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# SECTION **EM**

## ENGINE MECHANICAL

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# PRECAUTIONS

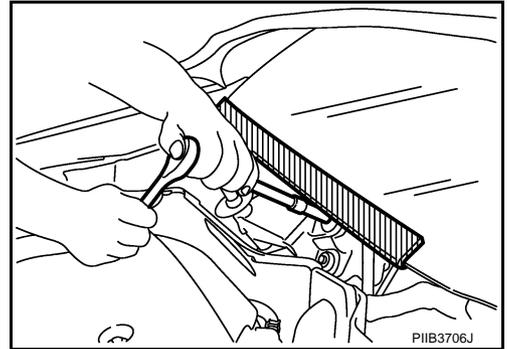
## PRECAUTIONS

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### Precautions for Procedures without Cowl Top Cover

NBS004M2

When performing the procedure after removing cowl top cover, cover the lower end of windshield with urethane, etc.



### Precautions for Supplemental Restraint System (SRS) “AIR BAG” and “SEAT BELT PRE-TENSIONER”

NBS004M3

The Supplemental Restraint System such as “AIR BAG” and “SEAT BELT PRE-TENSIONER”, used along with a front seat belt, helps to reduce the risk or severity of injury to the driver and front passenger for certain types of collision. This system includes seat belt switch inputs and dual stage front air bag modules. The SRS system uses the seat belt switches to determine the front air bag deployment, and may only deploy one front air bag, depending on the severity of a collision and whether the front occupants are belted or unbelted. Information necessary to service the system safely is included in the SRS and SB section of this Service Manual.

#### **WARNING:**

- To avoid rendering the SRS inoperative, which could increase the risk of personal injury or death in the event of a collision which would result in air bag inflation, all maintenance must be performed by an authorized NISSAN/INFINITI dealer.
- Improper maintenance, including incorrect removal and installation of the SRS, can lead to personal injury caused by unintentional activation of the system. For removal of Spiral Cable and Air Bag Module, see the SRS section.
- Do not use electrical test equipment on any circuit related to the SRS unless instructed to in this Service Manual. SRS wiring harnesses can be identified by yellow and/or orange harnesses or harness connectors.

### Precautions for Draining Engine Coolant

NBS001O3

Drain engine coolant when engine is cooled.

### Precautions for Disconnecting Fuel Piping

NBS001O4

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

### Precautions for Removal and Disassembly

NBS001O5

- 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. Power tools may be used where noted in the step.

### Precautions for Inspection, Repair and Replacement

NBS001O6

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

# PRECAUTIONS

## Precautions for Assembly and Installation

NBS00107

- Use torque wrench to tighten bolts or nuts to specification.
- 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 liquid gasket, packing, oil seal or O-ring.
- Guide pins are used for several parts alignment. When replacing and reassembling parts with guide pins make sure that guide pins are installed in the original position.
- Thoroughly wash, clean, and air-blow each part. Carefully check engine oil or engine 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, engine oil sliding surfaces well.
- Release air within route when refilling after draining engine coolant.
- Before starting the engine, apply fuel pressure to fuel lines with turning ignition switch "ON" (with the engine stopped). Then make sure there are no leaks at fuel line connections.
- After repairing, start engine and increase engine speed to check engine coolant, fuel, engine oil, and exhaust gases for leakage.

## Parts Requiring Angle Tightening

NBS00108

- Use the angle wrench [SST: KV10112100 (BT8653-A)] 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 angle 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 REMOVAL OF LIQUID GASKET SEALING

NBS00109

- After removing the mounting bolts and nuts, separate the mating surface using the seal cutter (SST) and remove the old liquid gasket sealing.

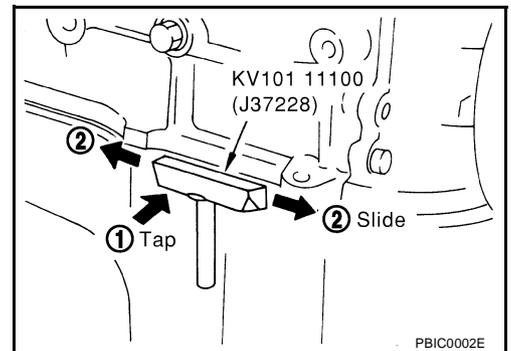
### **CAUTION:**

**Be careful not to damage the mating surfaces.**

- Tap seal cutter to insert it, and then slide it by tapping on the side as shown in the figure.
- In areas where seal cutter (SST) is difficult to use, use plastic hammer to lightly tap the parts, to remove it.

### **CAUTION:**

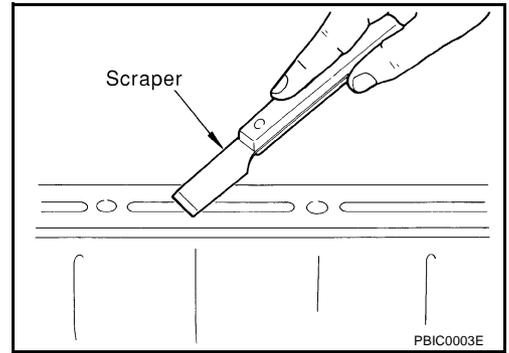
**If for some unavoidable reason tool such as screwdriver is used, be careful not to damage the mating surfaces.**



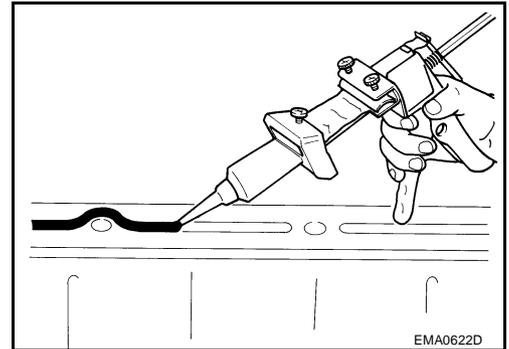
# PRECAUTIONS

## LIQUID GASKET APPLICATION PROCEDURE

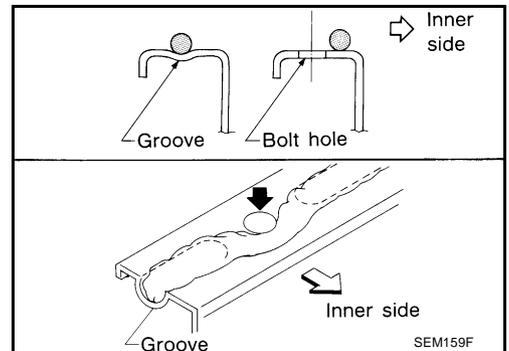
1. Using a scraper, remove the old liquid gasket adhering to the liquid gasket application surface and the mating surface.
  - Remove the liquid gasket completely from the groove of the liquid gasket application surface, mounting bolts, and bolt holes.
2. Wipe the liquid gasket application surface and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



3. Attach the liquid gasket tube to tube presser [SST: WS39930000 ( — )].  
**Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-45, "RECOMMENDED CHEMICAL PRODUCTS AND SEALANTS"](#).**



4. Apply the liquid gasket without breaks to the specified location with the specified dimensions.
  - If there is a groove for the liquid gasket application, apply the liquid gasket to the groove.
  - As for the bolt holes, normally apply the liquid gasket inside the holes. Occasionally, it should be applied outside the holes. Make sure to read the text of this manual.
  - Within 5 minutes of liquid gasket application, install the mating component.
  - If the liquid gasket protrudes, wipe it off immediately.
  - Do not retighten mounting nuts or bolts after the installation.
  - Wait 30 minutes or more after installing, refill the engine oil and engine coolant.



### **CAUTION:**

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

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# PREPARATION

## PREPARATION

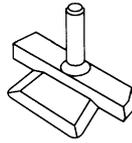
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### Special Service Tools

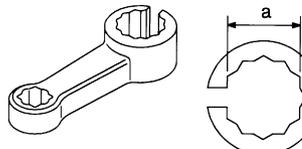
NBS0010A

The actual shapes of Kent-Moore tools may differ from those of special service tools illustrated here.

Tool number (Kent-Moore No.) Tool name	Description
KV10111100 (J-37228) Seal cutter	Removing steel oil pan and front cover, etc.
KV10114400 (J-38365) Heated oxygen sensor wrench	Loosening or tightening heated oxygen sensors <b>a: 22 mm (0.87 in)</b>
EG15050500 (J-45402) Compression gauge adapter	Inspection of compression pressure on No. 7 and No. 8 cylinders
KV10116200 (J-26336-A) Valve spring compressor 1. KV10115900 (J-26336-20) Attachment 2. KV10109230 ( — ) Adapter	Disassembling and assembling valve mechanism Part (1) is a component of KV10116200 (J-26336-A), but part (2) is not so.
KV101151S0 (J-38972) Lifter stopper set 1. KV10115110 (J-38972-1) Camshaft pliers 2. KV10115120 (J-38972-2) Lifter stopper	Changing adjusting shims
KV10112100 (BT8653-A) Angle wrench	Tightening bolts for bearing cap, cylinder head, etc.



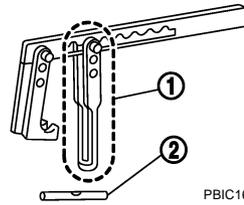
S-NT046



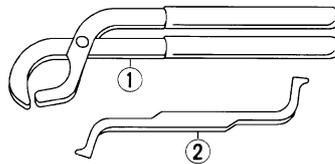
S-NT636



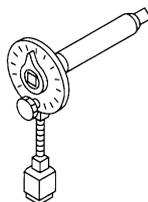
ZZA1225D



PBIC1650E



S-NT041

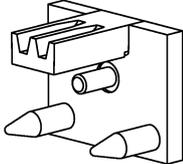


S-NT014

# PREPARATION

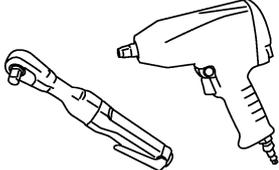
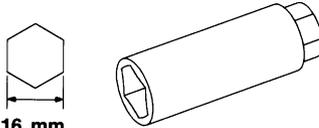
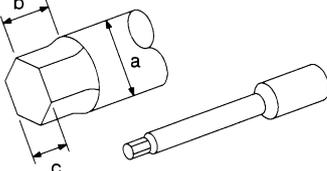
Tool number (Kent-Moore No.) Tool name	Description	A
KV10114700 (J-38139) Main bearing cap remover	Removing crankshaft main bearing cap	EM  C
KV10107902 (J-38959) Valve oil seal puller	Removing valve oil seal	D  E
KV10115600 (J-38958) Valve oil seal drift	Installing valve oil seal <b>Use side A.</b> 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)	F  G  H
EM03470000 (J-8037) Piston ring compressor	Installing piston assembly into cylinder bore	I  J
ST16610001 (J-23907) Pilot bushing puller	Removing crankshaft pilot converter	K  L
WS39930000 ( — ) Tube presser	Pressing the tube of liquid gasket	M

# PREPARATION

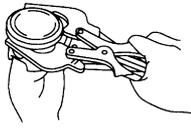
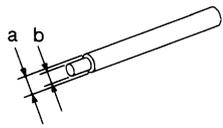
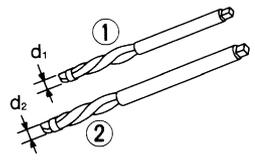
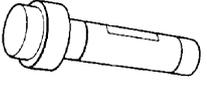
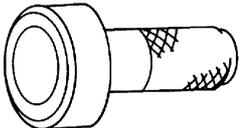
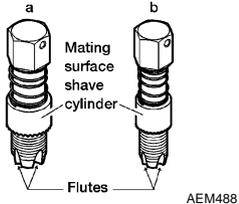
Tool number (Kent-Moore No.) Tool name		Description
— (J- 45476) Ring gear stopper	 PBIC1655E	Removing and installing crankshaft pulley
— (J-45488) Quick connector release	 PBIC0198E	Removing fuel tube quick connectors in engine room

## Commercial Service Tools

NBS0010B

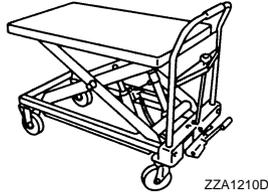
(Kent-Moore No.) Tool name		Description
( — ) Power tool	 PBIC0190E	Loosening bolts and nuts
( — ) Spark plug wrench	 <b>16 mm (0.63 in)</b> S-NT047	Removing and installing spark plug
(J-24239-01) Cylinder head bolt wrench	 NT583	Loosening and tightening cylinder head bolt, and used with angle wrench [SST: KV10112100 (BT8653-A)] <b>a: 13 (0.51) dia.</b> <b>b: 12 (0.47)</b> <b>c: 10 (0.39)</b> Unit: mm (in)
( — ) Valve seat cutter set	 S-NT048	Finishing valve seat dimensions

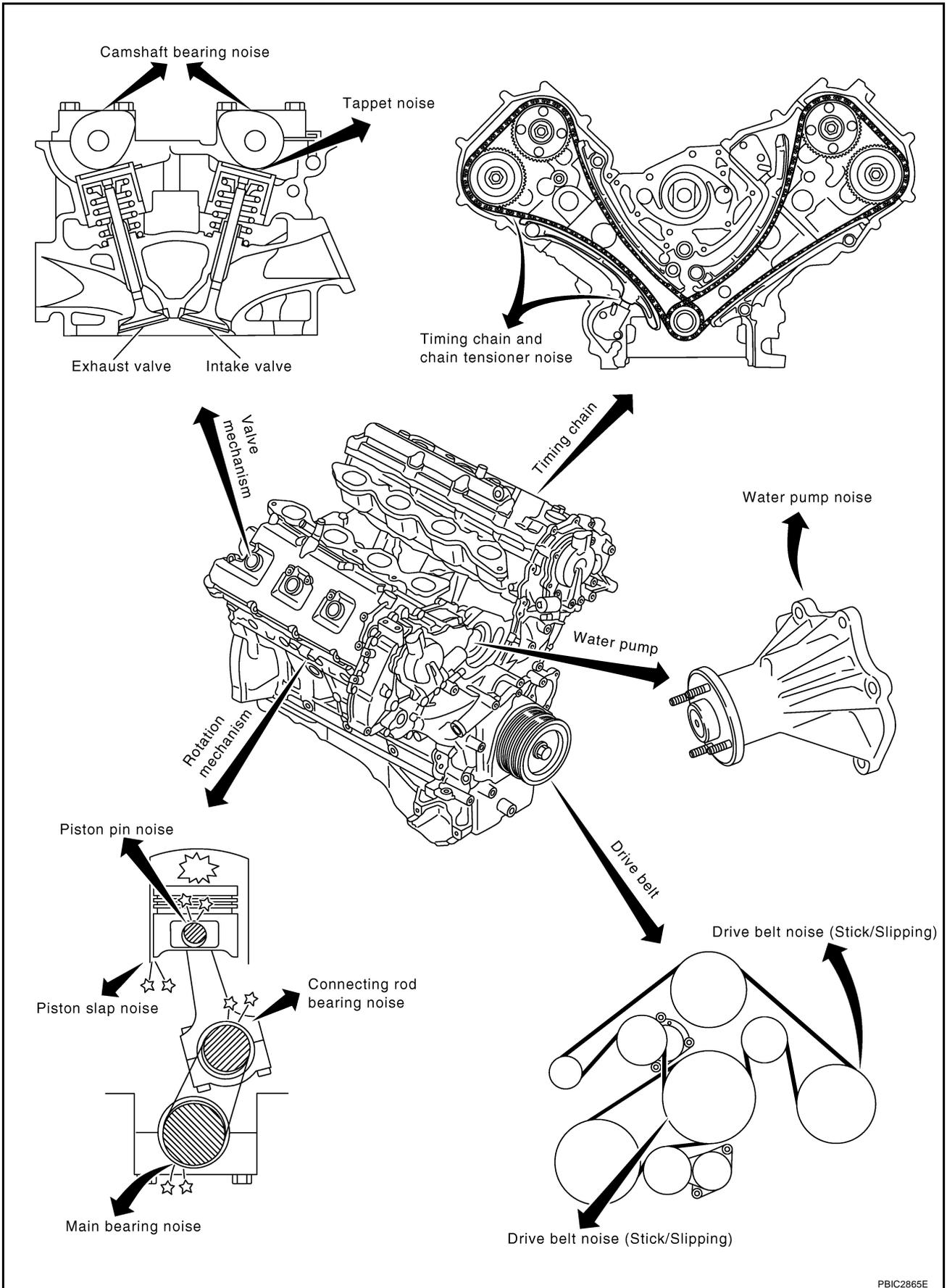
# PREPARATION

(Kent-Moore No.) Tool name	Description	A
( — ) Piston ring expander  S-NT030	Removing and installing piston ring	EM C
( — ) Valve guide drift  S-NT015	Removing and installing valve guide <b>Intake &amp; Exhaust:</b> <b>a: 9.5 mm (0.374 in) dia.</b> <b>b: 5.5 mm (0.217 in) dia.</b>	D E
( — ) Valve guide reamer  S-NT016	1: Reaming valve guide inner hole 2: Reaming hole for oversize valve guide <b>Intake &amp; Exhaust:</b> <b>d1 : 6.0 mm (0.236 in) dia.</b> <b>d2 : 10.2 mm (0.402 in) dia.</b>	F G
( — ) Front oil seal drift  ZZA0012D	Installing front oil seal when front cover is removed	H I J
( — ) Rear oil seal drift  ZZA0025D	Installing rear oil seal	K L
a: (J-43897-18) b: (J-43897-12) oxygen sensor thread cleaner  AEM488	Reconditioning the exhaust system threads before installing a new heated oxygen sensor (Use with anti-seize lubricant shown below.) <b>a: J-43897- 18 [18mm (0.71 in) dia.] for zirconia heated oxygen sensor and air fuel ratio sensor</b> <b>b: J-43897-12 [12mm (0.47 in) dia.] for titania heated oxygen sensor and air fuel ratio sensor</b>	M

# PREPARATION

(Kent-Moore No.) Tool name	Description
( — ) Anti-seize lubricant (Permatex 133AR or equivalent meeting MIL specification MIL-A-907)	Lubricating heated oxygen sensor thread cleaning tool when reconditioning exhaust system threads
( — ) Manual lift table caddy	Removing and installing engine





# NOISE, VIBRATION AND HARSHNESS (NVH) TROUBLESHOOTING

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

NBS0010D

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	Ticking or clicking	C	A	—	A	B	—	Tappet noise	Valve clearance	<a href="#">EM-57</a>
Rocker cover	Rattle	C	A	—	A	B	C	Camshaft bearing noise	Camshaft journal clearance	<a href="#">EM-52</a> <a href="#">EM-51</a>
Cylinder head									Camshaft runout	
Crankshaft pulley Cylinder block (Side of engine) Oil pan	Slap or knock	—	A	—	B	B	—	Piston pin noise	Piston and piston pin clearance Connecting rod bushing oil clearance	<a href="#">EM-100</a> <a href="#">EM-102</a>
	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	<a href="#">EM-104</a> <a href="#">EM-101</a> <a href="#">EM-101</a> <a href="#">EM-102</a>
	Knock	A	B	C	B	B	B	Connecting rod bearing noise	Connecting rod bushing oil clearance Connecting rod bearing clearance (Big end)	<a href="#">EM-102</a> <a href="#">EM-107</a>
	Knock	A	B	—	A	B	C	Main bearing noise	Main bearing oil clearance Crankshaft runout	<a href="#">EM-107</a> <a href="#">EM-106</a>
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 Chain tensioner operation	<a href="#">EM-43</a> <a href="#">EM-39</a>
Front of engine	Squeaking or fizzing	A	B	—	B	—	C	Drive belts (Sticking or slipping)	Drive belts deflection	<a href="#">EM-14</a>
	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	<a href="#">CO-20.</a> <a href="#">"WATER PUMP"</a>

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

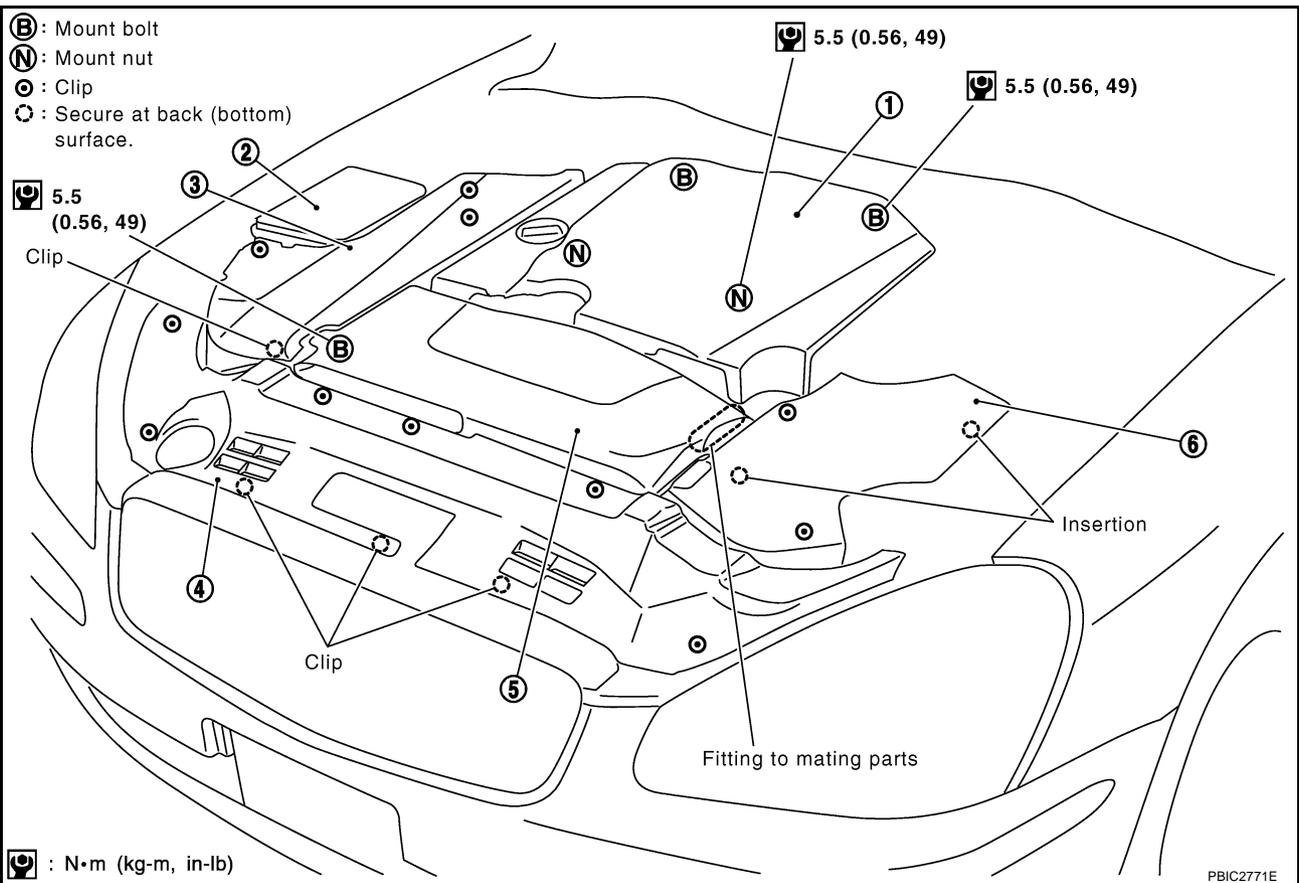
# ENGINE ROOM COVER

PFP:14049

## ENGINE ROOM COVER

### Removal and Installation

NBS0010E



- |                    |                     |                      |
|--------------------|---------------------|----------------------|
| 1. Engine cover    | 2. Relay box        | 3. Battery cover     |
| 4. Front air guide | 5. Air duct (inlet) | 6. Air cleaner cover |

### REMOVAL

- Remove clips on back with clip driver for each cover.

#### CAUTION:

**Do not damage or scratch cover when installing or removing.**

- Major parts and inspection points under each cover are as follows; (numbered as in figure)
  1. Spark plug, intake manifold, fuel injector
  2. Relay
  3. Battery, relay box
  4. Power steering fluid cooling tube
  5. Engine assembly front side, drive belts, cooling fan
  6. Mass air flow sensor, air cleaner case

### INSTALLATION

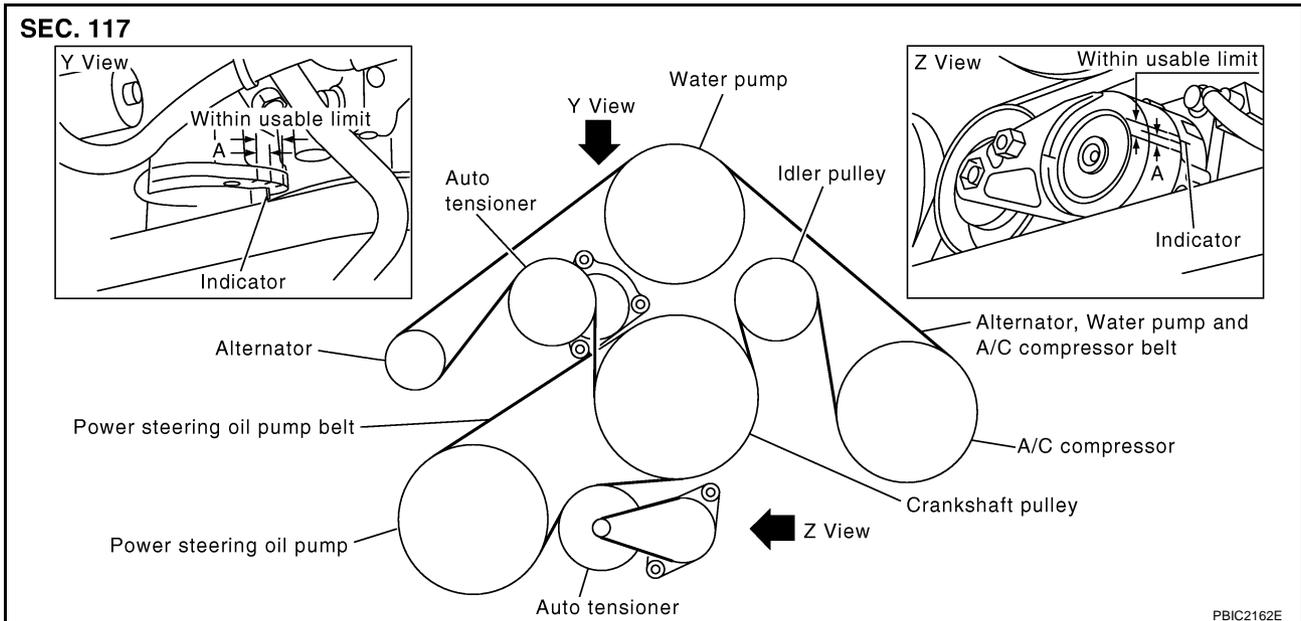
Install in the reverse order of removal.

## DRIVE BELTS

PF02117

### Checking Drive Belts

NBS0010F



**WARNING:**

Be sure to perform when engine is stopped.

- Remove air duct (inlet) when inspecting drive belt for alternator, water pump and A/C compressor.
- Remove engine undercover (with power tool) when inspecting power steering oil pump belt.
- Make sure that indicator (single line notch) of each auto tensioner is within the allowable working range (between three line notches).

**NOTE:**

- Check auto tensioner indication when engine is cold.
- When new drive belt is installed, the range should be A.
- The indicator notch is located on the moving side of auto tensioner for alternator, water pump and A/C compressor belt, while it is found on the fixed side for power steering oil pump belt.
- Visually check entire belt for wear, damage or cracks.
- If the indicator is out of allowable working range or belt is damaged, replace drive belt.

### Tension Adjustment

NBS0010G

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

### Removal and Installation

NBS0010H

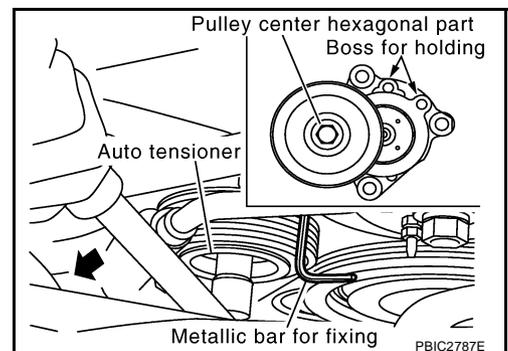
#### REMOVAL

#### Alternator, Water Pump and A/C Compressor Belt

1. Remove air duct (inlet). Refer to [EM-17, "AIR CLEANER AND AIR DUCT"](#) .
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.
  - Do not loosen the hexagonal part in center of drive belt auto-tensioner pulley (Do not turn it clockwise). If turned clockwise, the complete drive belt auto-tensioner must be replaced as a unit, including the pulley.
3. Under the above condition, insert a metallic bar of approximately 6 mm (0.24 in) in diameter (hexagonal bar wrench shown as example in the figure) through the holding boss to lock auto tensioner pulley arm.



# DRIVE BELTS

- Leave auto tensioner pulley arm locked until belt is installed again.
4. Remove alternator, water pump and A/C compressor belt.

## Power Steering Oil Pump Belt

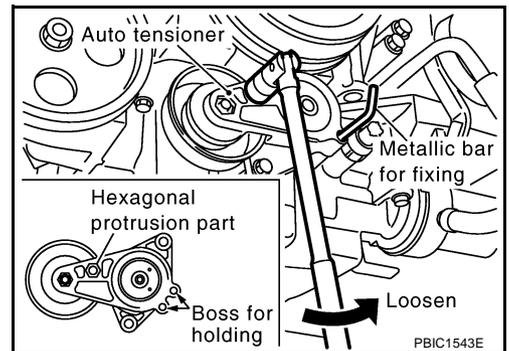
1. Remove air duct (inlet) and engine undercover (with power tool). Refer to [EM-17, "AIR CLEANER AND AIR DUCT"](#) .
2. Remove alternator, water pump and A/C compressor belt. Refer to [EM-14, "Alternator, Water Pump and A/C Compressor Belt"](#) .
3. While securely holding the hexagonal protrusion part of auto tensioner pulley with box wrench, 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.**

4. Under the above condition, insert a metallic bar of approximately 6 mm (0.24 in) in diameter (hexagonal bar wrench shown as example in the figure) through the holding boss to lock auto tensioner pulley arm.

- Leave auto tensioner pulley arm locked until belt is installed again.



5. Remove power steering oil pump belt.

## INSTALLATION

Note the following, and install in the reverse order of removal.

