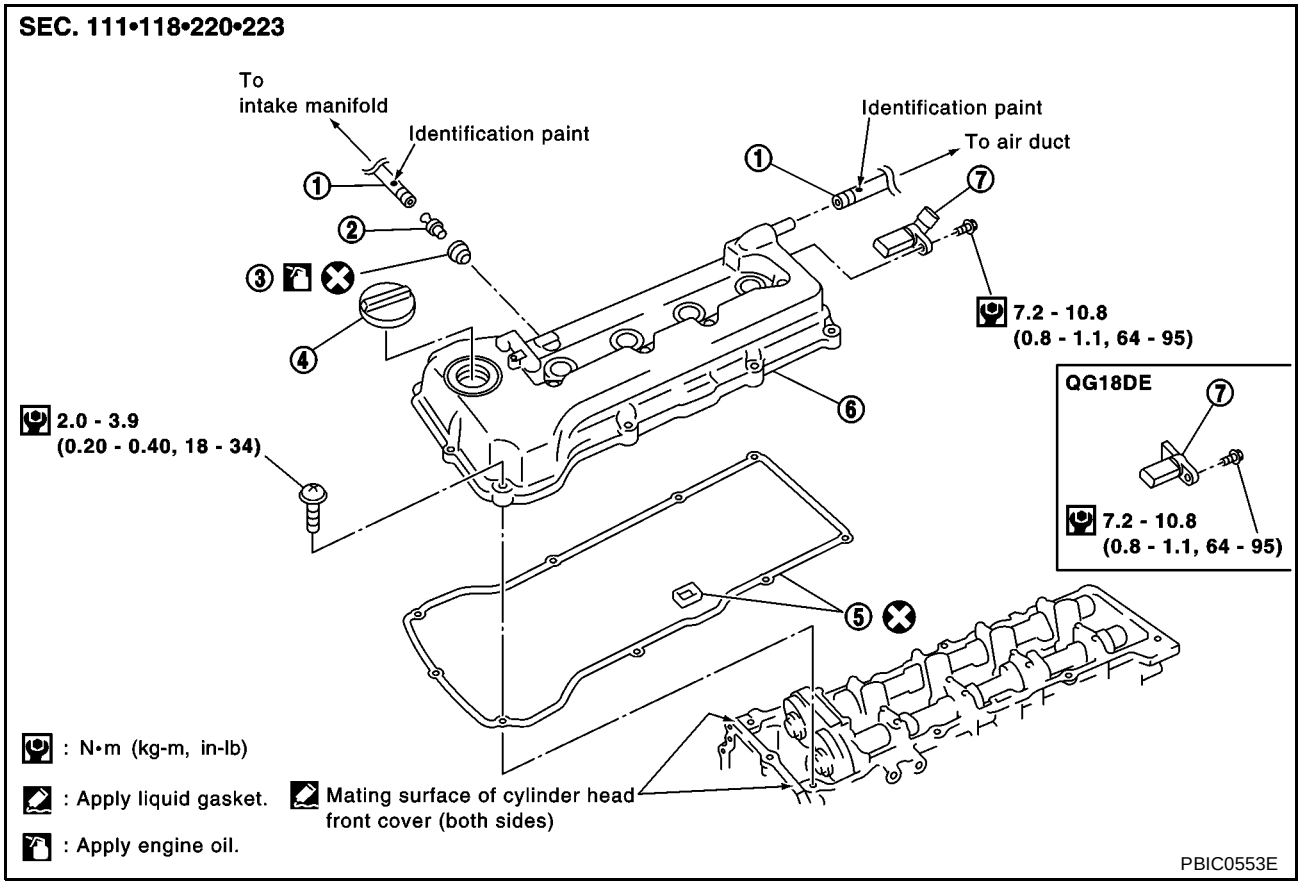
- Start engine, increase engine speed and make sure that there is no fuel leakage.

ROCKER COVER

PFP:13264

Removal and Installation

EBS00GUZ



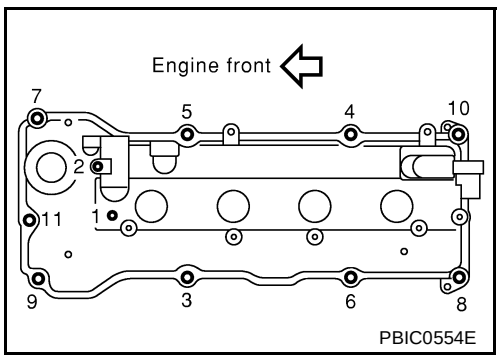
1	PCV hose	2	PCV control valve	3	Grommet
4	Oil filter cap	5	Gasket	6	Rocker cover
7	Camshaft position sensor (PHASE)				

CAUTION:

Apply new engine oil when installing the parts that specified to do so in the figure.

REMOVAL

1. Remove PCV hose.
2. Disconnect harness connector from fuel injector.
3. Remove camshaft position sensor (PHASE).
4. Remove ignition coil. Refer to EM-29, "Removal and Installation" .
5. Loosen bolts in reverse order shown in the figure.

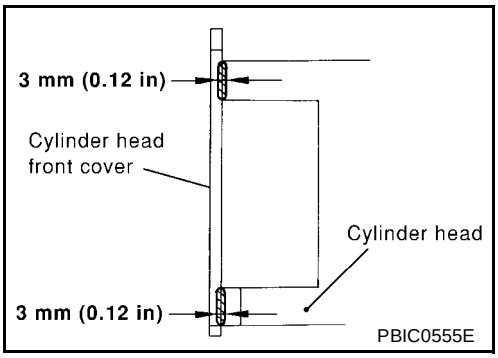


6. Remove PCV control valve from rocker cover.

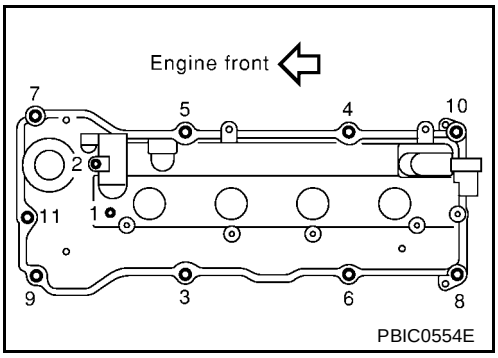
INSTALLATION

1. Install PCV control valve to rocker cover.
   - Insert until flange contacts grommet tightly.

2. Apply liquid gasket to positions shown in figure, then install rocker cover.



3. Tighten mounting screws to specified torque in 3 or more steps in numerical order shown in figure.
4. Install remaining parts in the reverse order of removal.

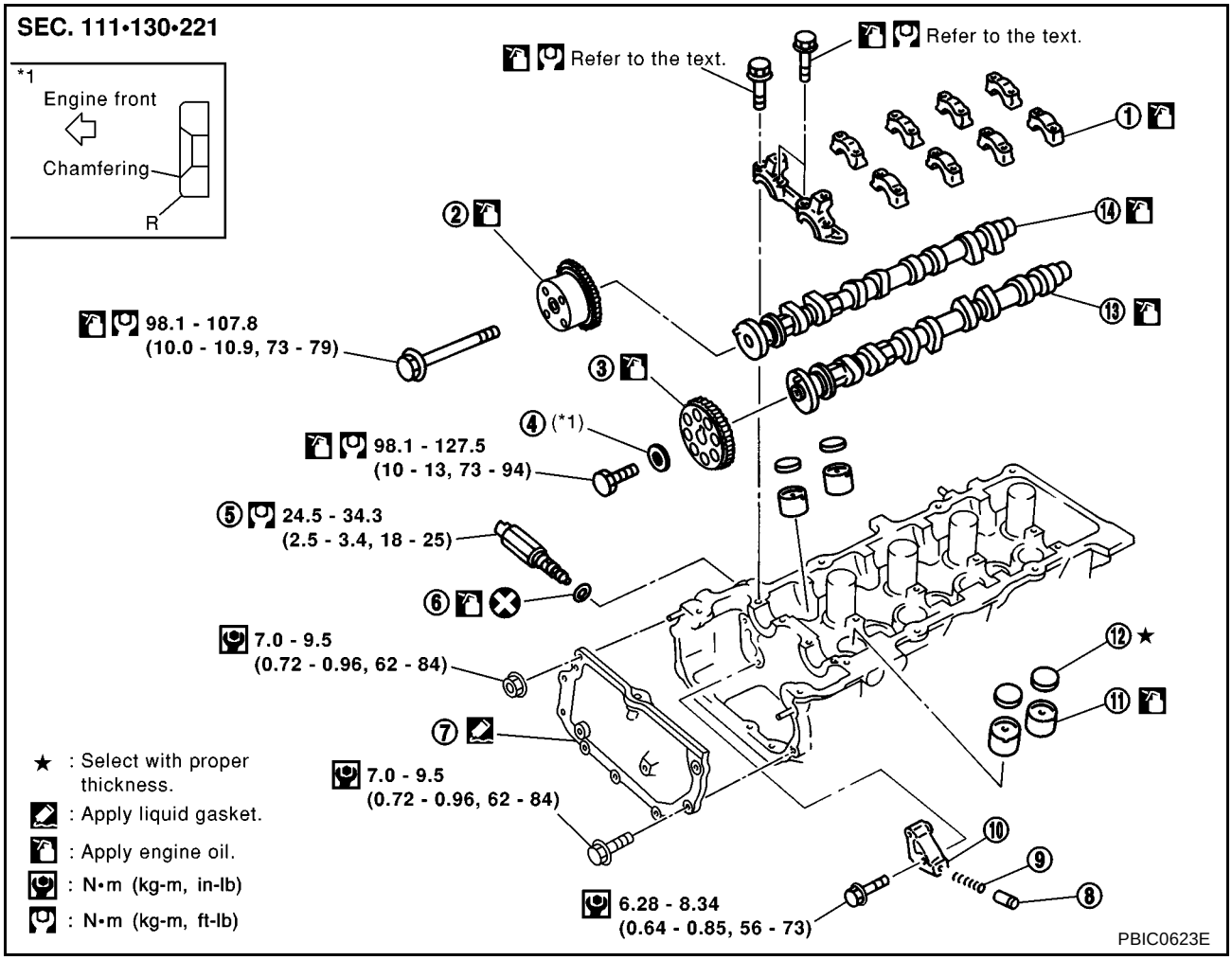


CAMSHAFT

PFP:13001

Removal and Installation

EBS00GWW



1	Camshaft bracket	2	Camshaft sprocket (INT)	3	Camshaft sprocket (EXH)
4	Washer	5	Intake valve timing control solenoid valve	6	O-ring
7	Cylinder head front cover	8	Plunger	9	Spring
10	Chain tensioner	11	Valve lifter	12	Adjusting shim
13	Camshaft (EXH)	14	Camshaft (INT)		

CAUTION:

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

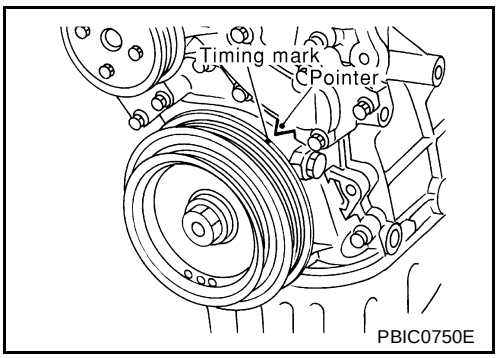
REMOVAL

1. Remove rocker cover. Refer to ROCKER COVER, EM-34, "Removal and Installation" .
2. Remove cylinder head front cover.
   - Tap its back with a suitable wooden bar to remove.

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

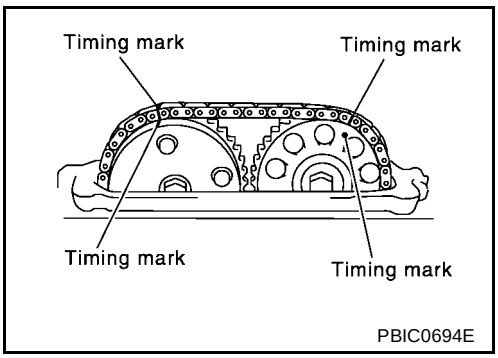
a. Open splash cover on RH undercover.

b. Rotate crankshaft pulley clockwise, and align mating marks for TDC with timing indicator on front cover.

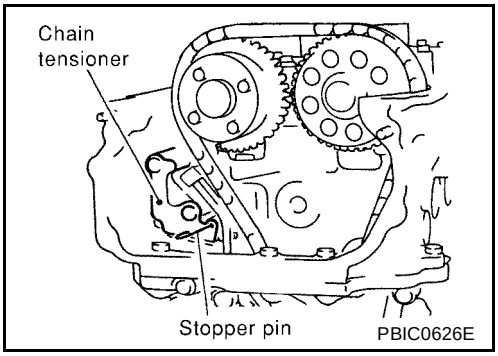


c. At the same time, make sure that the mating marks on camshaft sprockets are located as shown in the figure.
   - If not, rotate crankshaft pulley one more turn to line up the mating marks to the positions in the figure.

4. Remove chain guide from camshaft bracket.

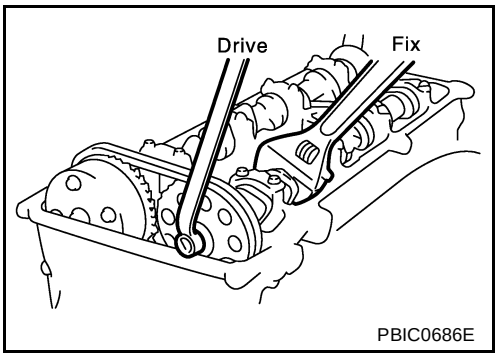


5. Remove chain tensioner.
   - Push plunger using a flat-bladed screwdriver, then fix it with a stopper pin (such as a hard wire), and remove mounting bolts.



6. Remove camshaft sprocket.

a. Exhaust camshaft is fixed by hexagon part of camshaft, and exhaust camshaft bolt is loosened, and camshaft sprocket is removed.



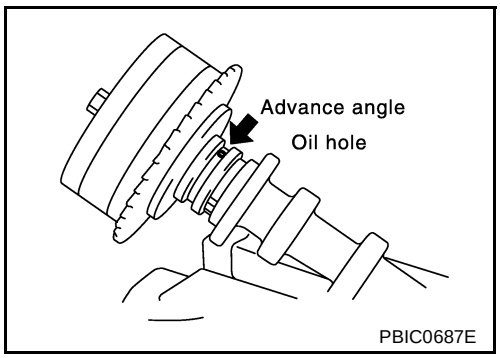
b. Intake camshaft removed with camshaft sprocket from cylinder head assembly.

CAUTION:

Never remove camshaft sprocket when intake camshaft assembled in cylinder head.

c. Camshaft is fixed on rise, and it confirms that camshaft sprocket does not turn.

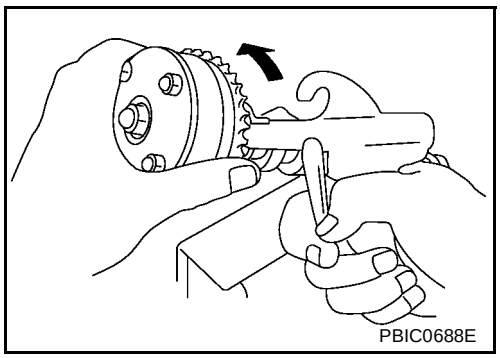
d. Oil hole except for the oil hole of the camshaft journal (advanced oil pressure hole) shown in the figure is stopped by the plastic tape etc.



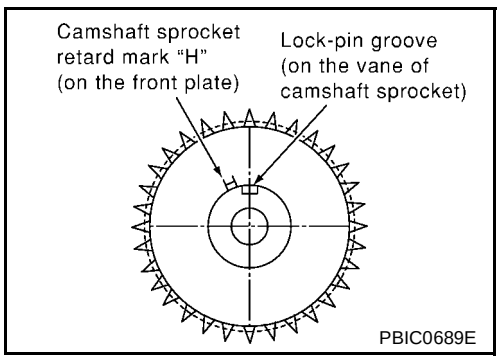
e. Camshaft sprocket is turned in the advanced direction (left direction) forcibly with adding air pressure of about 150 kPa (1.5 bar, 1.5 kg/cm^2 , 21.8 psi) to the oil hole.

NOTE:

- When camshaft sprocket is hard to turn, air pressure is a little leaked out.
- It is careful because it has possibility that oil files about when air pressure is added.



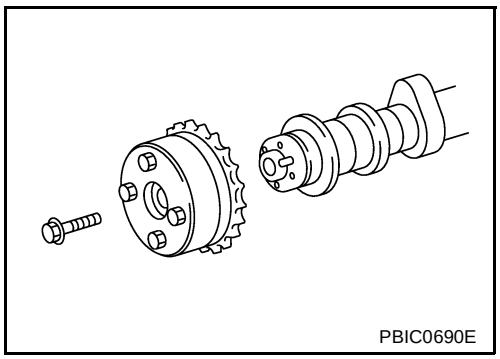
f. It confirms that camshaft sprocket retard marks “H” and lock pin groove deviate to the counterclockwise direction (approx. 23 degrees).



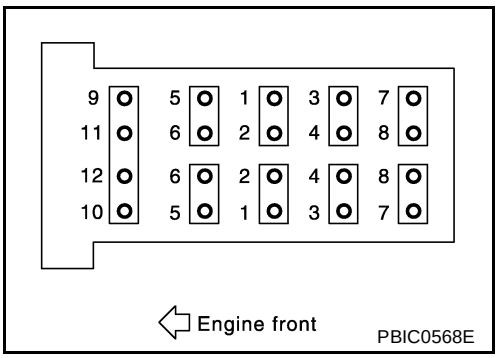
g. Remove camshaft sprocket bolt.

CAUTION:

- **Never remove other 3 bolts.**
- **If camshaft sprocket is used again, after release the lock pin.**



7. Remove camshaft brackets.
   - Loosen mounting bolts in several steps in reverse order shown in figure.



8. Remove camshaft.
9. Remove adjusting shims and valve lifters.
   - Correctly identify location where each part is installed. Keep parts in an organized way to avoid mixing them up.

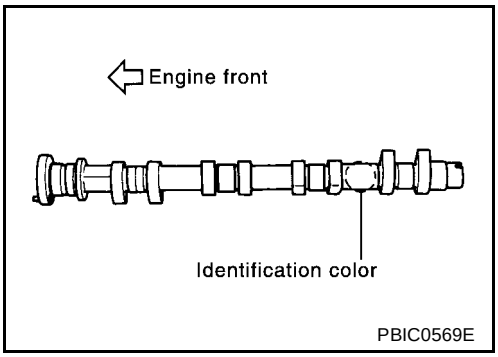
INSTALLATION

1. Install adjusting shims and valve lifters.
   - Install removed parts in the same locations as before.
   - Install adjusting shim with its stamp mark facing downward (valve lifter side).
2. Install camshaft.
   - Identify intake and exhaust camshafts by identification paint colors (painted between cylinders No. 3 and No. 4).

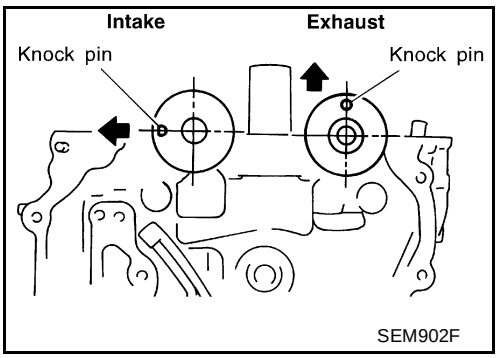
     Paint color:

     Intake : White

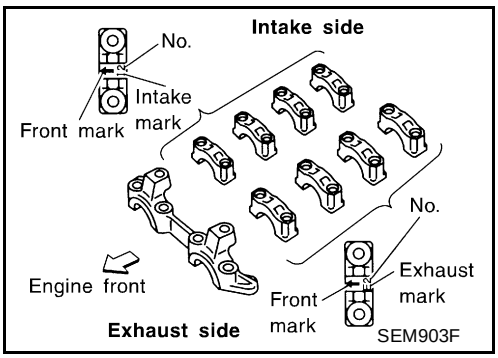
     Exhaust : Yellow



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



3. Install camshaft brackets.
   - Completely remove any foreign material on back surfaces of camshaft brackets and top surface of cylinder head.
   - Referring to marks on top surfaces of camshaft brackets, install them to their original positions and in their original directions.



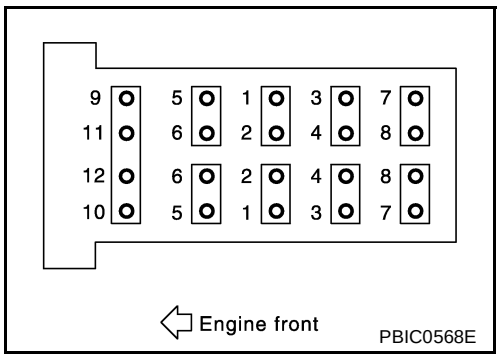
4. Tighten camshaft bracket mounting bolts in following steps.

a. Bolts vary depending on installation location. Refer to following and install appropriate bolts.

Bolt colors:

Nos. 1 - 10: Black (reamer bolt)

Nos. 11, 12: Gold



b. First tighten bolts 9 through 12, then tighten bolts 1 through 8 in numerical order.

: 2.0 N·m (0.20 kg-m, 18 in-lb)

c. Tighten in numerical order shown in figure.

: 5.9 N·m (0.60 kg-m, 52 in-lb)

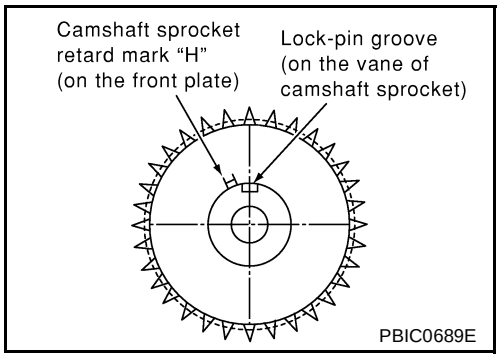
d. Tighten in numerical order shown in figure again.

: 9.0 - 11.8 N·m (1.0 - 1.2 kg-m, 80 - 104 in-lb)

5. Install camshaft sprockets.

a. Confirm that camshaft sprocket retard marks “H” (on the front plate) and lock pin groove (on the vane of camshaft sprocket) deviate to the counterclockwise direction. (approx. 23 degrees).

b. Remove knock pin of intake camshaft and hole of camshaft sprocket knock pin as shown in the figure, and insert it.

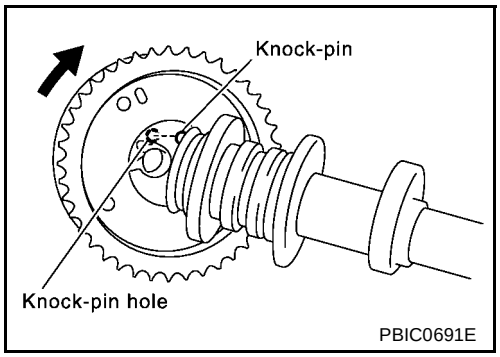


c. Push in knock pin when camshaft sprocket is turned in the direction shown in the figure and knock pin hole corresponds to knock pin while pushing camshaft sprocket lightly.

CAUTION:

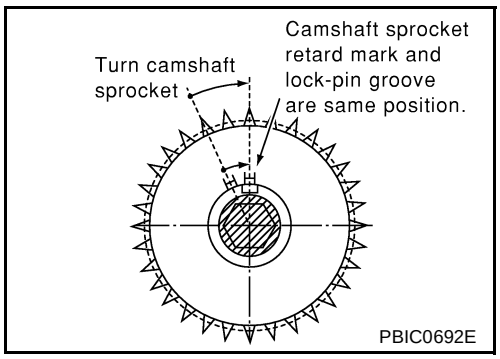
Never turn camshaft sprocket in retard direction (opposite direction shown in the figure).

d. Be careful not to turn vane of camshaft sprocket when tightening camshaft sprocket bolt. (Camshaft is fixed by hexagonal part of camshaft.)

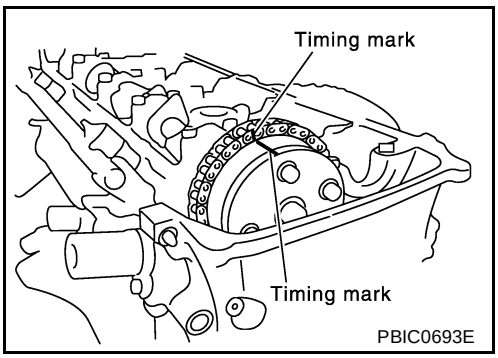


e. Turn camshaft sprocket in retard direction (clockwise direction) after tightening camshaft sprocket bolt, and confirm that camshaft sprocket locks at full retard position.

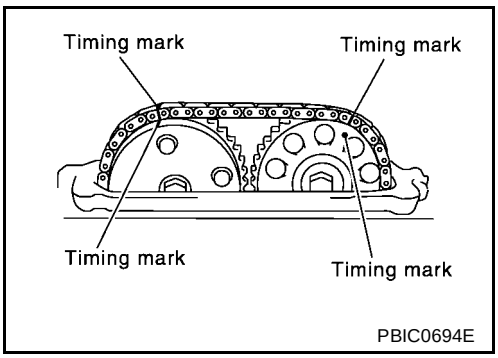
f. Confirms that the camshaft sprocket retard marks “H” corresponded to lock pin groove.



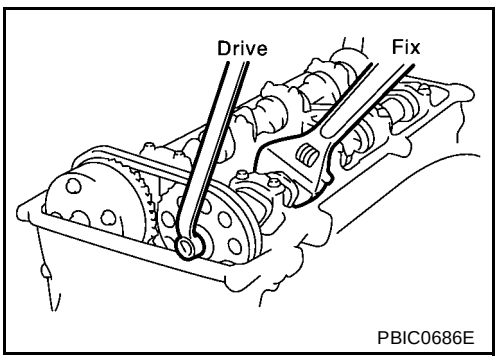
g. Check marks of timing chain and camshaft sprockets. Assemble timing chain to the camshaft sprocket.



h. Check mark of the timing chain and sprocket of exhaust. Assemble timing chain to the sprocket of exhaust.



i. Fix camshaft to hexagonal part and tighten camshaft sprocket bolt.



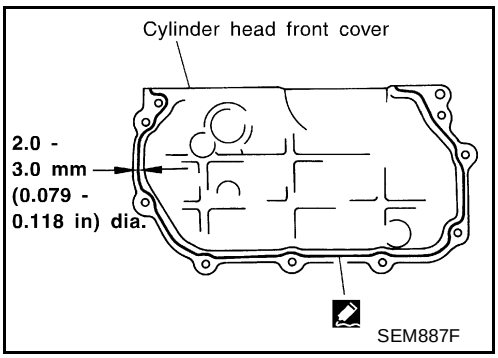
6. Install chain tensioner.

a. Compress plunger and hold it with a pin to install.

CAUTION:
If plunger has been removed from tensioner, insert plunger to tensioner straight to prevent O-ring inside tensioner from being twisted or damaged.

b. After installing chain tensioner, remove the pin and release plunger.

7. Install cylinder head front cover.
   - Apply a continuous bead of liquid gasket at location shown in figure.
   - Align cylinder head front cover with knock pin on cylinder head to install.



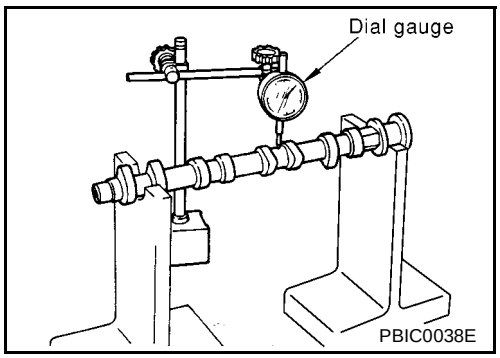
8. Check and adjust valve clearances.
   Refer to EM-44, "Valve Clearance" .
9. For the following operations, perform steps in the reverse order of removal.

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)

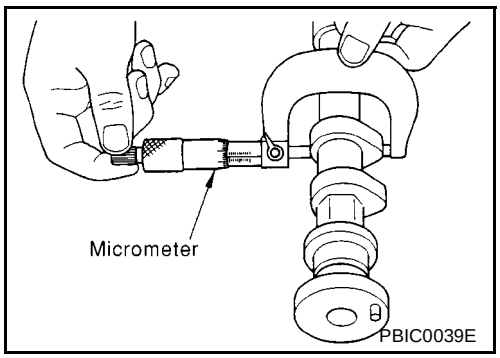


Camshaft Cam Height

1. Measure camshaft cam height.

Standard cam height:
Intake: 40.217 - 40.407 mm (1.5833 - 1.5908 in)
Exhaust: 39.205 - 39.395 mm (1.5435 - 1.5510 in)

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

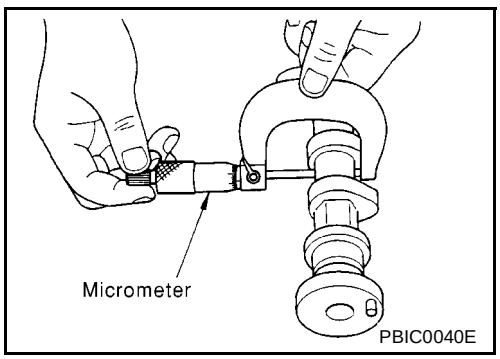


Camshaft Journal Clearance

Outer Diameter of Camshaft Journal

- Measure outer diameter of camshaft journal.

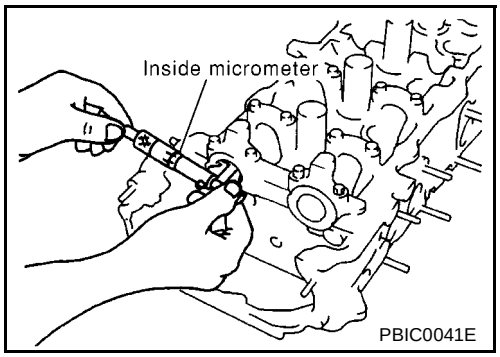
Standard outer diameter:
No. 1: 27.935 - 27.955 mm (1.0998 - 1.1006 in)
No. 2, 3, 4, 5: 23.935 - 23.955 mm (0.9423 - 0.9431 in)



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 - 1.1032 in)
No. 2, 3, 4, 5 : 24.000 - 24.021 mm (0.9449 - 0.9457 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.

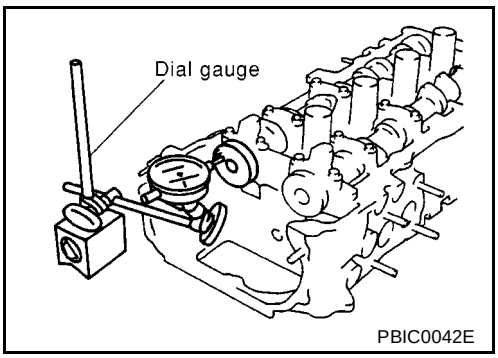
Camshaft End Play

- 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.

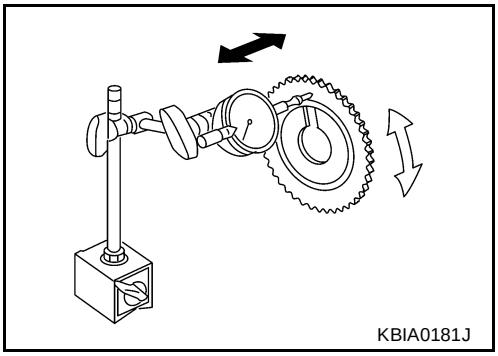


Camshaft Sprocket Runout

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

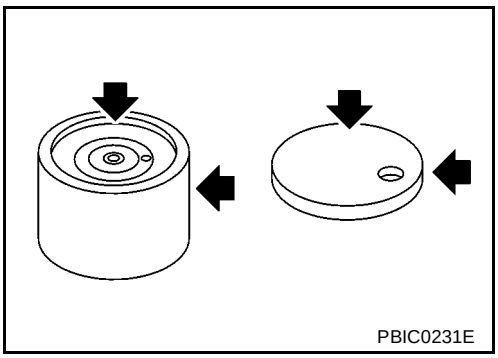
Runout : Less than 0.15 mm (0.0059 in)

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



Valve Lifter

- Check if surface of valve lifter and adjusting shim has any wear or cracks.



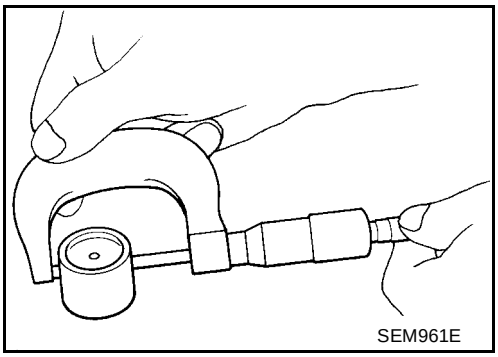
Valve Lifter Clearance

Outer Diameter of Valve Lifter

- Measure outer diameter of valve lifter.

Valve lifter outer diameter:

29.960 - 29.975 mm (1.1795 - 1.1801 in)

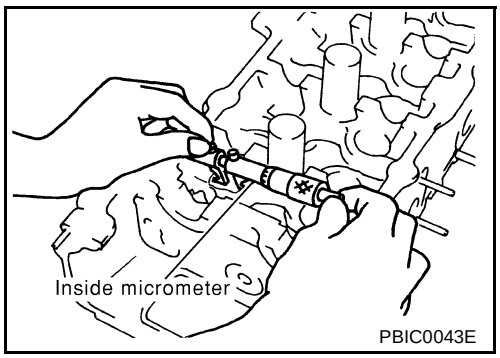


Valve Lifter Hole Diameter

- Using inside micrometer, measure diameter of valve lifter hole of cylinder head.

Standard:

30.000 - 30.021 mm (1.1811 - 1.1819 in)



Calculation of Valve Lifter Clearance

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

Standard:

0.025 - 0.061 mm (0.0001 - 0.0024 in)

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

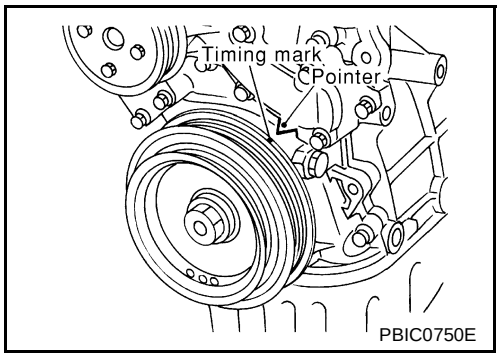
Valve Clearance

EBS00GWX

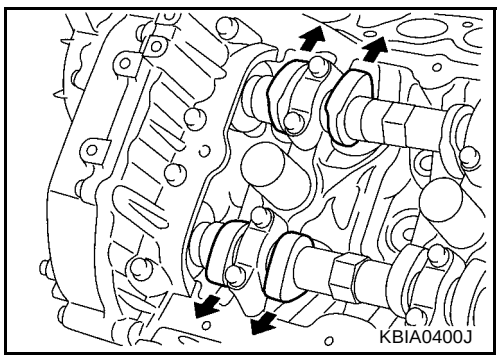
INSPECTION

- 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).

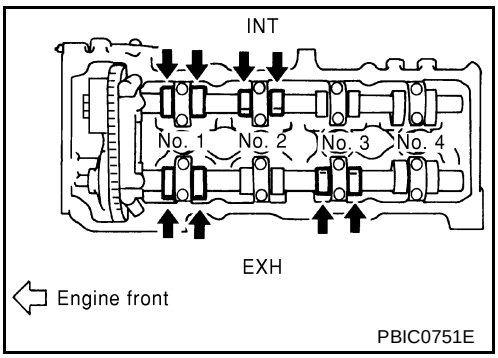
1. Warm up engine. Then stop it.
2. Remove RH splash cover.
3. Remove rocker cover.
   Refer to EM-34, "Removal and Installation" .
4. Turn crankshaft pulley in normal direction (clockwise when viewed from front) to align TDC identification notch (without paint mark) with timing indicator.



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.

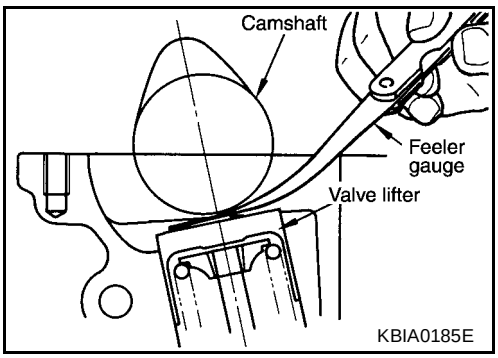


6. By referring to the figure, measure valve clearances at locations marked X as shown in the table below (locations indicated with black arrow in figure) with a feeler gauge.



- 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	**: 0.37 - 0.45 mm (0.015 - 0.018 in)**
Cold*	**Intake**	**: 0.25 - 0.33 mm (0.010 - 0.013 in)**
	Exhaust	**: 0.32 - 0.40 mm (0.013 - 0.016 in)**

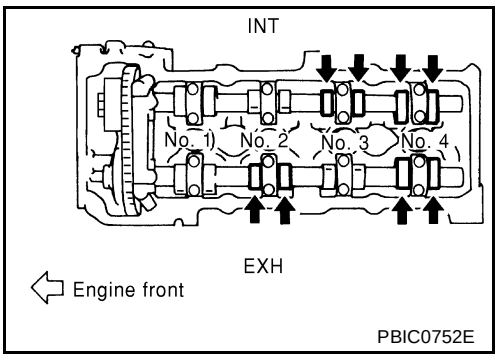
*Reference data at approximately 20°C (68°F)

CAUTION:

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

Intake	**: 0.21 - 0.47 mm (0.008 - 0.019 in)**
Exhaust	**: 0.30 - 0.56 mm (0.012 - 0.022 in)**

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.

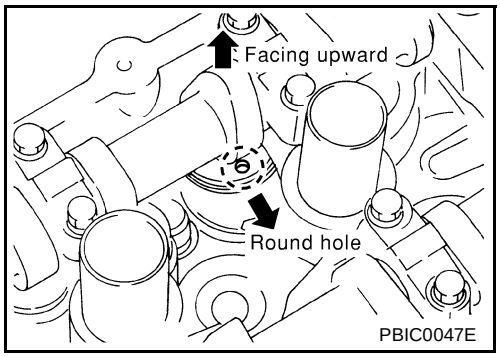
Cylinder	No.1		No.2		No.3		No.4	
Valve	INT	EXH	INT	EXH	INT	EXH	INT	EXH
Measurable				x	×		x	×

9. If out of specifications, adjust as follows.

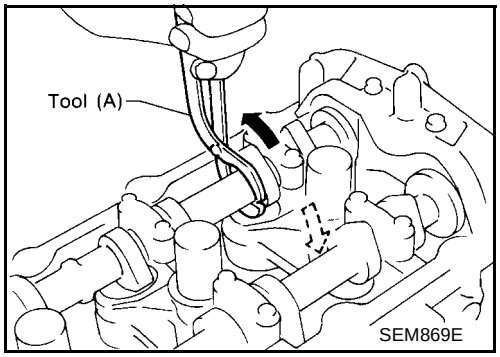
ADJUSTMENT

Adjust valve clearance while engine is cold.

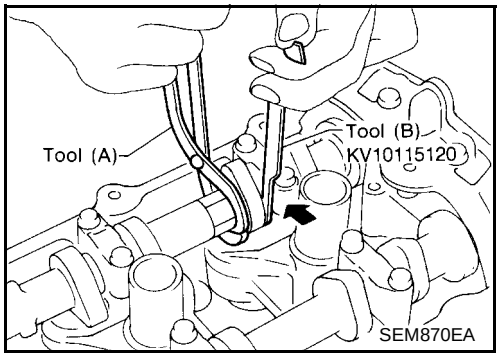
1. Turn crankshaft, to position cam lobe on camshaft of valve that must be adjusted upward.
2. Thoroughly wipe off engine oil around adjusting shim using a rag.
3. Using a extra-fine screwdriver, turn the round hole of the adjusting shim in the direction of the arrow.



4. Place Tool (A) around camshaft as shown in figure.
   Before placing Tool (A), rotate notch toward center of cylinder head (See figure.), to simplify shim removal later.
   CAUTION:
   Be careful not to damage cam surface with Tool (A).
5. Rotate Tool (A) (See figure.) so that valve lifter is pushed down.



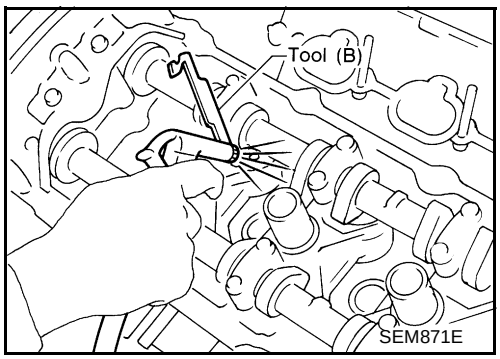
6. Place Tool (B) between camshaft and the edge of the valve lifter to retain valve lifter.
   CAUTION:
   - **Tool (B) must be placed as close to camshaft bracket as possible.**
   - **Be careful not to damage cam surface with Tool (B).**
7. Remove Tool (A).



8. Blow air into the hole to separate adjusting shim from valve lifter.

CAUTION:

- **When blowing, use goggles to protect your eye.**

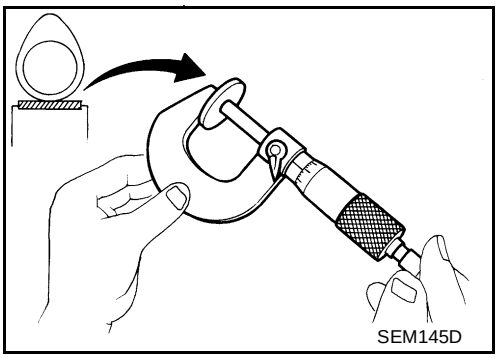


9. Remove adjusting shim using a small screwdriver and a magnetic finger.
10. Determine replacement adjusting shim size following formula.
    - Using a micrometer determine thickness of removed shim with measured at center.
    - Calculate thickness of new adjusting shim so valve clearance comes within specified values.
      R = Thickness of removed shim
      N = Thickness of new shim
      M = Measured valve clearance

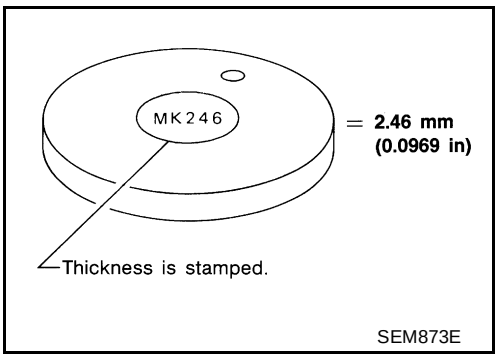
      Intake : N = R + [M – 0.37 mm (0.0146 in)]

      Exhaust : N = R + [M – 0.40 mm (0.0157 in)]

      Shims are available in 50 sizes from 2.00 mm (0.0787 in) to 2.98 mm (0.1173 in), in steps of 0.02 mm (0.0008 in).

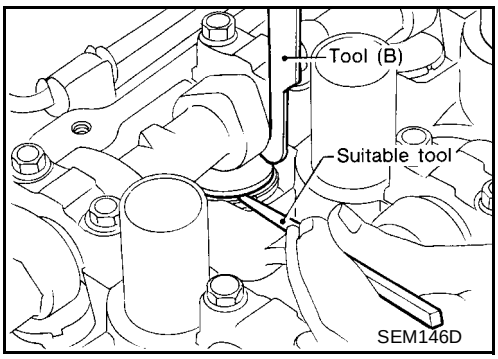

SEM145D

    - Select new shim with thickness as close as possible to calculated value.



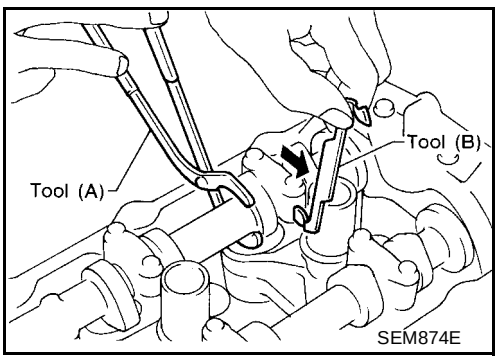
SEM873E

11. Install new shim using a suitable tool.
    - **Install with the surface on which the thickness is stamped facing down.**



SEM146D

12. Place Tool (A) as mentioned in steps 4 and 5.
13. Remove Tool (B).
14. Remove Tool (A).
15. Recheck valve clearance. (Cold value)
16. Finally check valve clearance with warmed up engine. (Hot value)



SEM874E

Valve clearance:

Unit: mm (in)

	Cold* (reference data)	Hot
Intake	0.25 - 0.33 (0.010 - 0.013)	0.32 - 0.40 (0.013 - 0.016)
Exhaust	0.32 - 0.40 (0.013 - 0.016)	0.37 - 0.45 (0.015 - 0.018)

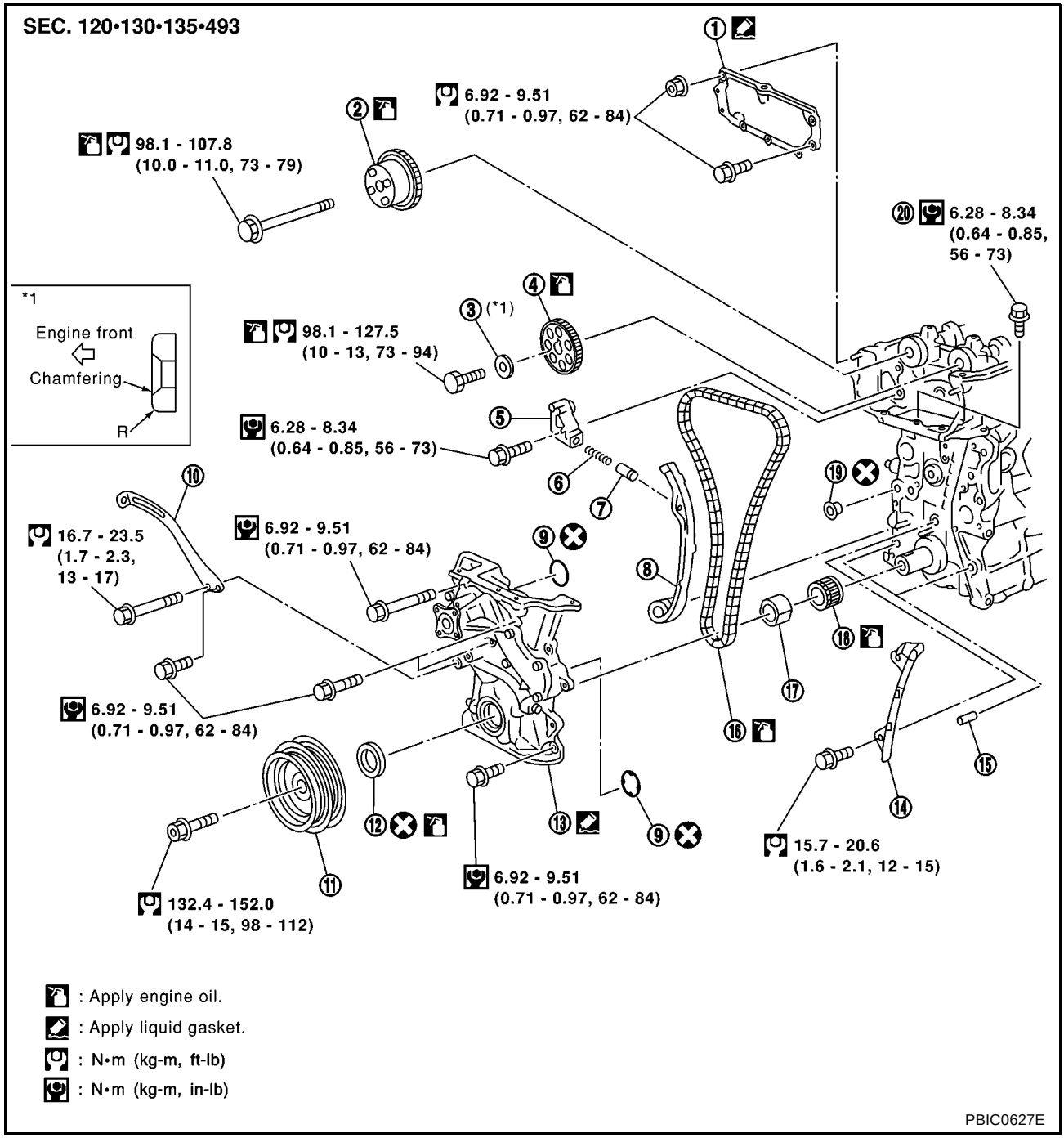
*: Approximately 20°C (68°F)

TIMING CHAIN

PFP:13028

Removal and Installation

EBS00GWY



1	Cylinder head front cover	2	Camshaft sprocket (INT)	3	Washer
4	Camshaft sprocket (EXH)	5	Chain tensioner	6	Spring
7	Plunger	8	Chain slack guide	9	O-ring
10	Power steering pump adjusting bar	11	Crankshaft pulley	12	Front oil seal
13	Front cover	14	Chain tension guide	15	Dowel pin
16	Timing chain	17	Oil pump drive spacer	18	Crank sprocket
19	O-ring (with collar)	20	Auxiliary bolt of cylinder head		

CAUTION:

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

REMOVAL

1. Place vehicle on lift.
2. Disconnect battery ground cable.
3. Remove undercover, front RH wheel and RH splash cover.
4. Drain engine coolant from radiator and cylinder block.
5. Drain engine oil from oil pan.
6. Remove drive belt.
7. Remove power steering pump from adjusting bar.
8. Remove alternator.
9. Remove ignition coils.
10. Remove rocker cover. Refer to EM-34, "Removal and Installation" .
11. Remove oil level gauge.
12. Remove exhaust front tube.
13. Remove center member.
14. Remove gusset.
15. Remove rear plate (lower) (A/T models).
16. Remove oil pan and oil strainer. Refer to EM-27, "Removal and Installation" .
17. For safe operation, and to reduce load to mount insulator, install removed center member again.
18. Remove engine front-side (right side of vehicle) engine mount.

a. Remove any parts that cause difficulties for operation around mount, or perform transfer.

b. Support cylinder block bottom surface with a transmission jack.

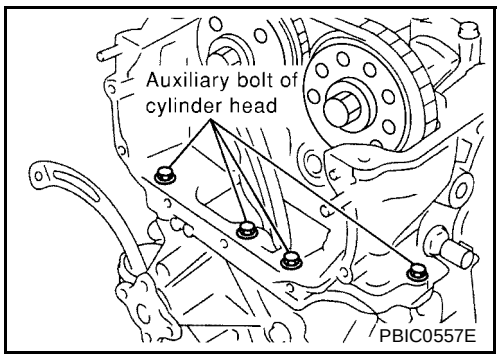
CAUTION:

- **When applying jack, use a wooden block to avoid damage to oil pan mounting surface.**
- **While performing following operations, support engine front-side with jack.**

c. Separate engine mounting insulator and bracket.

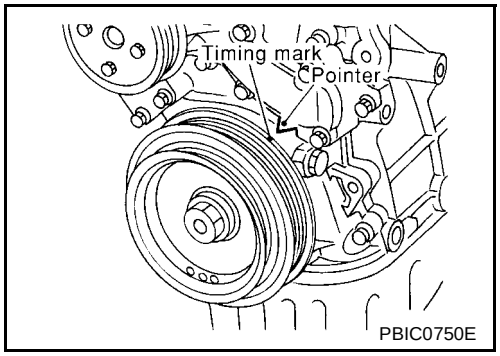
d. Remove engine mounting bracket.

19. Remove auxiliary bolts of cylinder head.

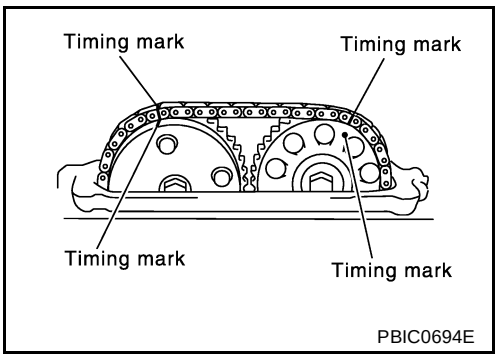


20. Set the No. 1 cylinder to the compression TDC.

a. Turn the crankshaft pulley clockwise, and align the timing indicator of the gear case to the timing mark of the crankshaft pulley.



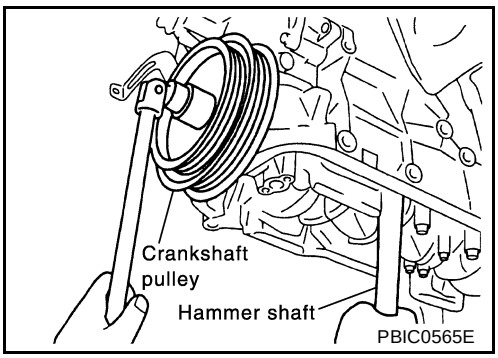
b. Make sure that the camshaft sprocket mating mark is in the position shown in the figure.
   - If the mating mark is not in position, turn the crankshaft pulley once more and position it.



21. Remove crankshaft pulley with the following procedure:
a. Secure crankshaft counter weight with handle of a hammer, and loosen crankshaft pulley bolts.

   CAUTION:
   Take care to prevent foreign material from entering the engine.

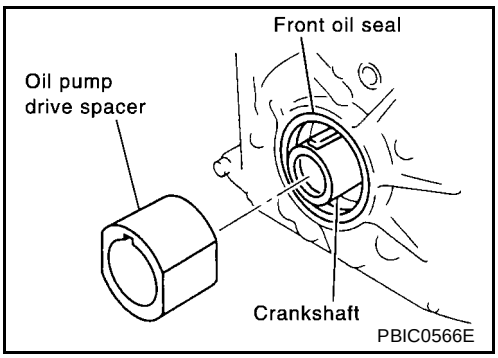
b. Remove crankshaft pulley.
22. Remove water pump pulley and idler pulley bracket assembly.



23. Remove front cover with the following procedure:
a. To increase freedom of front cover posture during removal/ installation, pull oil pump drive spacer out through front oil seal.
   - Pull it straight out using long-nose priers and two flat-bladed screwdrivers.

   CAUTION:
   Be careful not to damage side of oil pump drive spacer and front oil seal lip.

b. Remove power steering pump adjusting bar.

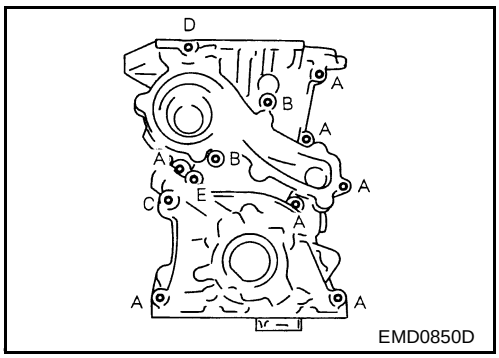


c. Remove front cover carefully.
   - Remove mounting bolts A - E shown in figure.

   NOTE:
   Bolts C and E have been removed in step b.

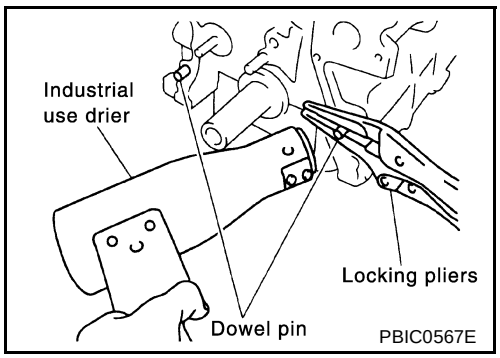
   CAUTION:
   - **When removing, be careful not to damage or bend front end of cylinder head gasket. Also after peeling off contact face between front cover and gasket, their surfaces shall be smooth.**
   - **If cylinder head gasket is damaged, replace it with new one.**

d. Remove O-rings from front cover and cylinder block.



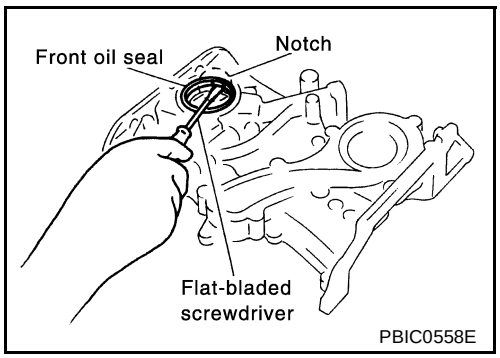
24. Pull two dowel pins for front cover out of cylinder block.
    - Heat them with industrial dryer sufficiently, then pull them out using locking pliers.

    NOTE:
    This operation is performed as preparation operation for front cover installation. This operation can be performed after removal of timing chain.

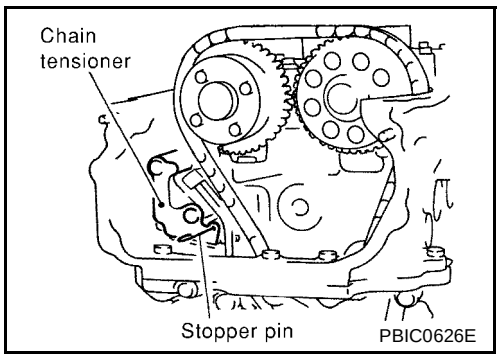


25. If front oil seal is need to be replaced, remove it from front cover.
    - Insert a flat-bladed screwdriver in notch on oil seal mounting point, and lift oil seal to remove.

    NOTE:
    Remove timing chain and its related parts with the following procedure:

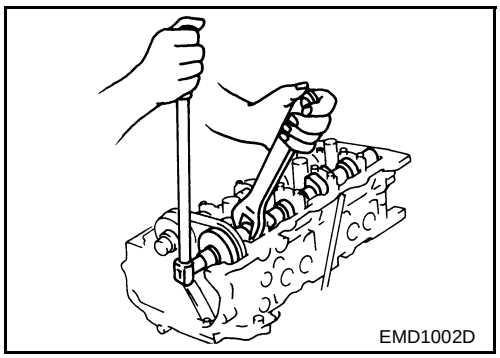


26. Remove chain tensioner.
    - Compress plunger with a flat-bladed screwdriver, hold it with a stopper pin, then remove mounting bolts.



27. Secure hexagonal part of camshaft with a spanner. Loosen mounting bolts, and remove camshaft sprockets.

    CAUTION:
    Do not secure camshaft at any point other than hexagonal part.

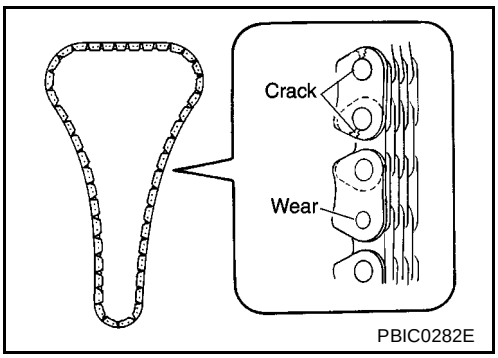


28. Remove timing chain, timing chain slack guide and tension guide.
29. Remove crankshaft sprocket.

INSPECTION AFTER REMOVAL

Timing Chain

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

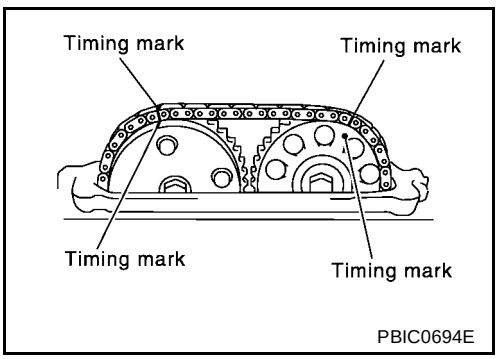


INSTALLATION

CAUTION:

- **Use a scraper to completely remove all liquid gasket adhering to mounting surface. De-grease and clean with white gasoline.**
- **After installation, wipe off any protruding liquid gasket.**

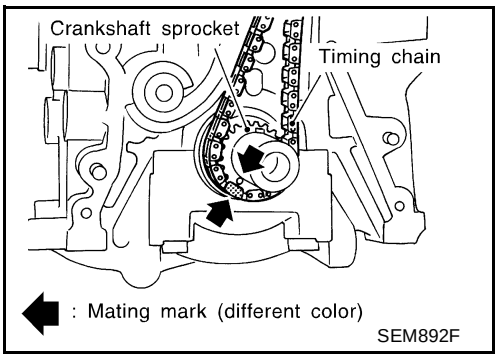
1. Install timing chain and its related parts with the following procedure:
   - For aligning positions for each sprocket and timing chain, and installed condition of their related parts, refer to figure.
   - Install each sprocket with its mating mark facing engine front side.



a. Install timing chain and crankshaft sprocket.
   - Make sure that crankshaft key points straight up (No.1 cylinder is at TDC).
   - Hook timing chain on front end of camshaft so that it will not fall off.

b. Install timing chain slack guide and tension guide.

c. Install camshaft sprocket.
   - Align mating marks for crankshaft sprocket and both camshaft sprockets.
   - Secure hexagonal part of camshaft with a spanner and tighten mounting bolts.
   - Procedure for securing is same as procedure for removal.



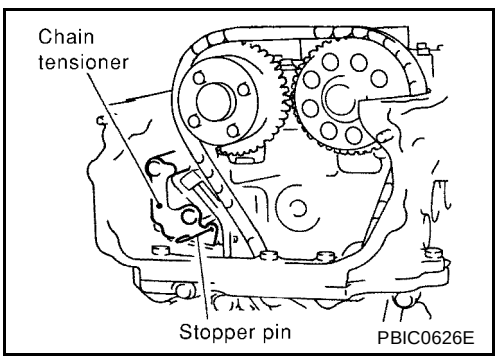
d. Install chain tensioner.
   - Compress plunger, hold it with a stopper pin, then install it.
   - After installation, remove stopper pin and release plunger.

e. Install chain guide between camshafts.

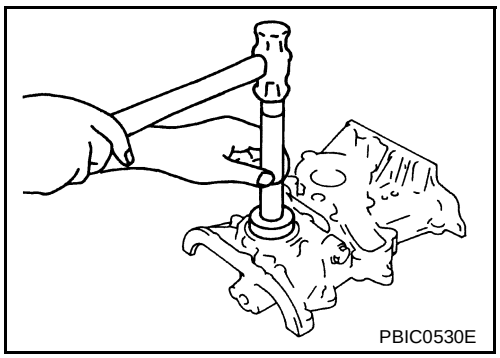
f. Make sure again that mating marks are properly aligned.

g. Install oil pump drive spacer, crankshaft pulley, and crankshaft pulley mounting bolts temporarily. Rotate crankshaft clockwise several times to make sure it rotates normally.

h. Remove parts installed temporarily in step g.



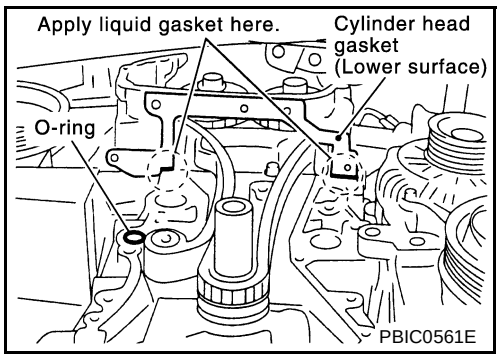
2. Install front oil seal to front cover.
   - Install it so that identification letters on oil seal will face toward front side of the engine.
   - Using an oil seal drift (commercial service tool), press oil seal in until it is flush with end surface of mounting position.
   - Make sure that oil seal outer circumference is free from damage and burr.



3. Install front cover with the following procedure:

a. Install O-ring to cylinder block.

b. Using a flat-bladed screwdriver, apply a continuous bead of liquid gasket to contact surface between cylinder head gasket lower surface and cylinder block (2 locations shown in figure).

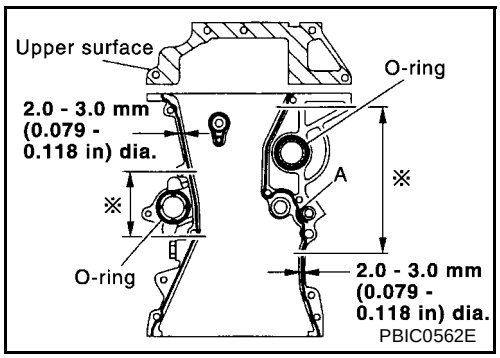


c. Apply a continuous bead of liquid gasket to back surface of front cover (location shown in figure).

CAUTION:
- **Do not apply liquid gasket to groove A shown in figure.**
- **Especially for locations indicated by * mark in figure, strictly observe application range of liquid gasket.**

d. Apply liquid gasket to top surface of front cover lightly and evenly.

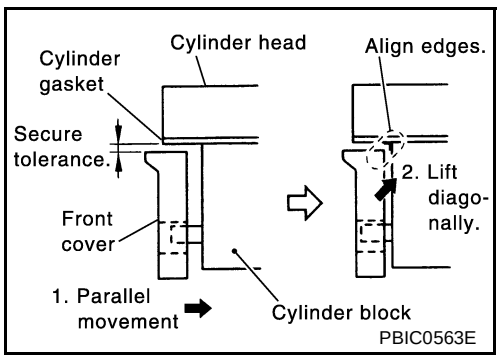
e. Install O-ring to back surface of front cover.



f. With socket of oil pump inner rotor placed on crankshaft top surface (clearance between front cover top surface and cylinder head gasket lower surface is secured), move front cover close to cylinder block. (Right side in figure)

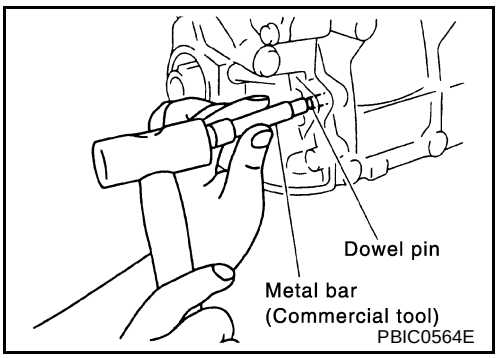
g. Lift front cover at an angle and install it to mounting position so that front cover will come in contact with both cylinder head gasket lower surface and cylinder block front surface at the same time. (Right side in figure)

CAUTION:
- **During work, be sure not to damage cylinder head gasket.**
- **When installing, avoid discontinuous bead of liquid gasket caused by allowing it to adhere to an unnecessary area.**



h. Install front cover with mounting bolts temporarily so that front cover will not move.

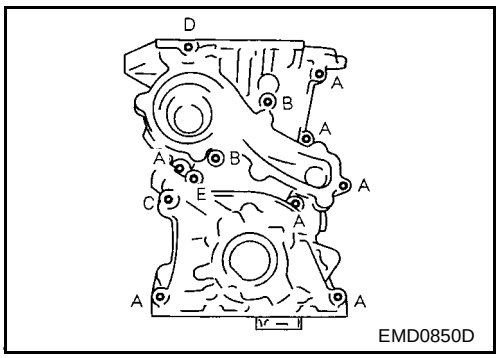
i. Press fit dowel pin into cylinder block through front cover.



j. Tighten front cover mounting bolts temporarily.
- A [M6 x 20 mm (0.79 in)], B [M6 x 40 mm (1.57 in)], C [M8 x 70 mm (2.76 in)], D [M6 x 73 mm (2.87 in)]
- Bolt C also secures power steering pump adjusting bar.
- Bolt E [M6 x 12 mm (0.47 in)] is for installing power steering pump adjusting bar.

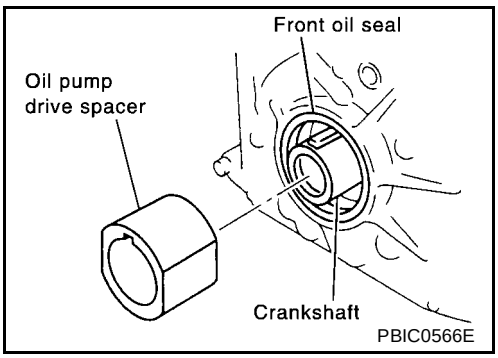
k. Tighten cylinder head auxiliary bolts (M6) temporarily.

l. Tighten front cover mounting bolts and cylinder head auxiliary bolts to specified torque.



4. Install oil pump drive spacer.
- When installing, align with flat of oil pump inner rotor.
- If they are not aligned, rotate inner rotor with a flat-bladed screwdriver to align them.

CAUTION:
Be careful not to damage oil seal lips.



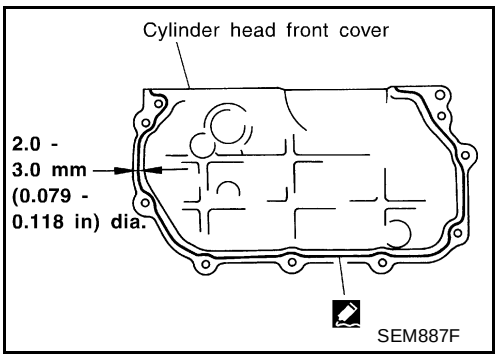
5. Install water pump pulley and idler pulley bracket assembly.
- Install water pump pulley with its identification paint for installation direction facing front of the engine.

6. Install crankshaft pulley.
- When installing it, make sure that front oil seal lip is not inverted and garter spring is in position.
- For direction of mounting bolt washer, refer to “Component Parts Location”.
- With same procedure as “removal”, secure crankshaft, and tighten mounting bolts.

7. Install cylinder head front cover.
- Apply liquid gasket to cylinder head front cover.
- Use Genuine Liquid Gasket or equivalent.

8. Install engine front mounting bracket.

9. Install remaining parts in the reverse order of removal.



INSPECTION AFTER INSTALLATION

- In order to allow liquid gasket to be cured, perform inspection at least 30 minutes after the last step in which parts sealed with liquid gasket are installed.

- With engine warmed up, check each part for engine oil leakage.

CYLINDER HEAD

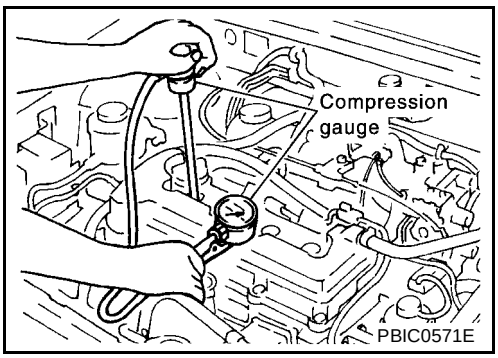
PFP:11041

On-Vehicle Service

EBS00GV8

CHECKING COMPRESSION PRESSURE

1. Warm up engine thoroughly. Then, stop it.
2. Release fuel pressure. Refer to EC-58, "FUEL PRESSURE RELEASE" (WITH EURO-OBD), EC-591, "FUEL PRESSURE RELEASE" (WITHOUT EURO-OBD).
3. Remove ignition coil and spark plug from each cylinder.
   Refer to IGNITION COIL EM-29, "Removal and Installation" and SPARK PLUG EM-30, "Removal and Installation" .
4. Connect engine tachometer (not required in use of CONSULT-ll).
5. Disconnect fuel injector harness connector so that no fuel is injected.



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.

Use compressor tester whose end (rubber portion) is less than 20 mm (0.79 in) dia. Otherwise, it may be caught by cylinder head during removal.

SEM387C

Compression pressure [kPa (bar, kg/cm^2 , psi)/rpm]

Engine type	QG16DE	QG18DE
Standard	1,353 (13.53, 13.8, 196)	1,324 (13.24, 13.5, 192)
Limit	1,157 (11.57, 11.8, 168)	1,128 (11.28, 11.5, 164)
Difference limit among cylinders	98 (0.98, 1.0, 14)	98 (0.98, 1.0, 14)

CAUTION:

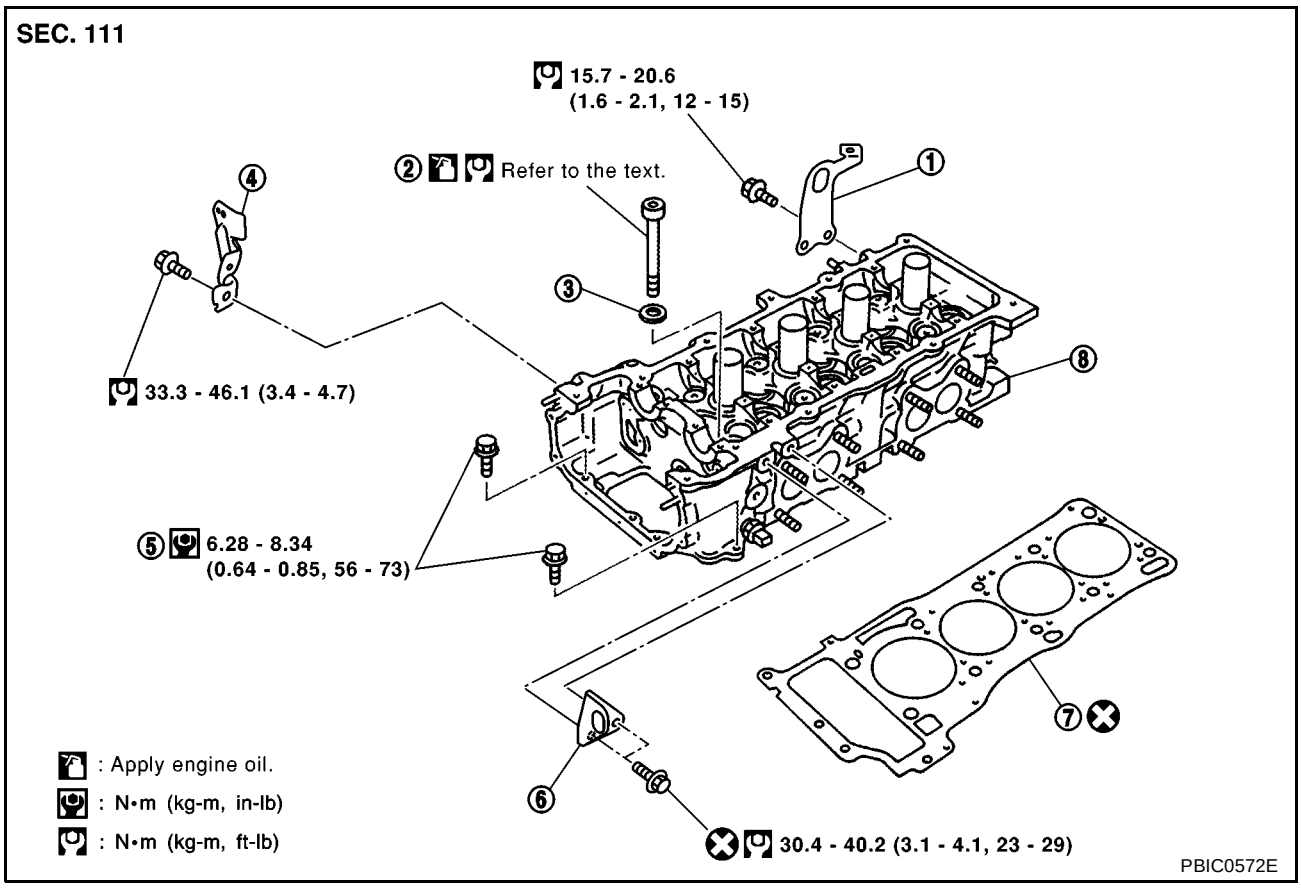
Always use a fully changed battery to obtain specified engine speed.

- 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

EBS00GWZ

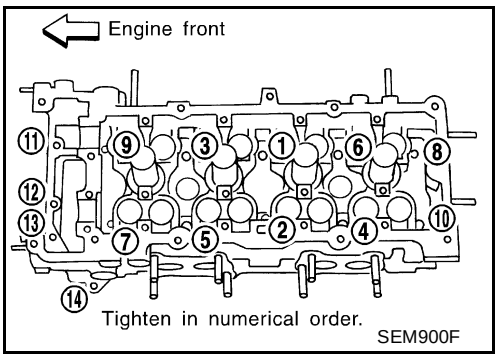


1	Rear engine slinger	2	Cylinder head bolt	3	Washer
4	Bracket	5	Auxiliary bolt of cylinder head	6	Front engine slinger
7	Cylinder head gasket	8	Cylinder head assembly		

REMOVAL

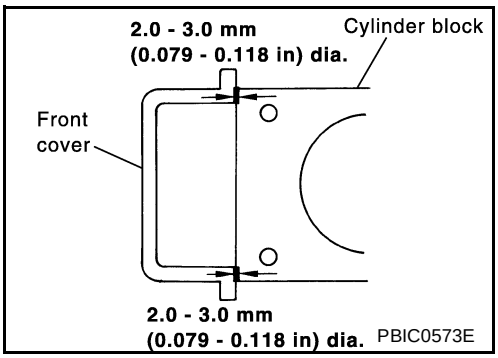
1. Release fuel pressure. Refer to EC-58, "FUEL PRESSURE RELEASE" (WITH EURO-OBD), EC-591, "FUEL PRESSURE RELEASE" (WITHOUT EURO-OBD).
2. Remove undercover.
3. Drain engine coolant. Refer to CO-8, "Changing Engine Coolant" .
4. Remove exhaust front tube. Refer to EX-3, "EXHAUST SYSTEM" .
5. Remove air duct. Refer to EM-17, "Removal and Installation" .
6. Remove intake manifold. Refer to EM-19, "Removal and Installation" .
7. Remove exhaust manifold. Refer to EM-23, "Removal and Installation" .
8. Remove thermostat housing. Refer to CO-20, "Removal and Installation" .
9. Remove ignition coil. Refer to EM-29, "Removal and Installation" .
10. Remove rocker cover. Refer to EM-34, "Removal and Installation" .
11. Remove camshaft. Refer to EM-133, "Removal and Installation" .

12. Remove cylinder head loosening bolts in reverse order shown in the figure.
13. Remove cylinder head gasket.



INSTALLATION

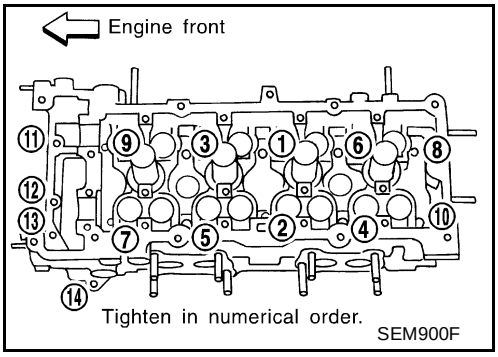
1. Apply liquid gasket to positions shown in figure, then install cylinder head gasket.



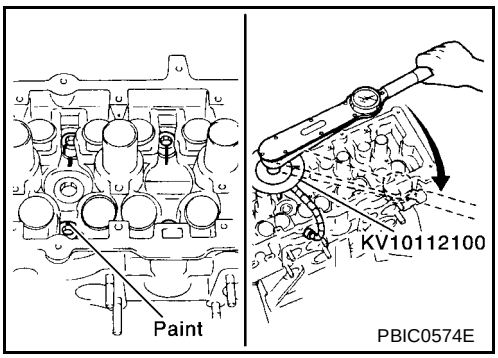
2. Install cylinder head assembly, tighten bolts (1) to (10) in numerical order shown in figure with the following procedure:

CAUTION:
In step “d”, loosen bolts in the reverse order of that indicated in figure.

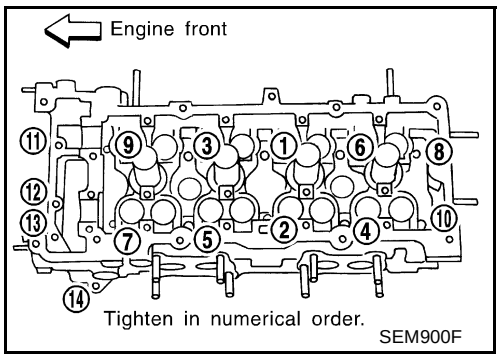
a. Apply new engine oil to threads and seating surface of mounting bolts.
b. Tighten all bolts to 29.4 N·m (3.0 kg-m, 22 ft-lb).
c. Tighten all bolts to 59 N·m (6.0 kg-m, 22 ft-lb).
d. Completely loosen to 0 N·m (0 kg-m, 0 ft-lb).
e. Tighten all bolts to 27.4 to 31.4 N·m (2.8 to 3.2 kg-m, 21 to 23 ft-lb).
f. Turn all bolts 50° to 55° (target: 50°) degrees clockwise.



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

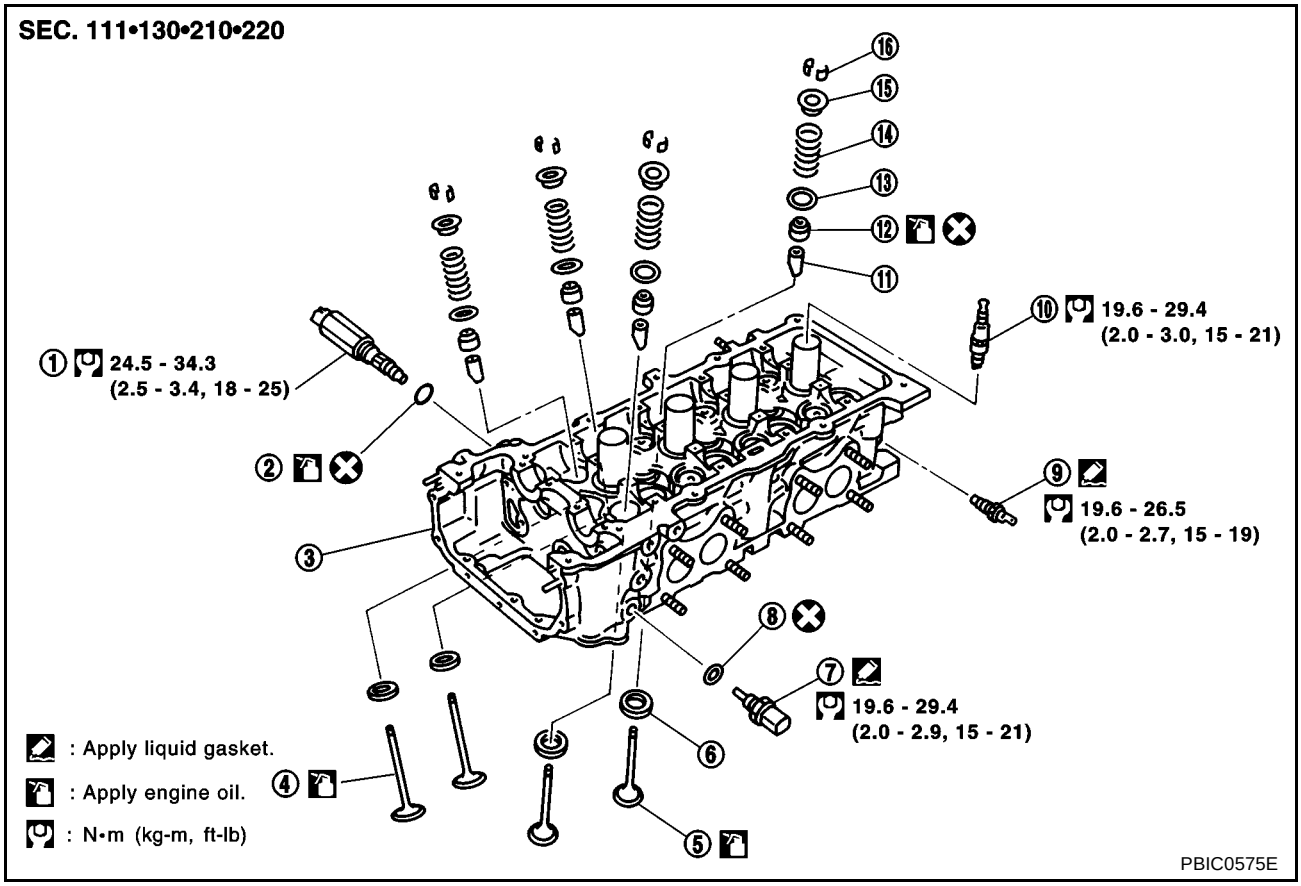


3. Tighten cylinder auxiliary bolts (11) to (14) in numerical order shown in figure.
   - Pay attention to shank length under bolt head. [11: 20 mm (0.79 in), 12 - 14: 25 mm (0.98 in)]



Disassembly and Assembly

EBS00GVA



1	Intake valve timing control solenoid valve	2	O-ring	3	Cylinder head
4	Valve (INT)	5	Valve (EXH)	6	Valve seat
7	Engine coolant temperature sensor	8	Copper washer	9	Thermal transmitter
10	Spark plug	11	Valve guide	12	Valve oil seal
13	Valve spring seat	14	Valve spring	15	Valve spring retainer
16	Valve collet				

CAUTION:

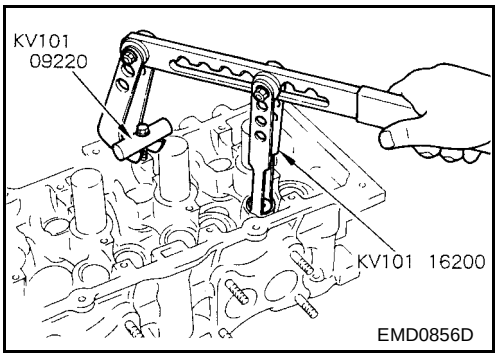
- **When installing camshafts, chain tensioners, oil seals or other sliding parts, lubricate contacting surface with new engine oil.**
- **Apply new engine oil to threads and seat surface when installing cylinder head, camshaft sprocket, crankshaft pulley and camshaft bracket.**
- **Attach tags to valve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

DISASSEMBLY

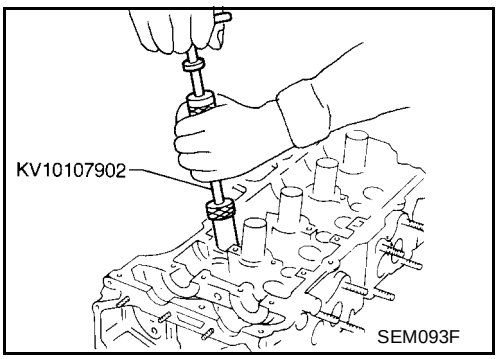
1. Remove adjusting shim and valve lifter.

- 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.
4. Push valve stem to combustion chamber side, and remove valve.
   - Inspect valve guide clearance before removal. Refer to EM-157, "VALVE GUIDE CLEARANCE" .
   - Confirm installation point.

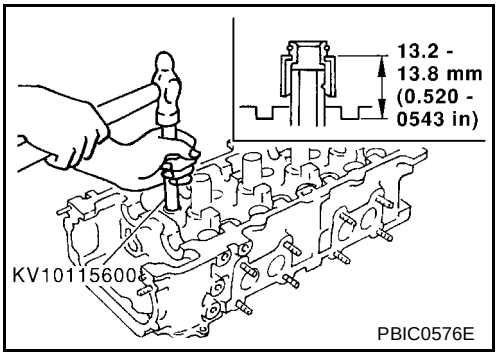


5. Remove valve oil seal with valve oil seal puller.
6. Remove valve spring seat.
7. When valve seat must be replaced, refer to EM-64, "VALVE SEAT REPLACEMENT" .
8. When valve guide must be replaced, refer to EM-62, "VALVE GUIDE REPLACEMENT" .
9. Remove spark plug with spark plug wrench.
10. Remove thermal transmitter and engine coolant temperature sensor.

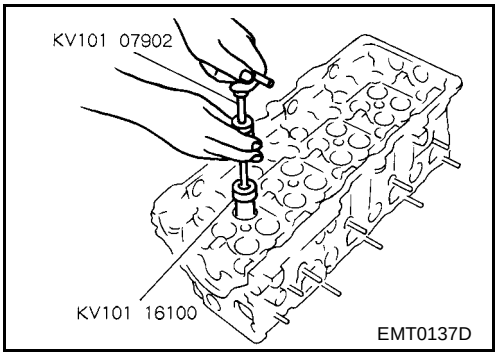


ASSEMBLY

1. Install valve guide. Refer to EM-62, "VALVE GUIDE REPLACEMENT" .
2. Install valve seat. Refer to EM-64, "VALVE SEAT REPLACEMENT" .
3. Install valve oil seal.
   - Install with valve oil seal drift to match dimension in illustration.
4. Install valve spring seat.
5. Install valve.
   - Install larger diameter to intake side.



6. Install valve spring.
   - Install smaller pitch identification color side to cylinder head side.
   - Confirm identification color of valve spring.
7. Install valve spring retainer.
8. 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.
9. Install adjusting shim and valve lifter.
10. Install thermal transmitter and engine coolant temperature sensor.
    - Apply genuine liquid gasket or equivalent to the thread.
11. Install spark plug with spark plug wrench.



Inspection After Disassembly

EBS00GVB

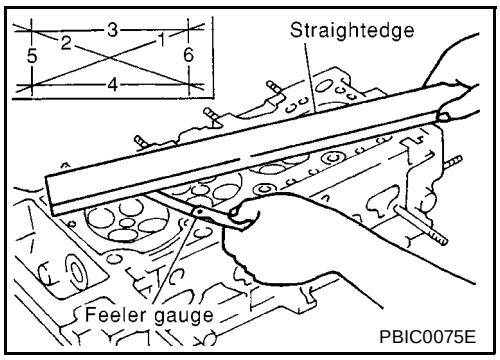
CYLINDER HEAD DISTORTION

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.

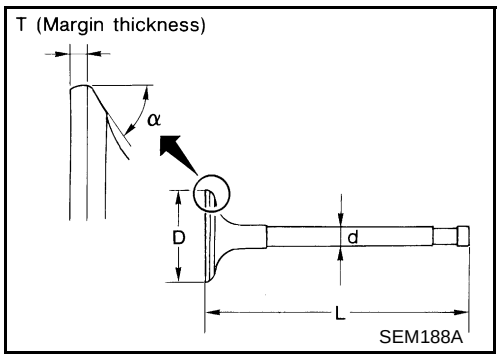
2. At each of several locations on bottom surface of cylinder head, measure distortion in six directions.

   Limit : 0.1 mm (0.004 in)



VALVE DIMENSIONS

Check dimensions of each valve. For dimensions, refer to SDS EM-192, "VALVE" .



VALVE GUIDE CLEARANCE

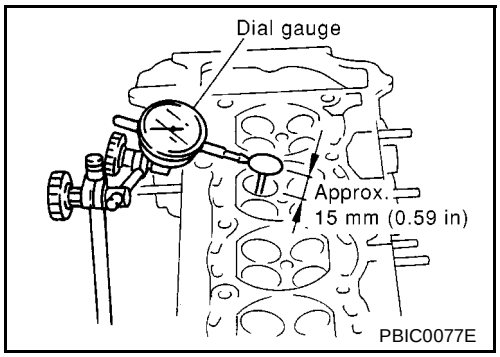
Perform this inspection before removing valve guide.

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 - 0.050 mm (0.0008 - 0.0020 in)

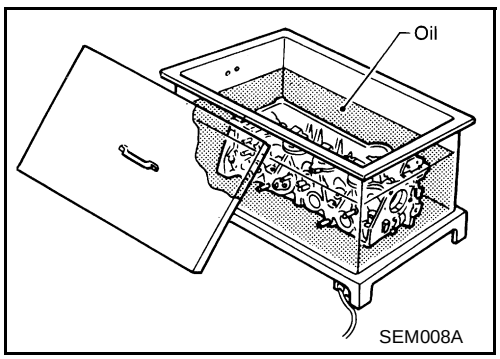
Exhaust : 0.040 - 0.070 mm (0.0016 - 0.0028 in)



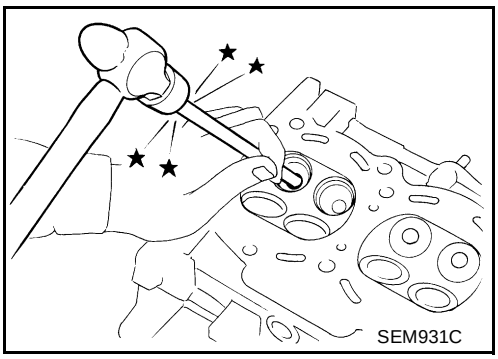
VALVE GUIDE REPLACEMENT

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.



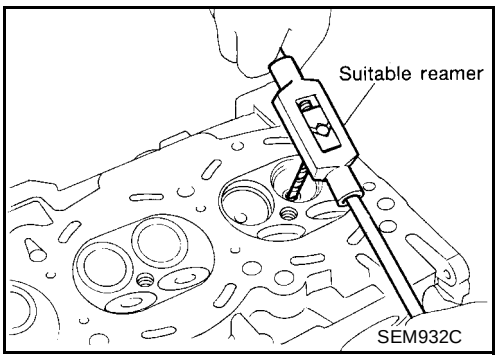
3. Ream cylinder head valve guide hole.

Valve guide hole diameter (for service parts):

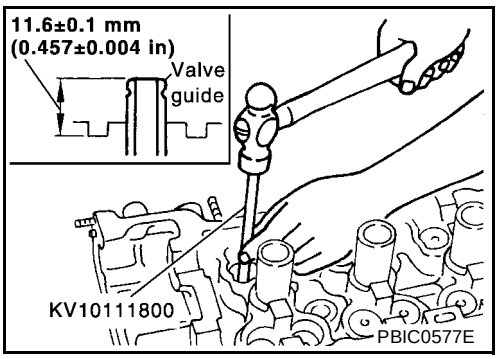
Intake and exhaust

: 9.685 - 9.696 mm (0.3813 - 0.3817 in)

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



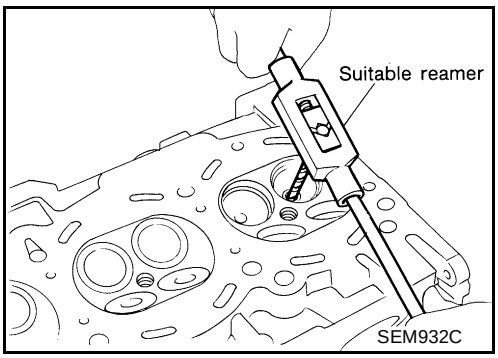
5. Press valve guide from camshaft side to dimensions as in illustration.



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

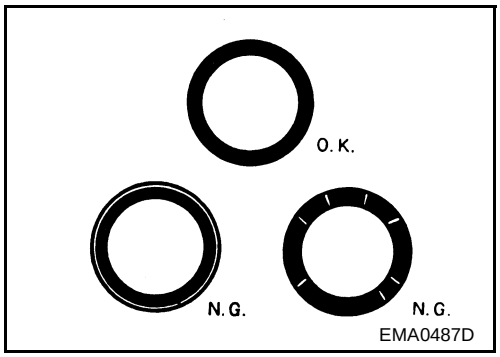
Standard

Intake and exhaust **: 5.500 - 5.515 mm (0.2165 - 0.2171 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.



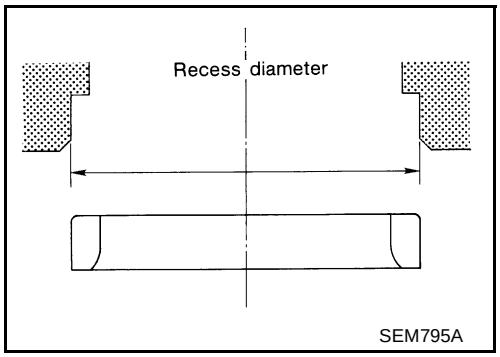
VALVE SEAT REPLACEMENT

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

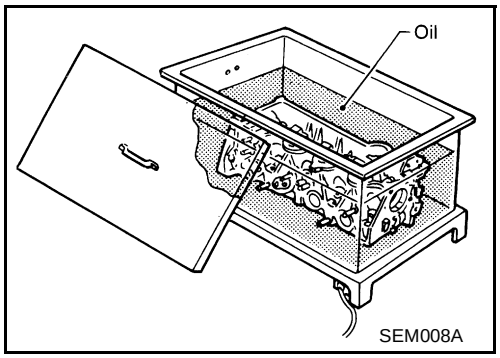
1. Bore out old seat until it collapses. Boring should not continue beyond the bottom face of the seat recess in cylinder head. Set the machine depth stop to ensure this.
2. Ream cylinder head recess diameter for service valve seat.

   Oversize [0.5 mm (0.020 in)]:
   Intake : 31.5 mm (1.240 in)
   Exhaust : 26.5 mm (1.043 in)

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

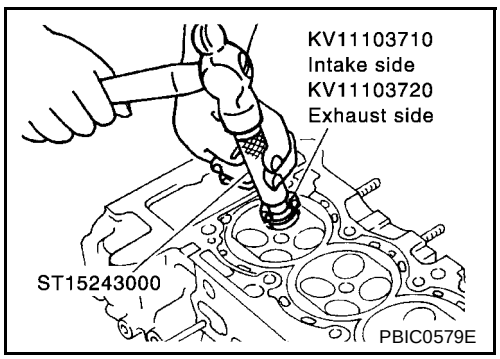


3. Heat cylinder head to 110 to 130°C (230 to 266°F) by soaking in heated oil.

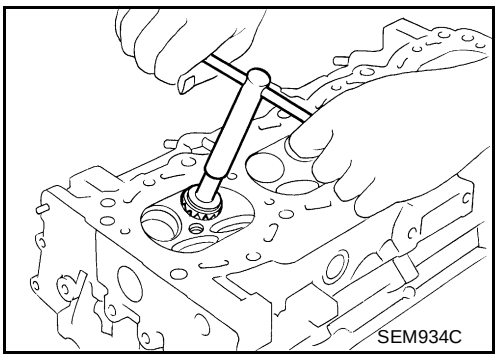


4. Provide valve seats cooled well with dry ice. Force fit valve seat into cylinder head.

   CAUTION:
   Avoid directly to touching cold valve seats.

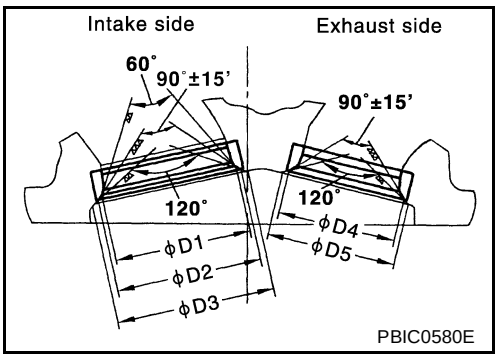


5. Using valve seat cutter set or valve seat grinder, finish the seat to the specified dimensions.



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:

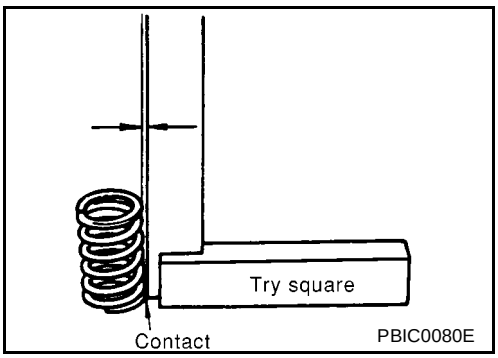
D1 dia.	**: 27.8 - 28.0 mm (1.094 - 1.102 in)**
D2 dia.	**: 29.5 - 29.7 mm (1.161 - 1.169 in)**
D3 dia.	**: 31.9 - 32.1 mm (1.256 - 1.264 in)**
D4 dia.	**: 24.5 - 24.7 mm (0.965 - 0.972 in)**
D5 dia.	**: 26.2 - 26.4 mm (1.031- 1.039 in)**

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 : 1.8 mm (0.071 in)



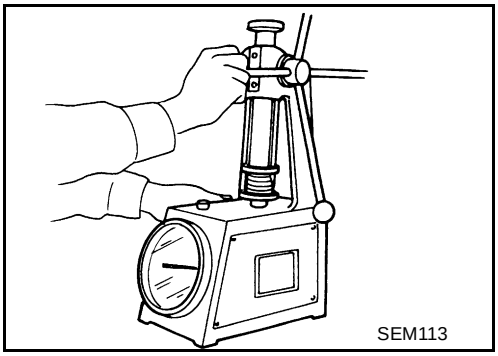
VALVE SPRING DIMENSIONS AND VALVE SPRING PRESSURE LOAD

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

CAUTION:
Do not remove valve spring seat.

Standard:

Free height	**40.0 mm (1.575 in)**
Installation height	**32.82 mm (1.2921 in)**
Installation load	**147.5 - 166.3 N (15.04 - 16.96 kg, 33.2 - 37.4 lb)**
Height during valve open	**23.64 mm (0.9307 in)**
Load with valve open	**347.8 - 392.2 N (35.5 - 40.0 kg, 78.2 - 88.2 lb)**

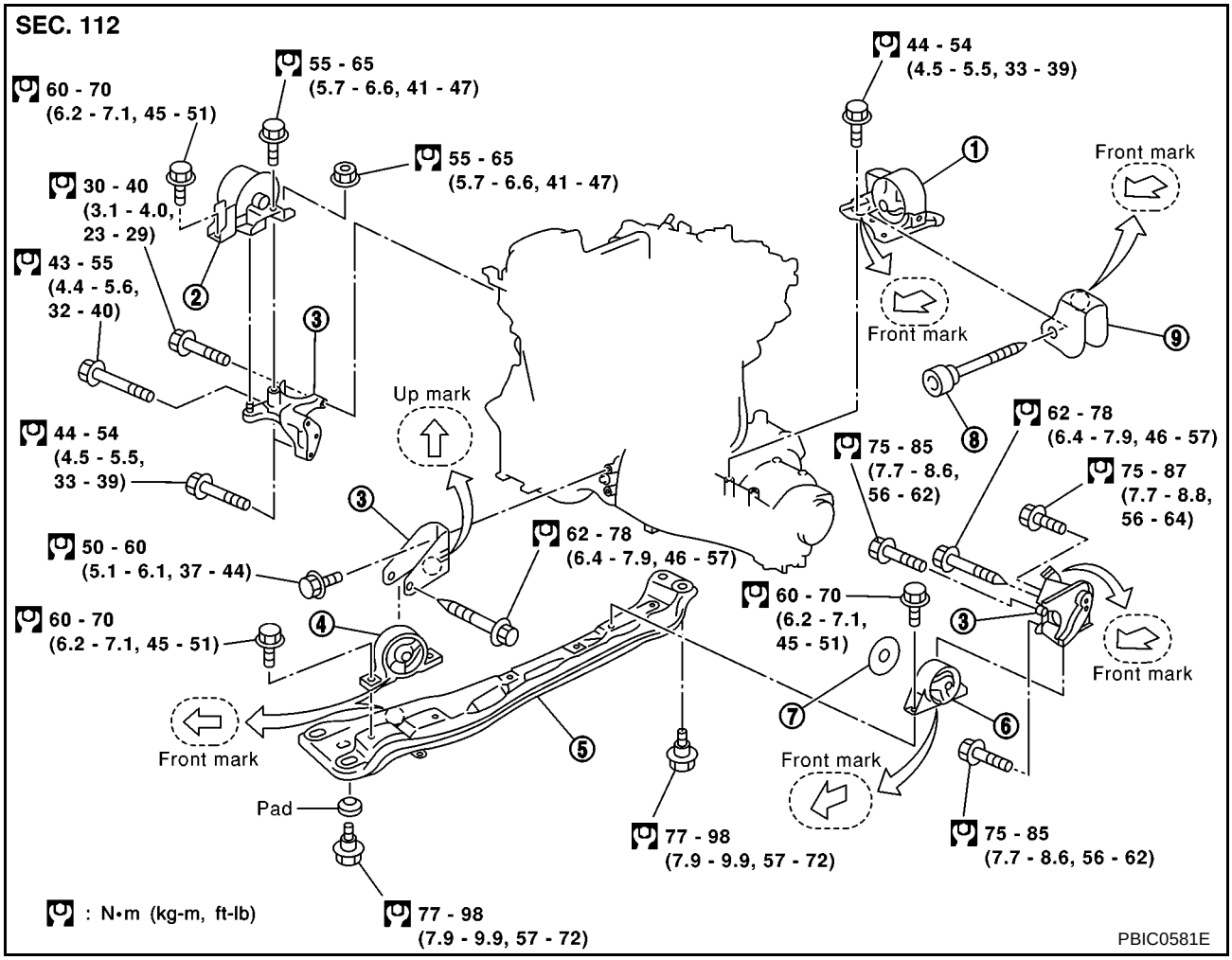


ENGINE ASSEMBLY

PFP:10001

Removal and Installation

EBS00GVC



1	LH engine mounting insulator	2	RH engine mounting bracket	3	Bracket
4	Front engine mounting insulator	5	Center member	6	Rear engine mounting insulator
7	Rubber	8	Through-bolt	9	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-37, "Garage Jack and Safety Stand" .**

REMOVAL

Description of work

Remove engine and transaxle assembly from under vehicle. Then separate and remove engine.

Preparation

1. Release fuel pressure. Refer to EC-58, "FUEL PRESSURE RELEASE" (WITH EURO-OBD), EC-591, "FUEL PRESSURE RELEASE" (WITHOUT EURO-OBD).
2. Remove engine hood.
3. Drain coolant from radiator drain plug.
4. Remove the following parts.
   - Undercover (with splash cover)
   - LH/RH front wheel
   - Battery
   - Drive belt; Refer to EM-16, "Removal and Installation" .
   - Air duct and air cleaner case assembly; Refer to EM-17, "Removal and Installation" .
   - Alternator
   - Radiator and radiator fan assembly; Refer to CO-11, "RADIATOR" .
   - Idler pulley and bracket Assembly
5. Disconnect engine room harness from the engine side and set it aside for easier work.
6. Disconnect all the body-side hoses (vacuum hose, etc.) and ground at engine side.

Engine room LH

7. Disconnect fuel feed hoses.

   CAUTION:
   Install a plug to prevent fuel from draining.
8. Disconnect heater hose, and install plug it to prevent engine coolant from draining.
9. Remove clutch operating cylinder from transaxle, and move it aside (M/T models).
10. Disconnect shift cable from transaxle (M/T models).

Engine room RH

11. Remove engine coolant reservoir tank.
12. Disconnect all hoses (such as vacuum hose) connected to body-side parts.
13. Remove air conditioner compressor with piping connected from bracket. Temporarily secure it on body with a rope to avoid putting load on it.

Vehicle underbody

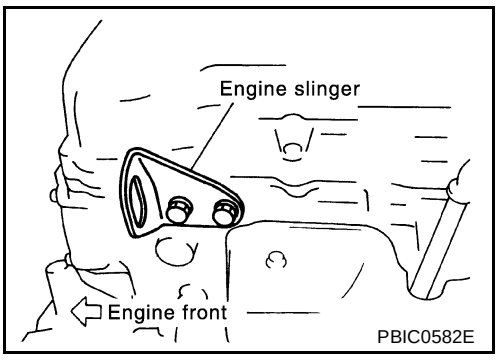
14. Remove exhaust front tube.
15. Remove M/T control rod and support rod (M/T vehicle).
16. Remove ABS wheel sensor and brake caliper. Then fix them on vehicle with rope or similar means.
17. Remove drive shaft from steering knuckle.

Removal

18. Install engine slinger to front left of cylinder head.

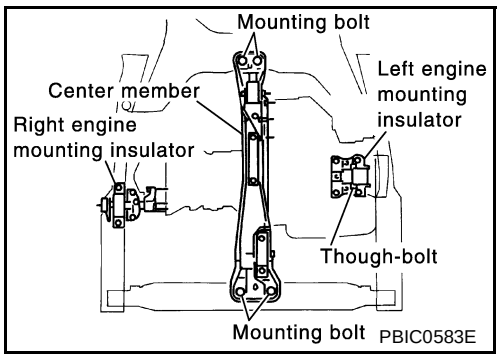
    : 30.4 - 40.2 N·m (3.1 - 4.1 kg-m, 23 - 29 ft-lb)

    NOTE:
    For rear side, use those provided on engine.



19. Install lifting chain hooks into engine slinger and suspend engine with hoist.

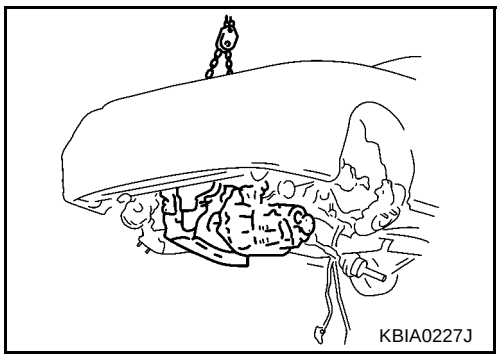
20. Remove RH engine mounting insulator.
21. Pull LH engine mounting through-bolt out.

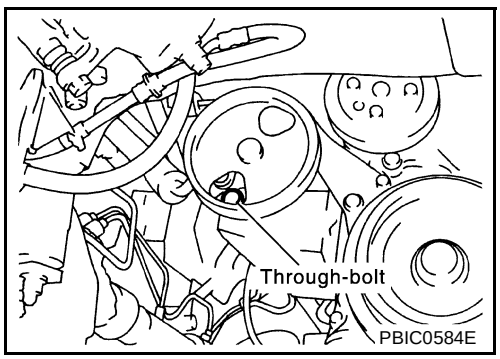


22. Remove mounting bolts at front and rear of center member.
23. Lower hoist (or raise lift), and remove engine transaxle assembly from vehicle.

CAUTION:

- **When carrying out this work, be sure to check all parts for interference with vehicle body.**
- **Be sure to check that all the applicable connections have been properly disconnected.**
- **Be careful to prevent vehicle from dropping off of the lift. Be aware that changes in center of gravity may cause balance incidents.**
- During work, remove through-bolt and remove power steering pump from engine side. Using rope or similar means, secure power steering pump to a location where they are not affected by operation.





[Disassembly]

- The following shows engine and transaxle disassembly on level ground.

CAUTION:

During disassembly, always support bottom with a wooden block. Suspend engine slinger with a hoist. Be sure to check safety of work at any time.

24. Remove center member.
25. 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.

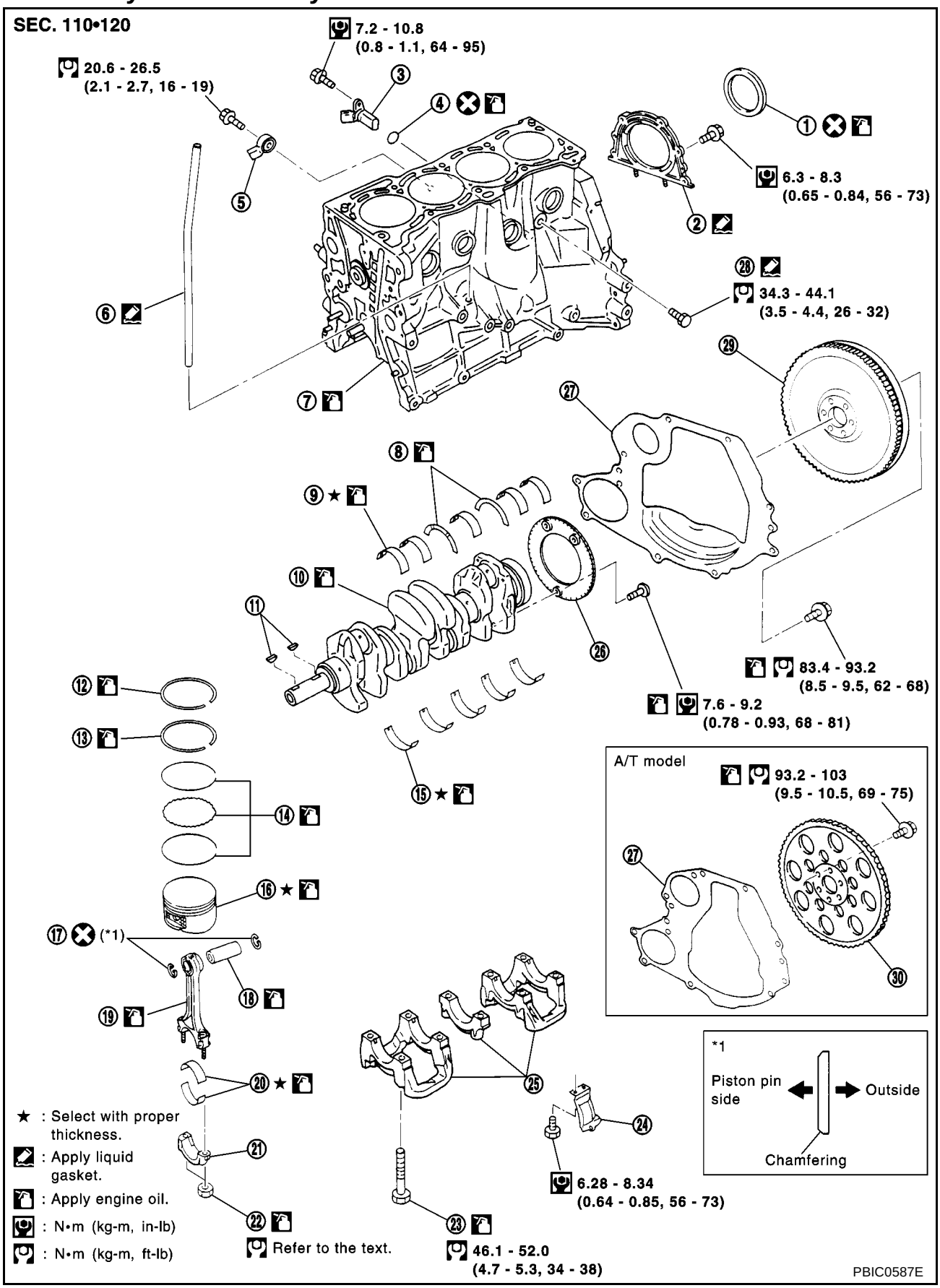
- Bleed air from passages in pipes and tubes of applicable lines.

CYLINDER BLOCK

PFP:11010

Disassembly and Assembly

EBS00GX0



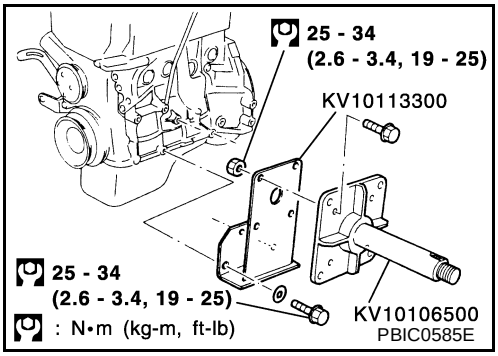
1	Rear oil seal	2	Rear oil seal retainer	3	Crankshaft position sensor (POS)
4	O-ring	5	Knock sensor	6	Oil level gauge guide
7	Cylinder block	8	Thrust bearing	9	Main bearing
10	Crankshaft	11	Key	12	Top ring
13	2nd ring	14	Oil ring	15	Main bearing
16	Piston	17	Snap ring	18	Piston pin
19	Connecting rod	20	Connecting rod bearing	21	Connecting rod cap
22	Connecting rod nut	23	Main bearing cap bolt	24	Baffle plate
25	Main bearing cap	26	Signal plate	27	Rear plate
28	Coolant drain plug	29	Flywheel	30	Drive plate

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

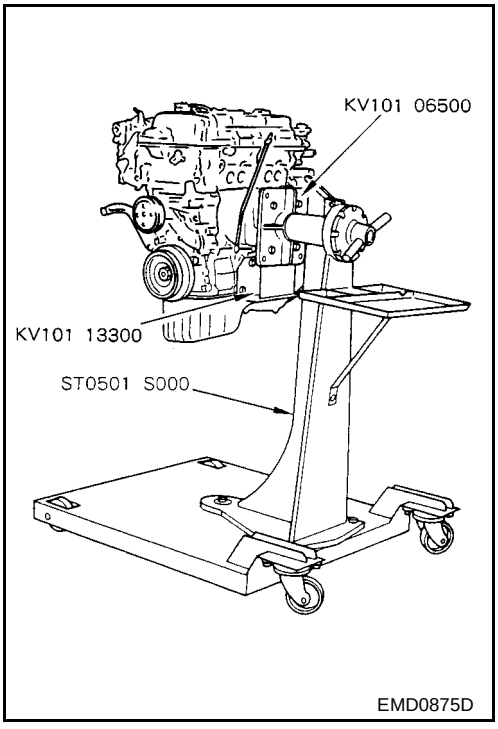
DISASSEMBLY

1. Remove engine and transaxle assembly from vehicle, and separate transaxle from engine. Refer to EM-66, "ENGINE ASSEMBLY" .
2. Mount engine on an engine stand with the following procedure.

a. Remove exhaust manifold.
b. Remove engine front bracket, alternator and air compressor bracket.
c. Install engine sub-attachment to left side of cylinder block.

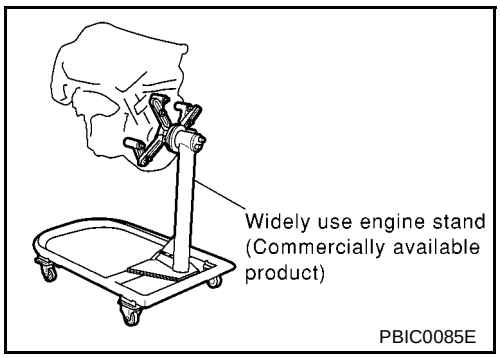


d. Lift engine, and mount it onto the engine stand.



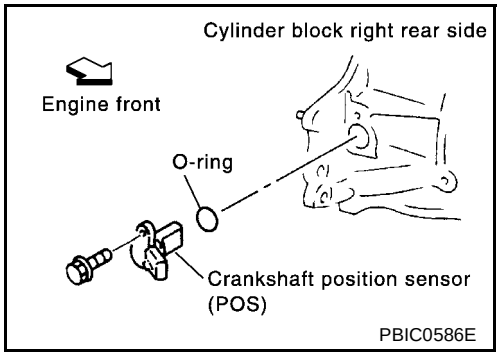
- A commercial engine stand can be used.

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



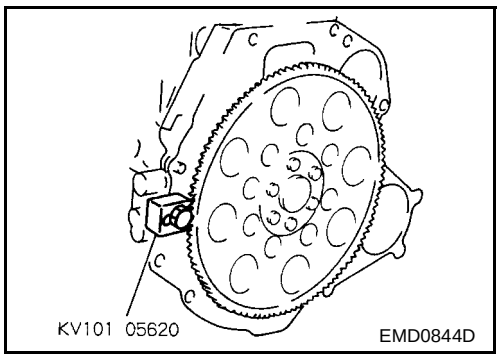
3. Drain engine oil and coolant from inside of engine.
4. Remove the following components and associated parts.
   - Fuel tube and injector assembly; Refer to EM-121, "Removal and Installation" .
   - Intake manifold; Refer to EM-116, "Removal and Installation" .
   - Intake manifold and collector assembly; Refer to EM-116, "Removal and Installation" .
   - Rocker cover; Refer to EM-34, "Removal and Installation" .
   - Oil pan and oil strainer; Refer to EM-123, "Removal and Installation" .
   - Front cover; Refer to EM-143, "Removal and Installation" .
   - Timing chain
   - Oil filter
   - Auxiliary bracket
   - Knock sensor
   - Clutch cover and clutch disc (M/T models)
   - Camshaft; Refer to EM-133, "Removal and Installation" .
   - Cylinder head; Refer to EM-153, "Removal and Installation" .
5. 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.**



6. Remove flywheel (M/T models) or drive plate (A/T models). Fix crankshaft with a ring gear stopper, and remove mounting bolts.
7. Remove rear plate.
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.

CAUTION:
- **Be careful not to damage rear oil seal retainer.**



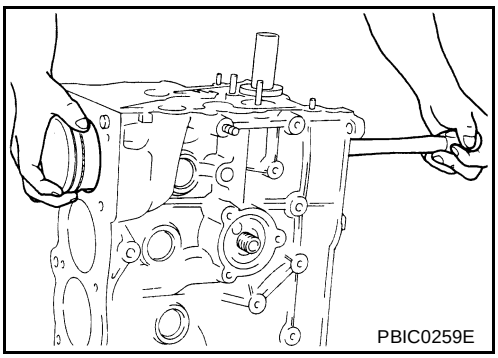
10. Remove the piston and connecting rod assembly.

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-182, "CONNECTING ROD SIDE CLEARANCE" .



11. Remove the connecting rod bearings.

CAUTION:

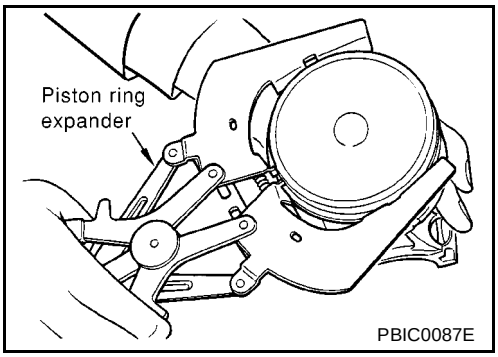
- **When removing them, note the installation position. Keep them in the correct order.**

12. Remove the piston rings form the piston.

- Use a piston ring expander.

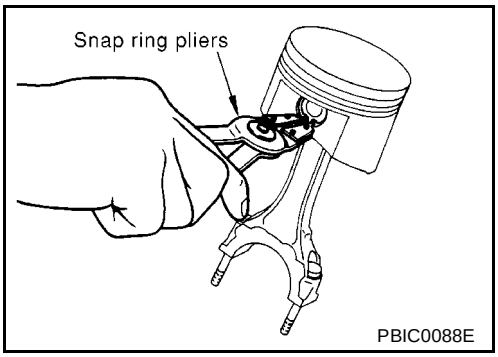
CAUTION:

- **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-183, "PISTON RING SIDE CLEARANCE" .**

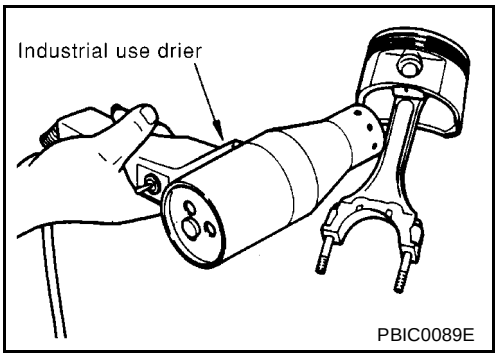


13. Remove the piston from the connecting rod as follows.

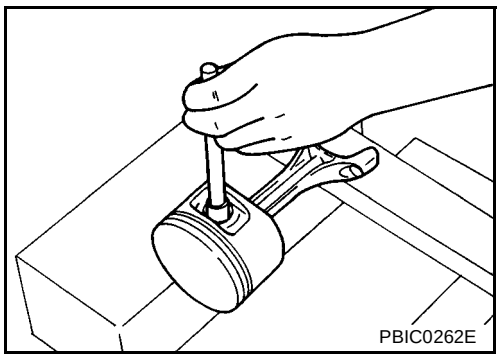
a. Using a snap ring pliers, remove the snap ring.



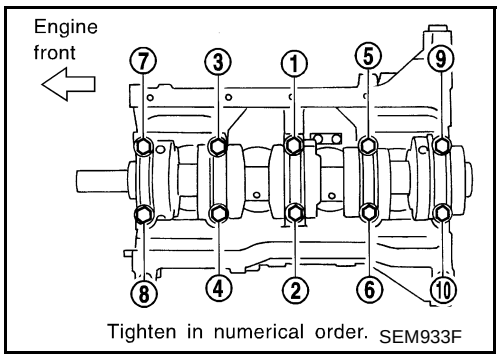
b. Heat piston to 60 to 70°C (140 to 158°F) with drier or equivalent.



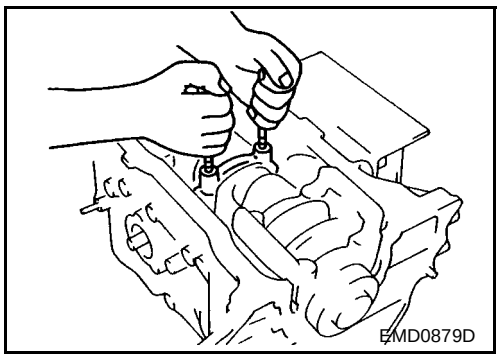
c. Push out piston pin with stick of outer diameter approximately 17 mm (0.67 in).



14. Remove main bearing cap bolts.
- Loosen main bearing cap bolts in several steps in reverse order shown in the figure, and remove them.
- Measure crankshaft side clearance before loosening main bearing cap bolts. Refer to EM-84, "CRANKSHAFT SIDE CLEARANCE" .



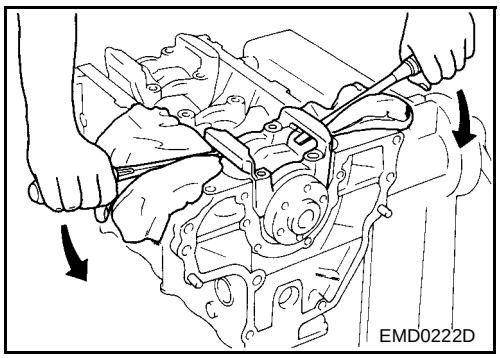
15. Remove main bearing caps.
- Using main bearing cap bolts as shown, remove center main bearing cap while shaking it back-and-forth.



- To remove front and rear main bearing caps, lever them off using screwdriver or similar tool. Or, using a plastic hammer, tap them back-and-forth.

CAUTION:

Using shop cloth or wooden block, protect oil pan mounting surface on cylinder block, so that mounting surface is not damaged.

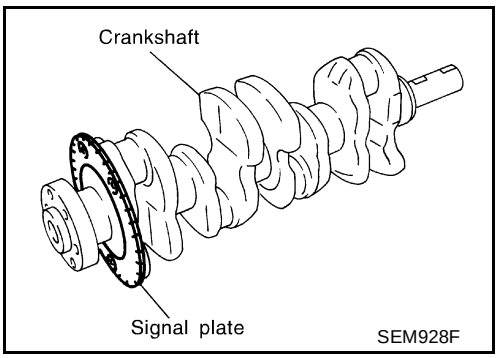


16. Remove crankshaft.

CAUTION:

- **When placing crankshaft on ground, be careful not to damage signal plate.**
- **Never remove signal plate unless it is necessary.**

NOTE:
If it is removed, positioning dowel pin (dowel pins for crankshaft and signal plate are specified as a single set) must be reinstalled.



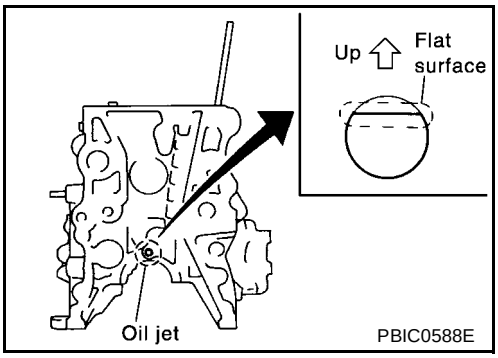
17. Remove main bearing and thrust bearing from cylinder block and main bearing cap.

CAUTION:
Check mounting positions, and store them without mixing them up.

18. Remove baffle plate.

ASSEMBLY

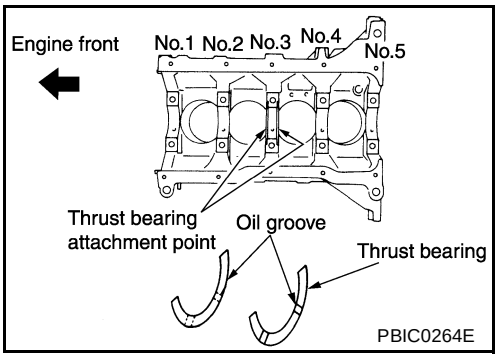
1. Blow air sufficiently through engine coolant passage of cylinder block, oil passage, crank case and cylinder bore to remove foreign objects.
2. Install oil jet for timing chain lubrication.
   - Face its flat surface upward, and push it as far as it will go.
3. Install baffle plate.



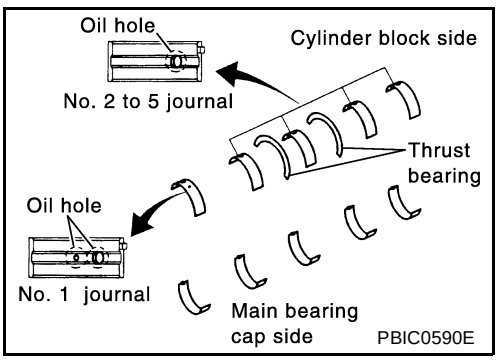
4. Install the main bearings and the thrust bearings.

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.
   - Main bearings (cylinder block side) for journal No. 1 and for No. 2 to No. 5 are different.
   - 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.



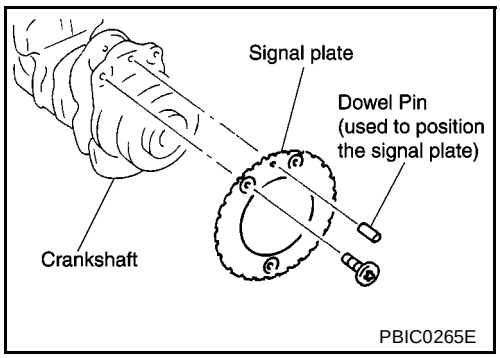
5. Install the signal plate to the crankshaft.

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.

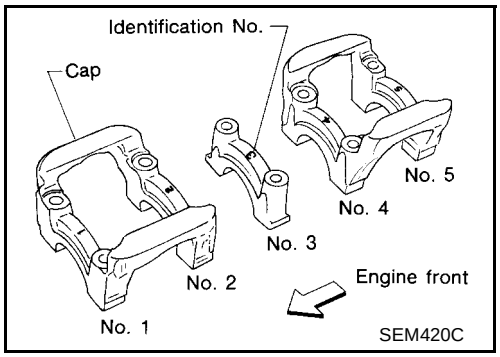
NOTE:
- Dowel pins of crankshaft and signal plate are provided as a set for each.



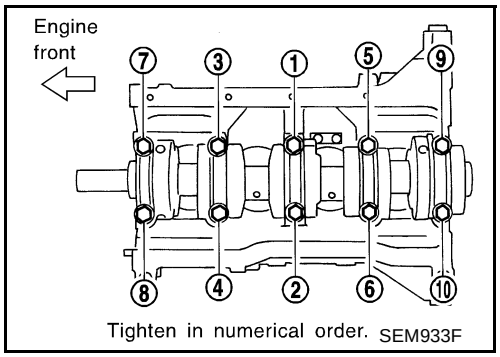
6. Install the crankshaft to the cylinder block.
- While turning the crankshaft by hand, check that it turns smoothly.

7. Install main bearing cap.
- Main bearing cap is identified by identification paint No. made on it before it is removed.
- Install it with arrow facing to front.

NOTE:
Main bearing cap cannot be replaced as a single part, because it is machined together with cylinder block.



8. Tighten main bearing bolts in several steps in numerical order shown in the figure.
- After tightening bolts to specified torque, make sure that crankshaft rotates smoothly.
- Check crankshaft side clearance. Refer to EM-84, "CRANKSHAFT SIDE CLEARANCE" .

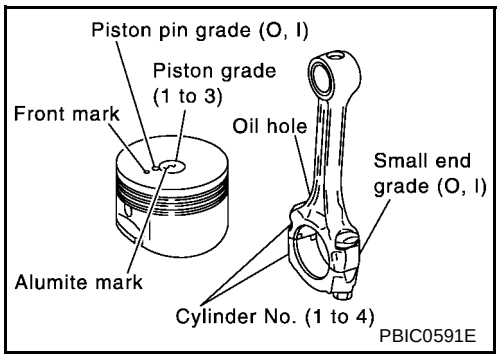


9. Install piston to connecting rod.

a. Using snap ring pliers (commercial service tool), install snap ring to groove of piston rear side.

b. Install piston to connecting rod.
- Using hot-air blower, heat piston to 60 to 70°C (140 to 158°F) so that piston pin can be easily inserted by hand. Insert piston pin into piston and connecting rod from front side of piston.
- Assemble so that front mark on piston head and oil hole in connecting rod are positioned as shown in the figure.

c. Install snap ring to front side of piston.
- Refer to step (a) to install snap ring.
- After installation, make sure that connecting rod moves smoothly.

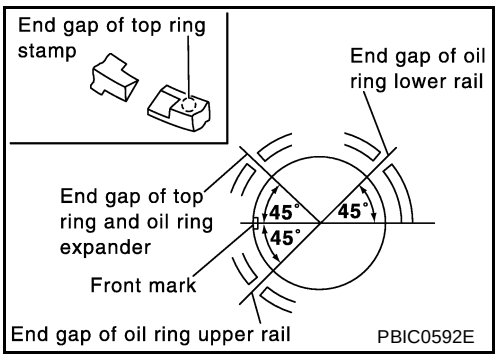


10. Install piston rings with piston ring expander.

CAUTION:
Be careful not to damage piston.

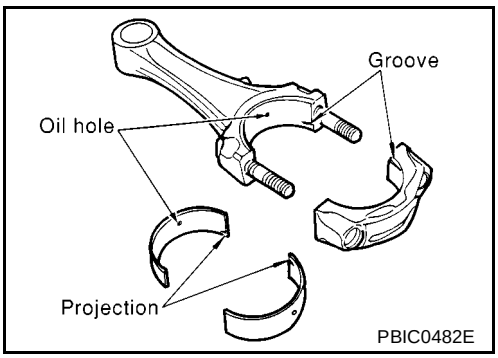
- Position end gaps of each piston ring to piston front mark as shown in figure, then install rings.
- Install top ring with stamp mark side facing upward.

CAUTION:
When installing top ring, be careful not to break end gap step.



11. Install the connecting rod bearings to the connecting rod and the connecting rod cap.

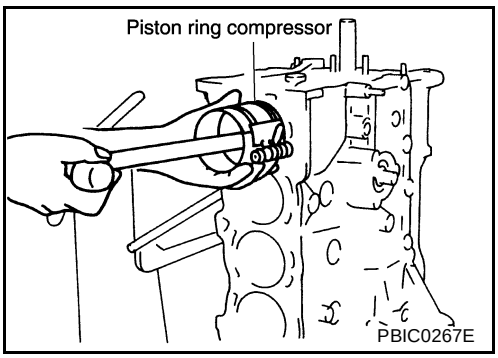
- When installing the connecting rod bearings, apply engine oil to the bearing surface (inside). Do not apply oil to the back surface, but thoroughly clean it.
- When installing, align the connecting rod bearing stopper protrusion with the notch of the connecting rod to install.
- Check the oil holes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



12. Install the piston and connecting rod assembly to the crankshaft.

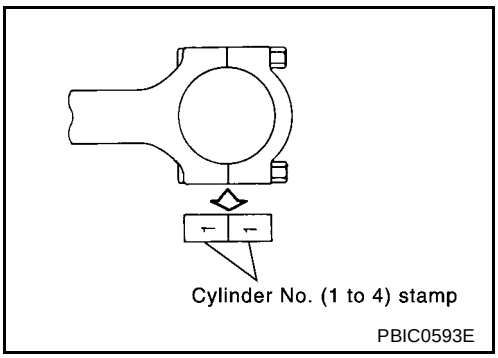
- Position the crankshaft pin corresponding to the connecting rod to be installed onto the bottom dead center.
- Apply engine oil sufficiently to the cylinder bore, piston and crankshaft pin.
- Match the cylinder position with the cylinder No. on the connecting rod to install.
- Using a piston ring compressor,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



13. Install the connecting rod cap.

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



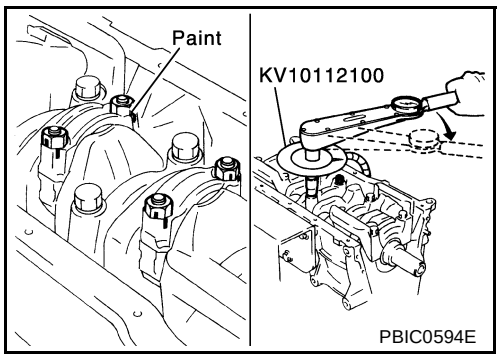
14. Tighten connecting rod nuts with the following procedure.

a. Lubricate connecting rod bolts and seat of nuts with new engine oil.

b. Tighten to a torque of 13.72 - 15.68 N·m (1.4 - 1.5 kg-m, 10.2 - 11.5 ft-lb)

c. Make matching marks (with white paint) on each nut and connecting rod cap, all in same direction. (when using a protractor)

d. Turn all nuts another 35 to 40 degrees (Target: 35 degrees).

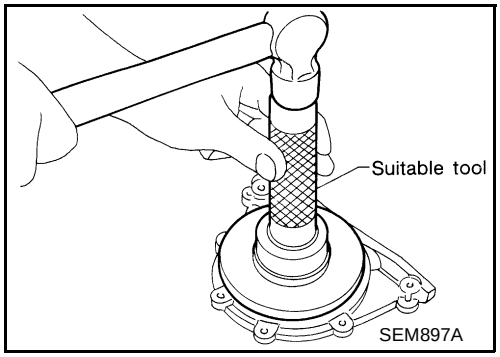


CAUTION:
Always use either angle wrench (special service tool) or protractor. Avoid tightening based on visual check alone.

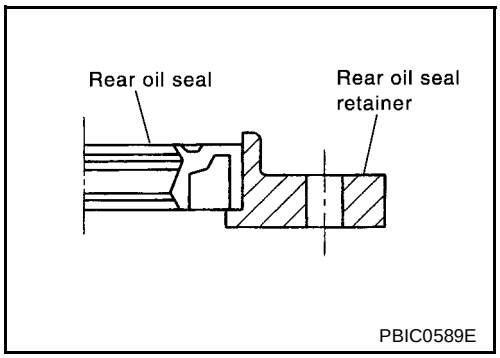
- After tightening nuts, make sure that crankshaft rotates smoothly.
- Check connecting rod side clearance. Refer to EM-85, "CONNECTING ROD SIDE CLEARANCE" .

15. Install rear oil seal.

- Use an oil seal drift (special service tool) to press it in. At this time, be careful not to cause any scratches or burrs on circumference of oil seal.



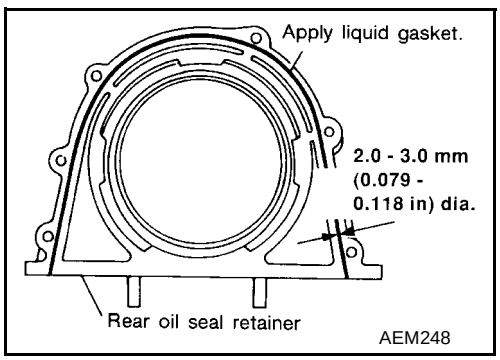
- Press oil seal into rear oil seal retainer until it does not project from end.



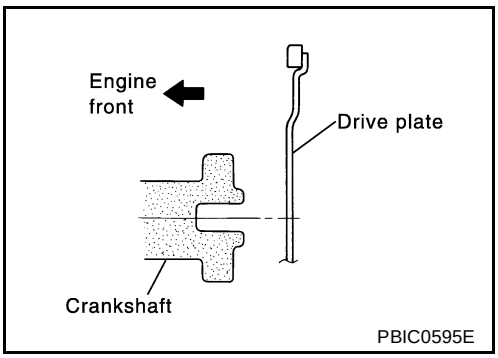
16. Install rear oil seal retainer.

- Apply continuous bead of liquid gasket to parts shown in figure.
- Install rear oil seal retainer by aligning it with dowel pins on cylinder block.

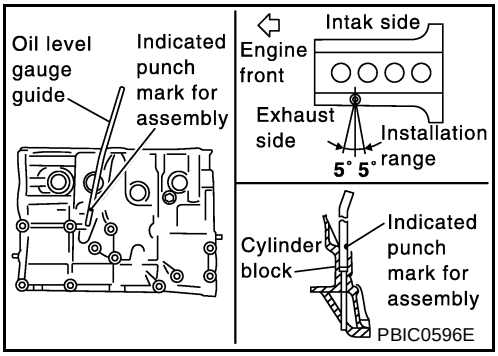
17. Install rear plate.



18. Install flywheel or drive plate.
    - Install drive plate in direction shown in figure.
    - Fix crankshaft with ring gear stopper (special service tool).
    - Tighten mounting bolts diagonally in several steps.

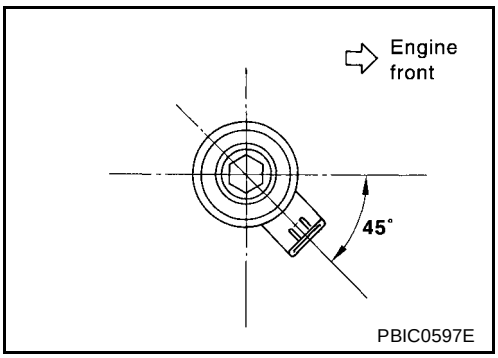


19. Install oil level gauge guide.
    - Press it in with punch mark for installing instruction in direction shown in figure.
    - Apply locking agent to pressed position.



20. 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 right by 45° as shown.
    - 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.



21. Install crankshaft position (POS) sensor.
22. Tighten accessory brackets to the following tightening torque.

    Tightening torque:

    Power steering pump bracket : 16.7 - 23.5 N·m (1.7 - 2.4 kg-m, 13 - 17 ft-lb)

    Alternator air conditioner compressor bracket : 33.3 - 46.1 N·m (3.4 - 4.7 kg-m, 25 - 34 ft-lb)

23. Assemble in the reverse order of disassembly.

How to Select Piston and Bearing

EBS00GX1

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)	Connecting rod bearing grade = crankshaft pin grade (outer diameter of pin). No grade exists for inner diameter to connecting rod large end.
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	—	—	—

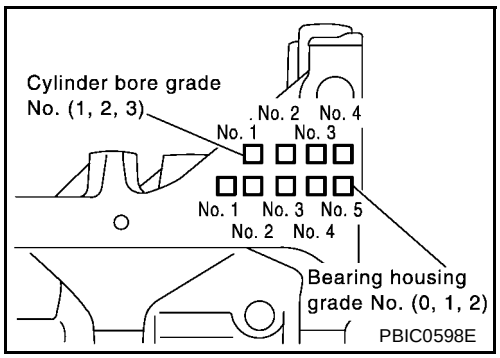
*For the service parts, the grade for fitting cannot be selected between a piston pin and a connecting rod. (Only 0 grade is available.) The information at the shipment from the plant is described as a reference.

- 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:

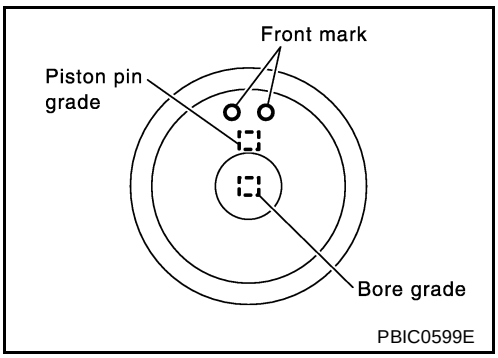
- Check the cylinder bore grade on rear lower surface of cylinder block, and select a piston of the same grade.
- If there is a corrected stamp mark on the cylinder block, use it as a correct reference.



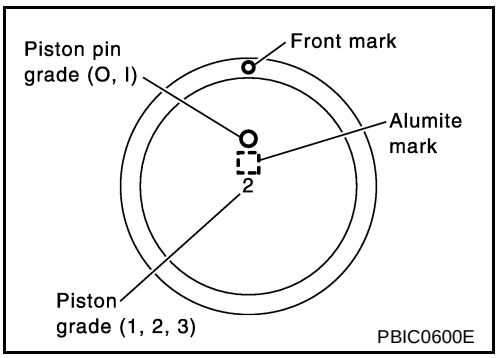
- Select the piston of the same grade.

  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.).

- QG16DE models



- QG18DE models



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

QG16DE

Unit: mm (in)

Grade number (Mark)	1	2	3
Inner diameter of cylinder bore	76.000 - 76.010 (2.9921 - 2.9925)	76.010 - 76.020 (2.9925 - 2.9929)	76.020 - 76.030 (2.9929 - 2.9933)
Outer diameter of piston	75.975 - 76.985 (2.9911 - 3.0309)	75.985 - 75.995 (2.9915 - 2.9919)	75.995 - 76.005 (2.9919 - 2.9923)

QG18DE

Unit: mm (in)

Grade number (Mark)	1	2	3
Inner diameter of cylinder bore	80.000 - 80.010 (3.1496 - 3.1500)	80.010 - 80.020 (3.1500 - 3.1504)	80.020 - 80.030 (3.1504 - 3.1508)
Outer diameter of piston	79.965 - 79.975 (3.1482 - 3.1486)	79.975 - 79.985 (3.1486 - 3.1490)	79.985 - 79.995 (3.1490 - 3.1494)

NOTE:

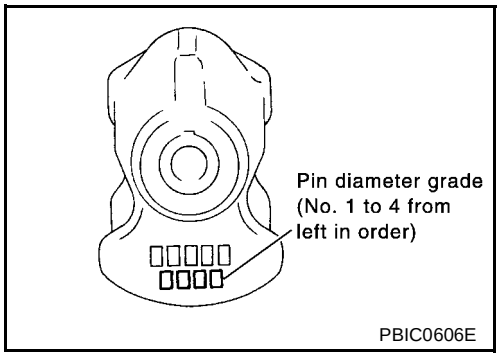
- The piston is available together with piston pin as an assembly.
- The piston pin (piston pin bore) grade is provided only for the parts installed at the plant. For service parts, no grades can be selected. (Only 0 grade is available.)

HOW TO SELECT CONNECTING ROD BEARING

When New Connecting Rod and Crankshaft are Used:

1. Compare the pin diameter grade of the crankshaft on front surface with the values of the selection table of connecting rod bearing.
2. Select the bearing of the same grade.

   NOTE:
   There is no grading for connecting rod big end.



When Crankshaft and Connecting Rod are Reused:

1. Confirm connecting rod big end inner diameter is within the standard.
2. Measure the pin outer diameter of the crankshaft.
3. Compare the measurement with the values of the selection table of connecting rod bearing.
4. Select the bearing of the same grade.

Connecting Rod Bearing Selection Table

Unit: mm (in)

Connecting rod big end ID		43.000 - 43.013 (1.6929 - 1.6934)	
Crankshaft pin OD	Grade (punched)	0 (no punching)	
39.968 - 39.974 (1.5735 - 1.5738)	0	● Bearing grade No. ● Bearing thickness ● Oil clearance ● Identification color	STD 0 1.503 - 1.506 (0.0592 - 0.0593) 0.014 - 0.039 (0.0006 - 0.0015) Black
39.962 - 39.968 (1.5733 - 1.5735)	1	● Bearing grade No. ● Bearing thickness ● Oil clearance ● Identification color	STD 1 1.506 - 1.509 (0.0593 - 0.0594) 0.014 - 0.039 (0.0006 - 0.0015) Red
39.956 - 39.962 (1.5731 - 1.5733)	2	● Bearing grade No. ● Bearing thickness ● Oil clearance ● Identification color	STD 2 1.509 - 1.512 (0.0594 - 0.0595) 0.014 - 0.039 (0.0006 - 0.0015) Green

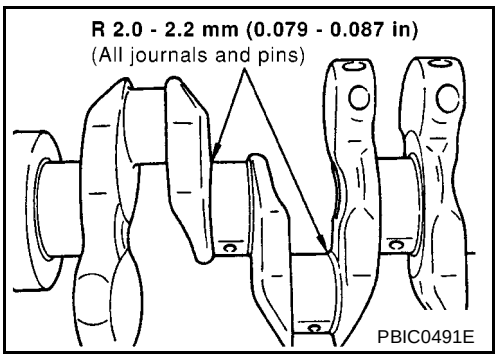
Undersize Bearings Usage Guide

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

Bearing undersize table

Unit: mm (in)

Size	Thickness
US 0.08 (0.0031)	1.542 - 1.546 (0.0607 - 0.0609)
US 0.12 (0.0047)	1.562 - 1.566 (0.0615 - 0.0617)
US 0.25 (0.0098)	1.627 - 1.631 (0.0641 - 0.0642)

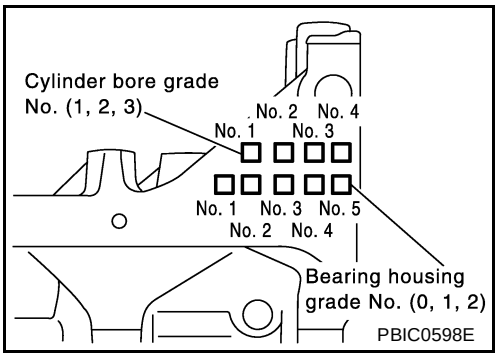


CAUTION:
In grinding the crankshaft pin to use undersize bearings, keep the fillet R (All crankshaft pins).

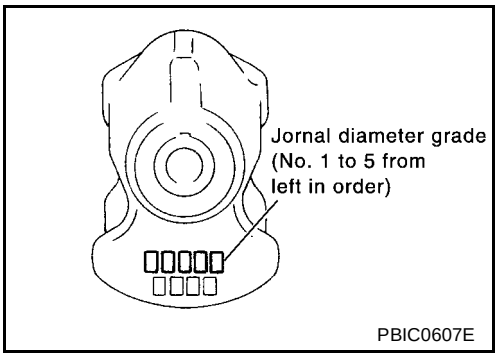
HOW TO SELECT MAIN BEARING

When New Cylinder Block and Crankshaft are Used:

1. Apply main bearing housing grade (0, 1 and 2) on bottom of cylinder block banks to row in main bearing selection table.



2. Apply journal diameter grade on crankshaft front to column in main bearing selection table.
3. Find bearing grade at crossing of row and column in main bearing selection table.



When Cylinder Block and Crankshaft are Reused:

1. Measure dimension of main bearing housing on cylinder block.
2. Find measured dimension in “Cylinder block main bearing housing inner diameter” row in following main bearing selection table.
3. Measure crankshaft journal diameter.
4. Find measured dimension in “Crankshaft journal outer diameter” column in following main bearing selection table.
5. Select main bearing (STD 0 - 4) at the point where selected row and column meet in following main bearing selection table.

Main Bearing Selection Table

Unit: mm (in)

Connecting block main bearing housing ID			53.644 - 53.652 (2.1120 - 2.1123)	53.652 - 53.660 (2.1123 - 2.1126)	53.660 - 53.668 (2.1126 - 2.1129)
Crankshaft journal OD	Grade (punched)		0	1	2
49.956 - 49.964 (1.9668 - 1.9671)	0	● Bearing grade No. ● Bearing thickness ● Oil clearance ● Identification color	STD 0 1.826 - 1.830 (0.0719 - 0.0720) 0.020 - 0.044 (0.0008 - 0.0017) Black	STD 1 1.830 - 1.834 (0.0720 - 0.0722) 0.020 - 0.044 (0.0008 - 0.0017) Red	STD 2 1.834 - 1.838 (0.0722 - 0.0724) 0.020 - 0.044 (0.0008 - 0.0017) Green
49.948 - 49.956 (1.9665 - 1.9668)	1	● Bearing grade No. ● Bearing thickness ● Oil clearance ● Identification color	STD 1 1.830 - 1.834 (0.0720 - 0.0722) 0.020 - 0.044 (0.0008 - 0.0017) Red	STD 2 1.834 - 1.838 (0.0722 - 0.0724) 0.020 - 0.044 (0.0008 - 0.0017) Green	STD 3 1.838 - 1.842 (0.0724 - 0.0725) 0.020 - 0.044 (0.0008 - 0.0017) Yellow
49.940 - 49.948 (1.9661 - 1.9665)	2	● Bearing grade No. ● Bearing thickness ● Oil clearance ● Identification color	STD 2 1.834 - 1.838 (0.0722 - 0.0724) 0.020 - 0.044 (0.0008 - 0.0017) Green	STD 3 1.838 - 1.842 (0.0724 - 0.0725) 0.020 - 0.044 (0.008 - 0.0017) Yellow	STD 4 1.842 - 1.846 (0.0725 - 0.0727) 0.020 - 0.044 (0.0008 - 0.0017) Blue

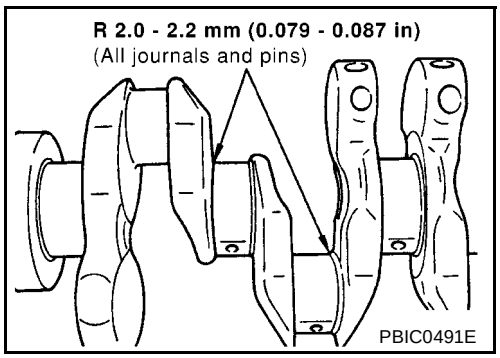
Use Undersize Bearing Usage Guide

- 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)	1.960 - 1.964 (0.0722 - 0.0773)
US 0.50 (0.0197)	2.085 - 2.089 (0.0821 - 0.0822)



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

Inspection After Disassembly

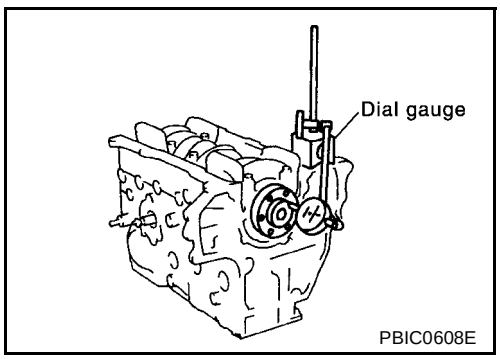
EBS00GX2

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 : 0.060 - 0.260 mm (0.0024 - 0.0102 in)
  Limit : 0.3 mm (0.012 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.

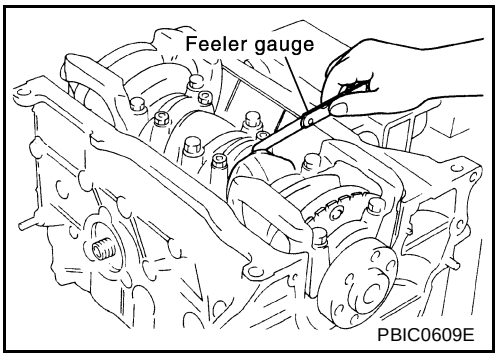


CONNECTING ROD SIDE CLEARANCE

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

  Standard : 0.200 - 0.470 mm (0.0079 - 0.0185 in)
  Limit : 0.5 mm (0.020 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.

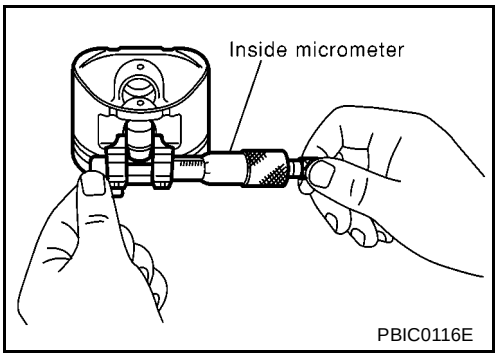


PISTON AND PISTON PIN CLEARANCE

Inner Diameter of Piston Pin

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

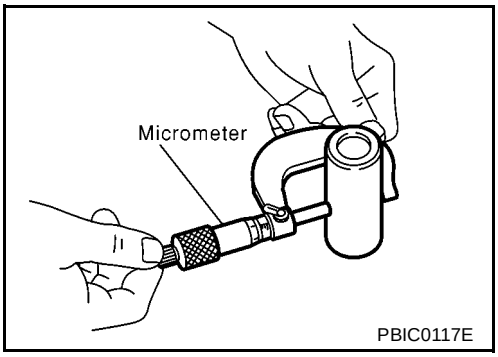
  Standard:
  QG16DE : 18.987 - 18.999 mm (0.7475 - 0.7480 in)
  QG18DE : 18.993 - 18.999 mm (0.7478 - 0.7480 in)



Outer Diameter of Piston Pin

- Measure outer diameter of piston pin with a micrometer.

  Standard : 18.989 - 19.001 mm (0.7476 - 0.7481 in)



Piston and Piston Pin Clearance

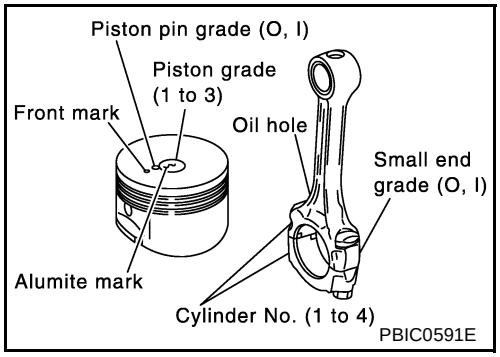
(Piston pin clearance) = (Piston pin bore diameter) – (Outer diameter of piston pin)

Standard:
QG16DE : – 0.004 to 0 mm (– 0.0002 to 0 in)
QG18DE : 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-175, "HOW TO SELECT PISTON" .
- Refer to connecting rod bearing selection table to replace connecting rod. Refer to EM-176, "HOW TO SELECT CONNECTING ROD BEARING" .

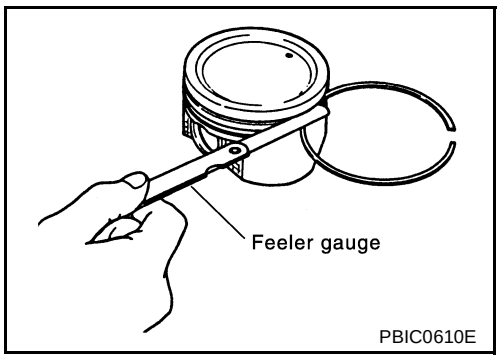
NOTE:

- 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-184, "CONNECTING ROD BUSHING OIL CLEARANCE (SMALL END)" for the values for each grade at the plant.
- Regarding marks on piston head, Refer to EM-175, "HOW TO SELECT PISTON" .



PISTON RING SIDE CLEARANCE

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



QG16DE

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 : 0.110 mm (0.0043 in)
2nd ring : 0.100 mm (0.0039 in)

QG18DE

Standard:

Top ring : 0.040 - 0.080 mm (0.0016 - 0.0031 in)
2nd ring : 0.030 - 0.070 mm (0.0012 - 0.0028 in)
Oil ring : 0.045 - 0.155 mm (0.0018 - 0.0061 in)

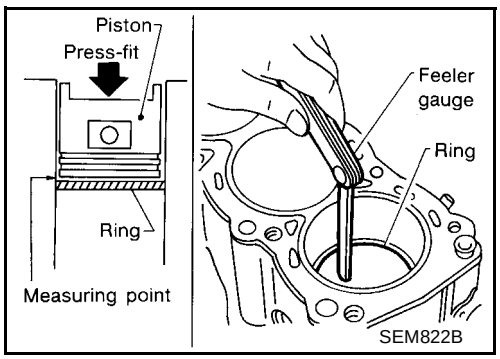
Limit:

Top ring : 0.110 mm (0.0043 in)
2nd ring : 0.100 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-186, "PISTON TO CYLINDER BORE CLEARANCE" .
- Insert piston ring until middle of cylinder with piston, and measure gap.



QG16DE

Standard:

Top ring : 0.20 - 0.39 mm (0.0079 - 0.0154 in)
2nd ring : 0.50 - 0.74 mm (0.0197 - 0.0291in)
Oil ring : 0.20 - 0.69 mm (0.0079 - 0.0272 in)

Limit:

Top ring : 0.54 mm (0.0213 in)
2nd ring : 0.85 mm (0.0335 in)
Oil ring : 0.95 mm (0.0374 in)

QG18DE

Standard:

Top ring : 0.20 - 0.39 mm (0.0079 - 0.0154 in)
2nd ring : 0.32 - 0.56 mm (0.0126 - 0.0220 in)
Oil ring : 0.20 - 0.69 mm (0.0079 - 0.0272 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

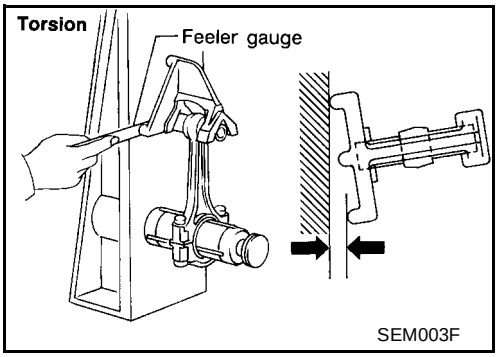
- Check with connecting rod aligner.

Bend:

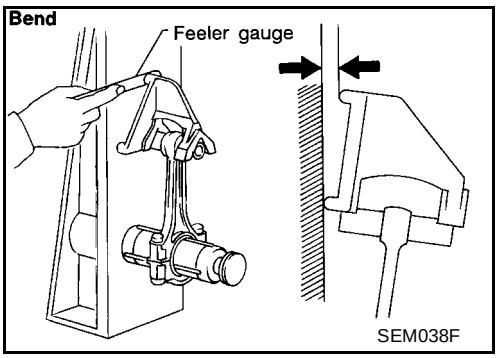
Limit : 0.15 mm (0.0059 in) per 100 mm (3.94 in) length

Torsion:

Limit : 0.30 mm (0.0118 in) per 100 mm (3.94 in) length



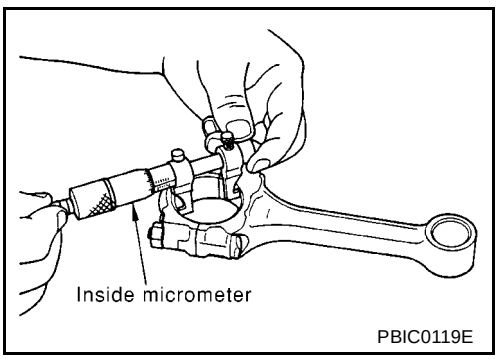
- If it exceeds the limit, replace connecting rod assembly.



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 : 43.000 - 43.013 mm (1.6929 - 1.6934 in)

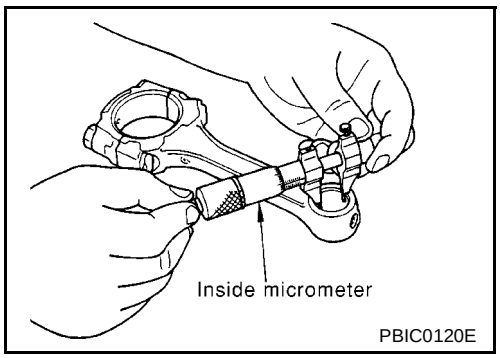


CONNECTING ROD BUSHING OIL CLEARANCE (SMALL END)

Inner Diameter of Connecting Rod (Small End)

- Measure inner diameter of bushing.

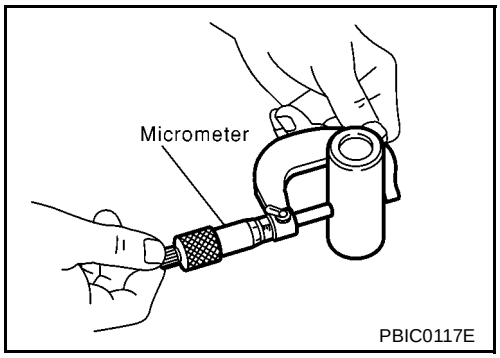
Standard : 19.000 - 19.012 mm (0.7480 - 0.7485 in)



Outer Diameter of Piston Pin

- Measure outer diameter of piston pin.

Standard : 18.989 - 19.001 mm (0.7476 - 0.7481 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)

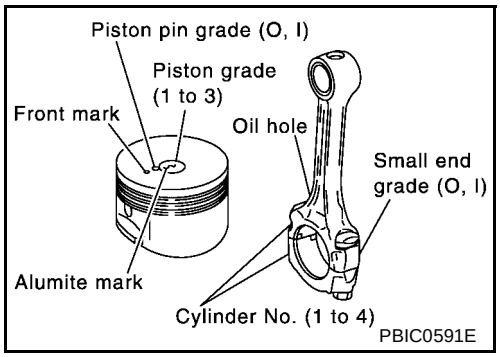
- If the measured value exceeds the standard, replace the connecting rod assembly and/or piston and piston pin assembly.
- If replacing the piston and piston pin assembly, refer to the “Piston Selection Table” to select the piston corresponding to the applicable bore grade of the cylinder block to be used. Refer to EM-175, "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		19.000 - 19.006 (0.7480 - 0.7483)	19.006 - 19.012 (0.7483 - 0.7485)
Piston pin outer diameter		18.989 - 18.995 (0.7476 - 0.7478)	18.995 - 19.001 (0.7478 - 0.7481)
Piston pin hole diameter	QG16DE	18.987 - 18.993 (0.7475 - 0.7478)	18.993 - 18.999 (0.7478 - 0.7480)
	QG18DE	18.989 - 18.999 (0.7476- 0.7480)	18.999 - 19.005 (0.7480 - 0.7482)

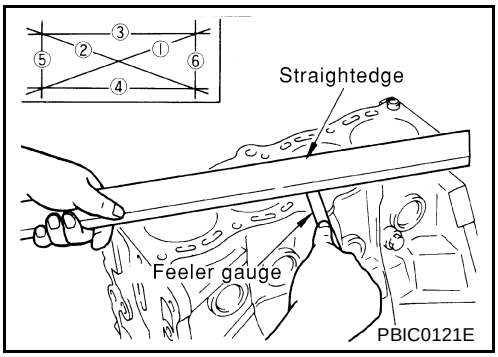


CYLINDER BLOCK DISTORTION

- 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.

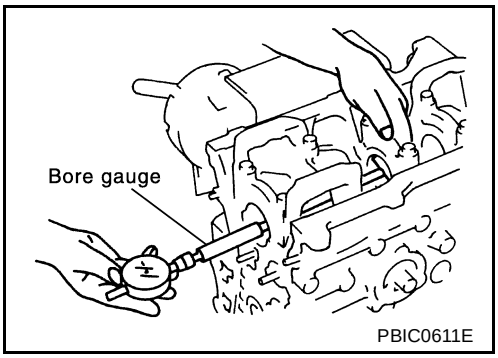


INNER DIAMETER OF MAIN BEARING HOUSING

- 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 : 53.644 - 53.668 mm (2.1120 - 2.1129 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.

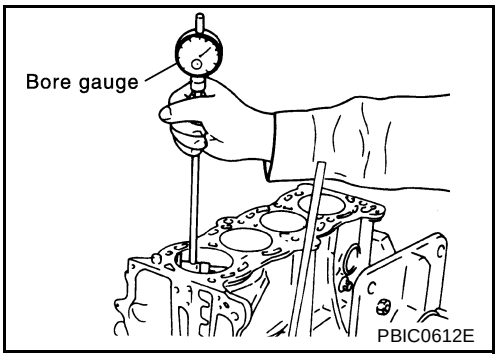


PISTON TO CYLINDER BORE CLEARANCE

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:

QG16DE : 76.000 - 76.030 mm (2.9921 - 2.9933 in) dia.

QG18DE : 80.000 - 80.030 mm (3.1496 - 3.1508 in) dia.

Wear limit:

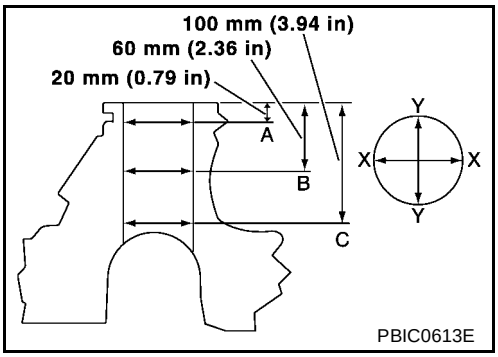
0.2 mm (0.008 in)

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)

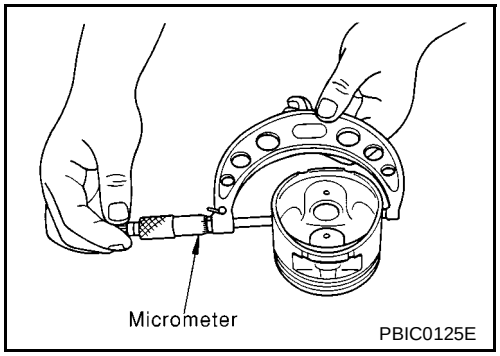


- If the measured value exceeds the limit, or if there are scratches and/or seizure on the cylinder inner wall, hone or rebore the inner wall.
- An oversize piston is provided. When using an oversize piston, rebore the cylinder so that the clearance of the piston cylinder satisfies the standard.

Oversize (OS) : 0.25 mm (0.0098 in)
: 0.5 mm (0.0197 in)

Outer Diameter of Piston

- Measure piston skirt diameter.



QG16DE

Measuring point : 43.6 mm (1.717 in) below piston head upper edge

Standard : 75.975 - 76.005 mm (2.9911 - 2.9923 in) dia.

QG18DE

Measuring point : 42.3 mm (1.665 in) below piston head upper edge

Standard : 79.965 - 79.995 mm (3.1482 - 3.1494 in) dia.

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).

QG16DE

Standard : 0.015 - 0.035 mm (0.0006 - 0.0014 in)

QG18DE

Standard : 0.025 - 0.045 mm (0.010 - 0.018 in)

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

OUTER DIAMETER OF CRANKSHAFT JOURNAL

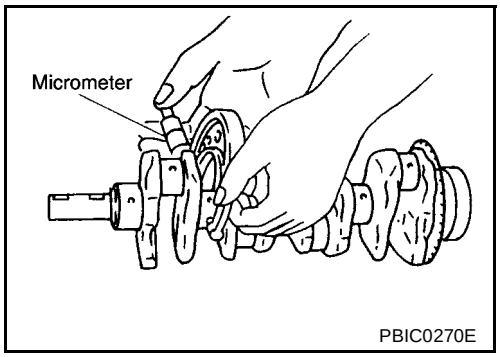
- Measure outer diameter of crankshaft journals.

Standard : 49.940 - 49.964 mm (1.9661 - 1.9671 in) dia.

OUTER DIAMETER OF CRANKSHAFT PIN

- Measure outer diameter of crankshaft pin.

Standard : 39.956 - 39.974 mm (1.5731 - 1.5738 in) dia.



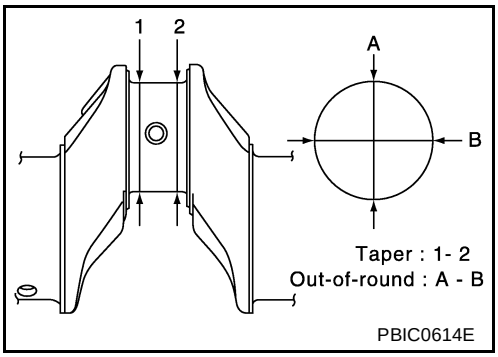
OUT-OF-ROUND AND TAPER OF CRANKSHAFT

- 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 A and B at 1 and 2.
- Taper is indicated by the difference in dimension between 1 and 2 at A and B.

Limit:

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

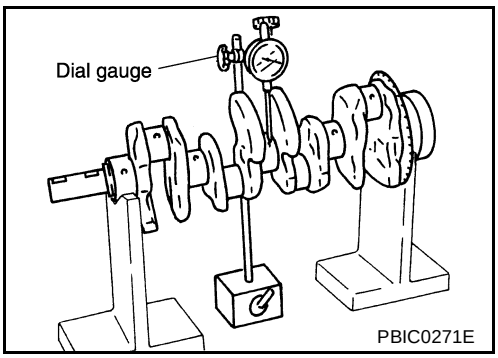
Taper (1 – 2) : 0.005 mm (0.0002 in)



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

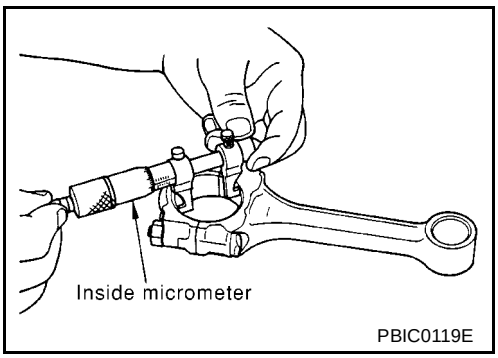
Method of Measurement

- 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 : 0.014 - 0.039 mm (0.0006 - 0.0015 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-176, "HOW TO SELECT CONNECTING ROD BEARING" .

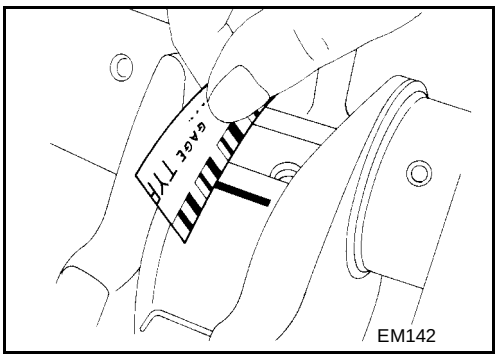
Method of Using Plastigage

- Remove oil and dust on the crankshaft pin and the surfaces of each bearing completely.
- Cut a plastigage 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 plastigage bag, measure the plastigage 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 : 0.020 - 0.044 mm (0.0008 - 0.0017 in)

Limit : 0.1 mm (0.004 in)

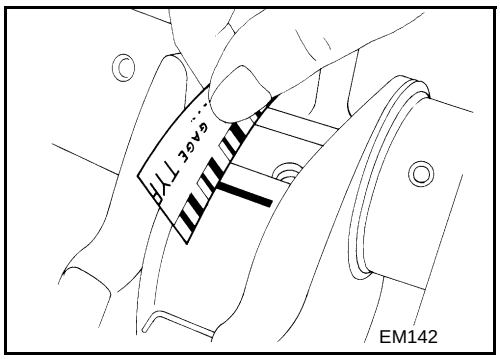
- If the measured value exceeds the limit, select main bearings referring to the main bearing inner diameter and crankshaft journal outer diameter, so that the oil clearance satisfies the standard. Refer to EM-178, "HOW TO SELECT MAIN BEARING" .

Method of Using Plastigage

- Remove oil and dust on the crankshaft journal and the surfaces of each bearing completely.
- Cut a plastigage 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 plastigage bag, measure the plastigage width.

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

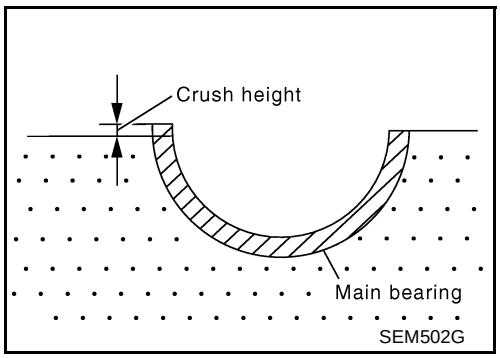


CRUSH HEIGHT OF MAIN BEARING

- 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.

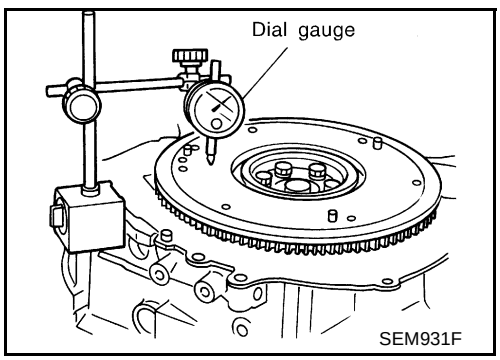


FLYWHEEL RUNOUT

- Measure deflection of contact surface with dial indicator.

Flywheel (M/T models)

Limit : 0.15 mm (0.0059 in)



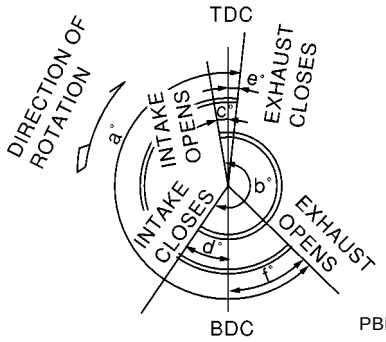
SERVICE DATA AND SPECIFICATIONS (SDS)

PFP:00030

Standard and Limit

EBS00GX3

GENERAL SPECIFICATIONS

Engine		QG16DE	QG18DE
Classification		Gasoline	
Cylinder arrangement		4, in-line	
Displacement	cm^3 (cu in)	1,597 (97.39)	1,769 (107.94)
Bore and stroke	mm (in)	76.0 x 88.0 (2.992 x 3.465)	80.0 x 88.0 (3.150 x 3.465)
Valve arrangement		DOHC	
Firing order		1-3-4-2	
Number of piston rings	Compression	2	
	Oil	1	
Number of main bearings		5	
Compression ratio		9.8	9.5
Compression pressure kPa (bar, kg/cm^2, psi) / 350 rpm	Standard	1,353 (13.53, 13.8, 196)	1,324 (13.24, 135, 192)
	Minimum	1,157 (11.57, 11.8, 168)	1,128 (11.28, 11.5, 164)
	Differential limit between cylinders	98 (0.98, 1.0, 14)	
Valve timing			

PBIC0187E

Unit: degree

a	b	c	d	e	f
208	228	–8	56	–2	30

INTAKE MANIFOLD AND EXHAUST MANIFOLD

Unit: mm (in)

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

DRIVE BELTS

Unit: mm (in)

		Deflection adjustment		
		Used belt		New belt
		Limit	After adjustment	
Alternator	Without air conditioner compressor	10.2 (0.402)	6.5 - 7.0 (0.256 - 0.276)	5.5 - 6.1 (0.217 - 0.240)
	With air conditioner compressor	8.1 (0.319)	5.3 - 5.7 (0.209 - 0.224)	4.5 - 5.0 (0.177 - 0.197)
Power steering oil pump		10.8 (0.425)	6.6 - 7.5 (0.260 - 0.295)	6.0 - 6.6 (0.236 - 0.260)
Applied pushing force		98 N (10 kg, 22 lb)		

*: If belt tension gauge cannot be installed at check points shown, check drive belts tension at a different location on the belt.

SPARK PLUG

Make		NGK	Champion
Type	Standard	LFR5A-11	REC10YC4
	Hot	LFR4A-11	—
	Cold	LFR6A-11	—
Plug gap mm (in)		1.0 - 1.1 (0.039 - 0.043)	

CYLINDER HEAD

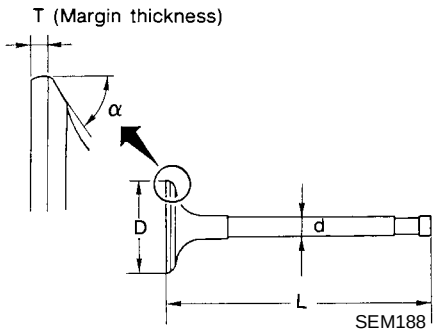
Unit: mm (in)

	Standard	Limit
Head surface distortion	Less than 0.03 (0.0012)	0.1 (0.004)
Height	117.9 (4.642)	—

VALVE

Valve Dimensions

Unit: mm (in)



Valve head diameter “D”	Intake	29.9 - 30.2 (1.177 - 1.189)
	Exhaust	24.9 - 25.2 (0.980 - 0.992)
Valve length “L”	Intake	92.00 - 92.50 (3.6220 - 3.6417)
	Exhaust	92.37 - 92.87 (3.6366 - 3.6563)
Valve stem diameter “d”	Intake	5.465 - 5.480 (0.2152 - 0.2157)
	Exhaust	5.445 - 5.460 (0.2144 - 0.2150)
Valve seat angle “α”		44°15′ - 44°45′
Valve margin “T”		0.8 - 0.14 (0.031 - 0.055)

Valve margin “T” limit	More than 0.5 (0.020)
Valve stem end surface grinding limit	0.2 (0.008)

Valve Clearance

Unit: mm (in)

	For adjusting		For checking
	Hot	Cold* (reference data)	Hot
Intake	0.32 - 0.40 (0.013 - 0.016)	0.25 - 0.33 (0.010 - 0.013)	0.21 - 0.47 (0.008 - 0.019)
Exhaust	0.37 - 0.45 (0.015 - 0.018)	0.32 - 0.40 (0.013 - 0.016)	0.30 - 0.56 (0.012 - 0.022)

*: At a temperature of approximately 20°C (68°F)

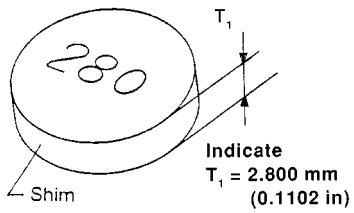
Whenever valve clearances are adjusted to cold specifications, check that the clearances satisfy hot specifications and adjust again if necessary.