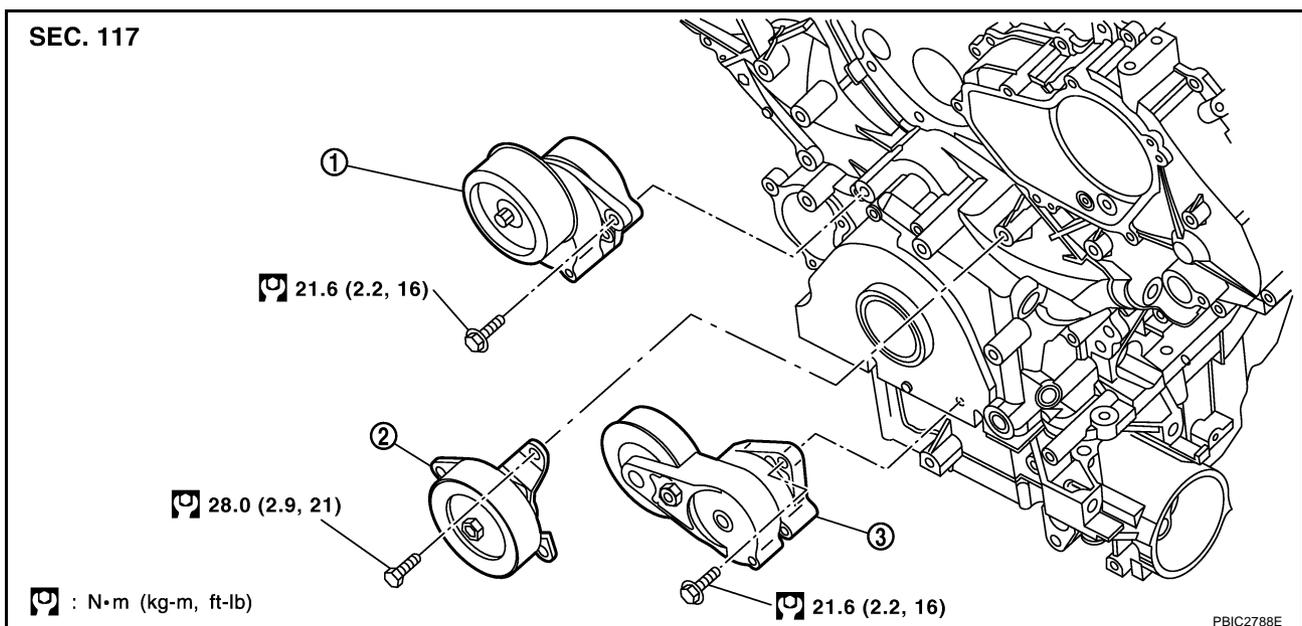
### CAUTION:

**Make sure belt is securely installed around all pulleys.**

- Unlock auto tensioner pulley arm to give tension to belt.
- Rotate crankshaft pulley several turns clockwise to equalize belt tension between pulleys.
- Make sure that belt tension is within the allowable working range, using indicator notch on auto tensioner. Refer to [EM-14, "Checking Drive Belts"](#) .

## Drive Belt Auto Tensioner and Idler Pulley

NBS00101



1. Auto tensioner (Used for alternator, water pump and A/C compressor belt)
2. Idler pulley
3. Auto tensioner (Used for power steering oil pump belt)

### CAUTION:

**The complete drive belt auto-tensioner must be replaced as a unit, including the pulley.**

# DRIVE BELTS

---

## REMOVAL

1. Remove air duct (inlet). Refer to [EM-17, "AIR CLEANER AND AIR DUCT"](#) .
2. Remove engine undercover (with power tool).
3. Remove drive belts. Refer to [EM-14, "Removal and Installation"](#) .
  - Keep auto tensioner pulley arm locked after belt is removed.
4. Remove auto tensioner and idler pulley with power tool.
  - Keep auto tensioner pulley arm locked to install or remove auto tensioner.

### **CAUTION:**

**Do not loosen the hexagonal part in center of drive belt auto-tensioner pulley (Do not turn it clockwise). If turned clockwise, the complete drive belt auto-tensioner must be replaced as a unit, including the pulley.**

## INSTALLATION

Install in the reverse order of removal.

### **CAUTION:**

**Do not swap the pulley between new and old drive belt auto-tensioner.**

## AIR CLEANER AND AIR DUCT

PFP:16500

### Removal and Installation

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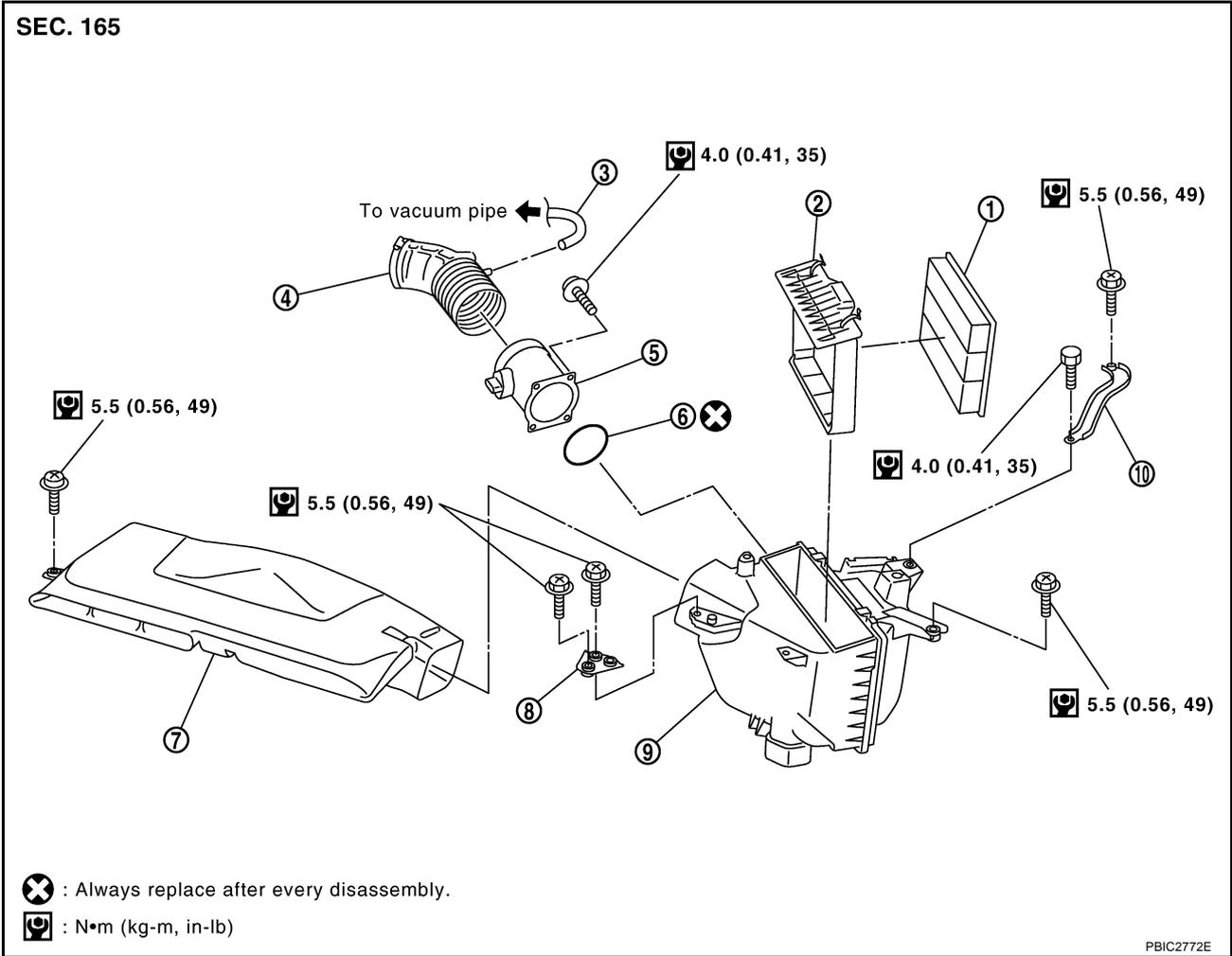
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- |                       |                         |                     |
|-----------------------|-------------------------|---------------------|
| 1. Air cleaner filter | 2. Holder               | 3. Vacuum hose      |
| 4. Air duct           | 5. Mass air flow sensor | 6. O-ring           |
| 7. Air duct (inlet)   | 8. Bracket              | 9. Air cleaner case |
| 10. Bracket           |                         |                     |

### REMOVAL

- Remove engine cover with power tool. Refer to [EM-13, "ENGINE ROOM COVER"](#).
- Remove air cleaner cover. Refer to [EM-13, "ENGINE ROOM COVER"](#).
- Disconnect harness connector from mass air flow sensor.
- Remove air duct (inlet), air duct and air cleaner case assembly disconnecting their joints.
  - Add marks as necessary for easier installation.
- Remove mass air flow sensor from air cleaner case, as necessary.

#### CAUTION:

**Handle mass air flow sensor with the following cares.**

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

### INSTALLATION

Note the following, and install in the reverse order of removal.

- Align marks. Attach each joint. Screw clamps firmly.

# AIR CLEANER AND AIR DUCT

---

## INSPECTION AFTER REMOVAL

Inspect air duct and resonator assembly for check or tear

- If anything found, replace air duct and resonator assembly.

## CHANGING AIR CLEANER FILTER

### Removal

1. Remove air cleaner cover. Refer to [EM-13, "ENGINE ROOM COVER"](#) .
2. Unhook clips and lift up holder with air cleaner filter.
3. Remove air cleaner filter.

### Installation

Install in the reverse order of removal.

# INTAKE MANIFOLD

PPF:14003

A

## INTAKE MANIFOLD

### Removal and Installation

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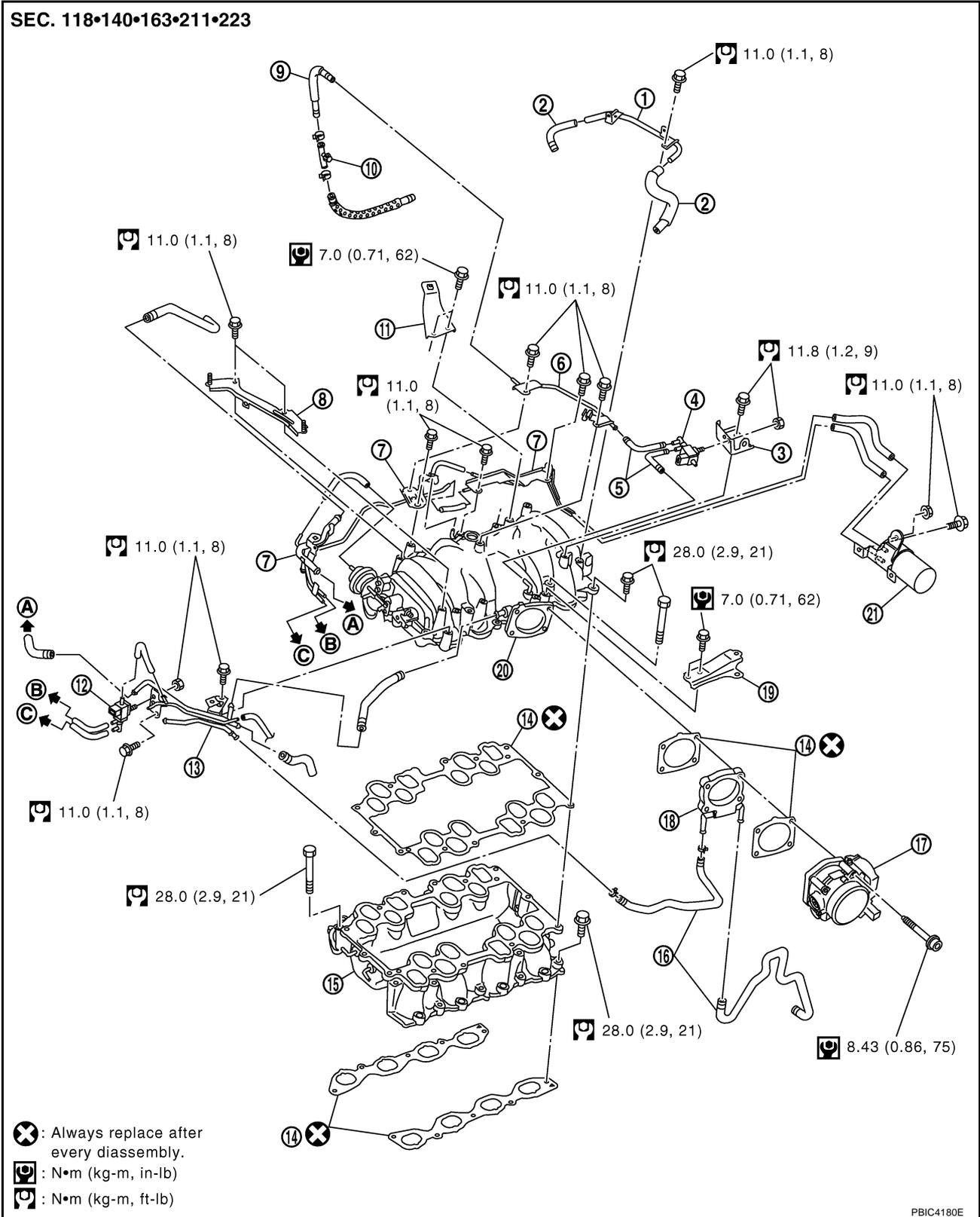
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- |  |                               |  |
|--|-------------------------------|--|
| 1. PCV tube  | 2. PCV hose                   | 3. EVAP canister purge volume control solenoid valve bracket |
| 4. EVAP canister purge volume control solenoid valve | 5. EVAP hose                  | 6. EVAP tube   |
| 7. Vacuum gallery                                    | 8. Engine cover front bracket | 9. EVAP hose   |

# INTAKE MANIFOLD

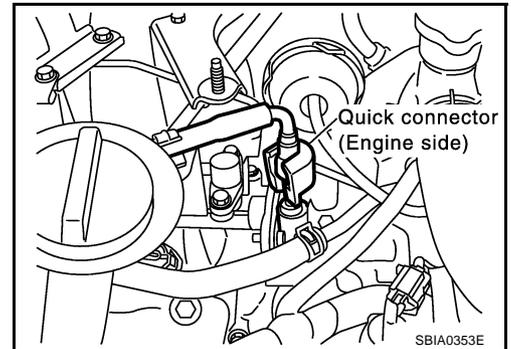
- |                               |  |                                 |
|-------------------------------|--|---------------------------------|
| 10. EVAP service port         | 11. Engine cover rear bracket          | 12. VIAS control solenoid valve |
| 13. Water gallery             | 14. Gasket                             | 15. Intake manifold (lower)     |
| 16. Water hose                | 17. Electric throttle control actuator | 18. Intake manifold adapter     |
| 19. Engine cover rear bracket | 20. Intake manifold (upper)            | 21. Vacuum tank                 |

## REMOVAL

### WARNING:

To avoid the danger of being scalded, do not drain engine coolant when engine is hot.

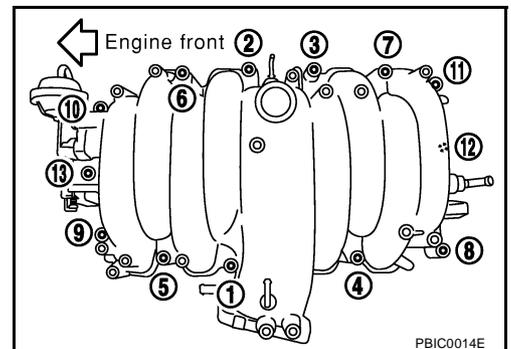
1. Remove engine cover (with power tool), air duct (inlet), air cleaner cover and battery cover. Refer to [EM-13, "Removal and Installation"](#).
2. Release fuel pressure. Refer to [EC-80, "FUEL PRESSURE RELEASE"](#).
3. Remove air duct and air cleaner case assembly. Refer to [EM-17, "Removal and Installation"](#).
4. Drain engine coolant when engine is cooled. Refer to [CO-8, "Changing Engine Coolant"](#).
5. Disconnect fuel feed hose quick connector on engine side. Refer to [EM-32, "FUEL INJECTOR AND FUEL TUBE"](#).



6. Remove or disconnect intake manifold (upper), harnesses, brackets, vacuum hose, water gallery, vacuum gallery and PCV hose and tube.
  - Add mating marks as necessary for easier installation.
7. Remove electric throttle control actuator as follows:
  - a. Disconnect harness connector.
  - b. Loosen mounting bolts diagonally.

### CAUTION:

- Handle carefully to avoid any shock to electric throttle control actuator.
  - Do not disassemble.
8. Disconnect water hoses from water gallery.
  9. Remove intake manifold adapter.
  10. Remove fuel injectors and fuel tube assembly. Refer to [EM-32, "Removal and Installation"](#).
  11. Loosen bolts in the reverse order of figure to remove intake manifold (upper) with power tool.

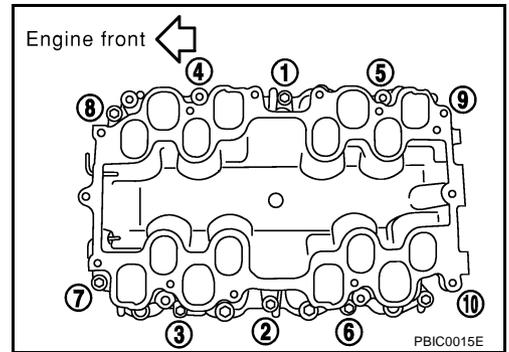


# INTAKE MANIFOLD

- Loosen bolts in the reverse order of figure to remove intake manifold (lower) with power tool.

**CAUTION:**

**Cover engine openings to avoid entry of foreign materials.**



- Remove intake manifold gaskets.

**CAUTION:**

**Cover engine openings to avoid entry of foreign materials.**

- Remove EVAP canister purge volume control solenoid from intake manifold (upper), if necessary.
- Remove VIAS control solenoid valve from water gallery, if necessary.
- Remove vacuum tank from intake manifold (lower), if necessary.

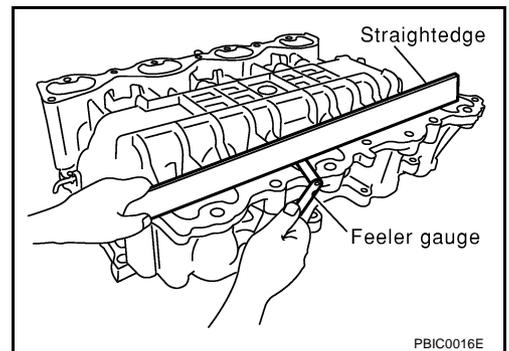
## INSPECTION AFTER REMOVAL

### Surface Distortion

- Using a straightedge and a feeler gauge, inspect surface distortion of intake manifold (upper and lower).

**Limit : 0.1 mm (0.004 in)**

- If it exceeds the limit, replace intake manifold (lower) and/or intake manifold (upper).



## INSTALLATION

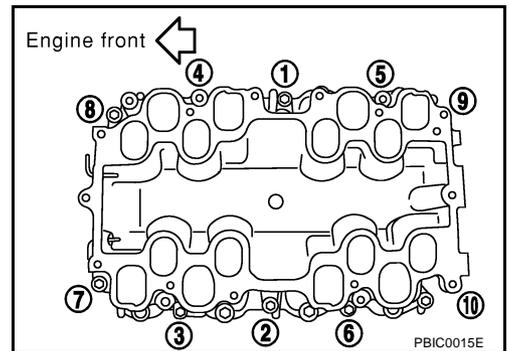
Note the following, and install in the reverse order of removal.

### Intake Manifold (Lower)

Tighten in numerical order as shown in the figure.

**NOTE:**

No. 7 and 8 have longer bolt length than others.



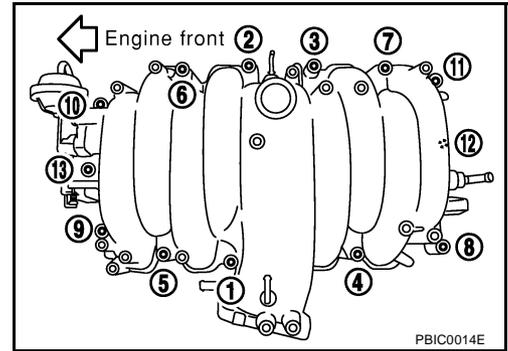
# INTAKE MANIFOLD

## Intake Manifold (Upper )

Tighten in numerical order as shown in the figure.

### NOTE:

No. 4 to 7 have longer bolt length than others.



## Electric Throttle Control Actuator

- Install intake manifold adapter gasket and electric throttle control actuator gasket so that three protrusions for installation identification do not face downward.
- Tighten mounting bolts of electric throttle control actuator equally and diagonally in several steps.
- After installation perform procedure in [EM-22, "INSPECTION AFTER INSTALLATION"](#) .

## Water Hose

Install water hose so that its overlap width for connection is between 27 mm (1.06 in) and 32 mm (1.26 in) (target: 27 mm, 1.06 in).

## Vacuum Hose

Refer to [EC-102, "Vacuum Hose Drawing"](#) .

## INSPECTION AFTER INSTALLATION

- After installing fuel tubes, make sure there is no fuel leakage at connections in the following steps.
  - Apply fuel pressure to fuel lines with turning ignition switch ON (with engine stopped). Then check for fuel leaks at connections.
  - Start engine and rev it up and check for fuel leaks at connections.
- Perform procedures for "Throttle Valve Closed Position Learning" after finishing repairs. Refer to [EC-78, "Throttle Valve Closed Position Learning"](#) .
- If electric throttle control actuator is replaced, perform procedures for "Idle Air Volume Learning" after finishing repairs. Refer to [EC-78, "Idle Air Volume Learning"](#) .

# EXHAUST MANIFOLD AND THREE WAY CATALYST

## EXHAUST MANIFOLD AND THREE WAY CATALYST

PPF:14004

### Removal and Installation

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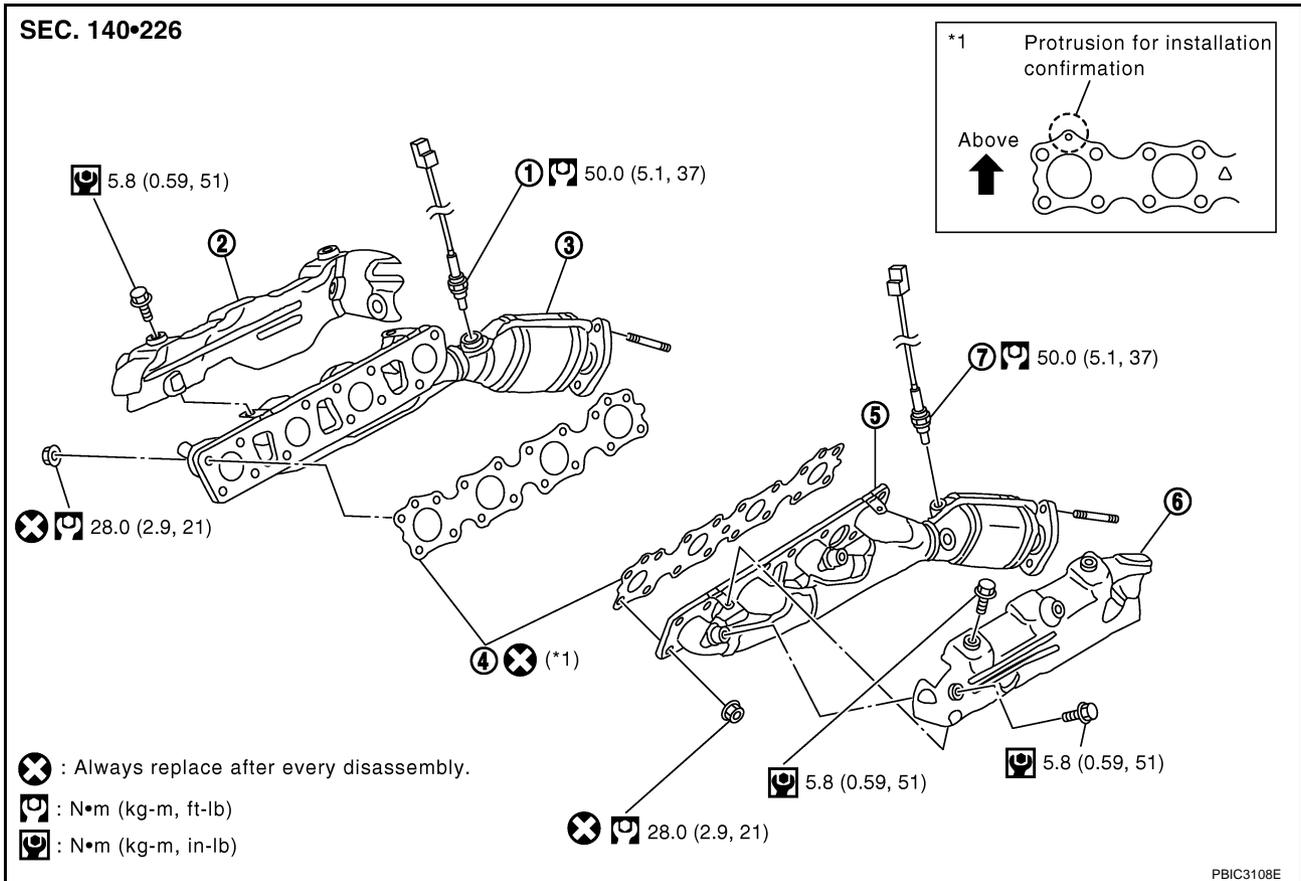
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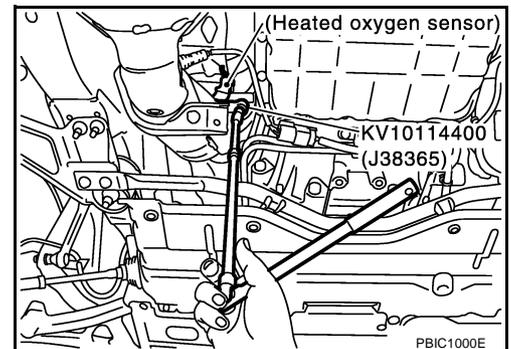
- |                                     |  |   |
|-------------------------------------|--|---|
| 1. Air fuel ratio sensor 1 (bank 2) | 2. Exhaust manifold cover (right bank)                 | 3. Exhaust manifold and three way catalyst (right bank) |
| 4. Gasket                           | 5. Exhaust manifold and three way catalyst (left bank) | 6. Exhaust manifold cover (left bank)                   |
| 7. Air fuel ratio sensor 1 (bank 1) |  |   |

### REMOVAL

1. Remove Air fuel ratio sensors.
  - Put marks to identify installation positions of each air fuel ratio sensor 1.
- a. Remove engine cover, air duct (inlet), battery cover and air cleaner cover. Refer to [EM-13, "ENGINE ROOM COVER"](#).
- b. Remove engine undercover (with power tool).
- c. Disconnect harness connector of each air fuel ratio sensor 1, and harness from bracket and middle clamp.
- d. Using the heated oxygen sensor wrench (SST), remove air fuel ratio sensor 1 (bank1 and bank2).

#### CAUTION:

- Be careful not to damage air fuel ratio sensor.
- Discard any heated oxygen sensor which has been dropped onto a hard surface such as a concrete floor; use a new one.



2. Remove exhaust manifold and three way catalyst (left bank) using the steps below.

# EXHAUST MANIFOLD AND THREE WAY CATALYST

- Remove A/C compressor with power tool and put aside with piping connected. Refer to [ATC-149, "Removal and Installation of Compressor"](#) .
- Remove exhaust front tube with power tool. Refer to [EX-3, "Removal and Installation"](#) .
- Remove steering lower joint to enable steering shaft to move freely. Refer to [PS-15, "POWER STEERING GEAR"](#) .
- Support and lift up bottom of engine with transmission jack. Remove left engine mounting insulator along with left engine mounting brackets.
- Remove exhaust manifold cover (left bank).
- Loosen nuts in the reverse order of figure to remove exhaust manifold and three way catalyst (left bank) with power tool.

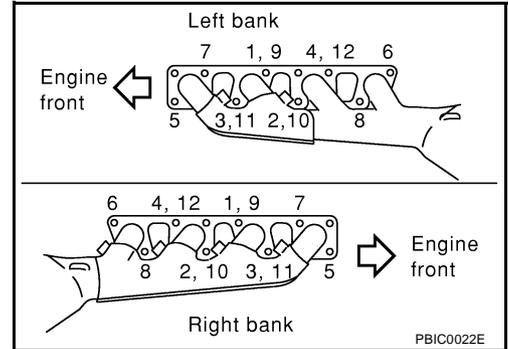
**NOTE:**

Disregard No. 9 to No. 12 when loosening.

- Remove exhaust manifold and three way catalyst (right bank) using the steps below.
  - Remove drive belt. Refer to [EM-14, "DRIVE BELTS"](#) .
  - Remove alternator. Refer to [SC-25, "Removal and Installation"](#) .
  - Remove exhaust front tube with power tool. Refer to [EX-3, "Removal and Installation"](#) .
  - Remove nuts on bottom of right engine mounting insulator, and lift up right side of engine approximately 3 cm (1.18 in) with transmission jack.
  - Remove starter motor. Refer to [SC-14, "Removal and Installation"](#) .
  - Support and lift up bottom of engine with transmission jack. Remove right engine mounting insulator along with right engine mounting brackets.
  - Remove exhaust manifold cover (right bank).
  - Loosen nuts in the reverse order of figure to remove exhaust manifold and three way catalyst (right bank) with power tool.

**NOTE:**

Disregard No. 9 to No. 12 when loosening.

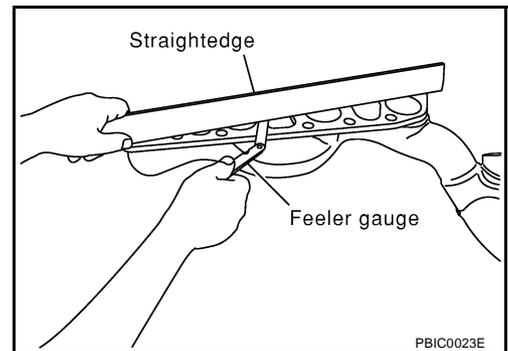


## INSPECTION AFTER REMOVAL

### Surface Distortion

- Use a straightedge and a feeler gauge to check the surface distortion of each exhaust manifold and three way catalyst flange surface.

**Limit : 0.3mm (0.012in)**
- If it exceeds the limit, replace exhaust manifold and three way catalyst.



## INSTALLATION

Note the following, and install in the reverse order of removal.

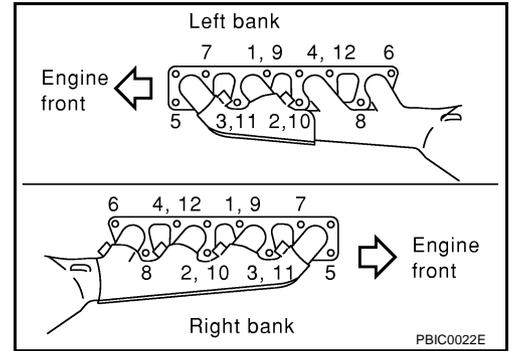
### Exhaust Manifold Gasket

Install exhaust manifold gasket with its directional protrusion set upward. Refer to [EM-23, "Removal and Installation"](#) .

# EXHAUST MANIFOLD AND THREE WAY CATALYST

## Exhaust Manifold

- Install exhaust manifold and three way catalyst in numerical order shown in the figure.
- Tighten nuts No. 1 to No. 4 in two steps. Order No. 9 to 12 shows second step.



## Air Fuel Ratio sensor 1 and Heated Oxygen Sensor 2

- Install air fuel ratio sensor and heated oxygen sensors in the original position.
- Install referring the following if the installation positions cannot be identified.

### Glass tube color

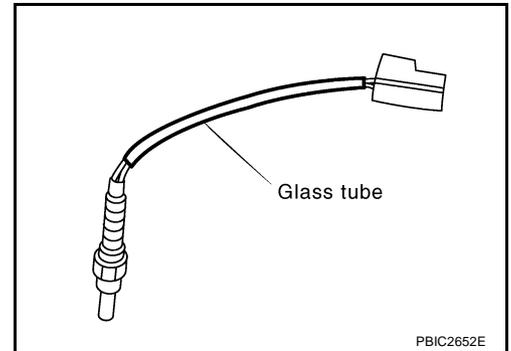
Air fuel ratio sensor 1 (bank 1)* <sup>1</sup>	: Black
Air fuel ratio sensor 1 (bank 2)* <sup>1</sup>	: Black
Heated oxygen sensor 2 (bank 1)* <sup>2</sup>	: White
Heated oxygen sensor 2 (bank 2)* <sup>2</sup>	: White

\*<sup>1</sup> : Length of bank1 for air fuel ratio sensor is different from bank2.

\*<sup>2</sup> : Refer to [EX-3. "EXHAUST SYSTEM"](#) about heated oxygen sensor 2.

### CAUTION:

- Before installing a new air fuel ratio sensor 1 and a new heated oxygen sensor 2, clean exhaust system threads using the heated oxygen sensor thread cleaner (commercial service tool: J-43897-18 or J-43897-12), and apply anti-seize lubricant (commercial service tool).
- Do not over torque the air fuel ratio sensor 1 and heated oxygen sensor 2. Doing so may cause damage to the air fuel ratio sensor 1 and heated oxygen sensor 2, resulting in the MIL coming on.



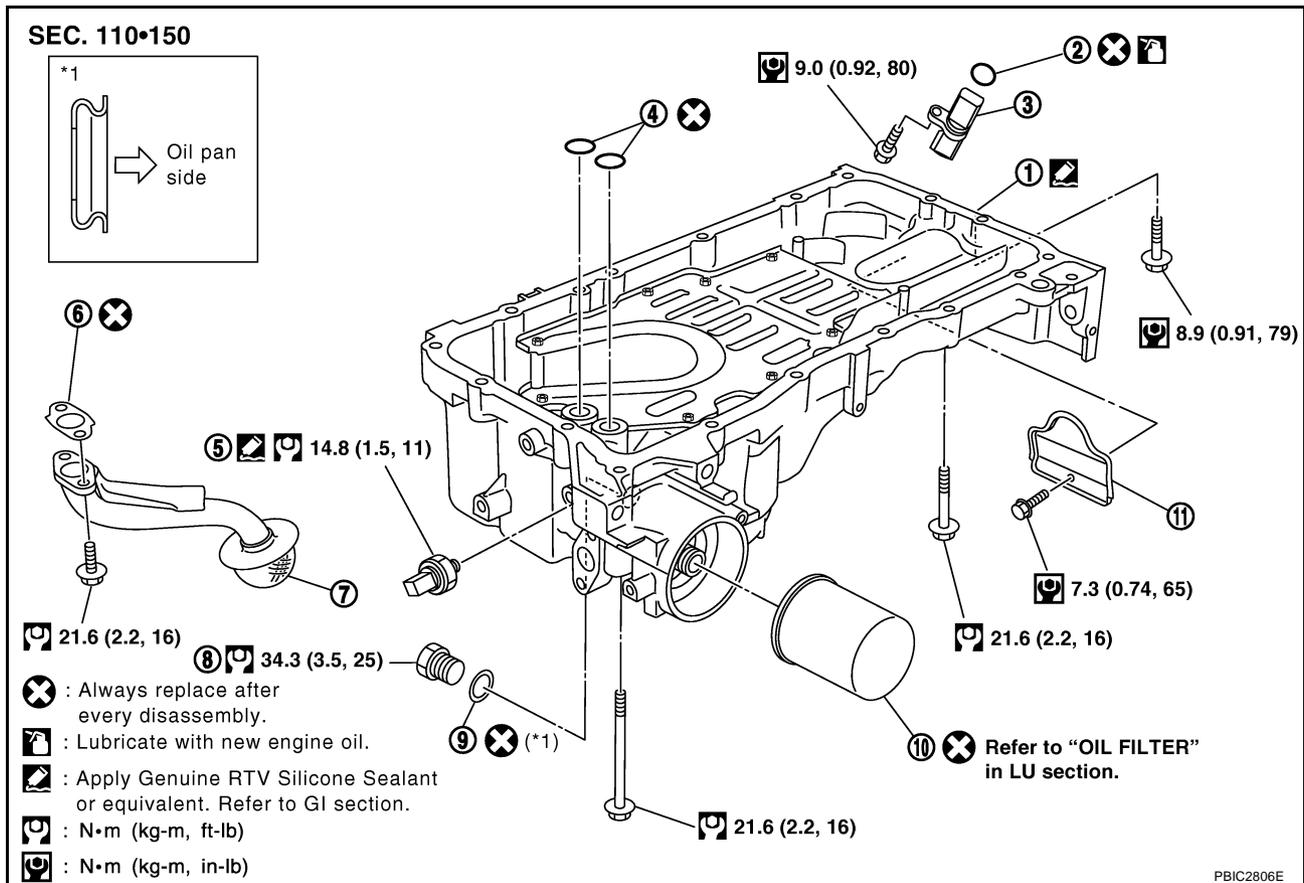
# OIL PAN AND OIL STRAINER

PF11110

NBS0010M

## OIL PAN AND OIL STRAINER

### Removal and Installation



- |                 |                        |                                     |
|-----------------|------------------------|-------------------------------------|
| 1. Oil pan      | 2. O-ring              | 3. Crankshaft position sensor (POS) |
| 4. O-ring       | 5. Oil pressure switch | 6. Gasket                           |
| 7. Oil strainer | 8. Oil pan drain plug  | 9. Washer                           |
| 10. Oil filter  | 11. Rear plate cover   |                                     |

### REMOVAL

#### WARNING:

To avoid the danger of being scalded, do not drain engine oil when engine is hot.

- Remove front tires.
- Remove hood assembly. Refer to [BL-13, "HOOD"](#).
- Remove engine undercover (with power tool).
- Remove engine cover, battery cover, air duct (inlet) and air cleaner cover. Refer to [EM-13, "ENGINE ROOM COVER"](#).
- Drain engine oil. Refer to [LU-7, "Changing Engine Oil"](#).
- Remove drive belts. Refer to [EM-14, "Removal and Installation"](#).
- Remove auto tensioner of power steering oil pump belt. Refer to [EM-15, "Drive Belt Auto Tensioner and Idler Pulley"](#).
- Move power steering oil pump and remove power steering oil pump bracket.
- Remove oil filter. Refer to [LU-9, "Removal and Installation"](#).
- Remove A/C compressor fitting bolts, and put A/C compressor temporarily on vehicle side with ropes or equivalent. Refer to [ATC-149, "Removal and Installation of Compressor"](#).
- Disconnect harness and wires of lower side of oil pan from oil pan.
- Remove crankshaft position sensor (POS) from transmission.

#### CAUTION:

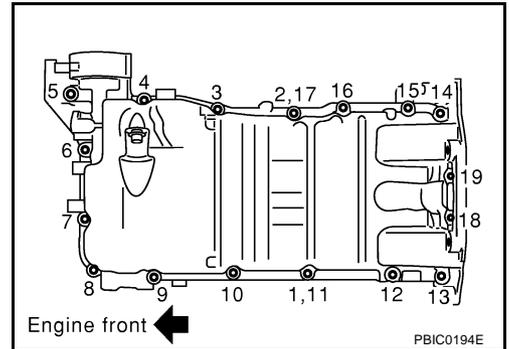
- Do not drop or shock it.

# OIL PAN AND OIL STRAINER

- Do not disassemble it.
  - Do not let steel powders contact magnetic parts of sensor tips.
  - Do not leave where magnetically effected.
13. Install engine slinger and hang engine assembly to secure position. Refer to [EM-79, "Removal and Installation"](#).
  14. Remove front suspension member with power tool. Refer to [FSU-16, "FRONT SUSPENSION MEMBER"](#).
  15. Remove oil pan as follows:
    - a. Remove rear plate cover.
    - b. Remove transmission joint bolts (M12: 4 bolts) which pierce oil pan. Refer to [AT-249, "TRANSMISSION ASSEMBLY"](#).
    - c. Loosen oil pan bolts with power tool in the reverse order of figure to remove.

## NOTE:

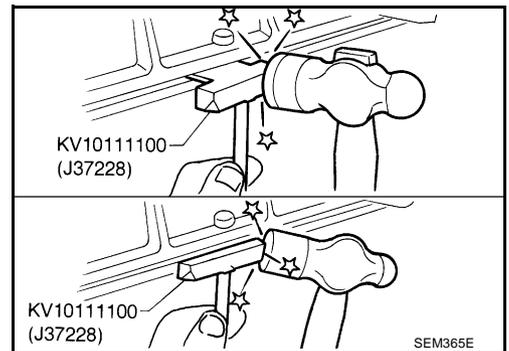
Disregard No. 11 and No. 17 when loosening.



- d. Insert the seal cutter (SST) between oil pan and cylinder block. Slide the seal cutter by tapping on side of the seal cutter with a hammer. Remove oil pan.

## CAUTION:

- Be careful not to damage mating surface.
- Do not insert a screwdriver, this will damage the mating surface.



- e. Remove O-rings from bottom of oil pump and front cover.
16. Remove oil strainer.

## INSPECTION AFTER REMOVAL

Clean oil strainer if any object attached.

## INSTALLATION

1. Install oil strainer.
2. Install oil pan as follows:
  - a. Use scraper to remove old liquid gasket from mating surfaces.
    - Also remove the old liquid gasket from mating surface of cylinder block.
    - Remove old liquid gasket from the bolt holes and threads.

## CAUTION:

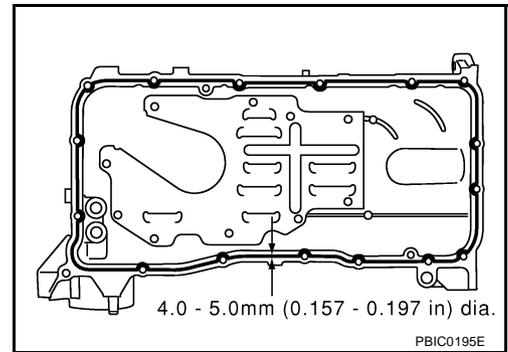
Do not scratch or damage the mating surfaces when cleaning off old liquid gasket.

## OIL PAN AND OIL STRAINER

- b. Apply liquid gasket thoroughly as shown in figure. Use **Genuine RTV Silicone Sealant or equivalent**. Refer to [GI-45, "RECOMMENDED CHEMICAL PRODUCTS AND SEALANTS"](#).

**CAUTION:**

Attaching should be done within 5 minutes after coating.



- c. Install new O-ring to oil pump and front cover side.  
d. Install oil pan.

**CAUTION:**

Install avoiding misalignment of O-rings.

- Tighten mounting bolts in numerical order as shown in the figure.

**NOTE:**

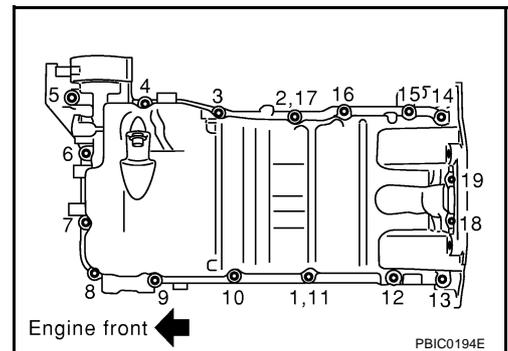
Tighten mounting bolts No. 1 and 2 in two steps. The numerical order No. 11 and 17 shown second steps.

- There are three types of mounting bolts. Refer to the following for locating bolts.

**M6 × 30 mm (1.18 in) : 18, 19**

**M8 × 100 mm (3.94 in) : 5, 9**

**M8 × 45 mm (1.77 in) : Except the above**



- e. Tighten transmission joint bolts. Refer to [AT-249, "TRANSMISSION ASSEMBLY"](#).  
f. Install rear plate cover.  
3. Install oil pan drain plug.
  - Refer to [EM-26, "Removal and Installation"](#) for installation direction of washer.  
4. Install in the reverse order of removal.

**NOTE:**

Pour engine oil at least 30 minutes after oil pan is installed.

### INSPECTION AFTER INSTALLATION

1. Check engine oil level and adjust the level. Refer to [LU-6, "ENGINE OIL"](#).
2. Start engine, and make sure there is no leak of engine oil.
3. Stop engine and wait for 15 minutes.
4. Check and adjust engine oil level again. Refer to [LU-6, "ENGINE OIL"](#).

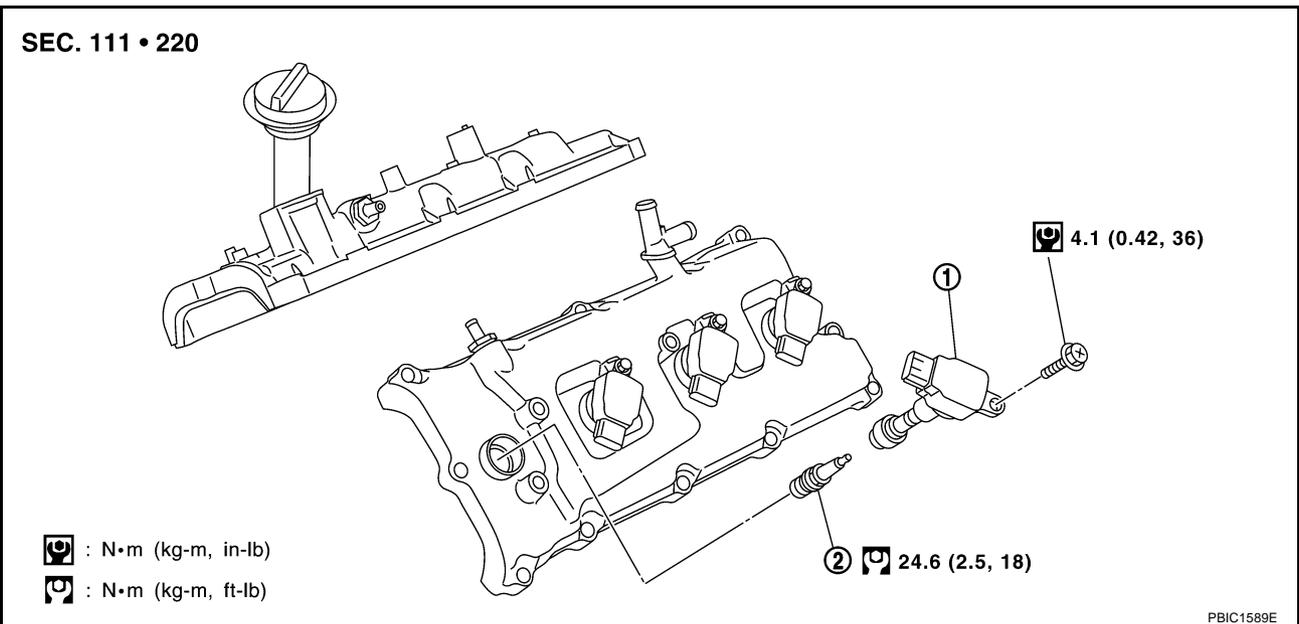
# IGNITION COIL

## IGNITION COIL

PFP:22448

### Removal and Installation

NBS0010N



1. Ignition coil

2. Spark plug

### REMOVAL

1. Remove engine cover (with power tool), air duct (inlet), air cleaner cover and battery cover. Refer to [EM-13, "Removal and Installation"](#).
2. Remove air duct and air cleaner case assembly. Refer to [EM-17, "AIR CLEANER AND AIR DUCT"](#).
3. Move heater hose and its peripheral parts aside. (No. 7 cylinder)
4. Disconnect harness connector from ignition coil.
5. Remove ignition coil.

#### **CAUTION:**

**Do not shock it.**

### INSTALLATION

Install in the reverse order of removal.

# SPARK PLUG (PLATINUM-TIPPED TYPE)

PFP:22401

## SPARK PLUG (PLATINUM-TIPPED TYPE)

### Removal and Installation

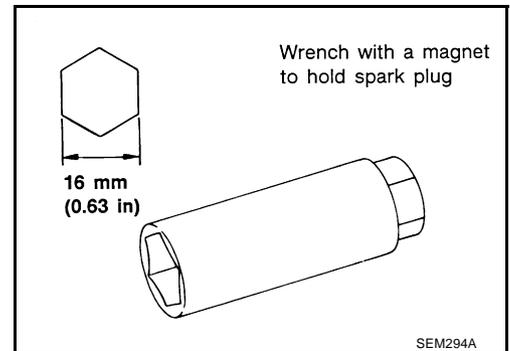
NBS00100

#### REMOVAL

1. Remove ignition coil. Refer to [EM-29, "IGNITION COIL"](#).
2. Remove spark plug with the spark plug wrench (commercial service tool).

**CAUTION:**

**Do not drop or shock it.**



#### 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 knock occurs with the standard type spark plug under conditions such as:

- Extended highway driving
- Frequent high engine revolution

**Spark plug (Platinum-tipped type):**

Make	NGK
Standard type	PLFR5A-11
Hot type	PLFR4A-11
Cold type	PLFR6A-11

**Plug gap (Nominal) : 1.1 mm (0.043 in)**

**CAUTION:**

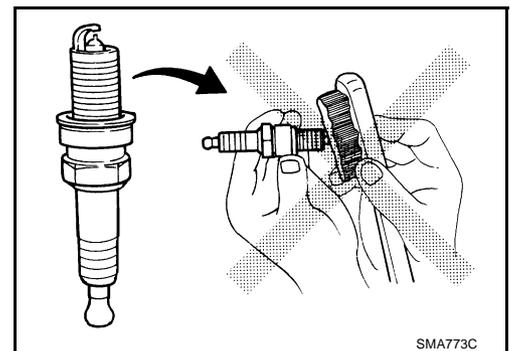
- Do not drop or shock spark plug.
- Do not use a wire brush for cleaning.
- If plug tip is covered with carbon, spark plug cleaner may be used.

**Cleaner air pressure:**

**Less than 588 kPa (6 kg/cm<sup>2</sup> , 85 psi)**

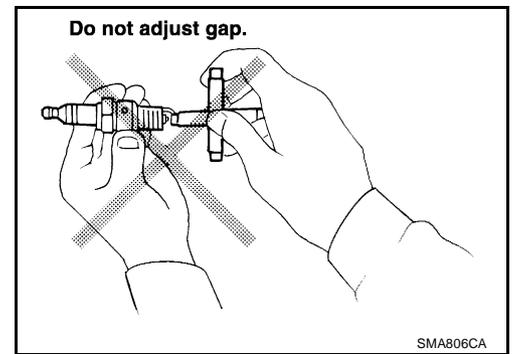
**Cleaning time:**

**Less than 20 seconds**



## SPARK PLUG (PLATINUM-TIPPED TYPE)

- Checking and adjusting plug gap is not required between change intervals.



### INSTALLATION

Install in the reverse order of removal.

**Spark plug:**

 : 24.6 N·m (2.5 kg·m, 18 ft·lb)

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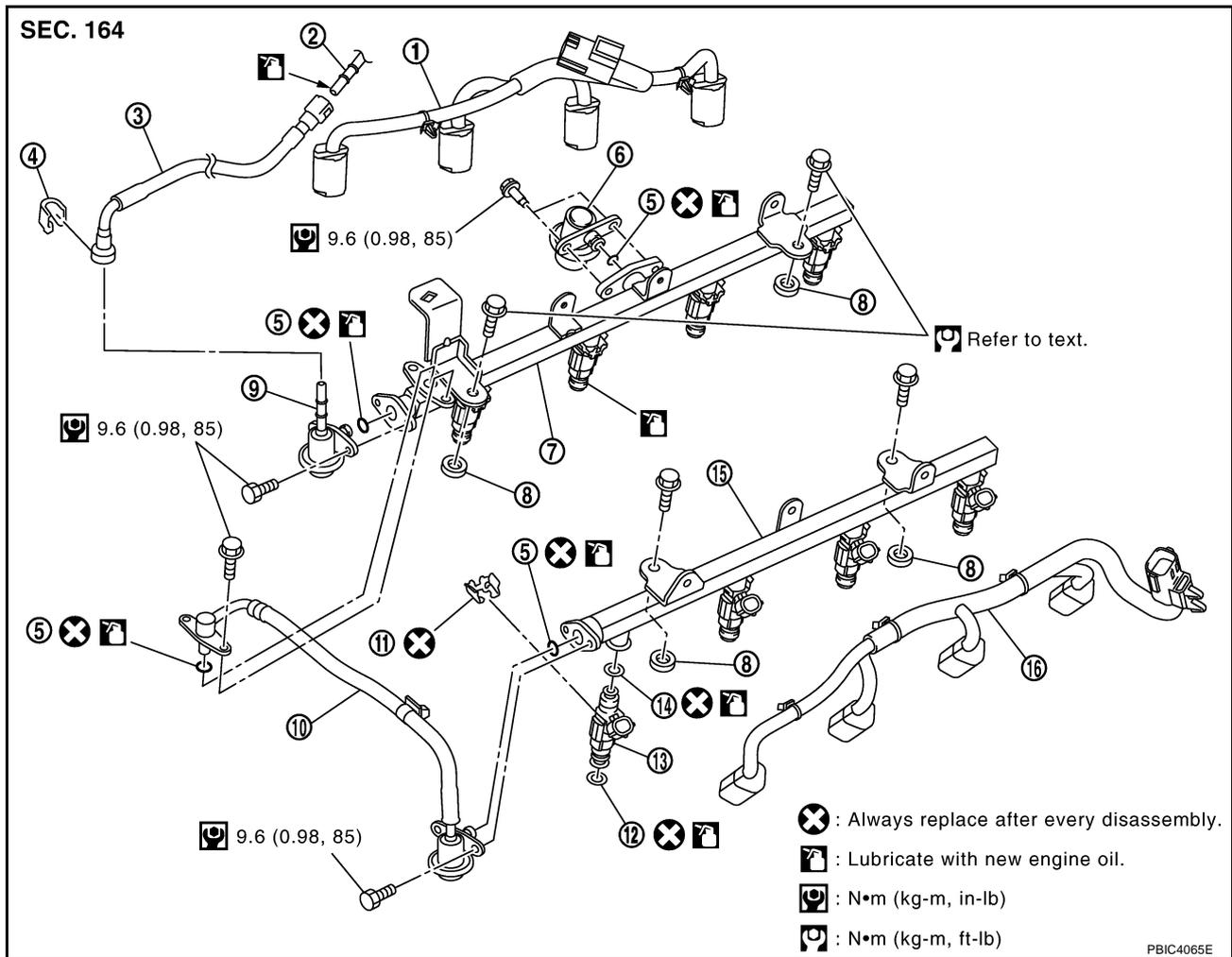
# FUEL INJECTOR AND FUEL TUBE

PFP:16600

NBS0010P

## FUEL INJECTOR AND FUEL TUBE

### Removal and Installation



- |  |                                   |                        |
|--|-----------------------------------|------------------------|
| 1. Fuel injector sub harness (right)   | 2. Centralized under-floor piping | 3. Fuel feed hose      |
| 4. Quick connector cap                 | 5. O-ring                         | 6. Fuel damper (right) |
| 7. Fuel tube (right)                   | 8. Spacer                         | 9. Fuel feed damper    |
| 10. Fuel damper and fuel hose assembly | 11. Clip                          | 12. O-ring (Green)     |
| 13. Fuel injector                      | 14. O-ring (Black)                | 15. Fuel tube (left)   |
| 16. Fuel injector sub harness (left)   |                                   |                        |

### CAUTION:

Do not remove or disassemble parts unless instructed as shown in the figure.

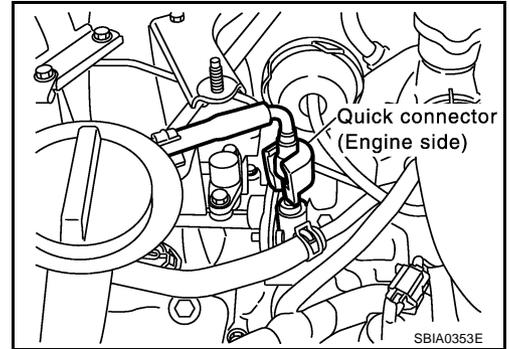
### REMOVAL

#### WARNING:

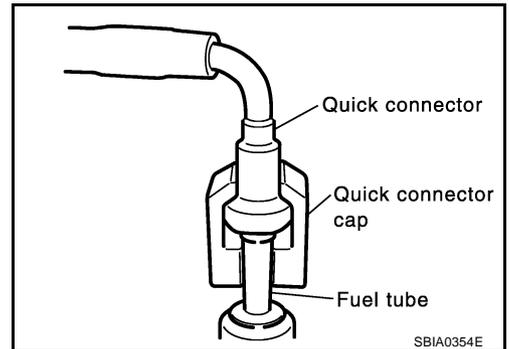
- Put a "CAUTION: INFLAMMABLE" sign in the workshop.
  - Be sure to work in a well ventilated area and furnish workshop with a CO<sub>2</sub> fire extinguisher.
  - Do not smoke while servicing fuel system. Keep open flames and sparks away from the work area.
1. Remove engine cover with power tool. Refer to [EM-13, "ENGINE ROOM COVER"](#).
  2. Release fuel pressure. Refer to [EC-80, "FUEL PRESSURE RELEASE"](#).

## FUEL INJECTOR AND FUEL TUBE

3. Disconnect fuel feed hose on engine side with the following: (Excepting to confirm whether or not there is quick connector cap, perform same procedure for the side of centralized under-floor piping as well.)



- a. Remove quick connector cap from quick connector connection. (engine side only)



- b. Disconnect quick connector from fuel tube (fuel feed damper) with the following:

**CAUTION:**

**Disconnect quick connector by using the quick connector release (SST: J-45488), not by picking out retainer tabs (centralized under-floor piping side).**

- i. With the sleeve side of the quick connector release facing quick connector, install the quick connector release onto fuel tube.
- ii. Insert the quick connector release into quick connector until sleeve contacts and goes no further. Hold the quick connector release on that position.

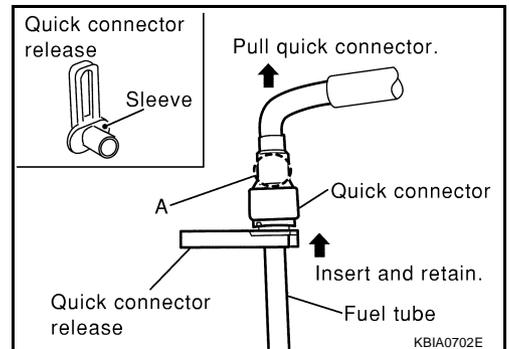
**CAUTION:**

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

- iii. Draw and pull out quick connector straight from fuel tube.

**CAUTION:**

- Pull quick connector holding "A" position as shown in the figure.



- 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.

- Keep parts away from heat source. Especially, be careful when welding is performed around them.

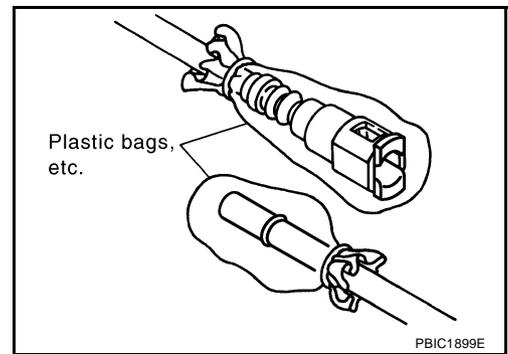
- Do not expose parts to battery electrolyte or other acids.

- Do not bend or twist connection between quick connector and fuel feed hose during installation/removal.

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# FUEL INJECTOR AND FUEL TUBE

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



4. Disconnect fuel damper and fuel hose assembly from fuel tubes (right and left).

**CAUTION:**

- While hoses are disconnected, plug them to prevent fuel from draining.
- Do not separate fuel damper and fuel hose assembly.

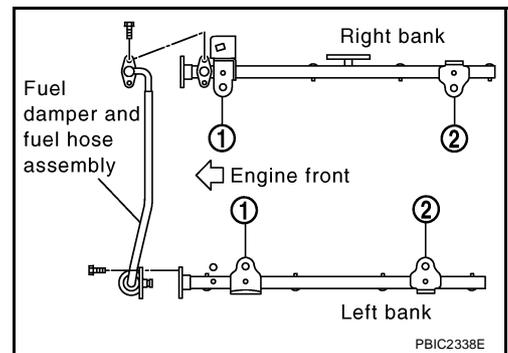
5. Remove intake manifold (upper) with power tool. Refer to [EM-19, "Removal and Installation"](#).

6. Disconnect fuel injector sub harness connector from fuel injector.

7. Loosen mounting bolts "2" to "1" as shown in the figure, and remove fuel tube and fuel injector assembly.

**CAUTION:**

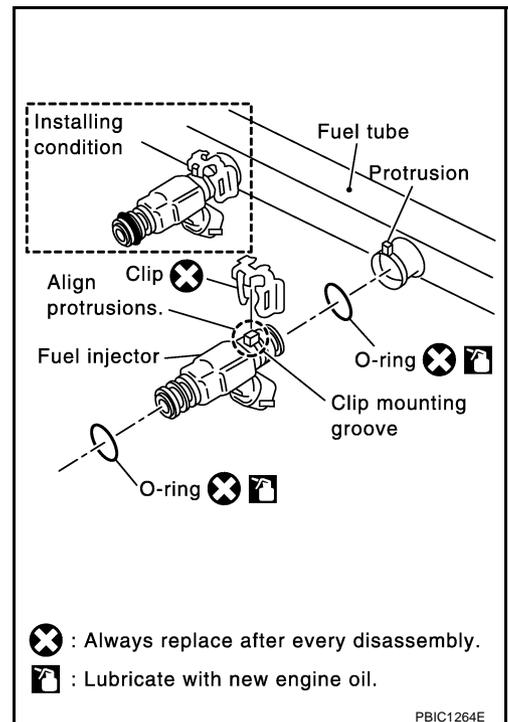
- When removing, be careful to avoid any interference with fuel injector.
- Use a shop cloth to absorb any fuel leaks from fuel tube.



8. Remove spacers on intake manifold (lower).
9. Remove fuel injector from fuel tube with the following:
  - a. Open and remove clip.
  - b. Remove fuel injector from fuel tube by pulling straight.