Available Shims

Thickness mm (in)	Identification mark
2.00 (0.0787)	200
2.02 (0.0795)	202
2.04 (0.0803)	204
2.06 (0.0811)	206
2.08 (0.0819)	208
2.10 (0.0827)	210
2.12 (0.0835)	212
2.14 (0.0843)	214
2.16 (0.0850)	216
2.18 (0.0858)	218
2.20 (0.0866)	220
2.21 (0.0870)	221
2.22 (0.0874)	222
2.23 (0.0878)	223
2.24 (0.0882)	224
2.25 (0.0886)	225
2.26 (0.0890)	226
2.27 (0.0894)	227
2.28 (0.0898)	228
2.29 (0.0902)	229
2.30 (0.0906)	230
2.31 (0.0909)	231
2.32 (0.0913)	232
2.33 (0.0917)	233
2.34 (0.0921)	234
2.35 (0.0925)	235
2.36 (0.0929)	236
2.37 (0.0933)	237
2.38 (0.0937)	238
2.39 (0.0941)	239
2.40 (0.0945)	240
2.41 (0.0949)	241

Thickness mm (in)	Identification mark
2.42 (0.0953)	242
2.43 (0.0957)	243
2.44 (0.0961)	244
2.45 (0.0965)	245
2.46 (0.0969)	246
2.47 (0.0972)	247
2.48 (0.0976)	248
2.49 (0.0980)	249
2.50 (0.0984)	250
2.51 (0.0988)	251
2.52 (0.0992)	252
2.53 (0.0996)	253
2.54 (0.1000)	254
2.55 (0.1004)	255
2.56 (0.1008)	256
2.57 (0.1012)	257
2.58 (0.1016)	258
2.59 (0.1020)	259
2.60 (0.1024)	260
2.61 (0.1028)	261
2.62 (0.1031)	262
2.63 (0.1035)	263
2.64 (0.1039)	264
2.65 (0.1043)	265
2.66 (0.1047)	266
2.68 (0.1055)	268
2.70 (0.1063)	270
2.72 (0.1071)	272
2.74 (0.1079)	274
2.76 (0.1087)	276
2.78 (0.1094)	278
2.80 (0.1102)	280
2.82 (0.1110)	282
2.84 (0.1118)	284
2.86 (0.1126)	286
2.88 (0.1134)	288
2.90 (0.1142)	290
2.92 (0.1150)	292
2.94 (0.1157)	294
2.96 (0.1165)	296

Thickness mm (in)	Identification mark
2.98 (0.1173)	298



AEM236

Valve Spring

Free height	mm (in)	40.0 (1.57)
Pressure N (kg, lb) at height	mm (in)	147.5 - 166.3 (15.04 - 16.96, 33.2 - 37.4) at 23.64 (0.9307)
Out-of-square	mm (in)	Less than 1.80 (0.0709)

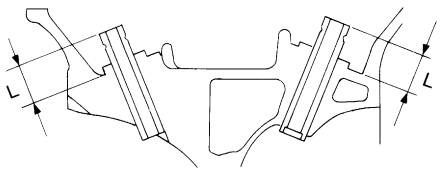
Valve Lifter

Unit: mm (in)

	Standard
Valve lifter outer diameter	29.960 - 29.995 (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)



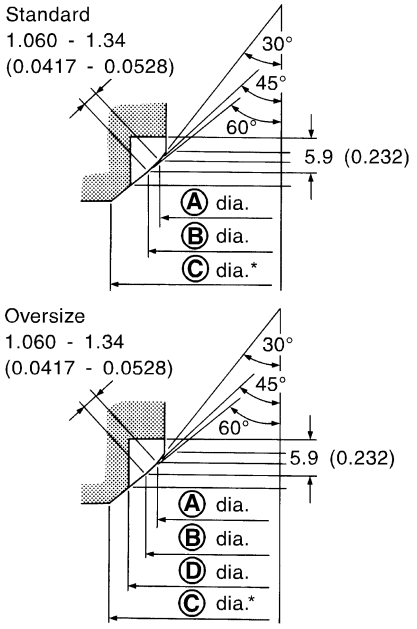
MEM096A

		Intake		Exhaust	
		Standard	Service	Standard	Service
Valve guide	Outer diameter	9.523 - 9.534 (0.3749 - 0.3754)	9.723 - 9.734 (0.3828 - 0.3832)	9.523 - 9.534 (0.3749 - 0.3754)	9.723 - 9.734 (0.3828 - 0.3832)
	Inner diameter (Finished size)	5.500 - 5.515 (0.2165 - 0.2171)		5.500 - 5.515 (0.2165 - 0.2171)	
Cylinder head valve guide hole diameter		9.475 - 9.496 (0.3730 - 0.3739)	9.685 - 9.696 (0.3813 - 0.3817)	9.475 - 9.496 (0.3730 - 0.3739)	9.685 - 9.696 (0.3813 - 0.3817)
Interference fit of valve guide		0.026 - 0.059 (0.0010 - 0.0023)	0.027- 0.049 (0.0011 - 0.0019)	0.026 - 0.059 (0.0010 - 0.0023)	0.027- 0.049 (0.0011 - 0.0019)
Stem to guide clearance		0.020 - 0.050 (0.0008 - 0.0020)		0.040 - 0.070 (0.0016 - 0.0028)	
Valve deflection limit (Dial gauge reading)		0.2 (0.008)			
Projection length “L”		11.5 - 11.7 (0.453 - 0.461)			

Valve Seat

Unit: mm (in)

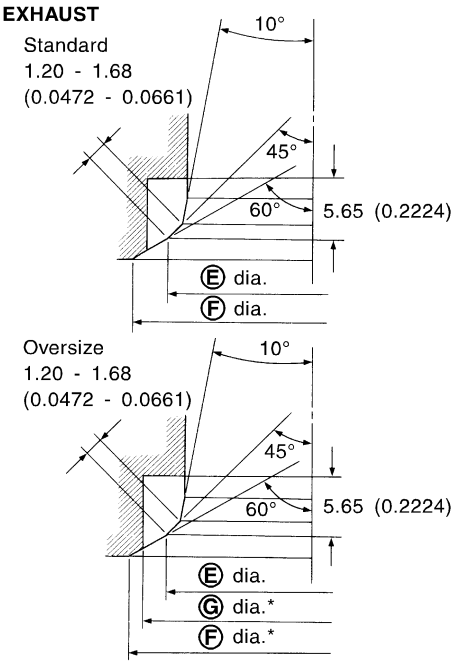
INTAKE



* Cylinder head machining data

SEM573DA

EXHAUST



* Cylinder head machining data

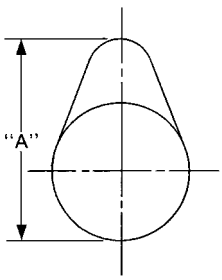
SEM574DA

Dia.	QG16·18DE
A	27.8 - 28.0 (1.094 - 1.102)
B	29.5 - 29.7 (1.161 - 1.169)
C	31.9 - 32.1 (1.256 - 1.264)
D	31.500 - 31.516 (1.2402 - 1.2408)
E	24.5 - 24.7 (0.9646 - 0.9724)
F	26.500 - 26.516 (1.043 - 1.0439)
G	26.2 - 26.4 (1.031 - 1.039)

CAMSHAFT AND CAMSHAFT BEARING

Unit: mm (in)

	Standard
Camshaft runout [TIR*]	Less than 0.02 (0.0008)



SEM671

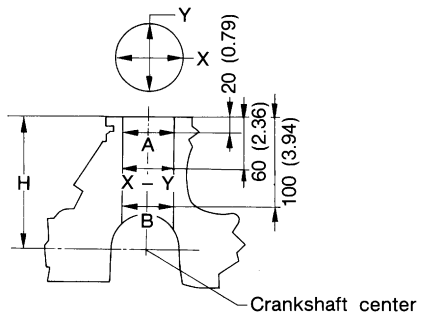
Cam height "A"	Intake	40.217 - 40.407 (1.5833 - 1.5908)
	Exhaust	39.205 - 39.395 (1.5435 - 1.5510)

	Standard
Outer diameter of camshaft journal	No. 1 27.935 - 27.955 (1.0998 - 1.1006) No. 2, 3, 4, 5 23.935 - 23.955 (0.9423 - 0.9431)
Inner diameter of camshaft bracket	No .1 28.000 - 28.021 (1.1024 - 1.1032) N0.2, 3, 4, 5 24.000 - 24.021 (0.9449 - 0.9457)
Camshaft journal clearance	0.045 - 0.086 (0.0018 - 0.0034)
Camshaft end play	0.115 - 0.188 (0.0045 - 0.0074)

*: Total indicator reading

CYLINDER BLOCK

Unit: mm (in)



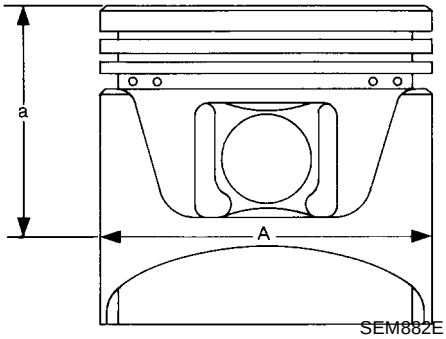
SEM171D

			QG16DE	QG18DE	Limit
			Standard		
Surface flatness			Less than 0.03 (0.0012)		0.1 (0.004)
Height “H” (nominal)			213.95 - 214.05 (8.4232 - 8.4271)		—
Cylinder bore inner diameter	Standard	Grade No. 1	76.000 - 76.010 (2.9921 - 2.9925)	80.000 - 80.010 (3.1496 - 3.1500)	0.2 (0.008)
		Grade No. 2	76.010 - 76.020 (2.7957 - 2.7961)	80.010 - 80.020 (3.1500 - 3.1504)	
		Grade No. 3	76.020 - 76.030 (2.7961 - 2.9933)	80.020 - 80.030 (3.1504 - 3.1508)	
Out-of-round (X – Y)			Less than 0.015 (0.0006)		—
Taper (A – B)			Less than 0.01 (0.0004)		—
Difference in inner diameter between cylinders			0.05 (0.0020)		0.2 (0.008)

PISTON, PISTON RING AND PISTON PIN

Available Piston

Unit: mm (in)



			QG16DE	QG18DE
			Standard	
Piston skirt diameter “A”	Standard	Grade No. 1	75.975 - 75.985 (2.9911 - 2.9915)	79.965 - 79.975 (3.1482 - 3.1486)
		Grade No. 2	75.985 - 75.995 (2.9915 - 2.9919)	79.975 - 79.985 (3.1486 - 3.1490)
		Grade No. 3	75.995 - 76.005 (2.9919 - 2.9923)	79.985 - 79.995 (3.1490 - 3.1494)
0.5 (0.002) oversize (service)			76.475 - 76.505 (3.0108 - 3.0120)	80.215 - 80.245 (3.1581 - 3.1592)
1.0 (0.039) oversize (service)			76.975 - 77.005 (3.0305 - 3.0317)	80.465 - 80.495 (3.1679 - 3.1691)
“a” dimension			43.6 (1.717)	42.3 (1.665)
Piston pin hole inner diameter			18.987 - 18.999 (0.7475 - 0.7480)	18.993 - 18.999 (0.7478 - 0.7480)
Piston to bore clearance			0.015 - 0.035 (0.0006 - 0.0014)	0.025 - 0.045 (0.0010 - 0.0018)

Piston Ring

Unit: mm (in)

		Standard		Limit	
		QG16DE	QG18DE	QG16DE	QG18DE
Side clearance	Top	0.045 - 0.080 (0.0018 - 0.0031)	0.040 - 0.080 (0.0016 - 0.0031)	0.110 (0.0043)	
	2nd	0.030 - 0.070 (0.0012 - 0.0028)		0.100 (0.0039)	
	Oil ring	0.065 - 0.135 (0.0026 - 0.0053)	0.045 - 0.155 (0.0018 - 0.0061)	—	
End gap	Top	0.20 - 0.39 (0.0079 - 0.0154)		0.54 (0.0213)	
	2nd	0.50 - 0.74 (0.0197 - 0.0291)	0.32 - 0.56 (0.0126 - 0.0220)	0.85 (0.0335)	0.67 (0.0264)
	Oil (rail ring)	0.20 - 0.69 (0.0079 - 0.0272)		0.95 (0.0374)	

Piston Pin

Unit: mm (in)

	QG16DE	QG18DE
Piston pin outer diameter	18.989 - 19.001 (0.7476 - 0.7481)	
Piston pin to piston clearance	-0.004 to 0 (-0.0002 to 0)	0.002 - 0.006 (0.0001 - 0.0002)

Piston pin to connecting rod bushing clearance	Standard	0.005 - 0.017 (0.0002 - 0.0007)
	Limit	0.023 (0.0009)

CONNECTING ROD

Unit: mm (in)

Center distance		140.45 - 140.55 (5.5295 - 5.5335)
Bend [per 100 (3.94)]	Limit	0.15 (0.0059)
Torsion [per 100 (3.94)]	Limit	0.30 (0.0118)
Connecting rod bushing inner diameter* (small end)		19.000 - 19.012 (0.7480 - 0.7485)
Connecting rod big end inner diameter		43.000 - 43.013 (1.6929 - 1.6934)
Side clearance	Standard	0.20 - 0.470 (0.0079 - 0.0185)
	Limit	0.50 (0.0197)

*: After installing in connecting rod

CRANKSHAFT

Unit: mm (in)

Main journal dia. “Dm”	Grade No. 0	49.956 - 49.964 (1.9668 - 1.9671)
	Grade No. 1	49.948 - 49.956 (1.9665 - 1.9668)
	Grade No. 2	49.940 - 49.948 (1.9661 - 1.9665)
Pin journal dia. “Dp”	Grade No. 0	39.968 - 39.974 (1.5735 - 1.5738)
	Grade No. 1	39.962 - 39.968 (1.5733 - 1.5735)
	Grade No. 2	39.956 - 39.962 (1.5731 - 1.5733)
Out-of-round (X – Y)	Standard	Less than 0.003 (0.0001)
	Limit	Less than 0.005 (0.0002)
Taper (A – B)	Standard	Less than 0.004 (0.0002)
	Limit	Less than 0.005 (0.0002)
Runout [TIR*]	Standard	Less than 0.04 (0.0016)
	Limit	Less than 0.05 (0.0020)
Free end play	Standard	0.060 - 0.260 (0.0024 - 0.0102)
	Limit	0.3 (0.012)

*: Total indicator reading

MAIN BEARING

Standard size

Unit: mm (in)

Grade No.	Thickness	Identification color
0	1.826 - 1.830 (0.0719 - 0.0720)	Black
1	1.830 - 1.834 (0.0720 - 0.0722)	Red
2	1.834 - 1.838 (0.0722 - 0.0724)	Green
3	1.838 - 1.842 (0.0724 - 0.0725)	Yellow
4	1.842 - 1.846 (0.0725 - 0.0727)	Blue

Undersize

Unit: mm (in)

	Thickness
0.25 (0.0098)	1.960 - 1.964 (0.0772 - 0.0773)
0.50 (0.0197)	2.085 - 2.089 (0.0821 - 0.0822)

CONNECTING ROD BEARING

Standard Size

Unit: mm (in)

Grade No.	Thickness	Identification color or number
0	1.503 - 1.506 (0.0592 - 0.0593)	Block
1	1.506 - 1.509 (0.0593 - 0.0594)	Red
2	1.509 - 1.512 (0.0594 - 0.0595)	Green

Undersize

Unit: mm (in)

Grade No.	Thickness	Identification color or number
0.08 (0.0031)	1.542 - 1.546 (0.0607 - 0.0609)	—
0.12 (0.0047)	1.562 - 1.566 (0.0615 - 0.0617)	—
0.25 (0.0098)	1.627 - 1.631 (0.0641 - 0.0642)	—

Bearing Clearance

Unit: mm (in)

Main bearing clearance	Standard	0.020 - 0.044 (0.0008 - 0.0017)
	Limit	0.1 (0.004)
Connecting rod bearing clearance	Standard	0.014 - 0.039 (0.0006 - 0.0015)
	Limit	0.1 (0.004)

MISCELLANEOUS COMPONENTS

Unit: mm (in)

Flywheel runout [TIR*]	Less than 0.15 (0.0059)
Camshaft sprocket runout [TIR*]	Less than 0.15 (0.0059)

*: Total indicator reading

Tightening Torque

EBS00GX4

*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

	Mass air flow sensor		8.4 - 10.8 (0.9 - 1.1, 75 - 95)*2
	Resonator		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
	Intake manifold		16.6 - 23.5 (1.7 - 2.3, 13 - 17)
	Intake manifold collector		7.0 - 9.5 (0.72 - 0.96, 62 - 84)*2
	Intake manifold support		16.6 - 23.5 (1.7 - 2.3, 13 - 17)
*1	Electric throttle control actuator	1)	8.8 - 10.8 (0.90 - 1.1, 6.5 - 7.9)
		2)	17.7 - 21.6 (1.8 - 2.2, 13 - 15)
	Exhaust manifold		25.5 - 29.4 (2.6 - 2.9, 19 - 21)
	Exhaust manifold cover		6.28 - 8.34 (0.64 - 0.85, 56 - 73)*2
	Heated oxygen sensor		58.8 - 78.4 (6.0 - 7.9, 44 - 57)
	Ground nut		79.4 (8.1, 59)
	Oil pan		6.28 - 8.34 (0.64 - 0.85, 56 - 73)*2
	Oil pan lower		6.28 - 8.34 (0.64 - 0.85, 56 - 73)*2
	Oil pan drain plug		29.4 - 39.2 (3.0 - 4.0, 22 - 28)
	Oil strainer		6.28 - 8.34 (0.64 - 0.85, 56 - 73)*2

	Ignition coil			3.73 - 5.0 (0.38 - 0.51, 33 - 44)*2
	Spark plug			19.6 - 29.4 (2.0 - 3.0, 15 - 21)
*1	Fuel tube		1) 2)	11.8 - 13.7 (1.2 - 1.4, 9 - 10) 16.7 - 23.5 (1.7 - 2.3, 13 - 17)
	Rocker cover			2.0 - 3.9 (0.20 - 0.40, 18 - 34)*2
	Camshaft position sensor (PHASE)			7.2 - 10.8 (0.8 - 1.1, 64 - 95) *2
	Camshaft sprocket (INT)			98.1 - 107.8 (10.0 - 10.9, 73 - 79)
	Camshaft sprocket (EXH)			98.1 - 127.5 (10.0 - 13.0, 73 - 94)
*1	Camshaft bracket		1) 2) 3)	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			132.4 - 152.0 (14.0 - 15.0, 98 - 112)
	Front cover	M6 bolt		7.0 - 9.5 (0.72 - 0.96, 62 - 84)*2
		M8 bolt		16.7 - 23.5 (1.7 - 2.3, 13 - 17)
	Timing chain tension guide			15.7 - 20.6 (1.6 - 2.1, 12 - 15)
*1	Cylinder head		1) 2) 3) 4) 5)	29.4 (3.0, 22) 58.8 (6.0, 43) 0 (0.0, 0) 29.4 (3.0, 22) 50° - 55° (Angle tightening)
	Flywheel (M/T)			83.4 - 93.2 (8.5 - 9.5, 62 - 68)
	Drive plate (A/T)			93.2 - 103 (9.5 - 10.0, 69 - 75)
	Intake valve timing control solenoid valve			24.5 - 34.3 (2.5 - 3.4, 18 - 25)
	Cylinder head front cover			7.0 - 9.5 (0.72 - 0.96, 62 - 84)*2
*1	Connecting rod bearing cap		1) 2)	13.7 - 15.7 (1.4 - 1.6, 10.1 - 11.5) 35° - 40° (Angle tightening)
	Knock sensor			20.6 - 26.5 (2.1 - 2.7, 16 - 19)
	Crankshaft position sensor (POS)			7.2 - 10.8 (0.8 - 1.1, 64 - 95)*2
	Rear oil seal retainer			6.28 - 8.34 (0.64 - 0.85, 56 - 73)*2
	Signal plate			7.6 - 9.2 (0.78 - 0.93, 68 - 81)*2

PRECAUTIONS

PFP:00001

Precautions for Drain Coolant

EBS00GA1

- Drain coolant when engine is cooled.

Precautions for Disconnecting Fuel Piping

EBS00GA2

- 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

EBS00GA3

- 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

EBS00GA4

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

Precautions for Assembly and Installation

EBS00GA5

- 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

EBS00GA6

- 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

EBS00GA7

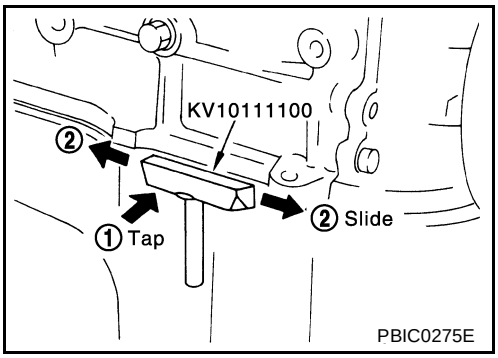
REMOVAL OF LIQUID GASKET SEALING

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

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.

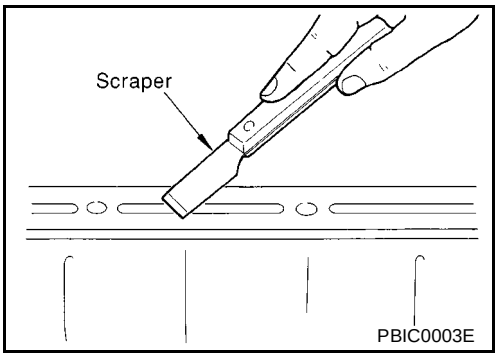


LIQUID GASKET APPLICATION PROCEDURE

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

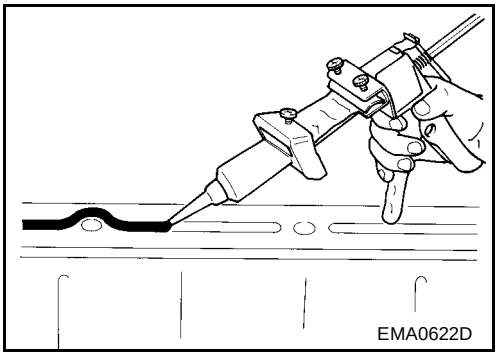
- Remove the liquid gasket completely from the groove of the gasket application surface, mounting bolts, and bolt holes.

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.



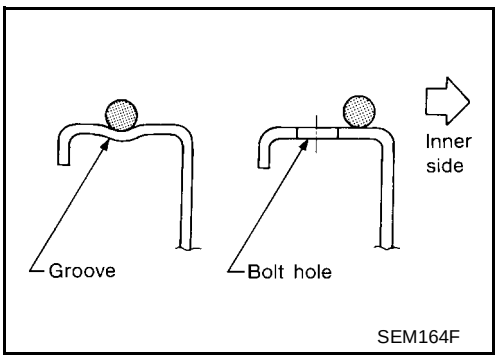
4. Apply the gasket without breaks to the specified location with the specified dimensions.

- 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. If specified, it should be applied outside the holes. Make sure to read the text of 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 the service manual, observe them.

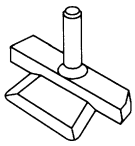
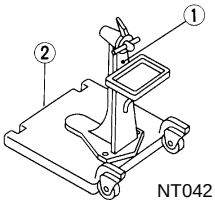
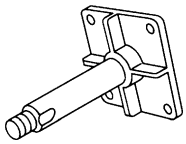
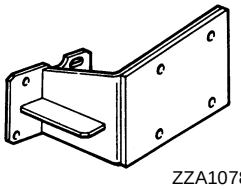
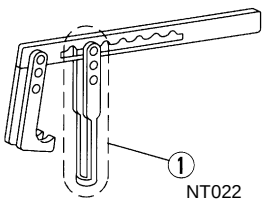
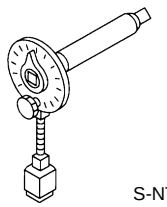
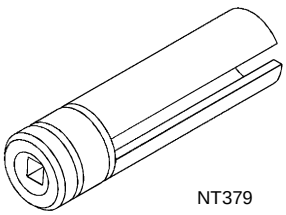


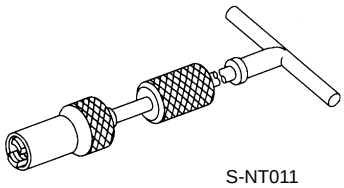
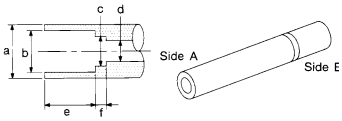
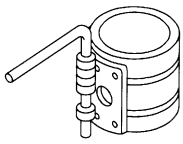
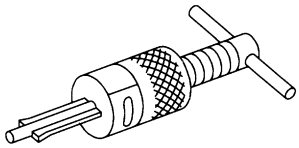
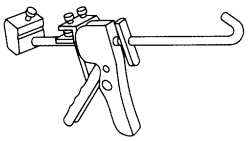
PREPARATION

PFP:00002

Special Service Tools

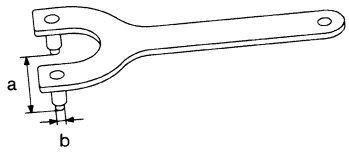
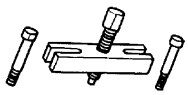
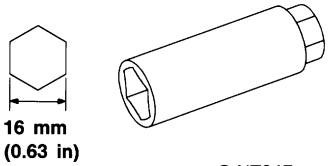
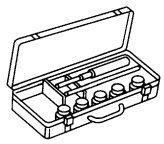
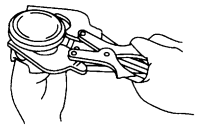
EBS00GA8

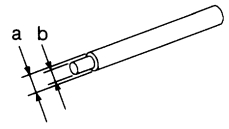
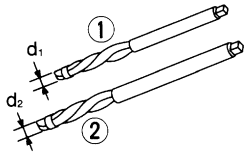
Tool number Tool name	Description
KV10111100 Seal cutter  S-NT046	Removing oil pan and timing chain case
ST0501S000 Engine stand assembly 1, ST05011000 Engine stand 2, ST05012000 Base  NT042	Disassembling and assembling
KV10106500 Engine stand shaft  NT028	
KV10115300 Engine sub-attachment  ZZA1078D	
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

EBS00GA9

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

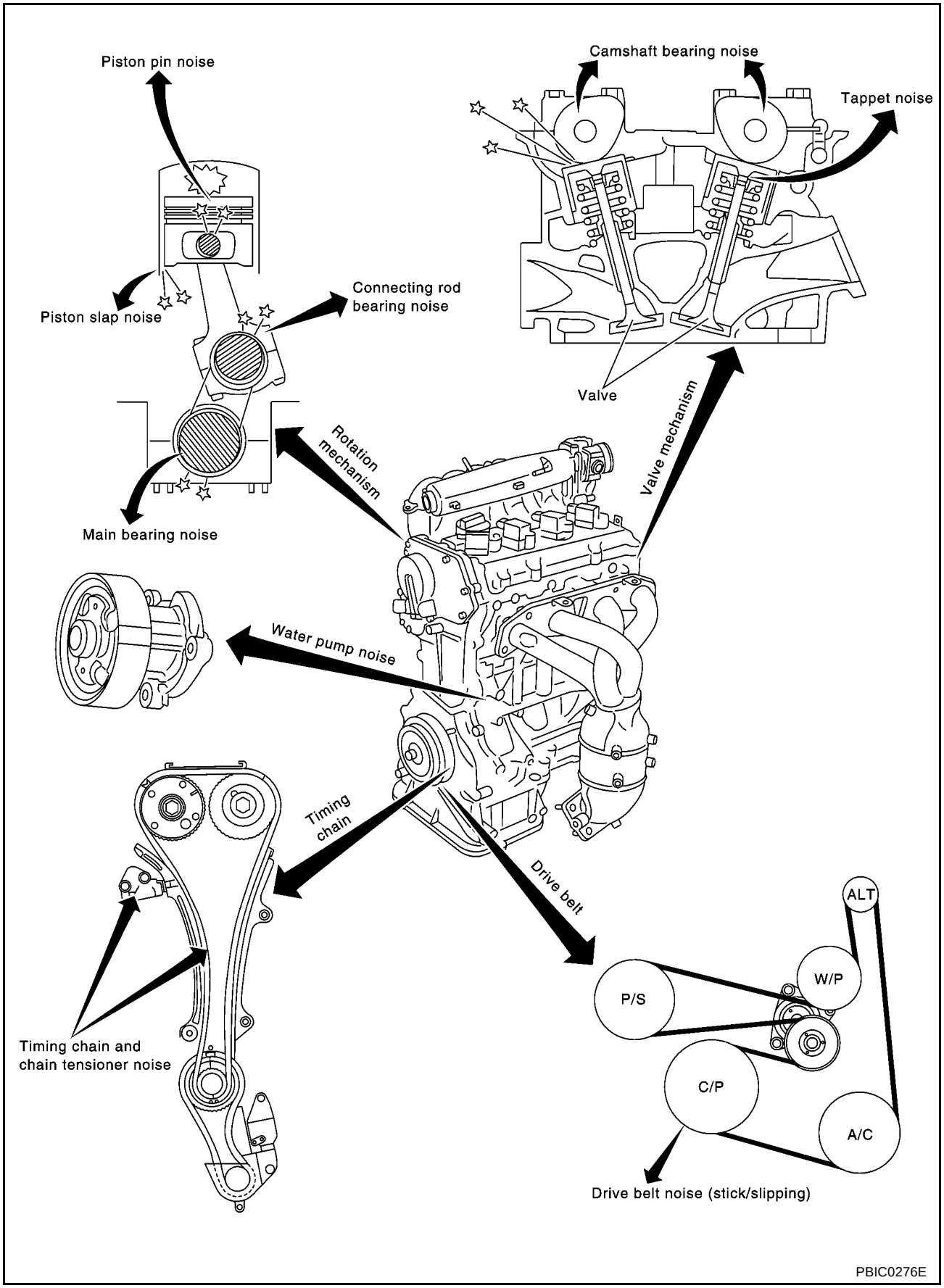
Tool number Tool name	Description	
Valve guide drift	 S-NT015	Removing and installing valve guide **Intake & Exhaust:** **a: 9.5 mm (0.374 in) dia.** **b: 5.5 mm (0.217 in) dia.**
Valve guide reamer	 S-NT016	1: Reaming valve guide inner hole 2: Reaming hole for oversize valve guide **Intake & Exhaust:** **d_1 : 6.0 mm (0.236 in) dia.** **d_2 : 10.2 mm (0.402 in) dia.**

NOISE, VIBRATION, AND HARSHNESS (NVH) TROUBLESHOOTING

PFP:00003

NVH Troubleshooting —Engine Noise

EBS00GAA



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

EBS00GAB

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-140
	Rattle	C	A	—	A	B	C	Camshaft bearing noise	Camshaft journal clearance Camshaft runout	EM-138 EM-138
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 clearance	EM-182 EM-184
	Slap or rap	A	—	—	B	B	A	Piston slap noise	Piston-to-bore clearance Piston ring side clearance Piston ring end gap Connecting rod bend and torsion	EM-186 EM-183 EM-183 EM-184
	Knock	A	B	C	B	B	B	Connecting rod bearing noise	Connecting rod bushing clearance (Small end) Connecting rod bearing clearance (Big end)	EM-184 EM-184
	Knock	A	B	—	A	B	C	Main bearing noise	Main bearing oil clearance Crankshaft runout	EM-188 EM-188
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-147 EM-143
Front of engine	Squeaking or fizzing	A	B	—	B	—	C	Drive belts (Sticking or slipping)	Drive belts deflection	EM-112
	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-38, "WATER PUMP"

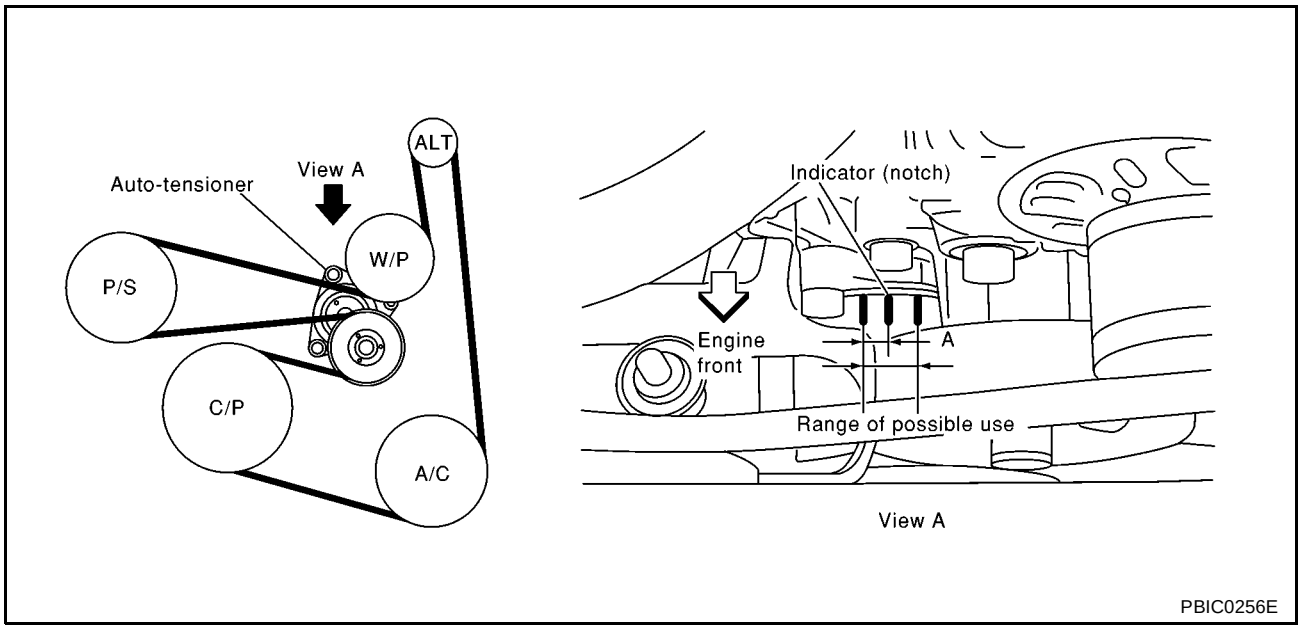
A: Closely related B: Related C: Sometimes related —: Not related

DRIVE BELTS

PFP:02117

Checking Drive Belts

EBS00GAC



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 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

EBS00GAD

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

Removal and Installation

EBS00GAE

REMOVAL

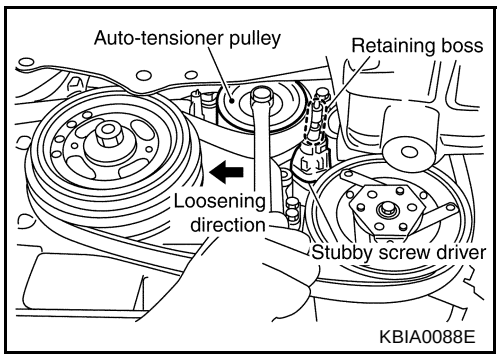
1. Open splash cover on RH undercover.
2. With box wrench, and while securely holding the hexagonal part in pulley center of auto-tensioner, move the wrench handle in the direction of arrow (loosening direction of tensioner).

   CAUTION:

   Avoid placing hand in a location where pinching may occur if the holding tool accidentally comes off.
3. Insert a rod approximately 6 mm (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 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.

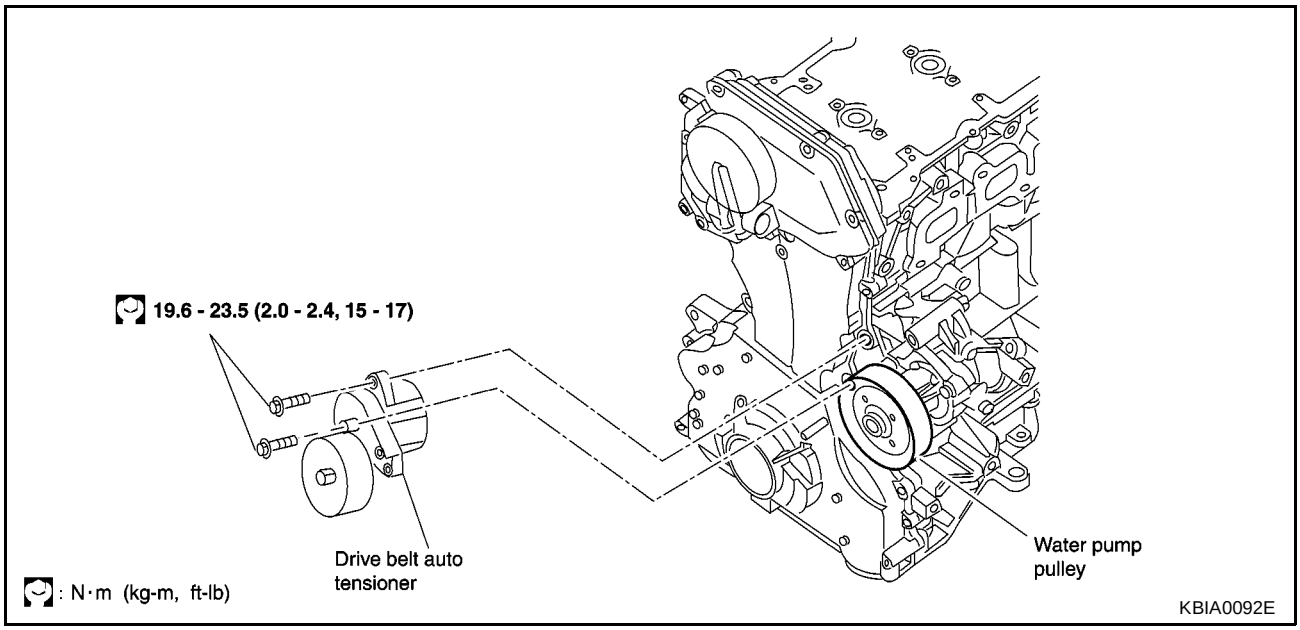
2. Insert a rod approximately 6 mm (0.24 in) in diameter through the rear of engine into holding boss to fix tensioner pulley.
3. Hook auxiliary drive belt onto all pulleys except for water pump. Hook belt onto water pump pulley at the end.

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-112, "Checking Drive Belts" .

Removal and Installation of Auxiliary Drive Belt Auto- tensioner

EBS00GAF



REMOVAL

1. Open splash cover on RH undercover.
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.

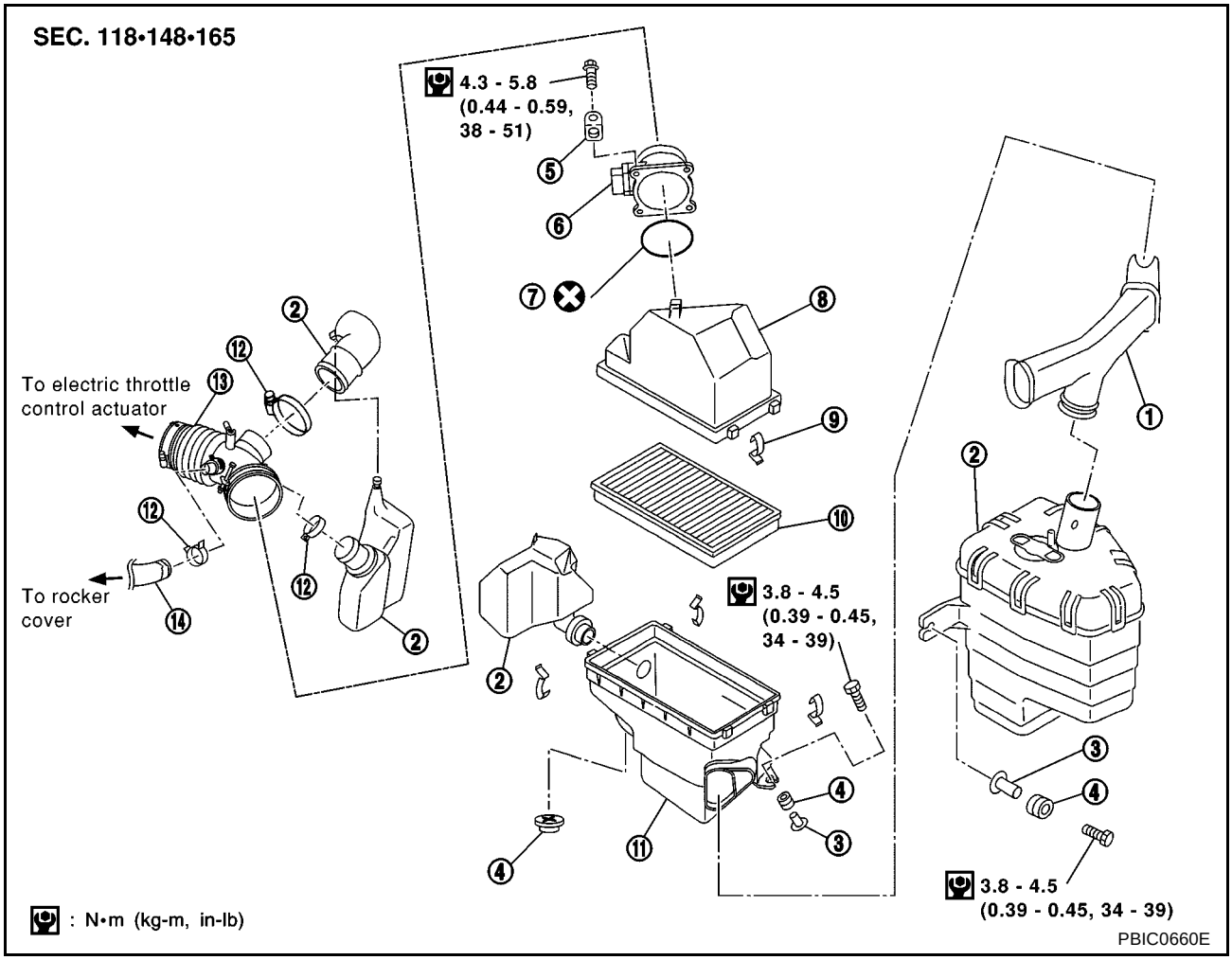
CAUTION:
Install auxiliary drive belt auto-tensioner carefully not to damage the water pump pulley.

AIR CLEANER AND AIR DUCT

PFP:16500

Removal and Installation

EBS00GAG



1	Air duct (inlet)	2	Resonator	3	Color
4	Grommet	5	Harness bracket	6	Mass air flow sensor
7	O-ring	8	Air cleaner case (upper)	9	Clip
10	Air cleaner element	11	Air cleaner case (lower)	12	Clamp
13	Air duct	14	PCV hose		

REMOVAL

1. Remove harness connector from mass air flow sensor.
2. Remove air duct (inlet) and resonator assembly, air cleaner case/ mass air flow sensor.

- Add marks as necessary for easier installation.

3. Remove mass air flow sensor from air cleaner case (upper).

CAUTION:
Handle mass air flow sensor with following cares.

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

4. Remove resonator in fender lifting left fender protector and LH splash cover.

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

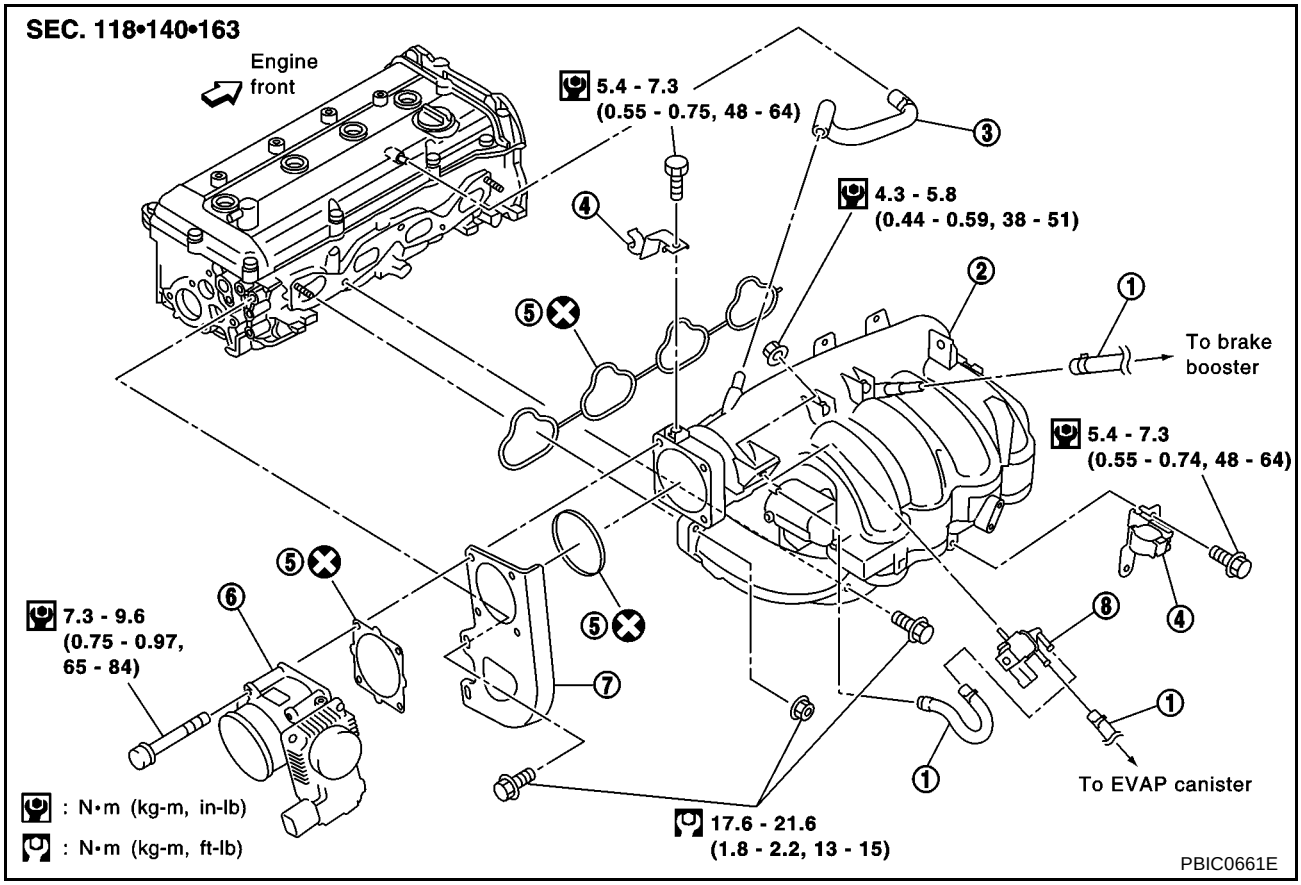
1. Remove clips and lift up air cleaner case (upper).
2. Remove air cleaner element.

INTAKE MANIFOLD

PFP:14003

Removal and Installation

EBS00GAH



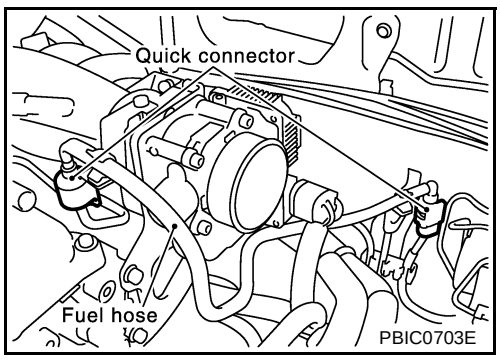
1	Vacuum hose	2	Intake manifold	3	PCV hose
4	Bracket	5	Gasket	6	Electric throttle control actuator
7	Intake manifold support	8	EVAP canister purge volume control solenoid valve		

REMOVAL

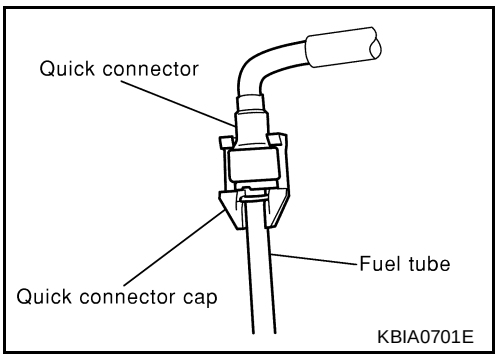
WARNING:

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

1. Release fuel pressure.
   Refer to EC-1001, "FUEL PRESSURE RELEASE" (WITH EURO-OBD), EC-1443, "FUEL PRESSURE RELEASE" (WITHOUT EURO-OBD).
2. Remove air cleaner case and air duct assembly.
   Refer to EM-114, "Removal and Installation" .
3. Disconnect fuel hose quick connector on engine side.



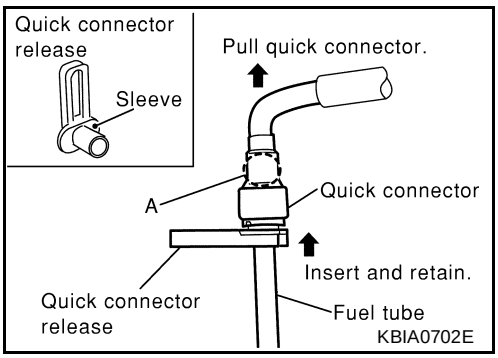
- Using tool of quick connector release (here in after “release”), perform the following steps to disconnect quick connector.



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.**

4. When removing fuel hose quick connector at vehicle piping side, preform as follows.

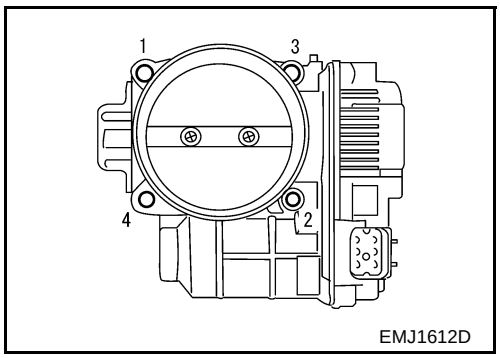
a. Remove quick connector cap.
b. Hold the sides of the connector, push in tubs and pull out the tube. (The figure is shown for reference only.)

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

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.**
  Retainer color: Green.
- **To keep clean the connecting portion and to avoid damage and foreign materials, cover them completely with plastic bags or something similar.**

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

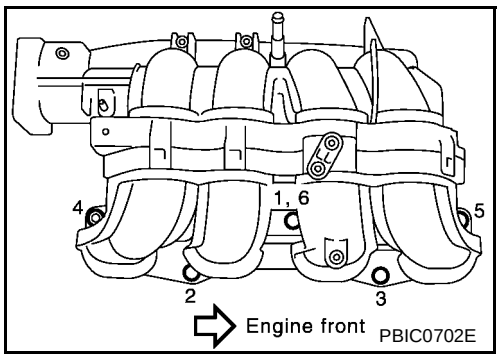
CAUTION:
- **Handle carefully to avoid any shock.**
- **Do not disassemble.**



6. Disconnect intake manifold harness, vacuum hose, and PCV hose.

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

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



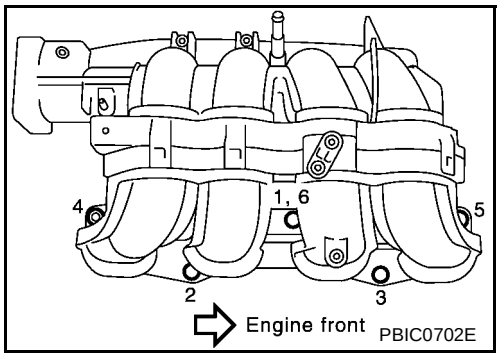
INSTALLATION

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

Tighten Intake Manifold Bolts and Nuts

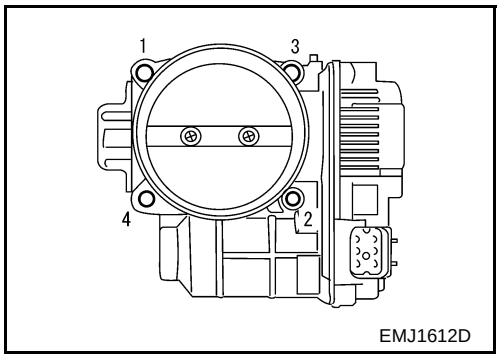
- Tighten in numerical order as shown in the figure.

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



Installation of Electric Throttle Control Actuator

- Tighten fixing bolts of electric throttle control actuator equally and diagonally in several steps.
- After installation perform procedure in EM-119, "INSPECTION AFTER INSTALLATION" .



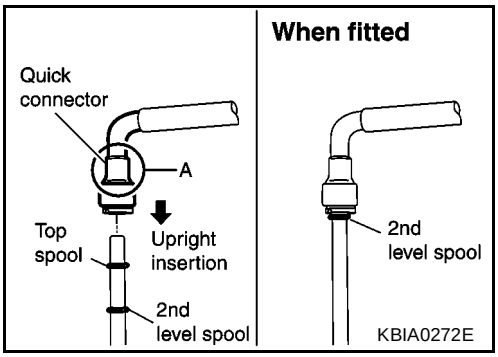
Connecting Quick Connector of Fuel Hose (Engine Side)

- Install quick connector as follows. (The steps are the same for quick connectors on engine side and vehicle)

1. Make sure no foreign substances are deposited in and around tube and quick connector and no damage on them.

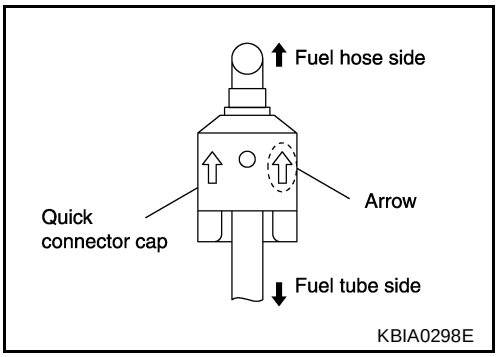
2. Thinly apply new engine oil around the fuel tube tip end.
3. Align center to insert quick connector straightly into fuel tube.
   - Insert fuel tube into quick connector until the first spool on fuel tubes is inserted completely and the second one is positioned slightly below the quick connectors 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.

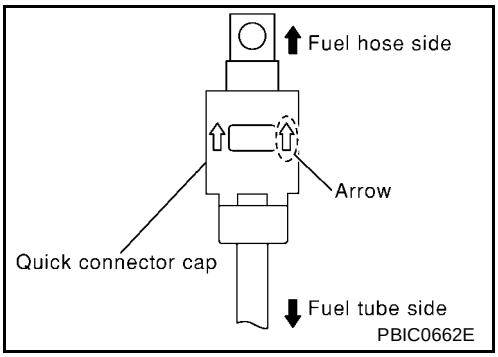
   NOTE:
   Recommended pulling force is 50 N (5.1 kg, 11.2 lb).
   Then clamp fuel hose with clamps.
5. Install quick connector cap on quick connector joint.
   - Direct arrow mark on quick connector cap to upper side (The figure shows quick connector cap for engine side).
6. Install fuel hose to hose clamp.



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 BASIC SERVICE PROCEDURE, EC-998, "Throttle Valve Closed Position Learning" (WITH EURO-OBD), EC-1440, "Throttle Valve Closed Position Learning" (WITHOUT EURO-OBD).

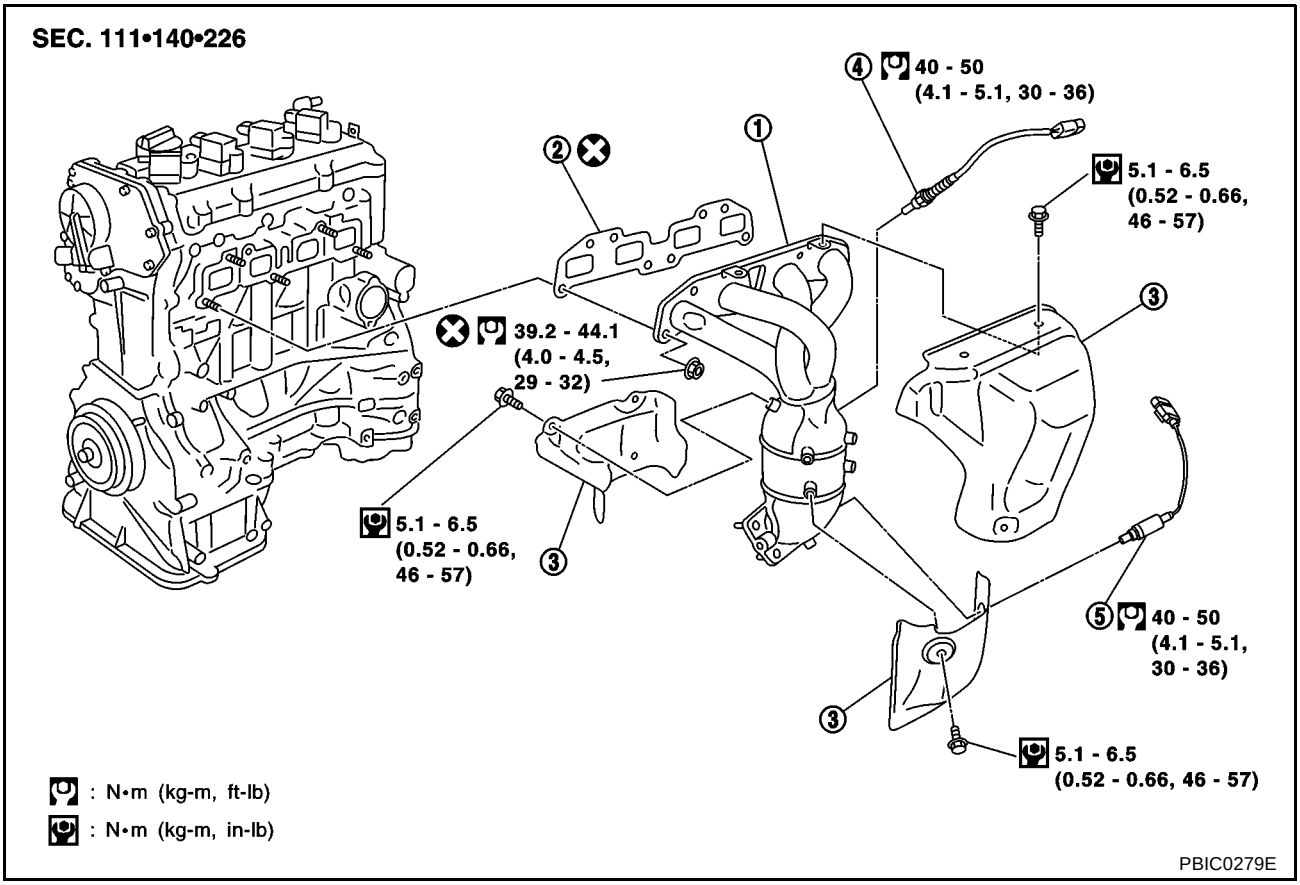
- If electric throttle control actuator is replaced, perform procedures for “Idle Air Volume Learning” after finishing repairs. Refer to BASIC SERVICE PROCEDURE, EC-999, "Idle Air Volume Learning" (WITH EURO-OBD), EC-1440, "Idle Air Volume Learning" (WITHOUT EURO-OBD).

EXHAUST MANIFOLD AND THREE WAY CATALYST

PFP:14004

Removal and Installation

EBS00GAI

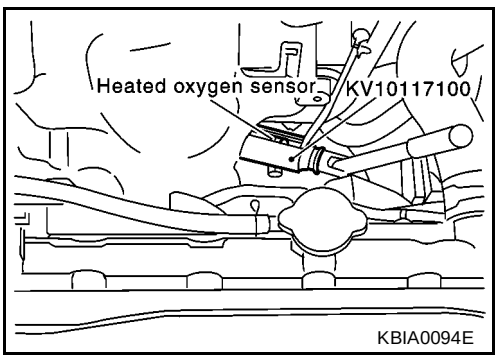


1	Exhaust manifold and three way catalyst assembly	2	Gasket	3	Exhaust manifold cover
4	Heated oxygen sensor 1	5	Heated oxygen sensor 2		

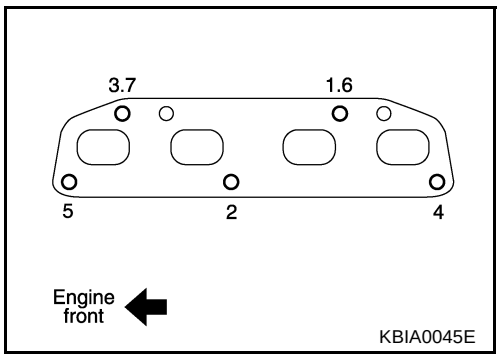
REMOVAL

1. Remove engine undercover of right side.
2. Remove drive belts. Refer to EM-112, "DRIVE BELTS" .
3. Remove cooling fan assembly. Refer to CO-31, "RADIATOR" .
4. Remove alternator.
5. Remove exhaust front tube from exhaust manifold and three way catalyst convertor.
6. Remove heated oxygen sensor harness.
7. 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.**
8. Remove exhaust manifold cover.



9. Remove exhaust manifold and three way catalyst loosening nuts in reverse order in the figure.
   - Disregard No. 6 and 7 when loosening.



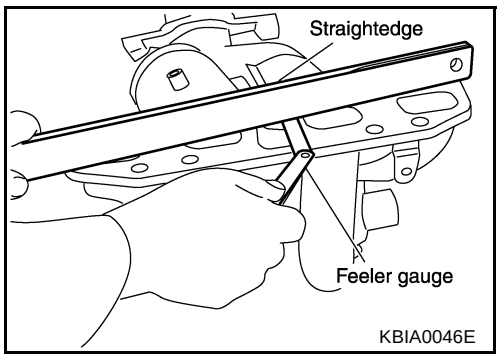
10. Remove exhaust manifold cover from exhaust manifold and three way catalyst assembly.

INSPECTION AFTER REMOVAL

Surface Distortion

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

  Limit : 0.3 mm (0.012 in)

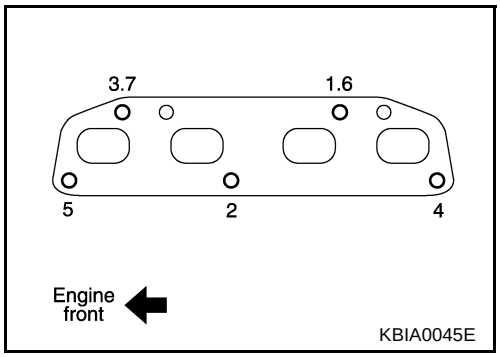


INSTALLATION

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

Tightening 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.



Installation of Heated Oxygen Sensor

CAUTION:

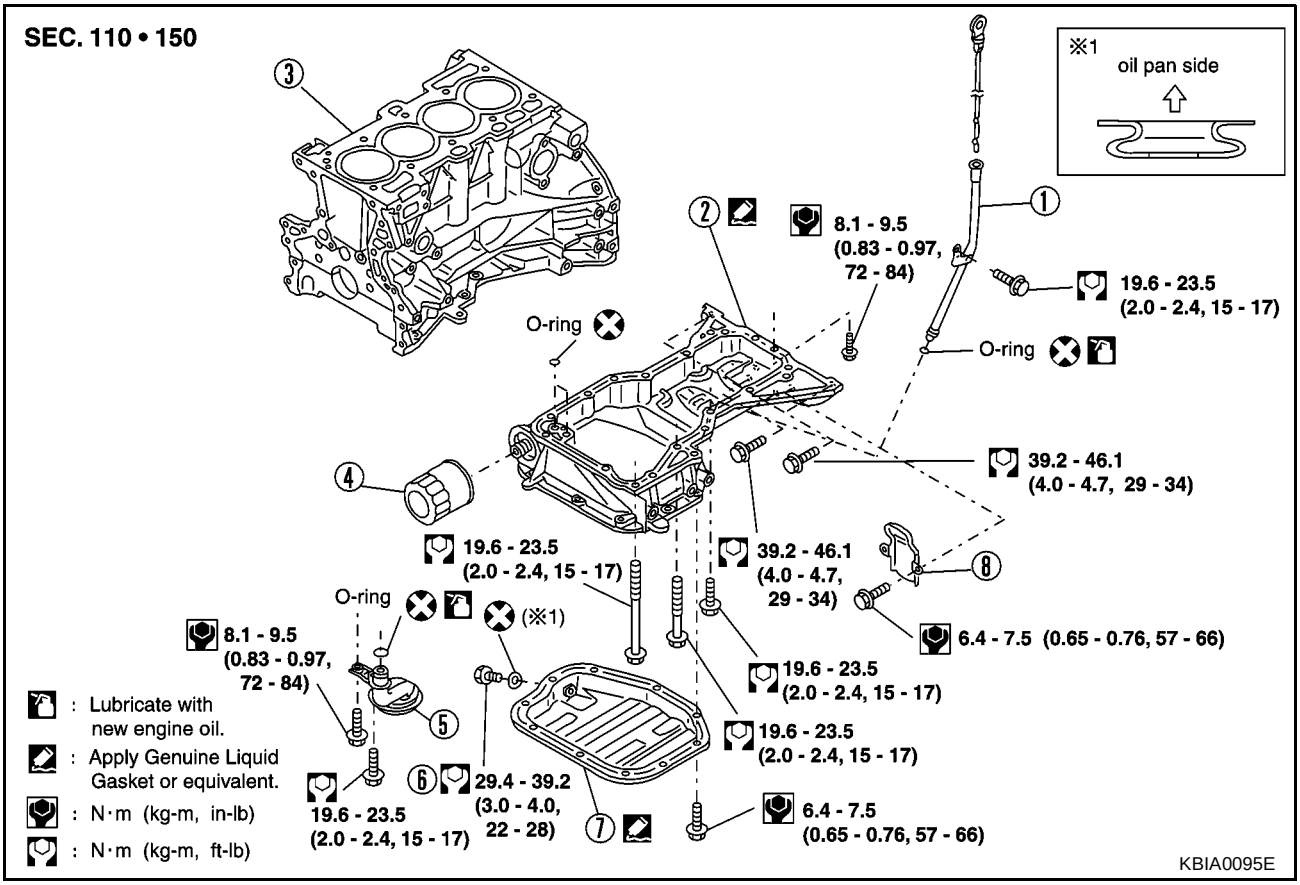
- **Do not over torque the heated oxygen sensor. Doing so may cause damage to the heated oxygen sensor, resulting in the MI coming on.**

OIL PAN AND OIL STRAINER

PFP:11110

Removal and Installation

EBS00GAJ



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 undercover both side.
2. Drain engine oil. Refer to LU-17, "Changing Engine Oil" .
3. Remove lower oil pan.

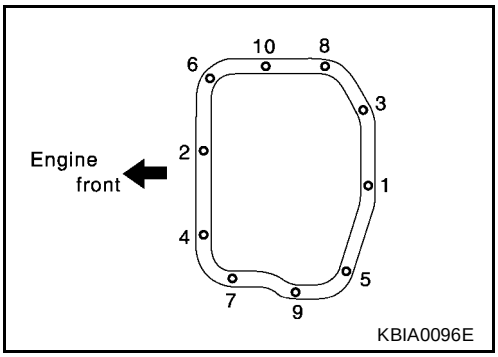
a. Loosen bolts in the reverse order of that shown in the figure.

b. Insert Tool Seal cutter between lower and upper oil pan. Remove lower oil pan.

4. Remove upper oil pan.

a. Remove drive belts.

b. Remove A/C compressor bolt and move the A/C compressor.



And locate it aside temporarily with ropes or equivalent not to disturb the following work.

c. Remove oil level gauge guide.

d. Remove front cross member. Refer to FSU-5, "FRONT SUSPENSION ASSEMBLY" .

e. Remove front exhaust tube.

f. Set a suitable transmission jack under transaxle and hoist engine with engine slinger. Remove center member.

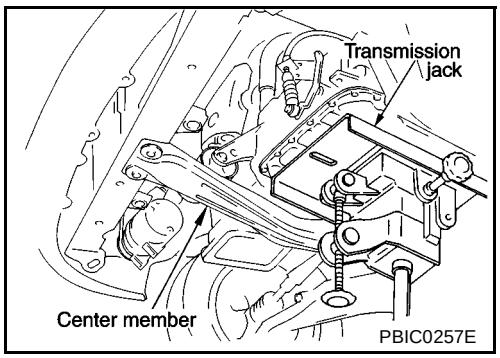
g. Remove engine mounting bracket of vehicle rear side.

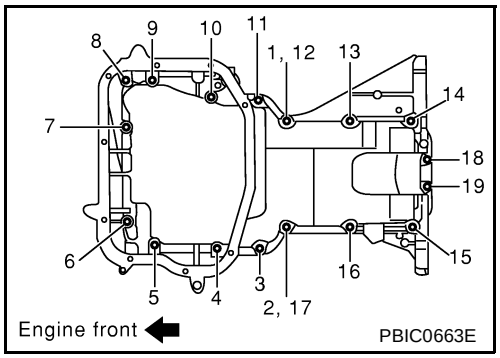
h. Remove rear plate cover.

i. Remove four engine-to transaxle bolts

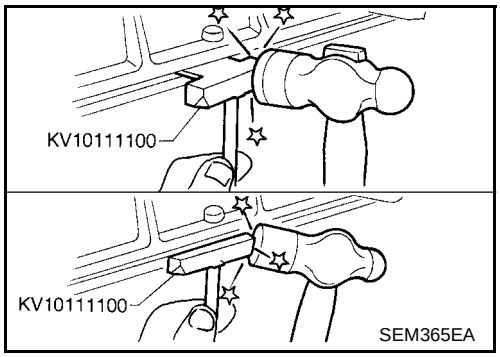
j. Loosen bolts in reverse order of illustration to remove upper oil pan.

- Disregard No. 12 and 17 when loosening.





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



5. Remove oil strainer.

INSPECTION AFTER REMOVAL

- Clean oil strainer if any object attached.

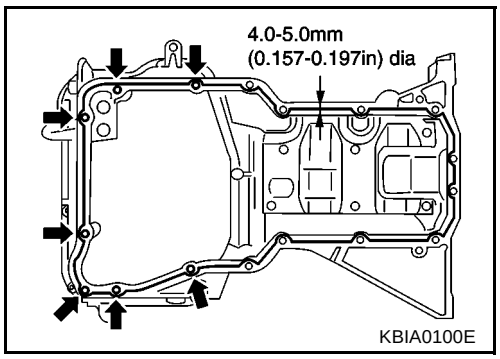
INSTALLATION

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.**

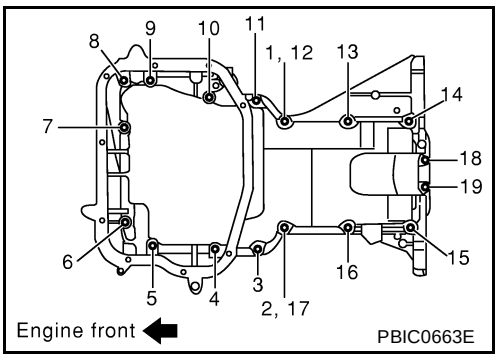
b. Install O-rings as front cover side.



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 × 45 mm (1.77 in) : No. 4,10,13,14,15,16
M8 ×100mm (3.97 in) : No. 5, 6, 7, 8, 9



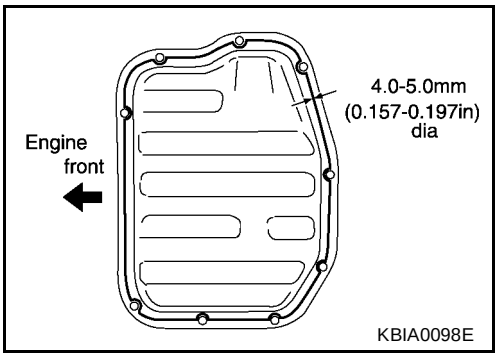
d. Tighten transmission joint bolts.

e. Install rear plate cover.

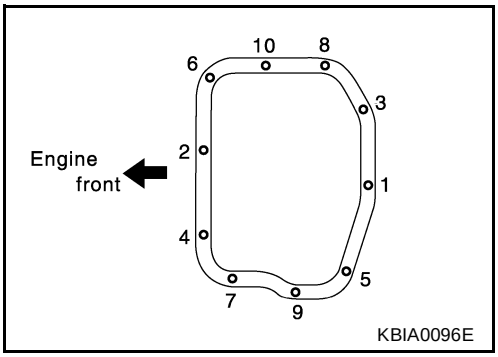
f. Install in the “4-g” to “4-a” order of removal after this step.

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

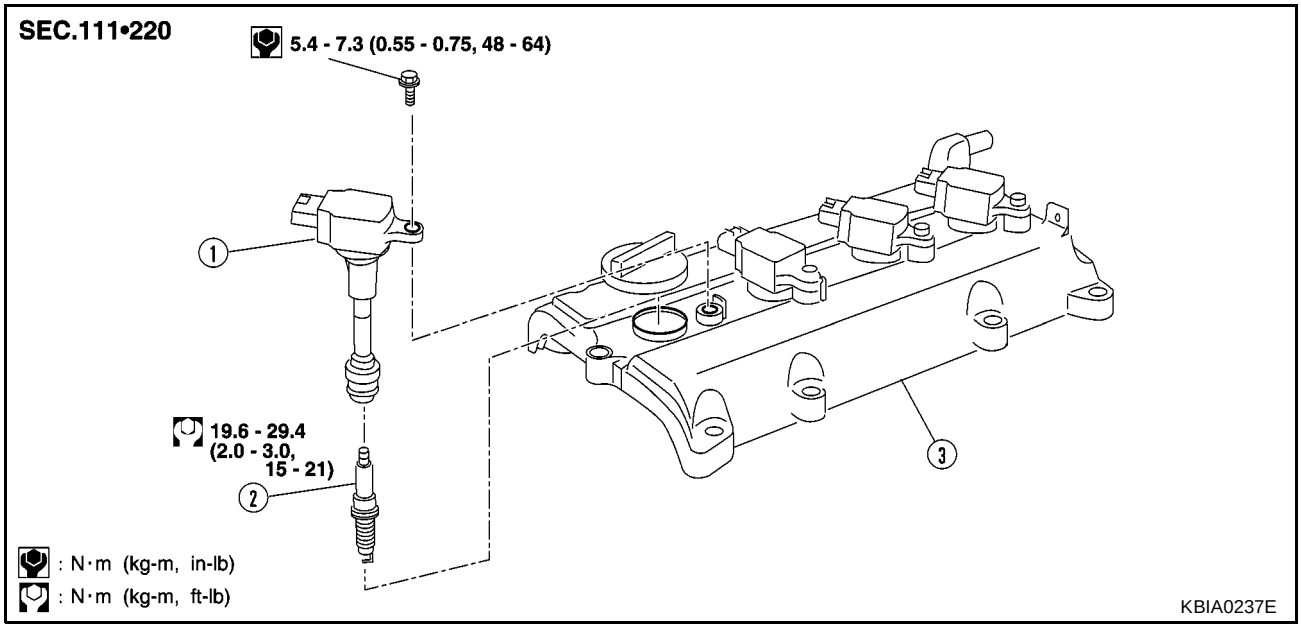
- Check for leakage of engine oil when engine is warmed.

IGNITION COIL

PFP:22448

Removal and Installation

EBS00GAK



1 Ignition coil 2 Spark plug 3 Rocker cover

REMOVAL

1. Remove harness connector from ignition coil.
2. Remove ignition coil.

CAUTION:
Do not shock it.

INSTALLATION

- Install in the reverse order of removal.

SPARK PLUG (CONVENTIONAL)

PFP:22401

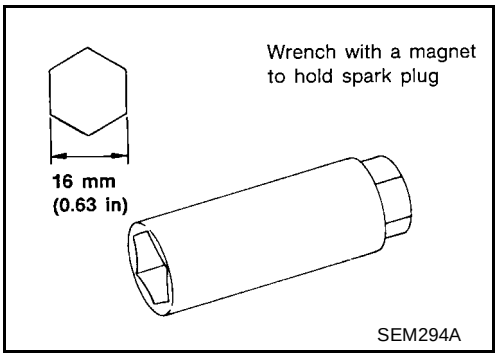
Removal and Installation

EBS00H9R

REMOVAL

1. Remove ignition coil. Refer to EM-126, "Removal and Installation" .
2. Remove spark plug with suitable spark plug wrench.

Make	NGK
Standard type	LFR5A-11
Hot type	LFR4A-11
Cold type	LFR6A-11



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.

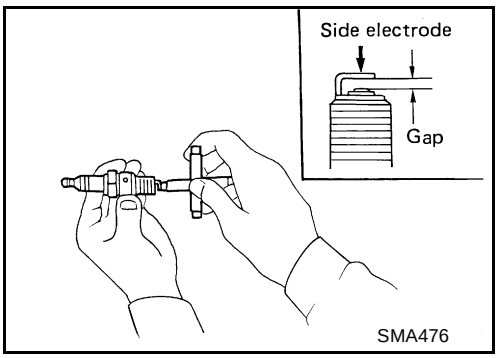
The cold type spark plug is suitable when spark plug knock occurs with the standard type spark plug under conditions such as.

- extended highway driving.
- frequent high engine revolution.

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

Gap : 1.0 - 1.1 mm (0.039 - 0.043 in)

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



INSTALLATION

- Install in the reverse order of removal.

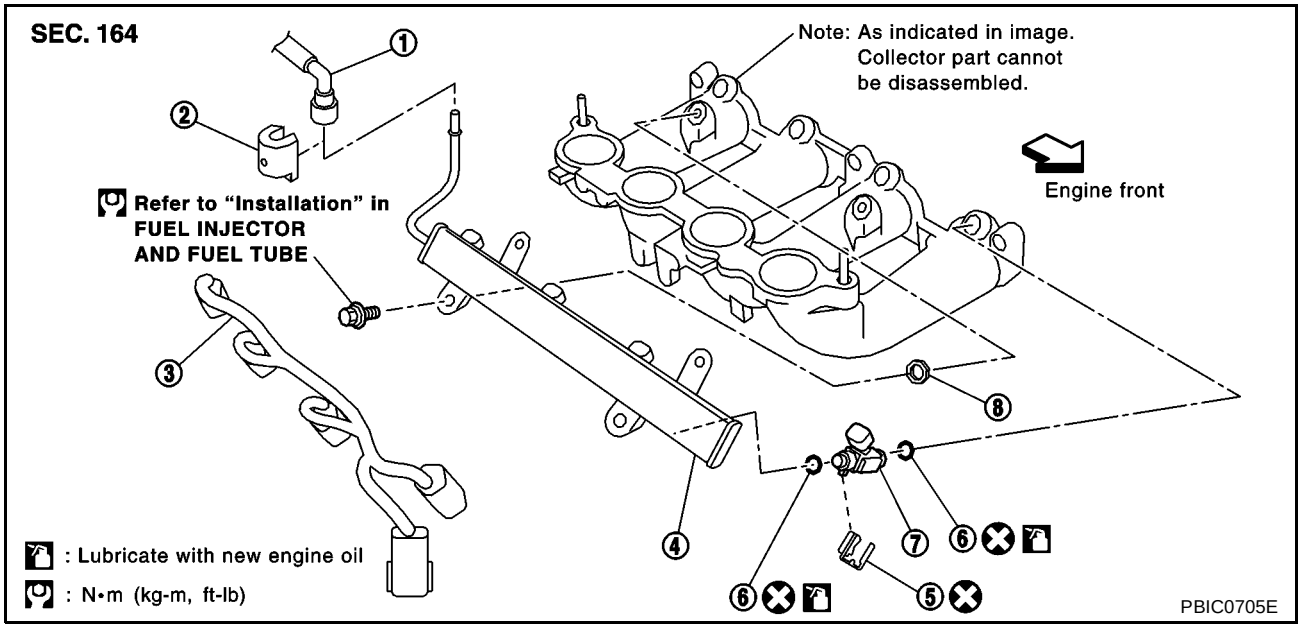
: 19.6 - 29.4 N·m (2.0 - 3.0 kg-m, 15 - 21 ft-lb)

FUEL INJECTOR AND FUEL TUBE

PFP:16600

Removal and Installation

EBS00GAM



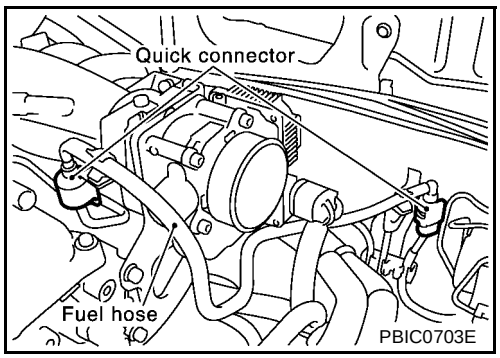
1	Fuel hose	2	Quick connector cap	3	Sub-harness
4	Fuel tube	5	Clip	6	O-ring
7	Fuel injector	8	Insulator		

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-1001, "FUEL PRESSURE RELEASE" (WITH EURO-OBD), EC-1443, "Fuel Pressure Check" (WITHOUT EURO-OBD).
2. Remove air duct, air cleaner case (upper) assembly. Refer to EM-114, "AIR CLEANER AND AIR DUCT" .
3. Disconnect fuel hose quick connector at fuel tube side.



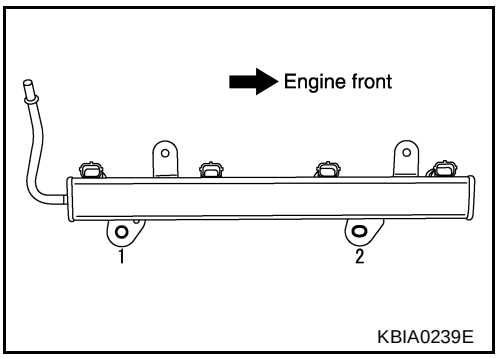
- Regarding how to disconnect and connect quick connector, Refer to EM-116, "INTAKE MANIFOLD" .

  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.**

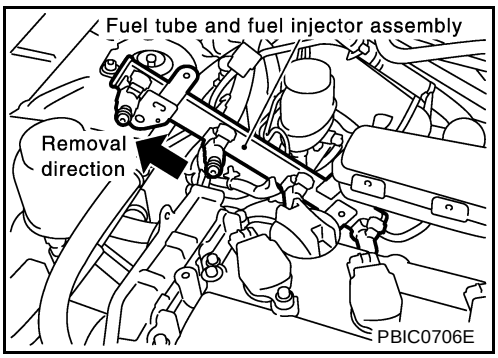
4. Disconnect intake manifold collector. Refer to EM-116, "INTAKE MANIFOLD" .
5. Disconnect sub-harness for injector at engine front side, and remove it from bracket.

6. Loosen mounting bolts in the reverse order in the figure, and remove fuel tube and fuel injector assembly.



7. Frequently changing direction of fuel tube and injector assembly, take it out toward rear side of vehicle.
   - If fuel hose clamp interferes with engine, tilt it to prevent contact with engine.

   CAUTION:
   When removing, be careful to keep fuel injector nozzle from interfering with intake manifold.



8. Remove fuel injector.

- Release clip and remove it.
- Pull fuel injector straight out of fuel tube.

  CAUTION:
  - **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 immediatly.**

2. Install fuel injector to fuel tube with the following procedure.

a. Insert clip into clip mounting groove on fuel injector.

- Insert clip so that projection A of fuel injector matches notch A of the clip.

CAUTION:

- **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.**

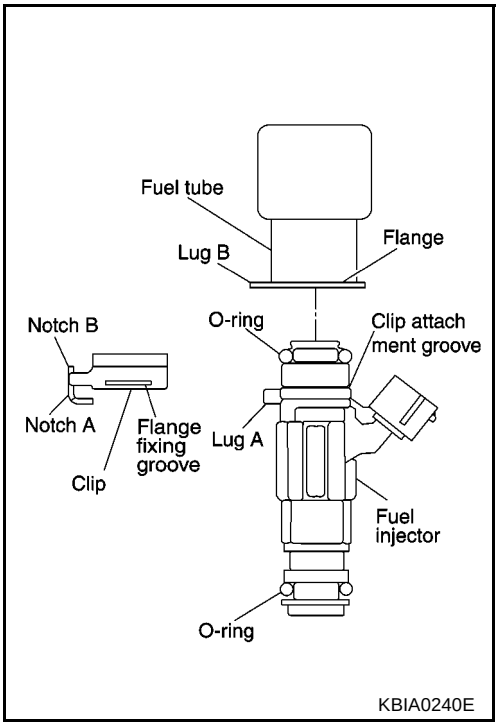
b. Insert fuel injector into fuel tube with clip attached.

- 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.

c. Make sure that installation is complete by checking that fuel injector does not rotate or come off.

3. Install fuel tube assembly with the following procedure.

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

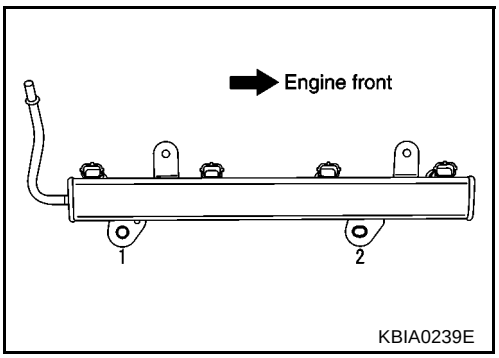


b. Tighten mounting bolts in two steps in the numerical order shown in the figure.

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)

4. Install intake manifold collector. Refer to EM-116, "INTAKE MANIFOLD" .
5. Connect fuel hose. Refer to EM-116, "INTAKE MANIFOLD" .
6. 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.

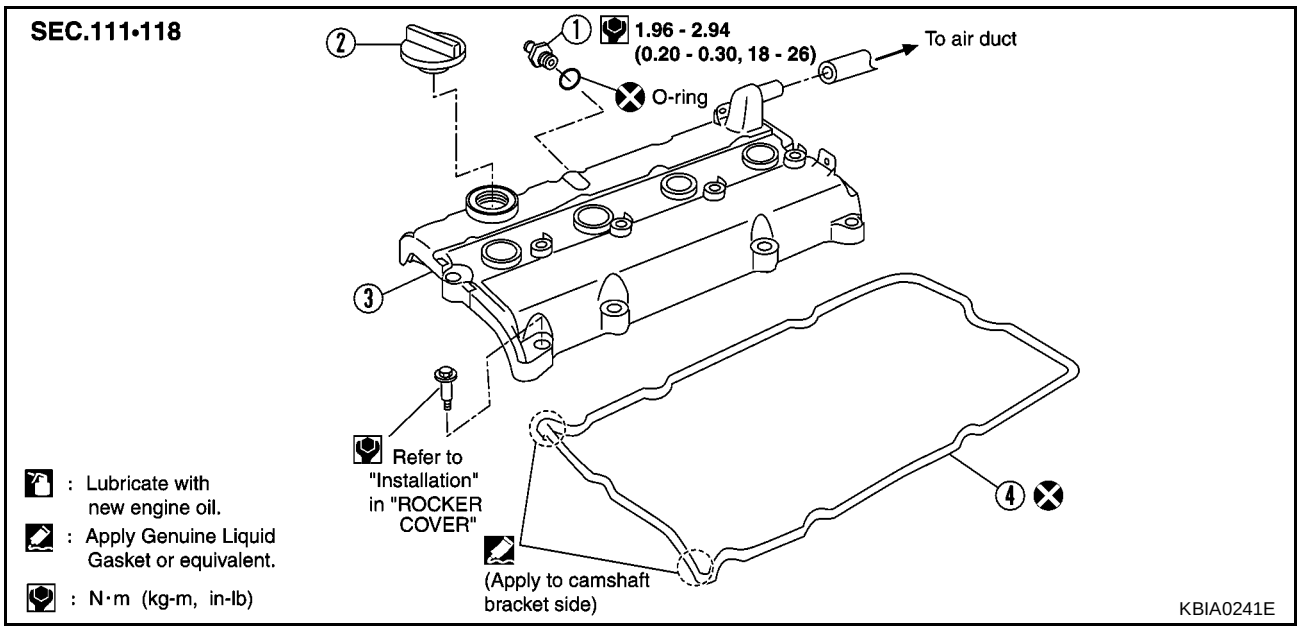
CAUTION:
Do not touch the engine immediately after stopped as engine becomes extremely hot.

ROCKER COVER

PFP:13264

Removal and Installation

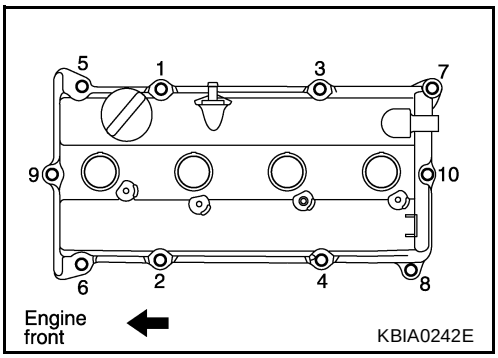
EBS00GAN



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

REMOVAL

1. Remove PCV hose.
2. Remove ignition coil. Refer to EM-126, "Removal and Installation" .
3. Loosen bolts in reverse order shown in the figure.

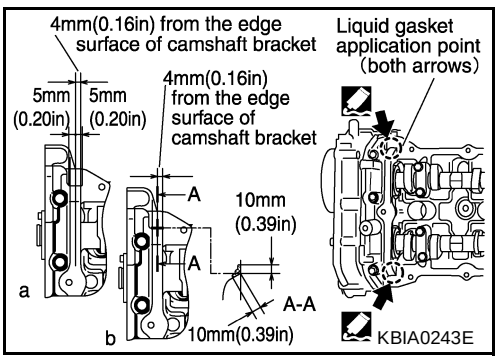


INSTALLATION

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.
- **Use Genuine Liquid gasket or equivalent.**

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



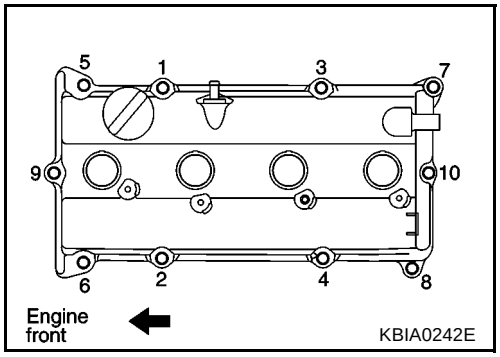
2. Install rocker cover.