**CAUTION:**

- Be careful with remaining fuel that may go out from fuel tube.
- Be careful not to damage injector nozzles during removal.
- Do not bump or drop fuel injectors.
- Do not disassemble fuel injectors.



10. Remove fuel damper (right) and fuel feed damper.

## INSTALLATION

1. Install fuel damper (right) and fuel feed damper.

# FUEL INJECTOR AND FUEL TUBE

- When handling O-rings, be careful of the following:

**CAUTION:**

- Handle O-ring with bare hands. Do not 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.
- When installing O-ring, be careful not to scratch it with tool or fingernails. Also be careful not to twist or stretch O-ring. If O-ring was stretched while it was being attached, do not insert it quickly into fuel tube.
- Insert O-ring straight into fuel tube. Do not decenter or twist it.

- Insert fuel damper (right) and fuel feed damper straight into fuel tube (right).
- Tighten mounting bolts evenly in turn.
- After tightening mounting bolts, make sure that there is no gap between flange and fuel tube (right).

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

**CAUTION:**

- Upper and lower O-ring are different. Be careful not to confuse them.

Fuel tube side : Black

Nozzle side : Green

- Handle O-ring with bare hands. Do not 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.
- When installing O-ring, be careful not to scratch it with tool or fingernails. Also be careful not to twist or stretch O-ring. If O-ring was stretched while it was being attached, do not insert it quickly into fuel tube.
- Insert O-ring straight into fuel tube. Do not decenter or twist it.

3. Install fuel injector to fuel tube with the following:

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

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

**CAUTION:**

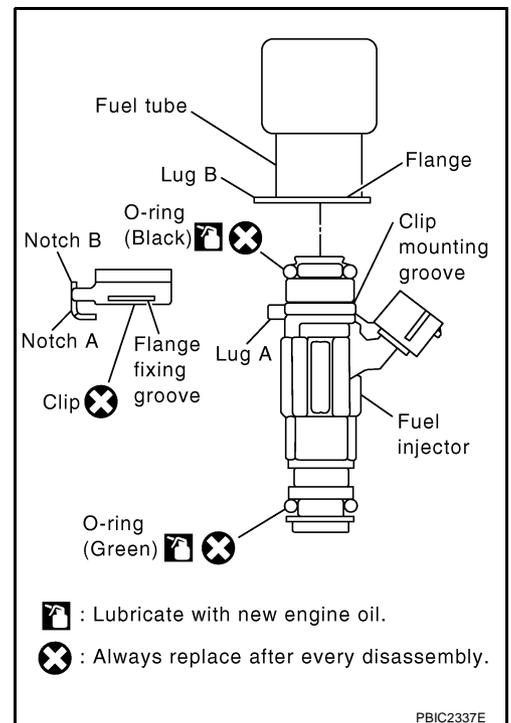
- Do not reuse clip. Replace it with a new one.
- Be careful to keep clip from interfering with O-ring. If interference occurs, replace O-ring.

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

- Insert it while matching it to the axial center.
- Insert fuel injector so that lug "B" of fuel tube 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 making sure that fuel injector does not rotate or come off.

- Make sure that protrusions of fuel injectors are aligned with notch of clips after installation.



4. Install spacers on intake manifold (lower).  
5. Install fuel tube and fuel injector assembly to intake manifold.

**CAUTION:**

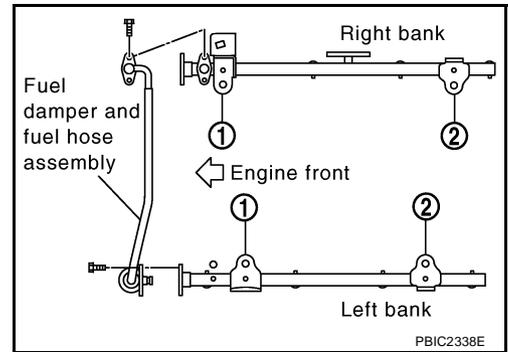
Be careful not to let tip of injector nozzle come in contact with other parts.

## FUEL INJECTOR AND FUEL TUBE

- Tighten mounting bolts “1” to “2” as shown in the figure and in two steps.

 **1st step** : 10.1 N-m (1.0 kg-m, 7 ft-lb)

 **2nd step** : 23.5 N-m (2.4 kg-m, 17 ft-lb)

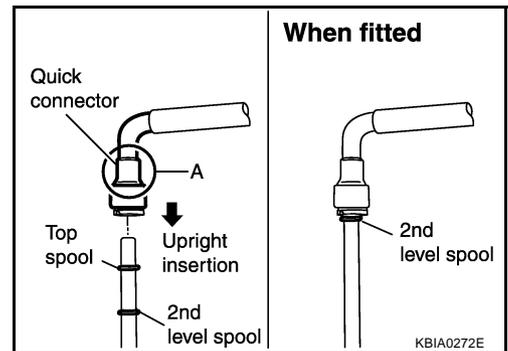


6. Connect fuel feed hose on engine side with the following: (Excepting to confirm whether or not there is quick connector cap, perform same procedure for the side of centralized under-floor piping as well.)
  - a. Make sure no foreign substances are deposited in and around fuel tube (fuel feed damper) and quick connector, and no damage on them.
  - b. Thinly apply new engine oil around fuel tube from tip end to spool end.
  - c. Align center to insert quick connector straightly into fuel tube.

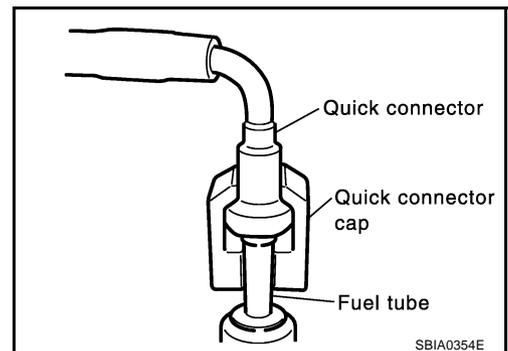
- Insert fuel tube into quick connector until top spool is completely inside quick connector, and 2nd level spool exposes right below quick connector.

### CAUTION:

- Hold “A” position as shown in the figure 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.



- d. Pull quick connector by hand holding “A” position. Make sure it is completely engaged (connected) so that it does not come out from fuel tube.
- e. Install quick connector cap on quick connector connection. (on engine side only).
- f. Install fuel feed hose to hose clamps.



7. Install in the reverse order of removal.

## INSPECTION AFTER INSTALLATION

### Check on Fuel Leakage

1. Turn ignition switch “ON” (with engine stopped). With fuel pressure applied to fuel piping, check for fuel leakage at connection points.

### NOTE:

Use mirrors for checking at points out of clear sight.

2. Start engine. With engine speed increased, check again for fuel leakage at connection points.

### CAUTION:

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

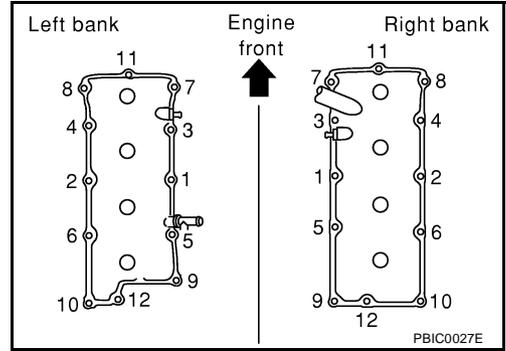


# ROCKER COVER

- Loosen bolts in the reverse order shown in the figure (with power tool).

**CAUTION:**

**Do not hold oil filler neck (right bank) not to damage it.**



- Remove rocker cover gaskets from rocker covers (right and left bank).
- Use scraper to remove all traces of liquid gasket from cylinder head and camshaft bracket (No. 1 and 6).

**CAUTION:**

**Do not scratch or damage the mating surface when cleaning off oil liquid gasket.**

## INSTALLATION

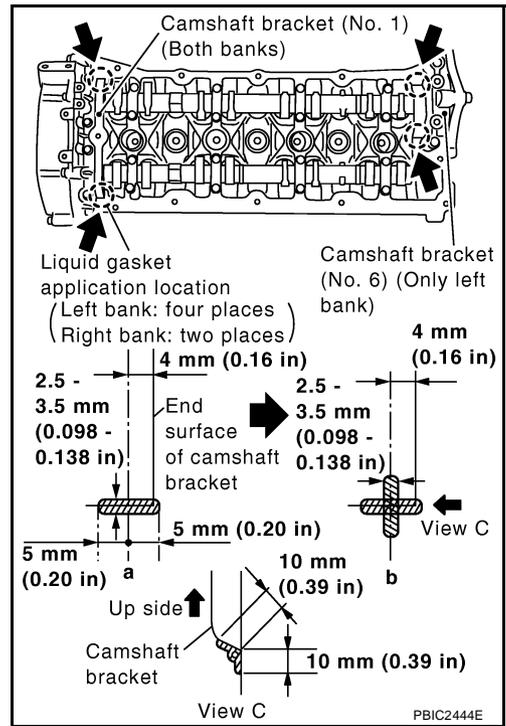
- Apply liquid gasket to joint part of cylinder head and camshaft bracket as follows:

**NOTE:**

Figure shows an example of left-bank side (zoomed in shows No.1 camshaft bracket). Apply only to No.1 camshaft bracket for right-bank side.

- Refer to figure "a" to apply liquid gasket to joint part of No.1 and No.6 camshaft bracket and cylinder head.
- Refer to figure "b" to apply liquid gasket in 90 degrees to figure "a".

**Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-45, "RECOMMENDED CHEMICAL PRODUCTS AND SEALANTS"](#).**



- Install rocker cover.
  - Check if rocker cover gasket is not dropped from installation groove of rocker cover.

- Tighten bolts in two steps separately in numerical order as shown in the figure.

**CAUTION:**

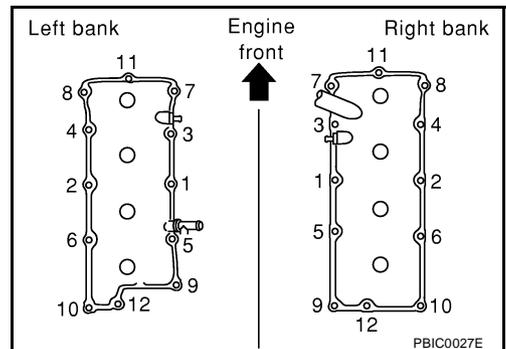
**Do not hold oil filler neck (right bank) not to damage it.**

**1st step**

: 2.0 N·m (0.2 kg·m, 18 in·lb)

**2nd step**

: 8.3 N·m (0.85 kg·m, 73 in·lb)



- Install in the reverse order of removal.

# TIMING CHAIN

## TIMING CHAIN

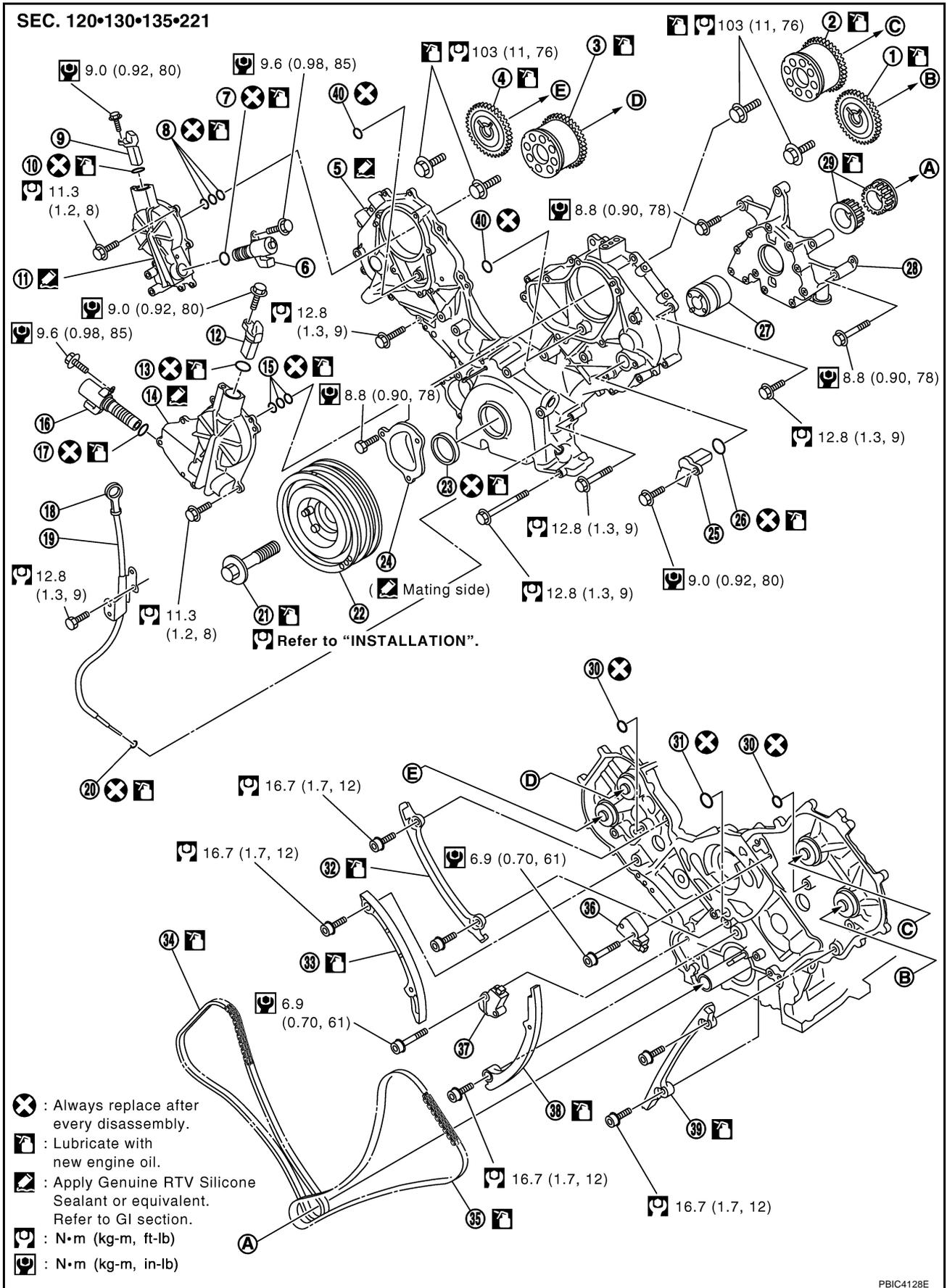
### Removal and Installation

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# TIMING CHAIN

- |  |  |   |
|--|--|---|
| 1. Camshaft sprocket (EXH)                                 | 2. Camshaft sprocket (INT)                         | 3. Camshaft sprocket (INT)                                  |
| 4. Camshaft sprocket (EXH)                                 | 5. Front cover                                     | 6. Intake valve timing control solenoid valve (right bank)  |
| 7. O-ring  | 8. Seal ring                                       | 9. Intake valve timing control position sensor (right bank) |
| 10. O-ring   | 11. Intake valve timing control cover (right bank) | 12. Intake valve timing control position sensor (left bank) |
| 13. O-ring   | 14. Intake valve timing control cover (left bank)  | 15. Seal ring   |
| 16. Intake valve timing control solenoid valve (left bank) | 17. O-ring   | 18. Oil level gauge   |
| 19. Oil level gauge guide                                  | 20. O-ring   | 21. Crankshaft pulley bolt                                  |
| 22. Crankshaft pulley                                      | 23. Front oil seal                                 | 24. Chain tensioner cover                                   |
| 25. Camshaft position sensor (PHASE)                       | 26. O-ring   | 27. Oil pump drive spacer                                   |
| 28. Oil pump assembly                                      | 29. Crankshaft sprocket                            | 30. O-ring  |
| 31. O-ring   | 32. Chain tension guide (right bank)               | 33. Chain slack guide (right bank)                          |
| 34. Timing chain (right bank)                              | 35. Timing chain (left bank)                       | 36. Chain tensioner (left bank)                             |
| 37. Chain tensioner (right bank)                           | 38. Chain slack guide (left bank)                  | 39. Chain tension guide (left bank)                         |
| 40. O-ring   |  |   |

## REMOVAL

- Remove engine assembly from vehicle. Refer to [EM-79, "Removal and Installation"](#) .
- Remove the following components and related parts:
  - Drive belt auto tensioner and idler pulley; Refer to [EM-15, "Drive Belt Auto Tensioner and Idler Pulley"](#) .
  - Thermostat housing and hoses; Refer to [CO-22, "Removal and Installation"](#) .
  - Ignition coil; Refer to [EM-29, "Removal and Installation"](#) .
  - Rocker cover; Refer to [EM-37, "Removal and Installation"](#) .
- If necessary, remove intake valve timing control position sensor (right and left bank) and camshaft position sensor (PHASE) from intake valve timing control cover and front cover.

### CAUTION:

- Handle components and parts carefully to avoid dropping and shocks.
- Do not disassemble.

- If necessary, remove intake valve timing control solenoid valve from intake valve timing control cover.

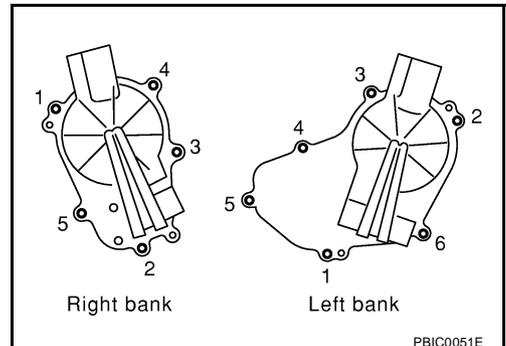
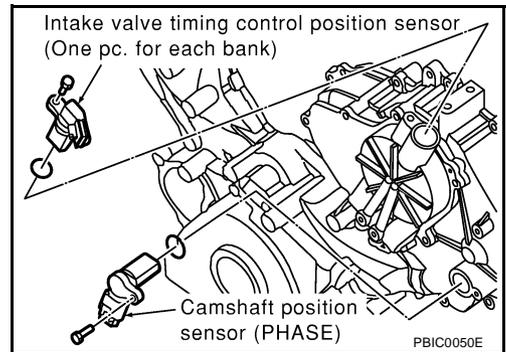
### CAUTION:

- Handle components and parts carefully to avoid dropping and shocks.
- Do not disassemble.

- Remove intake valve timing control cover as follows:
  - Loosen and remove fixing bolts in reverse order of that shown in figure.
  - Use the seal cutter [SST: KV10111100 (J-37228)] or the equivalent to cut liquid gasket for removal.

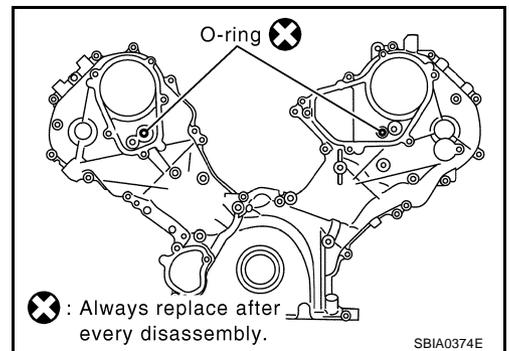
### CAUTION:

- Be careful not to damage mating surfaces.
- Pull out cover keeping levelness without an angle, as inner part of cover is engaged with the center of camshaft sprocket (INT).

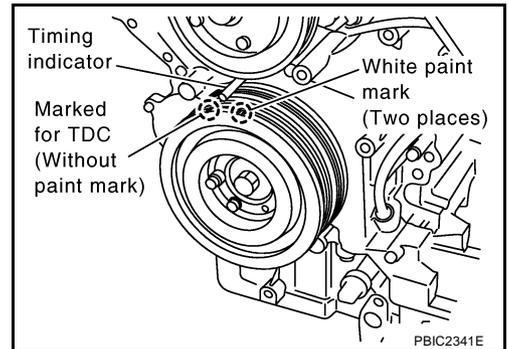


# TIMING CHAIN

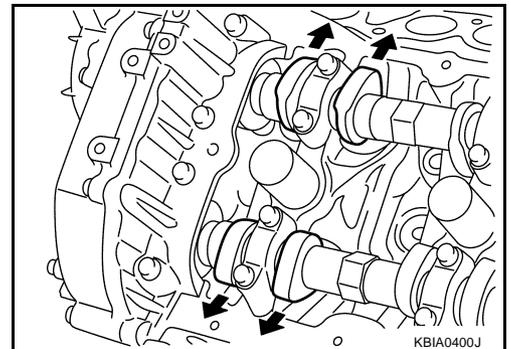
6. Remove O-ring from front cover.



7. Obtain compression TDC of No. 1 cylinder as follows:
- a. Turn crankshaft pulley clockwise to align the TDC identification notch (without paint mark) with timing indicator on front cover.



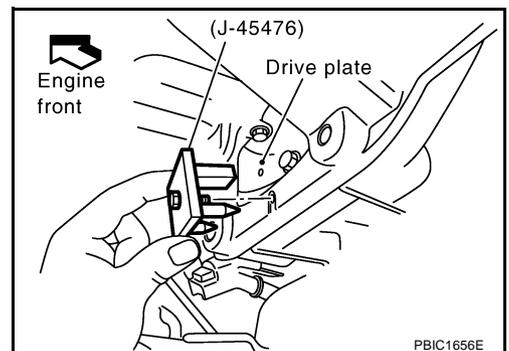
- b. At this time, make sure the both intake and exhaust cam noses of No.1 cylinder (top front on left bank) face outside.
- If they do not face outside, turn crankshaft pulley by 360 degrees once more.



8. Remove crankshaft pulley as follows:
- a. Remove rear plate cover. Refer to [EM-26. "OIL PAN AND OIL STRAINER"](#).
- b. Set the ring gear stopper (SST).
- c. Loosen crankshaft pulley bolt.
- d. Pull crankshaft pulley with both hands to remove it.

**CAUTION:**

- Do not remove crankshaft pulley bolt. Keep loosened crankshaft pulley bolt in place to protect removed crankshaft pulley from dropping.
- Do not remove balance weight (inner hexagon bolt) at the front of crankshaft pulley.



9. Remove oil pan and oil strainer. Refer to [EM-26. "OIL PAN AND OIL STRAINER"](#).

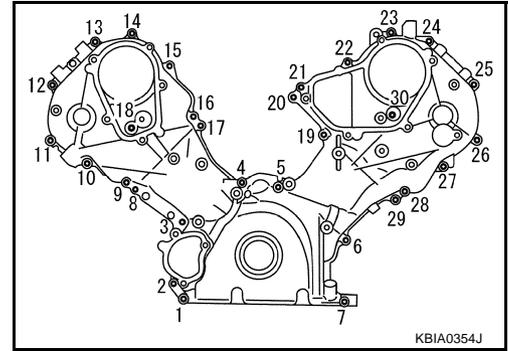
## TIMING CHAIN

10. Remove front cover as follows:

- a. Loosen and remove fixing bolts in the reverse order of that shown in figure.
- b. Use the seal cutter [SST: KV10111100 (J-37228)] or the equivalent to cut liquid gasket for removal.

**CAUTION:**

**Be careful not to damage mating surfaces.**

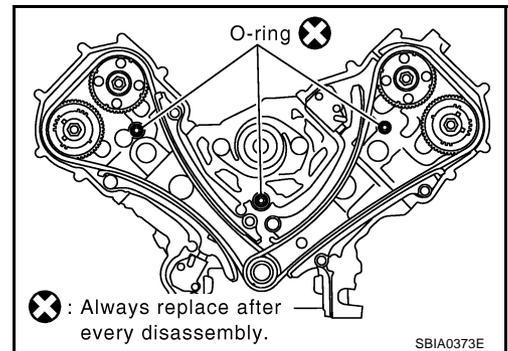


11. Remove front oil seal from front cover using suitable tool.

**CAUTION:**

**Be careful not to damage front cover.**

12. Remove O-rings from cylinder heads (right and left bank) and cylinder block.



13. Remove chain tensioner cover from front cover.

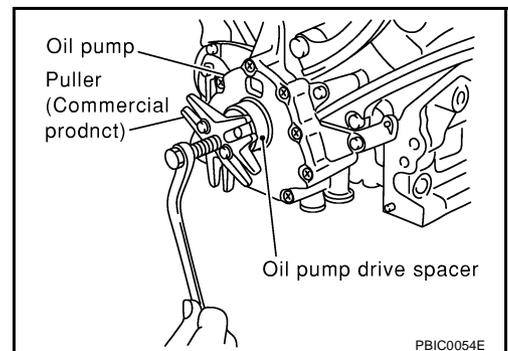
- Use seal cutter (SST: KV10111100) or equivalent to cut liquid gasket for remove.

14. Remove oil pump drive spacer.

- Install bolts into two bolt holes [M6 x pitch 1.0 mm (0.04 in)] on front surface. Using a small puller, pull spacer off from crankshaft.

**NOTE:**

The center to center dimension between the two bolt holes is 33 mm (1.30 in).



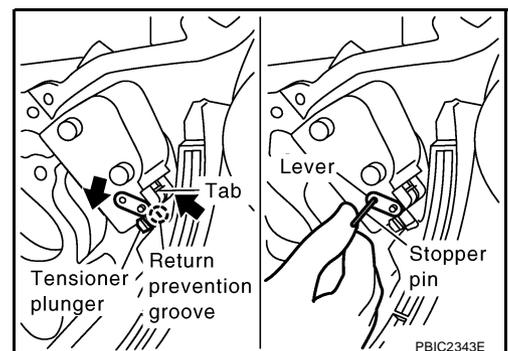
15. Remove oil pump. Refer to [LU-10. "OIL PUMP"](#).

16. Remove chain tensioner (left bank) as follows:

**NOTE:**

To remove timing chain and associated parts, start with those on left bank. The procedure for removing parts on right bank is omitted because it is the same as that for left bank.

- a. Press tab in the direction of arrow (or turn lever in the direction of arrow) to unlock the locking with the groove that stops tensioner plunger from returning.
  - Lightly press tensioner plunger to release the tension of spring for this operation.
- b. Push in tensioner plunger to align the hole on lever and that on pump main body.
  - Pushing in tensioner plunger too far does not allow the holes to align. Therefore, push in the plunger to the degree at which the start of stopper groove and tab engages.

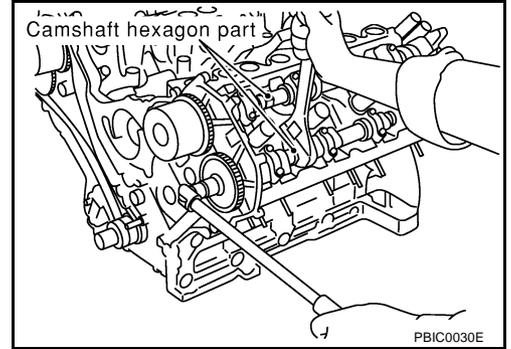


# TIMING CHAIN

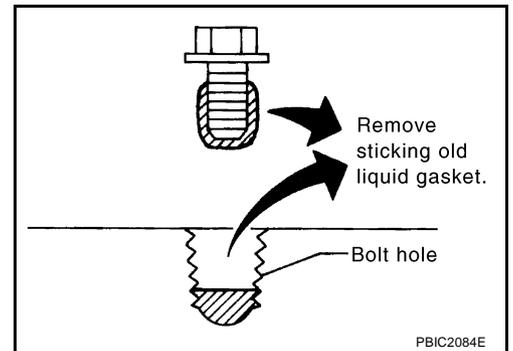
- c. Insert a stopper pin [hard wire with approx. 0.5 mm (0.020 in) diameter or a similar tool] to fix plunger. With the plunger fixed, remove chain tensioner.
17. Remove chain tension guide and chain slack guide.
18. Remove timing chain and crankshaft sprocket.
19. With hexagonal part of camshaft locked with wrench, loosen bolts securing camshaft sprocket to remove camshaft sprocket.

**CAUTION:**

To avoid interference between valves and pistons, do not turn crankshaft or camshaft with timing chain is disconnected.

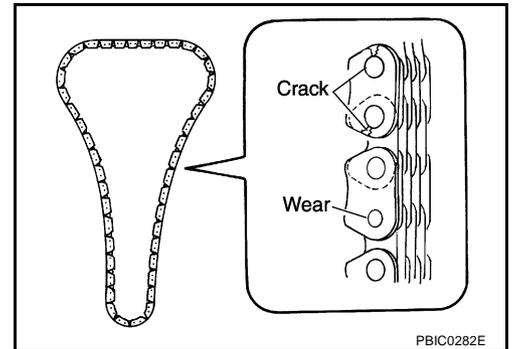


20. Using the same procedure as for left bank, remove timing chain and associated parts on right side.
21. Use scraper to remove all traces of old liquid gasket from front cover and opposite mating surfaces.
  - Remove old liquid gasket from bolt hole and thread.



## INSPECTION AFTER REMOVAL

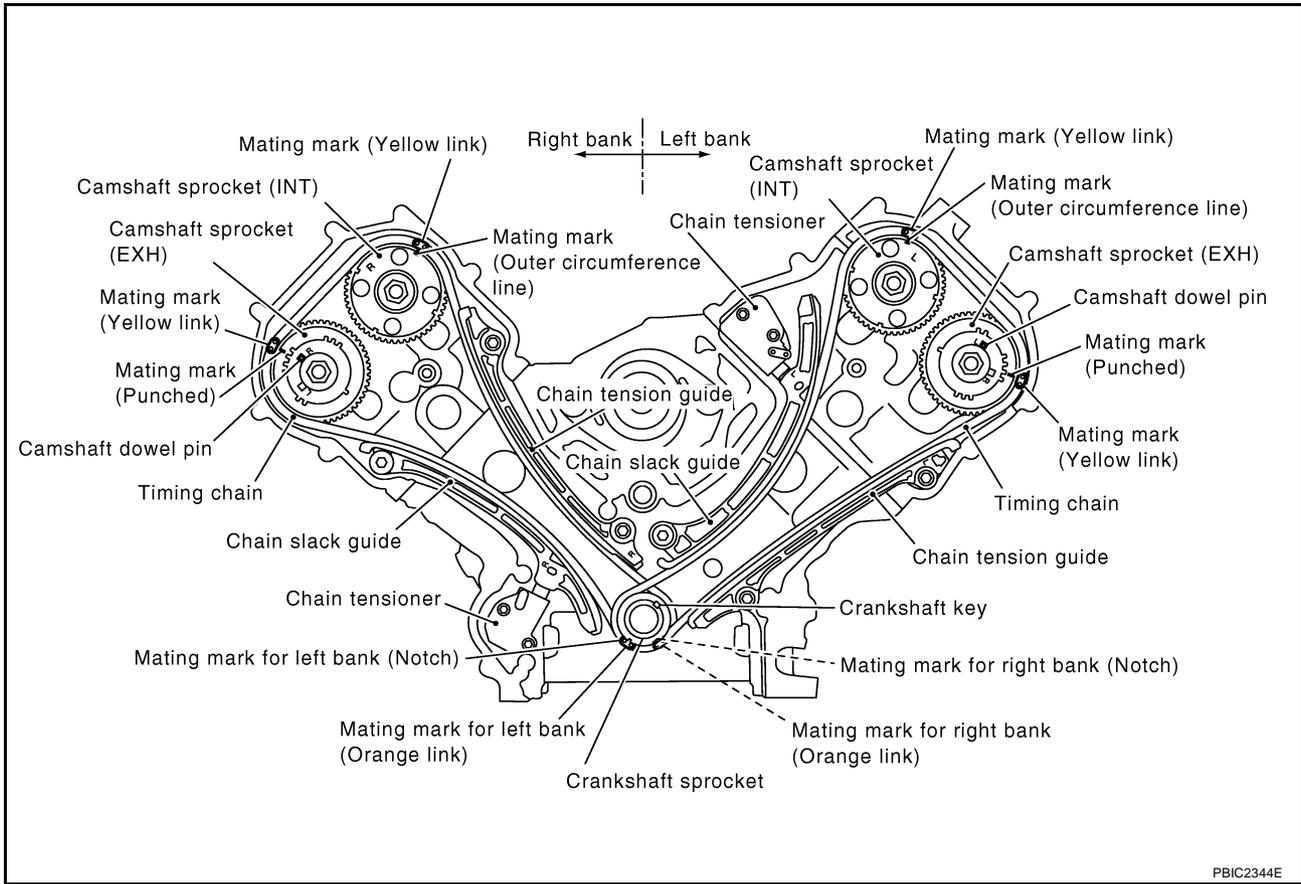
Check for cracks and any excessive wear at roller links and link plates. Replace timing chain if necessary.



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# TIMING CHAIN

## INSTALLATION



### NOTE:

- The above figure shows the relationship between the mating mark on each timing chain and that on the corresponding sprocket, with the components installed.
- Parts with an identification mark (R or L) should be installed on the corresponding bank according to the mark.

Parts with an identification mark:

- Camshaft sprocket (INT)
- Dowel pin groove of camshaft sprocket (EXH) (camshaft sprocket is same part both banks)
- Chain tension guide
- Chain slack guide

To install timing chain and associated parts, start with those on right bank. The procedure for installing parts on left bank is omitted because it is the same as that for installation on right bank.

1. Make sure that crankshaft key and dowel pin of each camshaft are facing in the direction indicated. (No.1 cylinder at compression TDC.)

### NOTE:

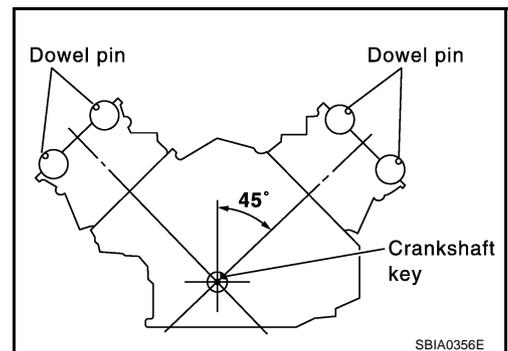
Camshaft does not stop at the position as shown in the figure, for the placement of cam nose. However it is generally accepted camshaft is placed for the same direction of the figure.

#### Camshaft dowel pin

: At cylinder head upper face side in each bank.

#### Crankshaft Key

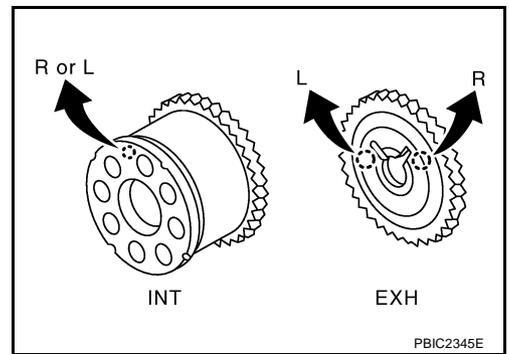
: At cylinder head side of left bank.



# TIMING CHAIN

## 2. Install camshaft sprockets.

- Install onto correct side by checking with identification mark on surface.
- Install camshaft sprocket (EXH) by selectively using the groove of dowel pin according to the bank. (Common part used for both banks.)
- Lock the hexagonal part of camshaft in the same way as for removal, and tighten fixing bolts.

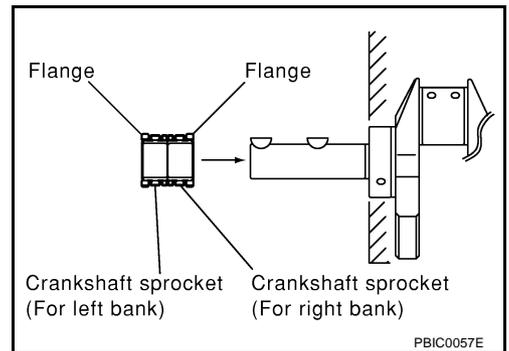


## 3. Install crankshaft sprockets for both banks.

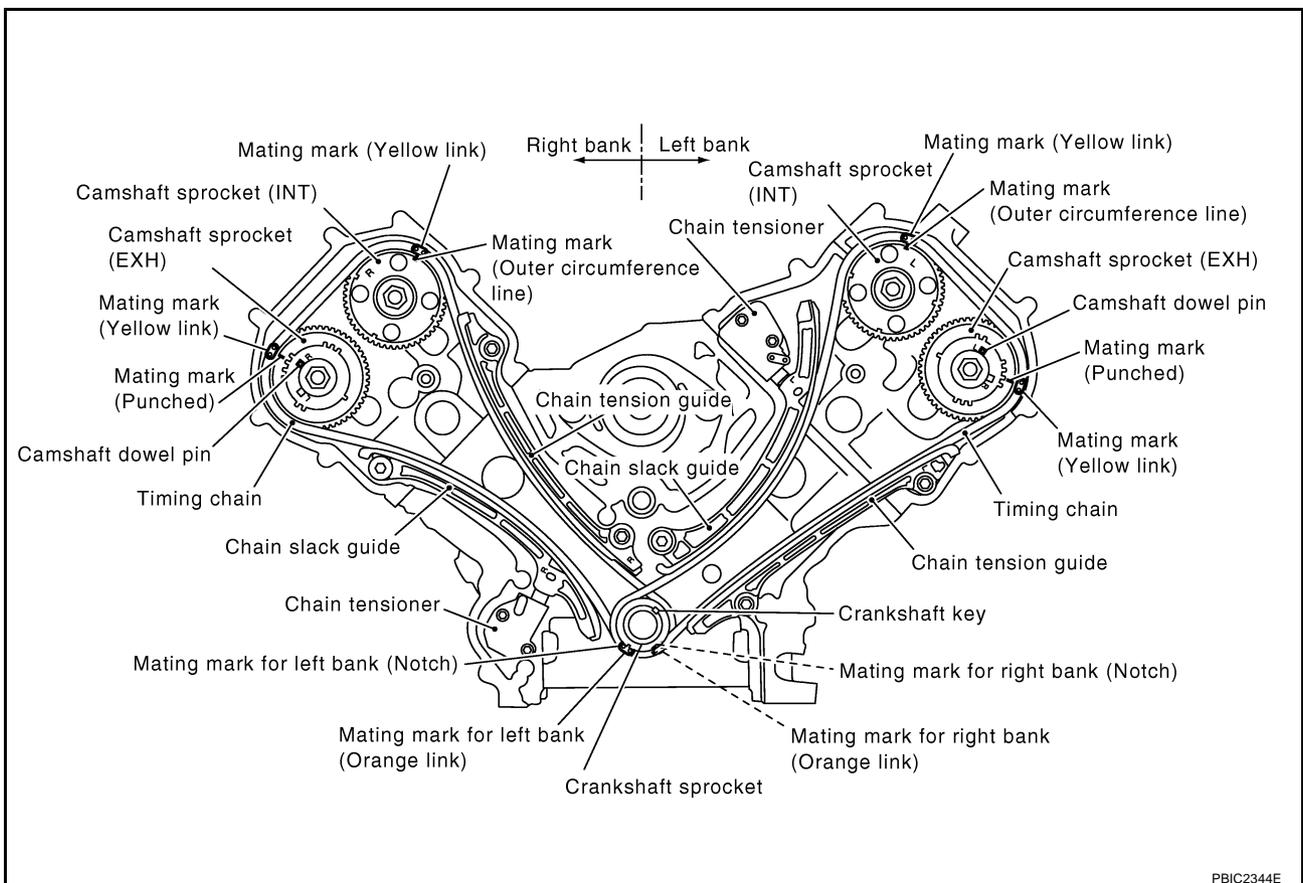
- Install each crankshaft sprocket so that its flange side (the larger diameter side without teeth) faces in the direction shown in figure.

**NOTE:**

The same parts are used but facing directions are different.



## 4. Install timing chains and associated parts.



- Align the mating mark on each sprocket and the timing chain for installation.

**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.

## TIMING CHAIN

### CAUTION:

For the above reason, after the mating marks are aligned, keep them aligned by holding them with a hand.

- Install chain slack guides and chain tension guides onto correct side by checking with identification mark on surface.
- Install chain tensioner with plunger fixed as described in its removal.

### CAUTION:

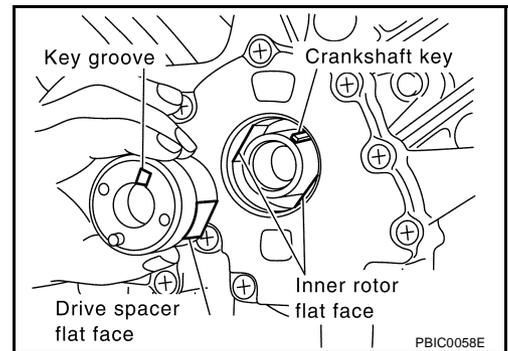
- Before and after the installation of chain tensioner, make sure that the mating mark on timing chain is not out of alignment.
- After installing chain tensioner, remove the stopper pin to release tensioner. Make sure that tensioner is released.
- To avoid chain-link skipping of timing chain, do not move crankshaft or camshafts until front cover is installed.

5. In the same way as for right bank, install timing chain and associated parts on left side.

6. Install oil pump assembly. Refer to [LU-10, "OIL PUMP"](#) .

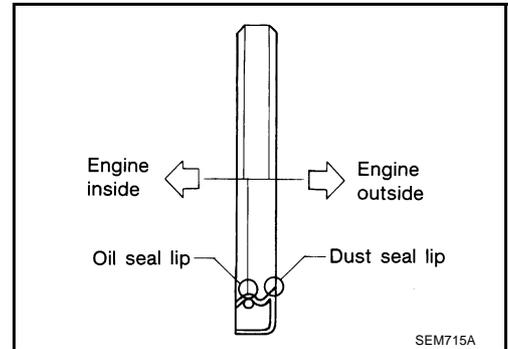
7. Install oil pump drive spacer as follows:

- Insert oil pump drive spacer according to the directions of crankshaft key and the two flat surfaces of oil pump inner rotor.
  - If the positional relationship does not allow the insertion, rotate oil pump inner rotor with a finger to allow the spacer.
- After confirming that the position of each part is in correct condition to allow for the spacer, force fit the spacer by lightly tapping with a plastic hammer until it contacts and does not go further.



8. Install front oil seal onto front cover.

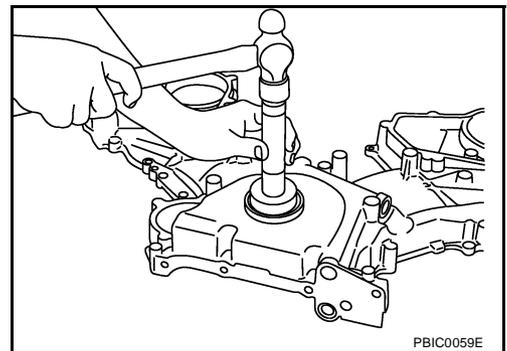
- Install new oil seal in the direction shown in the figure.



- Using the front oil seal drift (commercial service tool) or drift with 54 mm (2.13 in) diameter, force fit the seal until it levels with the front end surface of front cover.

### CAUTION:

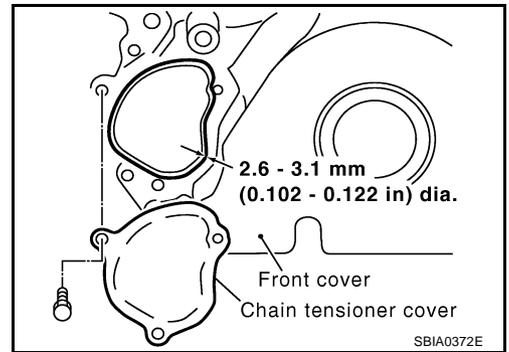
Be careful not to scratch or make burrs on circumference of oil seal.



# TIMING CHAIN

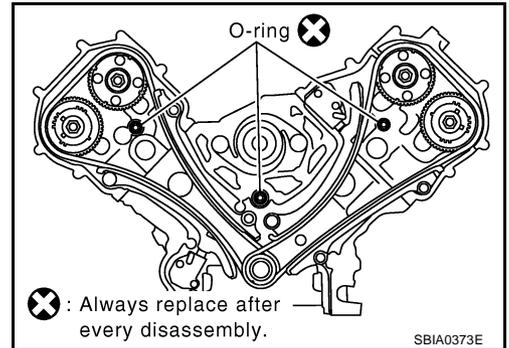
9. Install chain tensioner cover onto front cover.

- Apply liquid gasket as shown in the figure.  
**Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-45, "RECOMMENDED CHEMICAL PRODUCTS AND SEALANTS"](#).**



10. Install front cover as follows:

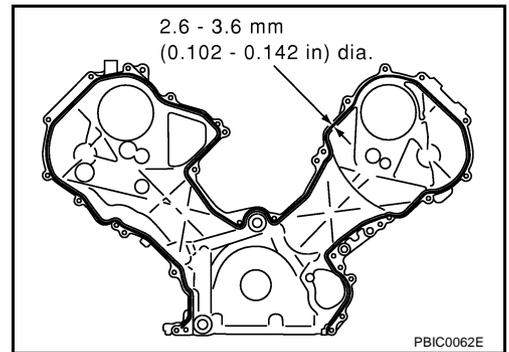
a. Install new O-rings onto cylinder head (right and left bank) and cylinder block.



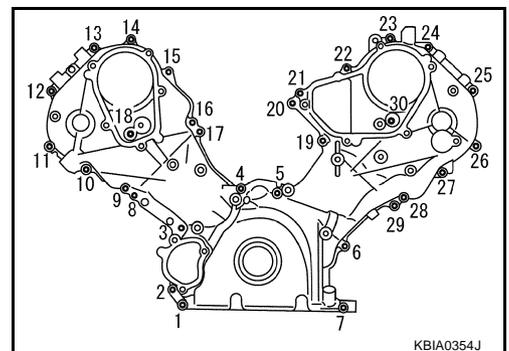
b. Apply liquid gasket as shown in the figure.  
**Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-45, "RECOMMENDED CHEMICAL PRODUCTS AND SEALANTS"](#).**

c. Make sure again that the timing mating mark on timing chain and that on each sprocket are aligned. Then, install front cover.

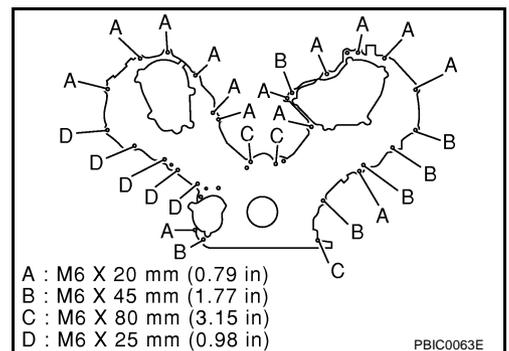
**CAUTION:**  
**Be careful to avoid interference with the front end of oil pump drive spacer. Such interference may damage front oil seal.**



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



- There are four type of mounting bolts.



# TIMING CHAIN

- e. After tightening, re-tighten to the specified torque.

**CAUTION:**

**Be sure to wipe off any excessive liquid gasket leaking onto surface mating with oil pan.**

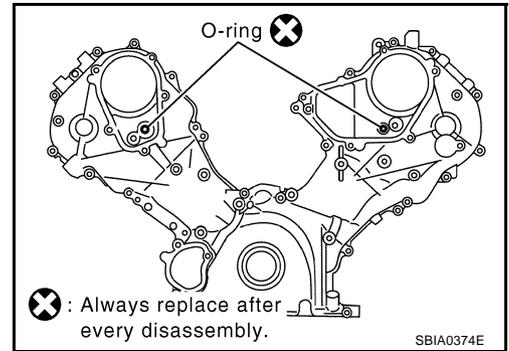
11. Install intake valve timing control cover as follows:

- a. At the back of intake valve timing control cover, install new seal rings (three for each) to the area to be inserted into camshaft sprocket (INT).

**CAUTION:**

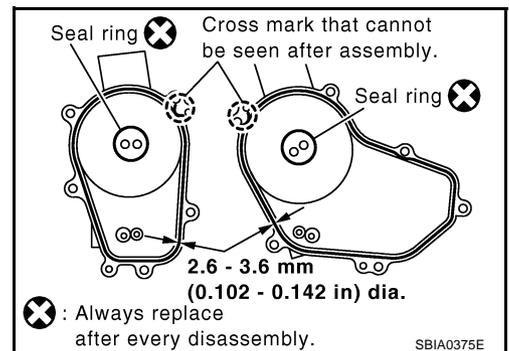
**Do not spread seal ring excessively to avoid breaks and deformation.**

- b. On the side of front cover, install new O-ring (one for each bank).

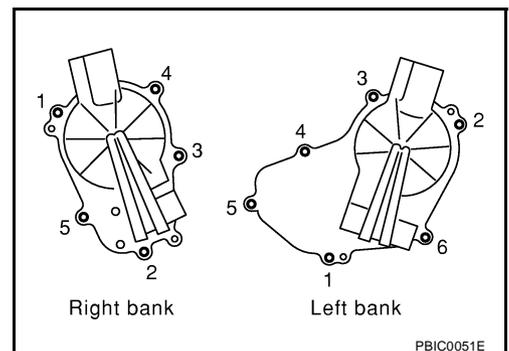


- c. Apply liquid gasket as shown in the figure.

**Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-45, "RECOMMENDED CHEMICAL PRODUCTS AND SEALANTS"](#).**



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



12. Install intake valve timing control position sensor, intake valve timing control solenoid valve and camshaft position sensor (PHASE) to intake valve timing control cover and front cover.

- Be sure to tighten bolts with flanges completely seated.

13. Install crankshaft pulley.

- Install according to the dowel pin of oil pump drive spacer.
- Lightly tapping its center with plastic hammer, insert pulley.

**CAUTION:**

**Do not tap pulley on the side surface where belt is installed (outer circumference).**

14. Tighten fixing bolt of crankshaft pulley as follows:

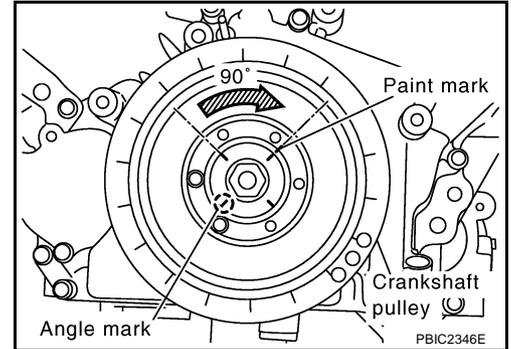
- a. Fix crankshaft with ring gear stopper (SST: J-45476).
- b. Apply engine oil onto threaded parts of bolts and seating areas.

# TIMING CHAIN

c. Tighten bolt crankshaft pulley bolt.

 : 93.1 N·m (9.5 kg-m, 69 ft-lb).

- d. Select one most visible notch of the four on bolt flange. Corresponding to the selected notch, put a mating mark (such as paint) on crankshaft pulley.
- e. Tighten further by 90 degrees. (Angle tightening)
- Check the tightening angle by referencing to the notches. The angle between two notches is 90 degrees.



15. Rotate crankshaft pulley in normal direction (clockwise when viewed from engine front) to check for interference among parts.
16. Install in the reverse order of removal.

**NOTE:**

If hydraulic pressure inside timing chain tensioner drops after removal/installation, slack in guide may generate a pounding noise during and just after engine start. However, this does not indicate an unusualness. Noise will stop after hydraulic pressure rises.

## INSPECTION AFTER INSTALLATION

### Inspection for Leaks

The following are procedures for checking fluids leak, lubricates leak and exhaust gases leak.

- Before starting engine, check oil/fluid levels including engine coolant and engine oil. If less than required quantity, fill to the specified level. Refer to [MA-10, "RECOMMENDED FLUIDS AND LUBRICANTS"](#).
- Use procedure below to check for fuel leakage.
  - Turn ignition switch "ON" (with engine stopped). With fuel pressure applied to fuel piping, check for fuel leakage at connection points.
  - Start engine. With engine speed increased, check again for fuel leakage at connection points.
- Run engine to check for unusual noise and vibration.
- Warm up engine thoroughly to make sure there is no leakage of fuel, exhaust gas, or any oils/fluids including engine oil and engine coolant.
- Bleed air from passages in lines and hoses, such as in cooling system.
- After cooling down engine, again check oil/fluid levels including engine oil and engine coolant. Refill to specified level, if necessary.

**Summary of the inspection items:**

Item	Before starting engine	Engine running	After engine stopped
Engine coolant	Level	Leakage	Level
Engine oil	Level	Leakage	Level
Other oils and fluids *	Level	Leakage	Level
Fuel	Leakage	Leakage	Leakage
Exhaust gas	—	Leakage	—

\* Transmission/transaxle/CVT fluid, power steering fluid, brake fluid, etc.

# CAMSHAFT

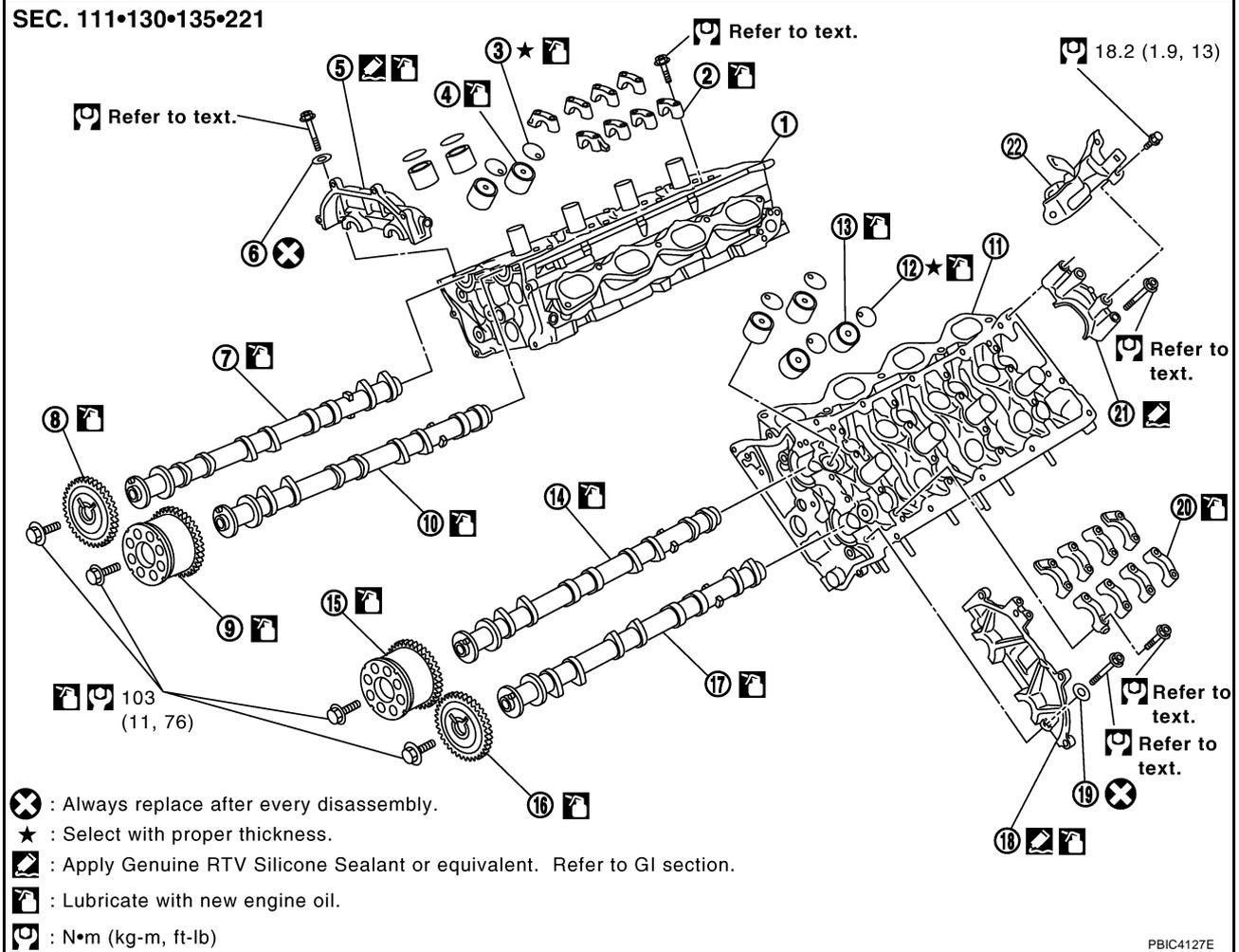
## CAMSHAFT

PFP:13001

### Removal and Installation

NBS0010S

SEC. 111•130•135•221



- ⊗ : Always replace after every disassembly.
- ★ : Select with proper thickness.
- ☑ : Apply Genuine RTV Silicone Sealant or equivalent. Refer to GI section.
- 🛢 : Lubricate with new engine oil.
- 🔧 : N•m (kg-m, ft-lb)

PBIC4127E

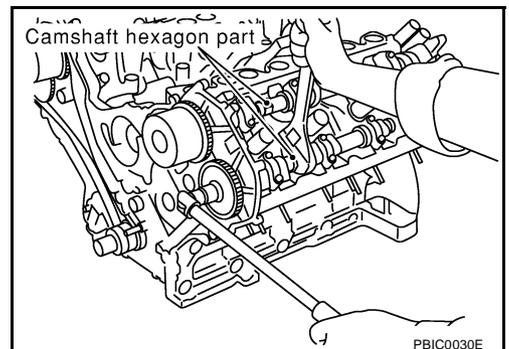
- |                               |                                       |                                   |
|-------------------------------|---------------------------------------|-----------------------------------|
| 1. Cylinder head (right bank) | 2. Camshaft bracket (No. 2, 3, 4, 5)  | 3. Adjusting shim                 |
| 4. Valve lifter               | 5. Camshaft bracket (No. 1)           | 6. Washer                         |
| 7. Camshaft (EXH)             | 8. Camshaft sprocket (EXH)            | 9. Camshaft sprocket (INT)        |
| 10. Camshaft (INT)            | 11. Cylinder head (left bank)         | 12. Adjusting shim                |
| 13. Valve lifter              | 14. Camshaft (INT)                    | 15. Camshaft sprocket (INT)       |
| 16. Camshaft sprocket (EXH)   | 17. Camshaft (EXH)                    | 18. Camshaft bracket (No.1)       |
| 19. Washer                    | 20. Camshaft bracket (No. 2, 3, 4, 5) | 21. Camshaft bracket (INT, No. 6) |
| 22. Bracket                   |                                       |                                   |

### REMOVAL

1. Remove timing chain. Refer to [EM-39. "Removal and Installation"](#).
2. With hexagonal part of camshaft locked with wrench, loosen bolts securing camshaft sprocket to remove camshaft sprocket.

#### CAUTION:

To avoid interference between valves and pistons, do not turn crankshaft or camshaft with timing chain disconnected.



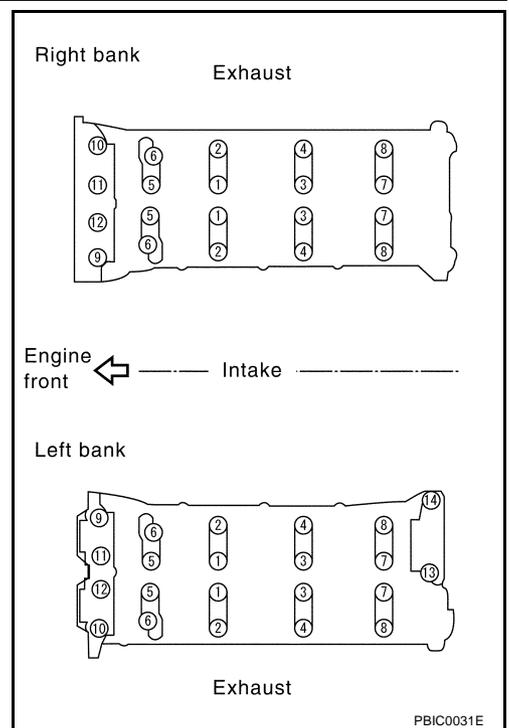
PBIC0030E

# CAMSHAFT

3. Loosen fixing bolts in the reverse order of that shown in the figure to remove camshaft brackets.
  - Lightly tapping with plastic hammer, remove No. 1 camshaft bracket and No. 6 camshaft bracket.

**NOTE:**

The bottom surface of each bracket will be stuck to cylinder head because of liquid gasket.



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

## INSPECTION AFTER REMOVAL

### Camshaft Runout

1. Put V block on precise flat bed, and support No. 2 and No. 5 journal of camshaft.

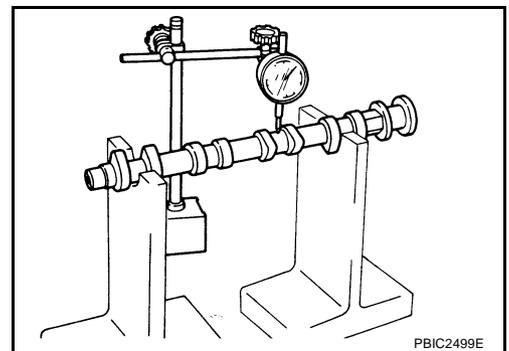
**CAUTION:**

Do not support journal No.1 (on the side of camshaft sprocket) because it has a different diameter from the other four locations.

2. Set a dial indicator vertically to No.3 journal.
3. Turn camshaft to one direction with hands, and measure camshaft runout on a dial indicator. (Total indicator reading)

**Limit : 0.02 mm (0.0008 in)**

- If it exceeds the limit, replace camshaft.



### Camshaft Cam Height

- Measure camshaft cam height.

**Standard:**

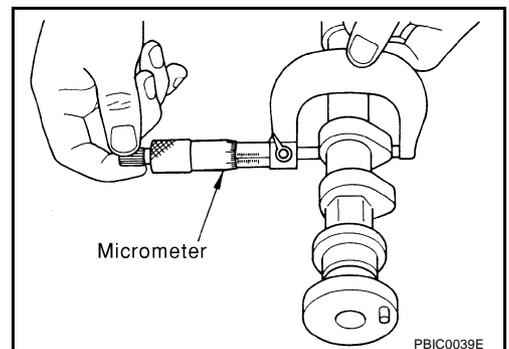
**Intake : 44.865 - 45.055 mm (1.7663 - 1.7738 in)**

**Exhaust : 43.925 - 44.115 mm (1.7293 - 1.7368 in)**

**Cam wear**

**limit : 0.2 mm (0.008 in)**

- If it exceeds the limit, replace camshaft.