- 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)



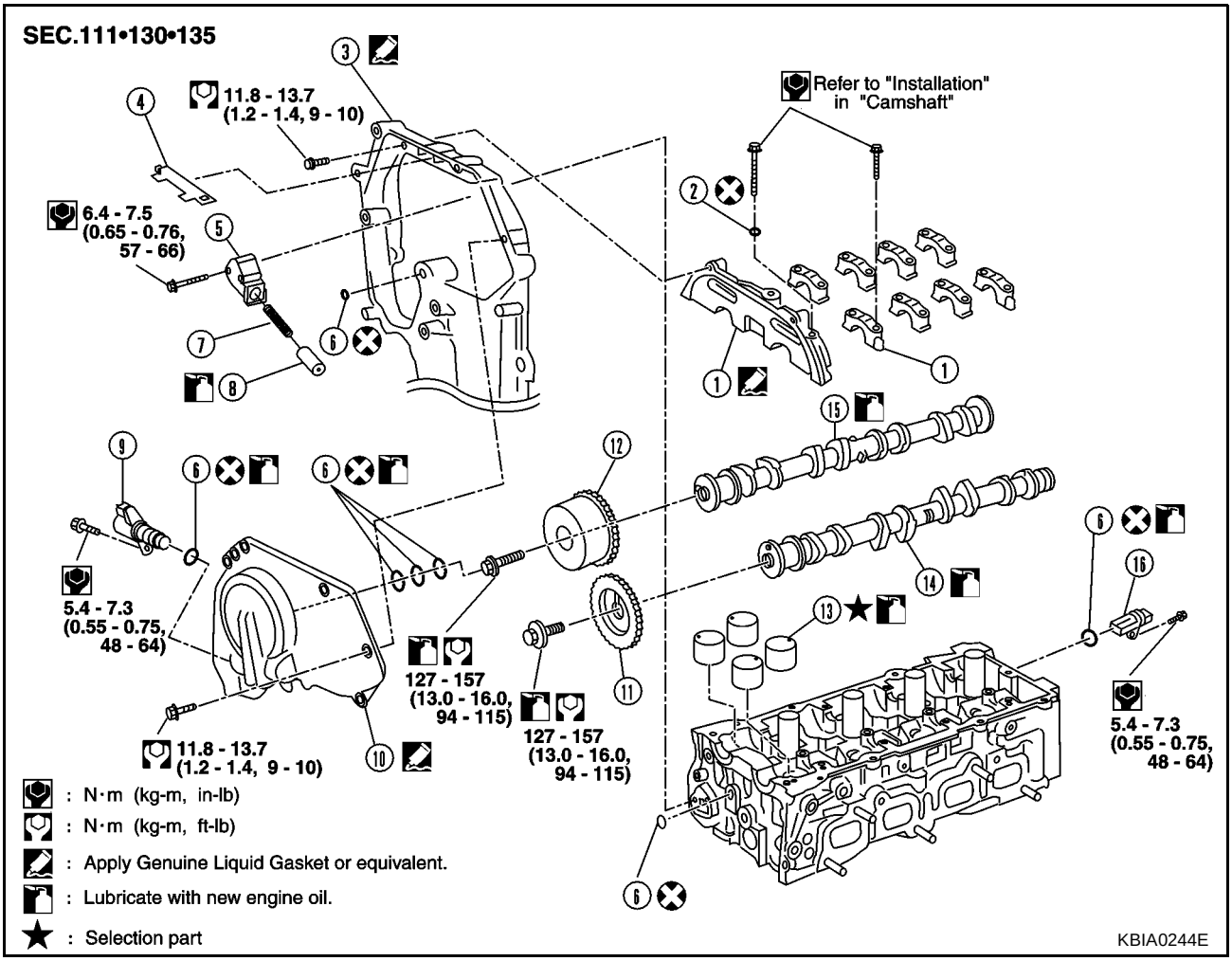
4. Install in the reverse order of removal after this step.

CAMSHAFT

PFP:13001

Removal and Installation

EBS00GAO



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-143, "TIMING CHAIN" .

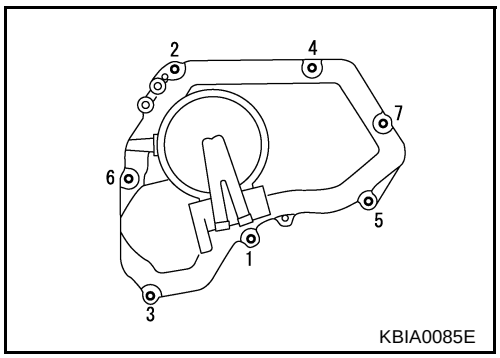
1. Release fuel pressure. Refer to EC-1001, "Fuel Pressure Check" (WITH EURO-OBD), EC-1443, "Fuel Pressure Check" (WITHOUT EURO-OBD).
2. Remove parts listed below.

- Ignition coil; Refer to EM-126, "Removal and Installation" .
- Rocker cover; Refer to EM-131, "Removal and Installation" .

3. Remove power steering reservoir tank.
4. Remove Intake valve timing control cover.

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

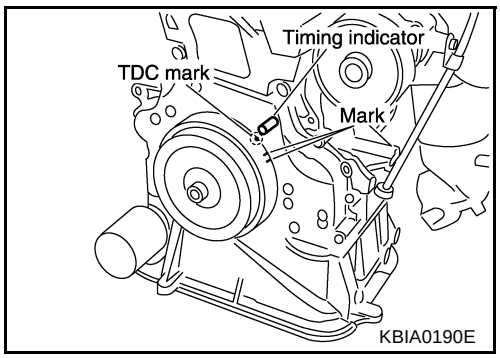
b. Remove the cover using Special Service Tool (Seal cutter).



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

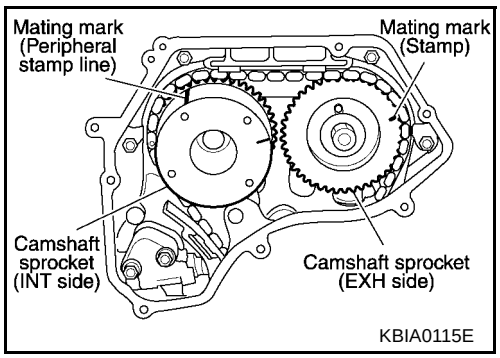
a. Open splash cover on RH undercover.

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.



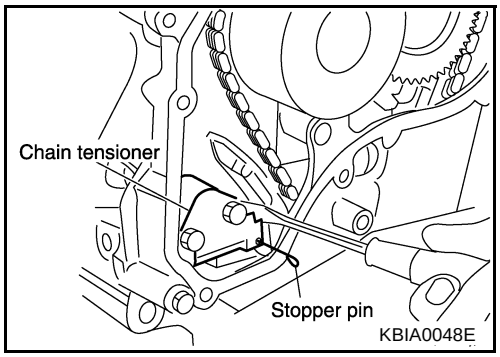
6. Pull chain guide between camshaft sprockets out through front cover.

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 0.5 mm (0.02 in) in diameter as a stopper pin.



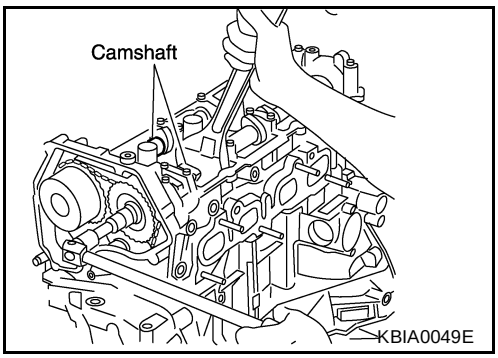
c. Secure hexagonal part of camshaft with a tool such as a spanner. Loosen camshaft sprocket mounting bolts and remove the camshaft sprockets.

CAUTION:

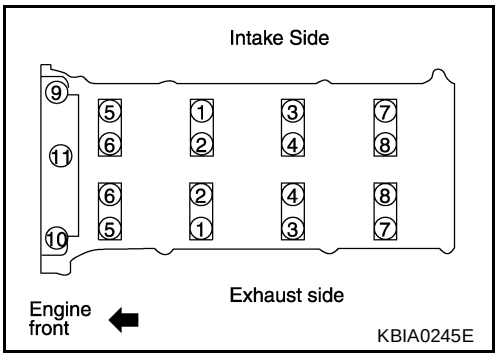
- **Do not rotate crankshaft or camshaft while timing chain is removed. It causes interference between valve and piston.**

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.



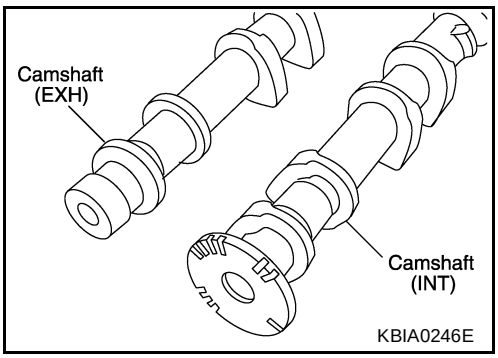
9. Remove valve lifter.
   - Check mounting positions, and store them without mixing them up.

INSTALLATION

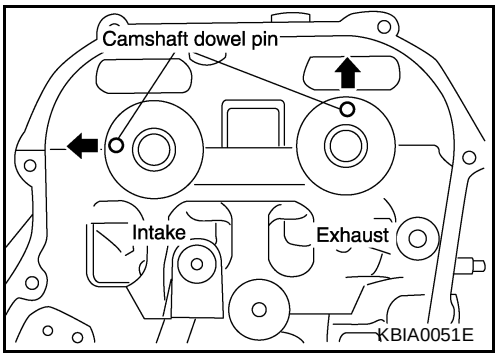
1. Install valve lifter.
   - Install them in the same positions they were in prior to removal.
2. Install camshaft.
   - Distinction between intake and exhaust camshafts is performed with a difference of shapes of rear end.

     Intake : Signal plate shape for camshaft potion (PHASE) sensor

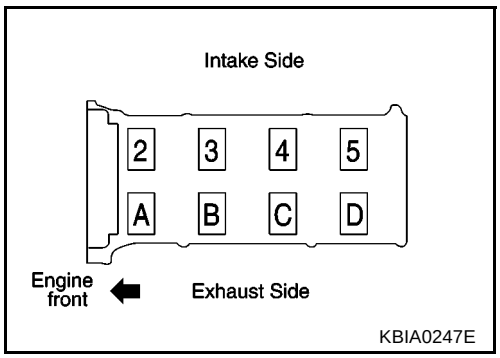
     Exhaust : Cone end shape.



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

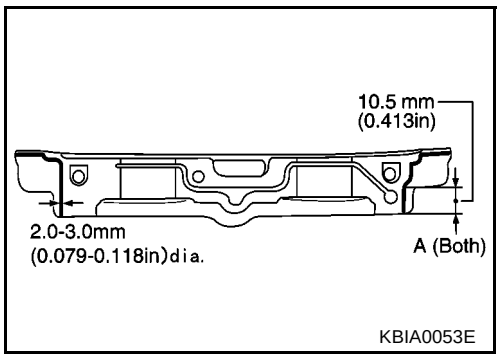


3. Install camshaft brackets.
   - Install by referring to identification mark on upper surface mark.
   - Install so that identification mark can be correctly read when viewed from the exhaust side.

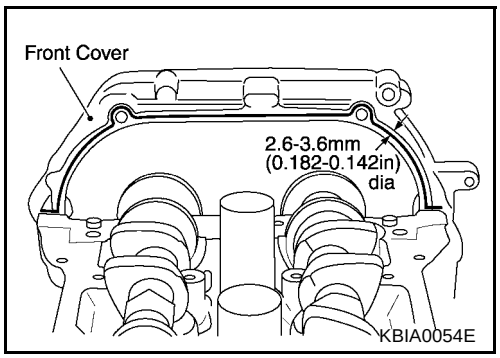


   - Install No. 1 camshaft bracket as follow.
   - Apply liquid gasket to No.1 camshaft bracket as in illustration.
   - **Use Genuine Liquid Gasket or equivalent.**

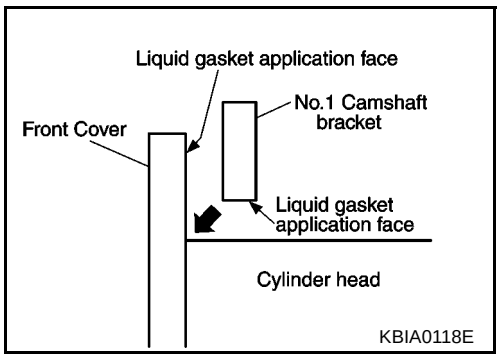
     CAUTION:
     - **After installation, be sure to wipe off any excessive liquid gasket leaking from part "A" (both on right and left sides).**



   - 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.



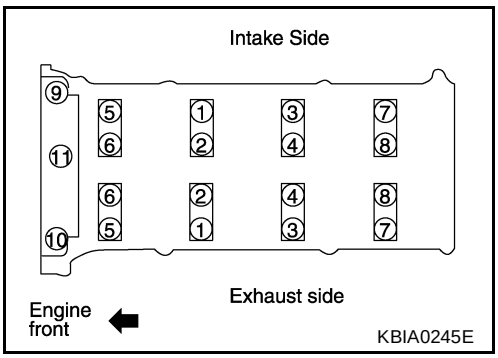
4. Tighten fixing bolts of camshaft brackets as follows.

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 11.8N·m (0.92 to 1.20 kg-m, 80 to 104 in-lb).



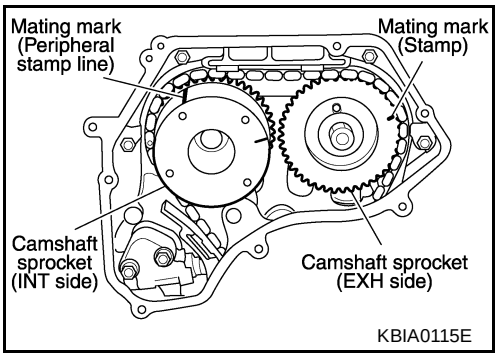
CAUTION:

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.

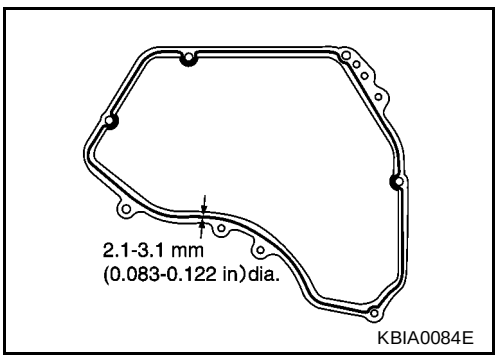
8. Install Intake valve timing control cover with the following procedure.

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

b. Install O-ring to front cover side.

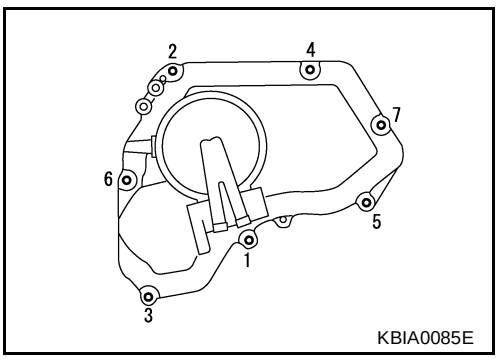
c. Apply liquid gasket to the positions shown in the figure.

- 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-140, "Valve Clearance" .

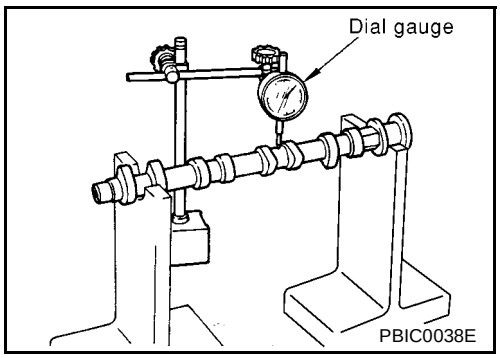
10. For the following operations, perform steps in the reverse order of removal.

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

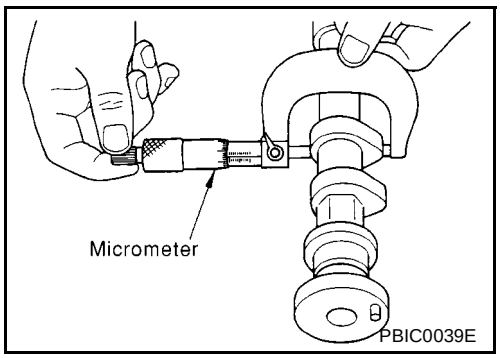
1. Measure camshaft cam height.

Standard cam height:

Intake : 45.665 - 45.855 mm (1.7978 - 1.8053 in)

Exhaust : 42.825 - 43.015 mm (1.6860 - 1.6935 in)

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



Camshaft Journal Clearance

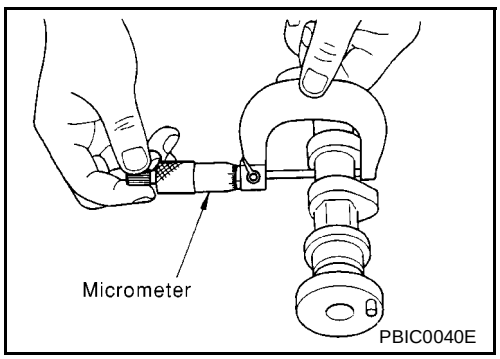
Outer Diameter of Camshaft Journal

- 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)



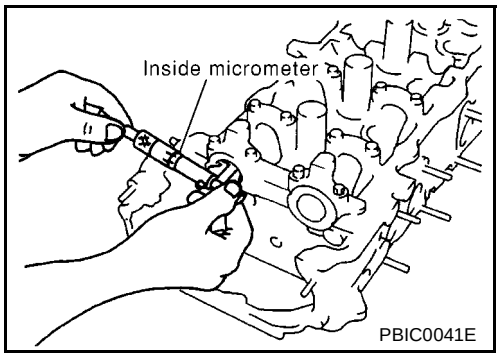
Inner Diameter of Camshaft Bracket

- 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 - 1.1032 in)

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.

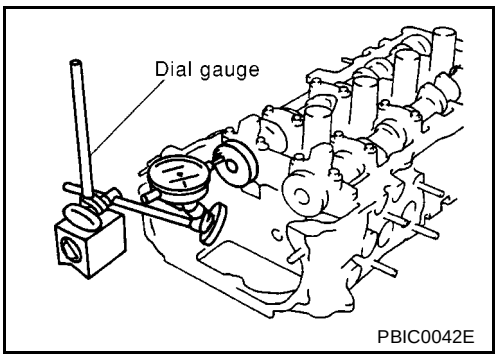
NOTICE:
Inner diameter of camshaft bracket is manufactured together with cylinder head. Replace the whole cylinder head assembly.

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.

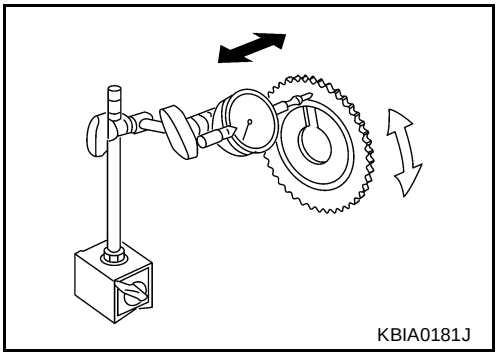


Camshaft Sprocket Runout

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

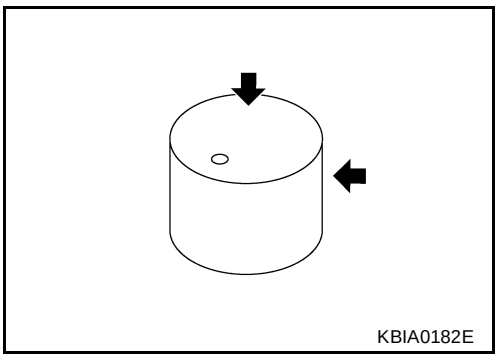
   Runout : Less than 0.15 mm (0.0059 in)

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



Valve Lifter

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

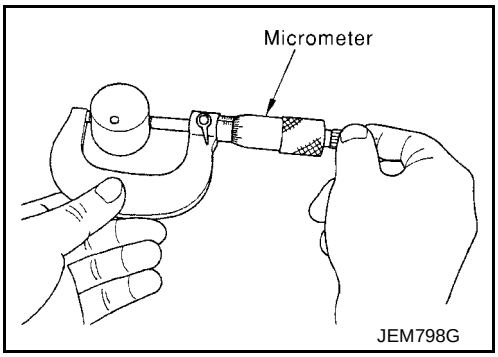


Valve Lifter Clearance

Outer Diameter of Valve Lifter

- Measure outer diameter of valve lifter.

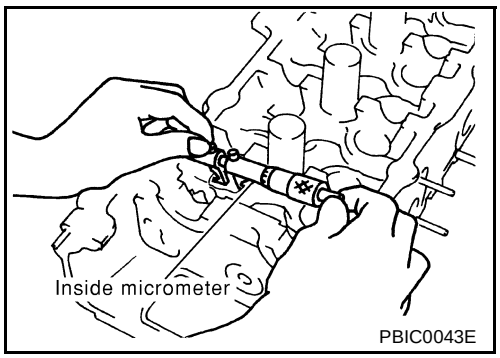
  Valve lifter outer diameter
  : 33.965 - 33.980mm (1.3372 - 1.3378 in)



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.

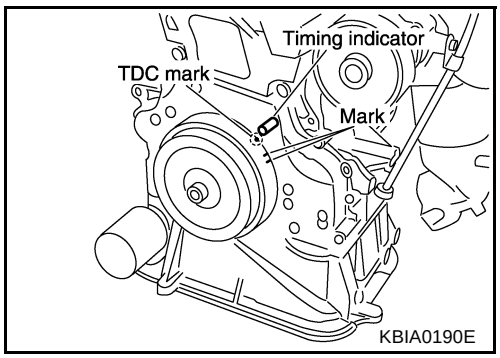
Valve Clearance

EBS00GAP

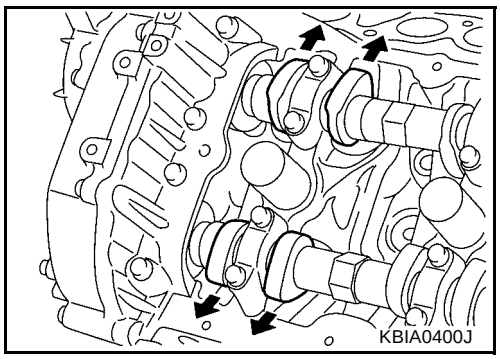
INSPECTION

- 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).

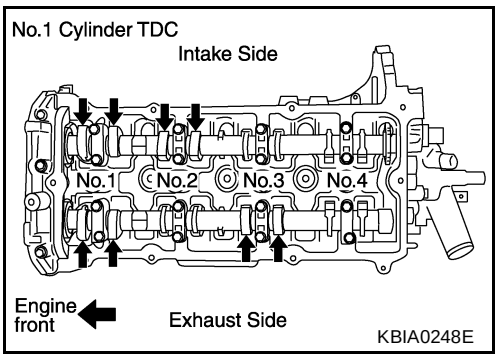
1. Warm up engine. Then stop it.
2. Remove splash cover on RH undercover.
3. Remove rocker cover.
   Refer to EM-131, "Removal and Installation" .
4. Turn crankshaft pulley in normal direction (clockwise when viewed from front) to align TDC identification notch (without paint mark) with timing indicator.



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.

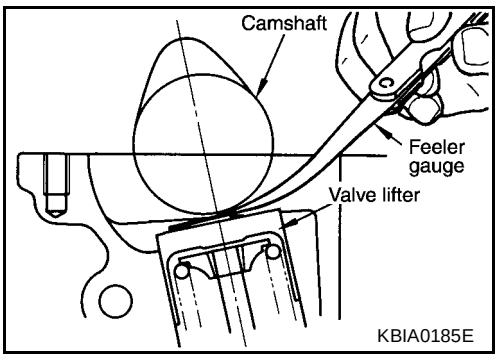


6. By referring to the figure, measure valve clearances at locations marked X as shown in the table below (locations indicated with black arrow in figure) with a feeler gauge.



- No.1 cylinder compression TDC.

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



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

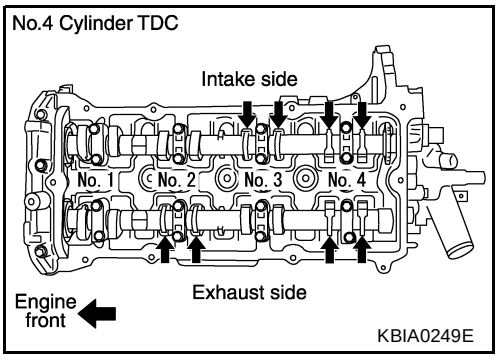
Valve clearance standard:

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				×	×		×	×

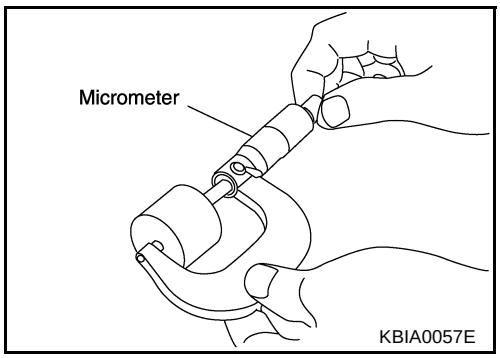
9. If out of specifications, adjust as follows.

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-133, "Removal and Installation" .
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.



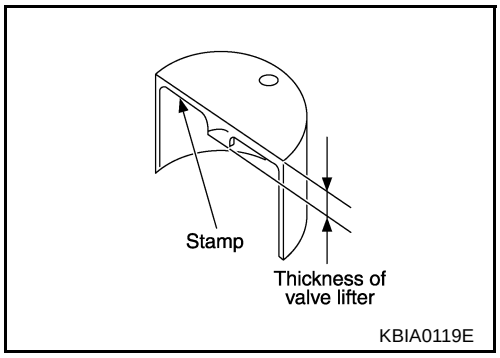
4. Use the equation below to calculate valve lifter thickness for replacement.

- Valve lifter thickness calculation.
  Thickness of replacement valve lifter = t1+ (C1 — C2)
  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 6.96 mm (0.2740 in) 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:

Unit: mm (in)

	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)

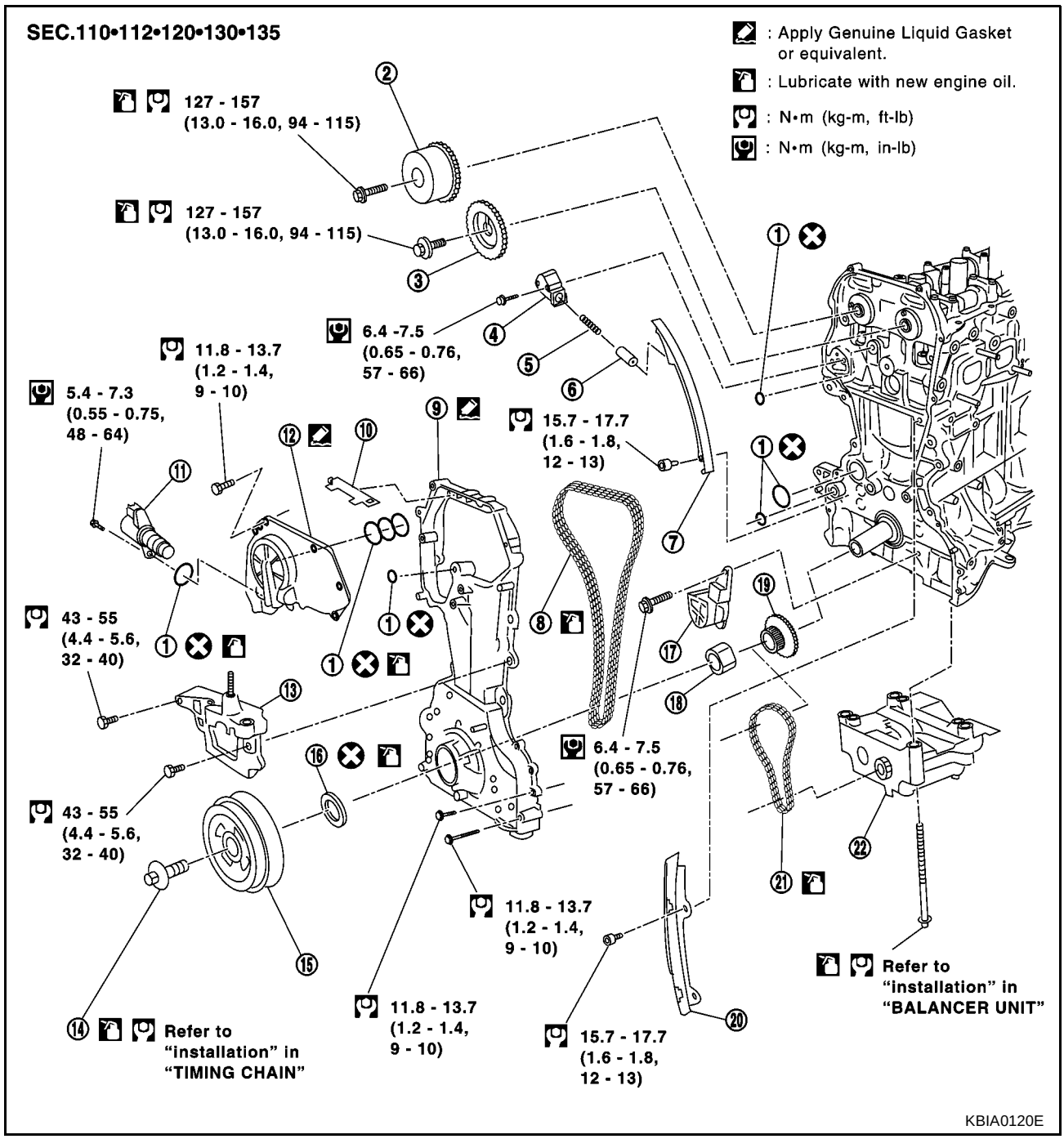
*: Approximately 20°C (68°F)

TIMING CHAIN

PFP:13028

Removal and Installation

EBS00GAQ



1	O-ring	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-126, "Removal and Installation" .
   - Rocker cover; Refer to EM-131, "Removal and Installation" .
   - Engine coolant reservoir tank
   - Auxiliary drive belt; Refer to EM-112, "Removal and Installation" .
   - Alternator
   - Auxiliary drive belt auto-tensioner; Refer to EM-113, "Removal and Installation of Auxiliary Drive Belt Auto- tensioner" .
   - Exhaust front tube; Refer to EX-3, "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:

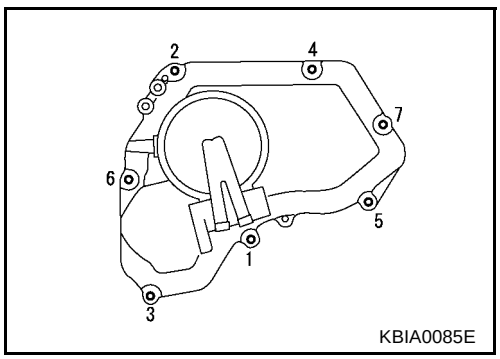
- **To avoid power steering fluid leakage, temporarily fix reservoir tank vertically.**

6. Suspend engine with a hoist, and support the engine posture.
   For installation of engine slingers, refer to EM-161, "ENGINE ASSEMBLY" .
7. Remove RH engine mounting 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-123, "Removal and Installation" .
11. Remove intake valve timing control cover.

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

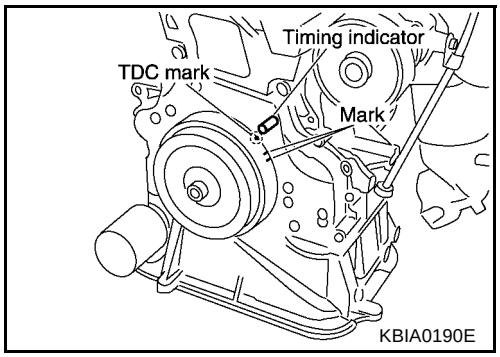
b. Remove the cover using Tool (Seal cutter).

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



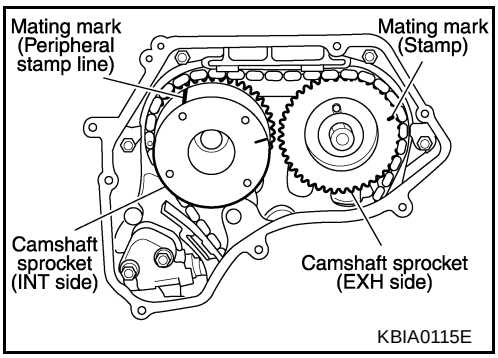
13. Set No.1 cylinder at TDC on its compression stroke with the following procedure.

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



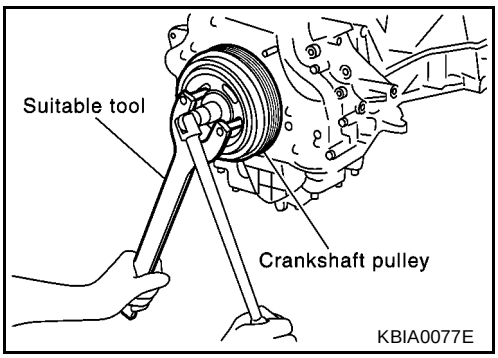
b. At the same time, make sure that the mating marks on camshaft sprockets are located as shown in the figure.

- If not, rotate crankshaft pulley one more turn to line up mating marks to the positions in the figure.

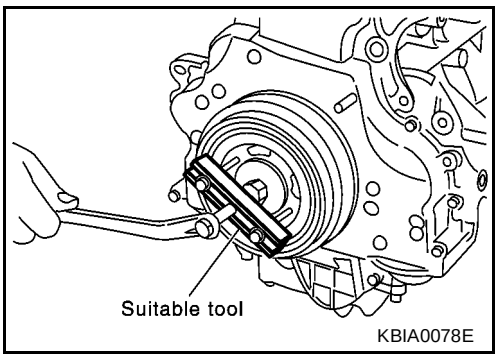


14. Remove crankshaft pulley with the following procedure.

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



b. Attach a pulley puller in the M6 (0.24 in dia.) thread hole on crankshaft pulley, and remove crankshaft pulley.



15. Remove front cover with following procedure.

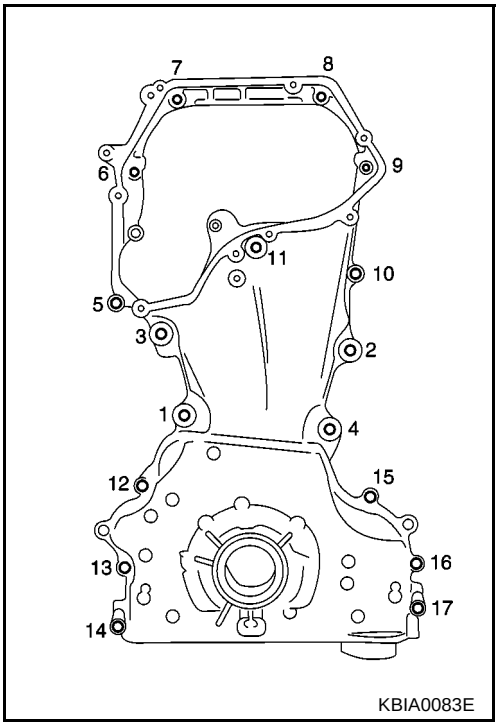
a. Loosen mounting bolts in the reverse order shown in the figure, and remove them.

b. Using a seal cutter, remove front cover.

CAUTION:

- **Be careful not to damage mounting surface.**

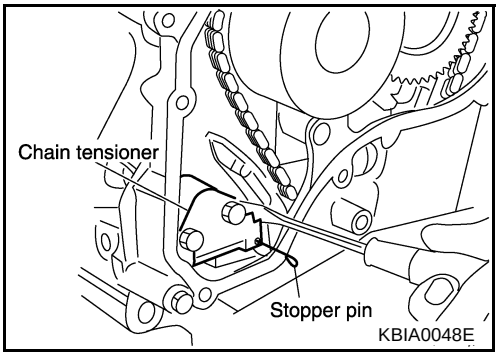
16. If front oil seal needs to be replaced, lift it with a screwdriver, and remove it.



17. Remove timing chain with the following procedure.

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

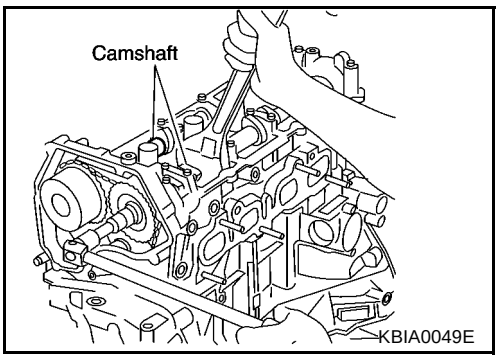
- Use wire of 0.5 mm (0.02 in) in diameter as a stopper pin.



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.

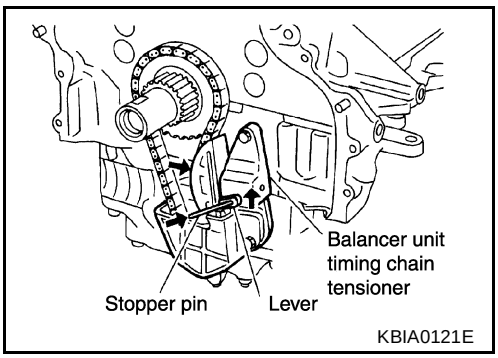
19. Remove timing chain tensioner for balancer unit with the following procedure.

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.



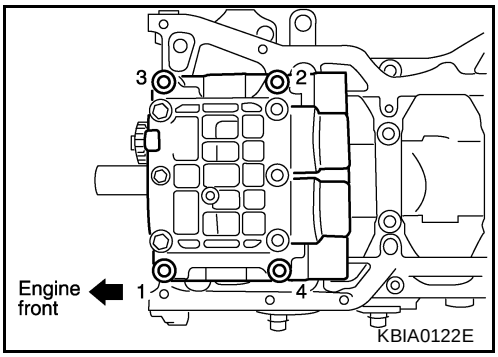
20. Remove timing chain for balancer unit and crankshaft sprockets.

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

- Use Torx socket (size E14)

CAUTION:

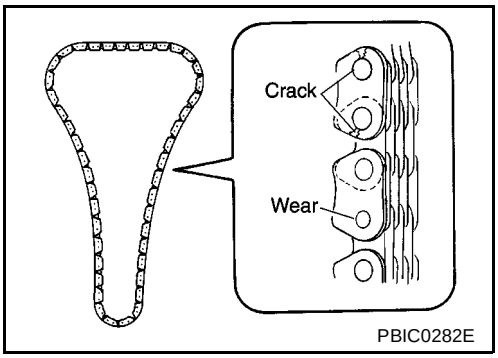
- **Do not disassemble balancer unit.**



INSPECTION AFTER REMOVAL

Timing Chain

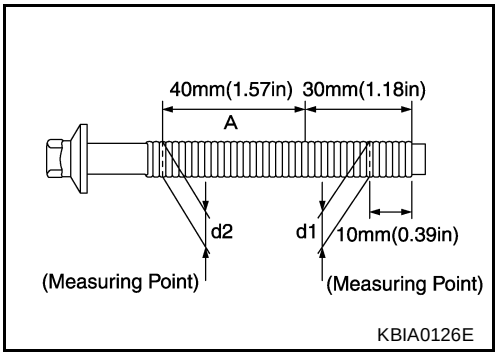
Check timing chain for cracks or serious wear. If a malfunction is detected, replace it.



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. 0059 in) or more.

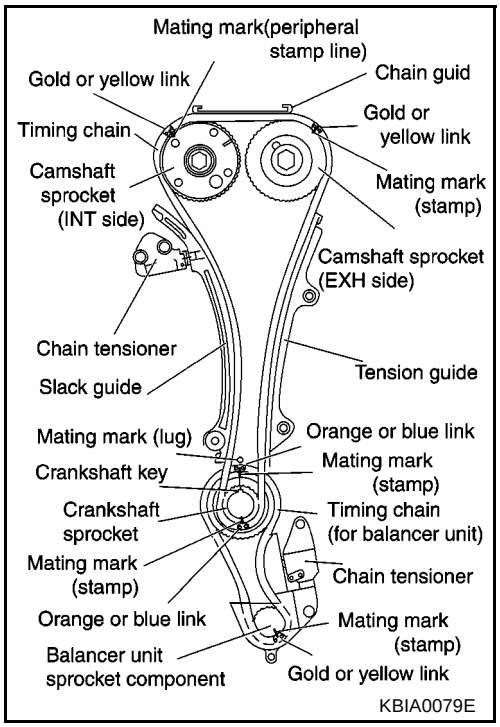


INSTALLATION

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-147, "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).

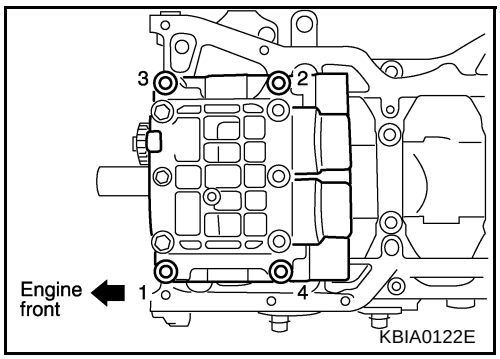
- Loosen in the reverse order of tightening.

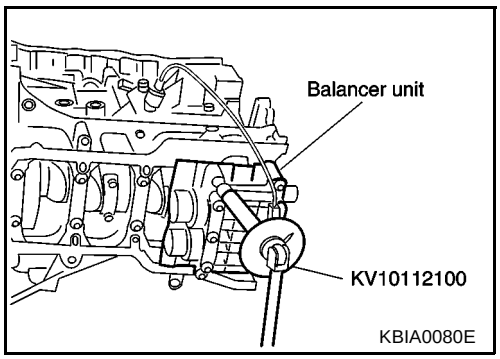
e. Tighten them to 45.2 to 51.0 N·m (4.6 to 5.2 kg-m, 34 to 37 ft-lb).

f. Turn them another 90 to 95° (Target: 90°).

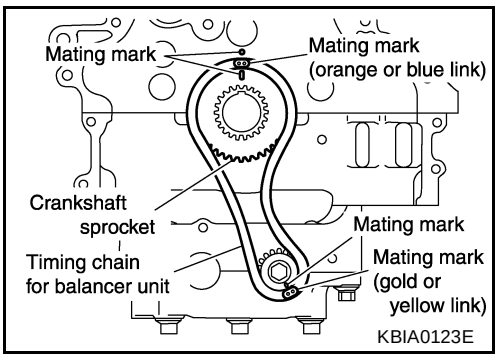
CAUTION:

- **Check tightening angle with an angle wrench or a pro-tractor. Do not make judgment by visual check alone.**



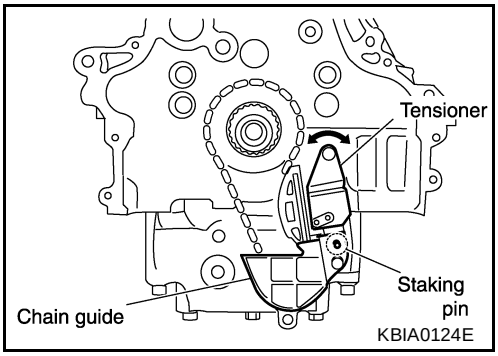


3. Install crankshaft sprocket and timing chain for balancer unit.
   - Make sure that crankshaft sprocket is positioned with mating marks on block and sprocket meeting at the top.
   - Install it by lining up mating marks on each sprocket and timing chain.



4. Install timing chain tensioner for balancer unit.

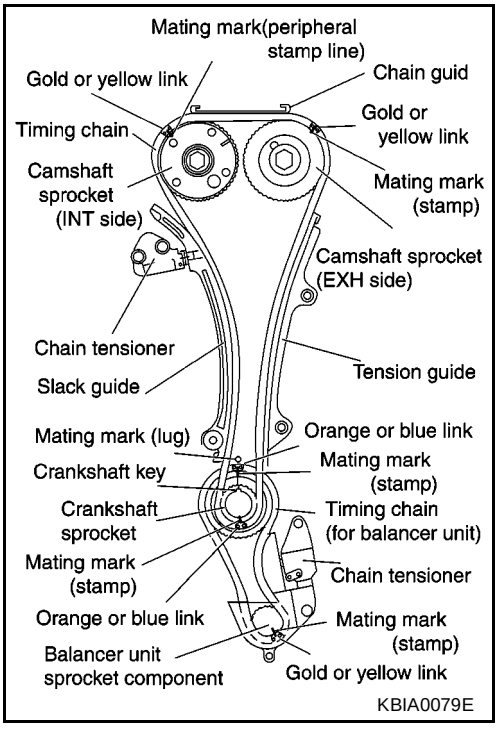
   NOTE:
   Chain guide and tensioner move freely with the caulking pin as the axle. Therefore, bolt hole position of the three points could be changed during removal. If points change, temporarily fix the two mounting bolts on the chain guide, and move the tensioner to mate the bolt holes.
   - Be careful 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.

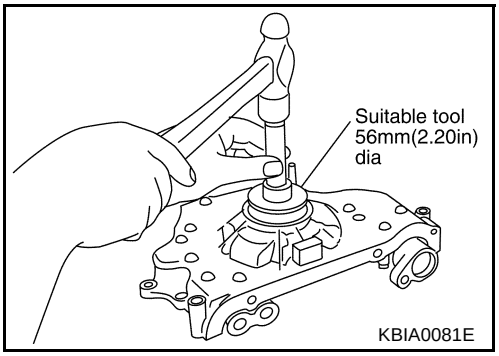
   NOTE:
   Before installing chain tensioner, it is possible to change the position of mating mark on timing chain for that on each sprocket for alignment.

   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 (2.20 in) 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.**



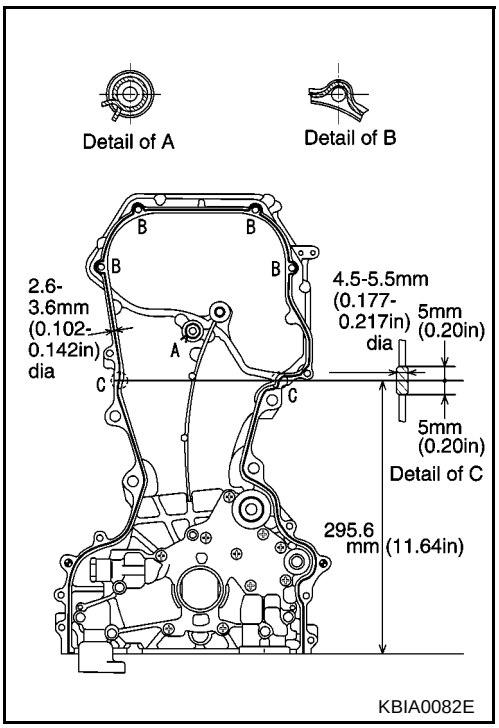
7. Install front cover with the following procedure.

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.

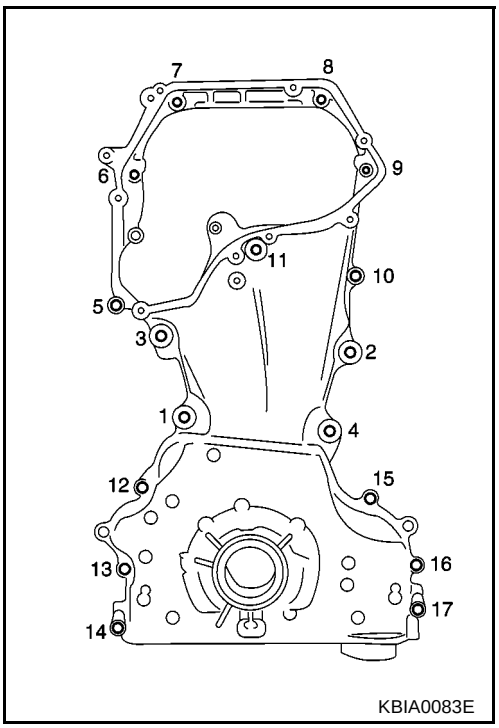
   M6 × 45 mm (1.77 in) : 5, 14, 17

   M6 × 20 mm (0.79 in) : 6, 7, 8, 9, 10, 11, 12, 13, 15, 16
   - At the same time, install the RH engine mounting bracket (at 1, 2, 3, 4 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.



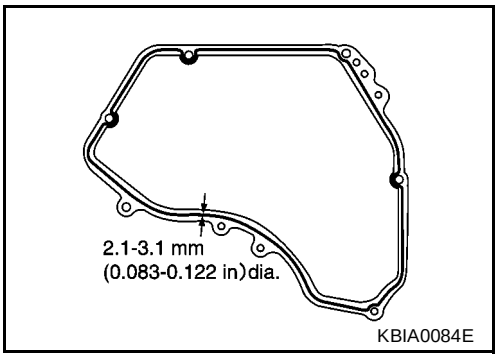
9. Install Intake valve timing control cover with the following procedure.

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

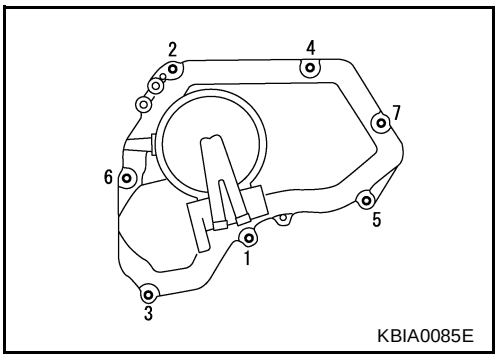
b. Install oil rings to the intake camshaft sprocket insertion points on intake valve timing control backside cover.

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.

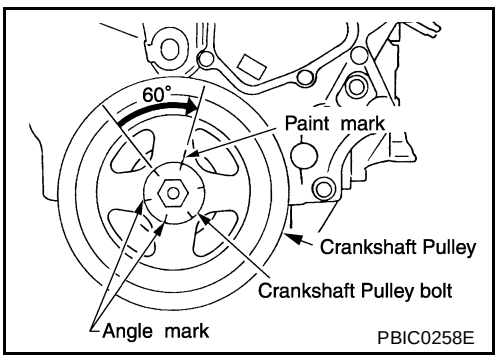
11. Tighten crankshaft pulley mounting bolts.
- Secure crankshaft pulley with a pulley holder, and tighten the bolts.
- Perform angle tightening with the following procedure.

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

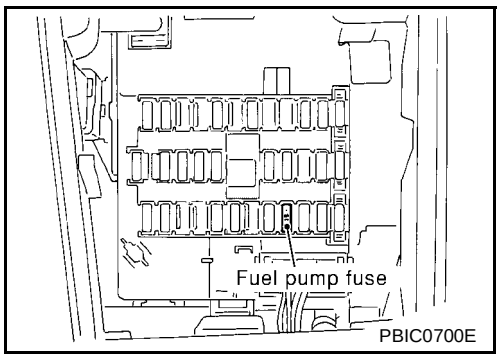
PFP:11041

On-Vehicle Service

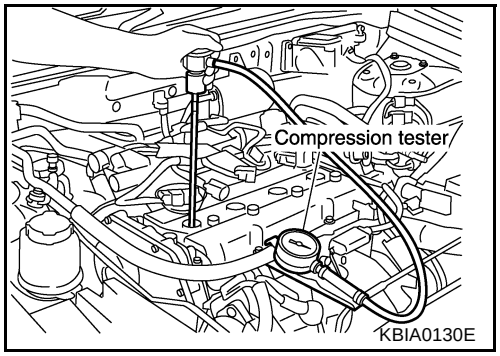
EBS00GAR

CHECKING COMPRESSION PRESSURE

1. Warm up engine thoroughly. Then, stop it.
2. Release fuel pressure. Refer to EC-1001, "FUEL PRESSURE RELEASE" (WITH EURO-OBD), EC-1443, "FUEL PRESSURE RELEASE" (WITHOUT EURO-OBD).
3. Remove ignition coil and spark plug from each cylinder.
   Refer to IGNITION COIL EM-126, "Removal and Installation" and SPARK PLUG EM-127, "Removal and Installation" .
4. Connect engine tachometer (not required in use of CONSULT-II).
5. Disconnect fuel pump fuse to avoid fuel injection during measurement.

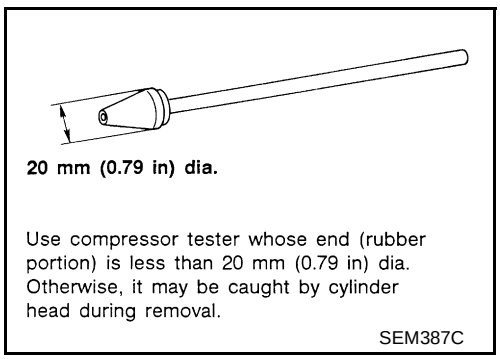


6. Install compression tester with adapter onto spark plug hole.



- 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.



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

Standard	Minimum	Deference limit between cylinders
1,187 (11.9, 12.1, 173) / 250	991 (9.9, 10.1, 144) / 250	98 (1.0, 1.0, 14) / 250

CAUTION:

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

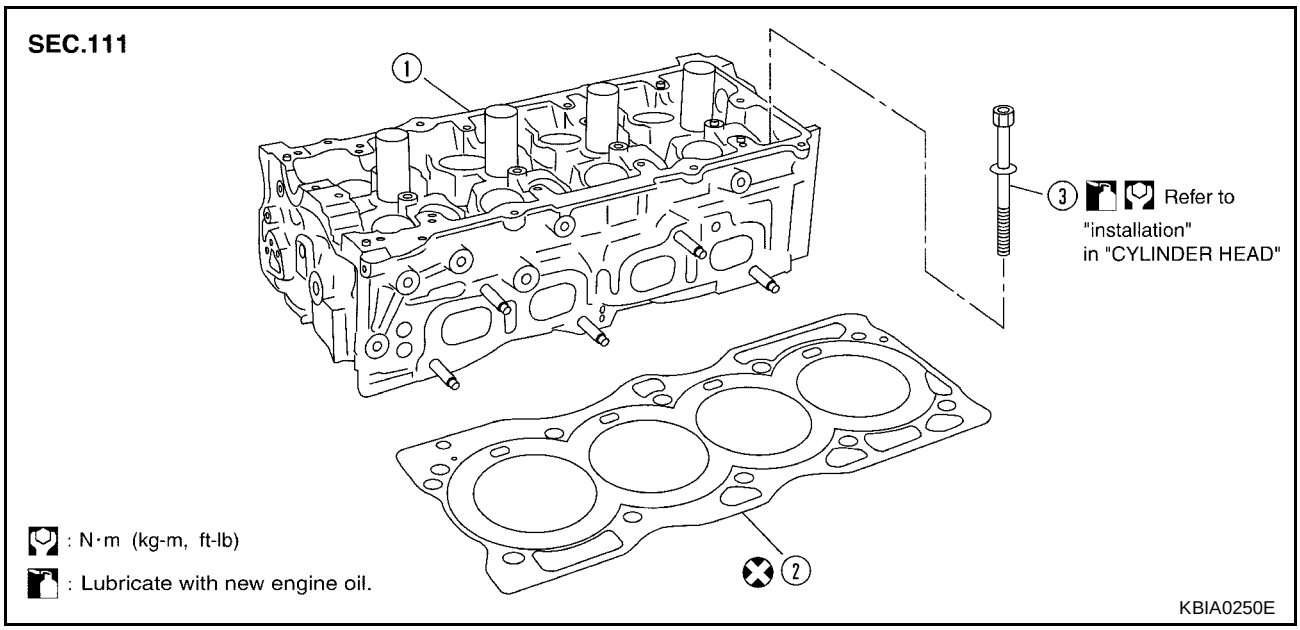
- If the engine speed is out of specified range, check battery liquid for proper gravity. Check engine speed again with normal battery gravity.
- If compression pressure is below minimum value, check valve clearances and parts associated with combustion chamber (Valve, valve seat, piston, piston ring,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

EBS00GAS



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

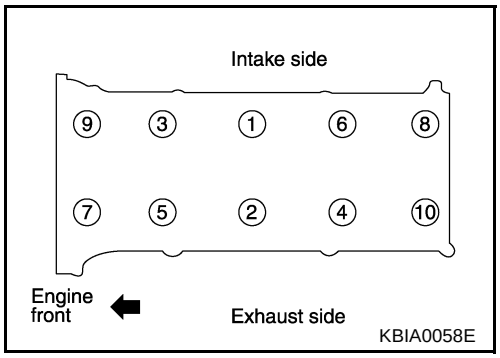
REMOVAL

1. Release fuel pressure. Refer to EC-1001, "FUEL PRESSURE RELEASE" (WITH EURO-OBD), EC-1443, "FUEL PRESSURE RELEASE" (WITHOUT EURO-OBD).
2. Drain engine coolant and engine oil.
3. Remove the following components and related parts.

- Engine hood and engine undercover.
- Air duct and air cleaner case assembly; Refer to EM-114, "Removal and Installation" .
- Ignition coils; Refer to EM-126, "Removal and Installation" .
- Rocker cover; Refer to EM-131, "Removal and Installation" .
- Engine coolant reservoir tank
- Auxiliary drive belt; Refer to EM-113, "Removal and Installation of Auxiliary Drive Belt Auto- tensioner" .
- Alternator
- Auxiliary drive belt auto-tensioner; Refer to EM-113, "Removal and Installation of Auxiliary Drive Belt Auto- tensioner" .
- Exhaust front tube; Refer to EX-3, "EXHAUST SYSTEM" .
- Exhaust manifold; Refer to EM-121, "Removal and Installation" .
- Intake manifold and fuel tube assembly; Refer to EM-116, "Removal and Installation" .
- Water control valve and housing; Refer to CO-40, "THERMOSTAT AND WATER CONTROL VALVE" .

4. Remove front cover and timing chain. Refer to EM-143, "Removal and Installation" .
5. Remove camshaft. Refer to EM-133, "Removal and Installation" .

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.



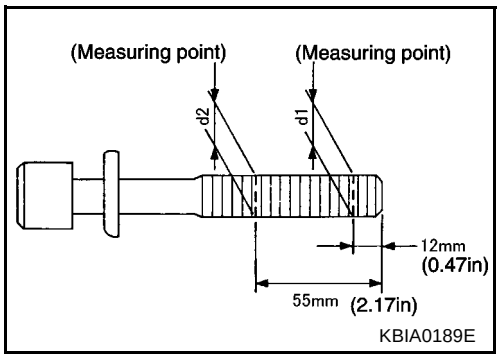
INSPECTION AFTER REMOVAL

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.



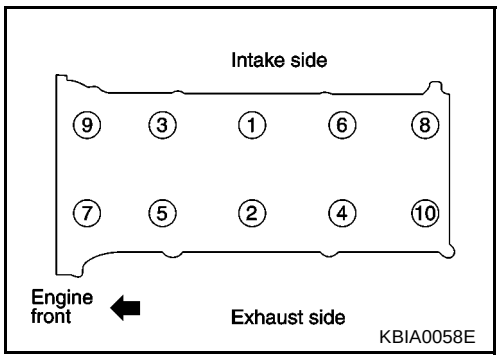
INSTALLATION

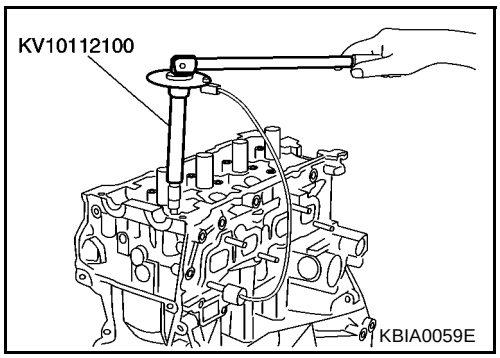
1. Install cylinder head gasket.
2. Follow the steps below to tighten fixing bolts in the order shown in figure to install cylinder head.

   CAUTION:
   - **If cylinder head bolts are re-used, check their outer diameters before installation. Refer to EM-154, "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.

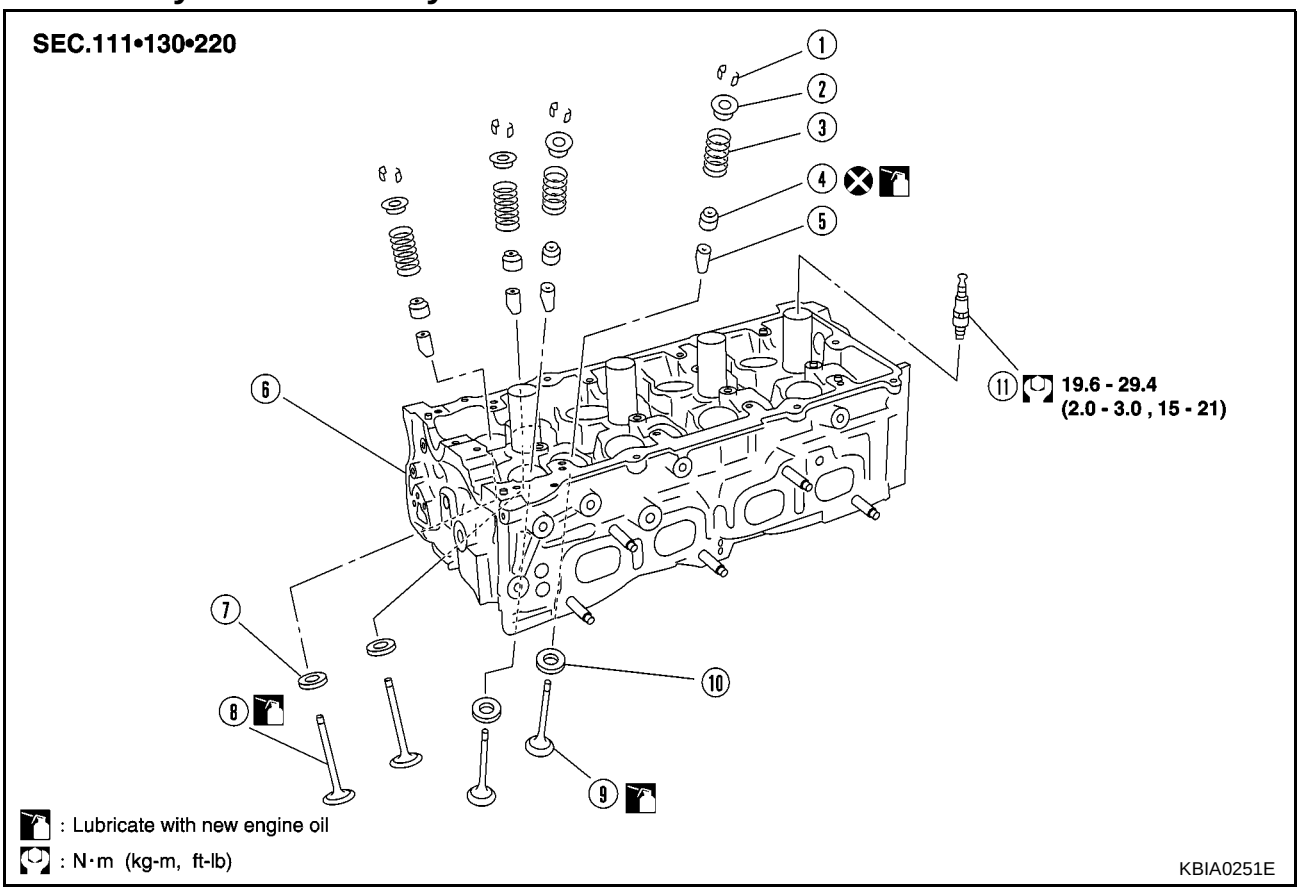




3. Install followings in reverse order of removal.

Disassembly and Assembly

EBS00GAT



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:

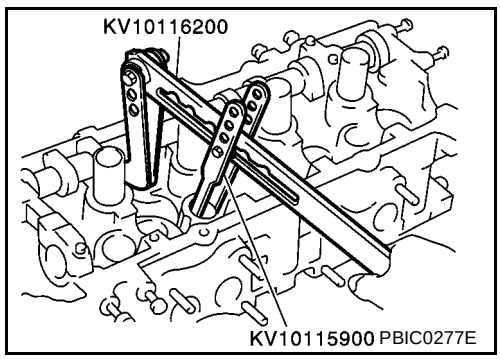
- **When installing camshafts, chain tensioners, oil seals or other sliding parts, lubricate contacting surface with new engine oil.**
- **Apply new engine oil to threads and seat surface when installing cylinder head, camshaft sprocket, crankshaft pulley and camshaft bracket.**
- **Attach tags to valve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

DISASSEMBLY

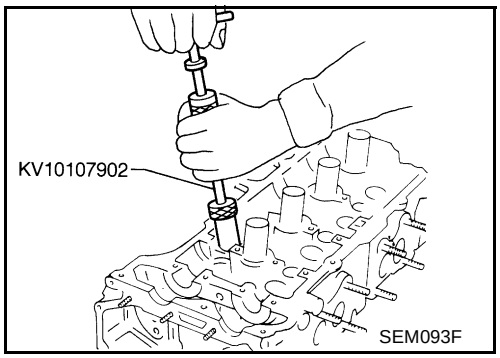
1. Remove valve lifter.
   - Confirm installation point.
2. Remove valve collet.
   - Compress valve spring with valve spring compressor. Remove valve collet with magnet driver.
3. Remove valve spring retainer and valve spring.

   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-157, "VALVE GUIDE CLEARANCE" .
   - Confirm installation point.

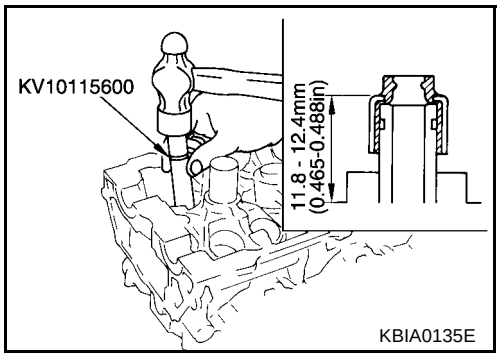


5. Remove valve oil seal with valve oil seal puller.
6. When valve seat must be replaced, refer to EM-158, "VALVE SEAT REPLACEMENT" to removal.
7. When valve guide must be replaced, refer to EM-157, "VALVE GUIDE REPLACEMENT" to removal.
8. Remove spark plug with spark plug wrench.



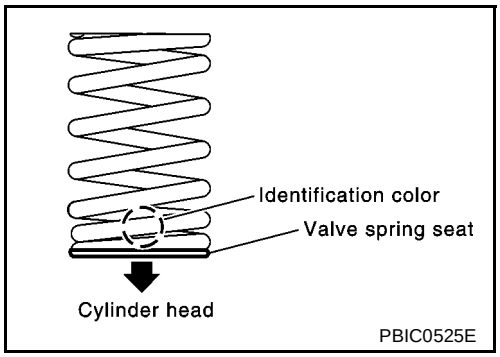
ASSEMBLY

1. Install valve guide. Refer to EM-157, "VALVE GUIDE REPLACEMENT" .
2. Install valve seat. Refer to EM-158, "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

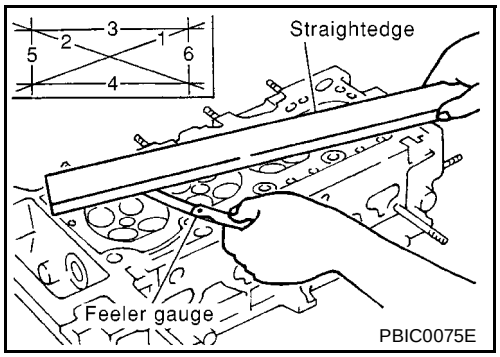
EBS00GAU

CYLINDER HEAD DISTORTION

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

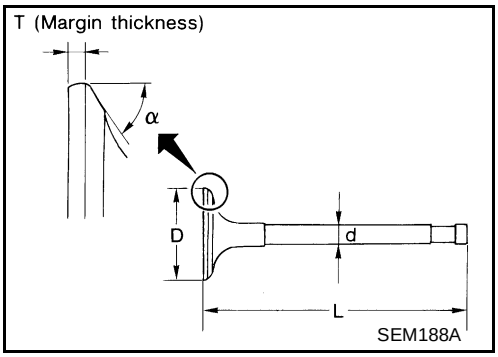
   CAUTION:
   Use utmost care not to allow gasket debris to enter passages for oil or water.
2. At each of several locations on bottom surface of cylinder head, measure distortion in six directions.

   Standard : 0.1mm (0.004 in)



VALVE DIMENSIONS

Check dimensions of each valve. For dimensions, refer to SDS EM-192, "VALVE" .



VALVE GUIDE CLEARANCE

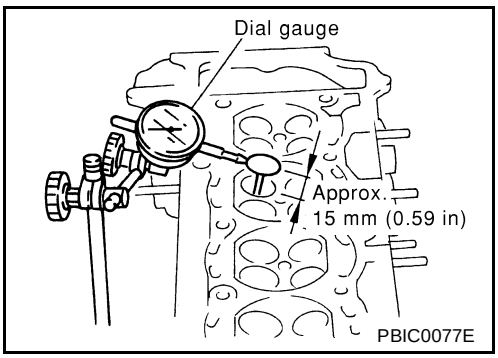
Perform this inspection before removing valve guide.

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)

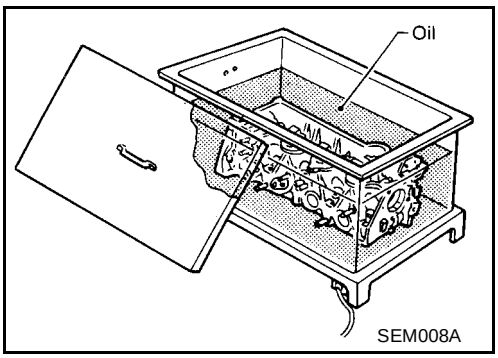
Exhaust : 0.030 - 0.063 mm (0.0012 - 0.0025 in)



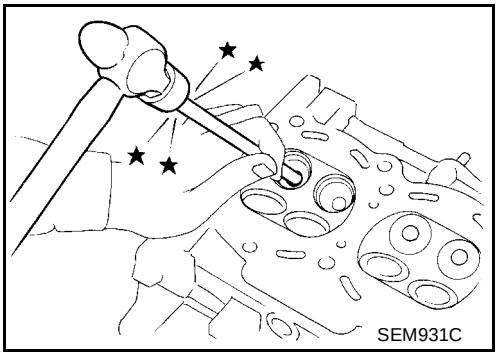
VALVE GUIDE REPLACEMENT

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.

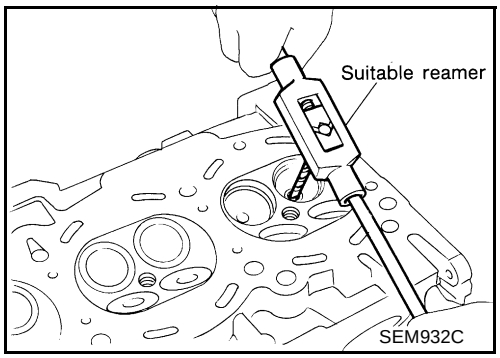


3. Ream cylinder head valve guide hole.

   Valve guide hole diameter (for service parts)

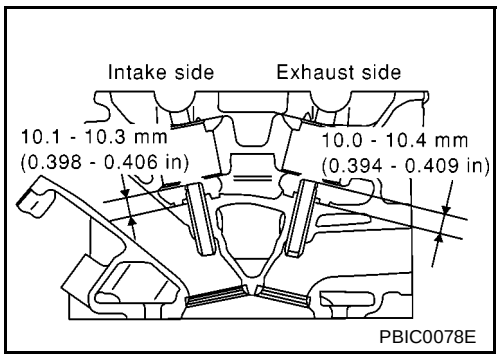
   Intake and exhaust

   : 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.

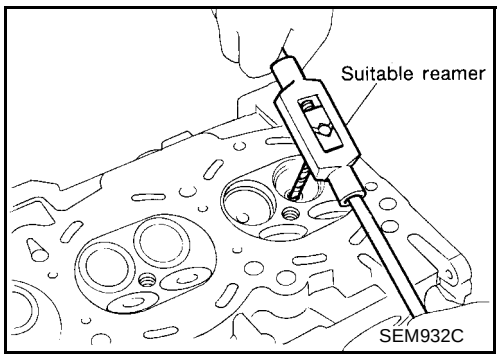
5. Press valve guide from camshaft side to dimensions as in illustration.



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

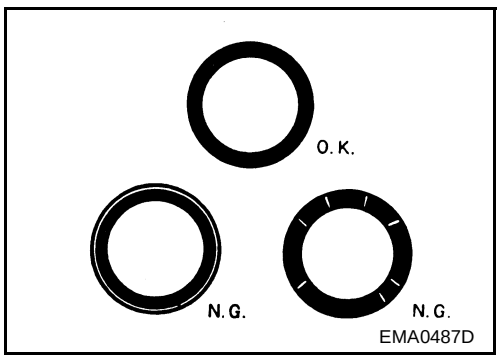
   Standard

   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.

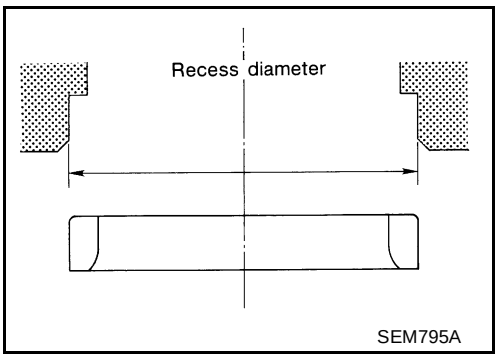
2. Ream cylinder head recess diameter for service valve seat.

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)

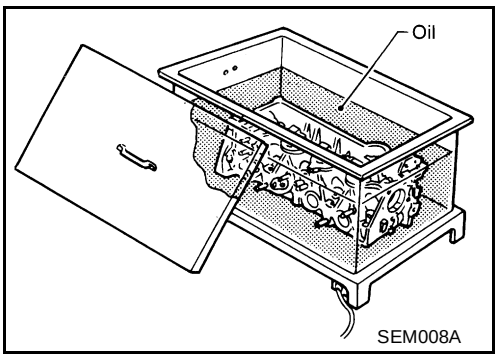
- Be sure to ream in circles concentric to the valve guide center.
- This will enable valve seat to fit correctly.



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:

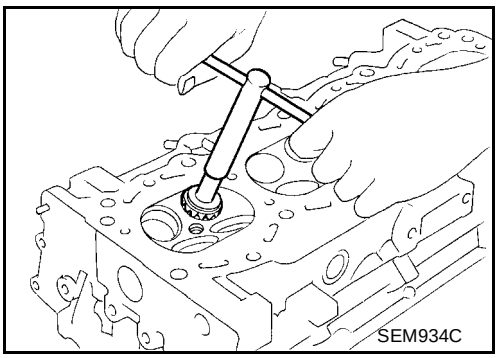
Avoid directly to touching cold valve seats.



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)

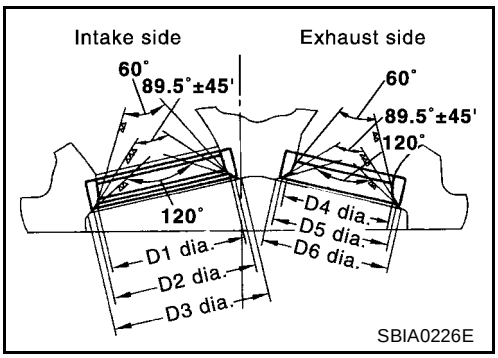
D2 dia. : 35.1 - 35.3 mm (1.382 - 1.390 in)

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 - 33.7 mm (1.319 - 1.327 in)

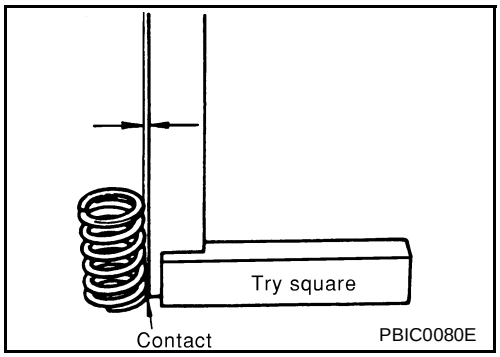


6. Using compound, grind to adjust valve fitting.
7. Check again for normal contact.

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)



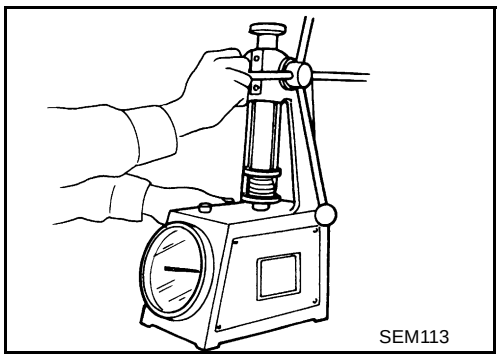
VALVE SPRING DIMENSIONS AND VALVE SPRING PRESSURE LOAD

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)

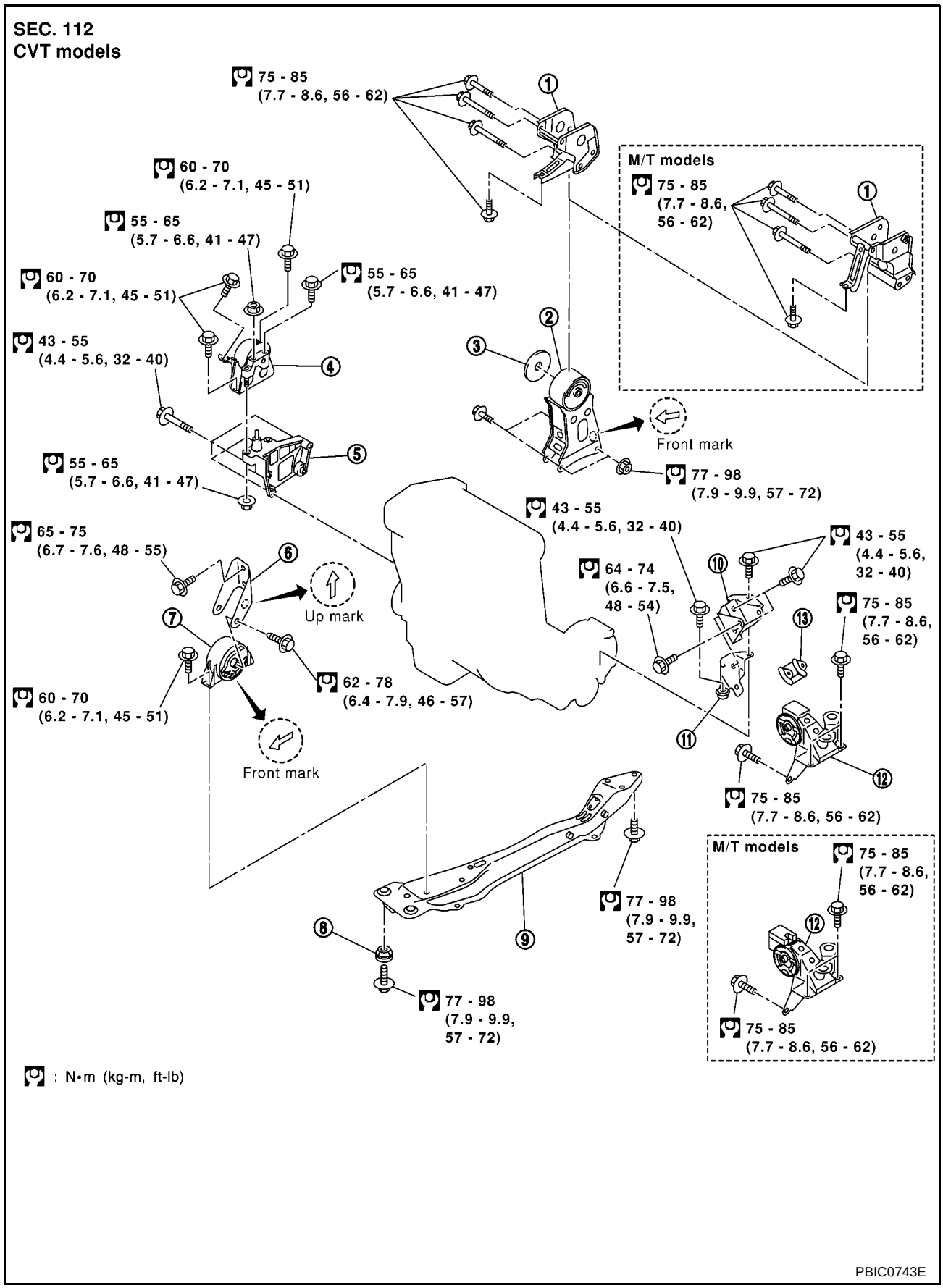


ENGINE ASSEMBLY

PFP:10001

Removal and Installation

EBS00GAV



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-37, "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-1001, "FUEL PRESSURE RELEASE" (WITH EURO-OBD), EC-1443, "FUEL PRESSURE RELEASE" (WITHOUT EURO-OBD).
2. Remove engine hood.
3. Drain coolant from radiator drain plug.
4. Remove the following parts.
   - LH/RH undercover (with splash cover)
   - LH/RH front wheel
   - Auxiliary drive belt; Refer to EM-113, "Removal and Installation of Auxiliary Drive Belt Auto- tensioner" .
   - Alternator
   - Air duct and air cleaner case assembly; Refer to EM-114, "Removal and Installation" .
   - Battery and battery tray
   - Radiator and cooling fan assembly; Refer to CO-31, "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-116, "INTAKE MANIFOLD" .
8. Disconnect heater hose, and install plug it to prevent engine coolant from draining.
9. Disconnect select 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.
12. Remove power steering pump with piping connected from engine. Temporarily secure it on body with a rope to avoid putting load on it.

Vehicle underbody
13. Remove front cross member. Refer to FSU-5, "FRONT SUSPENSION ASSEMBLY" .
14. Remove exhaust front tube.

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

Removal

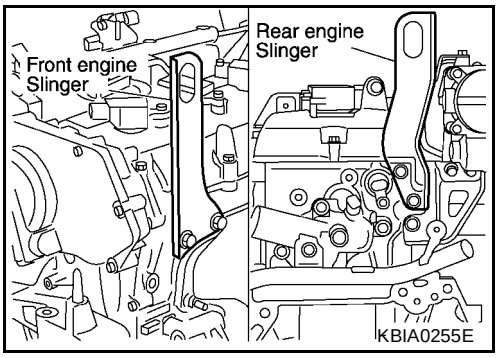
18. Install engine slingers into front left of cylinder head and rear right of cylinder head.

- 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)

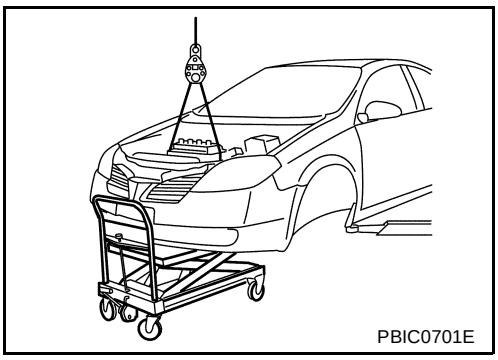


19. Lift with hoist and secure the engine in position.

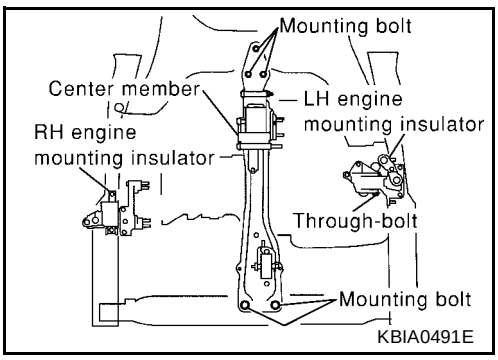
- Use a manual lift table caddy or equivalently rigid tool such as a jack or trestle. Securely support bottom of engine and transaxle, and simultaneously adjust hoist tension.

CAUTION:

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



20. Remove RH engine mounting insulator.
21. Pull LH engine mounting through-bolt out.
22. Remove center member.



23. Remove engine and transaxle assembly 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.**

24. Remove starter motor.
25. Remove rear engine mount bracket.
26. 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

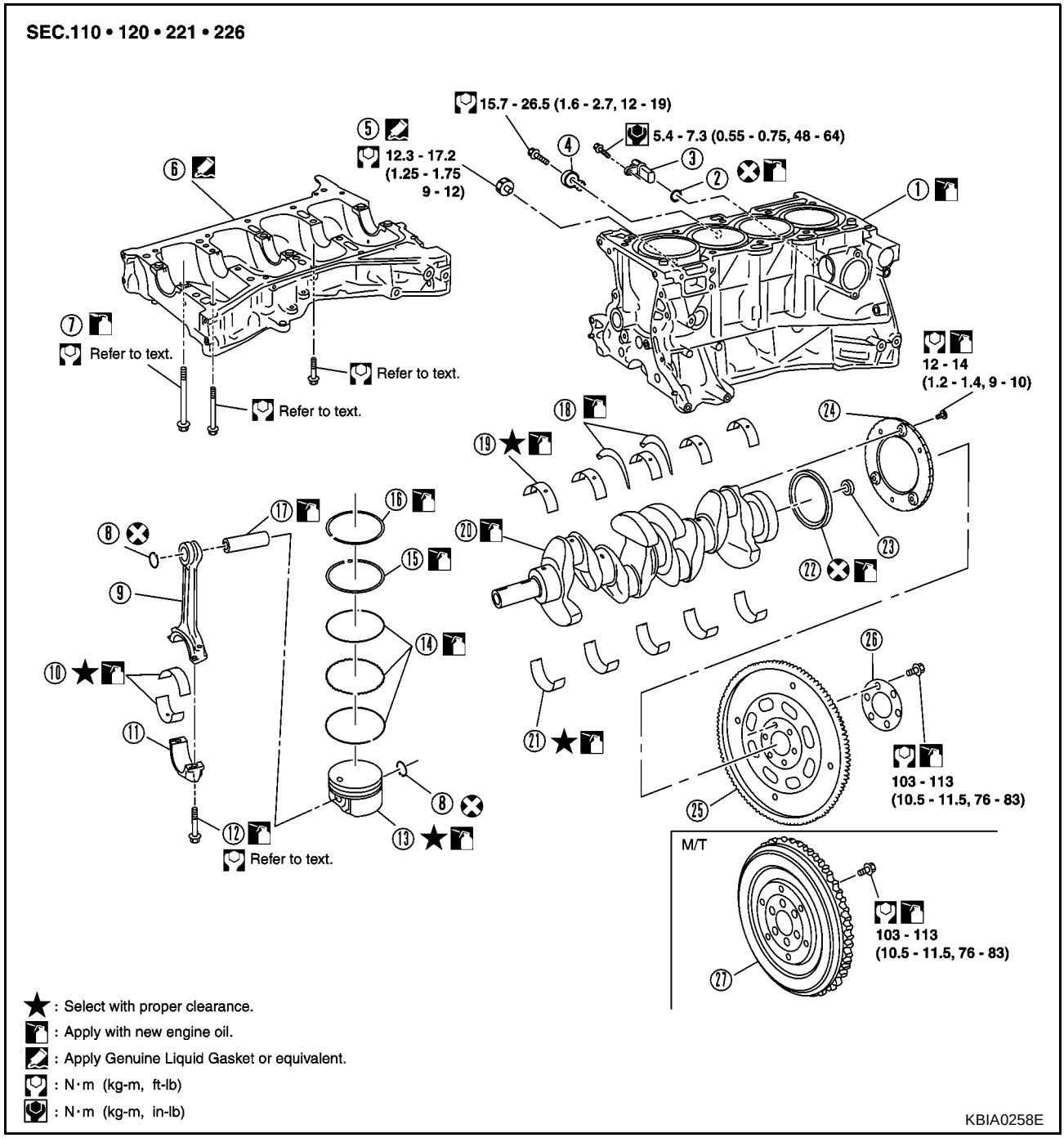
- Before starting engine, check the levels of coolant, lubrications and working oils. If less than required quantity, fill to the specified level.
- Run engine to check for unusual noise and vibration.
- Warm up engine thoroughly to make sure there is no leakage of coolant, lubricants, working oil, fuel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

CYLINDER BLOCK

PFP:11010

Disassembly and Assembly

EBS00GAW



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

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

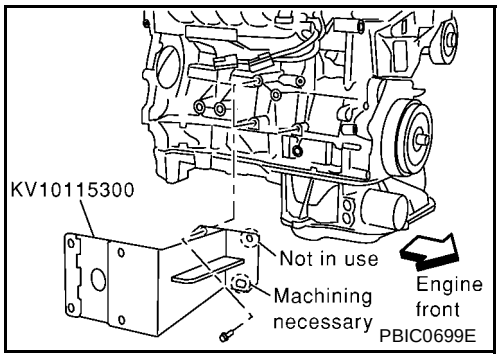
DISASSEMBLY

1. Remove engine and transaxle assembly from vehicle, and separate transaxle from engine. Refer to EM-161, "ENGINE ASSEMBLY" .
2. Mount engine on an engine stand with the following procedure.

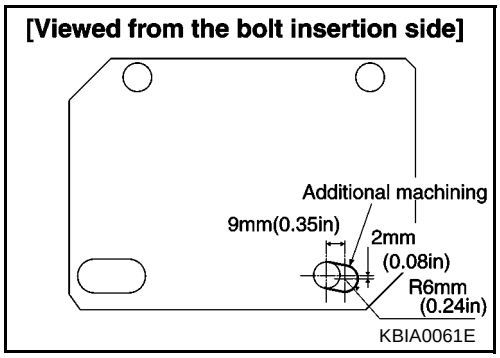
a. Remove oil cooler and oil cooler bracket on right side of cylinder block. Refer to LU-22, "OIL COOLER" .