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# CAMSHAFT

## Camshaft Journal Oil Clearance

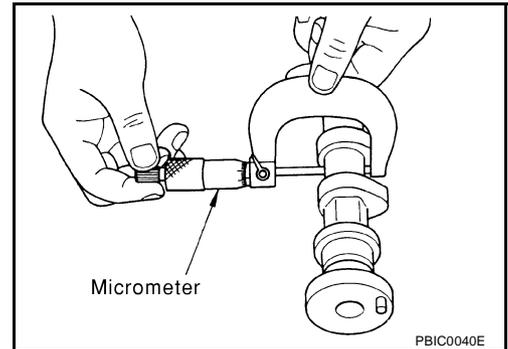
### CAMSHAFT JOURNAL OUTER DIAMETER

- Measure outer diameter of camshaft journal with a micrometer.

#### Standard:

No. 1 : 25.938 - 25.955 mm (1.0212 - 1.0218 in)

No. 2, 3, 4, 5 : 25.953 - 25.970 mm (1.0218 - 1.0224 in)

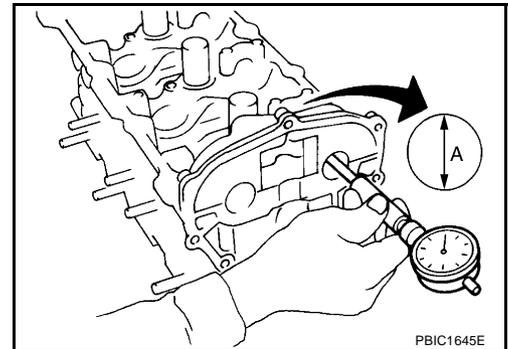


### CAMSHAFT BRACKET INNER DIAMETER

- Tighten camshaft bracket bolt with specified torque. Refer to [EM-54, "INSTALLATION"](#) for the tightening procedure.
- Measure the inner diameter "A" of camshaft bracket with an inside micrometer.

#### Standard:

26.000 - 26.021 mm (1.0236 - 1.0244 in)



### CAMSHAFT JOURNAL OIL CLEARANCE

- (Journal oil clearance) = (Camshaft bracket inner diameter) – (Camshaft journal outer diameter)

#### Standard:

No. 1 : 0.045 - 0.083 mm (0.0018 - 0.0033 in)

No. 2, 3, 4, 5 : 0.030 - 0.068 mm (0.0012 - 0.0027 in)

- If out of the standard, replace either or both camshaft and cylinder head.

#### NOTE:

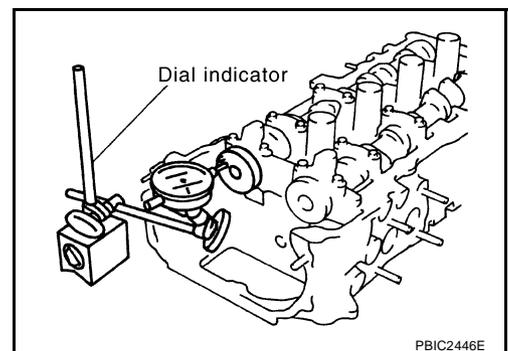
It is impossible to replace only camshaft bracket as camshaft bracket is manufactured with cylinder head. Replace the whole cylinder head assembly.

### Camshaft End Play

1. Install camshaft in cylinder head. Refer to [EM-54, "INSTALLATION"](#) for tightening procedure.
2. Install a dial indicator in thrust direction on front end of camshaft. Measure the camshaft end play when camshaft is moved forward/backward (in direction to axis).

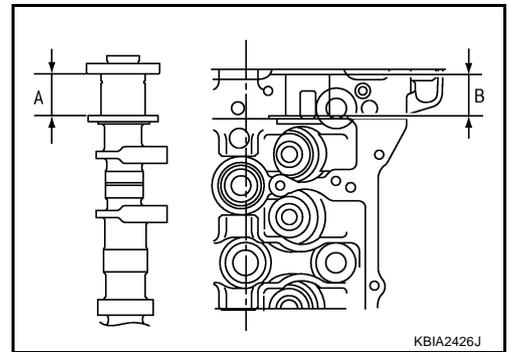
#### Standard:

0.115 - 0.188 mm (0.0045 - 0.0074 in)



# CAMSHAFT

- Measure the following parts if out of the standard.
  - Dimension "A" for camshaft No. 1 journal  
**Standard : 30.500 - 30.548 mm (1.2008 - 1.2027 in)**
  - Dimension "B" for cylinder head No. 1 journal  
**Standard : 30.360 - 30.385 mm (1.1953 - 1.1963 in)**
- Refer to the standards above, and then replace camshaft and/or cylinder head.



A  
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## Camshaft Sprocket Runout

1. Put V-block on precise flat table, and support No. 2 and No. 5 journal of camshaft.

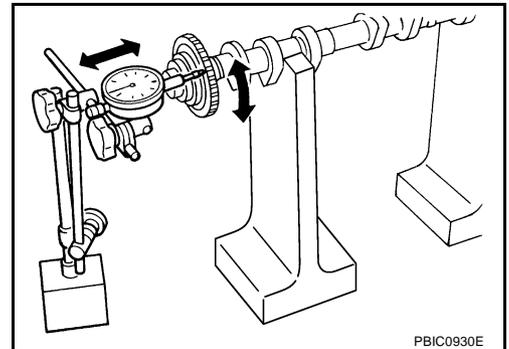
### CAUTION:

**Do not support journal No. 1 (on the side of camshaft sprocket) because it has a different diameter from the other four locations.**

2. Measure camshaft sprocket runout with a dial indicator (total indicator reading).

**Limit : 0.15 mm (0.0059 in)**

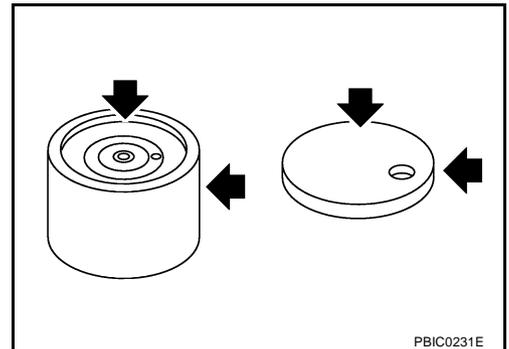
- If it exceeds the limit, replace camshaft sprocket.



## Valve Lifter and Adjusting Shim

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

- If anything above is found, replace valve lifter or adjusting shim.
- When replacing adjusting shim. Refer to [EM-57, "Valve Clearance"](#).

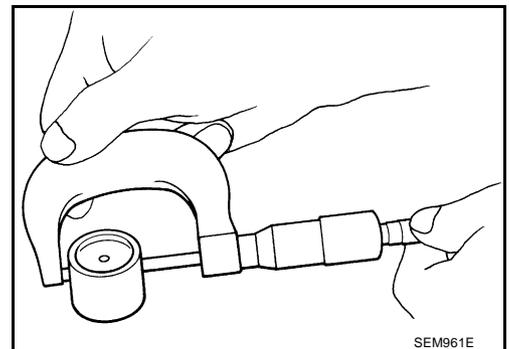


## Valve Lifter Clearance

### VALVE LIFTER OUTER DIAMETER

- Measure outer diameter of valve lifter with a micrometer.

**Standard: 33.965 - 33.975 mm (1.3372 - 1.3376 in)**



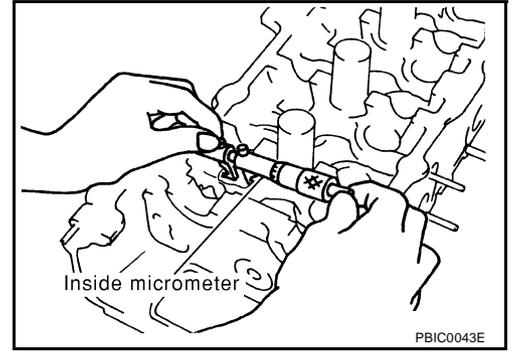
# CAMSHAFT

## VALVE LIFTER HOLE DIAMETER

- Measure inner diameter of valve lifter hole of cylinder head with an inside micrometer.

### Standard:

**34.000 - 34.016 mm (1.3386 - 1.3392 in)**



## VALVE LIFTER CLEARANCE

- (Valve lifter clearance) = (valve lifter hole diameter) – (valve lifter outer diameter)

### Standard:

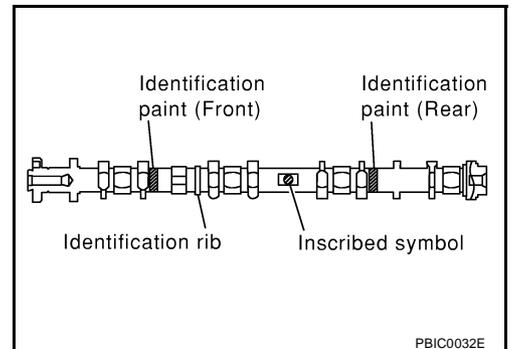
**0.025 - 0.051 mm (0.0010 - 0.0020 in)**

- If out of the standard, referring to each standard of valve lifter outer diameter and valve lifter hole diameter, replace either or both valve lifter and cylinder head.

## INSTALLATION

1. Install adjusting shims and valve lifters if necessary.
  - Install removed parts in the same locations as before.
2. Install camshafts. Refer to the table below for identification of right and left bank, and intake and exhaust.

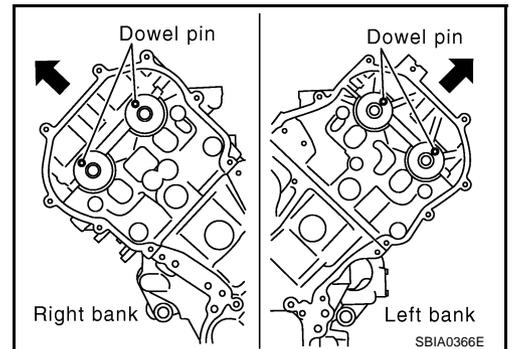
Bank	INT/EXH	Identification paint (front)	Identification paint (rear)	Identification rib	Inscribed symbol
Left	INT	Blue	—	No	LH
	EXH	—	Orange	No	LH
Right	INT	Blue	—	Yes	RH
	EXH	—	Orange	Yes	RH



- Install so that dowel pin at the front of camshaft face is in the direction shown in the figure. (No.1 cylinder at compression TDC)

### Camshaft dowel pin

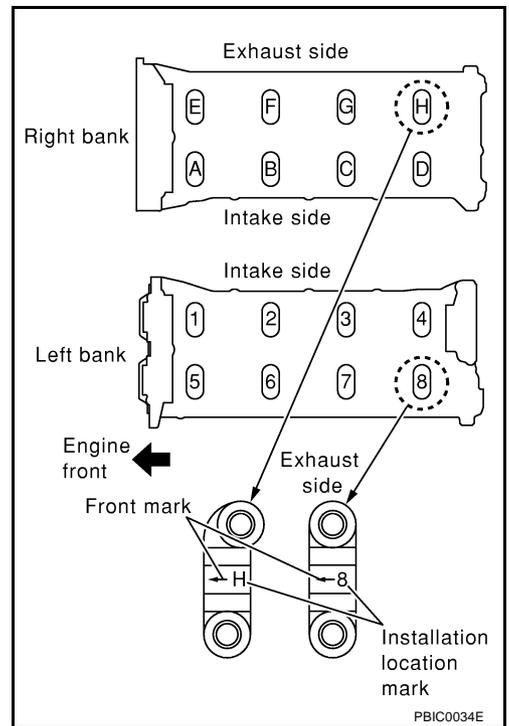
**: At cylinder head upper face side in each bank**



# CAMSHAFT

## 3. Install camshaft brackets as follows:

- Remove foreign material completely from camshaft bracket backside and from cylinder head installation face.
- Install by referring to installation location mark on upper surface and front mark.
- Install so that installation location mark can be correctly read when viewed from the side of left exhaust bank.



- Apply liquid gasket to camshaft bracket (No.1) as in the figure.

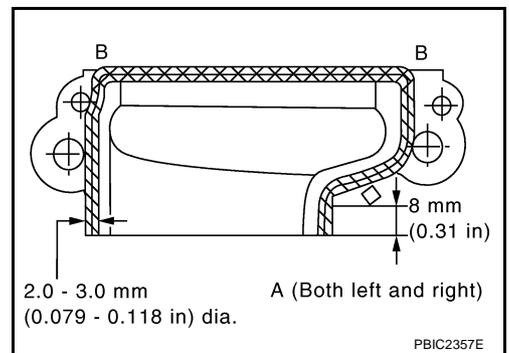
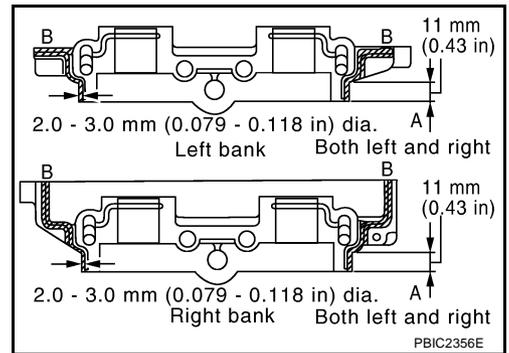
**Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-45, "RECOMMENDED CHEMICAL PRODUCTS AND SEALANTS"](#) .**

**CAUTION:**

- After installation, be sure to wipe off any excessive liquid gasket leaking from part "A" and "B"(both on right and left sides).
  - Remove completely any excess of liquid gasket inside bracket.
- Apply liquid gasket to camshaft bracket (INT,No.6) on left bank intake as in the illustration.

**CAUTION:**

- After installation, be sure to wipe off any excessive liquid gasket leaking from part "A", and "B"(both on right and left sides).
- Remove completely any excess of liquid gasket inside bracket.



# CAMSHAFT

4. Tighten camshaft bracket bolts in the following steps, in numerical order as shown in the figure.

a. Tighten No. 9 to 12 in numerical order as shown.

: **2.0 N·m (0.2 kg-m, 1 ft-lb)**

b. Tighten No. 1 to 8 in numerical order as shown.

: **2.0 N·m (0.2 kg-m, 1 ft-lb)**

c. Tighten No. 13 to 14 in numerical order as shown. (Left bank only)

: **2.0 N·m (0.2 kg-m, 1 ft-lb)**

d. Tighten all bolts in numerical order as shown.

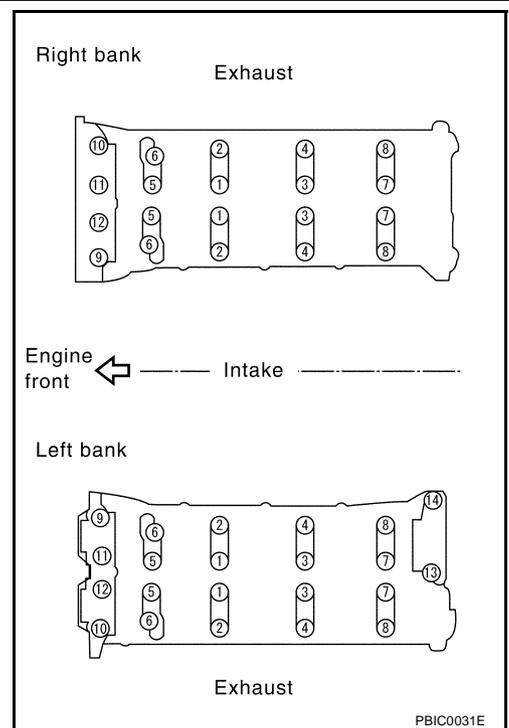
: **5.9 N·m (0.6 kg-m, 4 ft-lb)**

e. Tighten No. 1 to 12 in numerical order as shown.

: **10.4 N·m (1.1 kg-m, 8 ft-lb)**

f. Tighten No. 13 to 14 in numerical order as shown. (Left bank only)

: **31.4 N·m (3.2 kg-m, 23 ft-lb)**



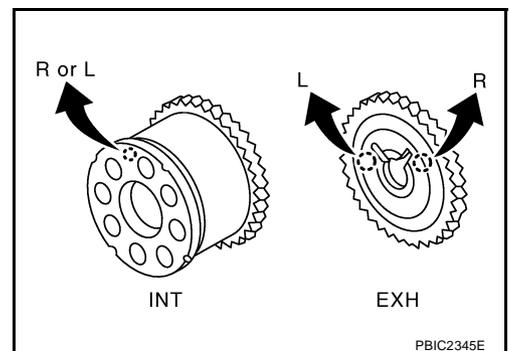
## CAUTION:

After tightening mounting 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 camshaft bracket (INT, No. 6) on left bank.
- Mating surface of front cover

5. Install camshaft sprockets.

- Install by checking with identification mark on surface.
- Install camshaft sprocket (EXH) by selectively using the groove of dowel pin according to the bank. (Common part used for both banks.)
- Lock the hexagonal part of camshaft in the same way as for removal, and tighten mounting bolts.



6. Check and adjust valve clearances. Refer to [EM-57, "Valve Clearance"](#) .

7. Install in the reverse order of removal.

## INSPECTION AFTER INSTALLATION

### Inspection of Camshaft Sprocket (INT) Oil Groove

#### CAUTION:

- Perform this inspection only when DTC P0011 and/or P0021 are detected in self-diagnostic results of CONSULT-II and it is directed according to inspection procedure of EC section. Refer to [EC-82, "TROUBLE DIAGNOSIS"](#) .
  - Check when the engine is cold so as to prevent burns from any splashing engine oil.
1. Check the engine oil level. Refer to [LU-6, "ENGINE OIL"](#) .
  2. Perform the following procedure so as to prevent the engine from being unintentionally started while checking.
    - a. Release fuel pressure. Refer to [EC-80, "FUEL PRESSURE RELEASE"](#) .
    - b. Disconnect ignition coil and injector harness connectors.

# CAMSHAFT

3. Remove intake valve timing control solenoid valve. Refer to [EM-39, "TIMING CHAIN"](#) .
4. Crank the engine, and then make sure that engine oil comes out from intake valve timing control cover oil hole. End crank after checking.

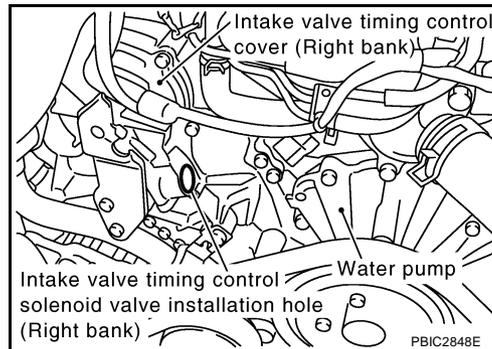
**WARNING:**

Be careful not to touch rotating parts (drive belt, idler pulley, and crankshaft pulley, etc.).

**CAUTION:**

Engine oil may squirt from intake valve timing control solenoid valve installation hole during cranking. Use a shop cloth to prevent the engine components and the vehicle. Do not allow engine oil to get on rubber components such as drive belt or engine mount insulators. Immediately wipe off any splashed engine oil.

- Clean oil groove between oil strainer and intake valve timing control solenoid valve if engine oil does not come out from intake valve timing control cover oil hole. Refer to [LU-4, "LUBRICATION SYSTEM"](#) .
5. Remove components between intake valve timing control solenoid valve and camshaft sprocket (INT), and then check each oil groove for clogging.
    - Clean oil groove if necessary. Refer to [LU-4, "LUBRICATION SYSTEM"](#) .
  6. After inspection, install removed parts.

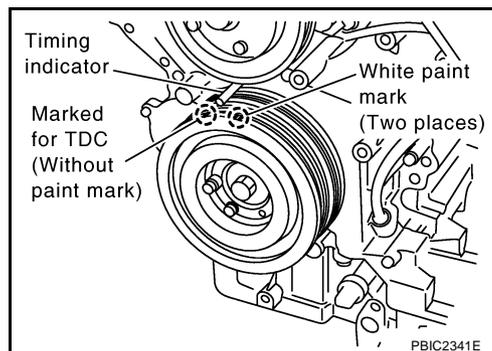


## Valve Clearance INSPECTION

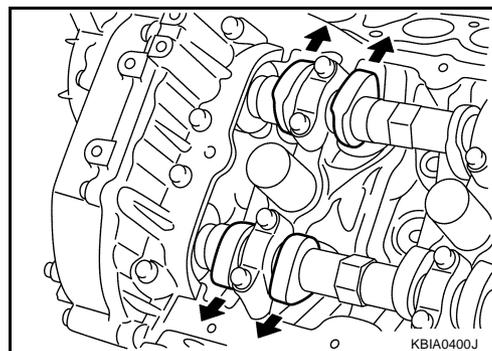
NBS0010T

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 (engine starting, idling, and/or noise).

1. Remove rocker cover (right and left bank) with power tool. Refer to [EM-37, "Removal and Installation"](#) .
2. Turn crankshaft pulley in normal direction (clockwise when viewed from engine front) to align TDC identification notch (without paint mark) with timing indicator.

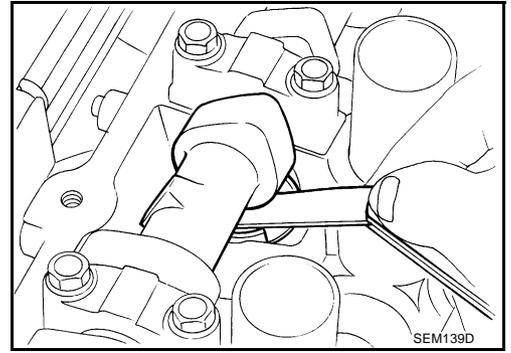


3. At this time, make sure that the both intake and exhaust cam noses of No. 1 cylinder (top front on left bank) face outside.
  - If they do not face outside, turn crankshaft pulley by 360 degrees once more.



# CAMSHAFT

4. Measure the clearance between valve lifter and camshaft with a feeler gauge.



## Valve clearance:

Unit: mm (in)

	Cold	Hot * (reference data)
Intake	0.26 - 0.34 (0.010 - 0.013)	0.304 - 0.416 (0.012 - 0.016)
Exhaust	0.29 - 0.37 (0.011 - 0.015)	0.308 - 0.432 (0.012 - 0.017)

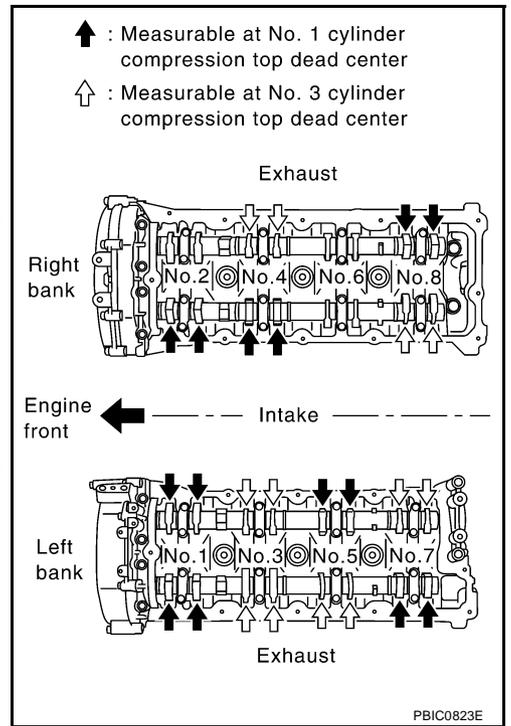
\*: Approximately 80°C (176°F)

5. 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.

### NOTE:

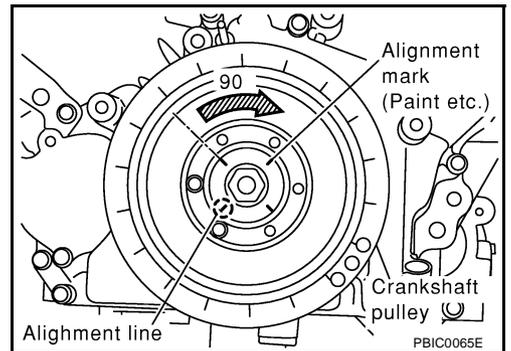
Firing order 1-8-7-3-6-5-4-2

- No.1 cylinder compression TDC



Measuring position (Right bank)		No. 2 CYL	No. 4 CYL	No. 6 CYL	No. 8 CYL
No. 1 cylinder at TDC	EXH				×
	INT	×	×		
Measuring position (Left bank)		No. 1 CYL	No. 3 CYL	No. 5 CYL	No. 7 CYL
No. 1 cylinder at TDC	INT	×		×	
	EXH	×			×

6. Turn crankshaft pulley clockwise by 270 degrees from the position of No. 1 cylinder compression TDC to obtain No. 3 cylinder compression TDC.

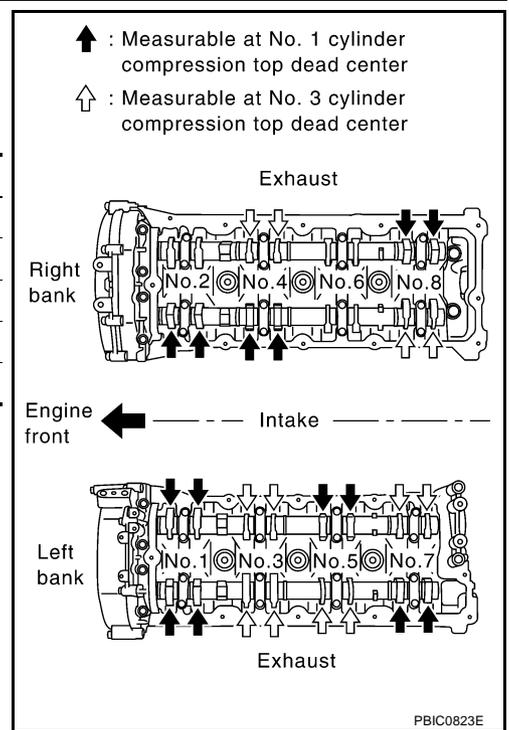


# CAMSHAFT

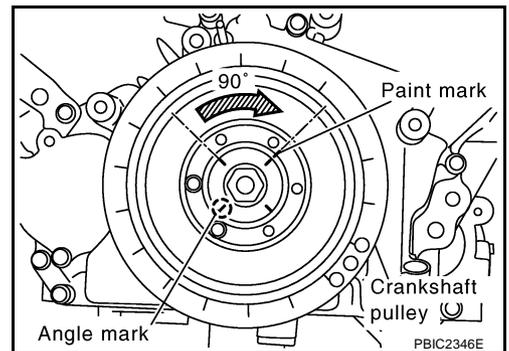
7. By referring to the figure, measure valve clearances at locations marked X as shown in the table below (locations indicated with white arrow in figure).

- No.3 cylinder compression TDC.

Measuring position (Right bank)		No. 2 CYL	No. 4 CYL	No. 6 CYL	No. 8 CYL
No. 3 cylinder at TDC	EXH		×		
	INT				×
Measuring position (Left bank)		No. 1 CYL	No. 3 CYL	No. 5 CYL	No. 7 CYL
No. 3 cylinder at TDC	INT		×		×
	EXH		×	×	

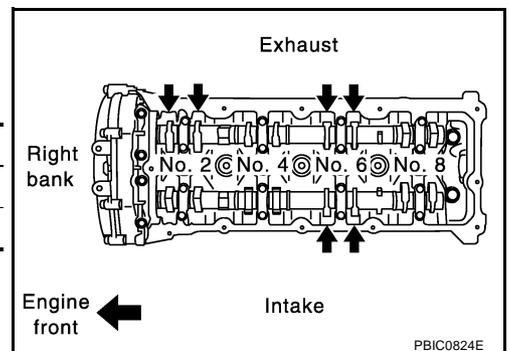


8. Rotate crankshaft pulley clockwise (when view from engine front) by 90 degrees from the position of No. 3 cylinder compression TDC to align No. 6 cylinder at TDC of its compression stroke.



- By referring to the figure, measure valve clearances at locations marked "X" as shown in the table below.
- No. 6 cylinder compression TDC

Measuring position (Right bank)		No. 2 CYL	No. 4 CYL	No. 6 CYL	No. 8 CYL
No. 6 cylinder at TDC	EXH	×		×	
	INT			×	



9. For measured value are out of standard, perform adjustment. Refer to [EM-60, "ADJUSTMENT"](#).

A  
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# CAMSHAFT

## ADJUSTMENT

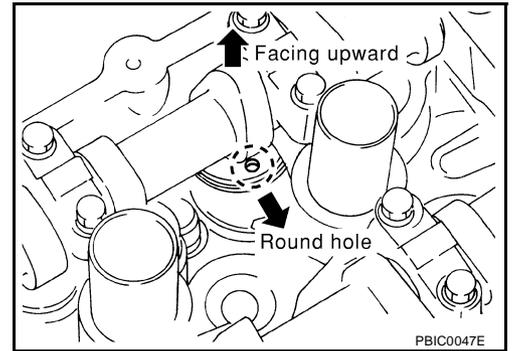
### NOTE:

**Adjust valve clearance while engine is cold.**

1. Turn crankshaft, to position cam nose on camshaft 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.

### CAUTION:

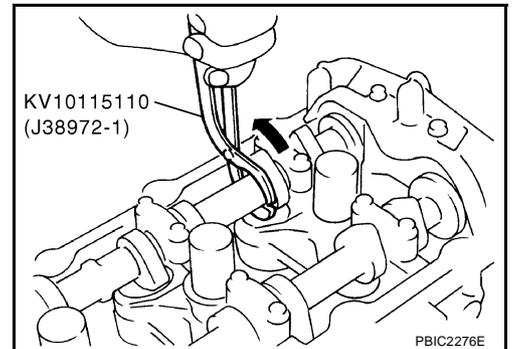
**Perform (the above procedure) while camshaft do not contact with adjusting shim.**



4. Compress valve spring by snapping camshaft using the camshaft pliers (SST), by pulling camshaft to the same direction of the arrow and by pushing valve lifter down.

### CAUTION:

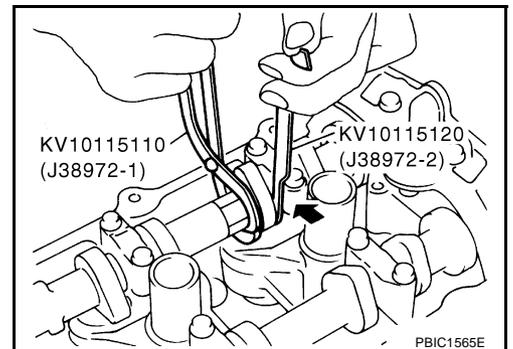
**Be careful not to damage cam surface with the camshaft pliers.**



5. Place the lifter stopper (SST) between camshaft and the edge of valve lifter to retain valve lifter.

### CAUTION:

- The lifter stopper must be placed as close to camshaft bracket as possible.
- Be careful not to damage cam surface with the lifter stopper.



6. Remove the camshaft pliers (SST).

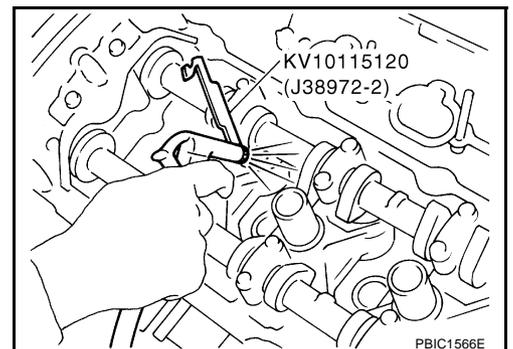
### CAUTION:

**When returning the camshaft pliers quickly, the lifter stopper (SST) hit and damages the journal portion of camshaft. Therefore turn the camshaft pliers slowly.**

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

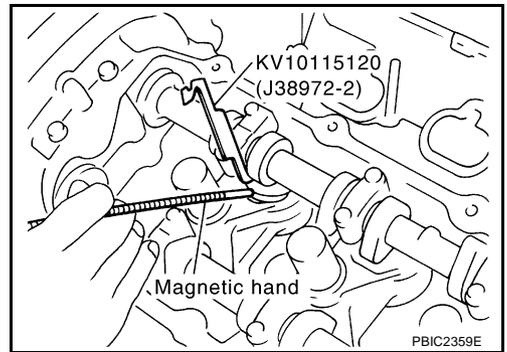
### CAUTION:

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



# CAMSHAFT

8. Remove adjusting shim using a small screwdriver and a magnetic hand.



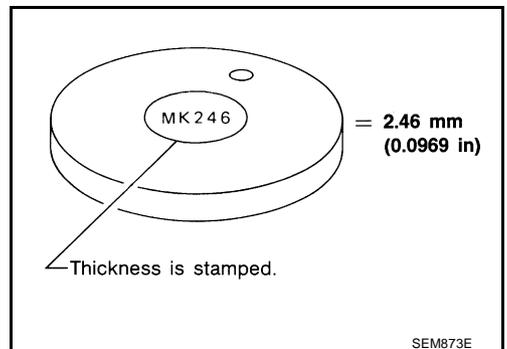
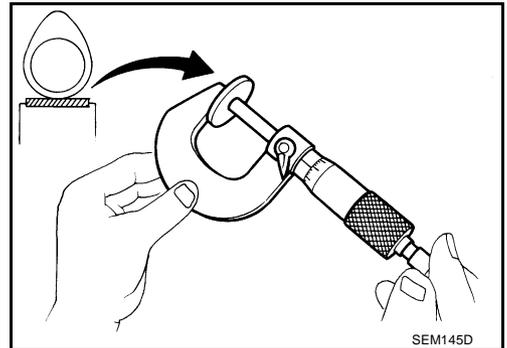
9. Determine replacement adjusting shim size following formula.
- Using a micrometer determine thickness of removed shim with measured at center.
  - Calculate thickness of new adjusting shim so valve clearance comes within specified values.  
R = Thickness of removed shim  
N = Thickness of new shim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

**Intake** :  $N = R + [M - 0.30 \text{ mm (0.0118 in)}]$

**Exhaust** :  $N = R + [M - 0.33 \text{ mm (0.0130 in)}]$

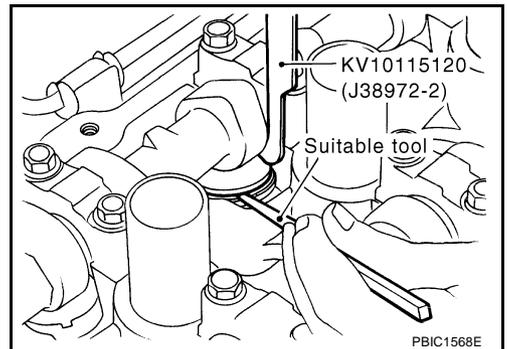
Shims are available in 64 sizes from 2.32 mm (0.0913 in) to 2.95 mm (0.1161 in) in steps of 0.01 mm (0.0004 in). Refer to [EM-112, "Available Shims"](#).

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



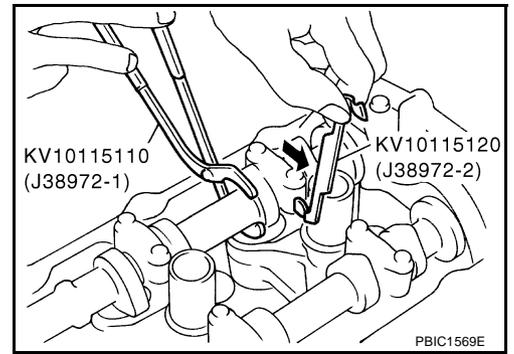
10. Install new shim using a suitable tool.

- **Install with the surface on which the thickness stamped is facing down.**



## CAMSHAFT

11. Place the camshaft pliers (SST) as mentioned in step 4.
12. Remove the lifter stopper (SST).
13. Remove the camshaft pliers (SST).



14. Manually turn crankshaft pulley a few turns.
15. Make sure that valve clearances for cold engine are within specifications by referring to the specified values. Refer to [EM-57, "INSPECTION"](#) .
16. Install all removed parts in the reverse order of removal. Refer to [EM-54, "INSTALLATION"](#) .
17. Warm up the engine, and check for unusual noise and vibration.

## OIL SEAL

PFP:00100

### Removal and Installation of Valve Oil Seal

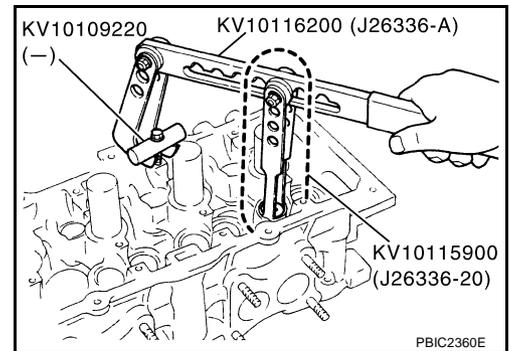
NBS0010U

#### REMOVAL

1. Remove camshaft relating to valve oil seal to be removed. Refer to [EM-50, "CAMSHAFT"](#) .
2. Remove adjusting shims and valve lifters. Refer to [EM-50, "CAMSHAFT"](#) .
  - Correctly identify location where each part is installed. Keep parts in an organized way to avoid mixing them up.
3. Turn crankshaft until the cylinder requiring new oil seals is at TDC. This will prevent the valve from dropping into cylinder.
4. Remove valve collet.
  - Compress valve spring with the valve spring compressor, attachment and adapter (SST). Remove valve collet with magnetic hand.

**CAUTION:**

**When working, take care not to damage valve lifter holes.**

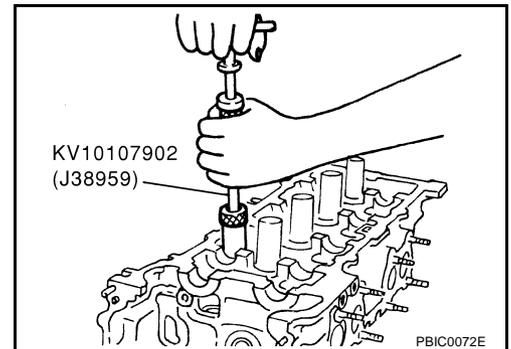


5. Remove valve spring retainer and valve spring (with valve spring seat).

**CAUTION:**

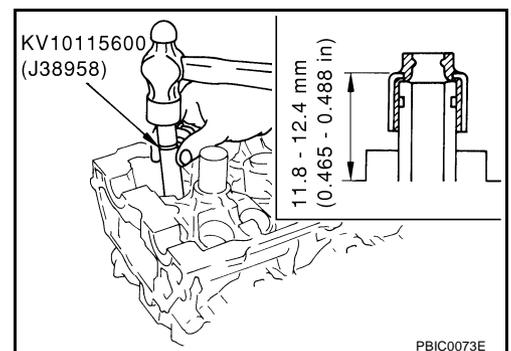
**Do not remove valve spring seat from valve spring.**

6. Remove valve oil seal using the valve oil seal puller (SST).



#### INSTALLATION

1. Install valve oil seal.
  - Apply engine oil on new valve oil seal joint and seal lip.
  - Install with the valve oil seal drift (SST) to match dimension in figure.



2. Install in the reverse order of removal.

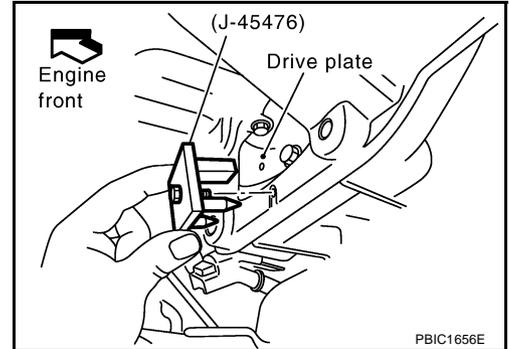
# OIL SEAL

NBS0010V

## Removal and Installation of Front Oil Seal

### REMOVAL

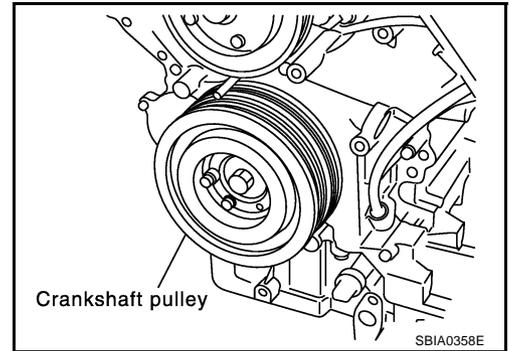
1. Remove the following:
  - Engine undercover
  - Drive belt; Refer to [EM-14, "DRIVE BELTS"](#) .
  - Cooling fan assembly; Refer to [CO-18, "COOLING FAN"](#) .
  - Rear plate cover; Refer to [EM-26, "OIL PAN AND OIL STRAINER"](#) .
2. Remove crankshaft pulley as follows:
  - a. Set the ring gear stopper (SST).



- b. Loosen crankshaft pulley bolt.
- c. Pull crankshaft pulley with both hands to remove it.

### CAUTION:

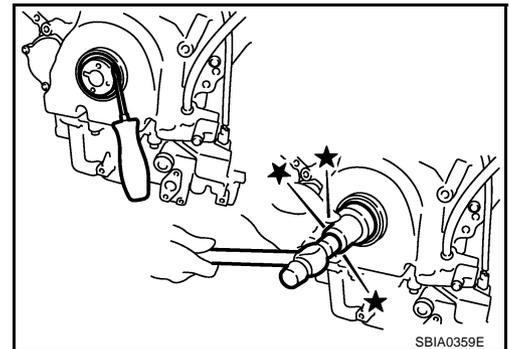
- Do not remove crankshaft pulley bolt. Keep loosened crankshaft pulley bolt in place to protect removed crankshaft pulley from dropping.
- Do not remove balance weight (inner hexagon bolt) at the front of crankshaft pulley.



3. Remove front oil seal using a suitable tool.

### CAUTION:

Be careful not to damage front cover and oil pump drive spacer.

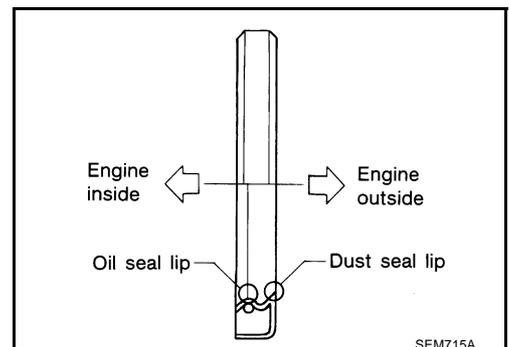


### INSTALLATION

1. Install front oil seal onto front cover.
  - Install new front oil seal in the direction shown in the figure.
  - Apply engine oil on new front oil seal.

### CAUTION:

Be careful not to scratch or make burrs on circumference of oil seal.

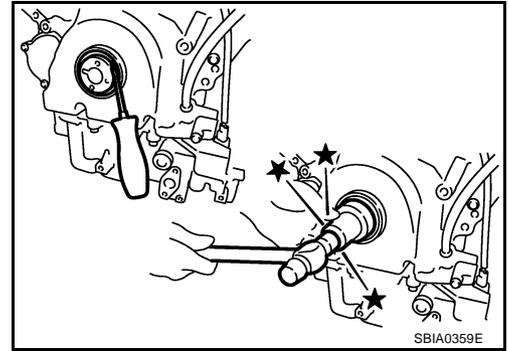


## OIL SEAL

- Using the front oil seal drift (commercial service tool) or drift with 54 mm (2.13 in) diameter, force fit the seal until it levels with the front end surface of front cover.

**CAUTION:**

- Be careful not to damage front cover and oil pump drive spacer.
- Press fit straight and avoid causing burrs or tilting oil seal.



2. Install in the reverse order of removal.

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# OIL SEAL

NBS0010W

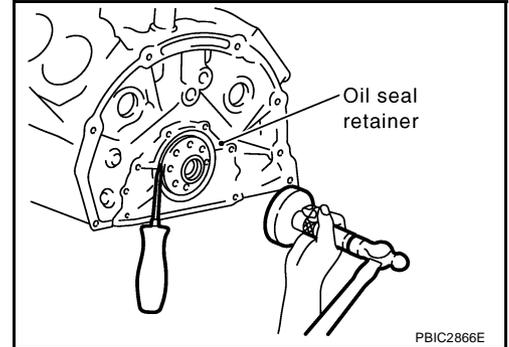
## Removal and Installation of Rear Oil Seal

### REMOVAL

1. Remove transmission assembly. Refer to [AT-249, "TRANSMISSION ASSEMBLY"](#) .
  - a. Remove drive plate. Refer to [EM-83, "Disassembly and Assembly"](#) .
  - b. Remove engine rear plate. Refer to [EM-83, "Disassembly and Assembly"](#) .
2. Remove rear oil seal using a suitable tool.

#### **CAUTION:**

**Be careful not to damage crankshaft and oil seal retainer surface.**

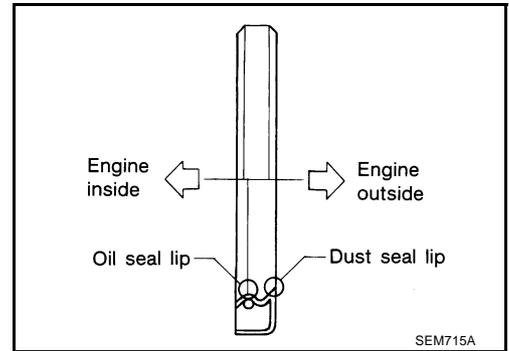


### INSTALLATION

1. Install rear oil seal using the rear oil seat drift (commercial service tool).
  - Install new oil seal in the direction shown in the figure.
  - Apply engine oil on new rear oil seal.

#### **CAUTION:**

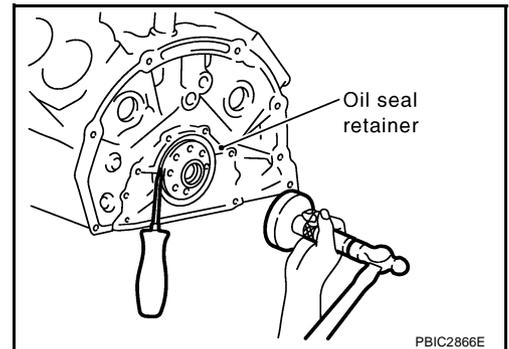
**Be careful not to scratch or make burrs on circumference of rear oil seal.**



- Tap until flattened with front edge of oil seal retainer. Do not damage or scratch outer circumference of oil seal.

#### **CAUTION:**

- **Be careful not to damage crankshaft and rear oil seal retainer.**
- **Press fit straight and avoid causing burrs or tilting oil seal.**



2. Install in the reverse order of removal.

# CYLINDER HEAD

## CYLINDER HEAD

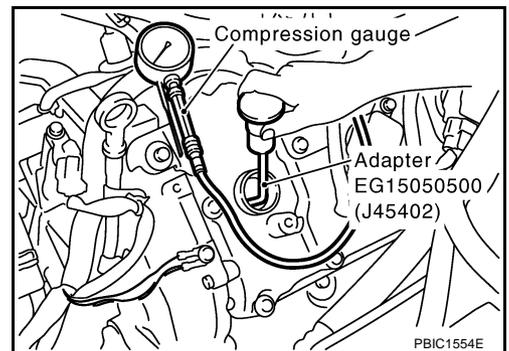
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### On-Vehicle Service

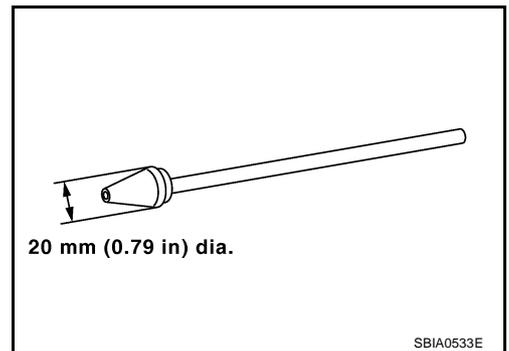
NBS0010X

### CHECKING COMPRESSION PRESSURE

1. Warm up engine thoroughly. Then, stop it.
2. Remove engine cover (with power tool), air cleaner cover and battery cover. Refer to [EM-13, "Removal and Installation"](#).
3. Release fuel pressure as follows:
  - a. Remove fuel pump fuse, and start engine. Refer to [EC-80, "FUEL PRESSURE RELEASE"](#) for fuel pump fuse location.
  - b. After engine stalls, crank it two or three times to release all fuel pressure.
    - Let fuel pump fuse removed until the end of step 7.
4. Remove ignition coil and spark plug from each cylinder. Refer to [EM-29, "Removal and Installation"](#) and [EM-30, "Removal and Installation"](#).
5. Connect engine tachometer (not required in use of CONSULT-II).
6. Install the compression gauge with adapter (SST) onto spark plug hole.
  - Use the compression gauge adapter (SST) which is required on No. 7 and No. 8 cylinders.



- Use the compression gauge adapter (if no SST is used) whose picking up end inserted to spark plug hole is smaller than 20 mm (0.79 in) in diameter. Otherwise, it may be caught by cylinder head during removal.



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

### Compression pressure

Unit: kPa (kg/cm<sup>2</sup>, psi) /rpm

Standard	Minimum	Deference limit between cylinders
1,320 (13.5, 191) / 300	1,130 (11.5, 164) / 300	98 (1.0, 14) / 300

### CAUTION:

**Always use a fully charged battery to obtain specified engine speed.**

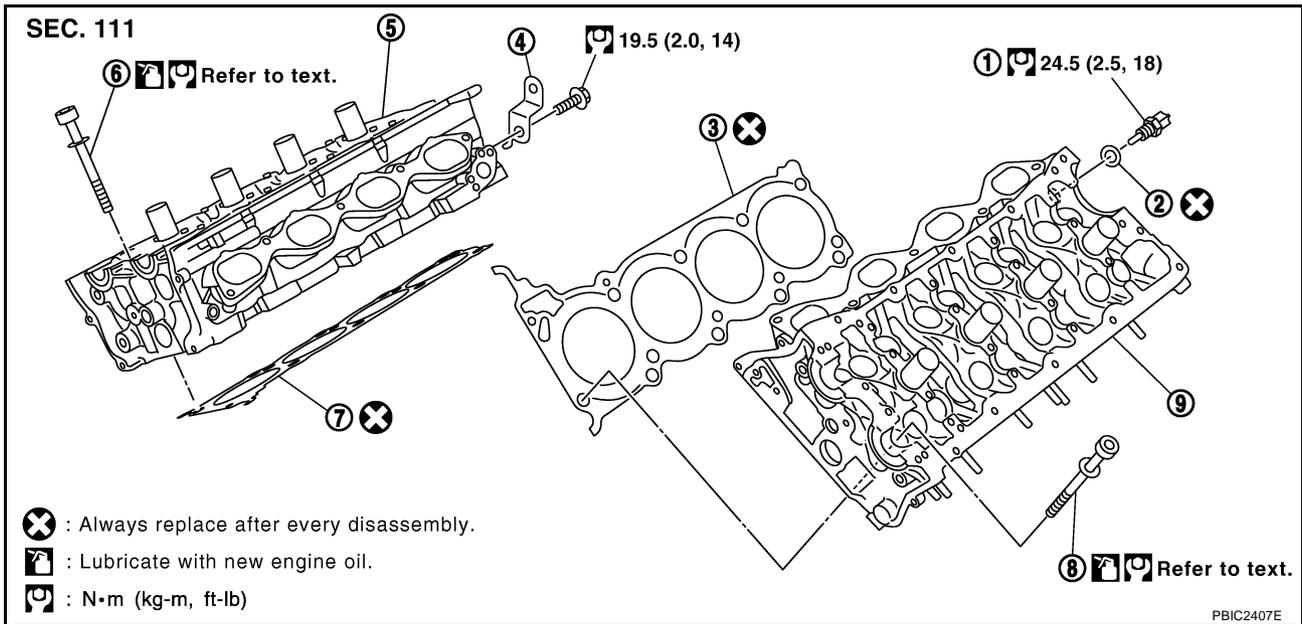
- If the engine speed is out of specified range, check battery liquid for proper gravity. Check engine speed again with normal battery gravity.
- If compression pressure is below minimum value, check valve clearances and parts associated with combustion chamber (Valve, valve seat, piston, piston ring,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

# CYLINDER HEAD

- If the added engine oil improves the compression, the piston rings may be worn out or damaged. Check piston rings and replace if necessary.
  - If the compression pressure remains at low level despite the addition of engine oil, valves may be malfunctioning. Check valves for damage. Replace 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, cylinder head gaskets are leaking. In such a case, replace cylinder head gaskets.
8. Install removed parts in the reverse order of removal.
  9. Start engine, and confirm that engine runs smoothly.
  10. Perform trouble diagnosis. If DTC appears, erase it. Refer to [EC-82, "TROUBLE DIAGNOSIS"](#).

## Removal and Installation

NBS0010Y



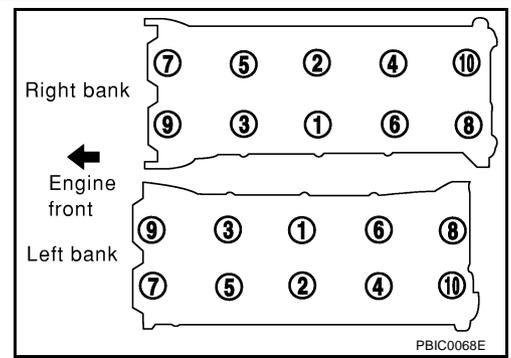
- |                                      |                               |                                     |
|--------------------------------------|-------------------------------|-------------------------------------|
| 1. Engine coolant temperature sensor | 2. Washer                     | 3. Cylinder head gasket (left bank) |
| 4. Harness bracket                   | 5. Cylinder head (right bank) | 6. Cylinder head bolt               |
| 7. Cylinder head gasket (right bank) | 8. Cylinder head bolt         | 9. Cylinder head (left bank)        |

## REMOVAL

1. Remove engine assembly from vehicle. Refer to [EM-79, "Removal and Installation"](#).
2. Remove the following components and related parts:
  - Auto tensioner of drive belts and idler pulley. Refer to [EM-15, "Drive Belt Auto Tensioner and Idler Pulley"](#).
  - Thermostat housing and radiator hose. Refer to [CO-22, "Removal and Installation"](#).
  - Oil pan and oil strainer. Refer to [EM-26, "Removal and Installation"](#).
  - Intake manifold (upper and lower). Refer to [EM-19, "Removal and Installation"](#).
  - Fuel tube (right and left), fuel damper and fuel hose assembly and fuel injector. Refer to [EM-32, "Removal and Installation"](#).
  - Ignition coil. Refer to [EM-29, "Removal and Installation"](#).
  - Rocker cover. Refer to [EM-37, "Removal and Installation"](#).
  - Exhaust manifold and three way catalyst. Refer to [EM-23, "EXHAUST MANIFOLD AND THREE WAY CATALYST"](#).
3. Remove camshaft sprockets and camshafts. Refer to [EM-50, "Removal and Installation"](#).

# CYLINDER HEAD

- Remove cylinder head bolts in the reverse order shown in the figure and using the cylinder head bolt wrench (Commercial service tool: J-24239-01).



- Remove cylinder head gaskets.

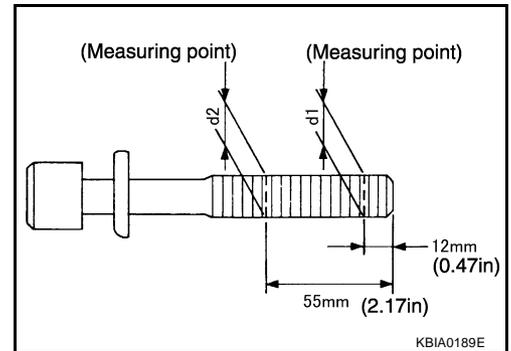
## INSPECTION AFTER REMOVAL

### Cylinder Head Bolts Outer Diameter

- 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 0.18 mm (0.0071 in)**

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



### Cylinder Head Distortion

#### NOTE:

When performing this inspection, cylinder block distortion should be also checking. Refer to [EM-103, "CYLINDER BLOCK DISTORTION"](#).

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

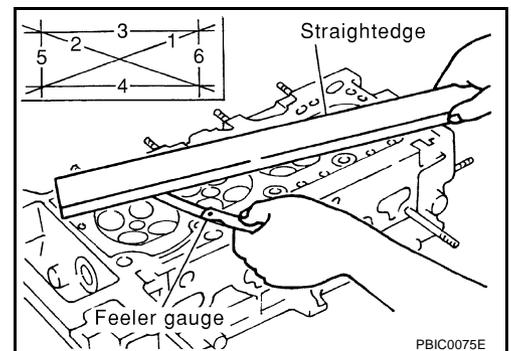
#### CAUTION:

**Use utmost care not to allow liquid gasket debris to enter passages for engine oil or engine coolant.**

- At each of several locations on bottom surface of cylinder head, measure distortion in six directions with a straightedge and a feeler gauge.

**Limit : 0.1mm (0.004 in)**

- If it exceeds the limit, replace cylinder head.

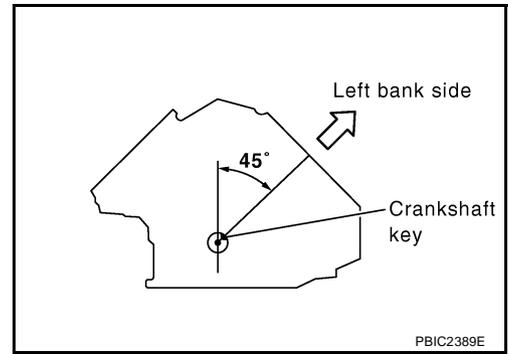


## INSTALLATION

- Install cylinder head gaskets.
- Turn crankshaft until No. 1 piston is set at TDC.

# CYLINDER HEAD

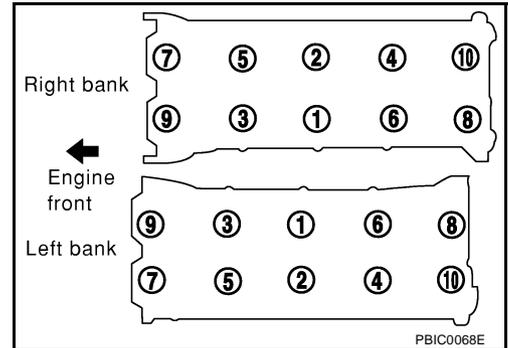
- Crankshaft key should line up with the left bank cylinder center line as shown in the figure.



3. Install cylinder head follow the steps below to tighten cylinder head bolts in numerical order as shown in the figure with the cylinder head bolt wrench (commercial service tool: J-24239-01).

**CAUTION:**

- If cylinder head bolts are re-used, check their outer diameters before installation. Refer to [EM-69, "Cylinder Head Bolts Outer Diameter"](#).



- a. Apply new engine oil to threads and seating surface of cylinder head bolts.
- b. Tighten all cylinder head bolts.

: 98.1 N·m (10 kg·m, 72 ft·lb)

- c. Completely loosen all cylinder head bolts.

: 0 N·m (0 kg·m, 0 ft·lb)

**CAUTION:**

In step "c", loosen cylinder head bolts in the reverse order of that indicated in the figure.

- d. Tighten all cylinder head bolts.

: 44.1 N·m (4.5 kg·m, 33 ft·lb)

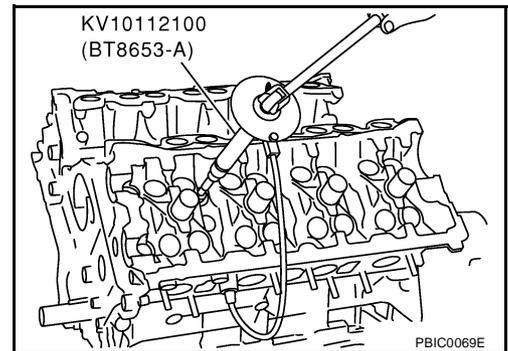
- e. Turn all cylinder head bolts 60 degrees clockwise. (Angle tightening)

**CAUTION:**

Check the tightening angle by using angle wrench (SST). Avoid judgment by visual inspection without SST.

- Check tightening angle indicated on angle wrench indicator plate.

- f. Turn all cylinder head bolts 60 degrees clockwise again. (Angle tightening)



4. Install in the reverse order of removal.

## INSPECTION AFTER INSTALLATION

### inspection for Leaks

The following are procedures for checking fluids leak, lubricates leak and exhaust gases leak.

- Before starting engine, check oil/fluid levels including engine coolant and engine oil. If less than required quantity, fill to the specified level. Refer to [MA-10, "RECOMMENDED FLUIDS AND LUBRICANTS"](#).
- Use procedure below to check for fuel leakage.

# CYLINDER HEAD

- Turn ignition switch "ON" (with engine stopped). With fuel pressure applied to fuel piping, check for fuel leakage at connection points.
- Start engine. With engine speed increased, check again for fuel leakage at connection points.
- Run engine to check for unusual noise and vibration.
- Warm up engine thoroughly to make sure there is no leakage of fuel, exhaust gas, or any oils/fluids including engine oil and engine coolant.
- Bleed air from passages in lines and hoses, such as in cooling system.
- After cooling down engine, again check oil/fluid levels including engine oil and engine coolant. Refill to specified level, if necessary.