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

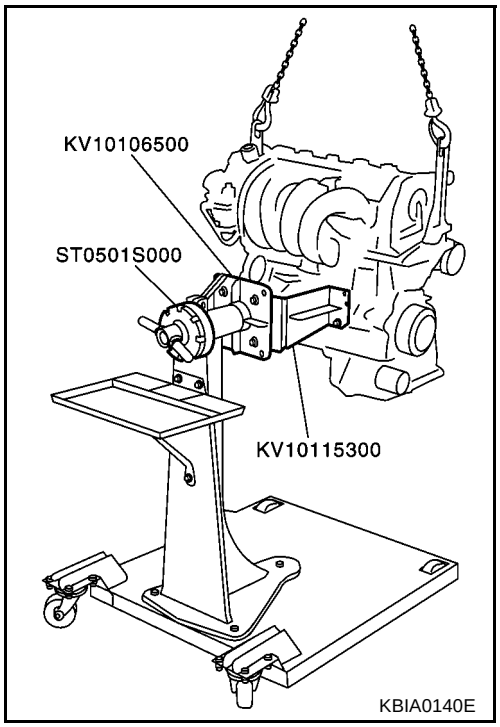
- Do not use bolt hole at the upper right looking from bolt insertion side.



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

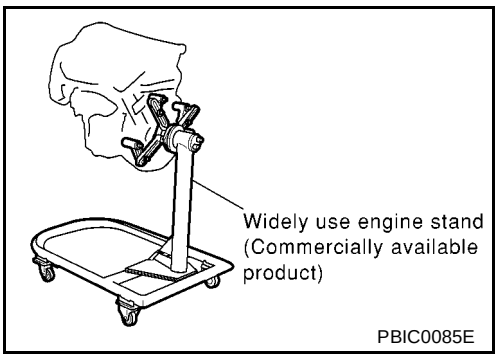


c. Lift engine, and mount it onto the engine stand.



- 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.

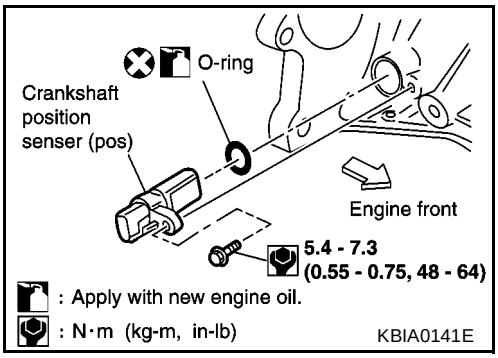


3. Drain engine oil and coolant from inside of engine.
4. Remove the following components and associated parts.
   - Exhaust manifold and three way catalyst assembly; Refer to EM-121, "Removal and Installation" .
   - Intake manifold; Refer to EM-116, "Removal and Installation" .
   - Fuel tube assembly; Refer to EM-128, "Removal and Installation"
   - Ignition coil; Refer to EM-126, "Removal and Installation" .
   - Rocker cover; Refer to EM-131, "Removal and Installation" .
   - Oil pan and oil strainer; Refer to EM-123, "Removal and Installation" .
   - Front cover, timing chain and balancer unit; Refer to EM-143, "Removal and Installation" .
   - Camshaft; Refer to EM-133, "Removal and Installation" .
   - Cylinder head; Refer to EM-153, "Removal and Installation" .
5. Remove knock sensor.

CAUTION:
Carefully handle the sensor avoiding shocks.

6. Remove crankshaft position sensor (POS).

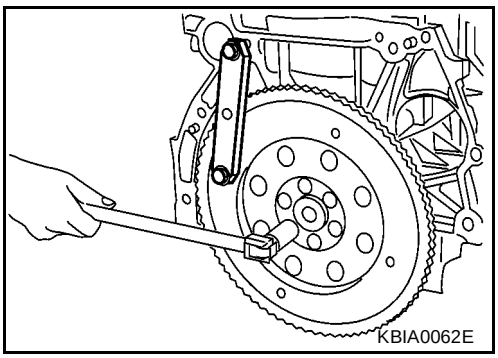
CAUTION:
- **Avoid impacts such as a dropping.**
- **Do not disassemble.**
- **Keep it away from metal particles.**
- **Do not place sensor close to magnetic materials.**



7. Remove flywheel (M/T models) or drive plate (CVT models). Fix crankshaft with a stopper plate, and remove mounting bolts.
   Torx bit (size T55) : Flywheel (M/T models)
   Torx socket (size E20): Drive plate (CVT models)

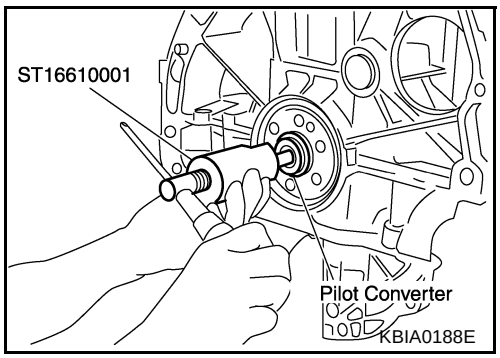
CAUTION:
- **Be careful not to damage contact surface for the clutch disc of the flywheel.**

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 (CVT models).

NOTE:
M/T models have no pilot push.



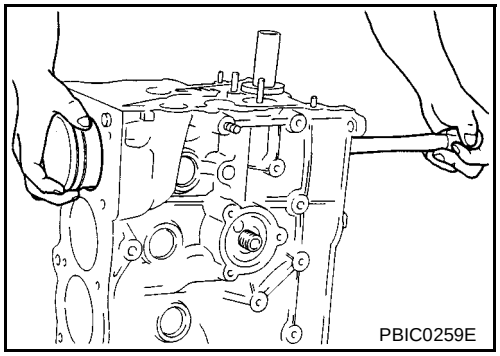
9. Remove the piston and connecting rod assembly.

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-182, "CONNECTING ROD SIDE CLEARANCE" .



10. Remove the connecting rod bearings.

CAUTION:

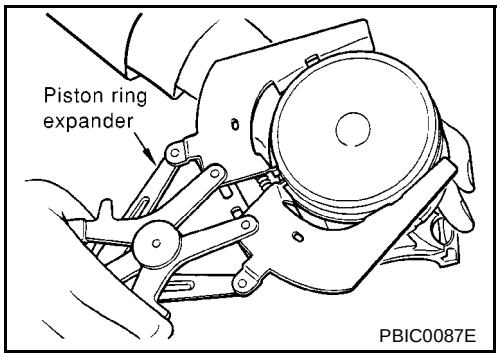
- **When removing them, note the installation position. Keep them in the correct order.**

11. Remove the piston rings form the piston.

- Use a piston ring expander.

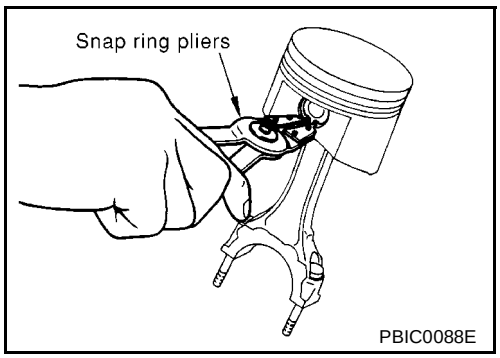
CAUTION:

- **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-183, "PISTON RING SIDE CLEARANCE" .**

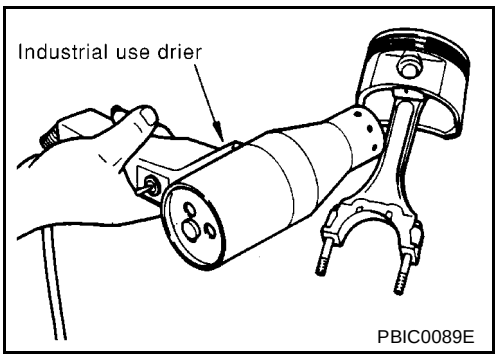


12. Remove the piston from the connecting rod as follows.

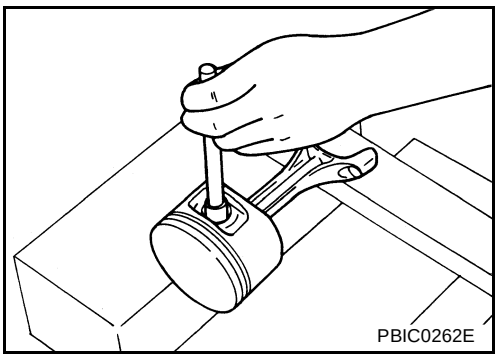
a. Using a snap ring pliers, remove the snap ring.



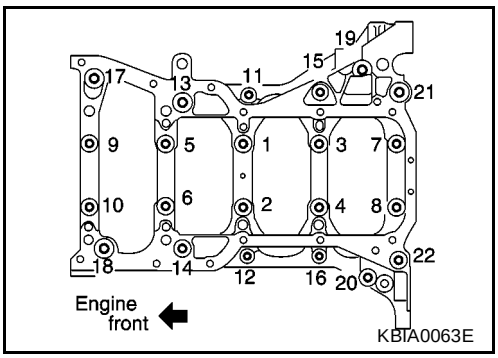
b. Heat piston to 60 to 70°C (140 to 158°F) with drier or equivalent.



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



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-181, "CRANKSHAFT SIDE CLEARANCE" .

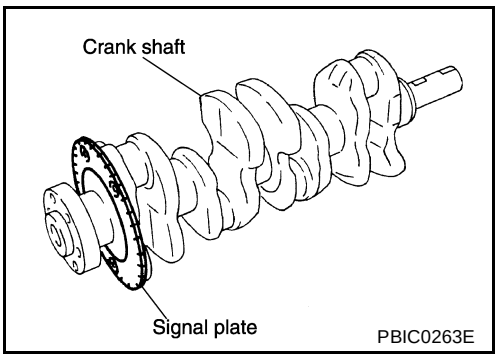


14. Remove lower cylinder block.
    - Using Tool (Seal cutter), cut liquid gasket off, and remove it from cylinder block.

    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.

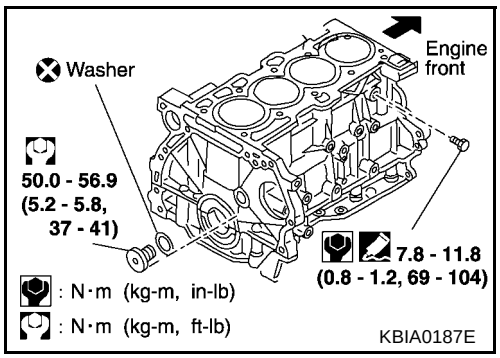
CAUTION:
Identify installation positions, and store them without mixing them up.

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.

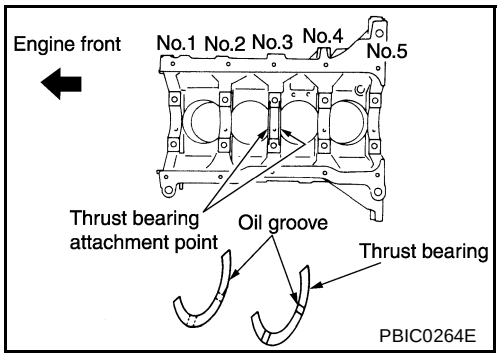
2. Install each plug to the cylinder block.
   - Apply liquid gasket.
     Use Genuine Liquid Gasket or equivalent.
   - Replace the copper washers with new ones.



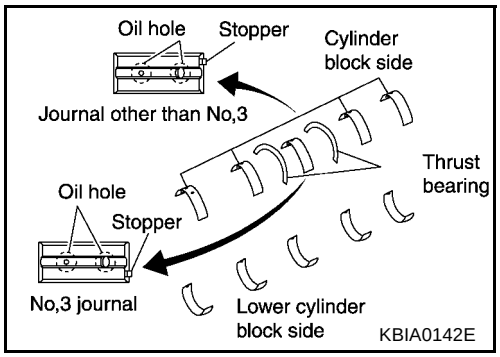
3. Install the main bearings and the thrust bearings.

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.



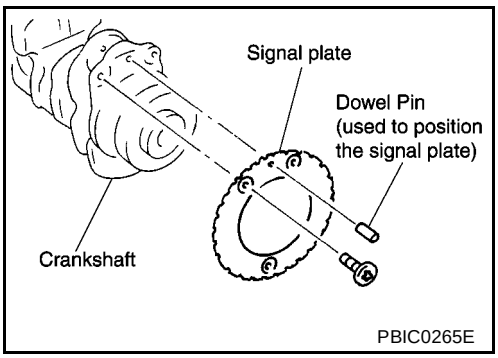
4. Install the signal plate to the crankshaft.

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.

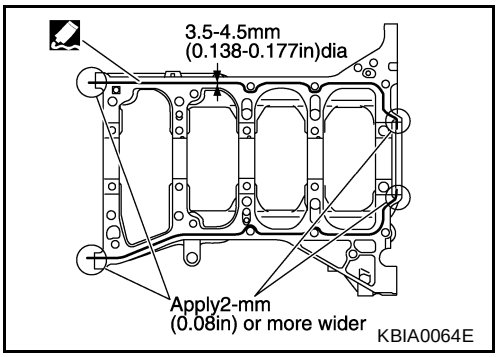


5. Install the crankshaft to the cylinder block.
- While turning the crankshaft by hand, check that it turns smoothly.

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.

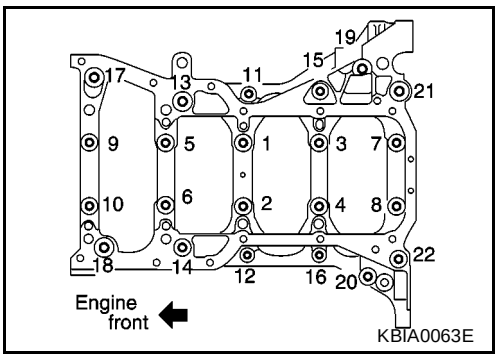


7. Tighten lower cylinder block mounting bolts in the numerical order in the figure by following the procedure below.

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

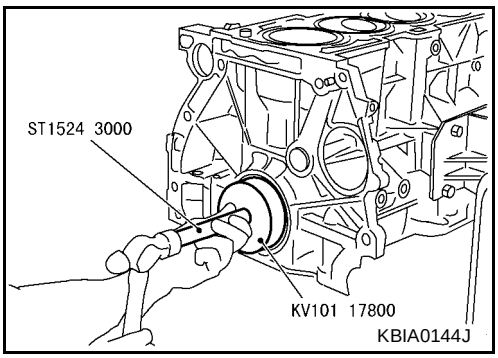
b. Tighten M10 bolts in order from 1 to 10 with tightening torque 36.3 to 42.2 N·m (3.7 to 4.3 kg-m, 27 to 31 ft-lb).

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

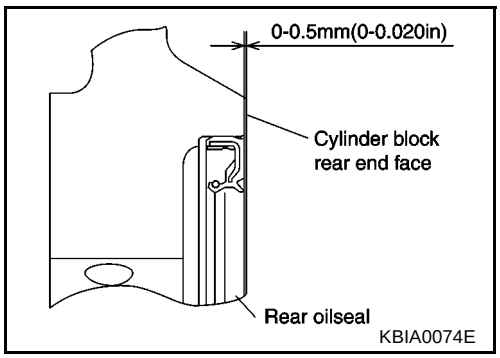


8. Install rear oil seal.

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.

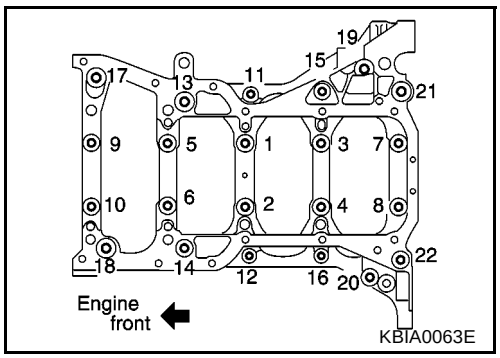
NOTE:
Step “a” and “b” have been completed before installation of rear oil seal (step 7).

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

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

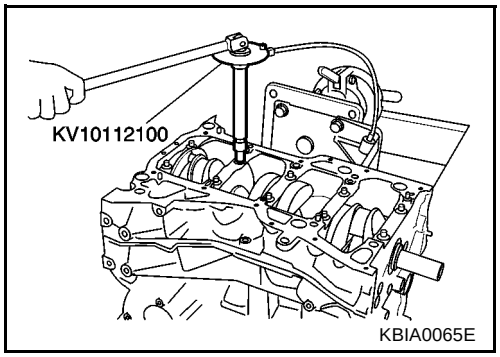
c. Tighten M10 bolts to 60 to 65°(target: 60°) in order from 1 to 10.

d. Tighten M8 (0.39 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 to EM-181, "CRANKSHAFT SIDE CLEARANCE" .

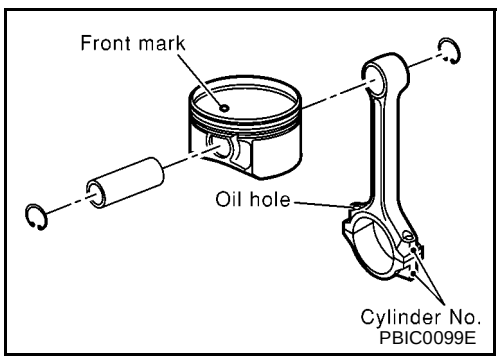


10. Install the piston to the connecting rod.

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.

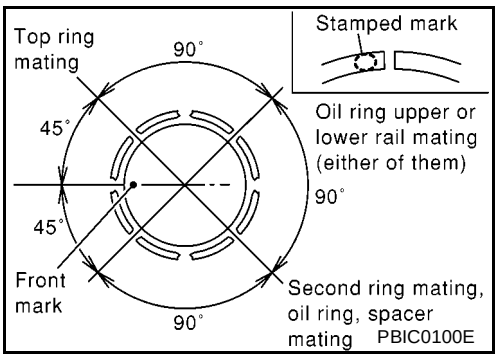
CAUTION:

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.

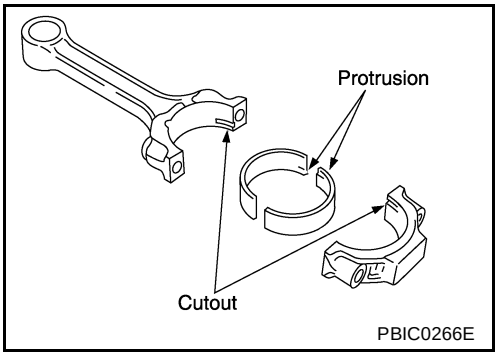
Stamped mark : 1E (top ring)

: 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.

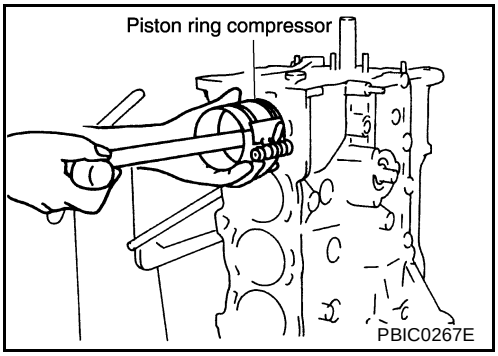


13. Install the piston and connecting rod assembly to the crankshaft.

- 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.

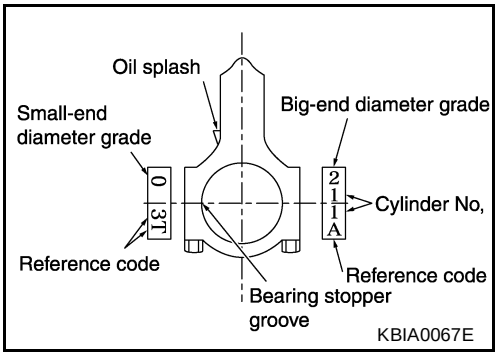
CAUTION:

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.

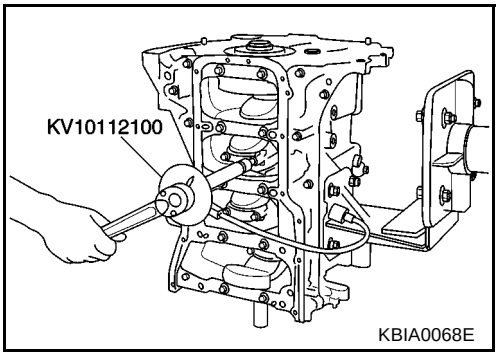
a. Apply engine oil to the threads and seats of the connecting rod bolts.

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).

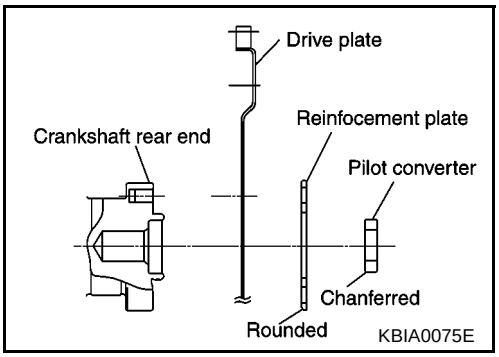
d. Then tighten all bolts 90 to 95 degrees clockwise (target: 90 degrees) (Angle tightening).

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



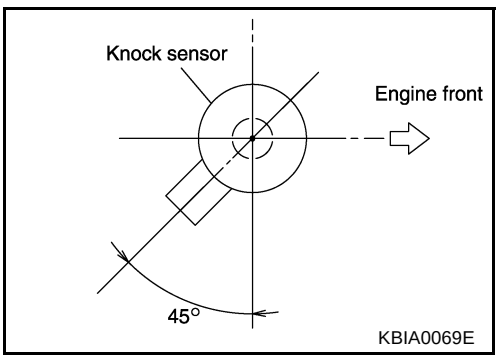
- After tightening the bolt, make sure that the crankshaft rotates smoothly.
- Check the connecting rod side clearance. Refer to EM-182, "CONNECTING ROD SIDE CLEARANCE".

16. Install flywheel (M/T models) or drive plate (CVT models).
- 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.

CAUTION:
If any impact by dropping is applied to the knock sensor, replace it with new one.
- 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 shown.
- Do not tighten the mounting bolts while holding the connector.
- Make sure that the knock sensor does not interfere with other parts.



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

How to Select Piston and Bearing

EBS00GAX

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.

Selection points	Selection parts	Selection items	Selection methods
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	—	—	—

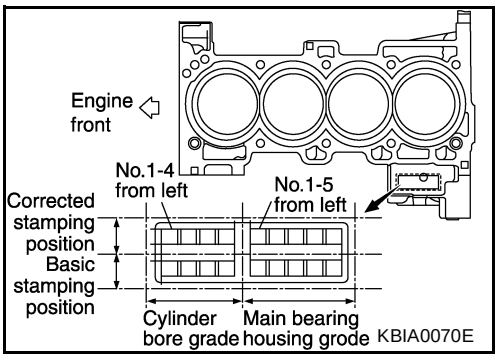
*For the service parts, the grade for fitting cannot be selected between a piston pin and a connecting rod. (Only 0 grade is available.) The information at the shipment from the plant is described as a reference.

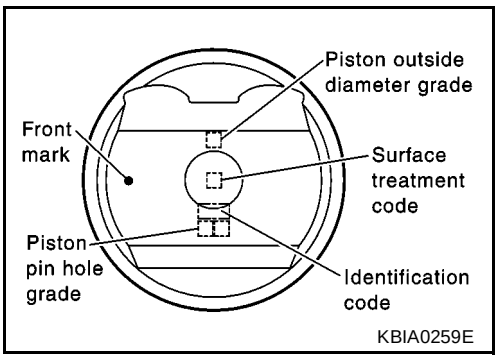
- The identification grade stamped on each part is the grade for the dimension measured in new condition. This grade cannot apply to reused parts.
- For reused or repaired parts, measure the dimension accurately. Determine the grade by comparing the measurement with the values of each selection table.
- 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:

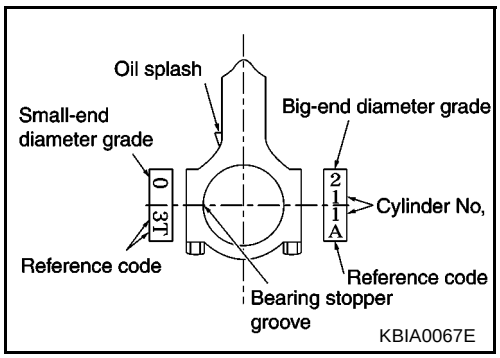
- The piston is available together with piston pin as an assembly.

- 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.)

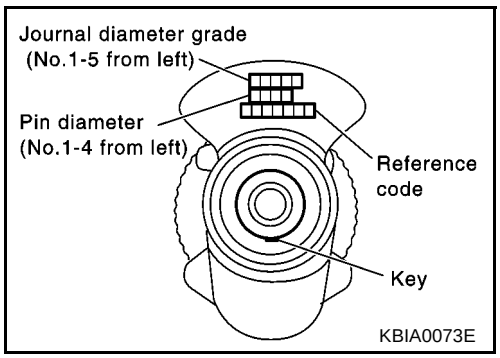
HOW TO SELECT CONNECTING ROD BEARING

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”.
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”.
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

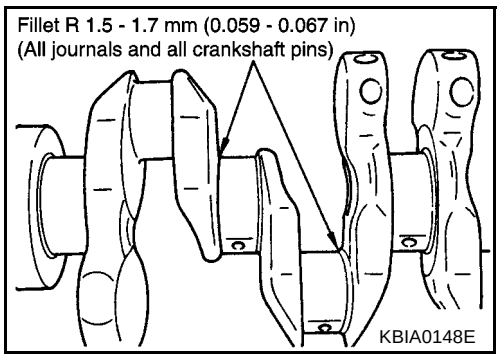
Undersize Bearings Usage Guide

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

Bearing undersize table

Unit: mm (in)

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

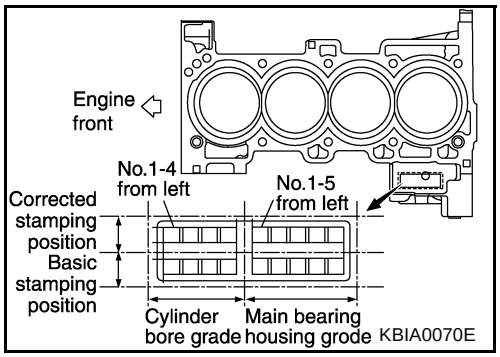


CAUTION:
In grinding the crankshaft pin to use undersize bearings, keep the fillet R (All crankshaft pins).

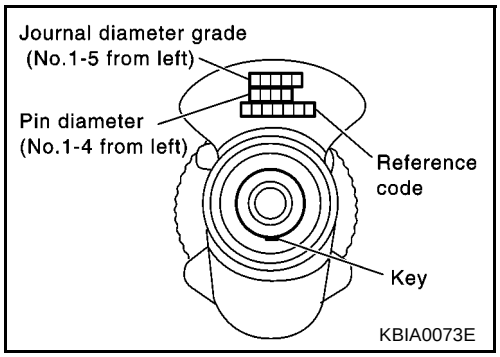
HOW TO SELECT MAIN BEARING

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 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)

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	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

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Main Bearing Selection Table (No.2 and 4 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	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

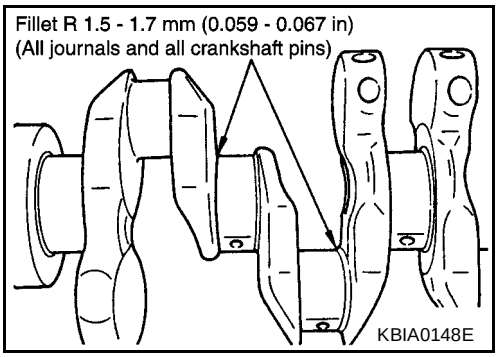
- Use undersize (US) bearing when oil clearance with standard size main bearing is not within specification.
- When using undersize (US) bearing, measure the bearing inner diameter with bearing installed, and grind journal until oil clearance falls within specification.

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

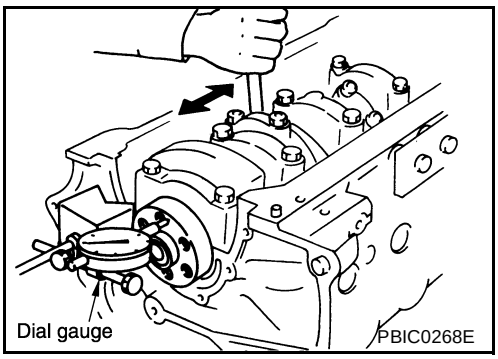
EBS00GAY

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.

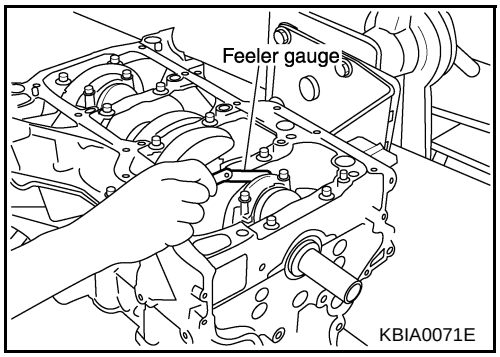


CONNECTING ROD SIDE CLEARANCE

- 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.

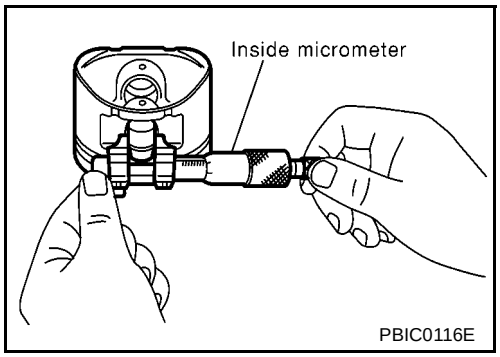


PISTON AND PISTON PIN CLEARANCE

Inner Diameter of Piston Pin

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

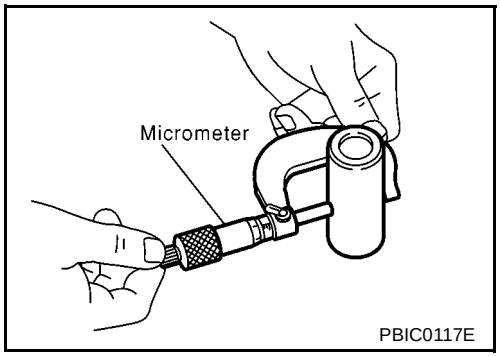
Standard : 19.993 - 20.005 mm (0.7871 - 0.7876 in)



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)

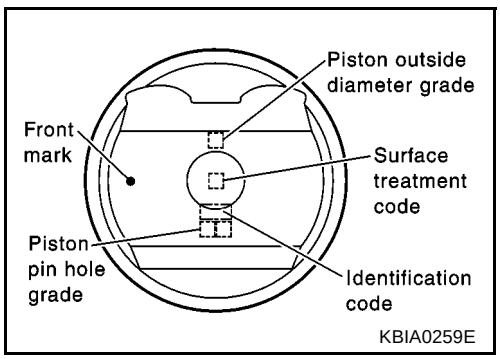


Piston and Piston Pin Clearance

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

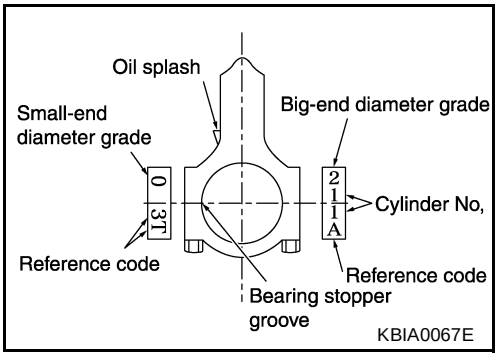
Standard : 0.002 - 0.006 mm (0.0001 - 0.0002 in)

- 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-175, "HOW TO SELECT PISTON" .
- Refer to connecting rod bearing selection table to replace connecting rod. Refer to EM-176, "HOW TO SELECT CONNECTING 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-184, "CONNECTING ROD BUSHING OIL CLEARANCE (SMALL END)" for the values for each grade at the plant.
- Regarding marks on piston head, Refer to EM-175, "HOW TO SELECT PISTON" .



PISTON RING SIDE CLEARANCE

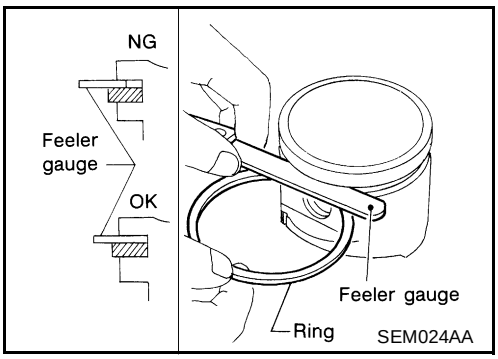
- Measure side clearance of piston ring and piston ring groove with feeler gauge.

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	**: 0.110 mm (0.0043 in)**
2nd ring	**: 0.100 mm (0.0039 in)**



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

PISTON RING END GAP

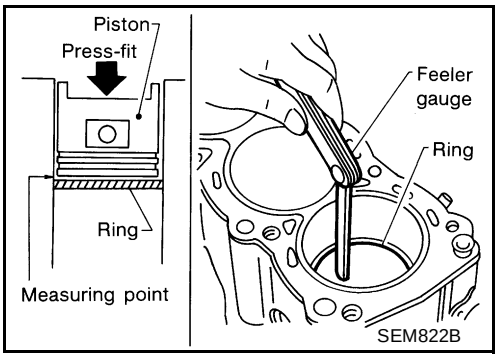
- Check if inner diameter of cylinder bore is within specification. Refer to EM-186, "PISTON TO CYLINDER BORE CLEARANCE" .
- Insert piston ring until middle of cylinder with piston, and measure gap.

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

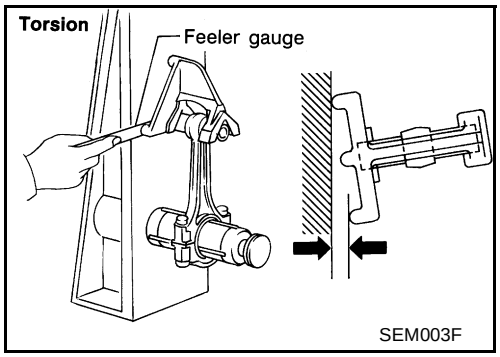
- Check with connecting rod aligner.

  Bend:

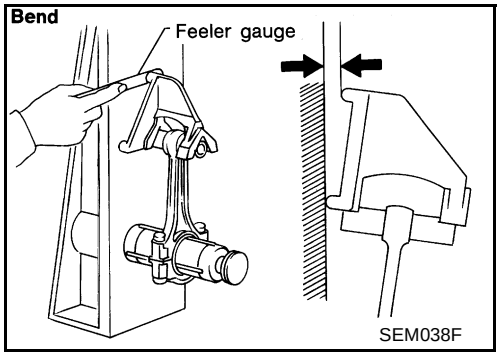
  Limit : 0.15 mm (0.0059 in) per 100 mm (3.94 in) length

  Torsion:

  Limit : 0.30 mm (0.0118 in) per 100 mm (3.94 in) length



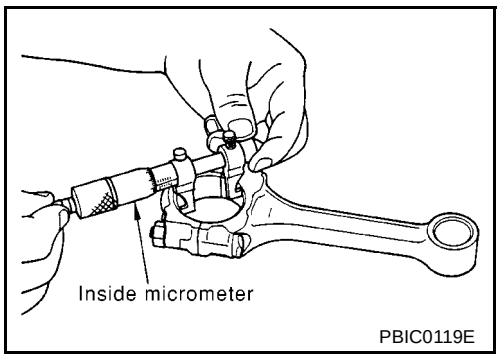
- If it exceeds the limit, replace connecting rod assembly.



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)

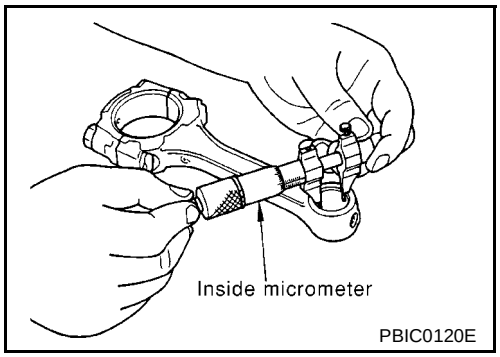


CONNECTING ROD BUSHING OIL CLEARANCE (SMALL END)

Inner Diameter of Connecting Rod (Small End)

- Measure inner diameter of bushing.

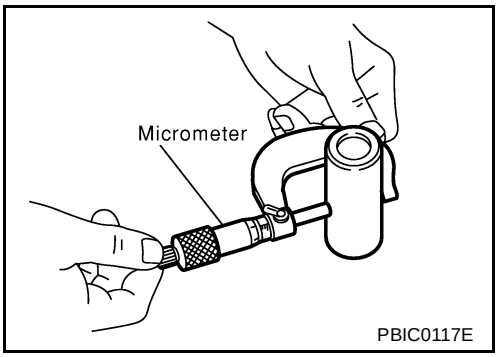
  Standard : 20.000 - 20.012 mm (0.7874 - 0.7879 in)



Outer Diameter of Piston Pin

- Measure outer diameter of piston pin.

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

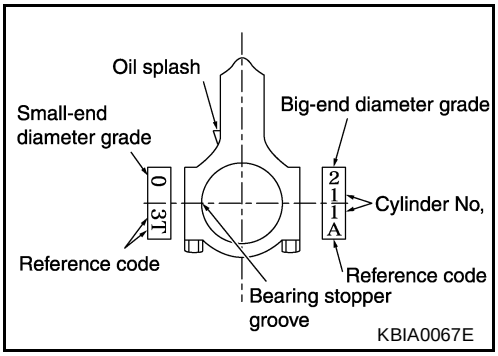


Connecting Rod Bushing Oil Clearance (Small End)

(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-175, "HOW TO SELECT PISTON" .

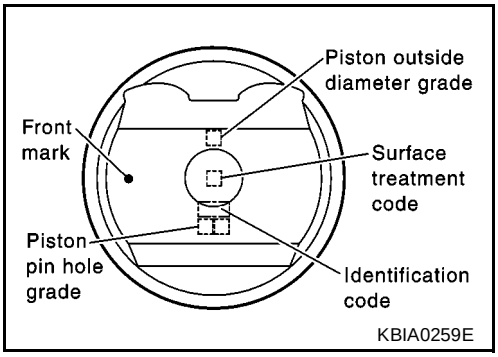


Factory installed parts grading:

- 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

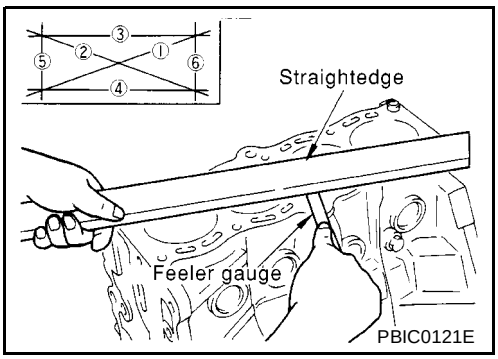
- Using a scraper, remove gasket on the cylinder block surface, and also remove oil, scale, carbon, or other contamination.

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.



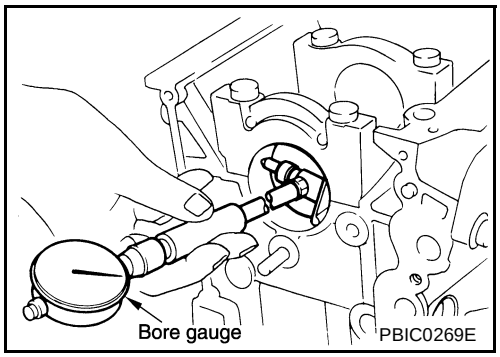
INNER DIAMETER OF MAIN BEARING HOUSING

- 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.



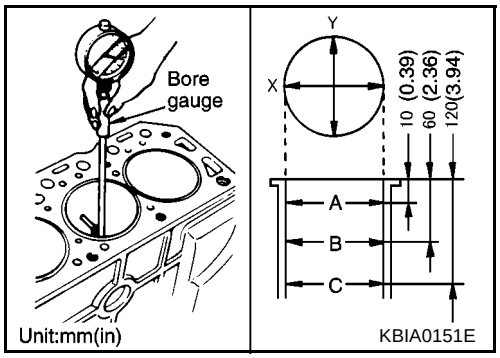
PISTON TO CYLINDER BORE CLEARANCE

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 rebore the inner wall.
- An oversize piston is provided. When using an oversize piston, rebore the cylinder so that the clearance of the piston cylinder satisfies the standard.

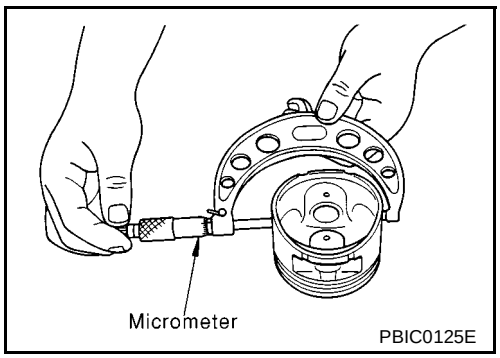
Oversize (OS) : 0.2 mm (0.008 in)

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.

Reboring Cylinder Bore

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

Rebored 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

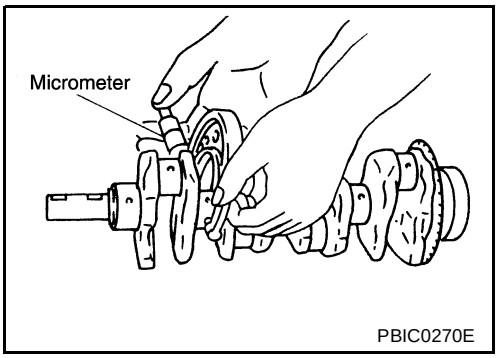
- Measure outer diameter of crankshaft journals.

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

OUTER DIAMETER OF CRANKSHAFT PIN

- Measure outer diameter of crankshaft pin.

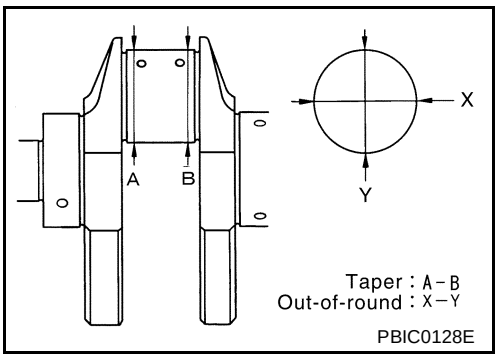
Standard : 44.956 - 44.974 mm (1.7699-1.7706 in) dia.



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.

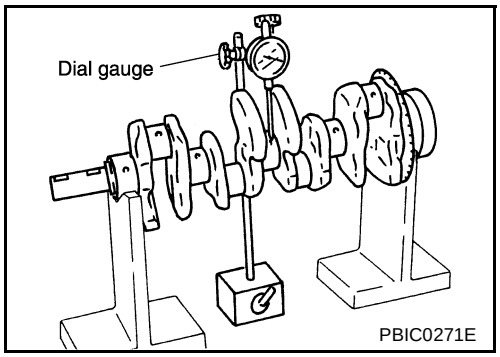
Limit:
Out-of-round (X– Y) : 0.005 mm (0.0002 in)
Taper (A – B) : 0.005 mm (0.0002 in)



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)



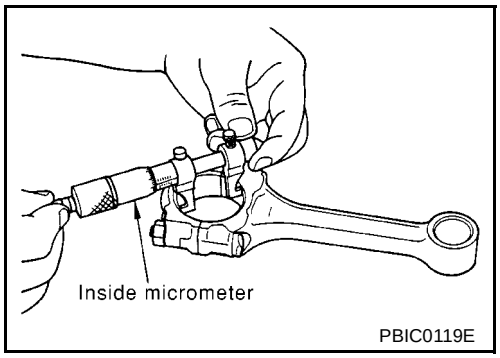
OIL CLEARANCE OF CONNECTING ROD BEARING

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)



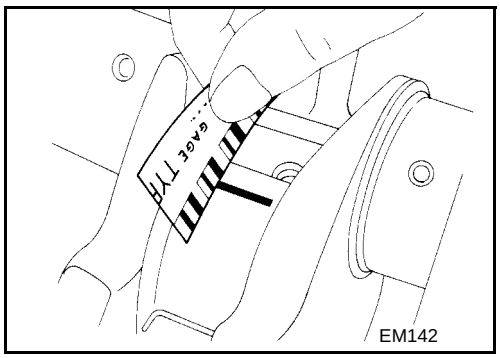
- If clearance cannot be adjusted within the standard, grind crankshaft pin and use undersized bearing. Refer to EM-176, "HOW TO SELECT CONNECTING ROD BEARING" .

Method of Using Plastigage

- Remove oil and dust on the crankshaft pin and the surfaces of each bearing completely.
- Cut a plastigage 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 plastigage bag, measure the plastigage 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)

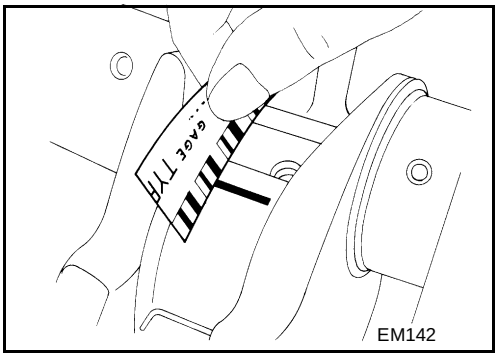
- If the measured value exceeds the limit, select main bearings referring to the main bearing inner diameter and crankshaft journal outer diameter, so that the oil clearance satisfies the standard. Refer to EM-178, "HOW TO SELECT MAIN BEARING" .

Method of Using Plastigage

- Remove oil and dust on the crankshaft journal and the surfaces of each bearing completely.
- Cut a plastigage 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 plastigage bag, measure the plastigage width.

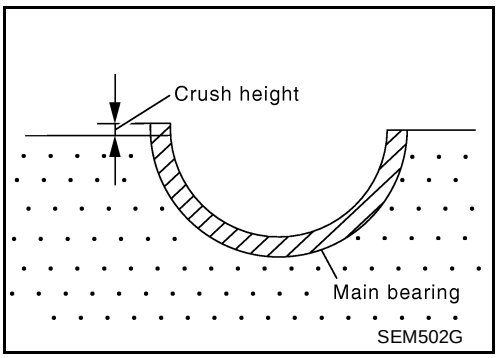
  NOTE:
  The procedure when the measured value exceeds the limit is same as that described in “the method by calculation.”



CRUSH HEIGHT 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.

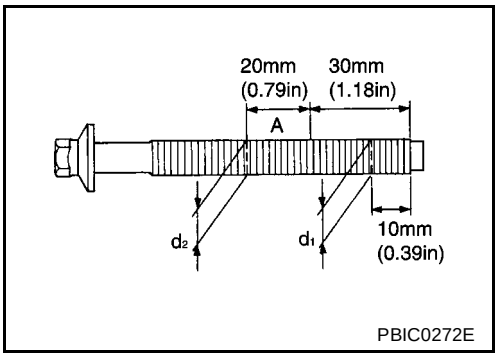
  Standard : There must be crush height
- If the standard is not met, replace main bearings.



OUTER DIAMETER OF LOWER CYLINDER BLOCK MOUNTING BOLT

- Perform only with M10 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.

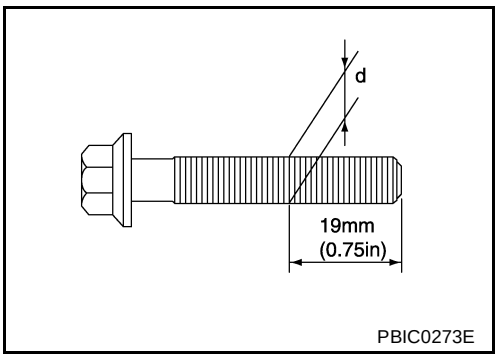
  Limit : 0.13 mm (0.0051 in) or more.



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:

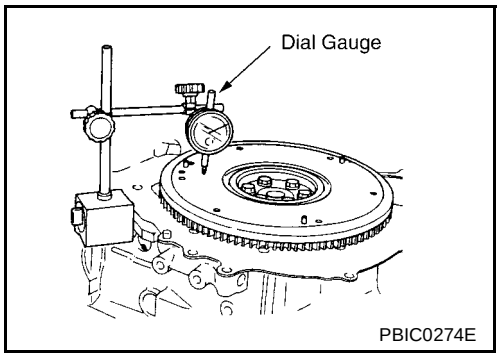
- Inspection for double mass flywheel only.
- Do not disassembly double mass flywheel.

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.

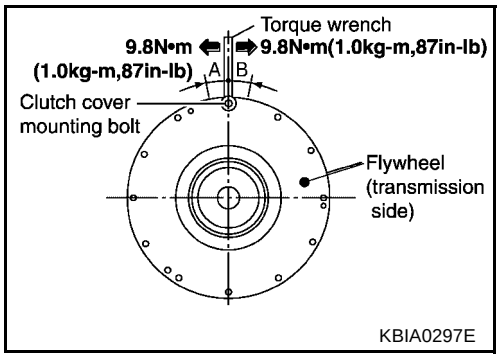
1. Install a bolt to clutch cover mounting hole, and place a torque wrench on the extended line of the flywheel center line.

- 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.



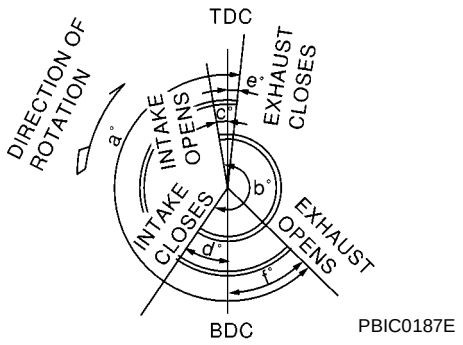
SERVICE DATA AND SPECIFICATIONS (SDS)

PFP:00030

Standard and Limit

EBS00GAZ

GENERAL SPECIFICATIONS

Cylinder arrangement		4, in-line
Displacement	cm^3 (cu in)	1,998 (121.92)
Bore and stroke	mm (in)	89.0 × 80.3 (3.504 × 3.161)
Valve arrangement		DOHC
Firing order		1-3-4-2
Number of piston rings	Compression	2
	Oil	1
Compression ratio		9.9
Compression pressure kPa (bar, kg/cm^2, psi) / 250 rpm	Standard	1,187 (11.9, 12.1, 173)
	Minimum	991 (9.9, 10.1, 144)
	Differential limit between cylinders	98 (1.0, 1.0, 14)
Valve timing		

PBIC0187E

Unit: degree

a	b	c	d	e	f
212	244	0	64	3	29

INTAKE MANIFOLD AND EXHAUST MANIFOLD

Unit: mm (in)

		Limit
Surface distortion	Exhaust manifold	0.3 (0.012)

DRIVE BELTS

Tension of drive belts	Auto adjustment by auto-tensioner

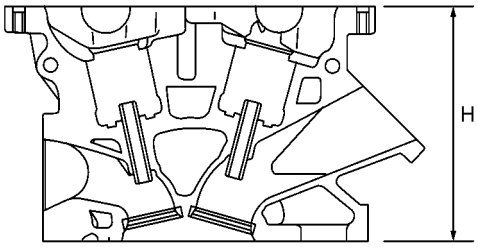
SPARK PLUG

Make		NGK
Standard type		LFR5A-11
Hot type		LFR4A-11
Cold type		LFR6A-11
Plug gap	mm (in)	1.0 - 1.1 (0.039 - 0.043)

CYLINDER HEAD

Unit: mm (in)

	Limit
Head surface distortion	0.1 (0.004)

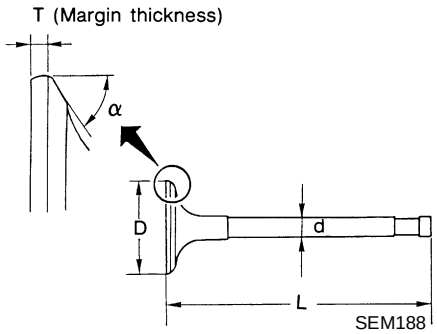


Nominal cylinder head height:
H = 129.4 mm (5.09 in) PBIC0283E

VALVE

Valve Dimensions

Unit: mm (in)



SEM188

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)

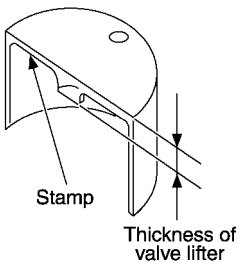
	Cold* (reference data)	Hot
Intake	0.24 - 0.32 (0.009 - 0.013)	0.32 - 0.40 (0.013 - 0.016)
Exhaust	0.26 - 0.34 (0.010 - 0.013)	0.33 - 0.41 (0.013 - 0.016)

*: Approximately 20°C (68 °F)

Available Valve Lifter

Thickness mm (in)	Identification mark
6.96 (0.2740)	696
6.98 (0.2748)	698

Thickness mm (in)	Identification mark
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 (02795)	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



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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

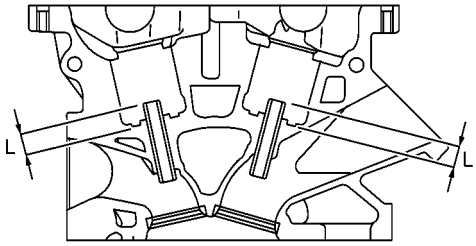
Unit: mm (in)

	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)

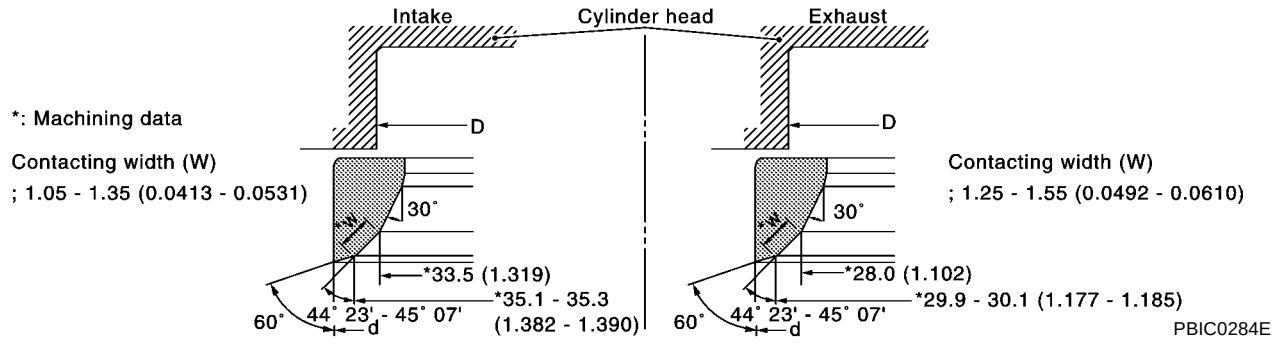


PBIC0184E

		Standard	Service
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)	
		Standard	
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)



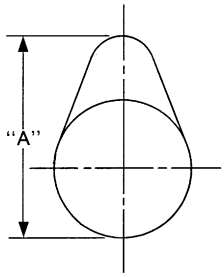
PBIC0284E

		Standard	Service
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)

	Standard
Camshaft runout [TIR*]	Less than 0.04 (0.0016)



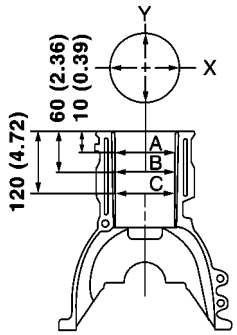
SEM671

Cam height "A"	Intake	45.665 - 45.855 (1.7978 - 1.8053)
	Exhaust	42.825 - 43.015 (1.6860 - 1.6935)
Outer diameter of camshaft journal		No. 1 27.935 - 27.955 (1.0998 - 1.1006) No. 2, 3, 4, 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, 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*]		Less than 0.15 (0.0059)

*: Total indicator reading

CYLINDER BLOCK

Unit: mm (in)



PBIC0281E

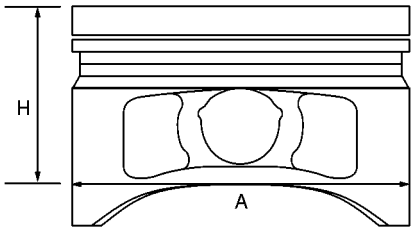
Surface flatness	Limit			0.1 (0.004)
Cylinder bore	Inner diameter	Standard	Grade No. 1	89.000 - 89.010 (3.5039 - 3.5043)
			Grade No. 2	89.010 - 89.020 (3.5043 - 3.5047)
			Grade No. 3	89.020 - 89.030 (3.5047 - 3.5051)
		Wear limit		0.2 (0.008)
Out-of-round (X – Y)				Less than 0.015 (0.0006)
Taper (A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

		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		152.85 - 152.95 (6.02 - 6.02)
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	48.000 - 48.001 (1.8898 - 1.8898)
	Grade No. 1	48.001 - 48.002 (1.8898 - 1.8898)
	Grade No. 2	48.002 - 48.003 (1.8898 - 1.8899)
	Grade No. 3	48.003 - 48.004 (1.8899 - 1.8899)
	Grade No. 4	48.004 - 48.005 (1.8899 - 1.8900)
	Grade No. 5	48.005 - 48.006 (1.8900 - 1.8900)
	Grade No. 6	48.006 - 48.007 (1.8900 - 1.8900)
	Grade No. 7	48.007 - 48.008 (1.8900 - 1.8901)
	Grade No. 8	48.008 - 48.009 (1.8901 - 1.8901)
	Grade No. 9	48.009 - 48.010 (1.8901 - 1.8902)
	Grade No. A	48.010 - 48.011 (1.8902 - 1.8902)
	Grade No. B	48.011 - 48.012 (1.8902 - 1.8902)
	Grade No. C	48.012 - 48.013 (1.8902 - 1.8903)

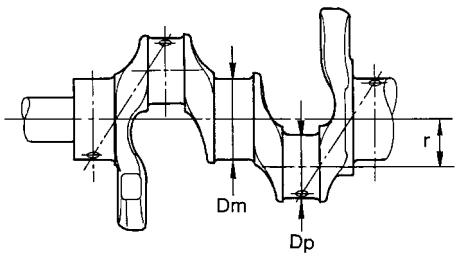
*: After installing in connecting rod

CRANKSHAFT

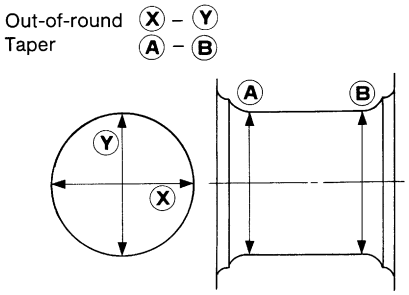
Unit: mm (in)

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)
Center distance “r”		40.11 - 40.19 (1.5791 - 1.5823)
Out-of-round (X – Y)	Standard	Less than 0.005 (0.0002)
Taper (A – B)	Standard	Less than 0.005 (0.0002)
Runout [TIR*]	Limit	Less than 0.10 (0.004)

Free end play	Standard	0.10 - 0.26 (0.0039 - 0.0102)
	Limit	0.30 (0.0118)



SEM645

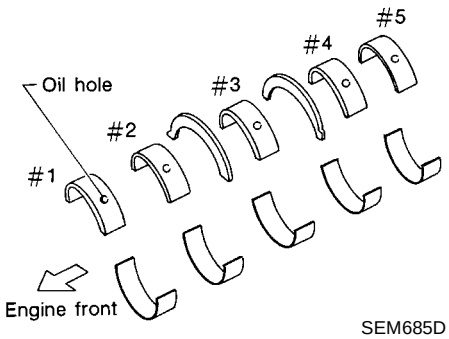


SEM715

*: Total indicator reading

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)

	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)

	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

EBS00GB0

*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

	Auto-tensioner			19.6 - 23.5 (2.0 - 2.4, 15 - 17)
	Mass air flow sensor			4.3 - 5.8 (0.44 - 0.59, 38 - 51)*2
	Resonator			3.8 - 4.5 (0.39 - 0.45, 34 - 39)*2
	Air cleaner case lower			3.8 - 4.5 (0.39 - 0.45, 34 - 39)*2
*1	Intake manifold			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			7.3 - 9.6 (0.75 - 0.97, 65 - 84)*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) 2)	9.3 - 10.8 (0.95 - 1.1, 0.7 - 0.8) 20.6 - 26.5 (2.1 - 2.7, 16 - 19)
*1	Rocker cover		1) 2)	0.98 - 2.9 (0.1 - 0.3, 9 - 25)*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			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° to 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)	45.2 - 51.0 (4.6 - 5.2, 34 - 37)
			2)	90° to 95° (Angle tightening)
			3)	0 (0.0, 0)
			4)	45.2 - 51.0 (4.6 - 5.2, 34 - 37)
			5)	90° to 95° (Angle tightening)
*1	Cylinder head		1)	98.1 (10.0, 72)
			2)	0 (0.0, 0)
			3)	34.3 - 44.1 (3.5 - 4.5, 26 - 32)
			4)	75° to 80° (Angle tightening)
			5)	75° to 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)	18.6 - 20.6 (1.9 - 2.1, 14 - 15)
			2)	90° to 95° (Angle tightening)
*1	Lower cylinder block	M10 bolt	1)	36.3 - 42.2 (3.7 - 4.3, 27 - 31)
		M10 bolt	2)	60° to 65° (Angle tightening)
		M8 bolt	3)	19.6 - 24.5 (2.0 - 2.5, 15 - 18)
	Knock sensor			15.7 - 26.5 (1.6 - 2.7, 12 - 19)
	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

EBS00GRO

- Drain coolant when engine is cooled.

Precautions for Disconnecting Fuel Piping

EBS00GRP

- 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

EBS00GRQ

- 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

EBS00GRR

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

Precautions for Assembly and Installation

EBS00GRS

- 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

EBS00GRT

- 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

EBS00GRU

REMOVAL OF LIQUID GASKET SEALING

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

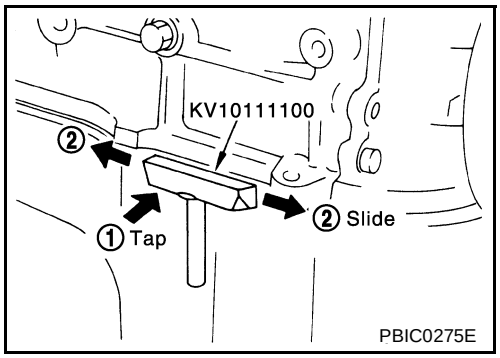
CAUTION:

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.

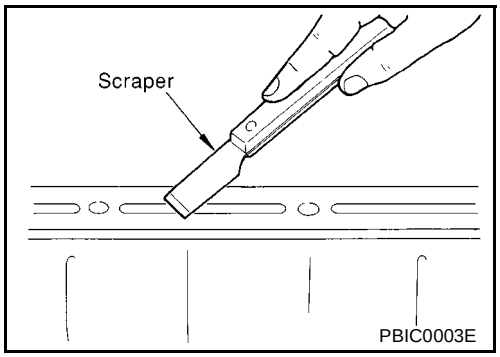


LIQUID GASKET APPLICATION PROCEDURE

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

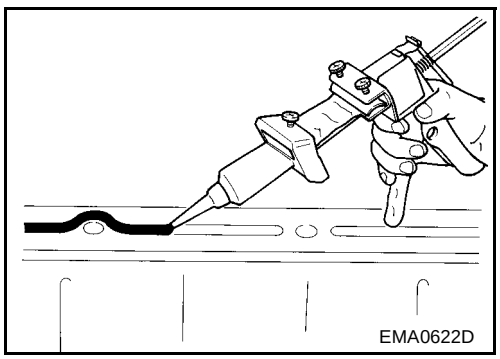
- Remove the liquid gasket completely from the groove of the gasket application surface, mounting bolts, and bolt holes.

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.

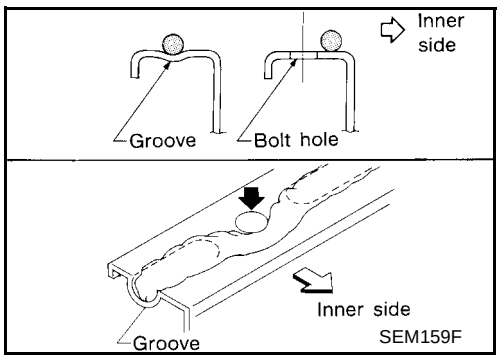
- If there is a groove for the liquid gasket application, apply the gasket to the groove.



- 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.

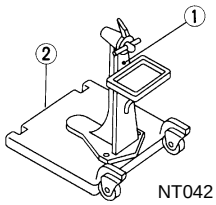
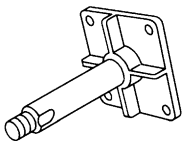
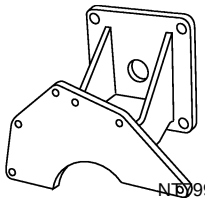
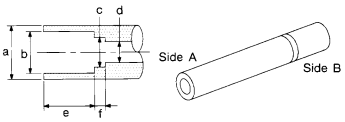
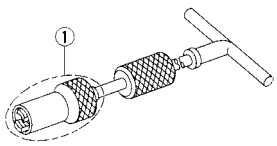
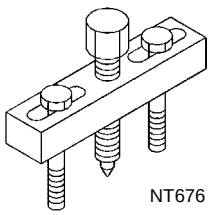


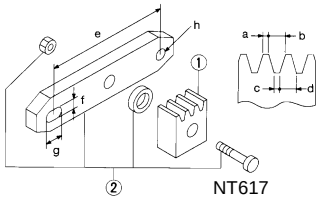
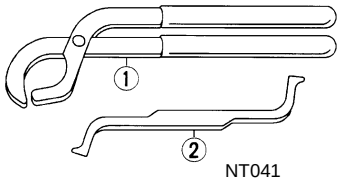
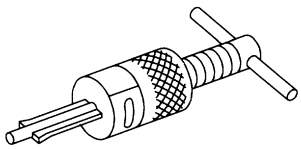
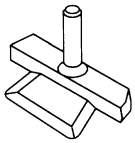
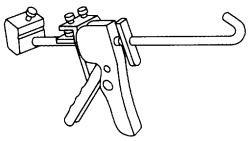
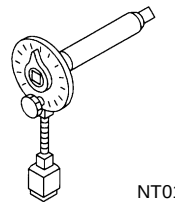
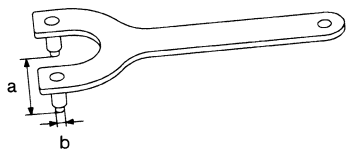
PREPARATION

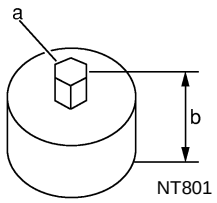
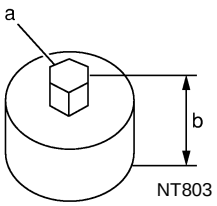
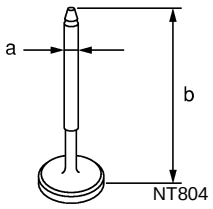
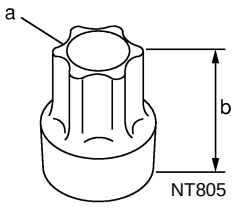
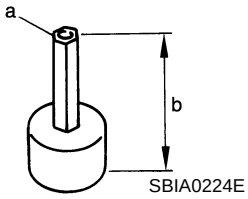
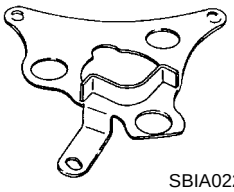
PFP:00002

Special Service Tools

EBS00GRV

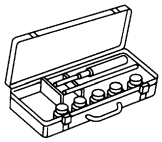
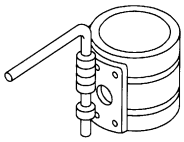
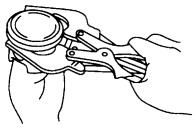
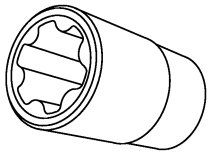
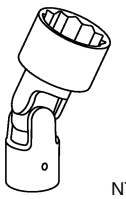
Tool number Tool name		Description
ST0501S000 Engine stand assembly 1 ST05011000 Engine stand 2 ST05012000 Base	 NT042	Disassembling and assembling
KV10106500 Engine stand shaft	 NT028	
KV11105900 Engine sub-attachment	 NT099	Used with KV10106500
KV10115600 Valve oil seal drift	 NT603	Installing valve 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

EBS00GRW

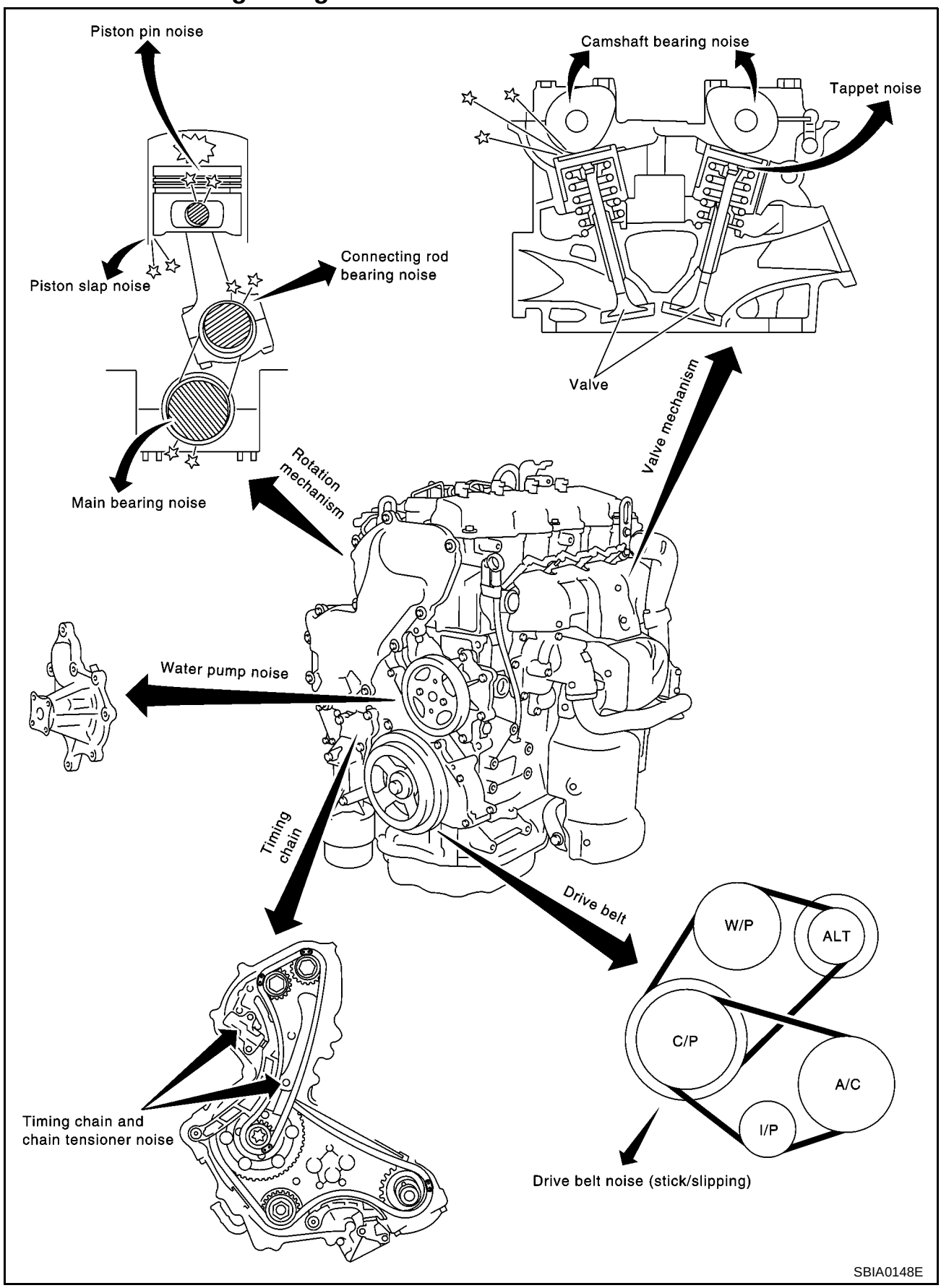
Tool name	Description
Valve seat cutter set  NT048	Finishing valve seat dimensions
Piston ring compressor  NT044	Installing piston assembly into cylinder bore
Piston ring expander  NT030	Removing and installing piston ring
TORX socket  NT807	
Standard Universal  NT808	

NOISE, VIBRATION, AND HARSHNESS (NVH) TROUBLESHOOTING

PFP:00003

NVH Troubleshooting —Engine Noise

EBS00GRX



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

EBS00GRY

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-255
	Rattle	C	A	—	A	B	C	Camshaft bearing noise	Camshaft oil clearance Camshaft runout	EM-252 EM-251
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-301 EM-303
	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-304 EM-301 EM-302 EM-302
	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-303 EM-306
	Knock	A	B	—	A	B	C	Main bearing noise	Main bearing oil clearance Crankshaft runout	EM-306 EM-306
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-259 EM-264
Front of engine	Squeaking or fizzing	A	B	—	B	—	C	Drive belts (Sticking or slipping)	Drive belts deflection	EM-211
	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-59

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

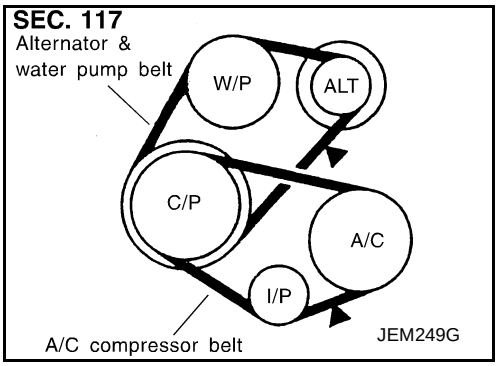
DRIVE BELTS

PFP:02117

Checking Drive Belts

EBS00GRZ

- 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

EBS00GS0

- 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:

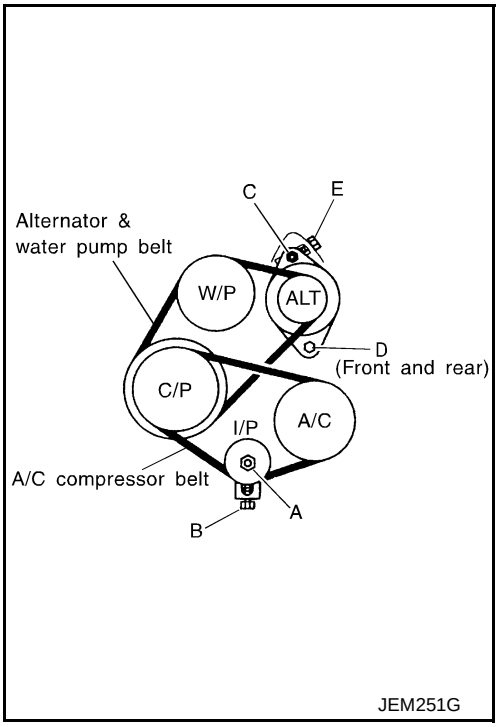
- **When a new belt is installed as a replacement, adjust it to the value specified under “New” value because of insufficient adaptability with pulley grooves.**
- **If the belt deflection of the current belt is out of the “Limit for re-adjusting”, adjust to the “Adjusted” value.**
- **When checking 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-211, "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-211, "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

EBS00GS1

REMOVAL

1. Loosen each belt. Refer to EM-211, "Tension Adjustment" .
2. Remove air conditioner compressor belt.
3. Remove alternator and water pump belt.

INSTALLATION

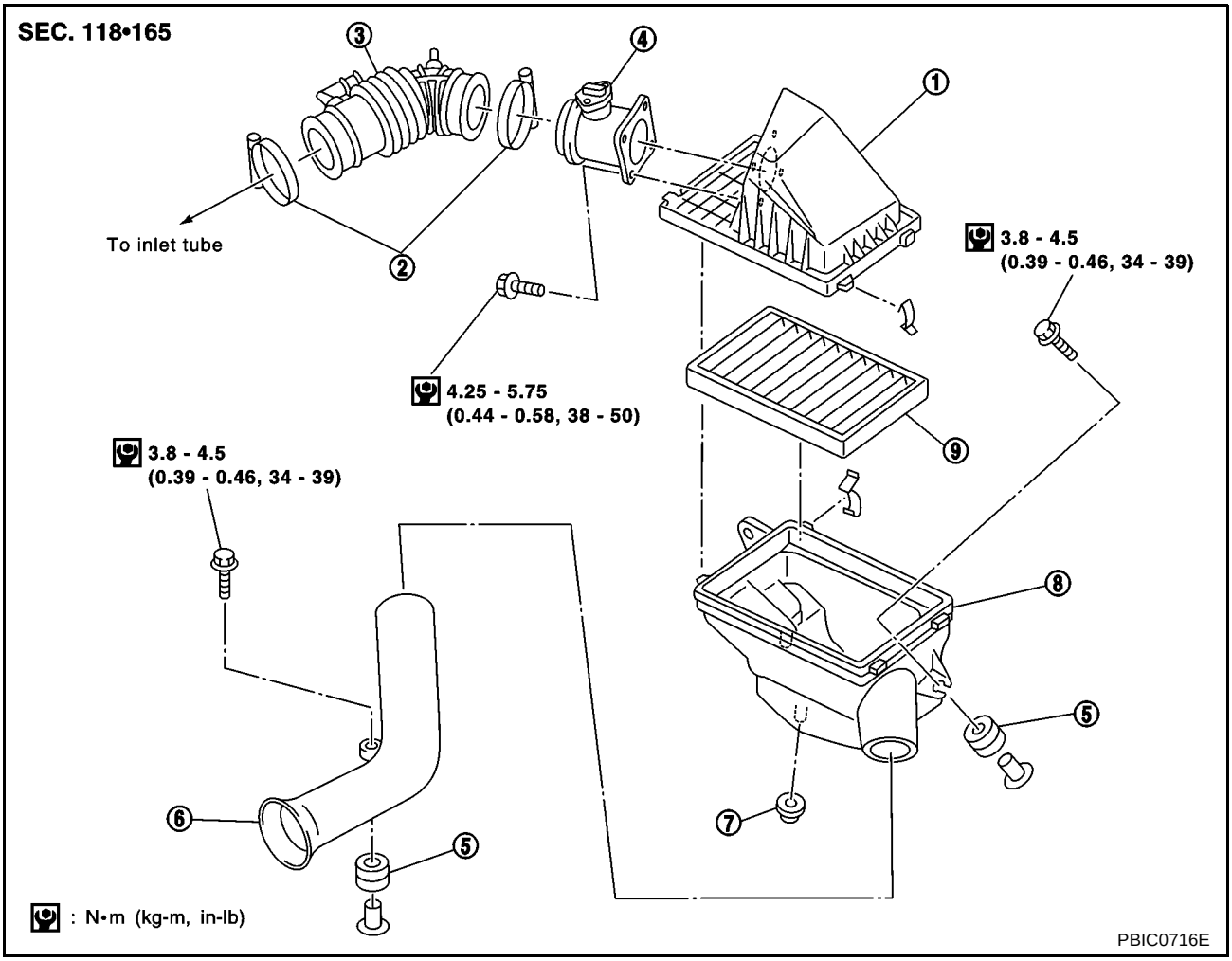
1. Install each belt on pulley in reverse order of removal.
2. Adjust belt tension. Refer to EM-211, "Tension Adjustment" .
3. Tighten nuts and bolts provided for adjustment to the specified torque.
4. Check again that each belt tension is as specified.

AIR CLEANER AND AIR DUCT

PFP:16500

Removal and Installation

EBS00GS2



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.

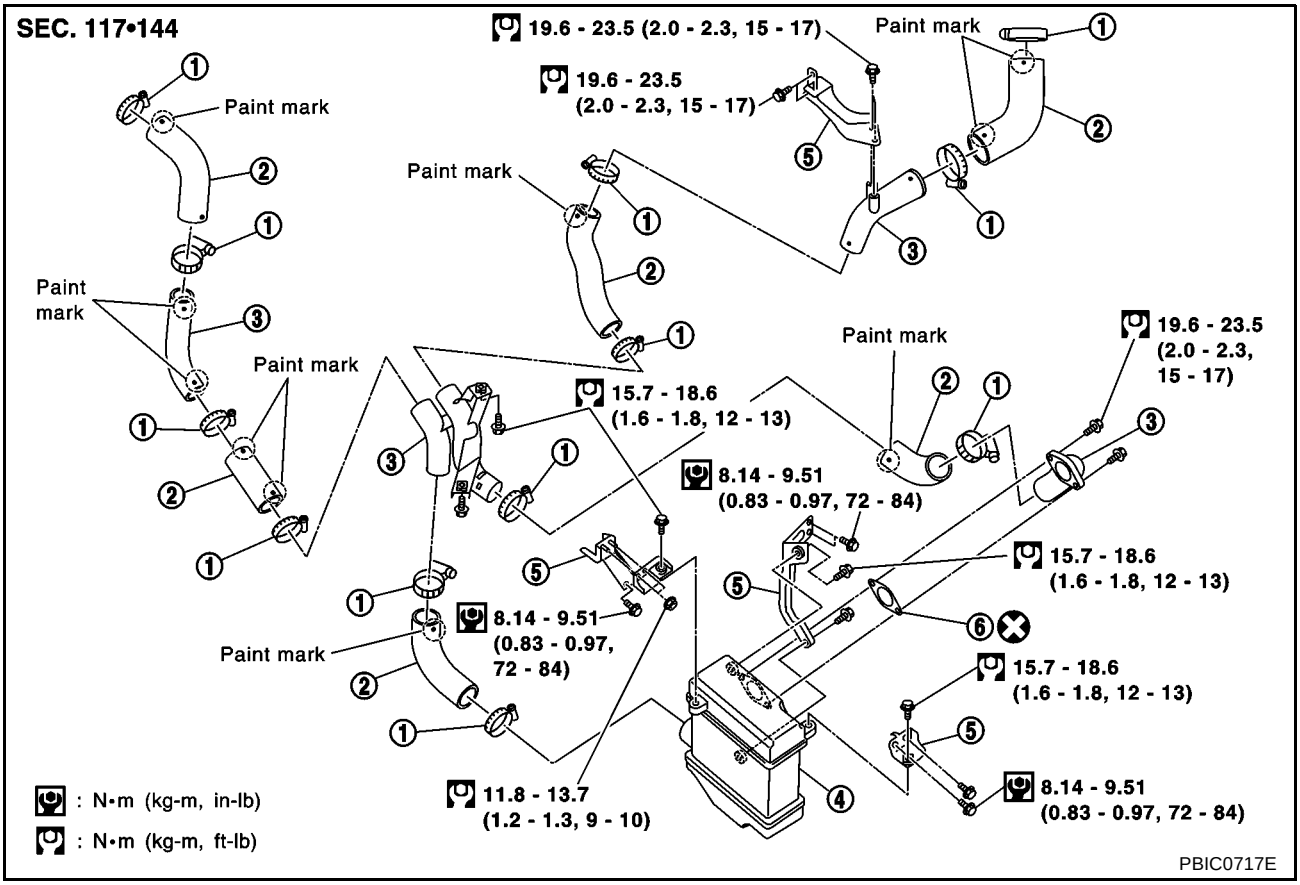
2. Remove clips and lift up air cleaner upper case.
3. Remove air cleaner element.

CHARGE AIR COOLER

PFP:14461

Removal and Installation

EBS00GS3



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

REMOVAL

1. Remove front part of front fender protector.
2. Remove air inlet hose.
3. Remove charge air cooler.
4. 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-54, "Checking Radiator".**

INSTALLATION

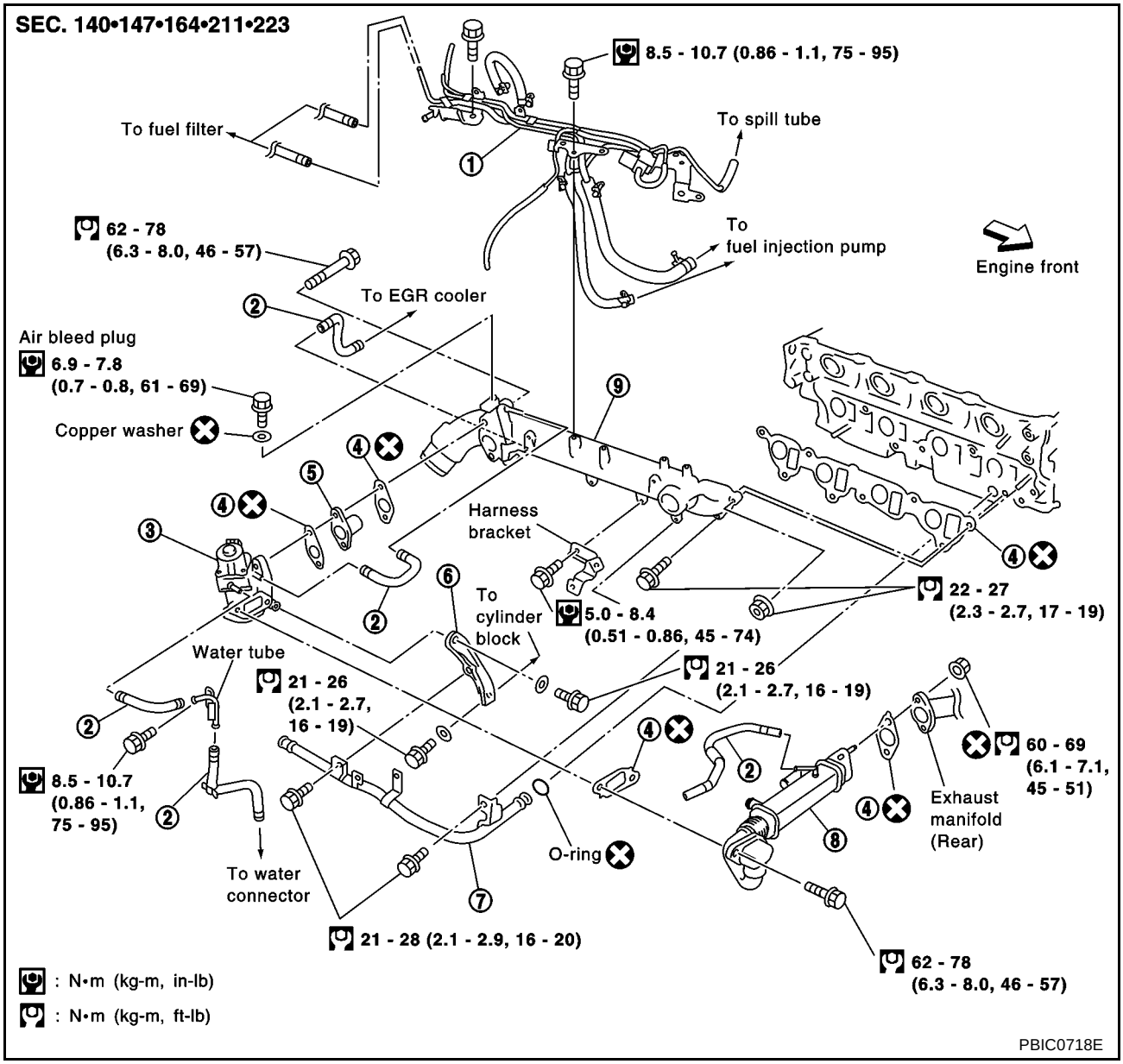
Pay attention to identification mark and direction when installing air inlet hose and tubes. Refer to EM-215, "Removal and Installation" .

INTAKE MANIFOLD

PFP:14003

Removal and Installation

EBS00GS4



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

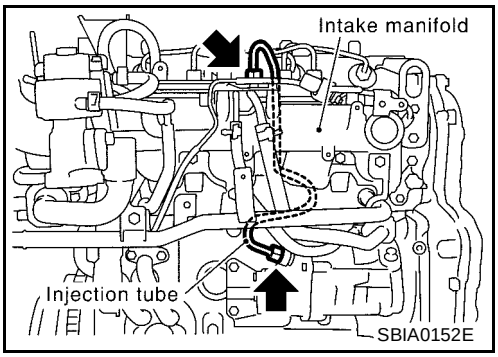
WARNING:

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

1. Drain engine coolant. Refer to CO-49, "Changing Engine Coolant" .
2. Remove air duct. Refer to EM-213, "Removal and Installation" .
3. Remove air inlet pipes. Refer to EM-220, "Removal and Installation"
4. Remove exhaust manifold cover.
5. Disconnect electronic EGR volume control valve water hoses and harness.
6. Disconnect heater hose.
7. Remove EGR cooler.

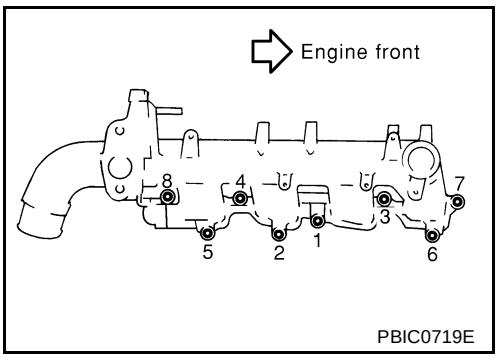
8. Remove vacuum hose.
9. Remove injection tube. Refer to EM-236, "Removal and Installation" .
10. Remove water pipe.
11. Remove fuel hose.
    - To prevent fuel from flowing out, plug the opening of the hose with a blind plug after disconnection.

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



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

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

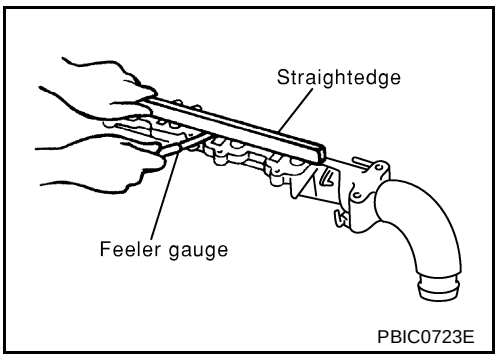


INSPECTION AFTER REMOVAL

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.

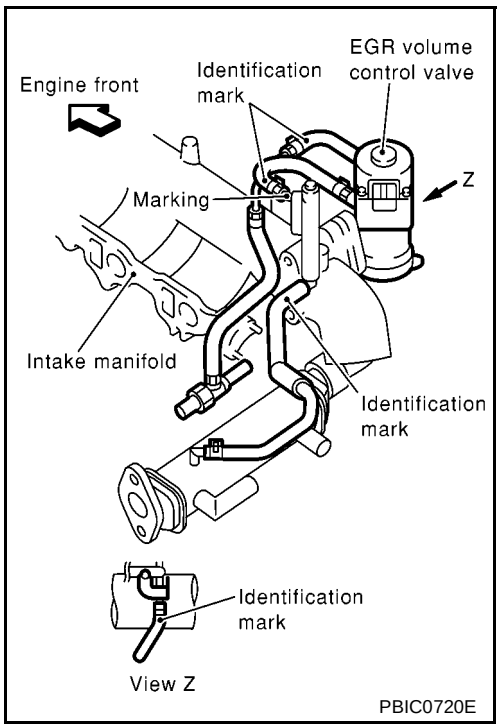
1. Install electronic EGR volume control valve.
   - **Handle with care avoiding any shocks.**
   - **Do not disassemble or adjust.**
2. Install intake manifold.
   - Tighten fixing bolts and nuts in numerical order as shown in the figure.
   - When stud bolts come off, install with the following torque..

   : 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-5, "Air Bleeding" .



INSPECTION AFTER INSTALLATION

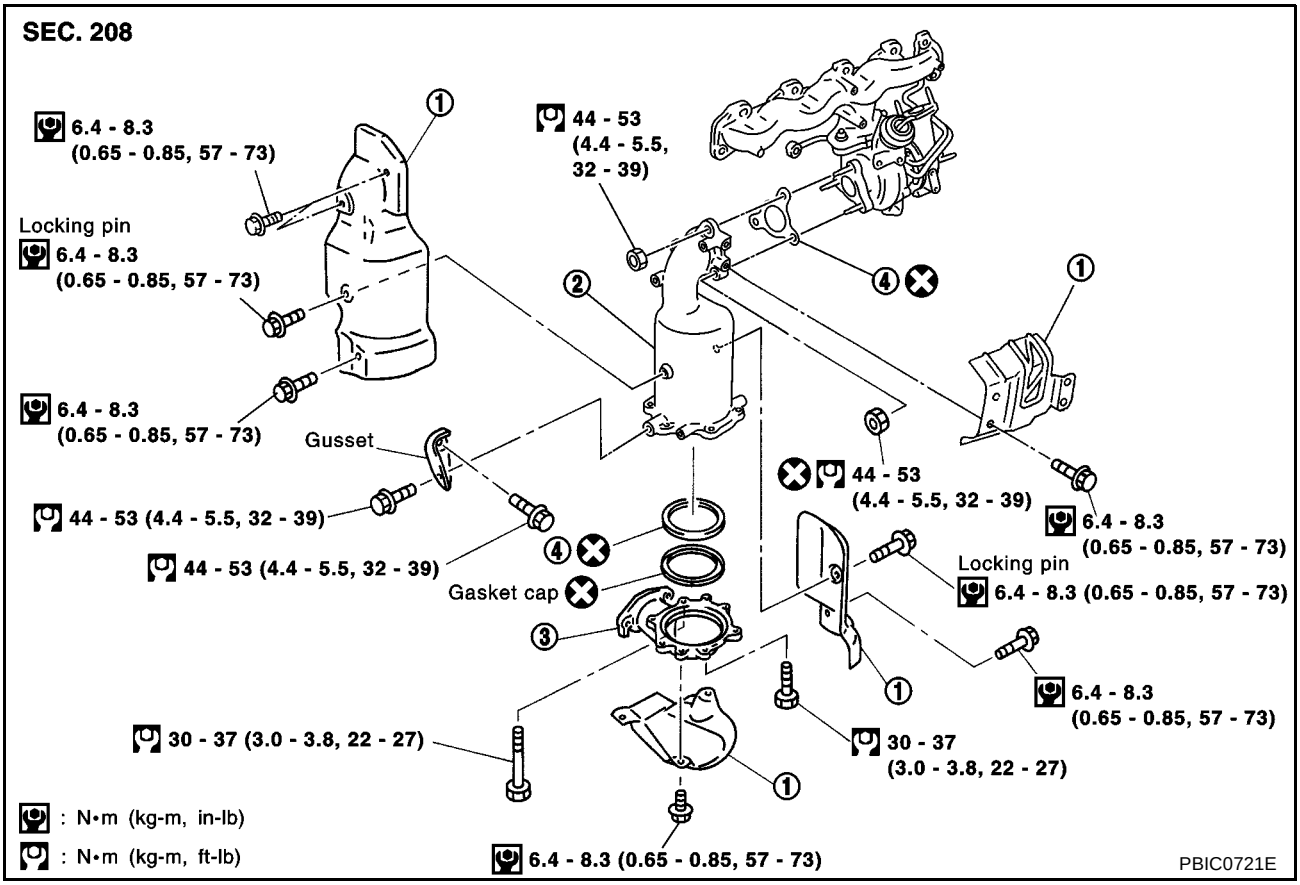
Start engine and increase engine speed to check for fuel leak.

CATALYST

PFP:20905

Removal and Installation

EBS00GS5



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

REMOVAL

1. Remove engine under cover.
2. Drain engine coolant. Refer to CO-49, "Changing Engine Coolant" .
3. Remove radiator upper and lower hoses.
4. Remove radiator and radiator fan. Refer to CO-52, "Removal and Installation" .
5. Remove radiator mount bracket and radiator.
6. Remove water inlet pipe.
7. Remove insulators.
8. Disconnect exhaust front tube.
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.

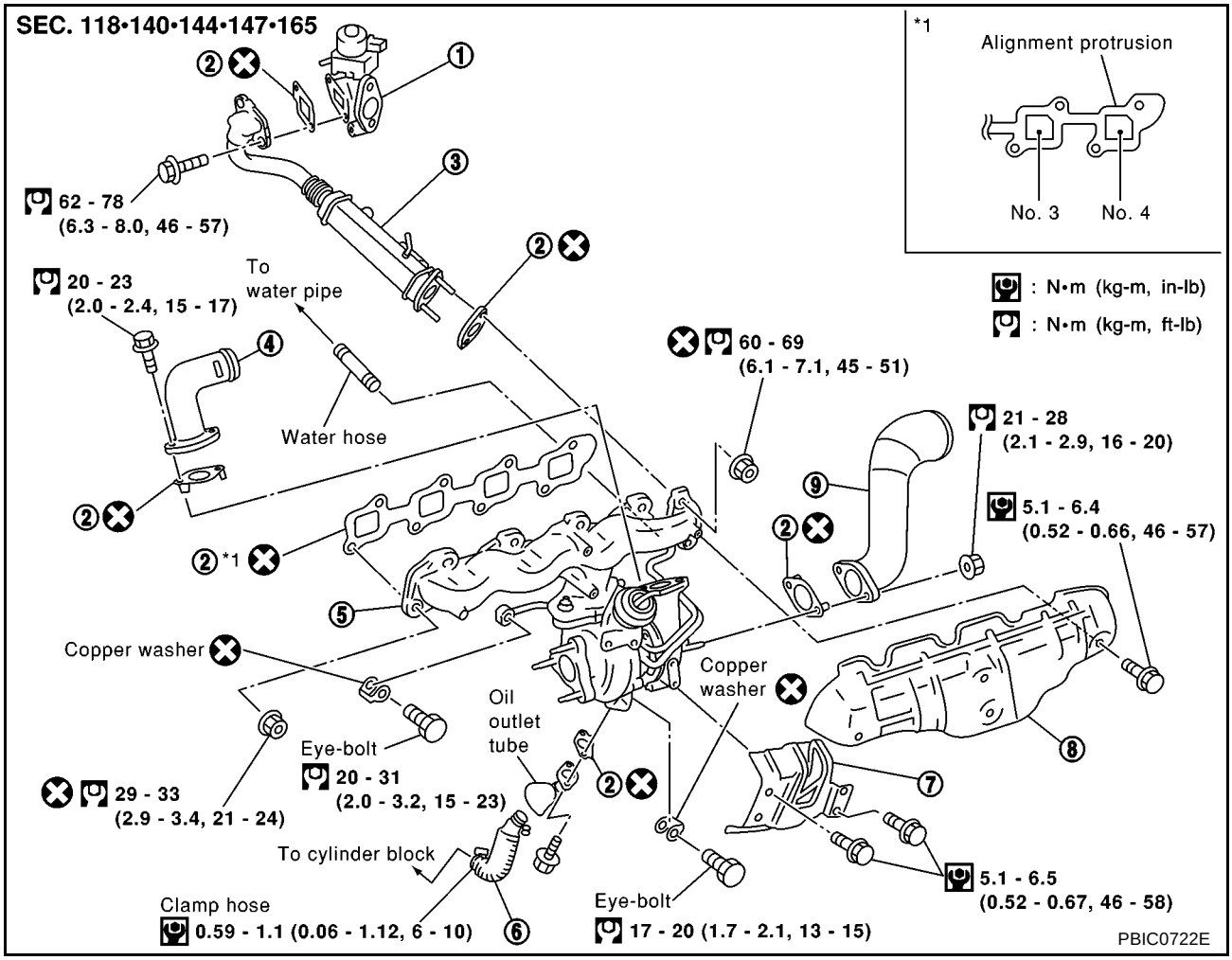
- Pushing gussets against the oil pan and the catalyst, temporarily tighten the mounting bolt. And then tighten it to the specified torque.

EXHAUST MANIFOLD AND TURBOCHARGER

PFP:14004

Removal and Installation

EBS00GS6

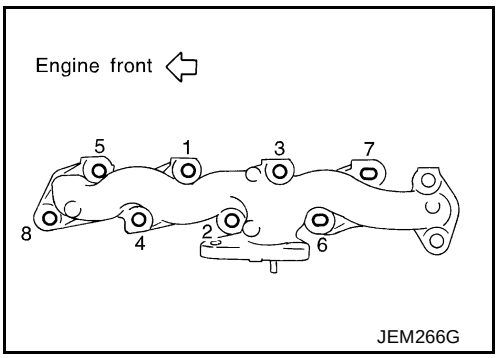


1.	Electronic EGR volume control valve	2.	Gasket	3.	EGR cooler
4.	Air inlet pipe	5.	Exhaust manifold & turbocharger assembly	6.	Oil return hose
7.	Turbo insulator	8.	Exhaust manifold insulator	9.	Air inlet pipe

REMOVAL

1. Drain engine coolant. Refer to CO-49, "Changing Engine Coolant" .
2. Remove air duct and air inlet pipe. Refer to EM-213, "Removal and Installation" .
3. Remove engine under cover.
4. Remove radiator upper and lower hoses.
5. Remove radiator and radiator fan. Refer to CO-52, "Removal and Installation" .
6. Remove radiator mount bracket and radiator. Refer to CO-52, "Removal and Installation" .
7. Remove water inlet pipe.
8. Disconnect exhaust front tube.
9. Remove catalyst. Refer to EM-219, "Removal and Installation" .
10. Remove exhaust manifold cover.
11. Remove insulator.
12. Each wiring and piping (disconnect/move)

13. Loosen exhaust manifold mounting nuts in the reverse order specified in the figure.
14. 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.

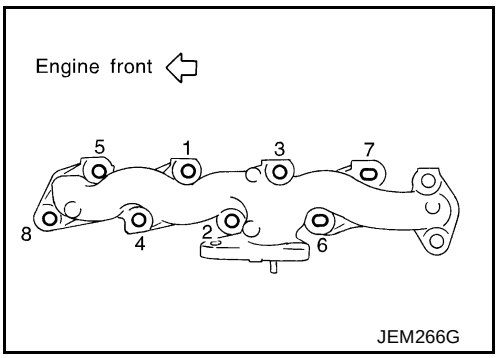
INSTALLATION

- 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.

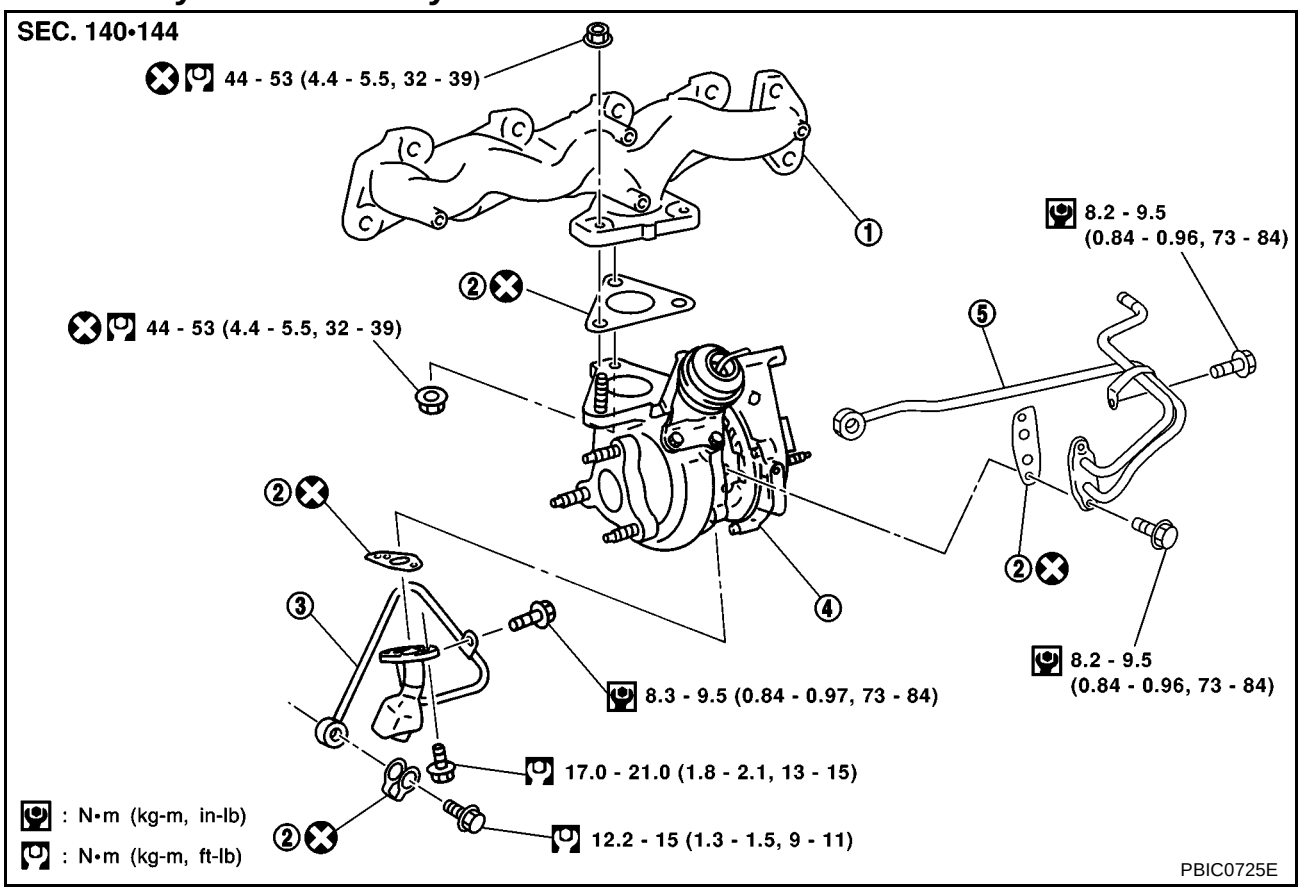


INSPECTION AFTER INSTALLATION

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

Disassembly and Assembly

EBS00GS7



1. Exhaust manifold
2. Gasket
3. Oil feed tube, oil return tube
4. Turbocharger
5. Water inlet tube, return 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:

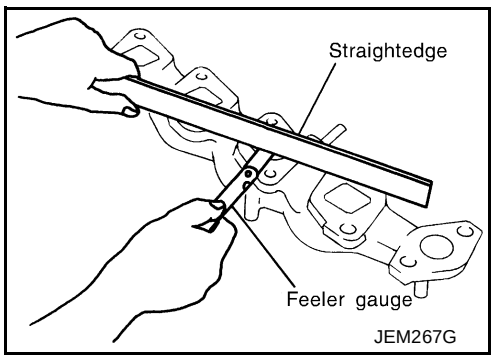
   : 24 - 27 N·m (2.4 - 2.8 kc/s, 18 - 20 football)

INSPECTION AFTER REMOVAL

Surface Distortion

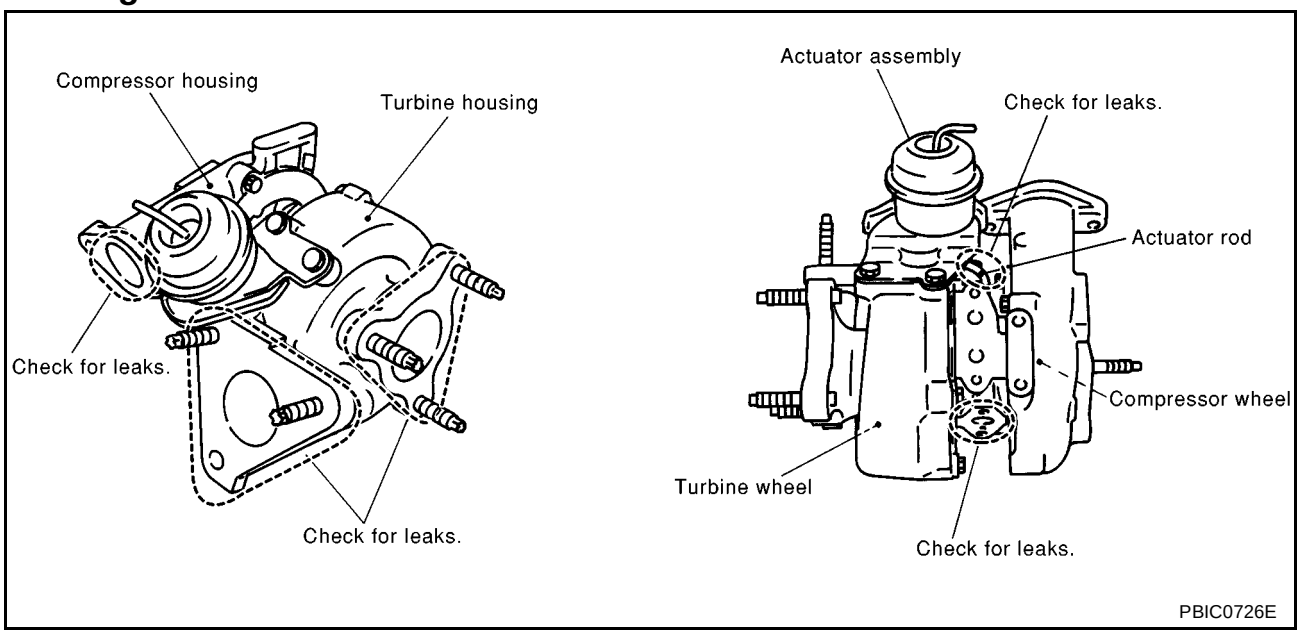
Check the distortion on the mounting surface in the six directions using a straightedge and a feeler gauge.

Limit : 0.3 mm (0.012 in)



Turbocharger

EBS00GS8



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:

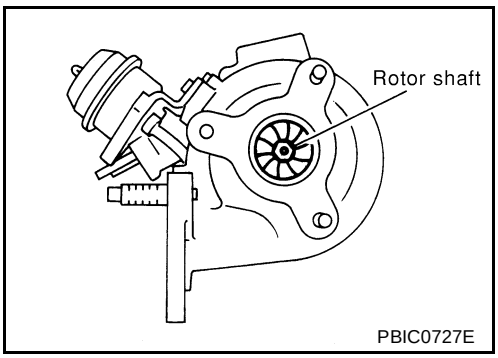
Suction side : Between turbocharger and air cleaner

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.

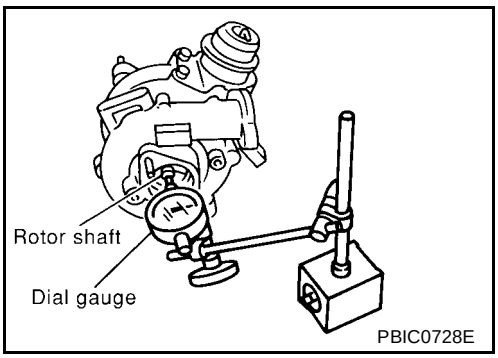
Standard : 0.086- 0.117 mm (0.0034 - 0.0046 in)



ROTOR SHAFT END PLAY

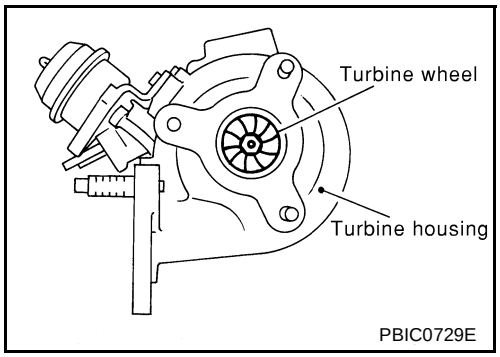
Place a dial gauge at the rotor shaft end in the axial direction to measure the end play.

Standard : 0.036 - 0.090 mm (0.0014 - 0.0035 in)



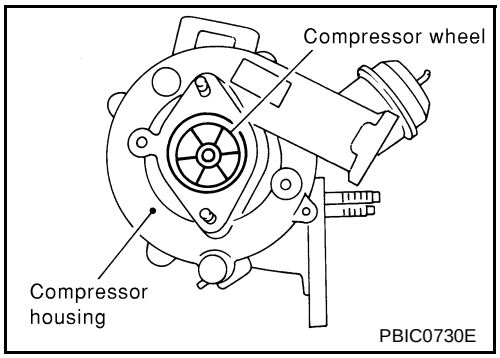
TURBINE WHEEL

- 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.



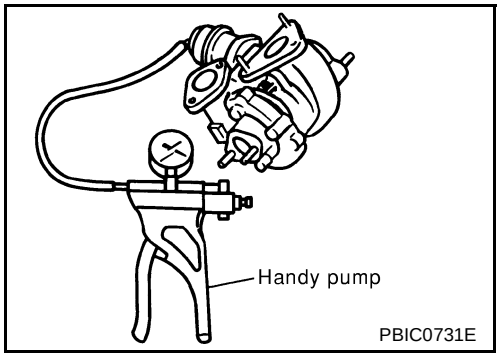
VARIABLE NOZZLE TURBOCHARGER CONTROL ACTUATOR

- 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):

: – 53.3 ± 1.3kPa (– 533 ± 13 mbar, – 400 ± 10mmHg, – 15.7 ± 0.394 inHg) / 0.2mm (0.0079in)

:– 36.0 ± 4.0kPa (– 360 ± 40mbar, – 270 ± 30mmHg , –10.6 ±1.18inHg) / 5.0 mm (0.197 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

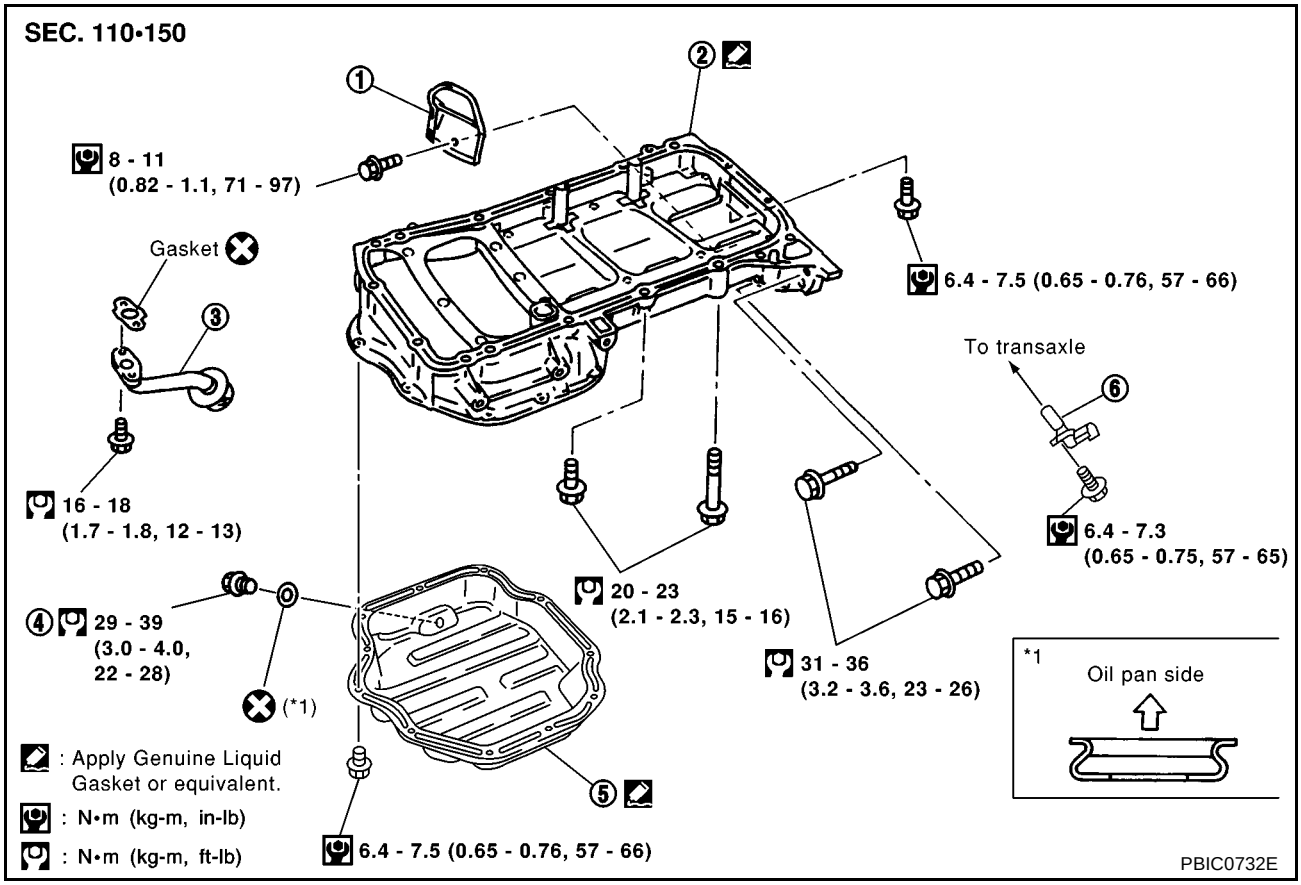
A: Large possibility
B: Medium possibility
C: Small possibility

OIL PAN AND OIL STRAINER

PFP:11110

Removal and Installation

EBS00GS9



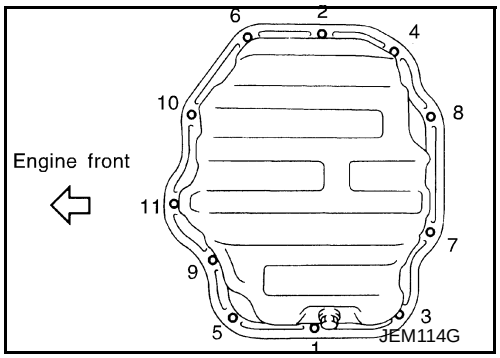
1. Rear plate cover
2. Oil pan upper
3. Oil strainer
4. Drain plug
5. Oil pan lower
6 Crankshaft position sensor (TDC)

REMOVAL

WARNING:

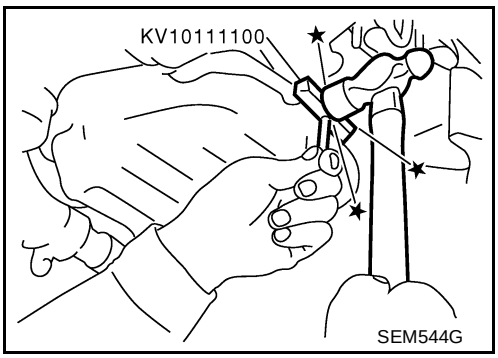
To avoid the danger of being scalded, never drain the engine oil when the engine is hot.
When removing the transaxle, first remove the crankshaft position sensor (TDC) from the assembly.
Be careful not to damage sensor edges and signal plate teeeh.

1. Remove engine under cover at both side.
2. Drain engine oil. Refer to LU-28, "Changing Engine Oil" .
3. Remove lower oil pan bolts, Loosen bolts in the reverse order of that shown in the figure.

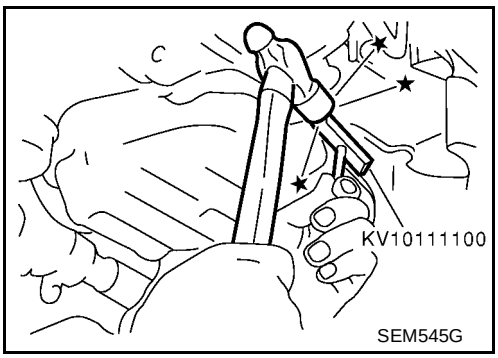


4. Remove lower oil pan.

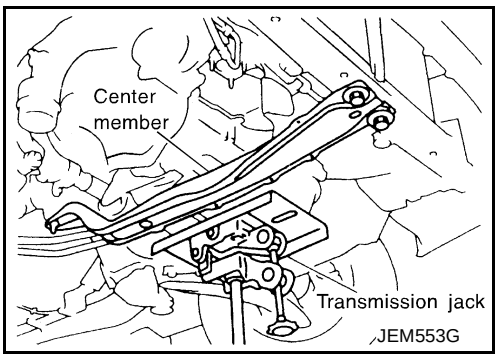
a. Insert Tool between upper oil pan and lower oil pan.
   - **Be careful not to damage aluminum mating surface.**
   - **Do not insert screwdriver, or oil pan flange will be deformed.**



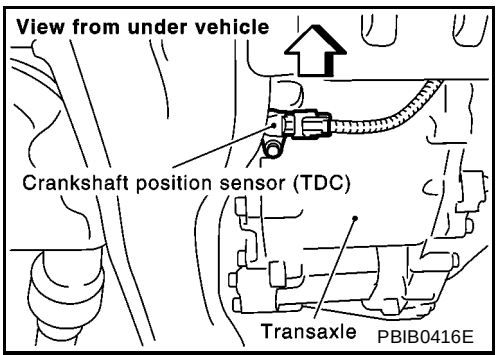
b. Slide Tool by tapping on the side of the Tool with a hammer.
c. Remove lower oil pan.



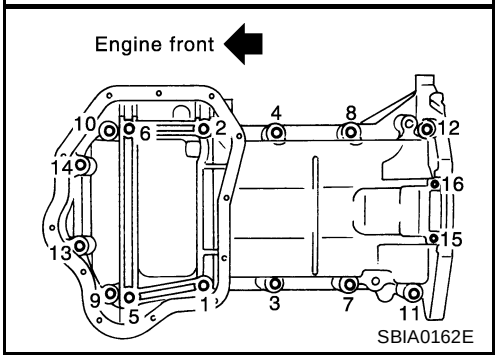
5. Remove drive belts.
6. Remove A/C compressor and bracket.
7. Remove front exhaust tube and its support.
8. Set a suitable transmission jack under transaxle and hoist engine with engine slinger. Refer to EM-285, "Removal and Installation" .
9. Remove center member.



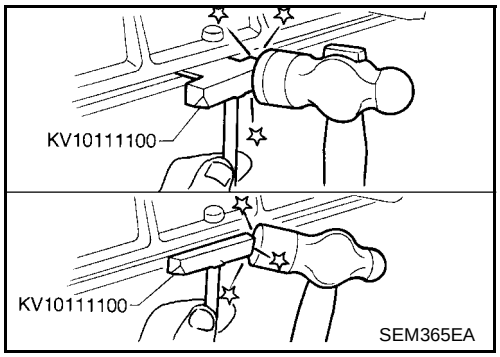
10. Remove crankshaft position sensor (TDC) from transaxle.
11. Remove rear plate cover and four engine-to transaxle bolts.
12. Remove catalyst and rear diffuser. Refer to EM-219, "Removal and Installation" .



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

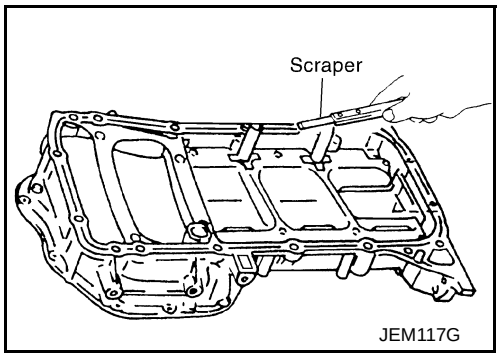


14. Remove upper oil pan.
    - Insert Tool (Seal cutter) between upper oil pan and cylinder block. Slide tool by tapping on the side of the tool with a hammer. Remove oil pan.
    - **Be careful not to damage aluminum mating surface.**
    - **Do not insert screwdriver, or oil pan flange will be deformed.**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



INSPECTION AFTER REMOVAL

Clean oil strainer if any object attached.

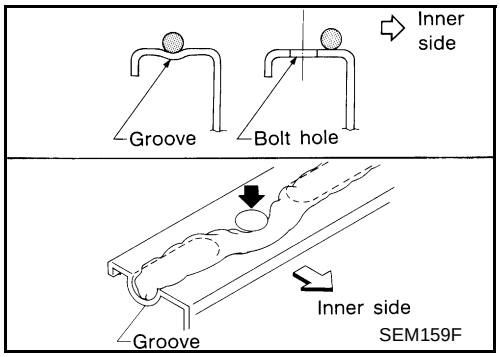


INSTALLATION

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

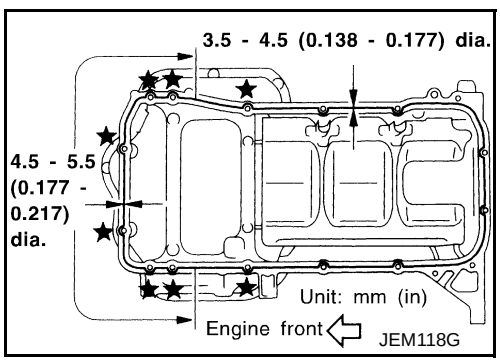
a. Use a scraper to remove old liquid gasket from mating surfaces.
    - **Also remove old liquid gasket from mating surface of cylinder block, front cover and lower oil pan.**
    - **Remove old liquid gasket from the bolt hole and thread.**

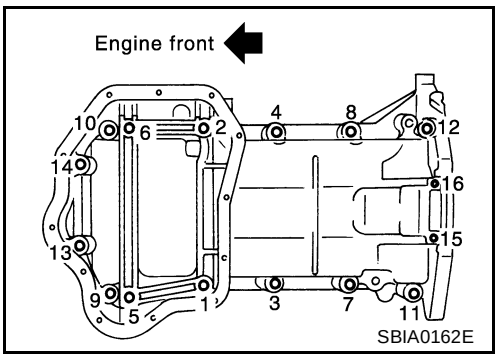
b. Apply a continuous bead of liquid gasket to mating surface of aluminum oil pan.
    - **Use Genuine Liquid Gasket or equivalent.**



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 liquid gasket bead is different around the front.)**
    - **Attaching should be done within 5 minutes after coating.**

d. Install upper oil pan.



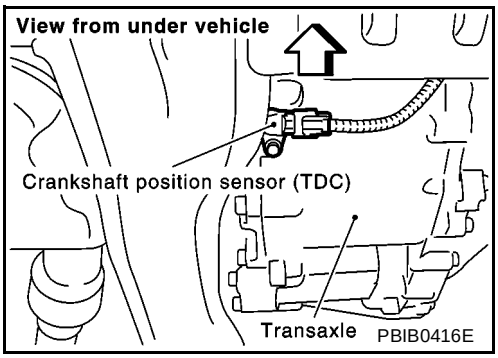


- Tighten bolts in numerical order to specified torque.
- Bolt dimensions vary depending on the installation location. Refer to the following and use appropriate bolts.

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

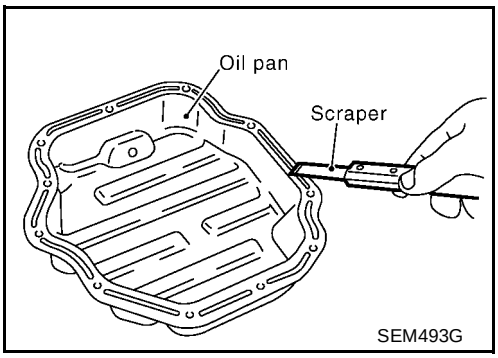
- The shank length under the bolt neck above is the length of the threaded part (pilot portion not included).

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

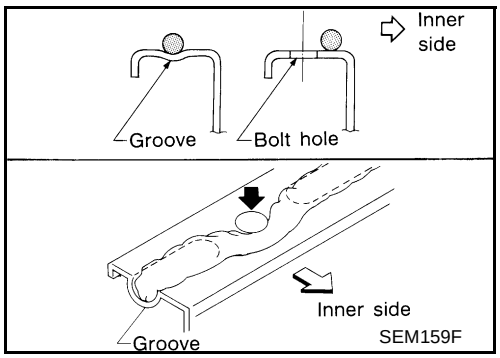


7. Install lower oil pan.

a. Use a scraper to remove old liquid gasket from mating surfaces.
   - **Also remove old liquid gasket from mating surface of upper oil pan.**

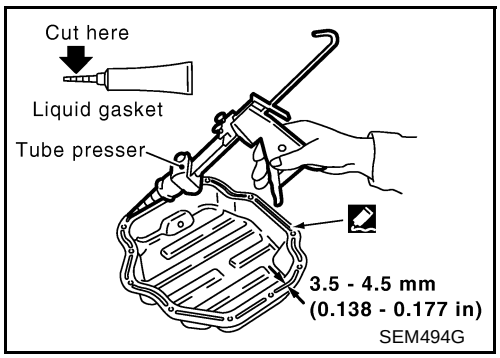


b. Apply a continuous bead of liquid gasket to mating surface of lower oil pan.
   - **Use Genuine Liquid Gasket or equivalent.**

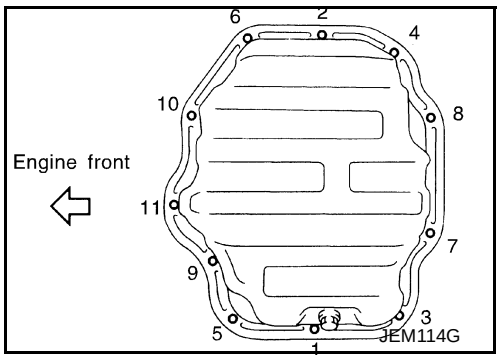


   - **Be sure liquid gasket is 3.5 to 4.5 mm (0.138 to 0.177 in) wide.**
   - **Attaching should be done within 5 minutes after coating.**

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

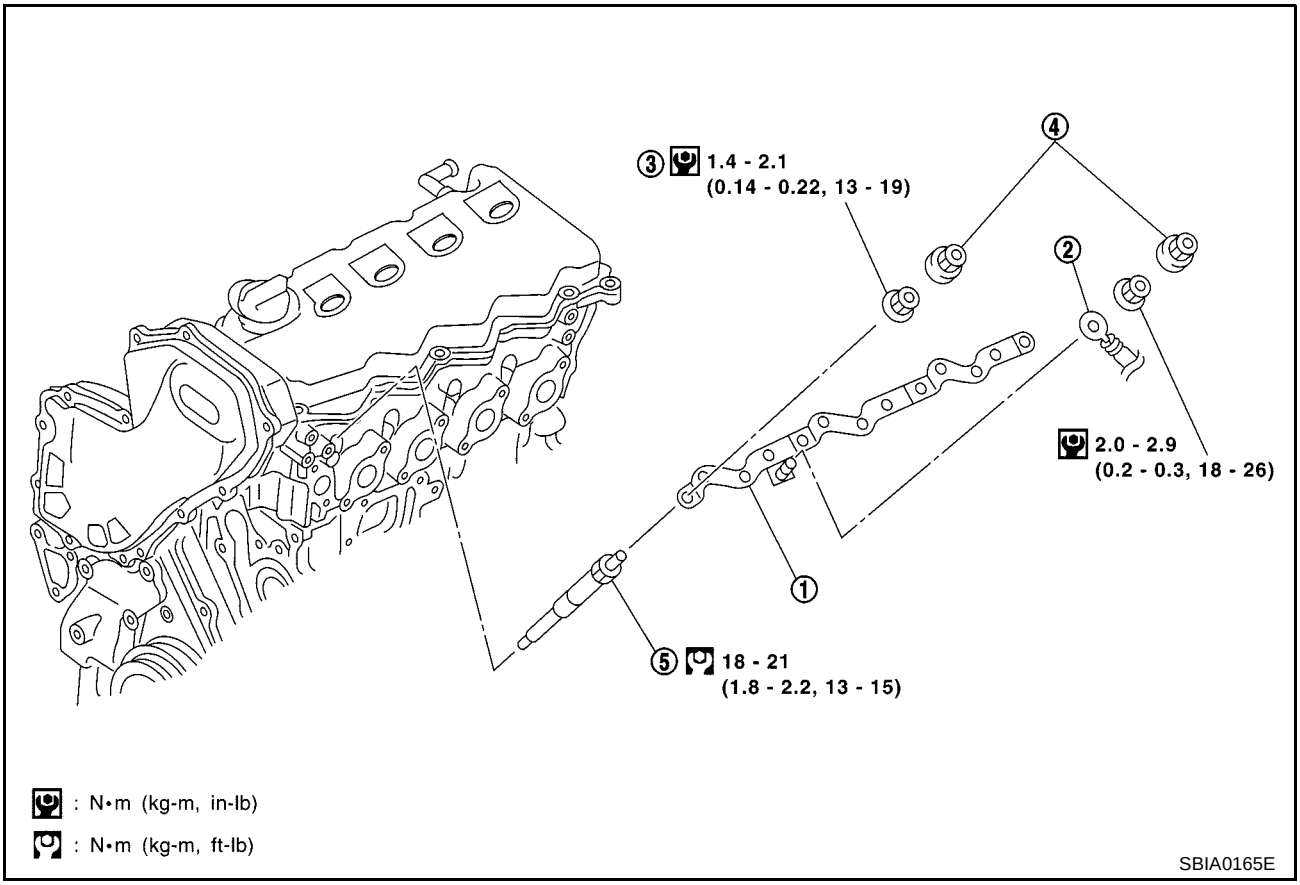
Check for leakage of engine oil when engine is warmed.

GLOW PLUG

PFP:22401

Removal and Installation

EBS00GSA



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. Disconnect harness connector from glow plate.
2. Remove glow nut to remove glow plate.
3. 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

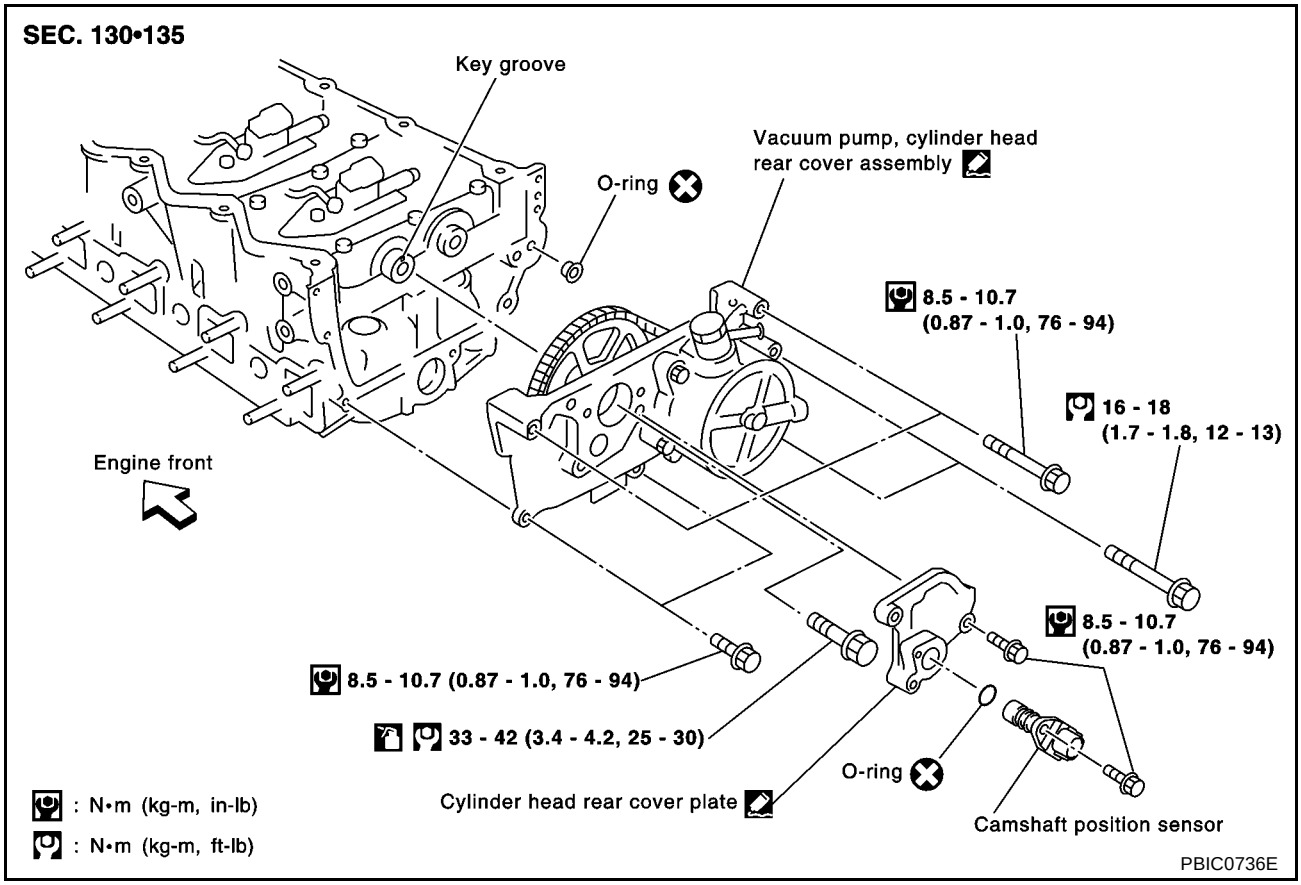
1. Remove adhered carbon from glow plug installation hole with a reamer.
2. Install glow plug.
3. Install remaining parts in reverse order of removal.

VACUUM PUMP

PFP:41920

Removal and Installation

EBS00GSB



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.

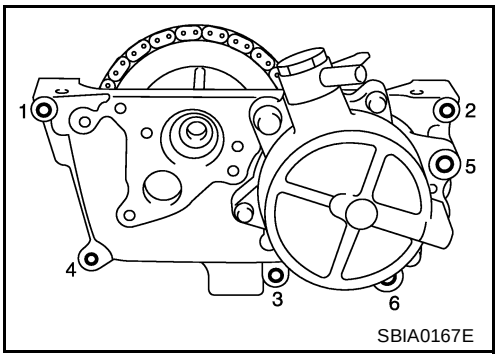
Standard : – 86.6 to – 101.3 kPa (– 866 to – 1,013 mbar, – 650 to – 760 mmHg, – 25.59 to – 29.92 inHg)

- 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-49, "Changing Engine Coolant" .
2. Remove air duct and air cleaner case. Refer to EM-213, "Removal and Installation" .
3. Disconnect harness connector from fuel injector.
4. Remove injection tube. Refer to EM-236, "Removal and Installation" .
5. Remove fuel injector oil seal.
6. Remove rocker cover. Refer to EM-248, "Removal and Installation" .
7. Remove spill tube. Refer to EM-236, "Removal and Installation" .
8. Remove nozzle support from No.2 cylinder and fuel injector. Refer to EM-236, "Removal and Installation" .
9. Remove air inlet pipes. Refer to EM-220, "Removal and Installation" .
10. Remove exhaust manifold cover.
11. Disconnect electronic EGR volume control valve water hose and harness.
12. Disconnect heater hose.

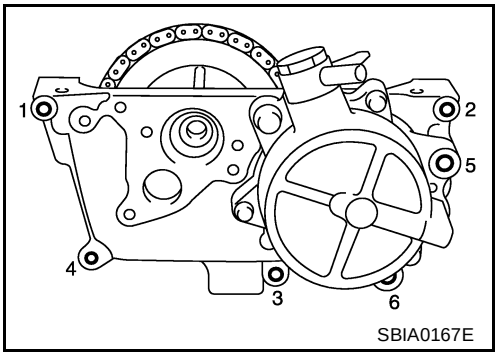
13. Remove EGR tube.
14. Disconnect vacuum hose from vacuum pump side.
15. Remove camshaft position sensor.
16. Remove cylinder head rear cover plate.
17. Loosen and remove the installation bolts in rear cam sprocket.
    - Loosen rear cam sprocket installation bolts by fixing the hexagonal portion of the camshaft.
18. 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

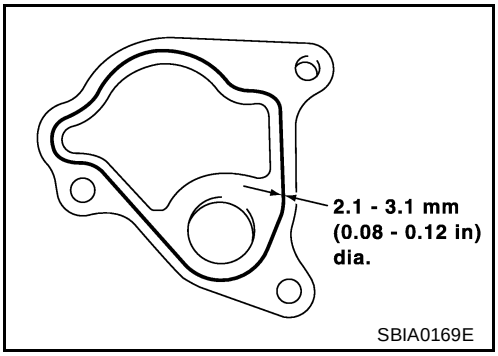
1. Install vacuum pump and cylinder head rear cover assembly onto cylinder head. Refer to EM-234, "ASSEMBLY" .
    - Apply Genuine Liquid Gasket or equivalent (Refer to EM-204, "Precautions for Liquid Gasket" .) to area shown in the figure.
    - **Attaching should be done with in 5 minutes after coating.**
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-204, "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), PCV 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).



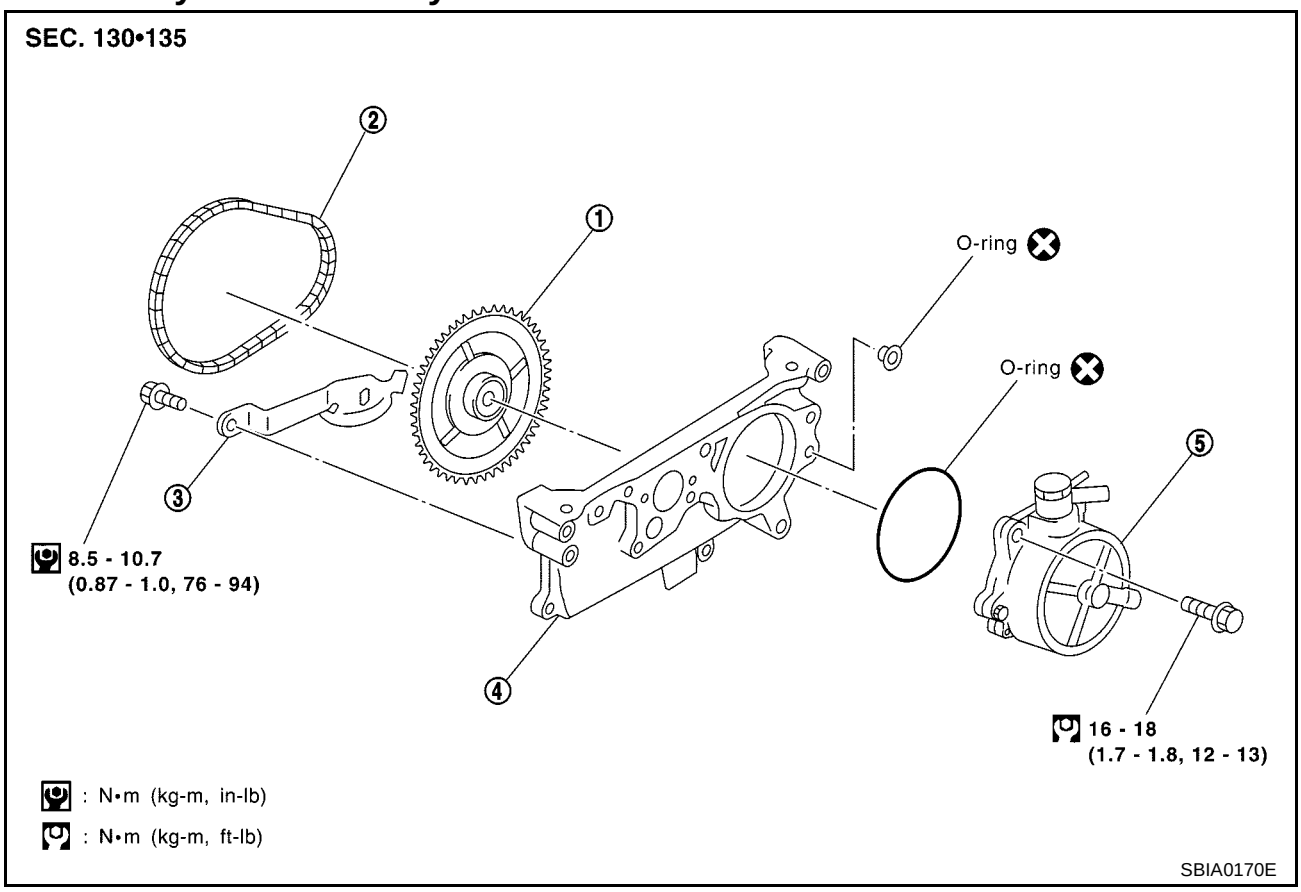
SBIA0169E

INSPECTION AFTER INSTALLATION

Check generated vacuum satisfies the specification at idle speed. Refer to EM-232, "INSPECTION BEFORE REMOVAL" .

Disassembly and Assembly

EBS00GSC



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.

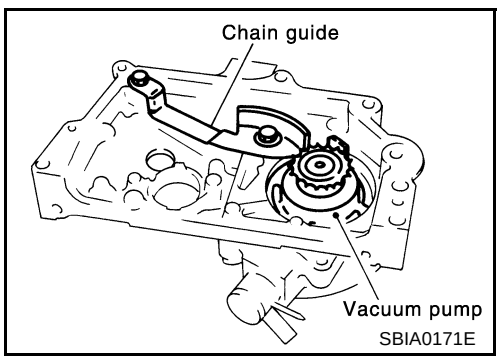
CAUTION:

Do not disassemble vacuum pump.

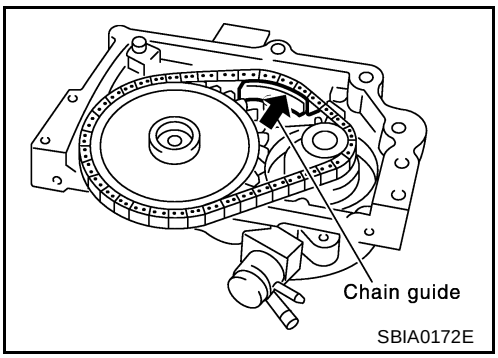
ASSEMBLY

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.

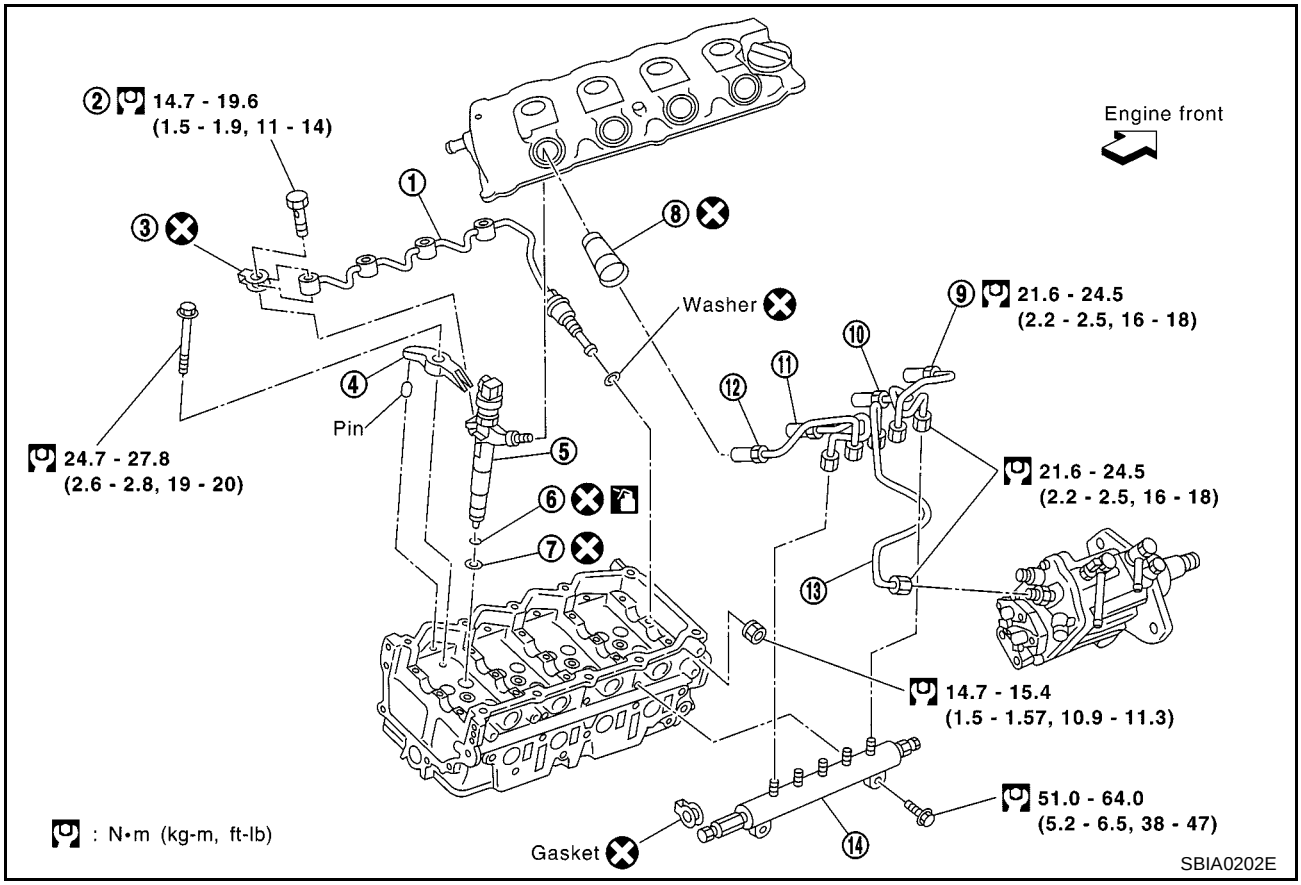


INJECTION TUBE AND FUEL INJECTOR

PFP:00018

Removal and Installation

EBS00GSD



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 harness connector from fuel injector.
2. Remove spill hose.
3. 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.

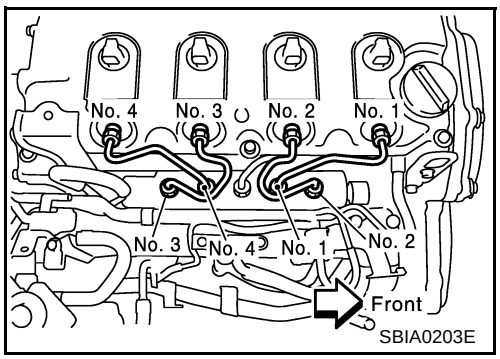
b. Remove injection tubes in order of 2-1-4-3 individually.

CAUTION:

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

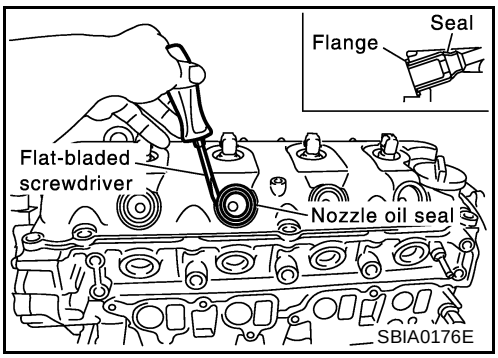
NOTE:

Removal procedure of fuel injector is shown below.



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

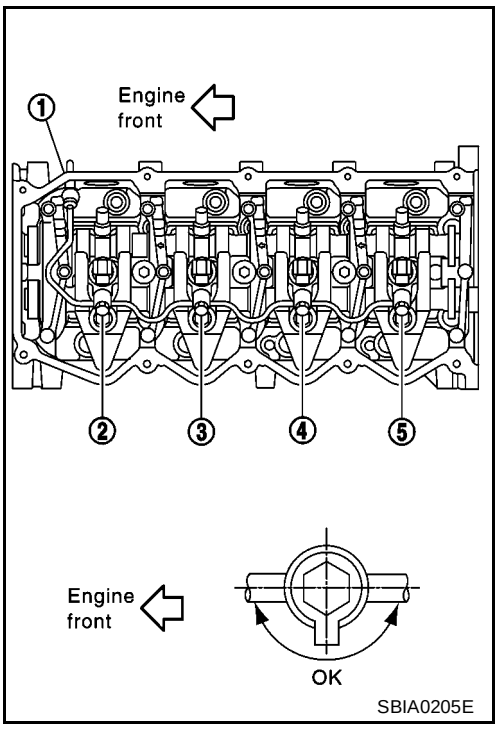
   NOTE:
   Nozzle oil seal seals between fuel injector and rocker cover. If only injection tube shall be removed and installed, nozzle oil seal replacement is not required.
5. Remove rocker cover. Refer to EM-248, "Removal and Installation" .



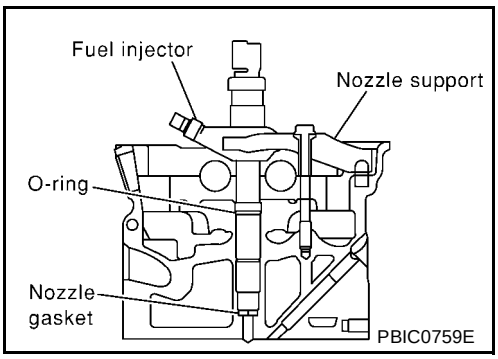
6. Remove spill tube mounting bolts and nut.
   - Loosen bolts and nut to the reverse order of the shown in the figure and remove then.
7. Following steps below, remove fuel injector.

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.



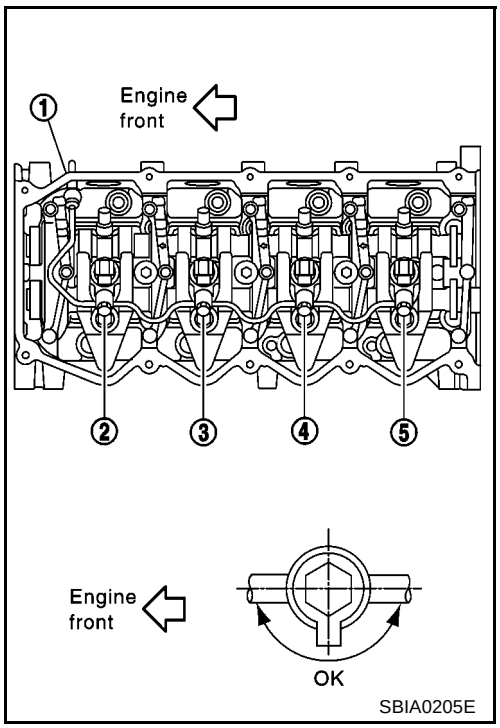
INSTALLATION

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 3-4-1-2.
c. Be sure to fit nozzle support without looseness.
d. Tighten nozzle support bolts.
e. Loosen injection tubes in the order of 2-1-4-3.

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.

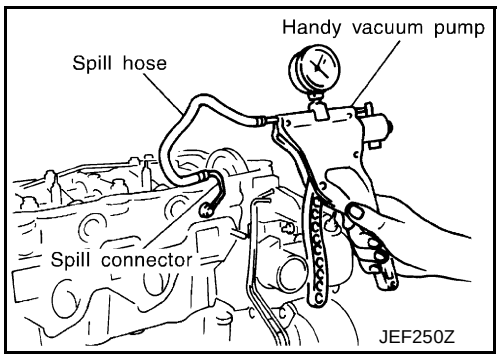


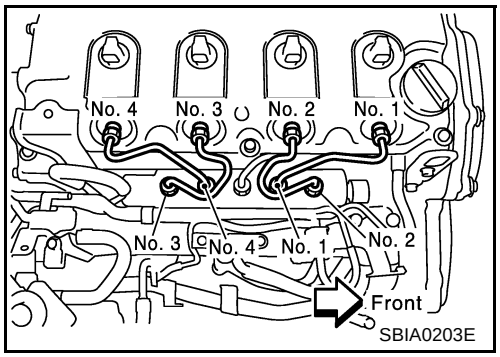
3. Carry out air tightness test for spill tube.
   - Connect a vacuum handy pump to spill connector. Check that vacuum is retained while applying following vacuum.

     Standard : – 53.3 to – 67.7 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-248, "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

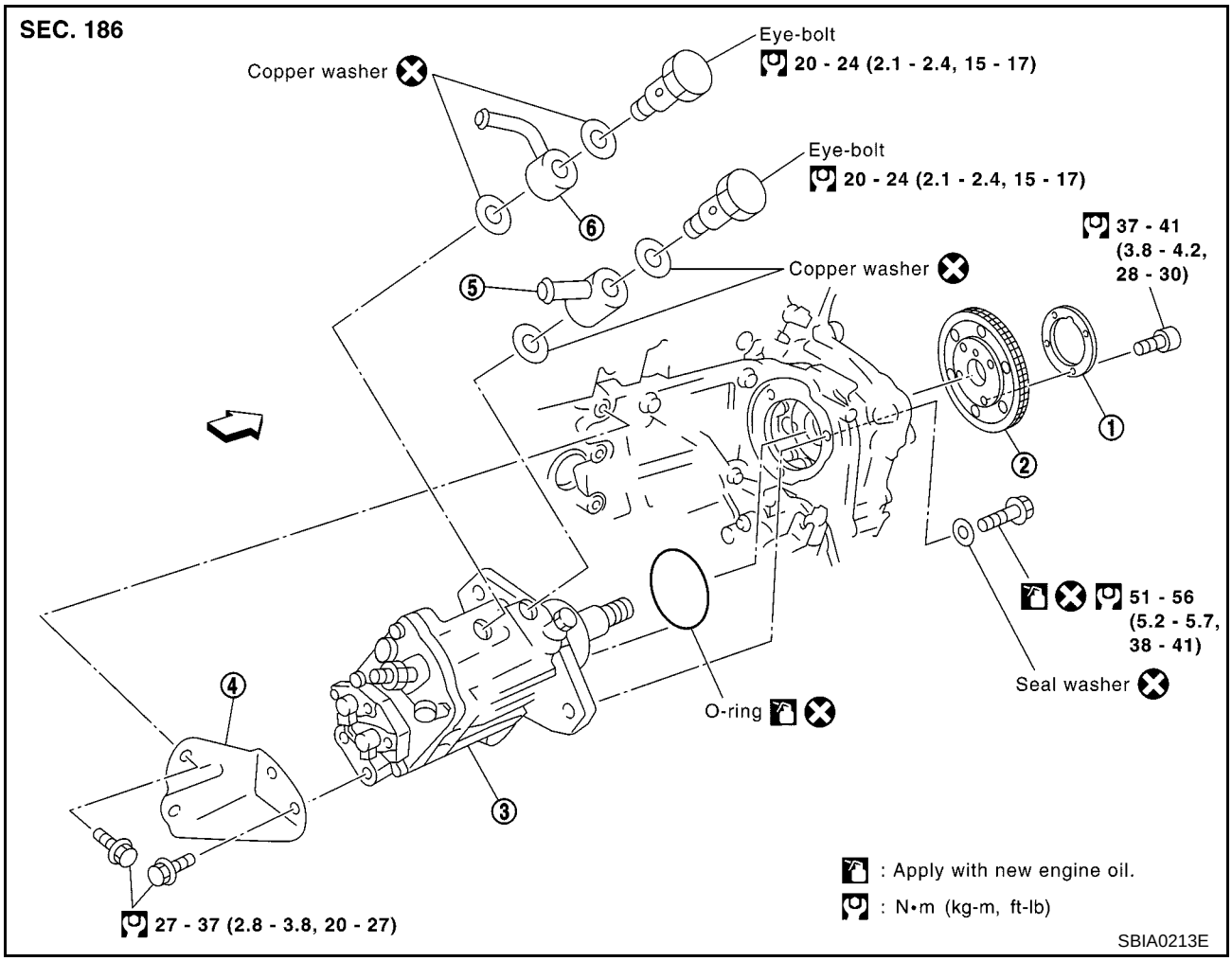
PFP:00018

Removal and Installation

EBS00GSE

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)

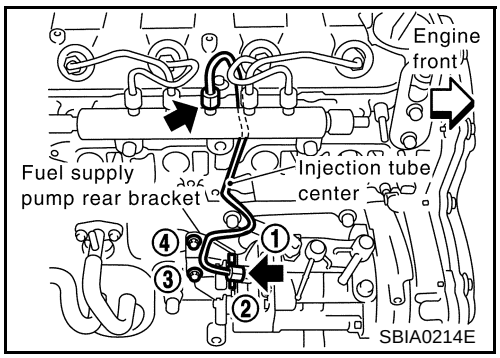
REMOVAL

1. Remove coolant reservoir tank.
2. Remove RH engine mount insulator and bracket. Refer to EM-285, "Removal and Installation" .
3. Pull power steering reservoir tank out of brackets to move power steering piping.

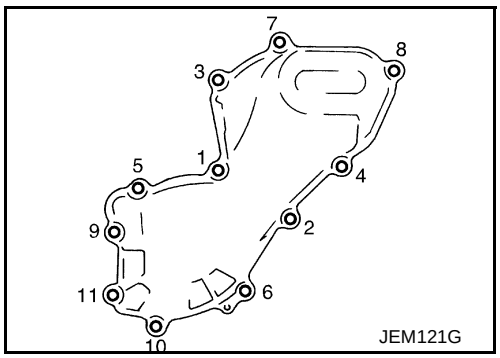
CAUTION:

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

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



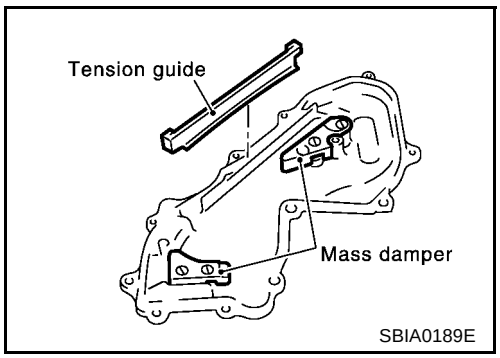
11. Remove front chain case.
    - Loosen fixing bolts in the reverse order of that shown in the figure and remove them.



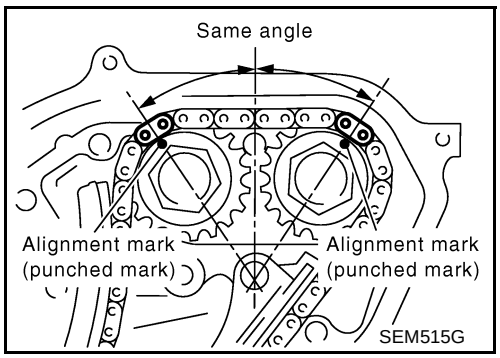
    - Remove No. 6, 10 and 11 bolts with the rubber washer as space is limited for pulling them out.

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.**

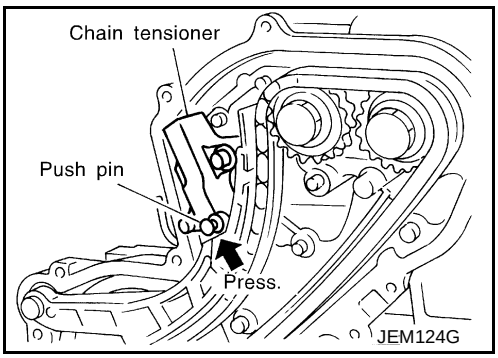


12. Set the No. 1 piston to TDC on its compression stroke.
    - Turn crankshaft pulley clockwise so that the alignment mark (punched mark) on each camshaft sprocket is positioned as shown in the figure.
    - **No position indicator is provided on the crankshaft pulley.**
    - **When installing, color 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.**

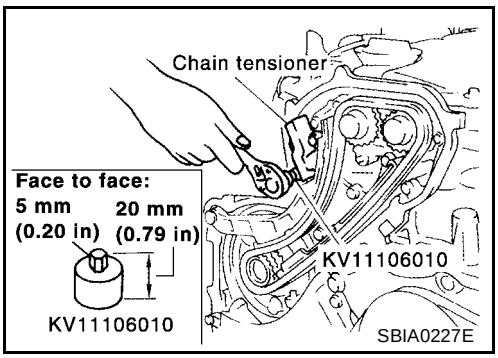


13. Remove chain tensioner.

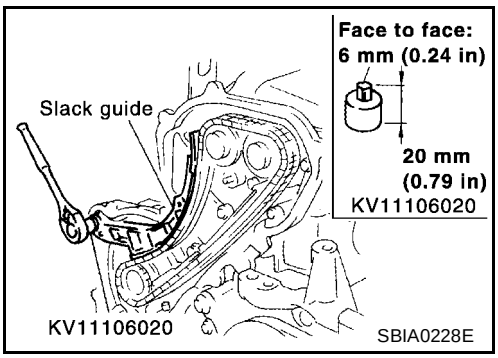
a. Push the plunger of chain tensioner and keep it pressed with a push pin.



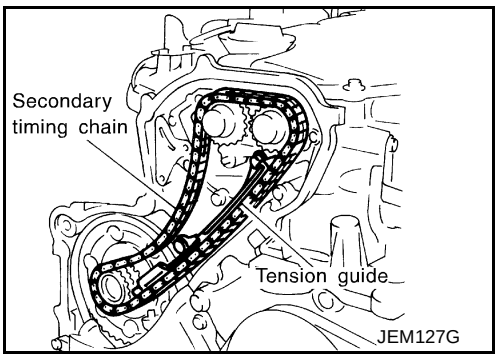
b. Using a hexagon-head wrench [face to face: 5 mm (0.20 in), SST], remove bolts to remove chain tensioner.



14. 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.



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

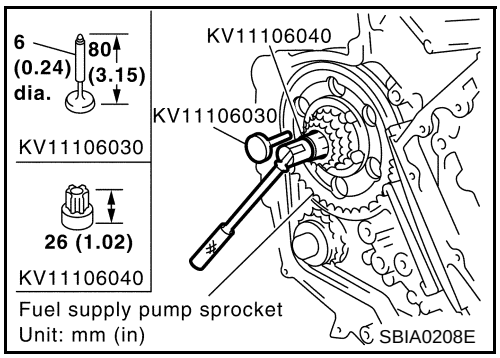


17. Hold fuel supply pump sprocket and remove bolt.

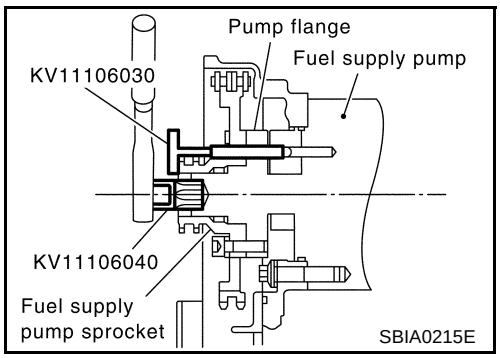
a. Insert positioning stopper pin (SST) into the hole 6 mm (0.24 in) in the diameter on the fuel supply pump sprocket.

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.

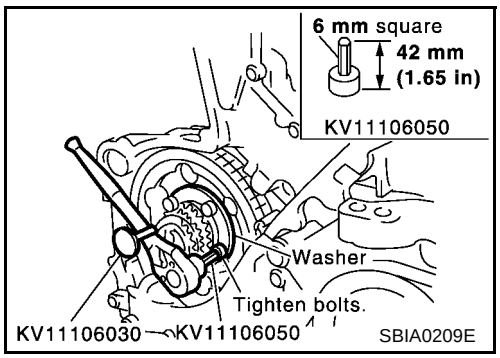
c. Push positioning stopper pin (SST) through pump sprocket to fuel supply pump body to hold pump sprocket.

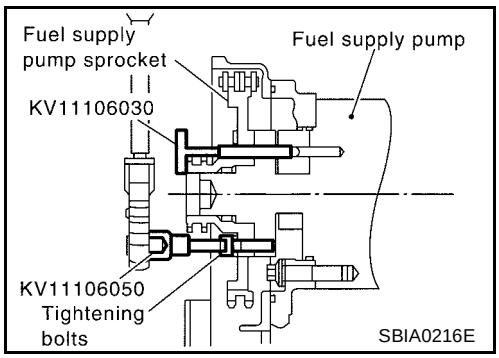


- Insert the positioning stopper pin until its flange contacts the fuel supply pump sprocket.
- Remove the TORX wrench (SST).

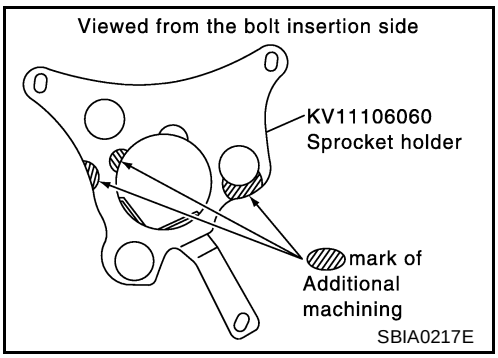


18. Using a hexagon-head wrench [face to face 6 mm (0.24 in) SST] remove bolts to fuel supply pump sprocket.

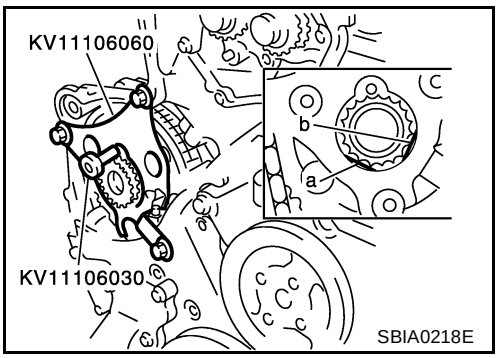




19. Using the sprocket holder (SST), hold the fuel supply pump sprocket to prevent falling.



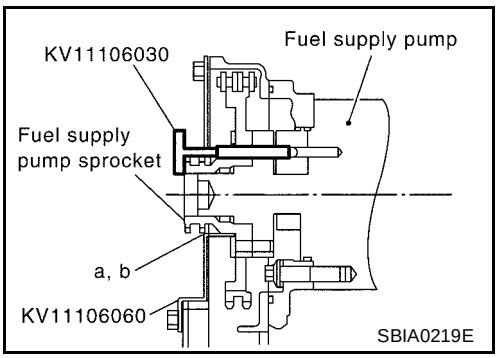
- As for the sprocket holder, install fuel supply pump mounting bolt through hole of KV11106060 as shown in figure.
- When the sprocket holder is installed, if the positioning stopper pin interferes, pull out the stopper pin approximately 10 mm (0.39 in), then install it.
- After the sprocket holder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



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

  CAUTION:

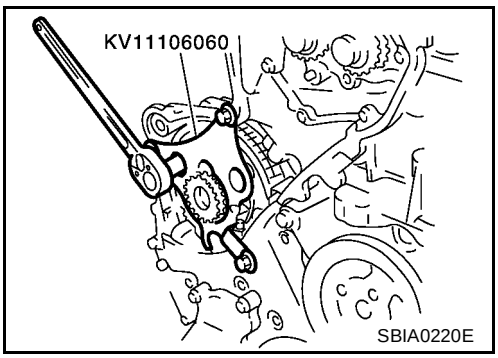
  Do not remove the sprocket holder until the fuel supply pump is installed.
- After the sprocket holder is installed, pull out the positioning stopper pin (SST) from the fuel supply pump sprocket.



20. 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:

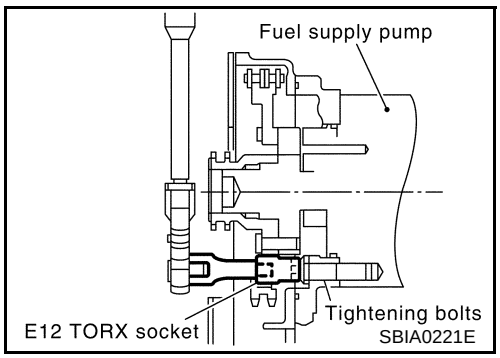
    Do not disassemble or adjust the fuel supply pump.



21. Remove the fuel supply pump mounting bolts.

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

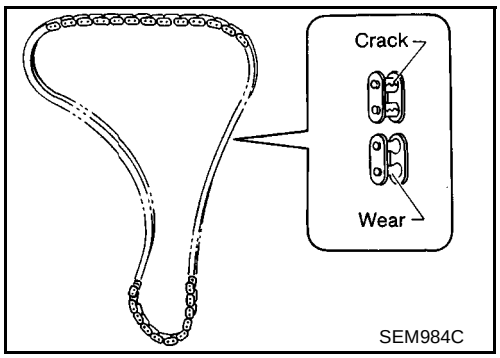
CAUTION:
For removal, be careful not to drop the seal washer into the engine.



INSPECTION AFTER REMOVAL

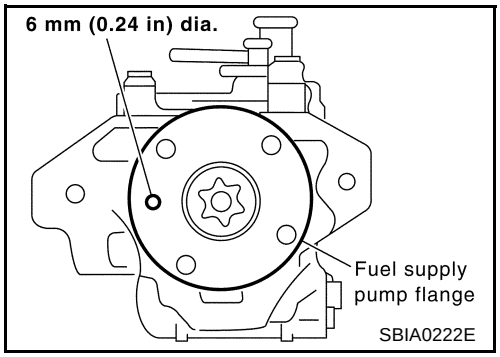
Timing Chain

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

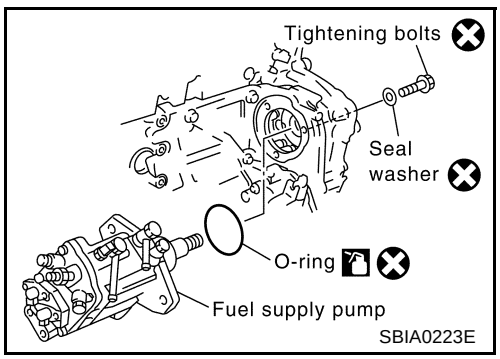


INSTALLATION

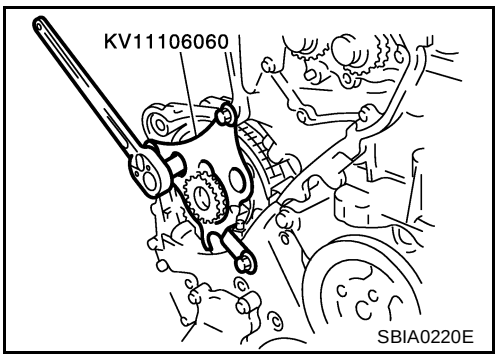
1. Before the fuel supply pump is installed, check that the notch of its flange and the 6 mm (0.24 in) dia. hole on the body are aligned.



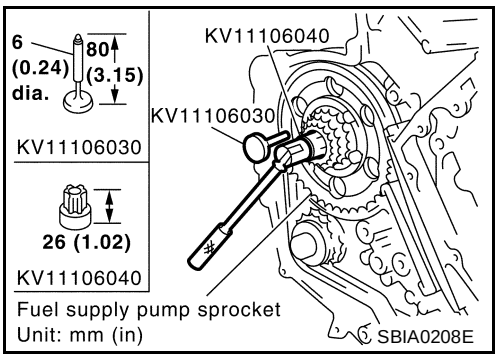
2. Insert the fuel supply pump to the mounting position from the rear side of the engine.



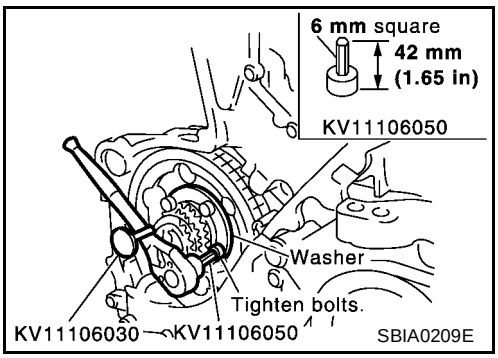
3. Using the extension bar (SST) and the TORX socket, tighten the mounting bolts of the fuel supply pump.
4. Remove the sprocket holder (SST).



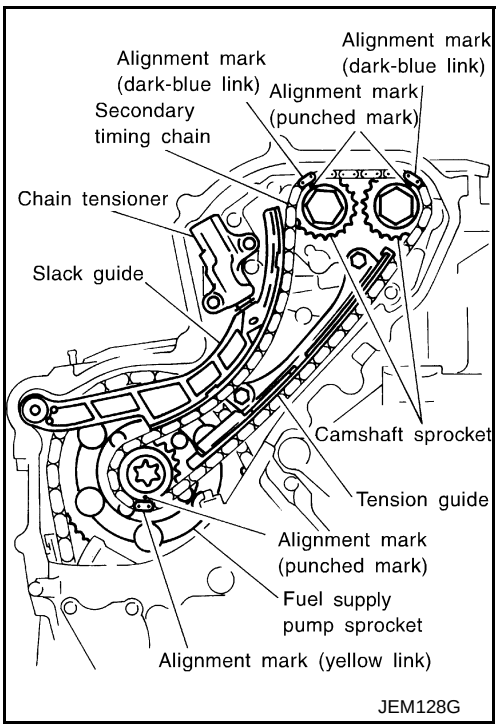
5. Using the TORX wrench (SST), turn the pump shaft gradually to adjust the position of the flange. Then, insert the positioning stopper pin (SST) to the 6 mm (0.24 in) dia. hole of the fuel supply pump sprocket through the pump flange and the pump body.
6. Remove the TORX wrench (SST)



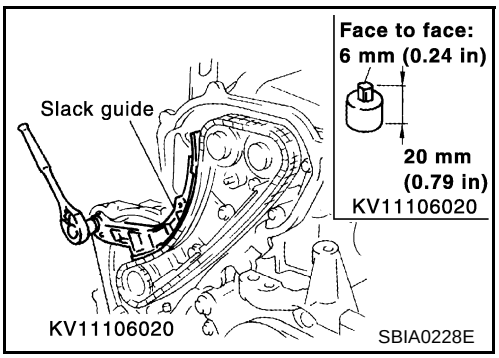
7. Using the hexagon wrench [face to face: 6 mm (0.24 in), long-type](SST), tighten the sprocket mounting bolt.
   - When the washer of the fuel supply pump sprocket is removed, install it with the marking “F” (front) facing the front of the engine.
8. Pull out the positioning stopper pin (SST).



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.

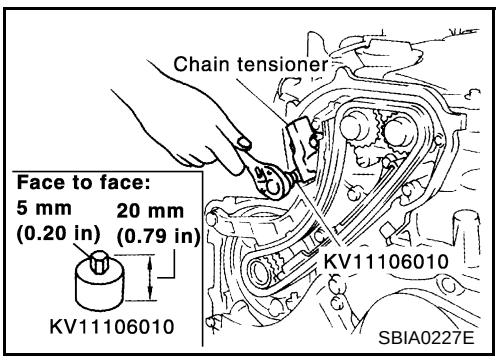


12. Install chain tensioner.

a. Push the plunger of the chain tensioner. While holding it with a push pin, install the chain tensioner.

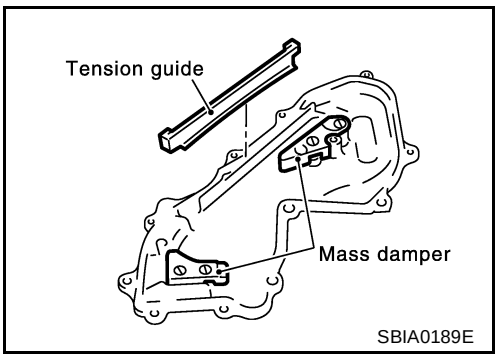
b. Using a hexagon-head wrench [face to face: 5 mm (0.20 in), SST], tighten bolts.

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.**



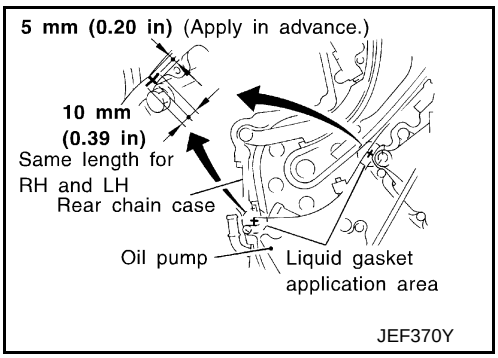
13. Install front chain case.

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-204, "Precautions for Liquid Gasket" .) on both ends of arched area (locations where rear chain case is adjoined) as shown in the figure.

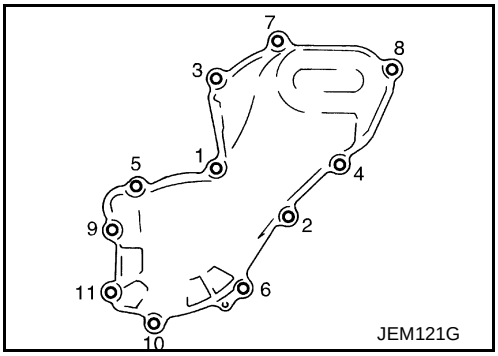
c. Install front chain case.
   - When installing, align dowel pin on oil pump case with the pin hole.



   - 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.

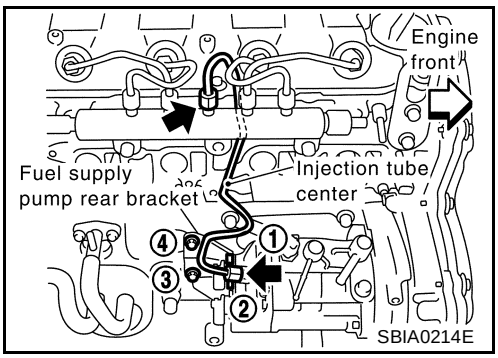


14. Install the fuel supply pump rear bracket.
   - Tighten fixing bolts in the numerical order shown in the figure.

15. Install the harness connector from fuel supply pump.

16. Install fuel hoses.

17. Hereafter, install in the reverse order of removal.

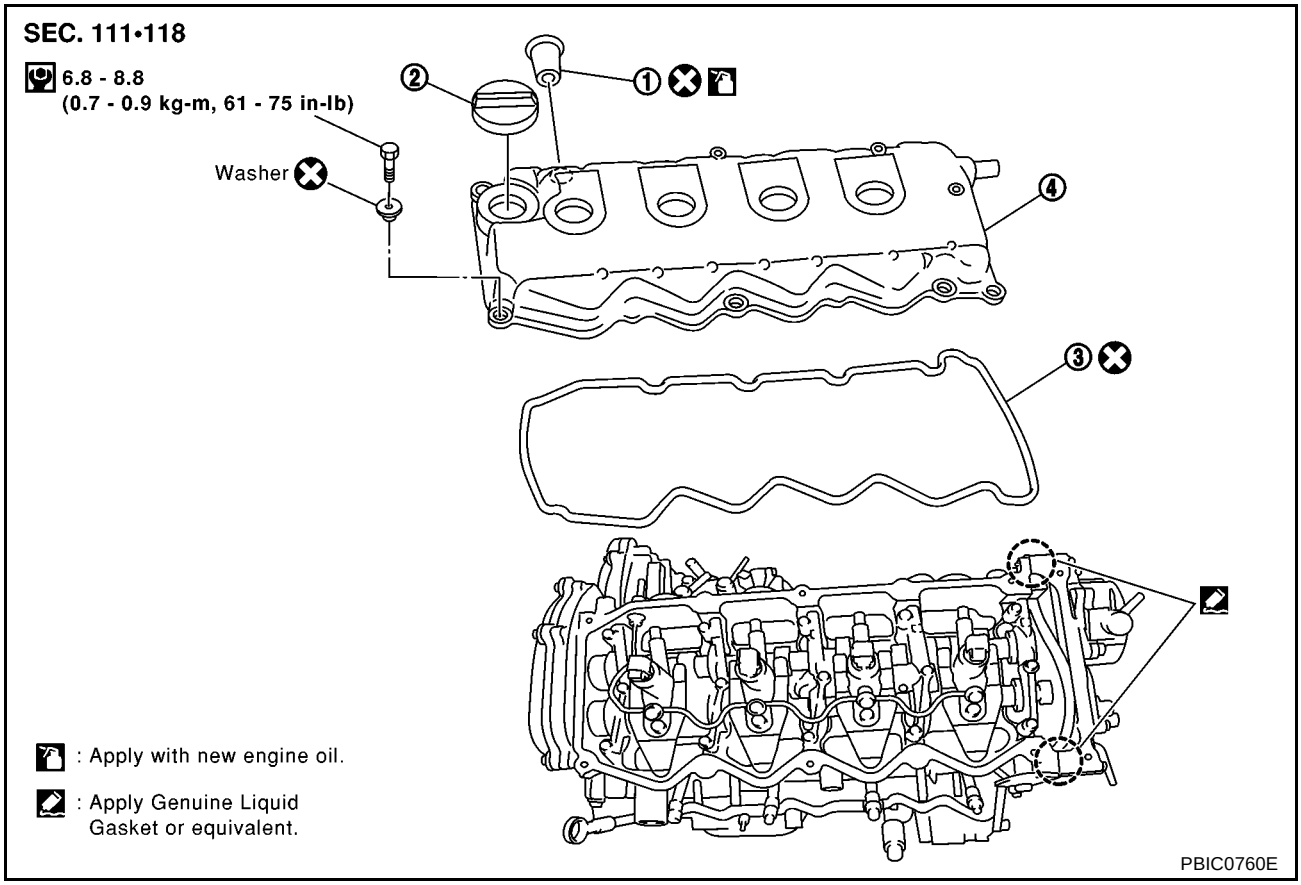


ROCKER COVER

PFP:13264

Removal and Installation

EBS00GSF



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

REMOVAL

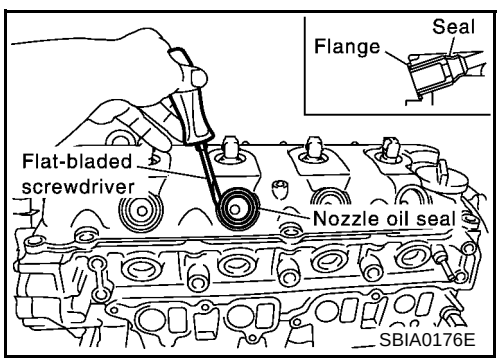
1. Remove harness connector from fuel injector.
2. Following steps below, remove injection tube.

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

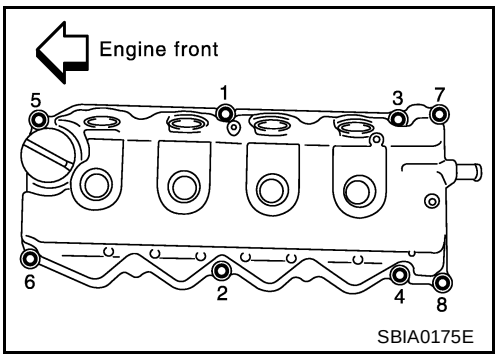
b. Remove injection tubes in order of 2-1-4-3 individually.

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

3. Remove fuel injector oil seal.
   - Using a slotted screwdriver, pry flange to remove oil seal.

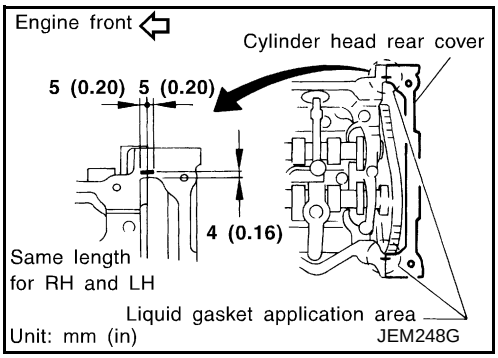


4. Remove rocker cover.
   - Loosen holding bolts in the reverse order of that shown in the figure and remove.

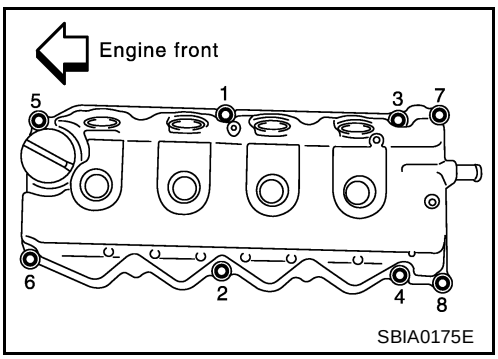


INSTALLATION

1. Apply 3.0 mm (0.118 in) dia. of Genuine Liquid Gasket or equivalent (Refer to EM-204, "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-5, "Air Bleeding" .



INSPECTION AFTER INSTALLATION

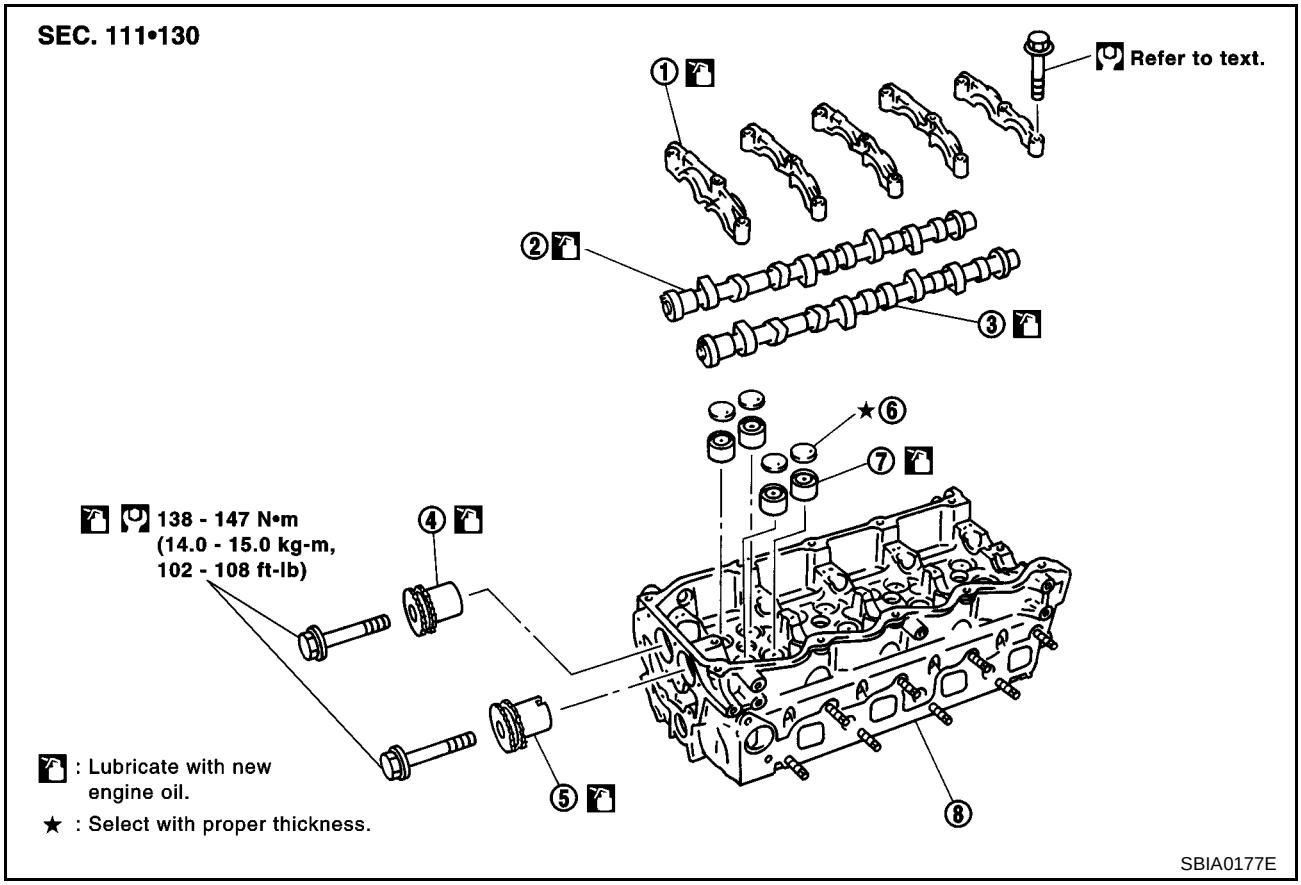
Start engine and increase engine speed to check for fuel leak.

CAMSHAFT

PFP:13001

Removal and Installation

EBS00GSG



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:

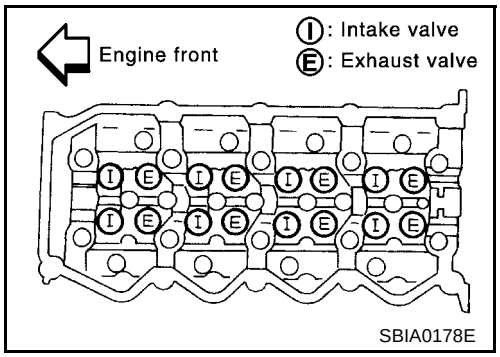
Apply new engine oil to parts marked in illustration before installation.

- 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

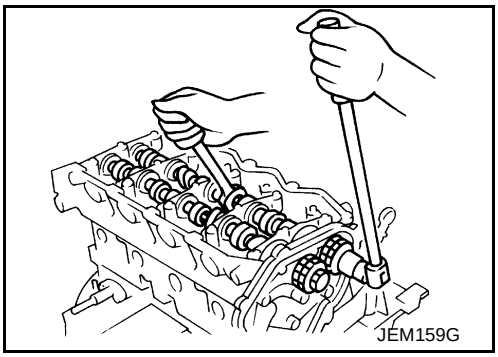
- Refer to the figure for intake and exhaust valve arrangement. (The camshafts have, alternately, either an intake valve or an exhaust valve.)



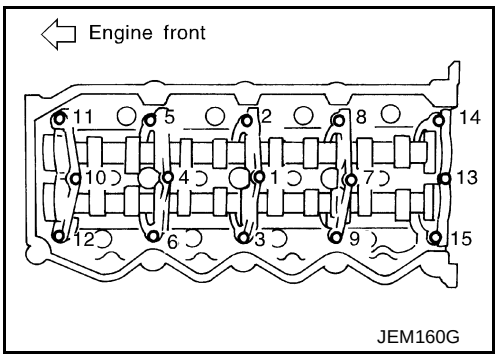
REMOVAL

1. Drain engine coolant. Refer to CO-49, "Changing Engine Coolant" .
2. Remove air duct and air inlet pipe. Refer to EM-213, "Removal and Installation" .
3. Remove rocker cover. Refer to EM-248, "Removal and Installation" .
4. Remove vacuum pump. Refer to EM-232, "Removal and Installation" .
5. Remove injection tube and fuel injector. Refer to EM-236, "Removal and Installation" .

6. Remove secondary timing chain. Refer to EM-259, "Removal and Installation" .
7. Set the No. 1 cylinder at TDC on its compression stroke.
8. Remove the camshaft stroke.
   - Loosen the camshaft gear installation bolt by fixing the hexagonal portion of the camshaft.



9. 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.
10. Remove the adjusting shim and valve lifter.
    - Remove by taking notice of the installation position, and place outside engine in order to prevent confusion.



INSPECTION AFTER REMOVAL

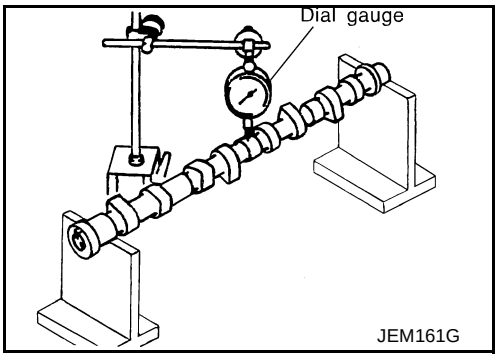
Visual Check of Camshaft

- 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)



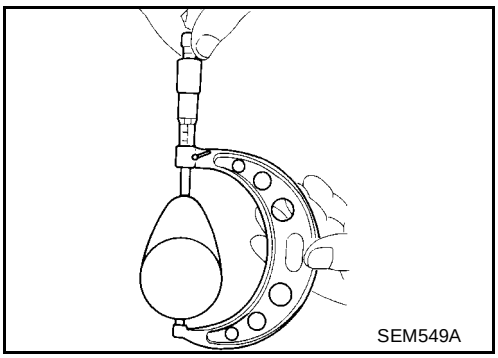
Height of Cam Nose

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)



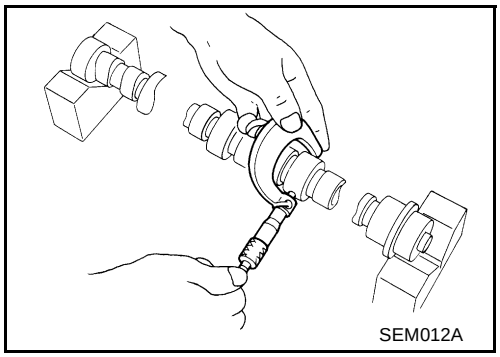
Camshaft Oil Clearance

Measure by using a micrometer.

Camshaft journal outer diameter:

Standard:

No. 1	**: 30.435 - 30.455 mm (1.1982 - 1.1990 in)**
No. 2, 3, 4, 5	**: 23.935 - 23.955 mm (0.9423 - 0.9431 in)**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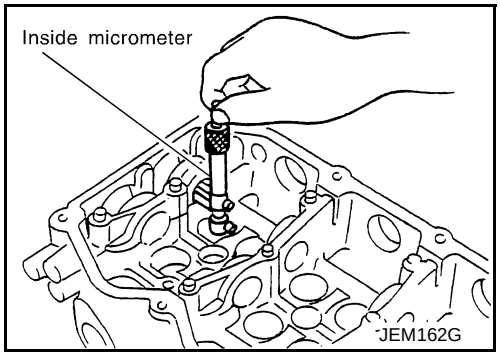
Camshaft Bracket Inner Diameter

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



JEM162G

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)

- 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.

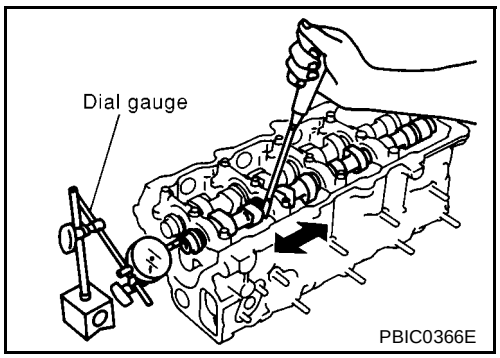
Camshaft End Play

- 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.



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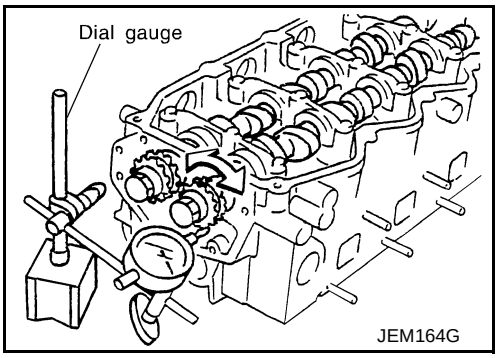
Camshaft Sprocket Runout

1. Install sprocket on camshaft.
2. Measure camshaft sprocket runout.

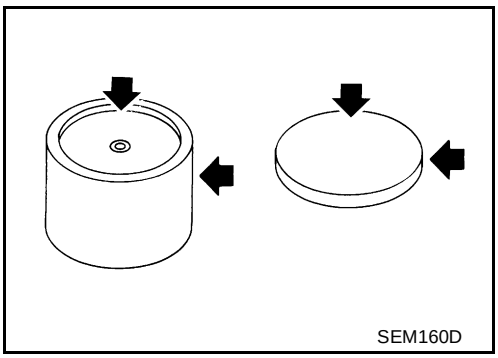
Runout (Total indicator reading):
: Less than 0.15 mm (0.0059 in)

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



Visual Inspection of Valve Lifter and Adjusting Shim

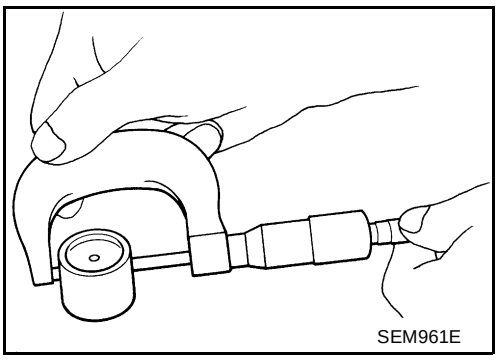
- Check lifter side for any signs of wear or damage. Replace if there are any abnormalities.
- Check cam nose contact and sliding surfaces for wear and scratches. Replace if there are any abnormalities.



Valve Lifter Bore Diameter

Measure the outer diameter of the valve lifter with a micrometer.

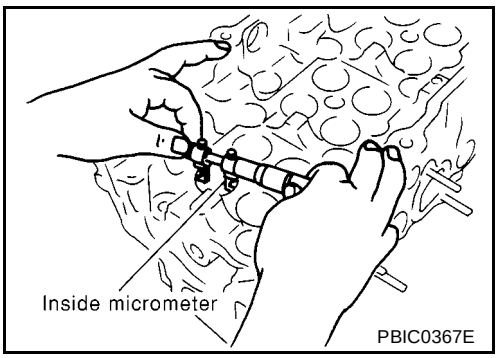
Standard : 29.960 - 29.975 mm (1.1795 - 1.1801 in)



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)



Valve Lifter Clearance Calculations

(Clearance) = (Valve lifter bore diameter) – (Valve lifter outer diameter)

Standard : 0.025 - 0.061 mm (0.0010 - 0.0024 in)

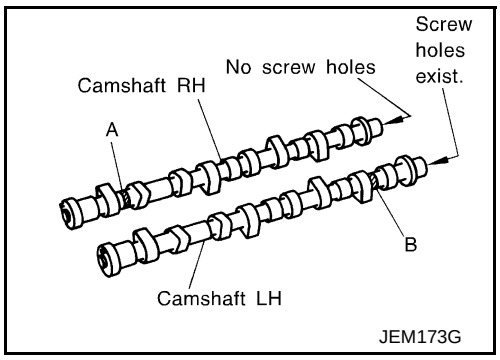
If it exceeds the standard value, refer to the outer diameter and bore diameter standard values and replace valve lifter and/or cylinder head.

INSTALLATION

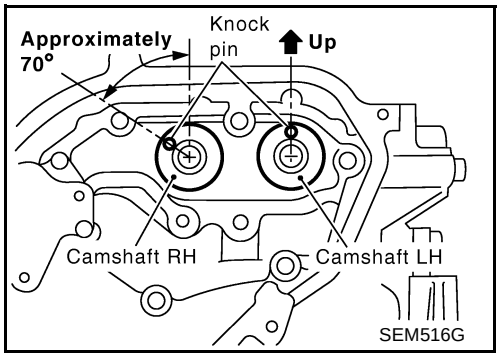
1. Install the valve lifter and adjusting shim.
   - Make sure that these are installed in the same position as before the removal process.
2. Install the camshaft.
   - Identify camshafts by the paint position and screw hole at the rear end.

     Camshaft RH : Paint is at position A without screw hole.

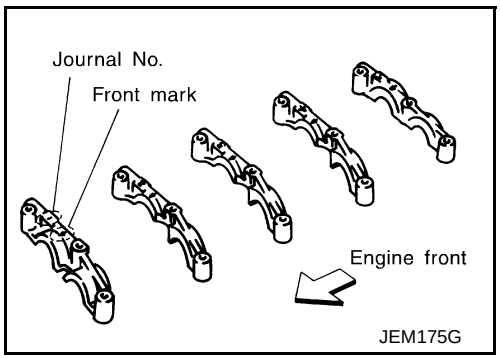
     Camshaft LH : Paint is at position B with screw hole.



   - 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.



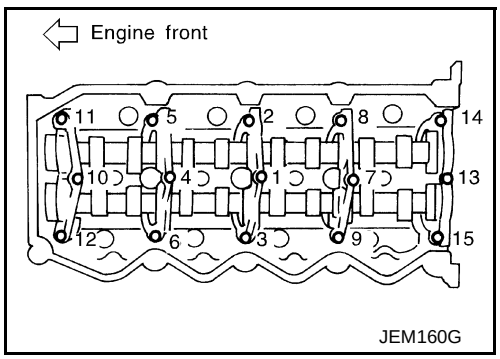
4. Tighten bolts in the order shown in the figure according to the following procedure:

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-255, "Valve Clearance" .
7. Hereafter, install in the reverse order of removal.

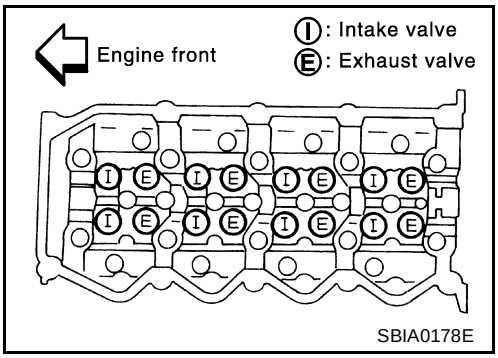
Valve Clearance

EBS00GSH

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.

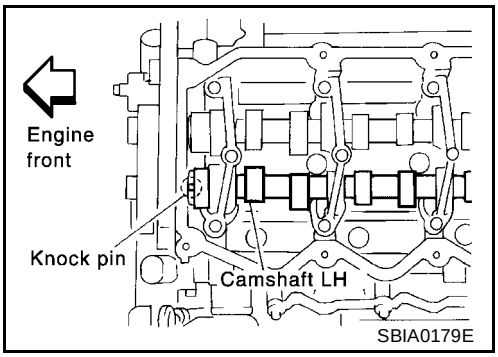
  NOTE:
  The camshafts have, alternately, either an intake valve or an exhaust valve.(Refer to illustration)



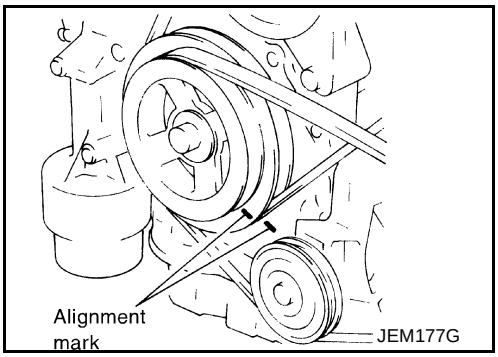
1. Drain engine coolant. Refer to CO-49, "Changing Engine Coolant" .
2. Remove air duct and air inlet pipe. Refer to EM-213, "Removal and Installation" .
3. Remove rocker cover. Refer to EM-248, "Removal and Installation" .
4. Remove vacuum pump. Refer to EM-232, "Removal and Installation" .
5. Remove injection tube and fuel injector. Refer to EM-236, "Removal and Installation" .
6. Remove secondary timing chain. Refer to EM-259, "Removal and Installation"

Check valve clearance while engine is cold and not running.

7. 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.)

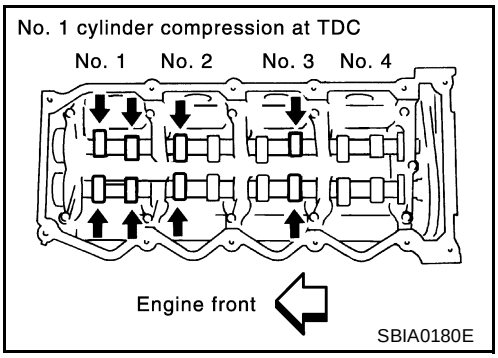


8. Put an alignment mark with paint, etc. on the crankshaft pulley and on the oil pump as an angle indicator.



9. 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. 1 cylinder is in the TDC	X	X	X			X		



- The injection order is 1-3-4-2.

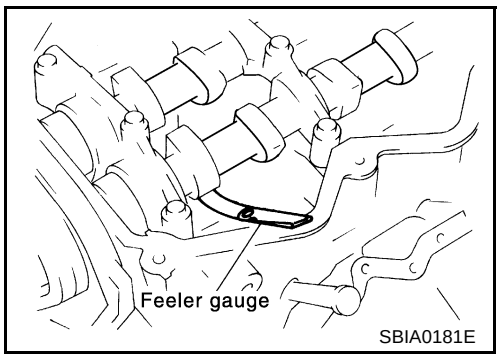
- Measure the valve clearance using a fine feeler gauge when the engine is cool (at normal temperature).

Valve clearance (Cold):

Standard:

Intake : 0.24 - 0.32 mm (0.0094 - 0.0126 in)

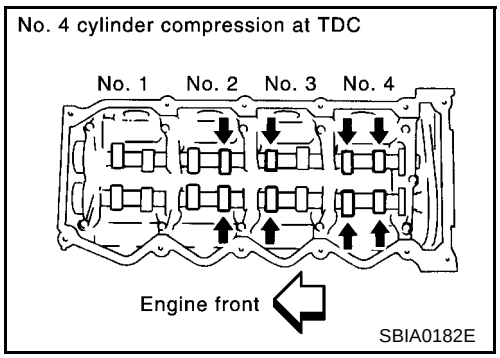
Exhaust : 0.26 - 0.34 mm (0.0102 - 0.0134 in)



10. Set the No. 4 cylinder at TDC by rotating the crankshaft clockwise once.

11. 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

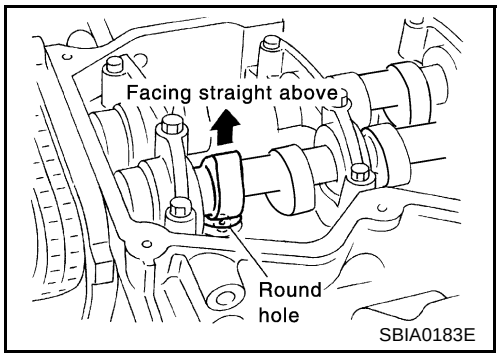


12. If the valve clearance is outside the specification, adjust as follows.

ADJUSTMENTS

- Remove the adjusting shim for parts which are outside the specified valve clearance.

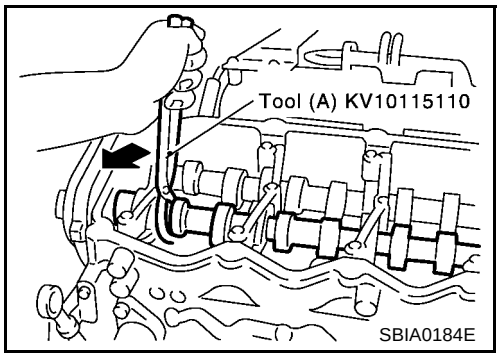
1. Remove the spill tube. Refer to EM-236, "Removal and Installation" .
2. Extract the engine oil on the upper side of the cylinder head (for the air blowing in step 7).
3. Rotate the crankshaft to face the camshaft for adjusting shims that are to be removed upward.



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.

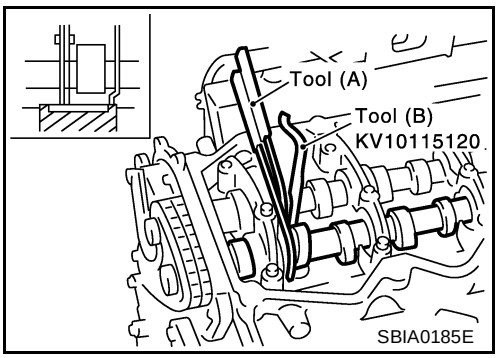
CAUTION:

Do not damage the camshaft, cylinder head and the outer circumference of the valve lifter.



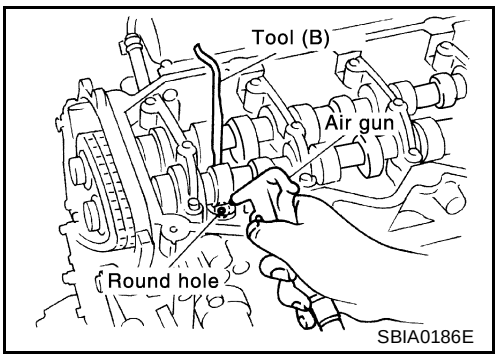
5. With the valve spring in a compressed state, remove the camshaft pliers by securely setting the outer circumference of the valve lifter with the end of the lifter stopper.
   - Hold the lifter stopper by hand until the shim is removed.

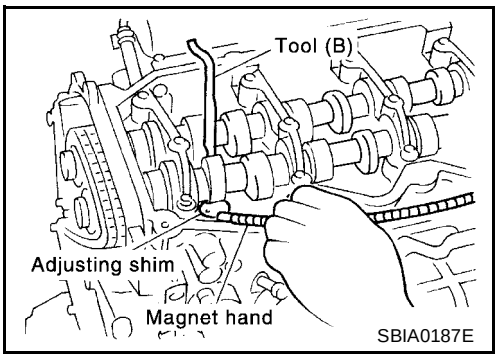
   CAUTION:
   Do not retrieve the camshaft pliers forcefully, as the camshaft will be damaged.



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

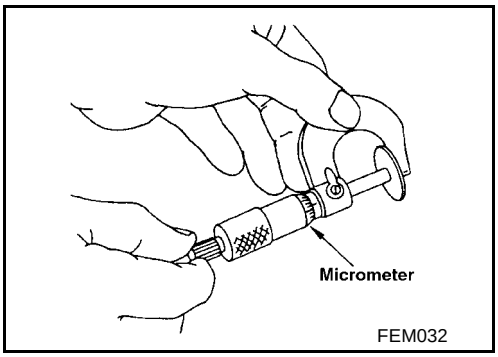
    M = Measured valve clearance

    Intake

    N = R + [M - 0.28 mm (0.0010 in)]

    Exhaust

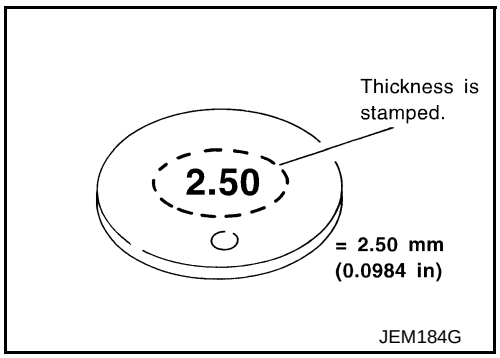
    N = R + [M - 0.30 mm (0.0118 in)]



- 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)

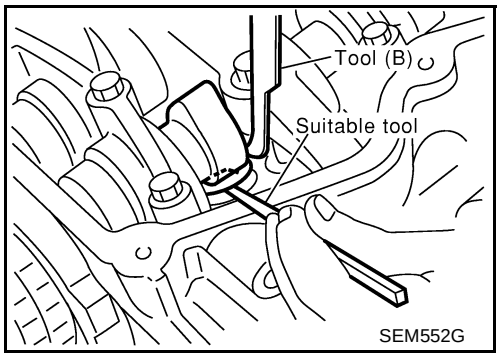
- **Shims are available in 33 size from 2.10 mm (0.0827 in) to 2.74 mm (0.1079 in), in steps of 0.02 mm (0.0008 in).**



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

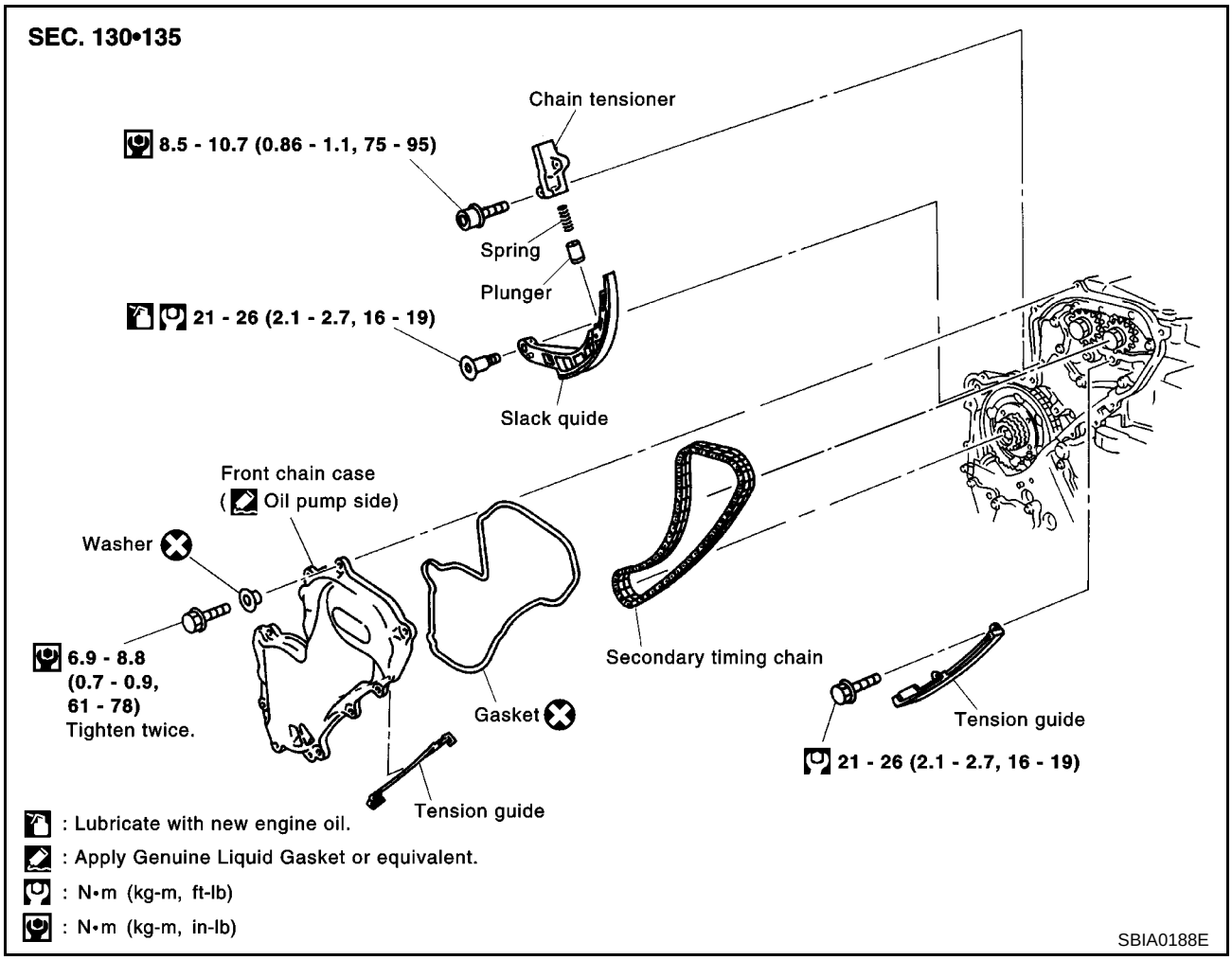
PFP:13028

Removal and Installation

EBS00GSI

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

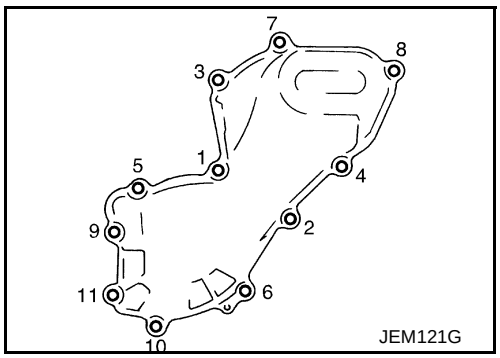
- For preparative work for removing/installing secondary timing chain to remove/install electronic fuel supply pump. Refer to EM-239, "FUEL SUPPLY PUMP" .
- To prepare for removing/installing secondary timing chain to remove/install camshaft. Refer to EM-250, "Removal and Installation" .

1. Remove coolant reservior tank.
2. Remove RH engine mount insulator and bracket. Refer to EM-285, "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.

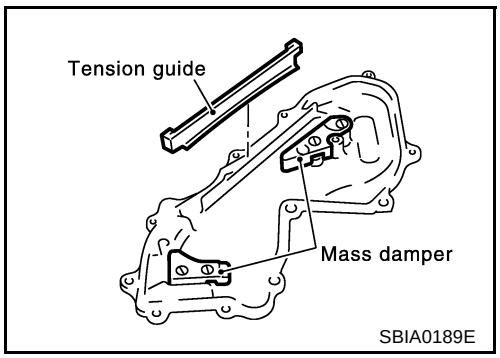
4. Remove front chain case.
   - Loosen fixing bolts in the reverse order of that shown in the figure and remove them.



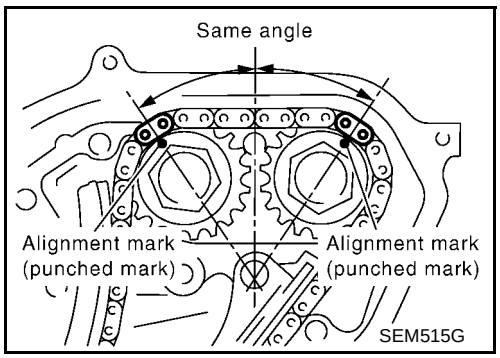
   - Remove No. 6, 10 and 11 bolts with the rubber washer as space is limited for pulling them out.

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.**

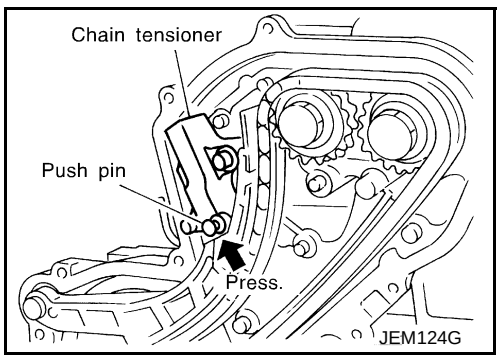


5. Set the No. 1 piston to TDC on its compression stroke.
   - Turn crankshaft pulley clockwise so that the alignment mark (punched mark) on each camshaft sprocket is positioned as shown in the figure.
   - **No position indicator is provided on the crankshaft pulley.**
   - **When installing, color 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.**

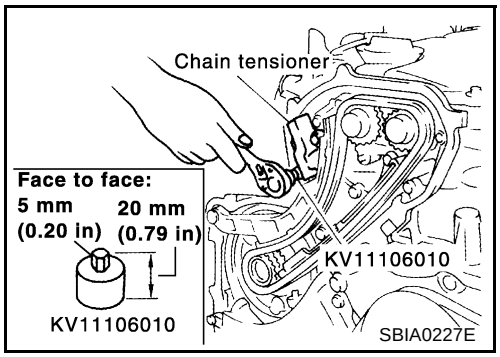


6. Remove chain tensioner.

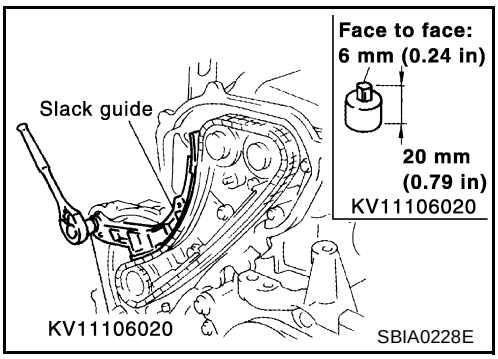
a. Push the plunger of chain tensioner and keep it pressed with a push pin.



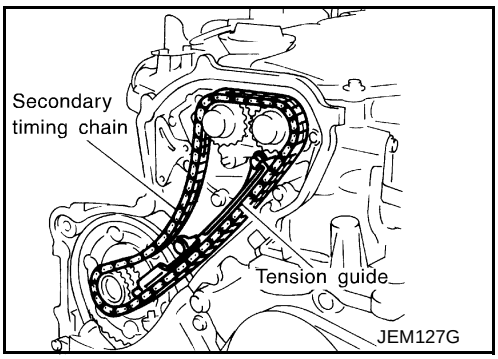
b. Using a hexagon-head wrench [face to face: 5 mm, (0.20 in) SST], remove bolts to remove chain tensioner.



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.



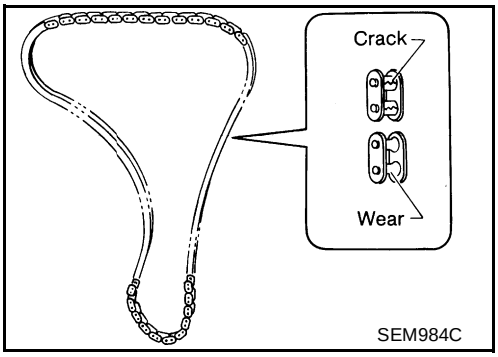
8. Remove timing chain tension guide.
9. Remove secondary timing chain.
   - Timing chain alone can be removed without removing sprockets.



INSPECTION AFTER REMOVAL

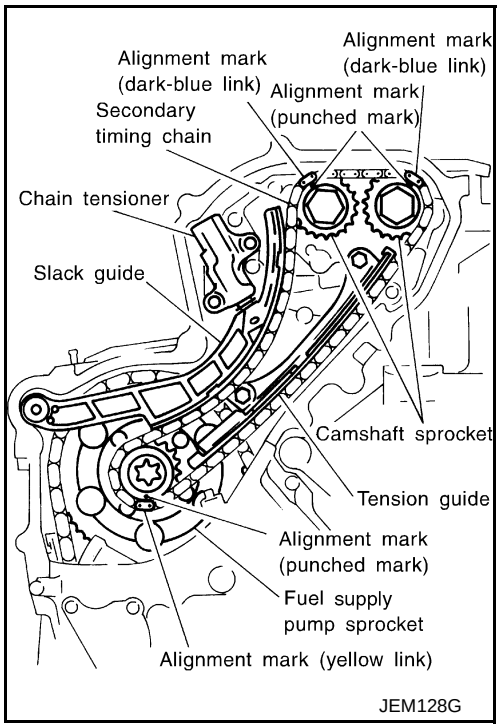
Timing Chain

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

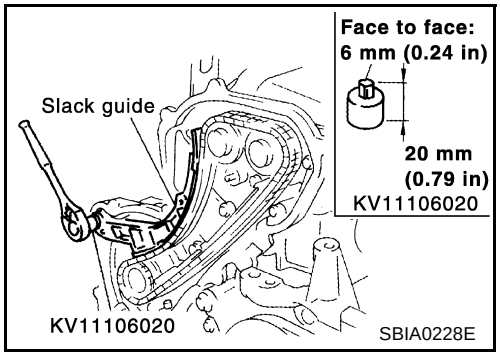


INSTALLATION

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.

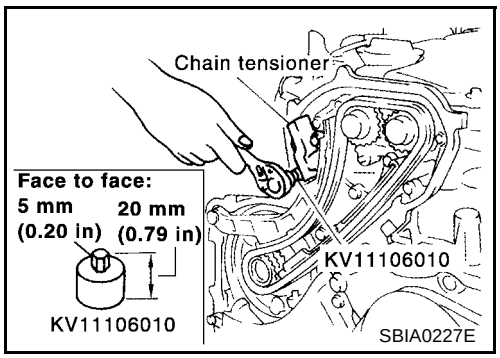


4. Install chain tensioner.

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.

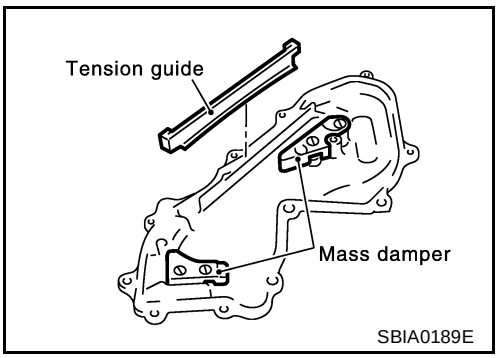
c. Pull out the push pin, etc. holding the plunger.
   - **Check again that the alignment marks on the sprockets and the colored alignment marks on the timing chain are aligned.**



5. Install front chain case.

a. Install tension guide on the back surface of front chain case.

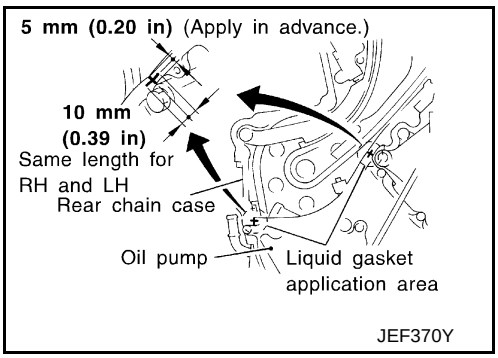
- Hold front chain case vertically when installing. Tension guide may come off if front chain case is tilted.



b. Apply Genuine Liquid Gasket or equivalent (Refer to EM-204, "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.

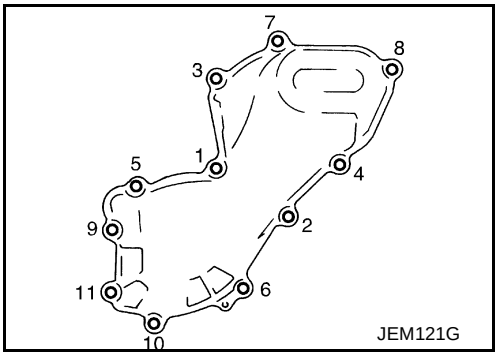


- Install No. 6, 10 and 11 bolts with the rubber washer to the front chain case.

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

EBS00GSJ

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.**

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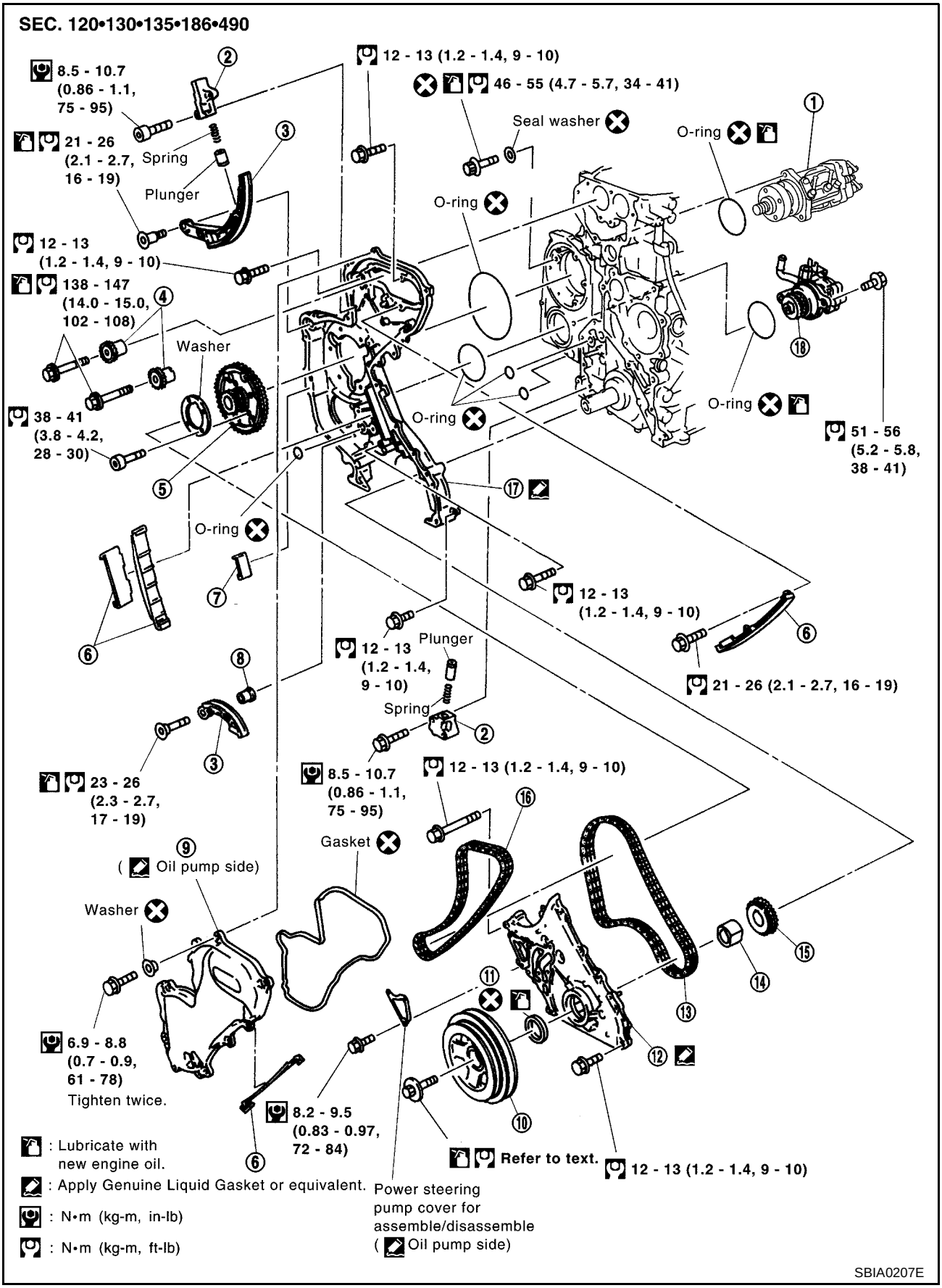


1. Fuel supply pump
2. Chain tensioner
3. Slack guide
4. Camshaft sprocket
5. Fuel supply pump sprocket
6. Tension guide

7. Chain guide
8. Spacer
9. Front chain case
10. Crankshaft pully
11. Front oil seal
12. Oil pump housing
13. Primary timing chain
14. Oil pump drive spacer.
15. Crankshaft sprocket
16. Secondary timing chain
17. Rear chain case
18. Power steering pump

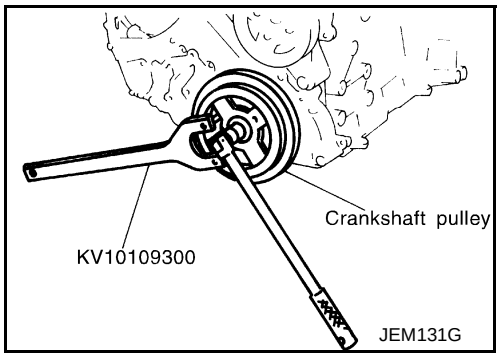
REMOVAL

1. Remove coolant reservior tank.
2. Remove air cleaner and air duct. Refer to EM-213, "Removal and Installation" .
3. Remove rocker cover. Refer to EM-248, "Removal and Installation" .
4. Remove RH engine mount insulator and bracket. Refer to EM-285, "Removal and Installation" .
5. Pull power steering reservoir tank out of brackets to move power steering piping.

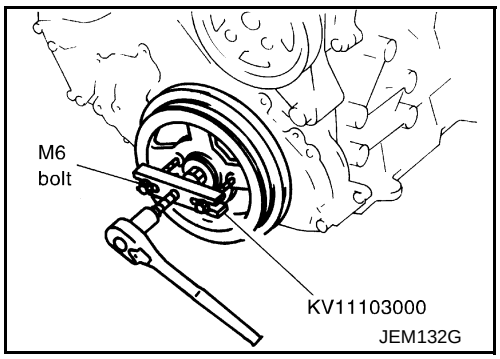
   CAUTION:
   To avoid removing power steering reservoir tank out of brackets move it with power steering piping aside.
6. Remove oil pan. Refer to EM-226, "Removal and Installation" .
7. Remove oil filter bracket. Refer to LU-31, "Removal and Installation" .
8. Remove injection tube and fuel injector. Refer to EM-236, "Removal and Installation" .
9. Remove secondary timing chain and associated parts. Refer to EM-259, "Removal and Installation" .
10. When removing rear chain case, remove camshaft sprockets. Refer to EM-250, "Removal and Installation" .
11. Remove crankshaft pulley.

a. Hold crankshaft pulley with the pulley holder (SST).

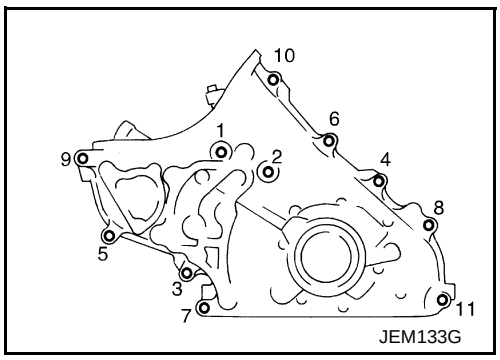
b. Loosen crankshaft pulley fixing bolt and pull out the bolt approximately 10 mm (0.39 in).



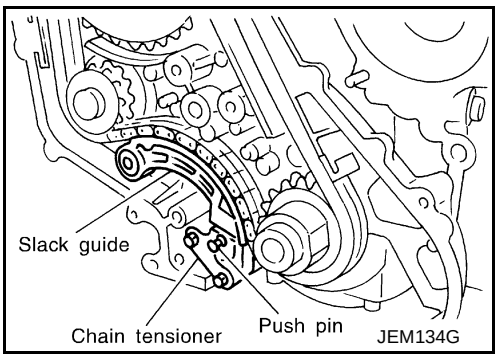
c. Using pulley puller (SST), remove crankshaft pulley.
   - Use two M6 bolts with approx. 60 mm (2.36 in) shank length for securing crankshaft pulley.



12. Remove oil pump housing.
    - Loosen bolts in the reverse order of that shown in the figure and remove them.
    - Use seal cutter (SST) etc. for removal.
13. Remove front oil seal from oil pump housing.
    - 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 housing.**



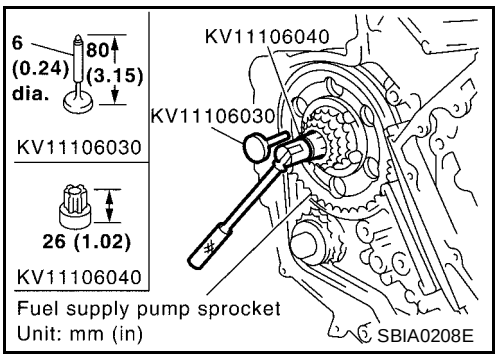
14. Remove chain tensioner.
    - When removing chain tensioner, push the sleeve of chain tensioner and keep it pressed with a push pin, etc.
15. Remove timing chain slack guide.



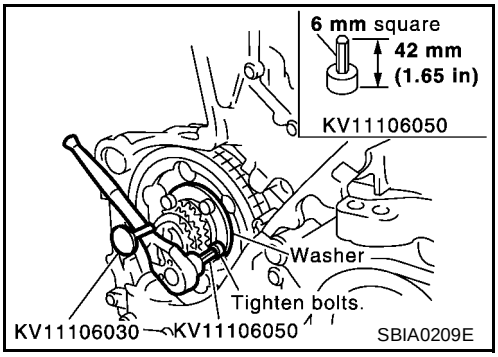
16. Hold fuel supply pump sprocket and remove bolt.

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

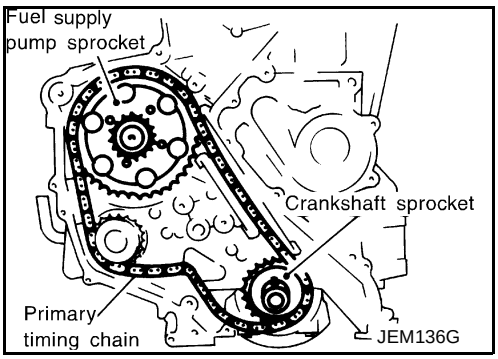
b. Using a TORX wrench (SST), turn pump shaft little by little to adjust the position of fuel supply pump sprocket so that the holes align.



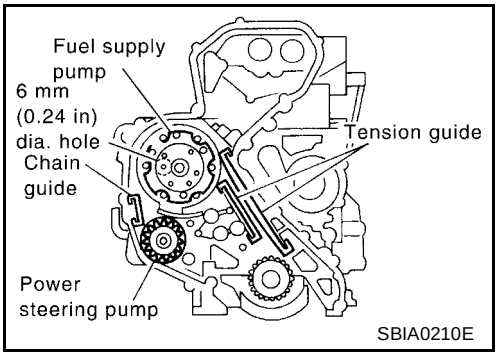
c. Push positioning stopper pin (SST) through fuel supply pump sprocket to fuel supply pump body to hold pump sprocket, and remove bolt.



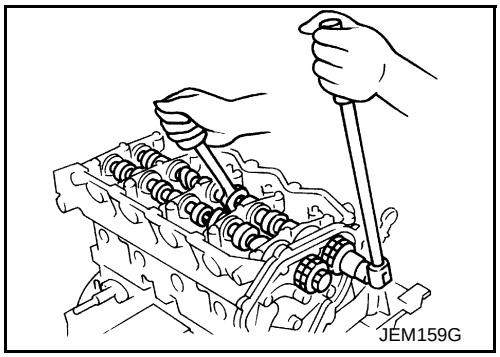
17. Remove primary timing chain with fuel supply pump sprocket and crankshaft sprocket.



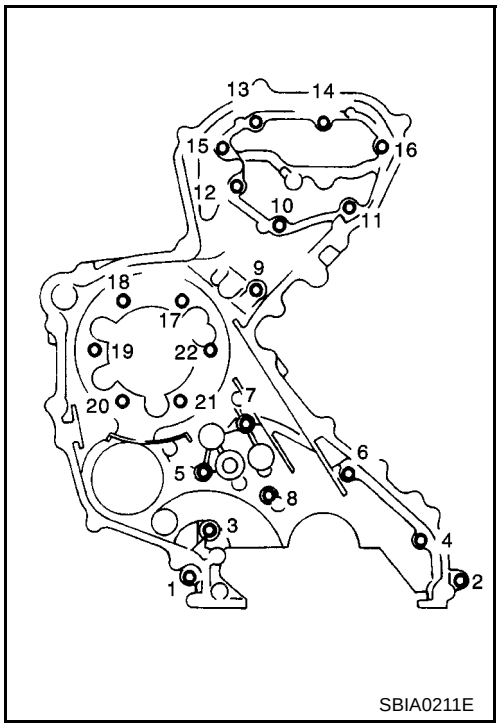
18. Remove chain guide and tension guides.
19. Remove fuel supply pump.
20. Remove power steering pump.



21. Remove camshaft sprockets.
    - Loosen the camshaft sprockets installation bolts by fixing the hexagonal portion of the camshaft.



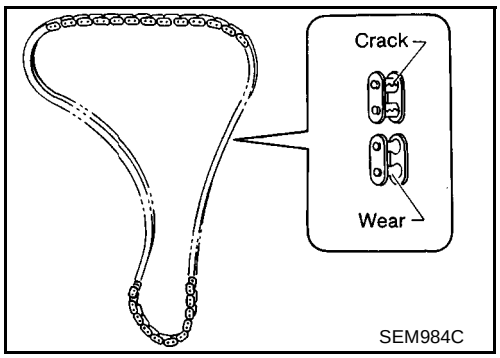
22. Remove rear chain case.
    - Loosen fixing bolts in the reverse order of that shown in the figure and remove them.
    - Use seal cutter (SST) for removal.



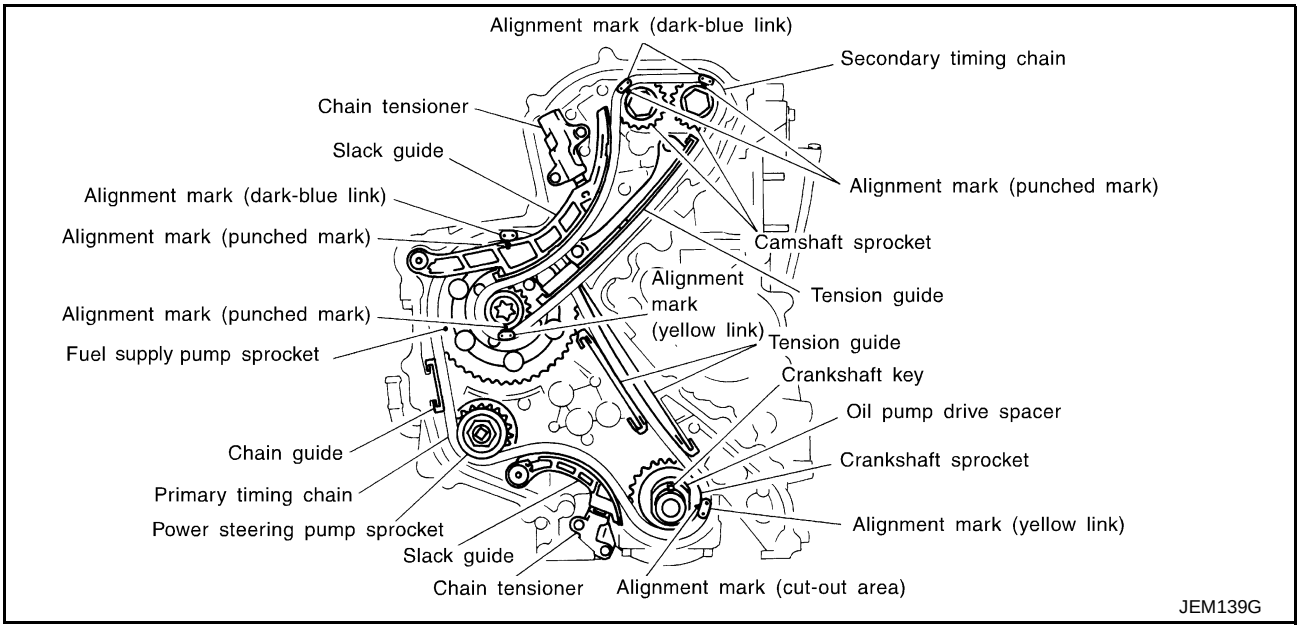
INSPECTION AFTER REMOVAL

Timing Chain

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

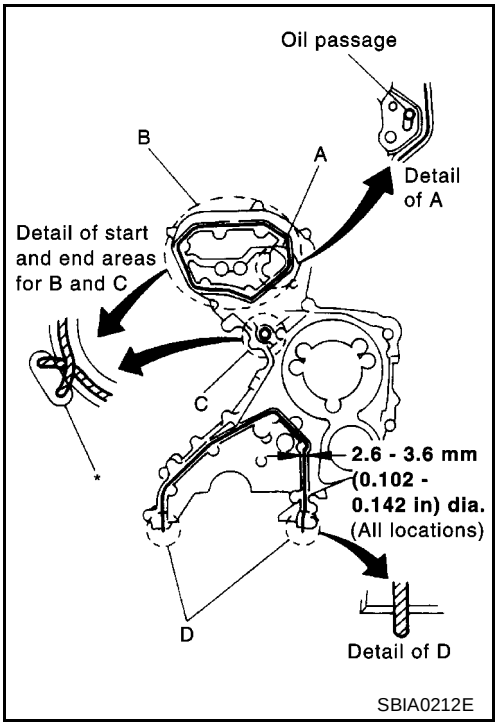


INSTALLATION

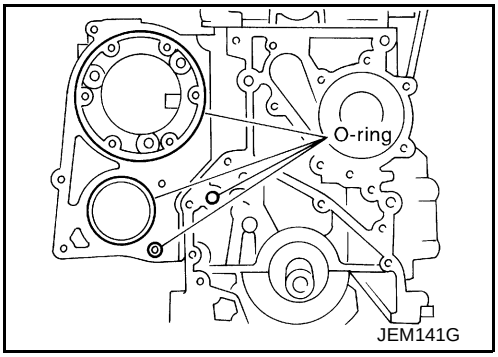


1. Install rear chain case.

a. Apply a continuous bead of Genuine Liquid Gasket or eqivalent on locations shown in the figure. Refer to EM-204, "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.



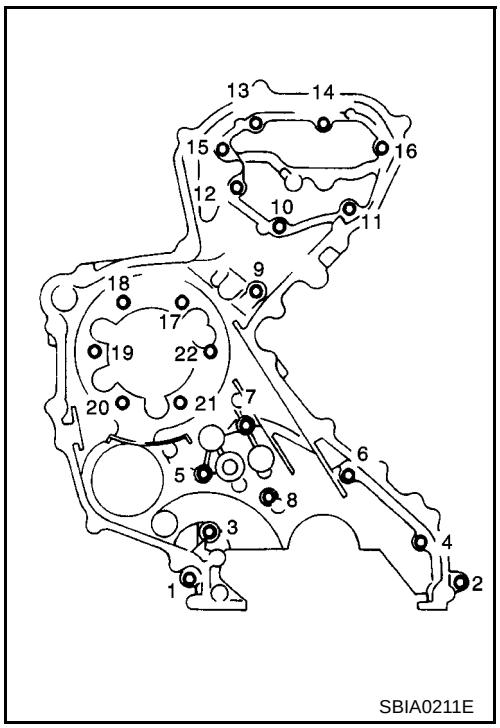
c. Install rear chain case.
   - When installing, align the dowel pin with the pin hole.

d. Tighten bolts in the numerical order shown in the figure.
   - Install the following four types of bolts, referring to the figure.

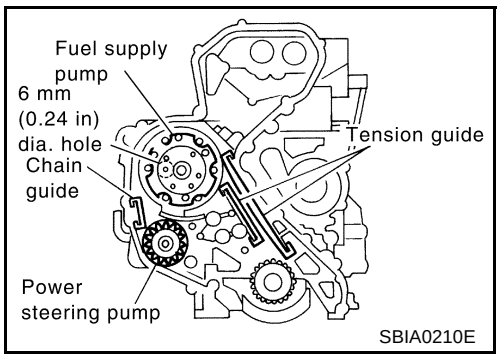
   16 mm (0.63 in) : Bolt No. 1, 2, 16, 17, 18, 19, 20, 21, 22
   20 mm (0.79 in) : Bolt No. 3, 4, 6, 9, 10, 11, 13, 14
   25 mm (0.98 in) : Bolt No. 12, 15
   35 mm (1.38 in) : Bolt No. 5, 7, 8

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

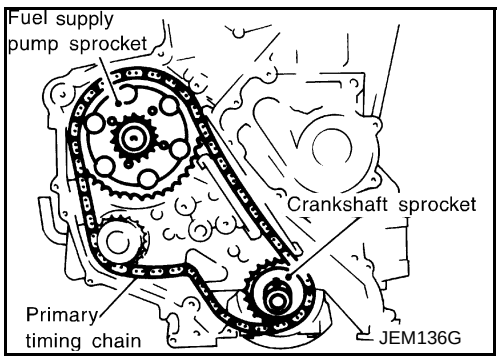
e. After tightening all the bolts, re-tighten in the same order.



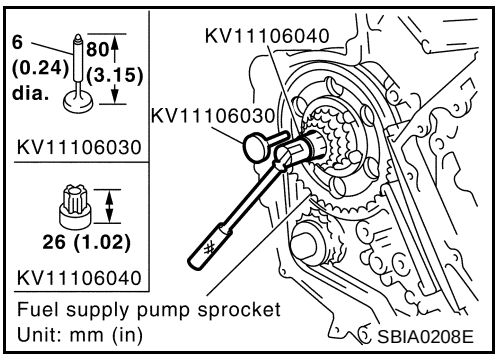
2. Install power steering pump.
3. Install fuel supply pump.
   - Before installing, make sure the notch on the fuel supply pump flange and the hole 6 mm (0.24 in) in diameter on the pump body are aligned.
4. Install chain guide and tension guides.
5. Install crankshaft sprocket, aligning it with the crankshaft key on the far side.

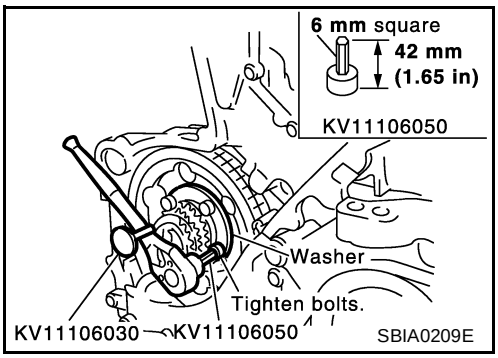


6. Install primary timing chain with fuel supply pump sprocket.
   - When installing, match the alignment marks on sprockets with color coded alignment marks (colored links) on the chain.
   - Install fuel supply pump sprocket washer with the surface marked “F” (front mark) facing the front of the engine.
7. Install timing chain onto power steering pump sprocket and through chain guide.

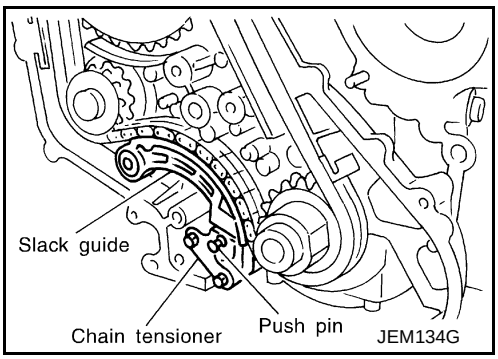


8. Use the positioning stopper pin (SST) to hold the fuel supply pump sprocket and install the bolt.
   - Using a TORX wrench (SST), turn the pump shaft little by little to adjust the position of the pump flange. Insert positioning stopper pin (SST) into the hole 6 mm (0.24 in) in diameter on the fuel 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.

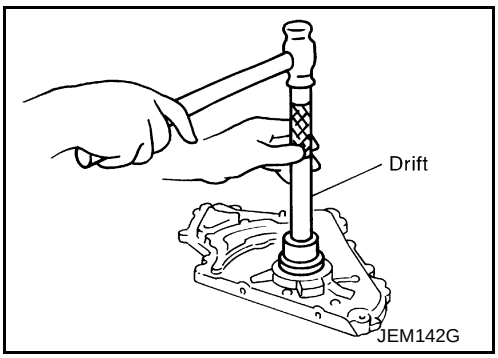




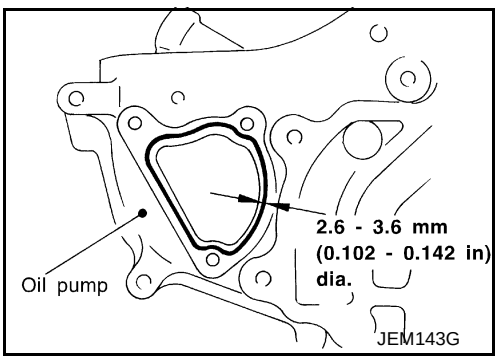
9. Install timing chain slack guide.
10. Install chain tensioner.
    - Push the plunger of the chain tensioner. While keeping plunger pressed down with a push pin, etc., install the chain tensioner.
    - After installation, pull out the push pin holding the plunger.
    - **Check again that the alignment marks on the sprockets and the colored alignment marks on timing chain are aligned.**



11. Install front oil seal to oil pump housing.
    - 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.**

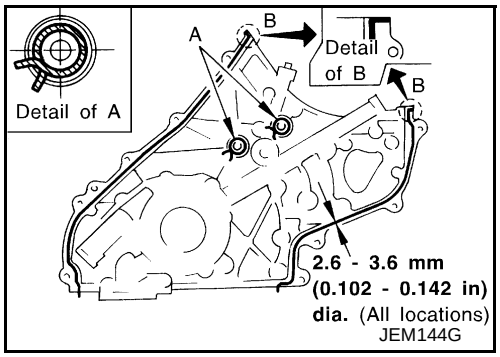


12. Install chain case cover (for opening for power steering pump removal/installation) to oil pump.
    - Apply a continuous bead of Genuine Liquid Gasket or equivalent as shown in the figure. Refer to EM-204, "Precautions for Liquid Gasket" .
    - Apply liquid gasket on oil pump-side surface.



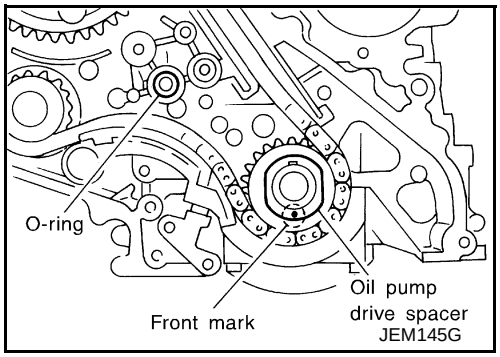
13. Install oil pump housing.

a. Apply a continuous bead of Genuine Liquid Gasket or equivalent on locations shown in the figure. Refer to EM-204, "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 housing.



b. Install oil pump drive spacer to crankshaft.
- Install with the front mark (punched mark) facing the front of the engine.

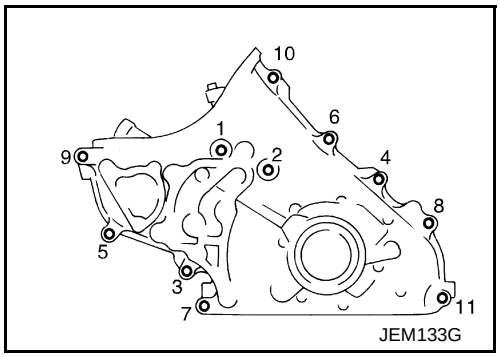
c. Install O-ring into the groove of rear chain case.



d. Install oil pump housing.
- 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:

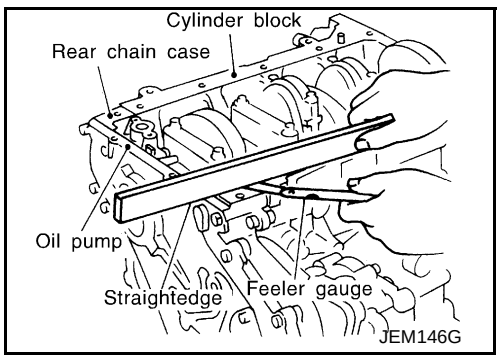
Oil pump housing and rear chain case:

Standard : – 0.14 to 0.14 mm (– 0.0055 to 0.0055 in)

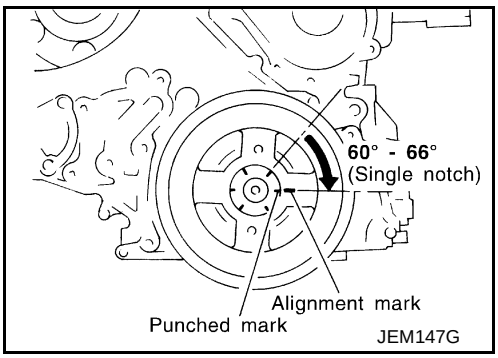
Rear chain case and cylinder block:

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-262, "INSTALLATION" .
17. Install in the reverse order of removal hereafter.



CYLINDER HEAD

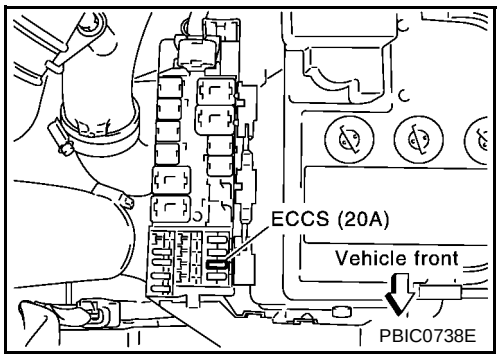
PFP:11041

On-Vehicle Service

EBS00GSK

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-1754, "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. To prevent fuel from being injected during inspection, remove fuse [ECCS (20A)] from fuse box on the left side of engine compartment.
   - Among marks on fuse box, [ECCS (20A)] .

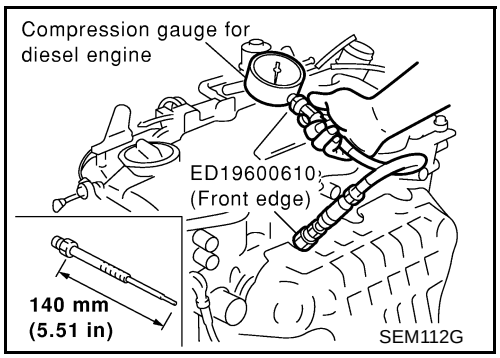


5. Remove glow plugs from all the cylinders. Refer to EM-231, "Removal and Installation" .

   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.**

6. 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)



7. Connect battery negative terminal.
8. 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

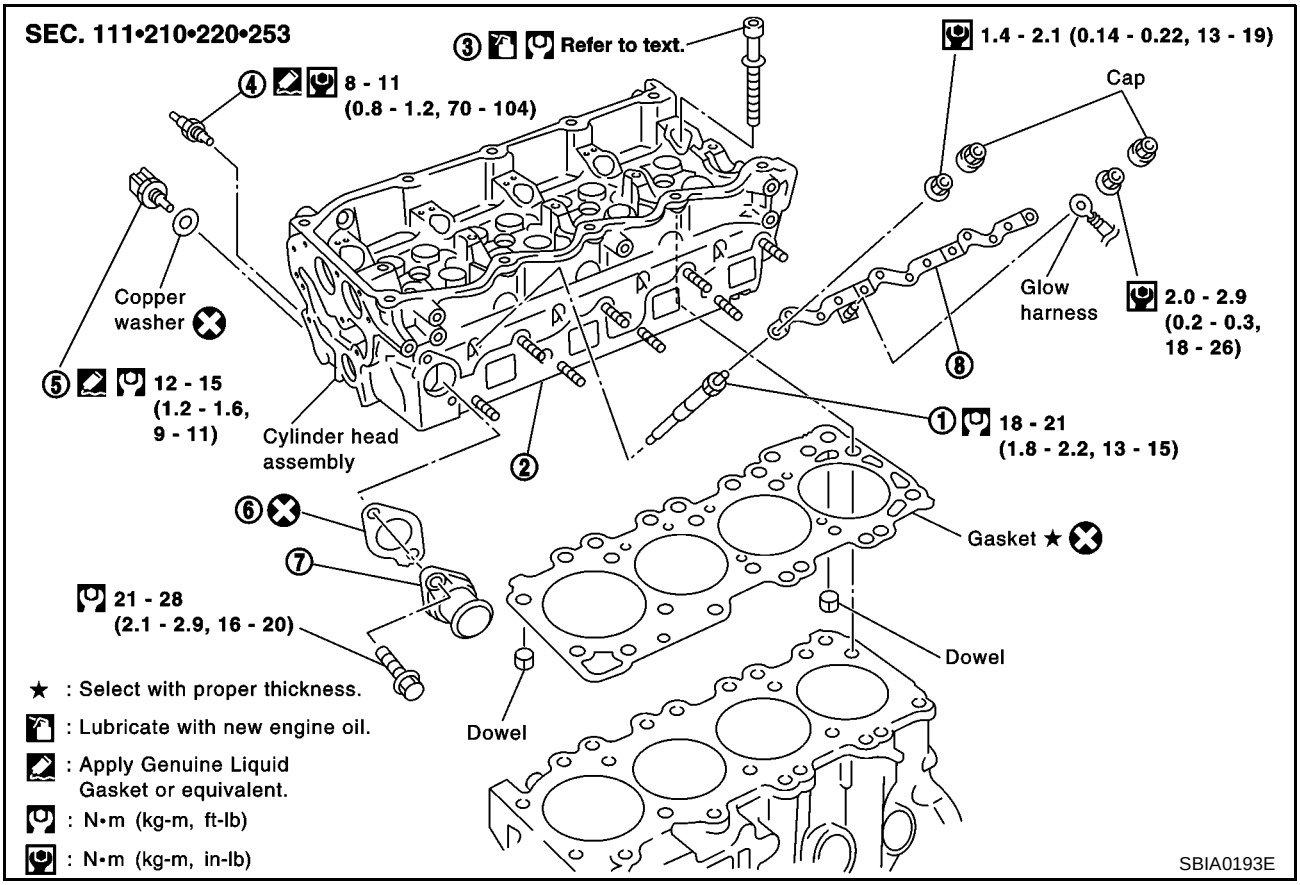
   - When engine rpm is out of the specified range, check the specific gravity of battery liquid. Measure again under corrected conditions.
   - If engine rpm exceeds the limit, check valve clearance and combustion chamber components (valves, valve seats, cylinder head gaskets, piston rings, pistons, cylinder 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.
9. 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 fuse [ECCS (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

EBS00GSL



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

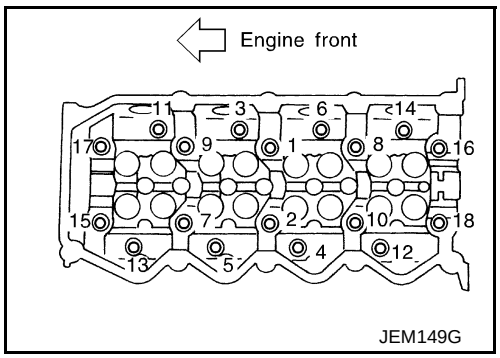
CAUTION:
Apply new engine oil to parts marked in illustration before installation.

REMOVAL

1. Drain engine coolant. Refer to CO-49, "Changing Engine Coolant" .
2. Remove the following parts.
   - Rocker cover (Refer to EM-248, "Removal and Installation" .)
   - Air cleaner and air duct (Refer to EM-213, "Removal and Installation" .)
   - Vacuum pump (Refer to EM-232, "Removal and Installation" .)
   - Injection tube, spill tube and fuel injector (Refer to EM-236, "Removal and Installation" .)
   - Intake manifold (Refer to EM-216, "Removal and Installation" .)
   - Exhaust manifold and Turbocharger (Refer to EM-220, "Removal and Installation" .)
   - Secondary timing chain (Refer to EM-259, "Removal and Installation" .)
   - Camshaft (Refer to EM-250, "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.**

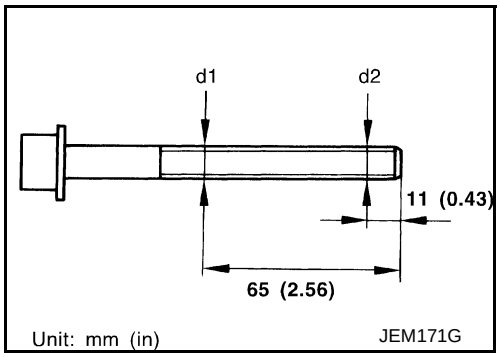
INSPECTION AFTER REMOVAL

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.

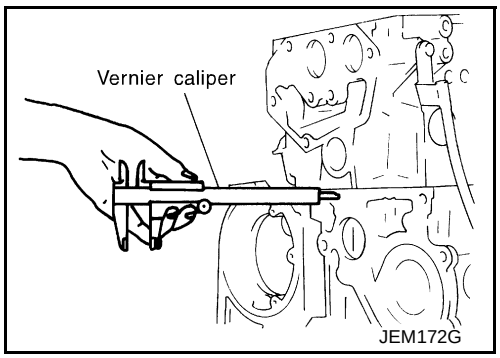


Cylinder Head-to-block Difference Check

- 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)

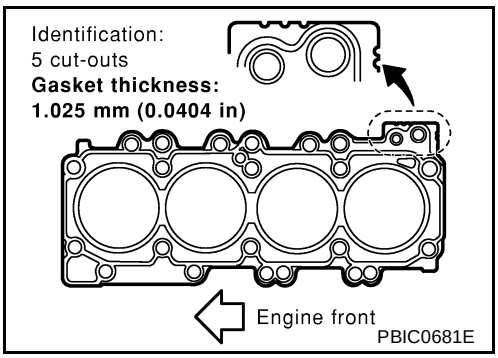
- If the difference is out of the range, check fitting of dowel pins and cylinder head.



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.

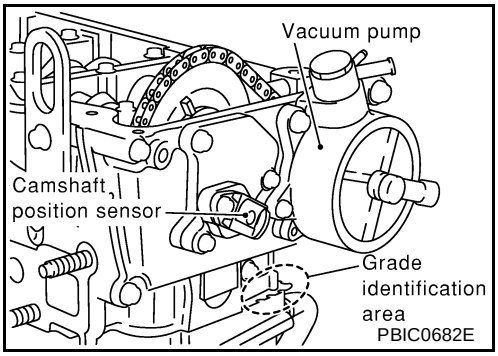
– **When replacing gasket alone**

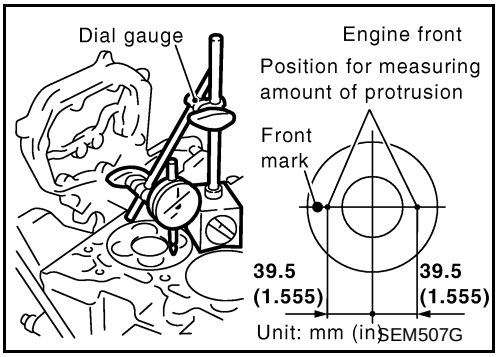
- Install a gasket with same thickness as that of the one removed.
- Identify the thickness of gasket by the number of cut-outs on the rear RH side.

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.

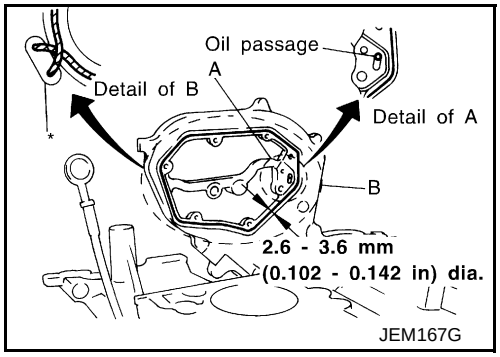
d. Measure at two locations per cylinder, that is eight locations for four cylinders. Select gasket based on the maximum protrusion of eight measurements.

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	

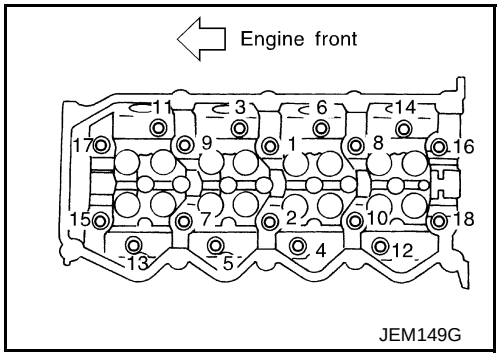
*: Measured with head bolts tightened

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-204, "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.

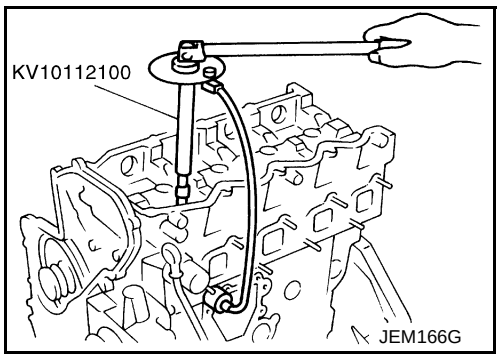


3. Install cylinder head assembly.
   - Tighten bolts in numerical order as shown in the figure according to the following procedure:

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).



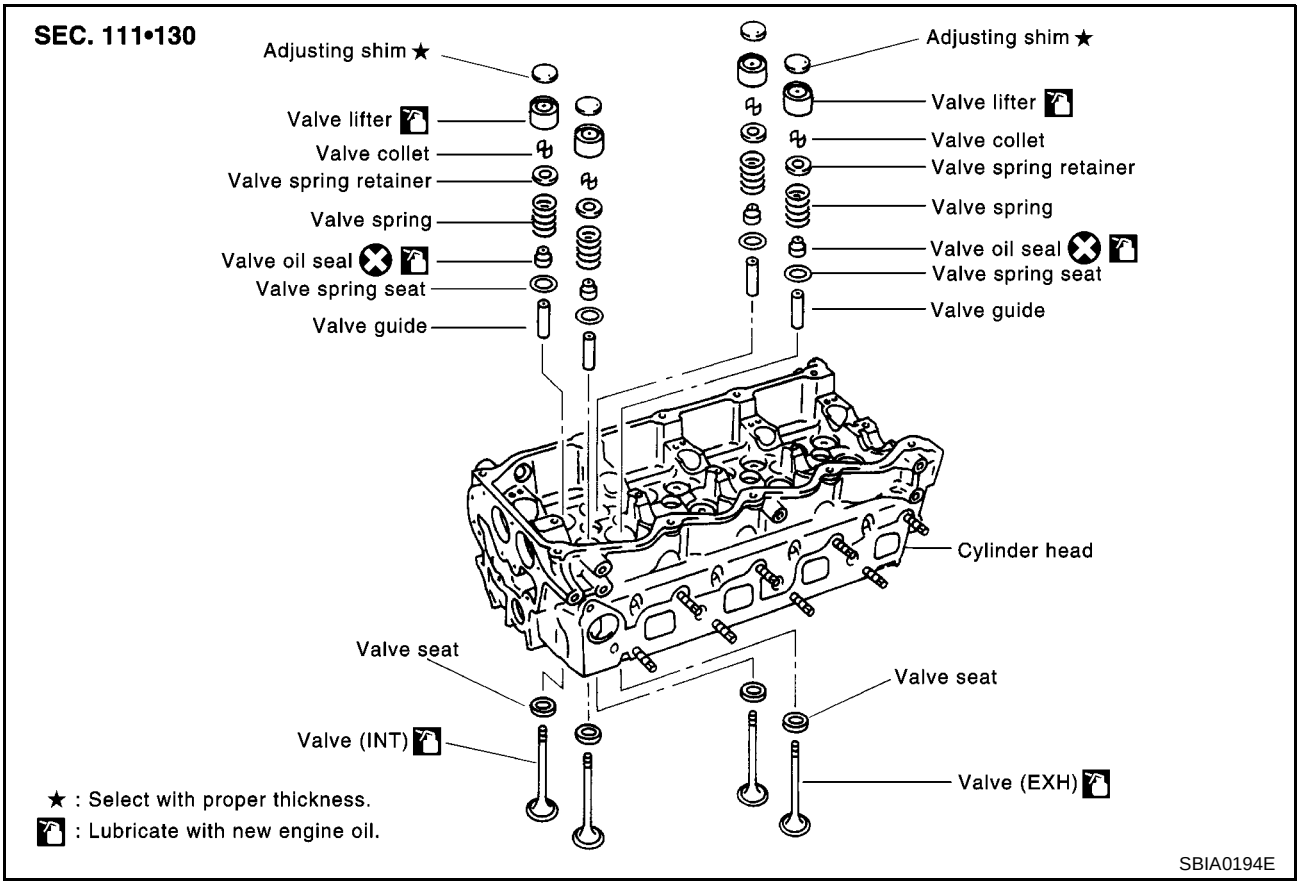
   - **When an angle wrench is not used, paint an alignment mark on the head of cylinder head bolt and cylinder head surface before tightening. Check the angle with a protractor.**



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

EBS00GSM

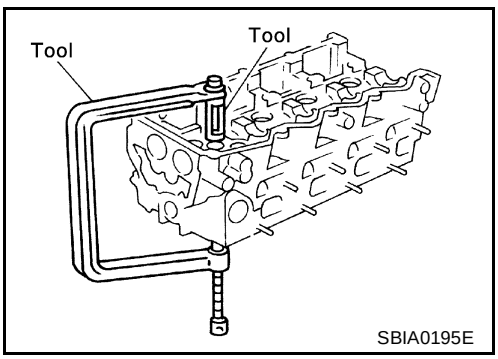


CAUTION:

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

DISASSEMBLY

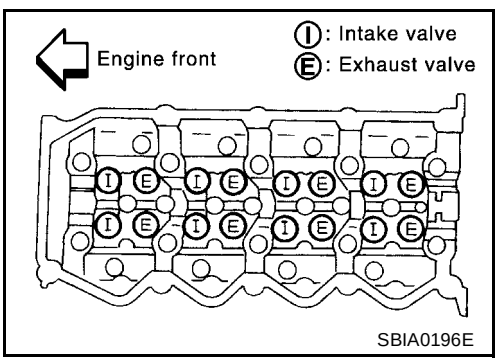
1. Remove adjusting shims and valve lifters.
   - Check the installation positions, and keep them to avoid being confused.
2. Remove valve.
   - Using valve spring compressor, compress valve spring. Using magnetic hand, remove valve collets.
3. Remove valve spring retainers and valve springs.
4. Remove valves as pressing valve stems toward combustion chamber.



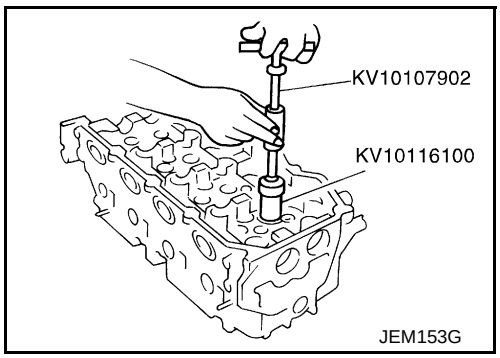
- Before removing the valve, check the valve guide clearance. Refer to EM-281, "Valve Guide Clearance" .
- Check installation positions, and keep them to avoid being confused.

  NOTE:

  Refer to the figure for intake and exhaust valve positions. Intake and exhaust valve driving cams are provided alternately for each camshaft.

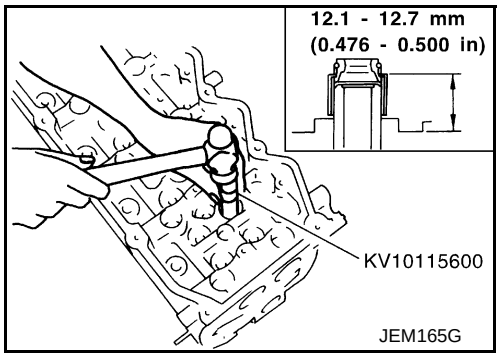


5. Remove valve oil seals using valve oil seal puller.
6. Remove valve spring seats.
7. Before removing valve spring seats, perform valve seat contact check. Refer to EM-282, "Valve Seat Contact" .
8. Before removing valve guides, perform valve guide clearance check. Refer to EM-281, "Valve Guide Clearance" .



ASSEMBLY

1. Install valve guides. Refer to EM-281, "Valve Guide Clearance" .
2. Install valve seats. Refer to EM-282, "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.



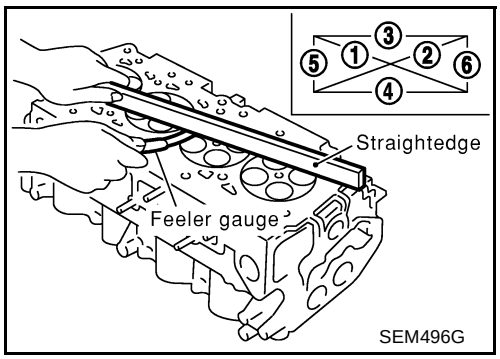
6. Install valve spring.
7. Install valve spring retainers.
8. Using valve spring compressor, compress valve springs. Then install valve collets using magnetic hand.
   - After installing valve collets, tap the stem end using a plastic hammer, and check the installation status.
9. Install valve lifters and adjusting shims to the same positions as before.

INSPECTION AFTER DISASSEMBLY

Cylinder Head Distortion

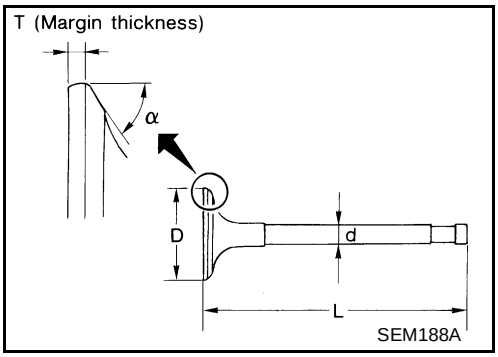
Using straightedge and feeler gauge, check the bottom of the cylinder head for distortion.

Limit : 0.04 mm (0.0016 in)



Valve Dimension

Check dimensions of each valve. For dimensions, refer to SDS, EM-311, "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

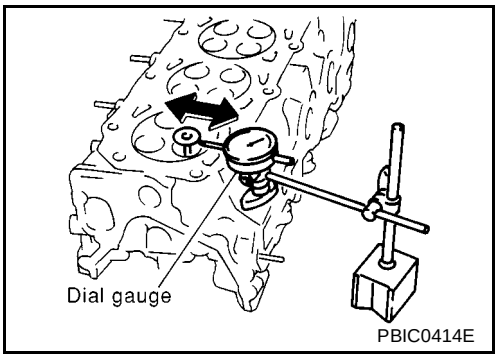
- Perform the inspection before removing valve guides.
- Check that the valve stem diameter is within specifications.
- Push valve approximately 25 mm (0.98 in) toward combustion chamber, move valve toward dial indicator to measure valve movement.
- Valve guide clearance is 1/2 of movement on dial indicator.

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)**

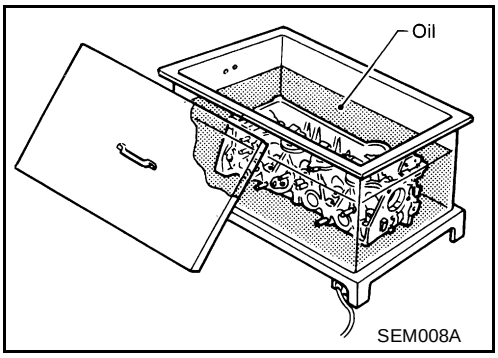


- If the measured value exceeds the limit, replace valve guide.

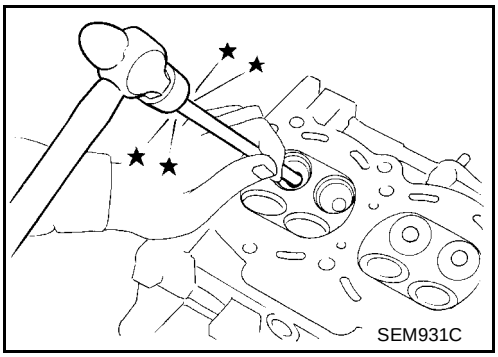
Valve Guide Replacement

- 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.

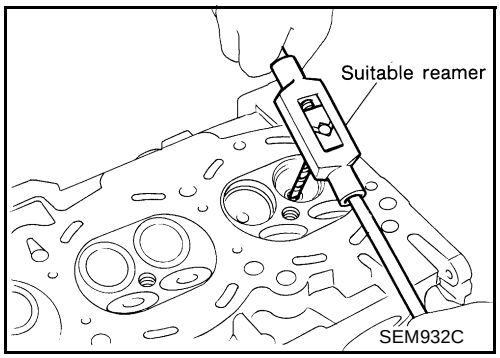


2. Using valve guide drift, tap valve guides out from the combustion chamber side.



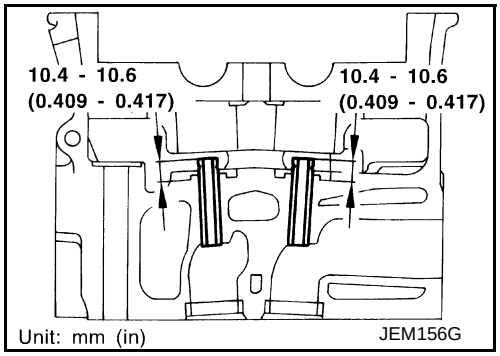
3. Remove cylinder head valve guide hole.

Valve guide hole diameter (for service parts):
: 10.175 - 10.196 mm (0.4006 - 0.4014 in)



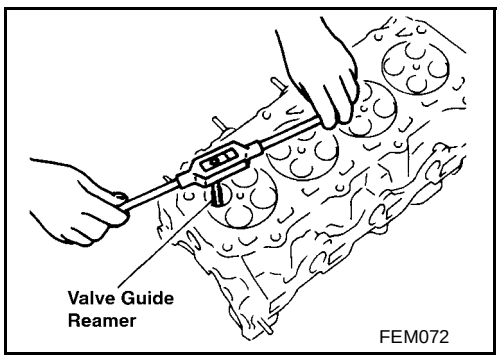
4. Heat cylinder head to 110 to 130°C (230 to 266°F) in oil bath.
5. Using valve guide drift, press fit valve guides from camshaft side, referring to the dimension shown in the figure.

Projection "L" : 10.4 - 10.6 mm (0.409 - 0.417 in)



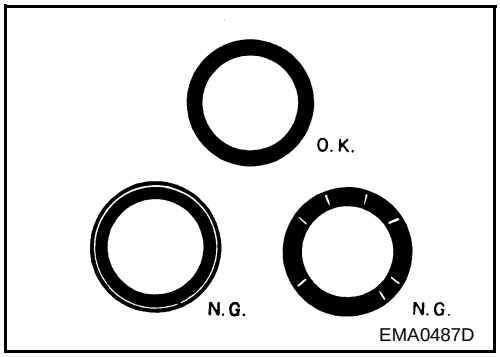
6. Using valve guide reamer, perform reaming to the press-fitted valve guides.

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.

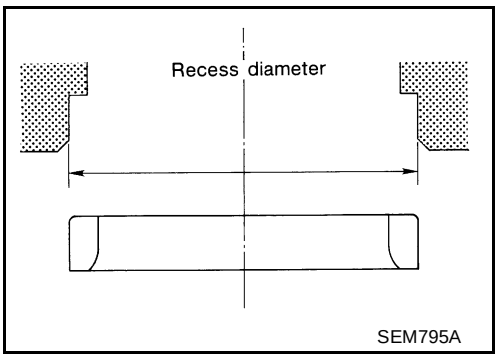


Valve Seat Replacement

- When removing valve seat, replace it with oversized [0.5 mm (0.020 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)

Exhaust

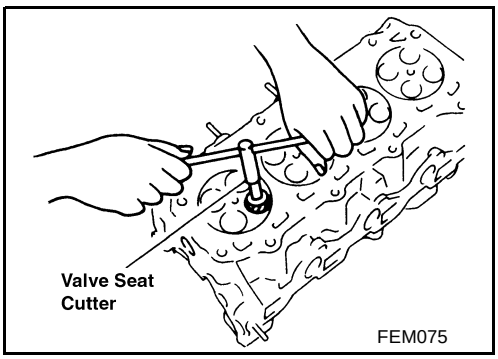
29.500 - 29.516 mm (1.1614 - 1.1620 in)

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.

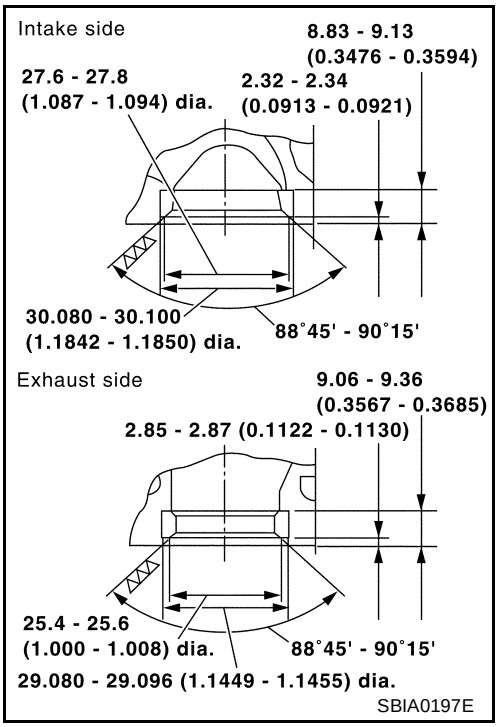
5. Using valve seat cutter, finish processing referring to the dimensions shown in the figure.



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-282, "Valve Seat Contact" .

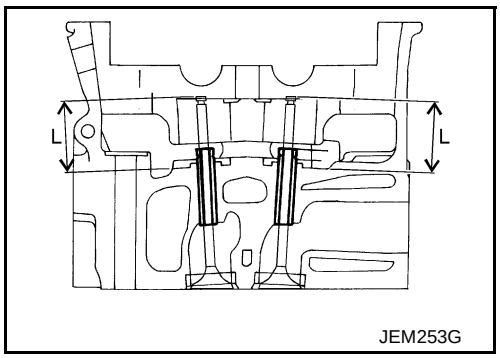


8. Use a depth gauge to measure the distance between the mounting surface of the cylinder head spring seat and the valve stem end. If the distance is shorter than specified, repeat step 5 above to adjust it. If it is longer, replace the valve seat with a new one.

Valve seat resurface limit "L":

Intake : 36.53 - 36.98 mm (1.4382 - 1.4559 in)

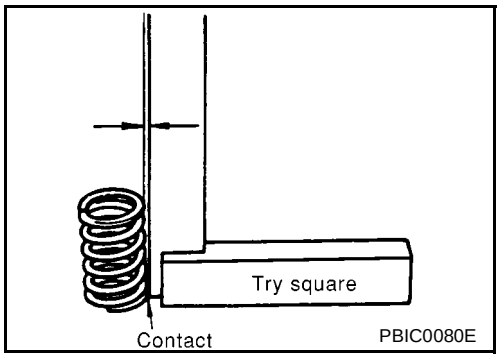
Exhaust : 36.53 - 37.01 mm (1.4382 - 1.4571 in)



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 : 0.78 mm (0.0307 in)



Valve Spring Dimensions and Valve Spring Pressure Load

Using valve spring tester, check the following.

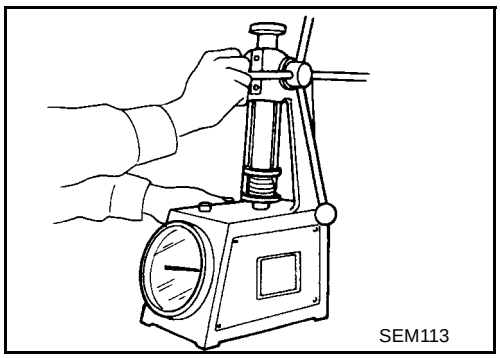
Free length : 44.74 mm (1.7614in)

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)

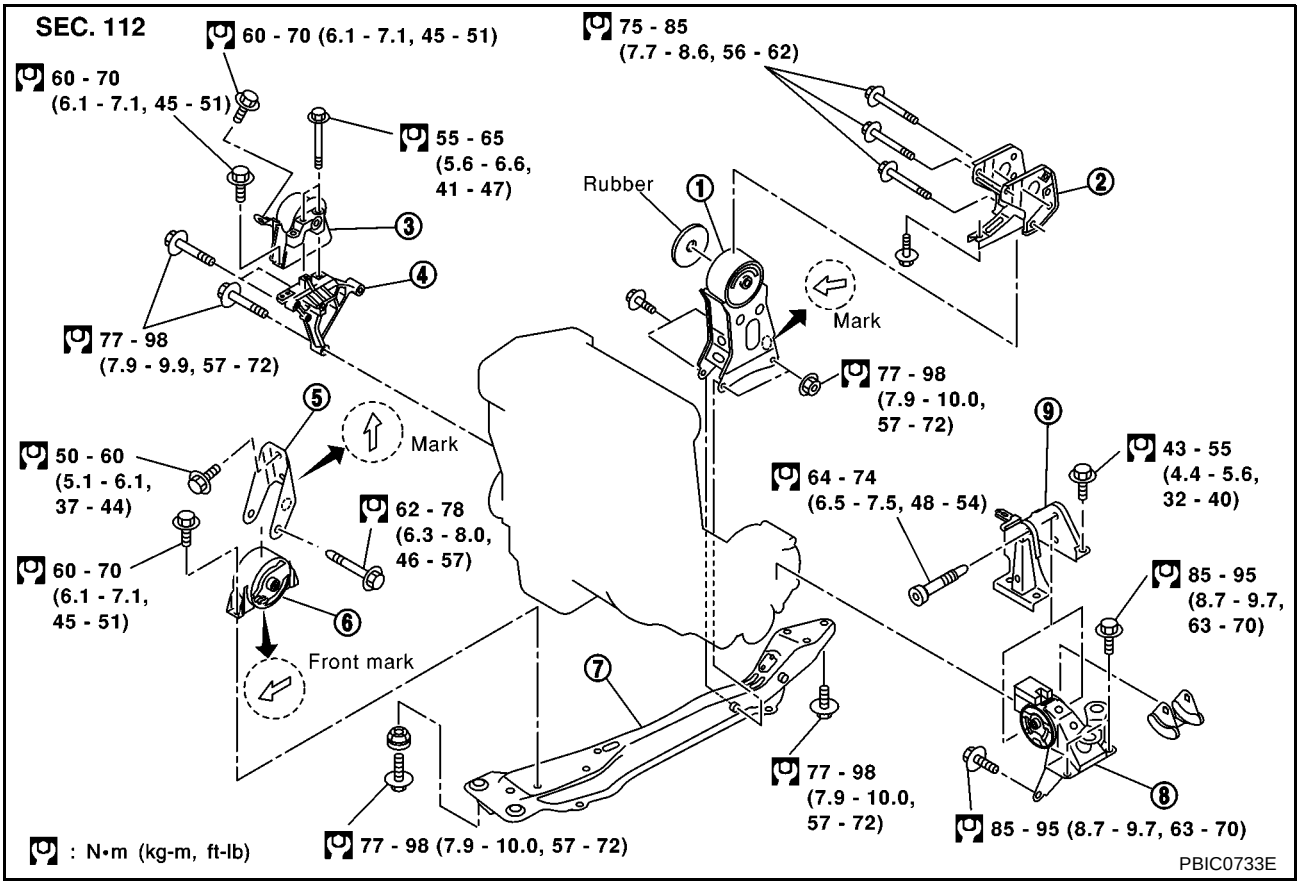


ENGINE ASSEMBLY

PFP:10001

Removal and Installation

EBS00GSN



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-37, "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-212, "Removal and Installation" .
   - Air duct and air cleaner case assembly; Refer to EM-213, "Removal and Installation" .
   - Alternator
   - Radiator and radiator fan assembly; Refer to CO-52, "Removal and Installation" .
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 steering shaft from steering gear.
14. Disconnect power steering fluid cooler piping at a point between body and engine.
15. Remove ABS sensor from brake caliper.
16. Remove brake caliper with piping connected from steering knuckle. Temporarily secure it on body with a rope to avoid load on it.
17. Remove LH/RH suspension from steering knuckle under strut.

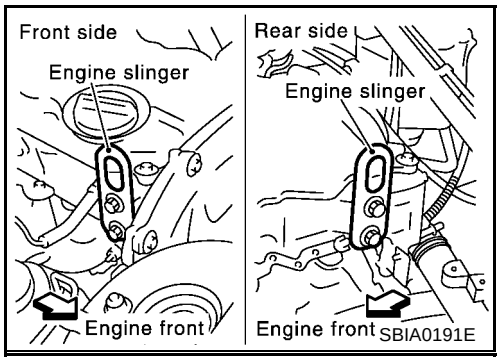
Removal

18. Install engine slingers into front right of cylinder head and rear left of cylinder head.

    Slinger bolts:

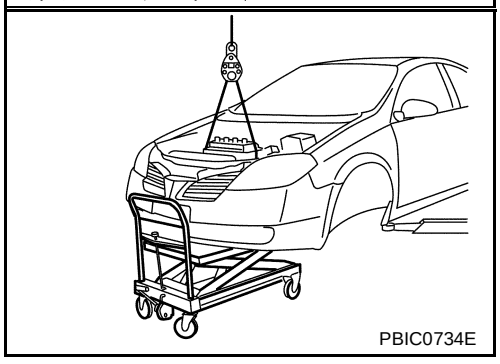
    : 30 - 37 N·m (3.0 - 3.8 kg-m, 22 - 27 ft-lb)

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

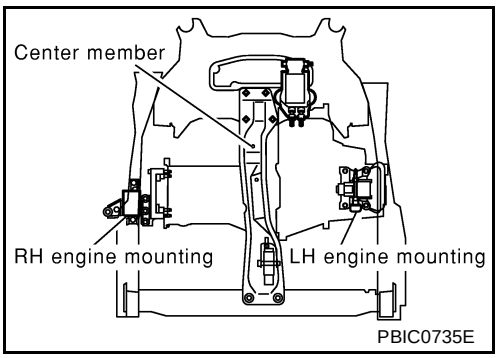


- Use a manual lift table caddy or equivalently rigid tool such as a jack or trestle. Securely support bottom of engine and transaxle, and simultaneously adjust hoist tension.

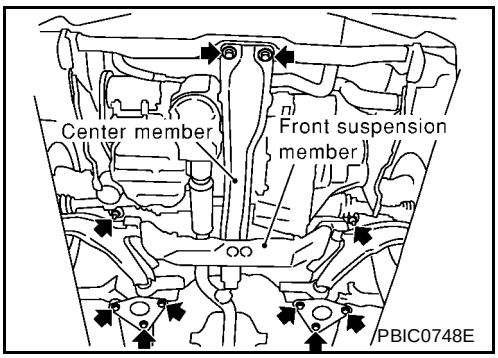
  CAUTION:
  Put a piece of wood or something similar as the supporting surface, secure a completely stable condition.



20. Remove RH engine mounting insulator.
21. Pull LH engine mounting through-bolt out.



22. Remove mounting bolts at front end of center member.
23. Remove front suspension member mounting bolts and nuts.
24. Remove engine, 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 power steering pump with piping connected from engine. Move it aside on suspension member.
26. Remove front engine mounting and rear engine mounting through-bolts to remove suspension member.
27. Remove starter motor.
28. 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

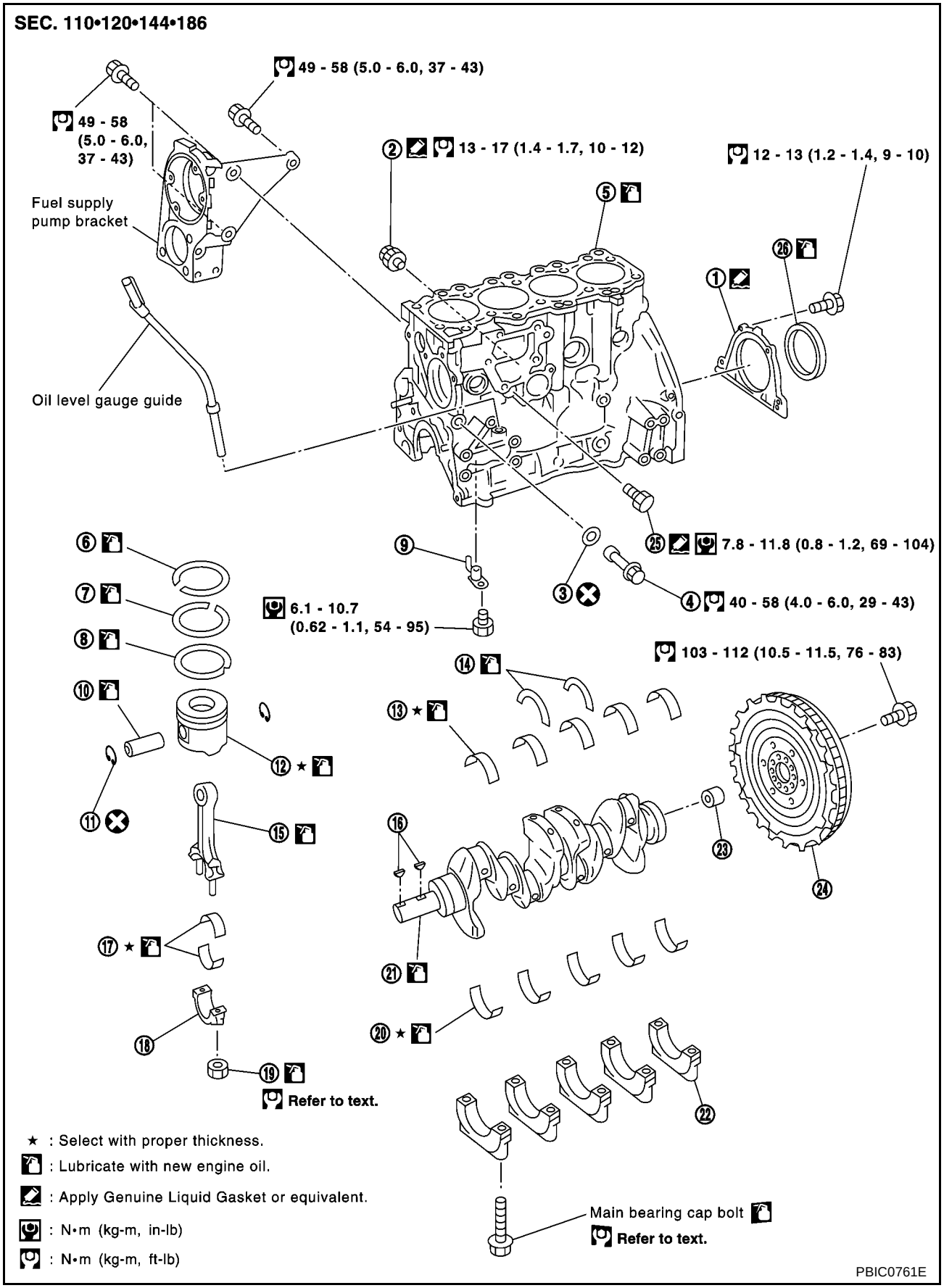
- Before starting engine check the levels of coolant, lubrications and working oils. If less than required quantity, fill to the specified level.
- Before starting engine, bleed air from fuel piping. Refer to FL-5, "Air Bleeding" .
- Run engine to check for unusual noise and vibration.
- Warm up engine 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

EBS00GSO

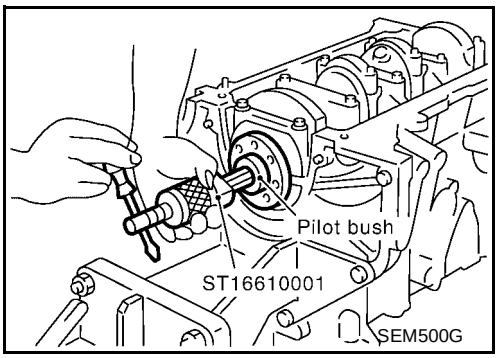


1. Rear oil seal retainer
2. Oil pressure switch
3. Coppet washer
4. Oil jet relief valve
5. Cylinder block
6. Top ring
7. Second ring
8. Oil ring
9. Oil jet
10. Piston pin
11. Snap ring
12. Piston
13. Main bearing
14. Thrust bearing
15. Connecting rod
16. Key
17. Connecting rod bearing
18. Connecting 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-285, "ENGINE ASSEMBLY" .
2. Remove clutch cover and disk. Refer to CL-18, "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.

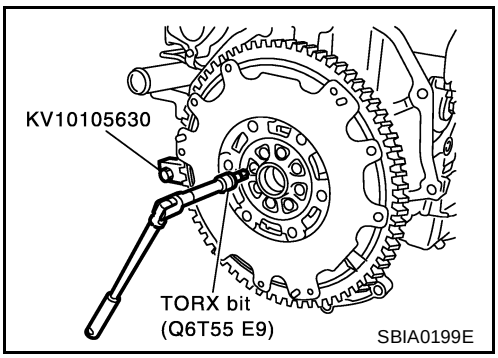


4. Install engine to engine stand as follows.

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.

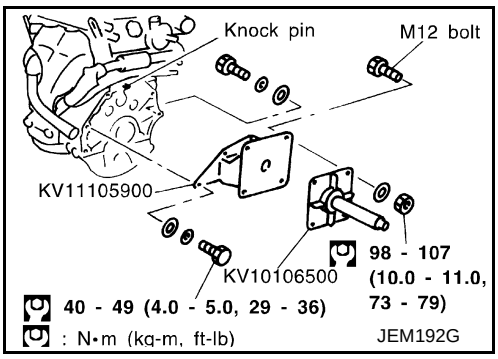


c. Install engine sub-attachment to the rear side of cylinder block.
   - Align knock pins on cylinder block with pin holes on attachment to install.

NOTE:
Installation bolts are part of engine sub-attachment.

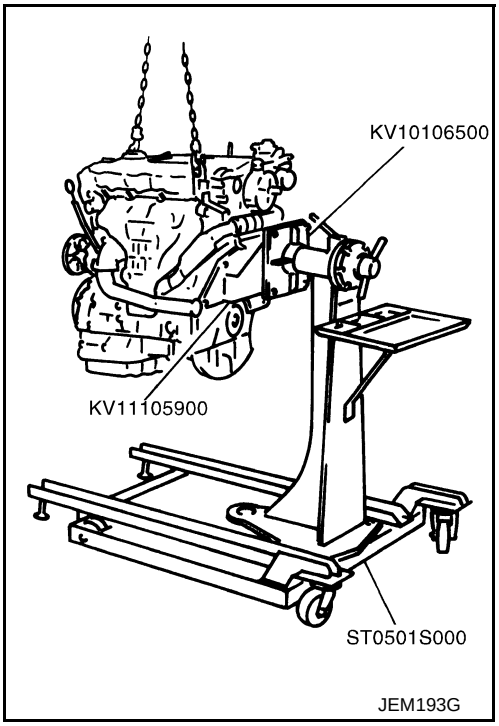
d. Install engine attachment.

NOTE:
Use commercially available M12 (0.47 in) mounting bolts and nuts (4 sets) with strength grade of 9T (minimum).



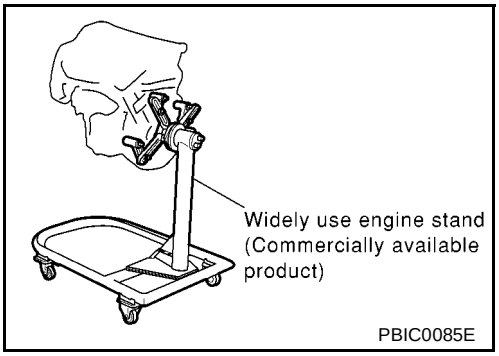
e. Hoist engine and install it to the engine stand.

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.

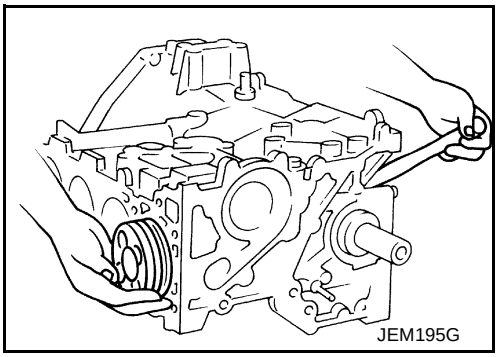


5. Drain engine oil and coolant from inside engine.
6. Remove the following parts and related parts. (Only major parts are listed.)
   - Intake manifold (Refer to EM-216, "Removal and Installation" .)
   - Exhaust manifold and Turbocharger (Refer to EM-220, "Removal and Installation" .)
   - Rocker cover (Refer to EM-248, "Removal and Installation").
   - Injection tube and fuel injector (Refer to EM-236, "Removal and Installation" .)
   - Oil pan and oil strainer (Refer to EM-226, "Removal and Installation" .)
   - Water pump (Refer to CO-59, "Removal and Installation" .)
   - Thermostat and water piping (Refer to CO-61, "Removal and Installation" .)
   - Vacuum pump and vacuum pipe (Refer to EM-232, "Removal and Installation" .)
   - Secondary timing chain (Refer to EM-259, "Removal and Installation")
   - Primary timing chain (Refer to EM-264, "Removal and Installation" .)
   - Fuel supply pump (Refer to EM-239, "Removal and Installation" .)
   - Camshaft (Refer to EM-250, "Removal and Installation" .)
   - Cylinder head (Refer to EM-275, "Removal and Installation" .)
   - Oil cooler (Refer to LU-34, "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.

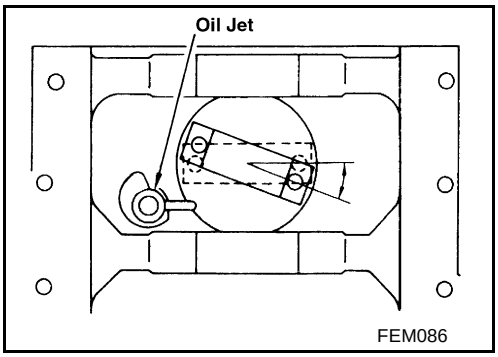
9. Remove rear oil seal from rear oil seal retainer.
   - Punch out with a flat-bladed screwdriver.
   - **Be careful not to damage rear oil seal retainer.**
10. Remove piston and connecting rod assembly.
    - Before removing piston and connecting rod assembly, check connecting rod side clearance.
      Refer to EM-300, "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.

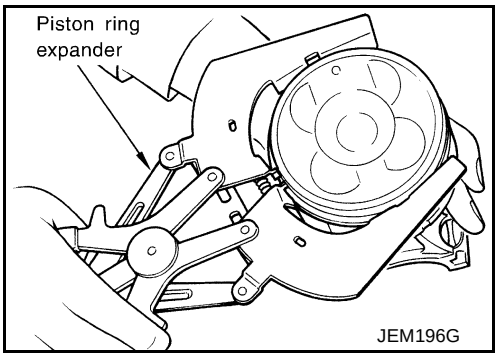
11. Remove connecting rod bearings from connecting rods and caps.
    - Keep them by cylinder to avoid confusion.



FEM086

12. Remove piston rings from pistons using piston ring expander.

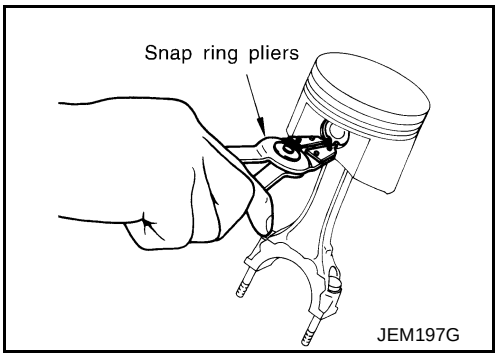
CAUTION:
- **When removing, prevent pistons from being damaged.**
- **Do not expand piston rings excessively. This may damage the piston rings.**



JEM196G

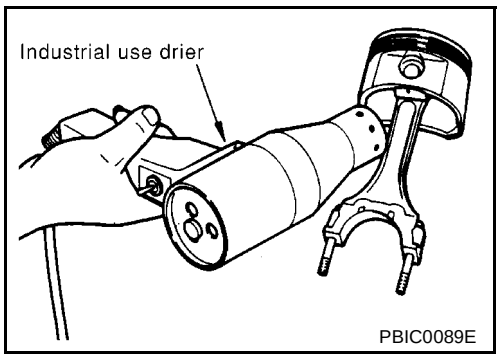
13. Remove pistons from connecting rods.

a. Using long nose pliers, remove snap rings.

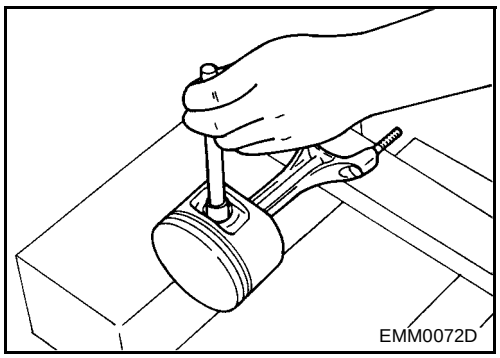


JEM197G

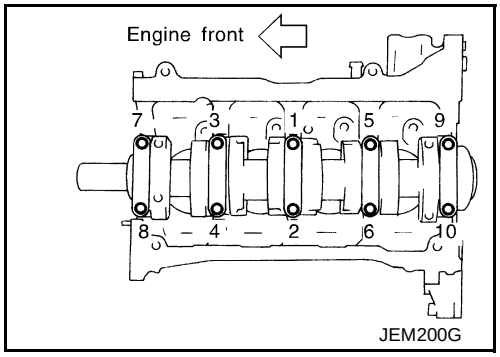
b. Using industrial dryer, heat pistons up to 60 to 70°C (140 to 158°F).



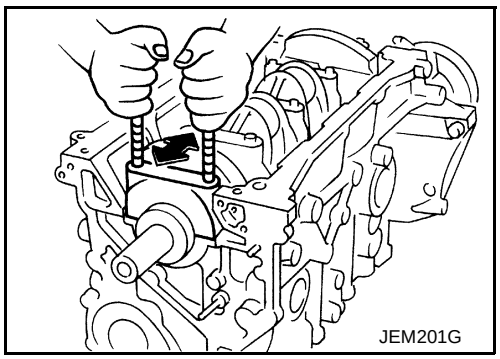
c. Using rod with outer diameter of 26 mm (1.02 in), press piston pins out.



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-300, "CRANKSHAFT SIDE CLEARANCE" .

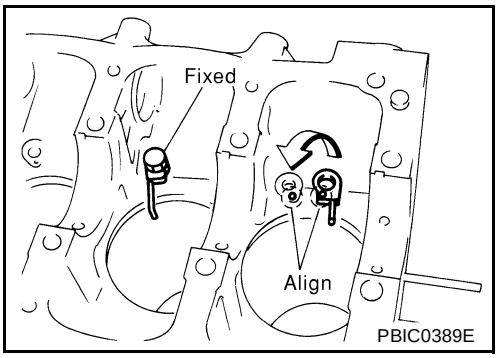


15. Remove main bearing caps.
    - Using main bearing cap bolts, remove by rocking bearing cap back and forth.
16. Remove crankshaft.
17. Remove main bearings and thrust bearings from cylinder block and main bearing caps.
    - **Check the correct installation locations of removed parts. Store them so they do not get mixed up.**
18. Remove oil jet.
19. Remove oil jet relief valve.



ASSEMBLY

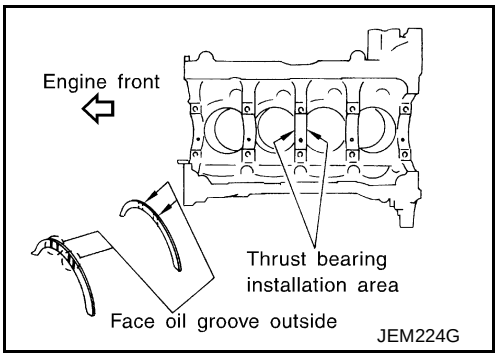
1. Blow air sufficiently to inside coolant passage, oil passage, crankcase and cylinder bore to remove foreign matter.
2. Install oil jet relief valve.
3. Install oil jet.
   - Align knock pin on back of oil jet with hole on block when installing oil jet.



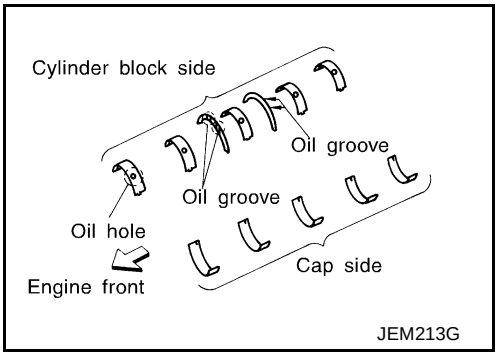
4. Install main bearings and thrust bearings.

a. Remove contamination, dust and oil from bearing mounting positions on cylinder block and main bearing caps.

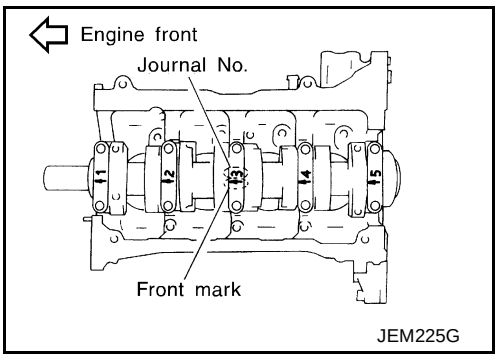
b. Install thrust bearings on both sides of No. 3 housing on cylinder block.
   - Install thrust bearings with oil groove facing to crankshaft arm (outside).



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-307, "MAIN BEARING CAP BOLT DEFORMATION" .

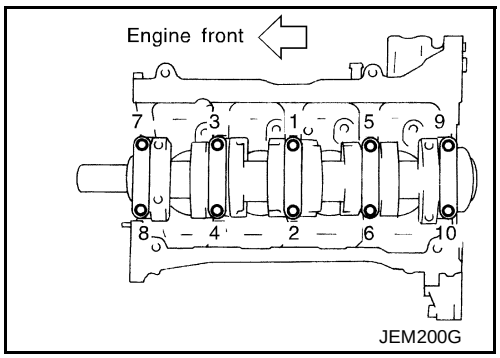


8. Tighten the main bearing cap bolts according to the following procedure:

a. Apply engine oil to the threaded part and seat surface of each bolt.

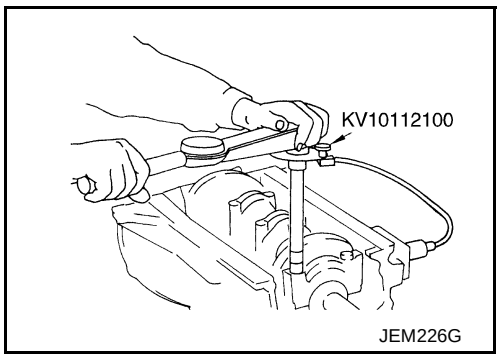
b. Tighten to 25 to 30 N·m (2.5 to 3.1 kg-m, 18 to 22 ft-lb) in the numerical order shown in the figure.

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-300, "CRANKSHAFT SIDE CLEARANCE" .



9. Check the outer diameter of connecting rod bolts. Refer to EM-307, "CONNECTING ROD BOLT DEFORMATION" .

10. Install pistons to connecting rod.

a. Using long nose pliers, install snap rings to grooves on piston rear side.

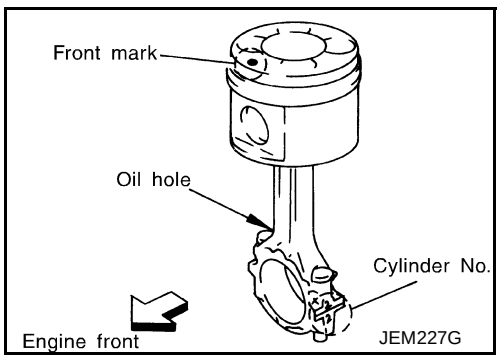
- Fit snap rings correctly into grooves.

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.



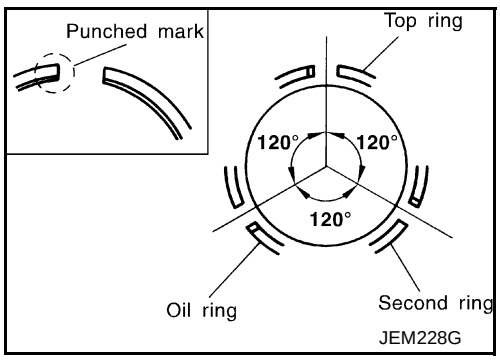
11. Use piston ring expander to install piston rings.

CAUTION:
When installing, prevent piston from being damaged.

- Install top ring and second ring with stamped surfaces facing upward.

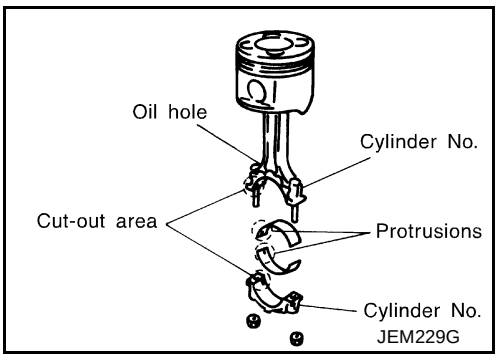
Identification stamp:

Top ring : R Top
Second ring : R 2ND



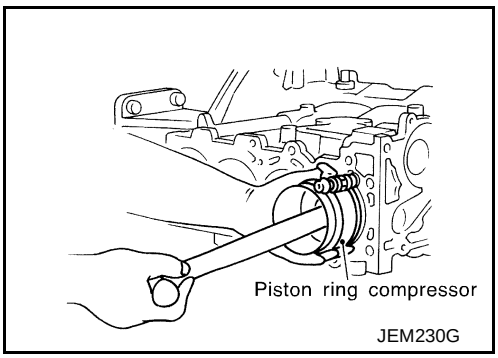
- Install rings so that three closed gap position 120° apart one another.
- Closed gaps do not need to face in a specific directions, as long as each are positioned 120° apart.

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.

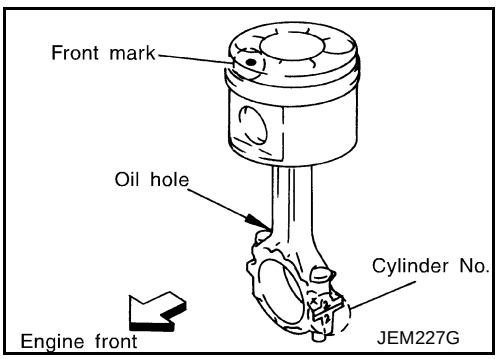


13. Install piston and connecting rod assembly to crankshaft.
    - Move crankshaft pin to be assembled to BDC.
    - Align cylinder position with cylinder No. on connecting rod to install piston and connecting rod assembly.
    - Using piston ring compressor, install piston and connecting rod assembly 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.

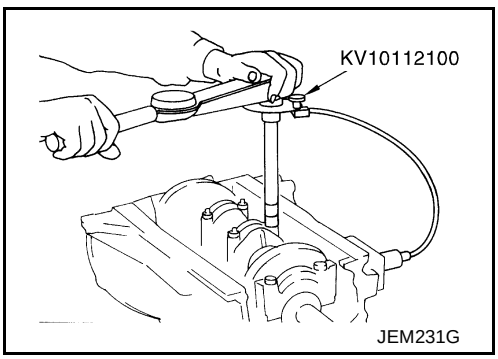


14. Install connecting rod caps and mounting nuts.
    - Align cylinder No. stamped on connecting rod with that on cap to install connecting rod cap.
    - Make sure that the front mark on connecting rod cap faces towards the front of the engine.



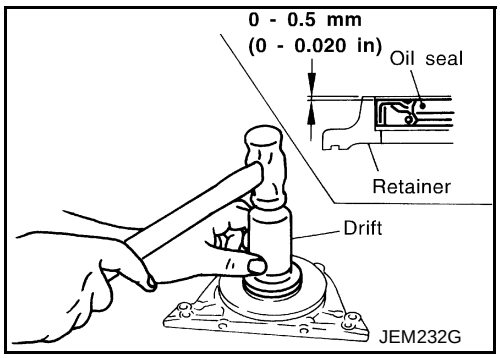
15. Tighten connecting rod nuts according to the following procedure:

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.

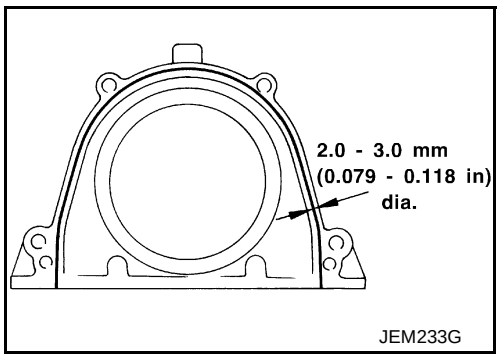


- Check connecting rod side clearance. Refer to EM-300, "CONNECTING ROD SIDE CLEARANCE" .

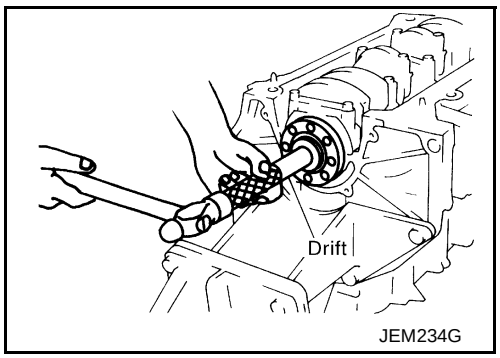
16. Force fit rear oil seal into rear oil seal retainer.
    - Using a drift [105 mm (4.13 in) dia.], force fit so that the dimension is as specified in the figure.
    - Avoid inclined fitting. Force fit perpendicularly.



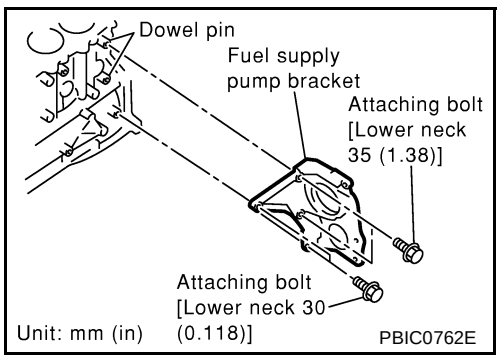
17. Install rear oil seal and retainer assembly.
    - Apply a continuous bead of liquid gasket to rear oil seal and retainer assembly as shown in the figure.



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 supply pump 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

EBS00GSP

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)

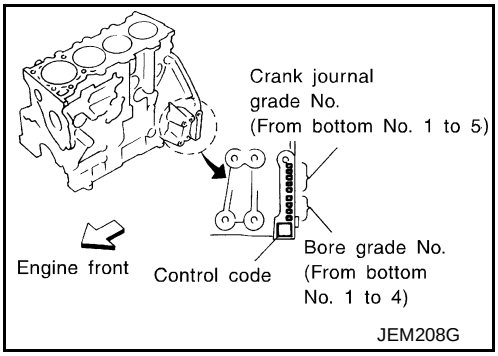
- The identification grade stamped on each part is the grade for the dimension measured in new condition. This grade cannot apply to reused parts.
- For reused or repaired parts, measure the dimension accurately. Determine the grade by comparing the measurement with the values of each selection table.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

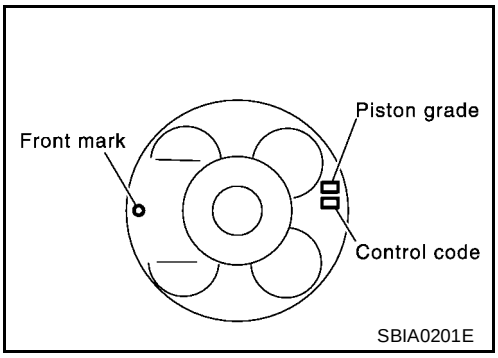
1. Identify the cylinder bore grade (No. 1, 2, or 3) on LH surface at the rear of cylinder block.
2. Select the piston of the same grade.

- 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

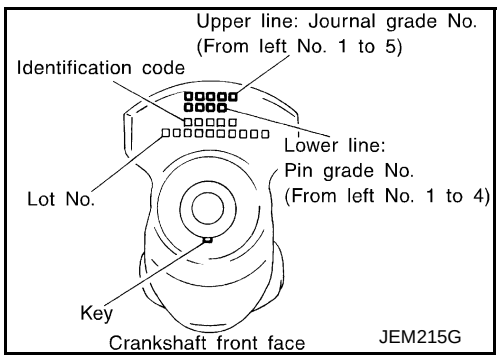
Unit: mm (in)

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

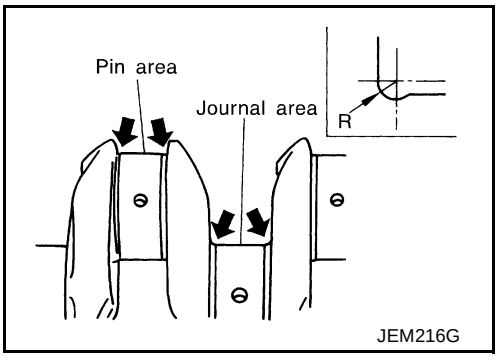
Under Size Bearing Usage

- 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)



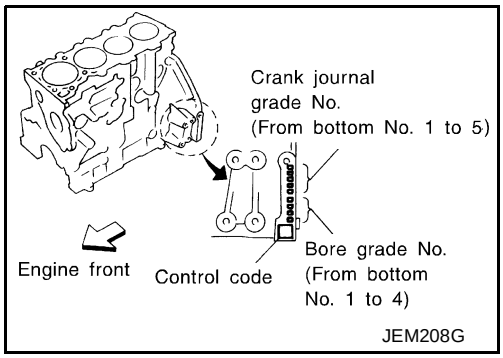
CAUTION:
When grinding the crankshaft journal to use an under size bearing, avoid damaging the fillet R.

Standard dimension R : 1.5 - 1.7 mm (0.0591 - 0.0669 in)

HOW TO SELECT MAIN BEARING

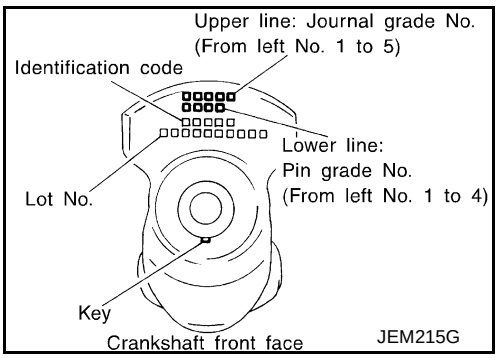
When Using a New Cylinder Block and Crankshaft

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) 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

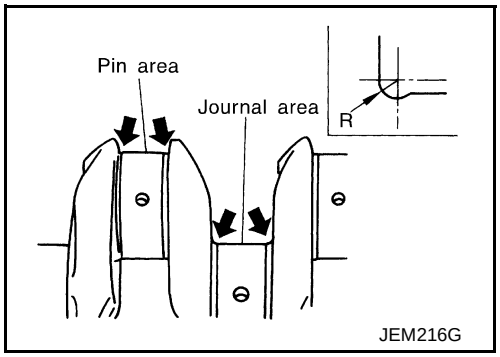
Unit: mm (in)

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

EBS00GSQ

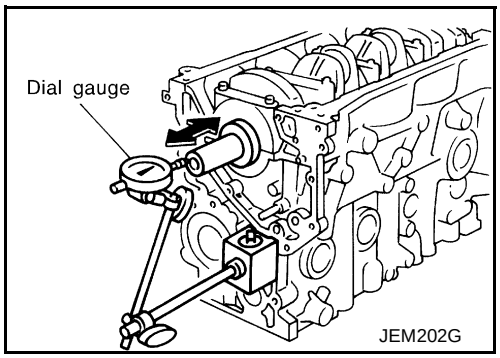
CRANKSHAFT SIDE CLEARANCE

- 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.



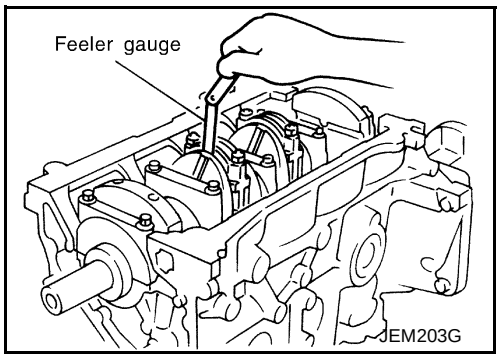
CONNECTING ROD SIDE CLEARANCE

- 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.

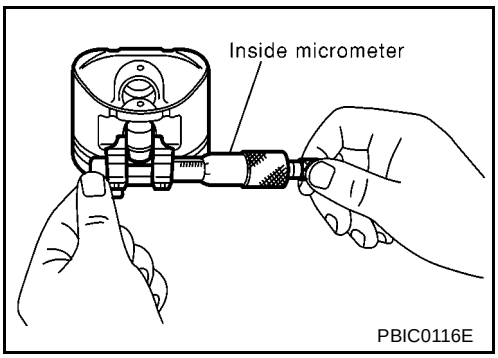


PISTON TO PISTON PIN CLEARANCE

Piston Pin Hole Inner Diameter

Using inside micrometer, measure piston pin hole inner diameter.

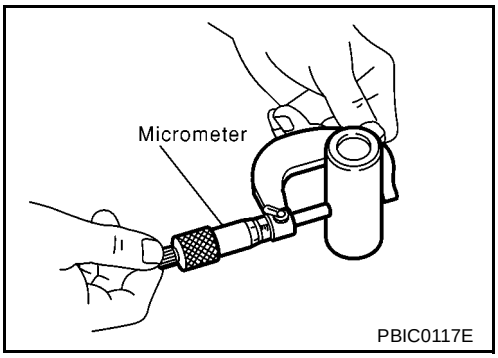
Standard : 27.997 - 28.005 mm (1.1022 - 1.1026 in)



Piston Pin Outer Diameter

Using micrometer, measure piston pin outer diameter.

Standard : 27.994 - 28.000 mm (1.1021 - 1.1024 in)



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)

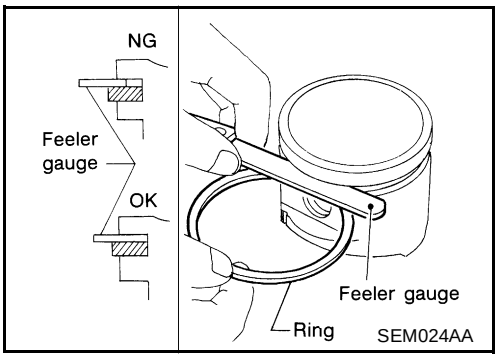
- If clearance is exceeds specification, replace either or both piston/piston pin assembly.

PISTON RING SIDE CLEARANCE

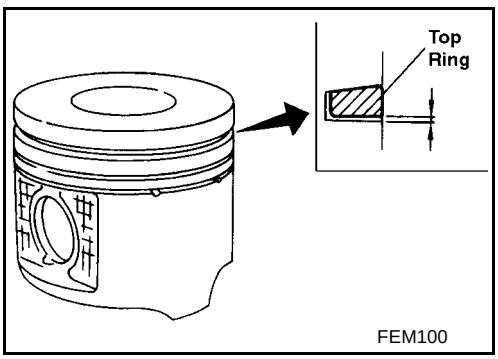
- Using feeler gauge, measure clearance between piston ring and piston ring groove.

Unit: mm (in)

Item	Standard	Limit
Top ring	0.050- 0.090 (0.0020 - 0.0035)	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.

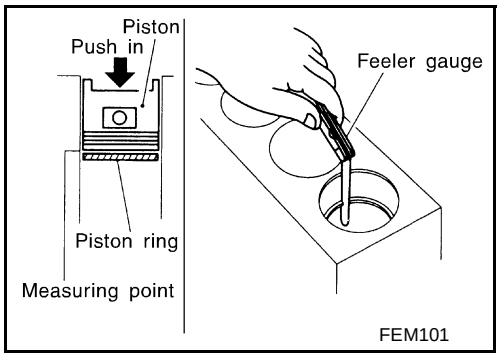


PISTON RING END GAP

- Check that cylinder bore diameter is within specifications. Refer to EM-304, "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	0.21 - 0.31 (0.0083 - 0.0122)	1.0 (0.039)
2nd ring	0.32 - 0.52 (0.0126 - 0.0205)	
Oil ring	0.30 - 0.55 (0.0118 - 0.0217)	

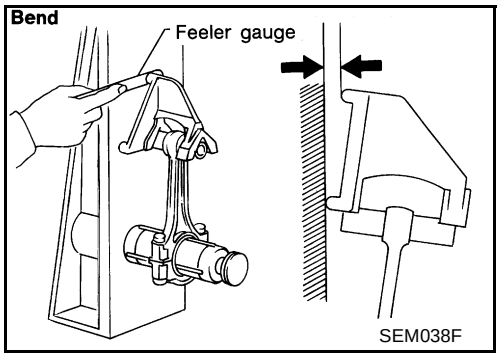


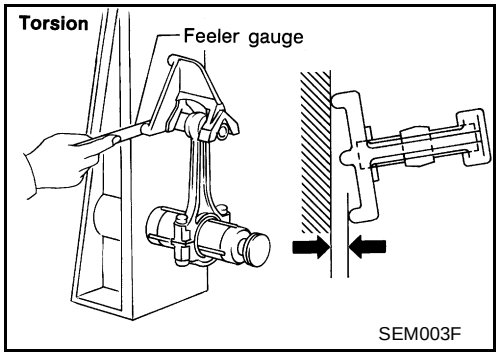
CONNECTING ROD BEND AND TORSION

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)

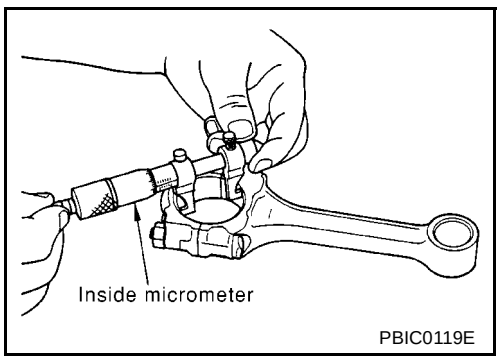




CONNECTING ROD BIG END INNER DIAMETER

- 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)

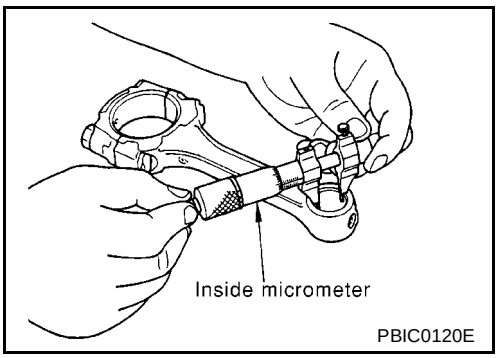


CONNECTING ROD BUSHING OIL CLEARANCE (SMALL END)

Connecting Rod Small End Inner Diameter

Use inside micrometer to measure small end inner diameter.

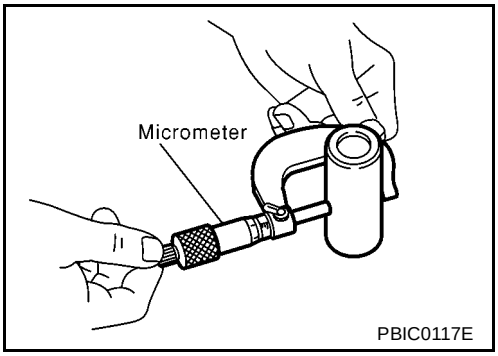
Standard : 28.026 - 28.038 mm (1.1034 - 1.1039 in)



Piston Pin Outer Diameter

Use micrometer to measure piston pin outer diameter.

Standard : 27.994 - 28.000 mm (1.1021 - 1.1024 in)



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)

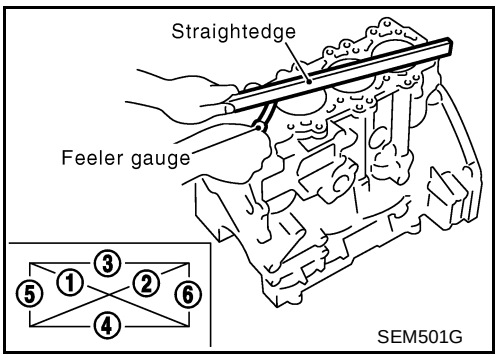
- If out of specifications, replace connecting rod and/or piston and piston pin assembly. Refer to EM-298, "HOW TO SELECT CONNECTING ROD BEARING" .

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)

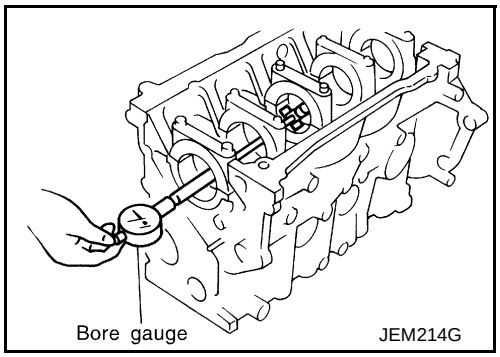


MAIN BEARING HOUSING INNER DIAMETER

- 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)

- If the measurement is out of the specified range, replace cylinder block and main bearing caps.



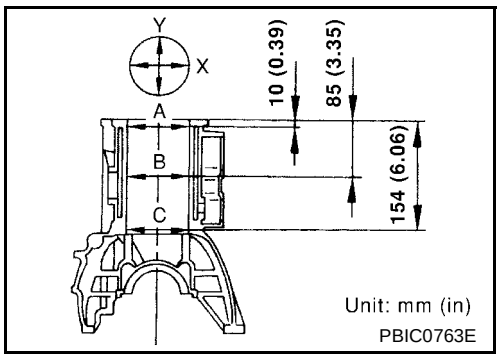
PISTON TO CYLINDER BORE CLEARANCE

Cylinder Bore Inner Diameter

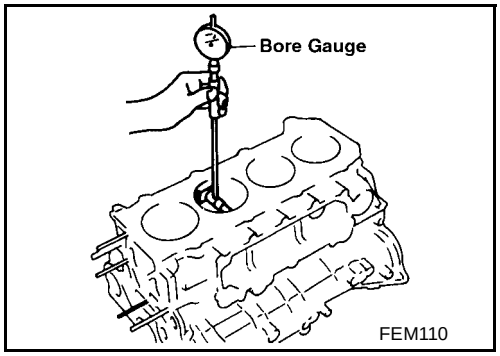
- Using bore gauge, measure cylinder inner diameters at 6 positions; top, middle, and bottom (C - A) in 2 directions (X, Y).

Cylinder inner diameter:

Standard	**: 86.000 - 86.030 mm (3.3858 - 3.5870 in)**
Wear limit	**: 0.07 mm (0.0028 in)**
Out-of-round limit (X - Y)	**: 0.015 mm (0.0006 in)**
Taper limit (C - A)	**: 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.

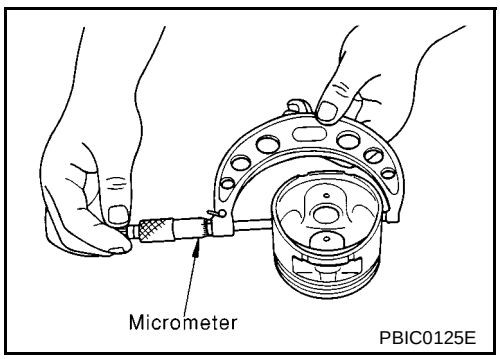


Piston Outer Diameter

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)**
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-297, "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:Rebored diameter

A: Piston diameter as measured

B: Piston-to-bore clearance

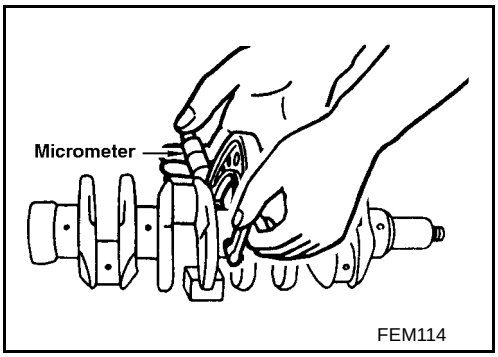
C: Honing allowance 0.02 mm (0.0008 in)

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)



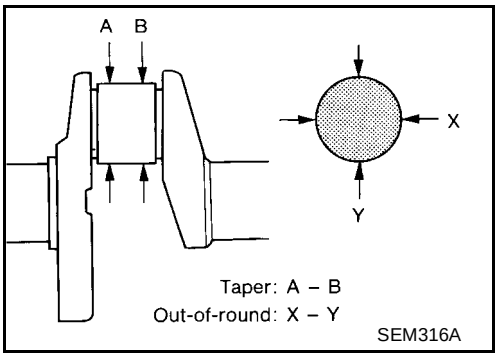
CRANKSHAFT PIN OUTER DIAMETER

Use micrometer to measure pin outer diameter.

Standard : 51.954 - 51.974 mm (2.0454 - 2.0462 in)

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:

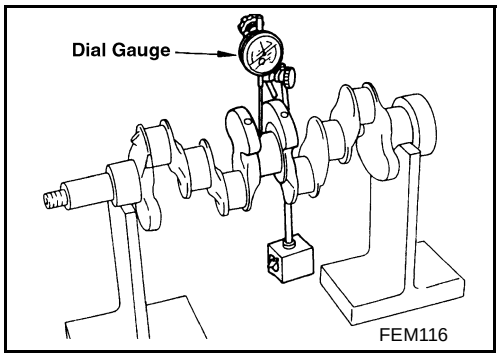
Standard : 0.003 mm (0.0001 in)

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)



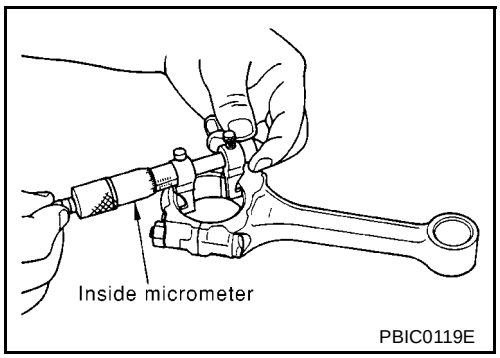
CONNECTING ROD BEARING OIL CLEARANCE

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-298, "HOW TO SELECT CONNECTING ROD BEARING" .



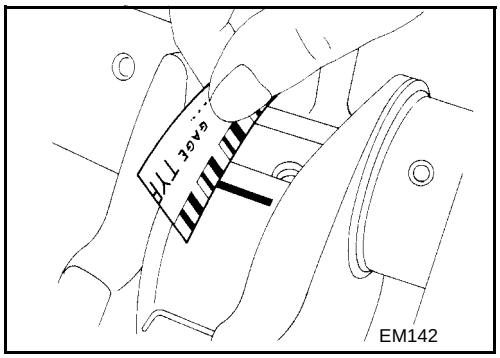
Method using plastigage

- 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)

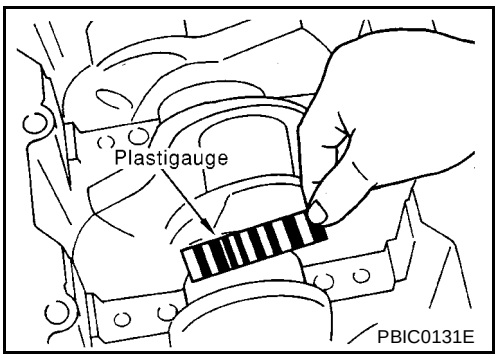
- If out of specification, check main bearing housing inner diameter and crankshaft journal outer diameter, and select appropriate main bearing to adjust clearance to specifications. Refer to EM-299, "HOW TO SELECT MAIN BEARING" .

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".

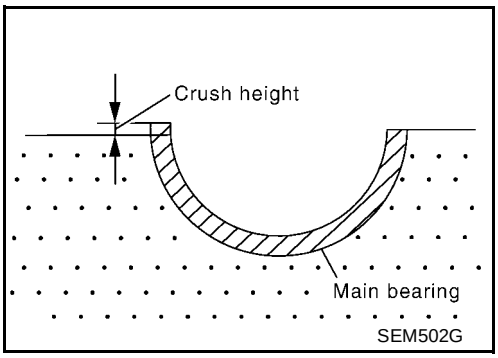
- Install main bearings to the cylinder block and bearing cap, and tighten the bolts to the specified torque. Then, measure the inner diameter of the main bearings.

MAIN BEARING CRUSH HEIGHT

- 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.

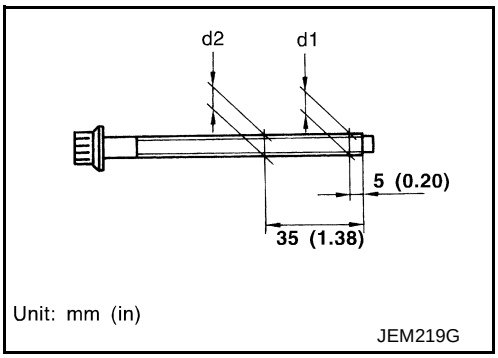
- If out of specification, replace main bearings.



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)

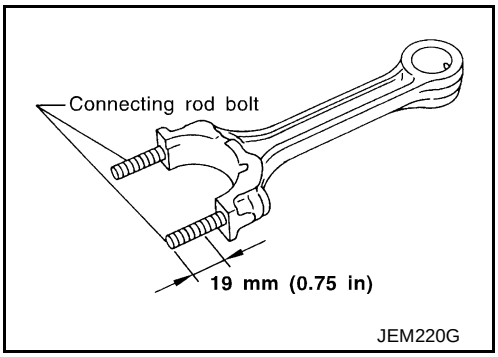


CONNECTING ROD BOLT DEFORMATION

- 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.

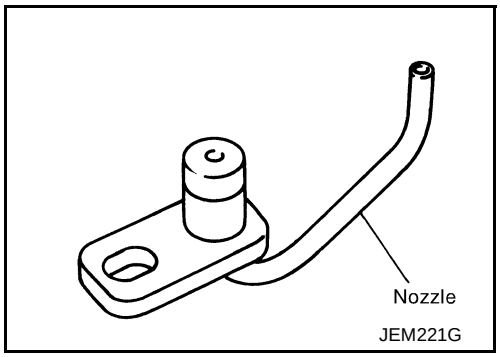


OIL JET

- 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.

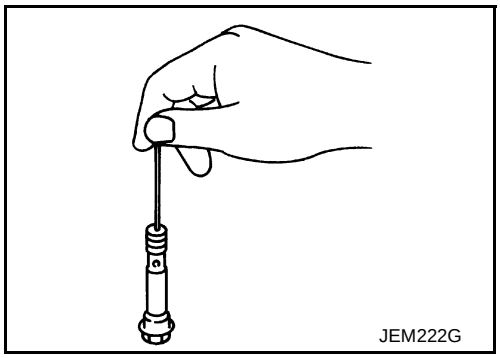


OIL JET RELIEF VALVE

- 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:

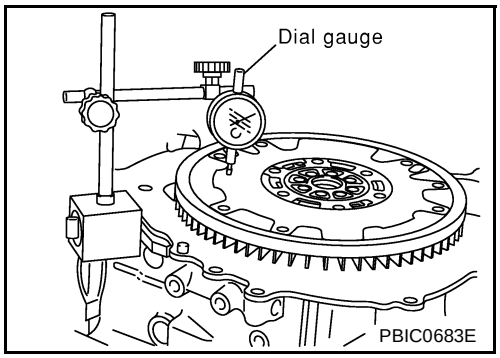
- Inspection for double mass flywheel only.
- Do not disassembly double mass flywheel.

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.

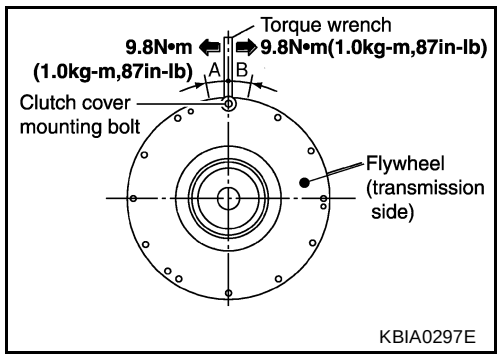
1. Install a bolt to clutch cover mounting hole, and place a torque wrench on the extended line of the flywheel center line.

- 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.



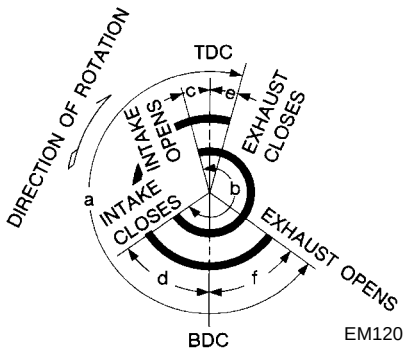
SERVICE DATA AND SPECIFICATIONS (SDS)

PFP:00030

Standard and Limit

EBS00GSR

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)

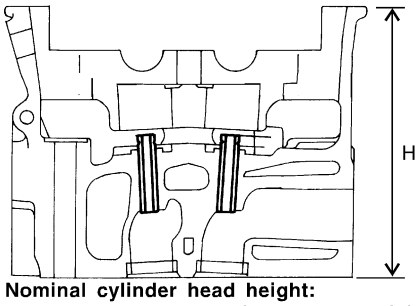
Applied belt	Belt deflection with 98 N (10 kg, 22 lb) force applied*		
	New	Adjusted	Limit for re-adjusting
Air conditioner compressor belt	4 - 5 (0.16 - 0.20)	6 - 7 (0.24 - 0.28)	8.5 (0.335)
Alternator & water pump belt	9.0 - 10.5 (0.354 - 0.413)	11.0 - 12.5 (0.433 - 0.492)	16.5 (0.650)

*: 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)



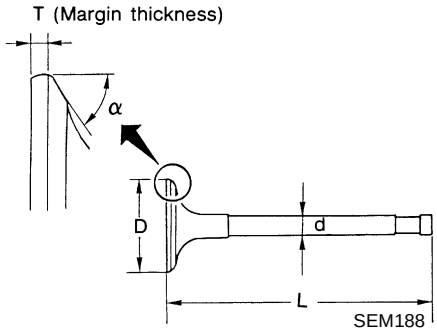
Nominal cylinder head height:
H = 153.9 - 154.1 mm (6.059 - 6.067 in)

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

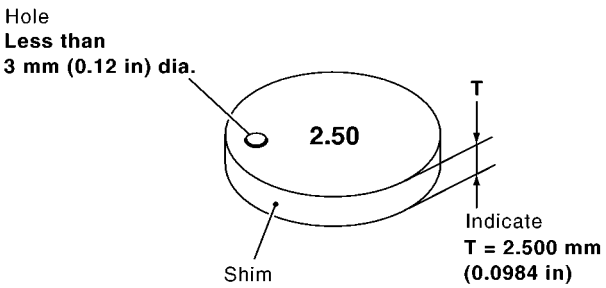
Unit: mm (in)

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)	44.74 (1.7614)
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)	0.78 (0.0307)
Heigh during valve open	mm (in)	24.82 (0.9772)
Load with valve open	N (kg, lb)	320 - 360 (32.65 - 36.73, 71.9 - 80.9)

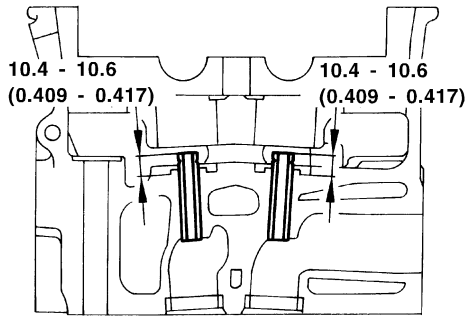
Valve Lifter

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)

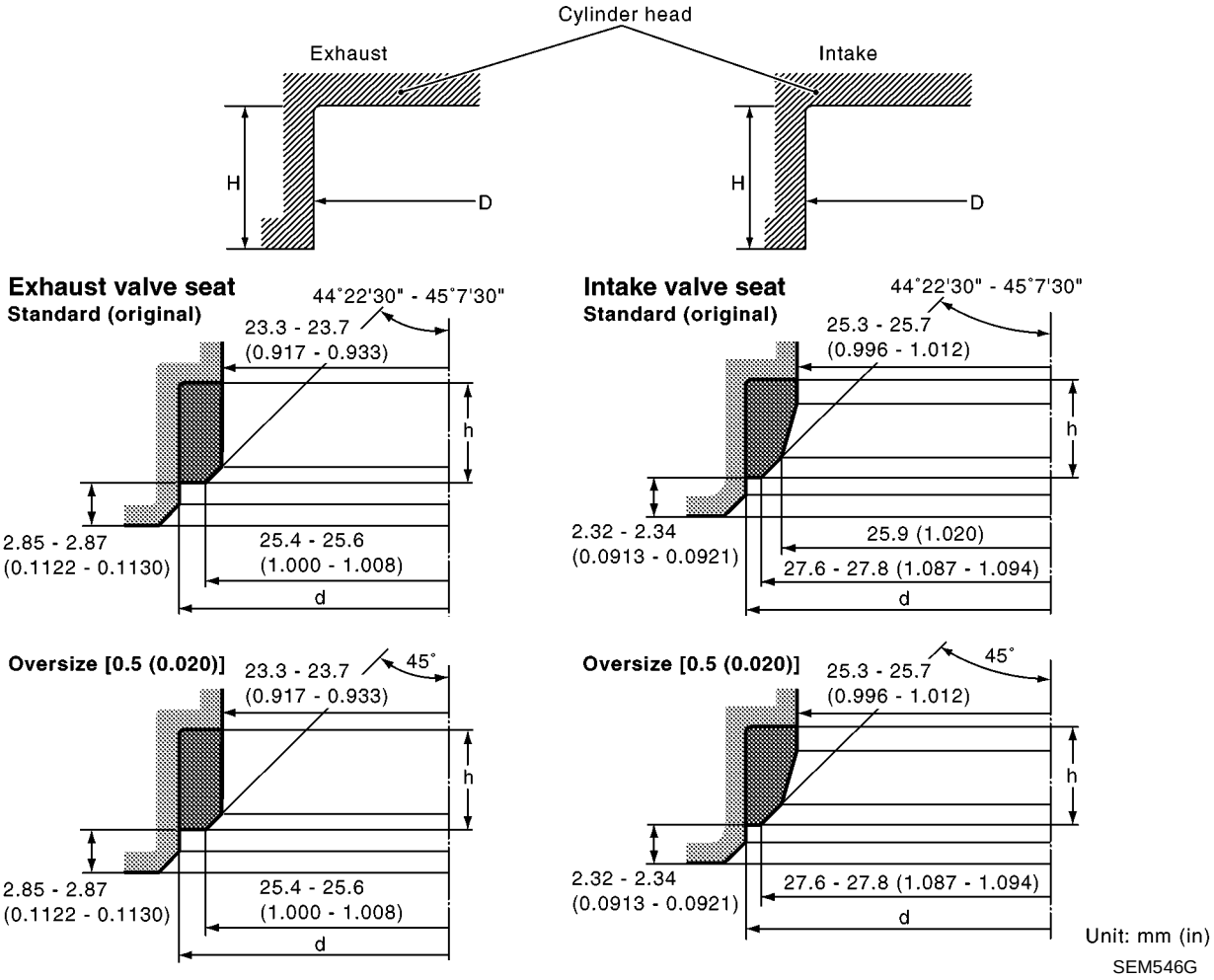


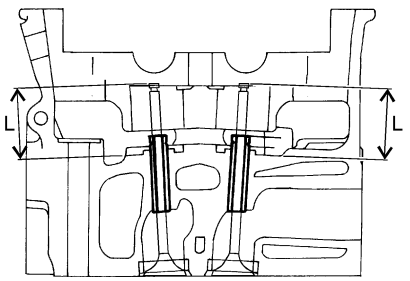
Unit: mm (in) JEM156G

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 (0.409 - 0.417)	

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)

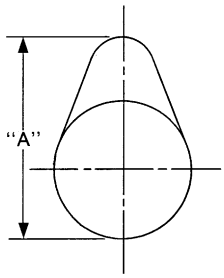
Depth (H)	Intake	8.83 - 9.13 (0.3476 - 0.3594)
	Exhaust	9.06 - 9.36 (0.3567 - 0.3685)
Projection (L)	Intake	36.53 - 36.98 (1.4382 - 1.4559)
	Exhaust	36.53 - 37.01 (1.4382 - 1.4571)

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 (0.0028 - 0.0058)	0.24 (0.0094)

*: Total indicator reading

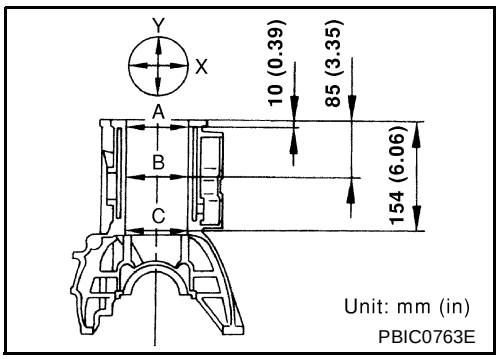


SEM671

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)



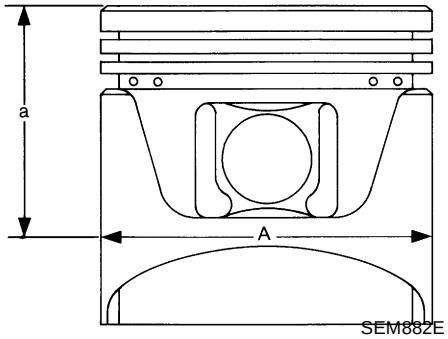
Surface flatness	Standard			Less than 0.03 (0.0012)
	Limit			0.04 (0.0016)
Cylinder bore	Inner diameter	Standard	Grade No. 1	86.000 - 86.010 (3.3858 - 3.3862)
			Grade No. 2	86.010 - 86.020 (3.3862 - 3.3866)
			Grade No. 3	86.020 - 86.030 (3.3866 - 3.3870)
		Wear limit		0.07 (0.0028)

Out-of-round (X – Y)		Less than 0.015 (0.0006)
Taper (C - A)		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	0.050 - 0.090 (0.0020 - 0.0035)	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	0.21 - 0.31 (0.0083 - 0.0122)	1.0 (0.039)
	2nd	0.32 - 0.52 (0.0126 - 0.0205)	1.0 (0.039)
	Oil (rail ring)	0.30 - 0.55 (0.0118 - 0.0217)	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)

CONNECTNG ROD

Unit: mm (in)

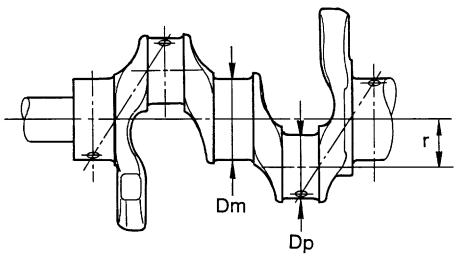
Center distance		157.5 (6.201)
Bend [per 100 (3.94)]	Limit	0.12 (0.0047)
Torsion [per 100 (3.94)]	Limit	0.12 (0.0047)
Connecting rod small end inner diameter		30.080 - 31.000 (1.1842 - 1.2205)
Piston pin bushing inner diameter*		28.026 - 28.038 (1.1034 - 1.1039)
Connecting rod big end inner diameter*		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

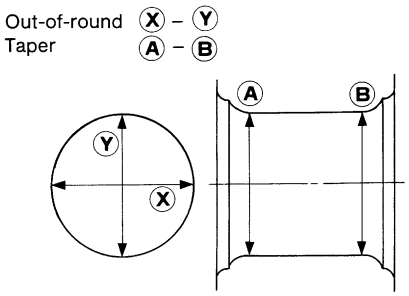
CRANKSHAFT

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



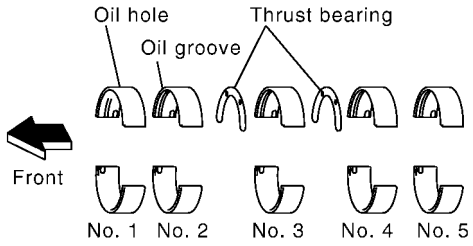
SEM715

*: 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

EBS00GSS

*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			15.7 - 18.6 (1.6 - 1.8 ,12 - 13)
	Air inlet tube			19.6 - 23.5 (2.0 - 2.3 ,15 - 17)
	EGR volume control valve			62.0 - 78.0 (6.3 - 8.0, 46 - 57)
	EGR tube			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			29.4 - 39.2 (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
	Tensior 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 housing		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 - 115, 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)