## Summary of the inspection items:

Item	Before starting engine	Engine running	After engine stopped
Engine coolant	Level	Leakage	Level
Engine oil	Level	Leakage	Level
Other oils and fluids *	Level	Leakage	Level
Fuel	Leakage	Leakage	Leakage
Exhaust gas	—	Leakage	—

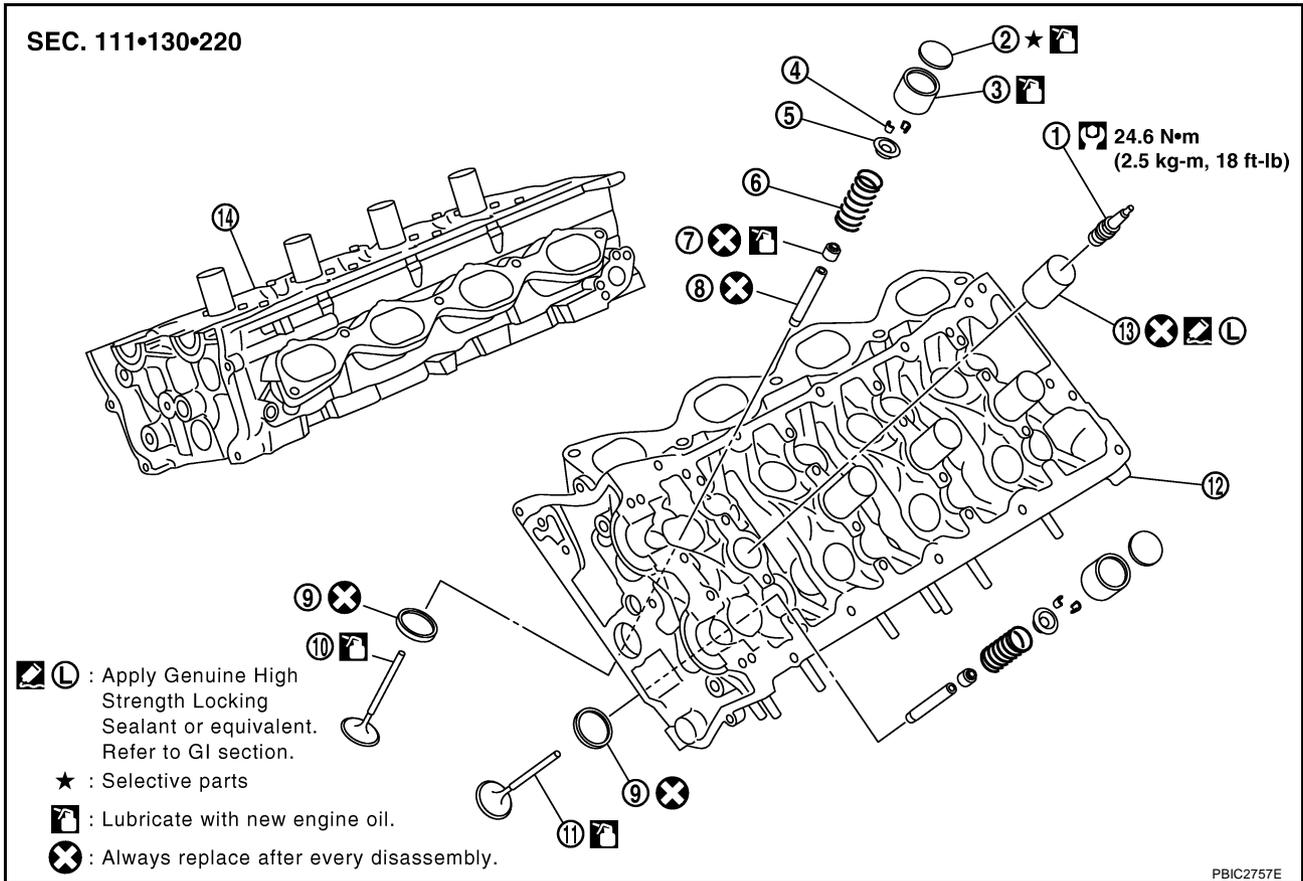
\* Transmission/transaxle/CVT fluid, power steering fluid, brake fluid, etc.

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EM  
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M

# CYLINDER HEAD

## Disassembly and Assembly

NBS0010Z



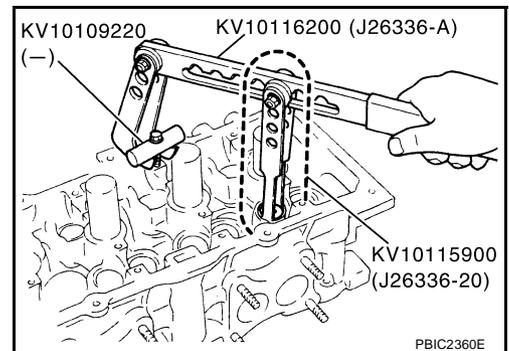
- |                     |                                |  |
|---------------------|--------------------------------|--|
| 1. Spark plug       | 2. Adjusting shim              | 3. Valve lifter                          |
| 4. Valve collet     | 5. Valve spring retainer       | 6. Valve spring (with valve spring seat) |
| 7. Valve oil seal   | 8. Valve guide                 | 9. Valve seat                            |
| 10. Valve (INT)     | 11. Valve (EXH)                | 12. Cylinder head (left bank)            |
| 13. Spark plug tube | 14. Cylinder head (right bank) |  |

### DISASSEMBLY

- Remove spark plug with the spark plug wrench (commercial service tool).
- Remove adjusting shim and valve lifter.
  - Confirm installation point and keep parts in an organized way to avoid mixing them up.
- Remove valve collet.
  - Compress valve spring with the valve spring compressor, attachment and adapter (SST). Remove valve collet with magnetic hand.

#### CAUTION:

When working, take care not to damage valve lifter holes.



- Remove valve spring retainer and valve spring (with valve spring seat).

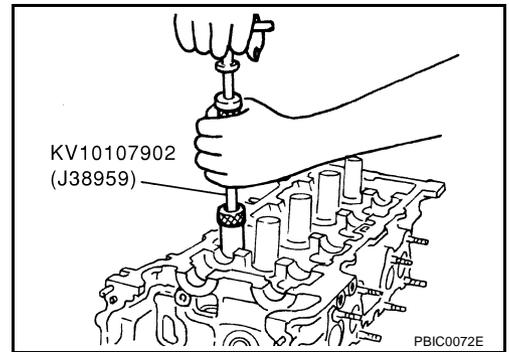
#### CAUTION:

Do not remove valve spring seat from valve spring.

- Push valve stem to combustion chamber side, and remove valve.
  - Confirm installation point and keep parts in an organized way to avoid mixing then up.

# CYLINDER HEAD

6. Remove valve oil seal with the valve oil seal puller (SST).



7. If valve seat must be replaced, refer to [EM-77, "VALVE SEAT REPLACEMENT"](#).
8. If valve guide must be replaced, refer to [EM-75, "VALVE GUIDE REPLACEMENT"](#).
9. Remove spark plug tube, as necessary.

- Using a pair of pliers, pull spark plug tube out of cylinder head.

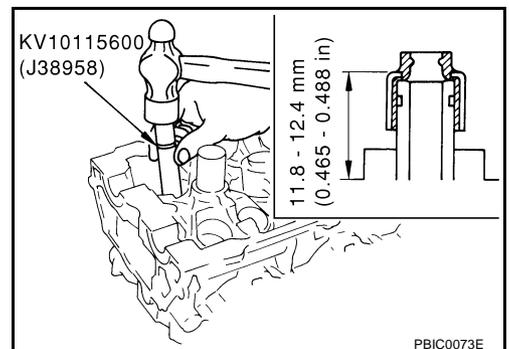
**CAUTION:**

- Take care not to damage cylinder head.
- Once removed, a spark plug tube will be deformed and cannot be reused. Do not remove it unless absolutely necessary.

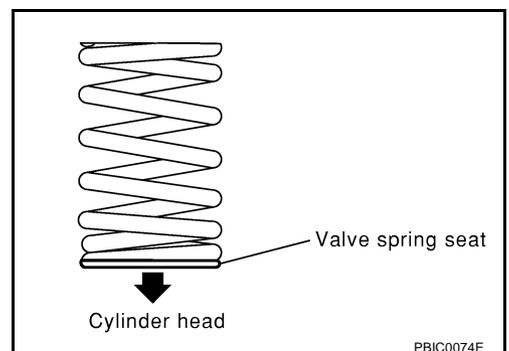
## ASSEMBLY

1. When valve guide is removed, install it. Refer to [EM-75, "VALVE GUIDE REPLACEMENT"](#).
2. When valve seat is removed, install it. Refer to [EM-77, "VALVE SEAT REPLACEMENT"](#).
3. Install valve oil seal.

- Apply new engine oil on valve oil seal joint and seal lip.
- Install with the valve oil seal drift (SST) to match dimension in figure.



4. Install valve.
  - Install in the original position.
  - Install larger diameter to intake side.
5. Install valve spring (with valve spring seat).
  - Install smaller pitch (valve spring seat side) to cylinder head side.



6. Install valve spring retainer.

# CYLINDER HEAD

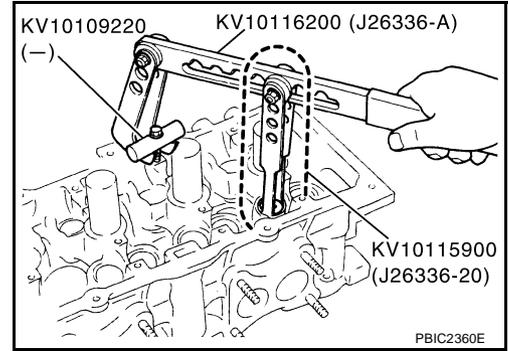
7. Install valve collet.

- Compress valve spring with the valve spring compressor, attachment and adapter (SST). Install valve collet with magnetic hand.

**CAUTION:**

**When working, take care not to damage valve lifter holes.**

- Tap stem edge lightly with plastic hammer after installation to check its installed condition.

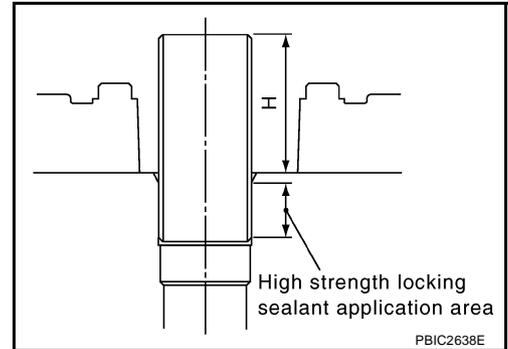


8. Install valve lifter and adjusting shim.

- Install in the original position.

9. Install spark plug tube as follows:

- Press-fit spark plug tube following procedure below.
- Remove old liquid gasket adhering to cylinder head mounting hole.
  - Apply liquid gasket to area within approximately 12 mm (0.47 in) from edge of spark plug tube press-fit side.
    - Use Genuine High strength locking sealant or equivalent. Refer to [GI-45, "RECOMMENDED CHEMICAL PRODUCTS AND SEALANTS"](#).
  - Using a drift, press-fit spark plug tube so that its height "H" in the figure is as specified.



**Standard press-fit height "H":**

**38.4 - 39.4 mm (1.512 - 1.551 in)**

**CAUTION:**

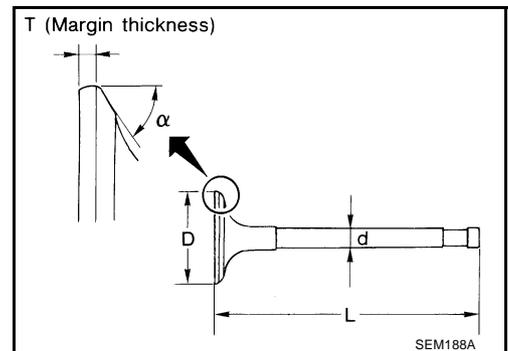
- **When press-fitting spark plug tube, take care not to deform it.**
- **After press-fitting, wipe off liquid gasket protruding onto cylinder head upper face.**

10. Install spark plug with the spark plug wrench (commercial service tool).

## Inspection After Disassembly VALVE DIMENSIONS

NBS001P0

- Check dimensions of each valve. For dimensions, refer to [EM-111, "Valve Dimensions"](#).
- If the dimensions are out of the standard, replace valve and check the valve seat contact. Refer to [EM-76, "VALVE SEAT CONTACT"](#).



# CYLINDER HEAD

## VALVE GUIDE CLEARANCE

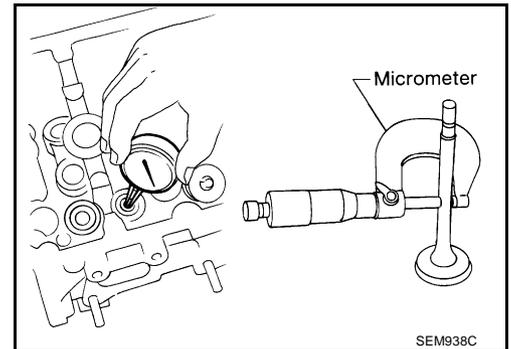
### Valve Stem Diameter

Measure diameter of valve stem with micrometer.

#### Standard

**Intake** : 5.972 - 5.980 mm (0.2351 - 0.2354 in)

**Exhaust** : 5.962 - 5.970 mm (0.2347 - 0.2350 in)



### Valve Guide Inner Diameter

Measure inner diameter of valve guide with inside micrometer.

#### Standard

**Intake and Exhaust** : 6.000 - 6.018 mm (0.2362 - 0.2369 in)

### Valve Guide Clearance

(Valve guide clearance) = (Valve guide inner diameter) – (Valve stem diameter).

#### Valve guide clearance:

##### Standard

**Intake** : 0.020 - 0.046 mm (0.0008 - 0.0018 in)

**Exhaust** : 0.030 - 0.056 mm (0.0012 - 0.0022 in)

##### Limit

**Intake** : 0.08 mm (0.003 in)

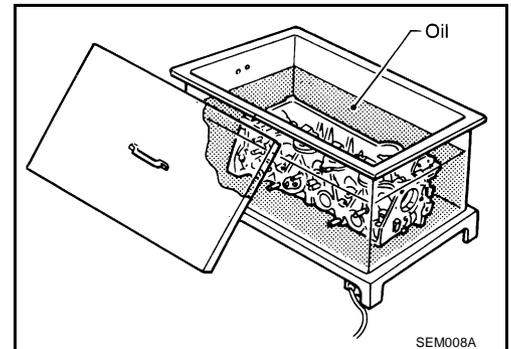
**Exhaust** : 0.10 mm (0.004 in)

- If it exceeds the limit, replace valve and/or valve guide.

## VALVE GUIDE REPLACEMENT

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

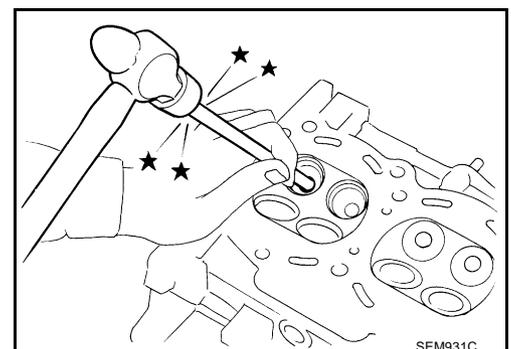
1. To remove valve guide, heat cylinder head to 110 to 130°C (230 to 266°F) by soaking in heated oil.



2. Drive out valve guide with a press [under a 20 kN (2 ton, 2.2 US ton, 2.0 Imp ton) pressure] or hammer and the valve guide drift (commercial service tool).

#### **WARNING:**

**Cylinder head contains heat, when working wear protective equipment to avoid getting burned.**



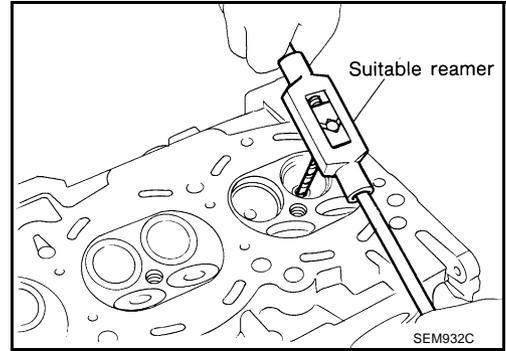
# CYLINDER HEAD

3. Using the valve guide reamer (commercial service tool), ream cylinder head valve guide hole.

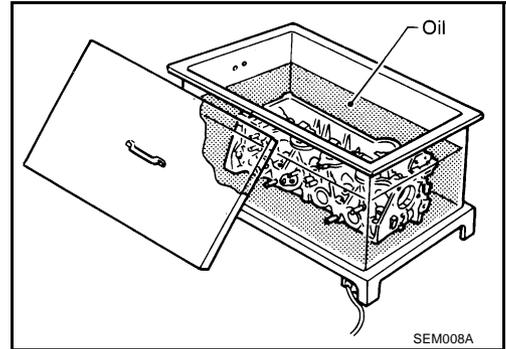
**Valve guide hole diameter (for service parts)**

**Intake and exhaust:**

**10.175 - 10.196 mm (0.4006 - 0.4014 in)**



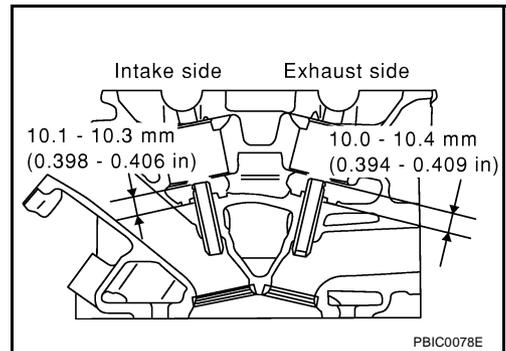
4. Heat cylinder head to 110 to 130°C (230 to 266°F) by soaking in heated oil.



5. Using the valve guide drift (commercial service tool), press valve guide from the camshaft side to dimensions as in the figure.

**WARNING:**

**Cylinder head contains heat, when working wear protective equipment to avoid getting burned.**

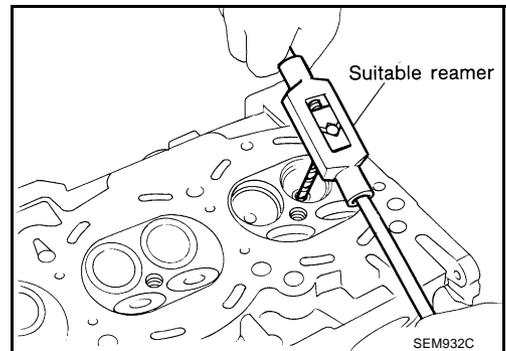


6. Using the valve guide reamer (commercial service tool), apply reamer finish to valve guide.

**Standard**

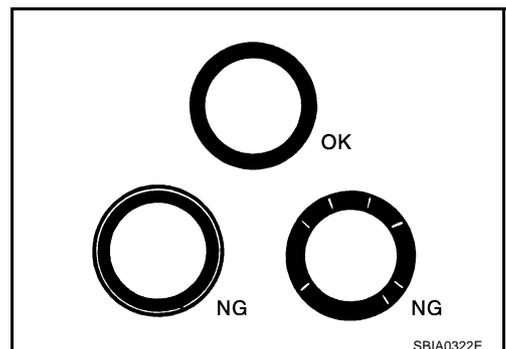
**Intake and exhaust:**

**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.



# CYLINDER HEAD

- If not, grind to adjust valve fitting and check again. If the contacting surface still has NG conditions even after the re-check, replace valve seat. Refer to [EM-77, "VALVE SEAT REPLACEMENT"](#) .

## 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.

### CAUTION:

**Prevent to scratch cylinder head by excessive boring.**

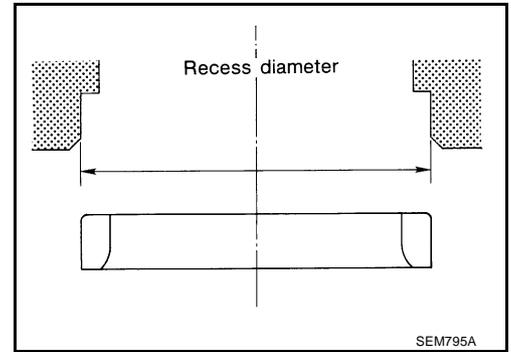
2. Ream cylinder head recess diameter for service valve seat.

### Oversize [0.5 mm (0.020 in)]

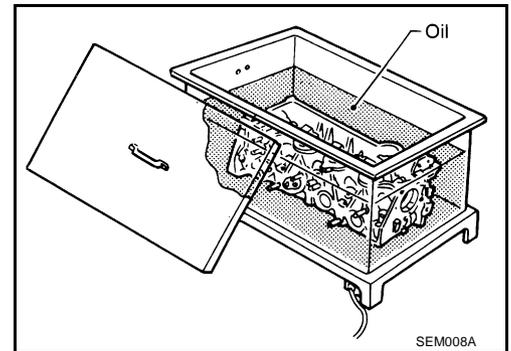
**Intake : 37.500 - 37.516 mm (1.4764 - 1.4770 in)**

**Exhaust : 32.700 - 32.716 mm (1.2874 - 1.2880 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.

### WARNING:

**Cylinder head contains heat, when working wear protective equipment to avoid getting burned.**

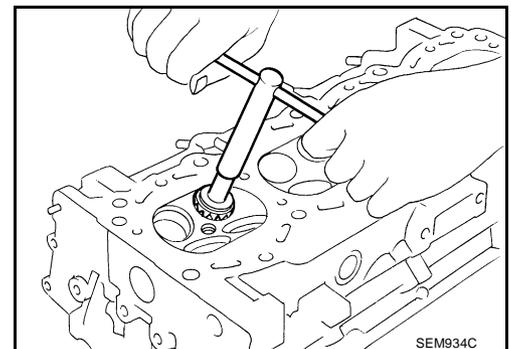
### CAUTION:

**Avoid directly touching cold valve seats.**

5. Using the valve seat cutter set (commercial service tool) and valve seat grinder, finish the seat to the specified dimensions. Refer to [EM-114, "Valve Seat"](#) .

### CAUTION:

**When using the 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.**



6. Using compound, grind to adjust valve fitting.
7. Check again for normal contact. Refer to [EM-76, "VALVE SEAT CONTACT"](#) .

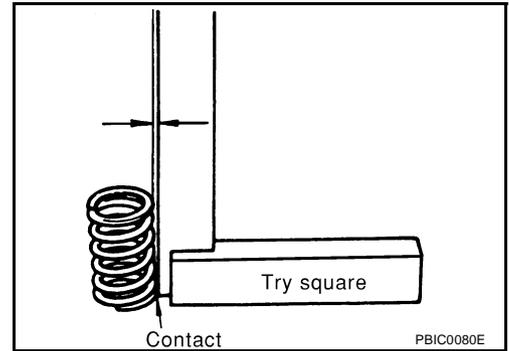
# CYLINDER HEAD

## 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 : 2.0 mm (0.079 in)**

- If it exceeds the limit, replace valve spring.



## VALVE SPRING DIMENSIONS AND VALVE SPRING PRESSURE LOAD

Check valve spring pressure at specified spring height.

### CAUTION:

Do not remove valve spring seat from valve spring (parts for assembly).

### Standard:

#### Intake and exhaust

##### Free height

: 46.35 - 46.85 mm (1.8247 - 1.8444 in)

##### Installation height

: 33.8 mm (1.331 in)

##### Installation load

: 165 - 189 N (16.8 - 19.3 kg, 37 - 42 lb)

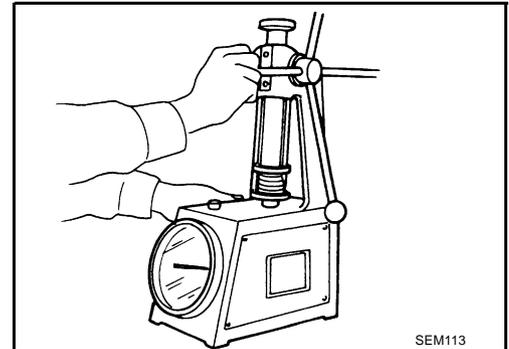
##### Height during valve open

: 24.4 mm (0.961 in)

##### Load with valve open

: 290 - 330 N (29.6 - 33.7 kg, 65 - 74 lb)

- If out of the standard, replace valve spring.



# ENGINE ASSEMBLY

PF10001

## ENGINE ASSEMBLY

### Removal and Installation

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C

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E

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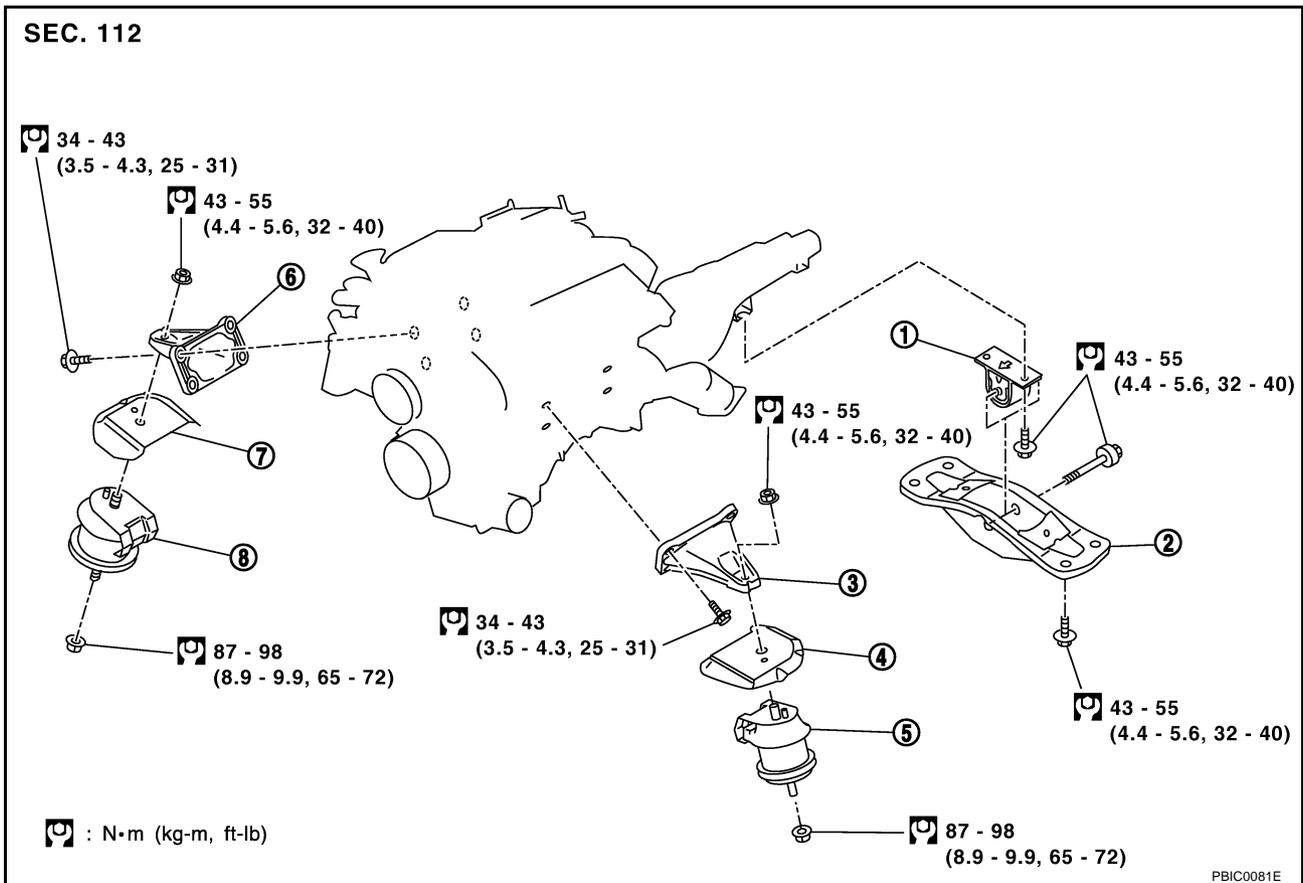
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- |                                   |                                    |                                  |
|-----------------------------------|------------------------------------|----------------------------------|
| 1. Rear engine mounting insulator | 2. Rear member                     | 3. Left engine mounting bracket  |
| 4. Heat insulator                 | 5. Left engine mounting insulator  | 6. Right engine mounting bracket |
| 7. Heat insulator                 | 8. Right engine mounting insulator |                                  |

#### 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 un instructed operations.
- Do not start working until exhaust system and engine coolant are cool enough.
- If items or work required are not covered by the engine section, refer to the applicable sections.
- Always use the support point specified for lifting.
- Use either 2-point 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-39, "Garage Jack and Safety Stand"](#).

#### REMOVAL

##### Outline

At first, remove engine transmission assembly with front suspension member from vehicle downward. Then separate engine from transmission.

##### Preparation

1. Release fuel pressure. Refer to [EC-80, "FUEL PRESSURE RELEASE"](#).

# ENGINE ASSEMBLY

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2. Drain engine coolant from radiator drain plug. Refer to [CO-8, "Changing Engine Coolant"](#) .

**CAUTION:**

- Perform this step when the engine is cold.
- Do not spill engine coolant on drive belt.

3. Remove the following:

- Engine cover, battery cover and air cleaner cover; Refer to [EM-13, "ENGINE ROOM COVER"](#) .
- Battery and battery tray; Refer to [SC-4, "BATTERY"](#)
- Air duct (inlet), air duct and air cleaner case assembly; Refer to [EM-17, "AIR CLEANER AND AIR DUCT"](#) .
- Radiator hoses and A/T fluid cooler hoses; Refer to [CO-11, "RADIATOR"](#) .
- Cooling fan shroud assembly; Refer to [CO-18, "COOLING FAN"](#) .

**CAUTION:**

After the removal, protect the radiator with a cover not to be damaged.

## Engine Room Left

1. Disconnect heater hoses, and install plugs to avoid leakage of engine coolant.
2. Disconnect wire bonding exhaust manifold cover to vehicle.
3. Discharge refrigerant from A/C circuit. Refer to [ATC-146, "REFRIGERANT LINES"](#) .
4. Remove A/C piping from A/C compressor, and temporarily fasten it on vehicle with a rope. Refer to [ATC-149, "Removal and Installation of Compressor"](#) .

## Engine Room Right

1. Disconnect fuel feed hose at the engine side connection.
  - For disconnection/connection of quick connector, refer to [EM-32, "Removal and Installation"](#) .
2. Disconnect engine room harness from the connected position close to the alternator, and set it aside for easier work.
3. Disconnect ground cable.
4. Disconnect vacuum hose between vehicle and engine and set it aside.
5. After draining fluid, remove power steering piping at the following parts:
  - Reservoir tank side between oil cooler and reservoir tank.
  - High pressure hose side between oil cooler and high pressure hose.

## Vehicle inside

1. Separate engine room harness indoors, and pull out engine room harness toward the engine side, tack them temporarily according to the following procedures.
  - a. Remove front kicking plate and dash side finisher. Refer to [EI-43, "BODY SIDE TRIM"](#) .
  - b. Remove instrument lower cover, glove box assembly and glove box cover. Refer to [IP-10, "INSTRUMENT PANEL ASSEMBLY"](#) .
  - c. Separate all the harness connectors connected to engine harness on the indoor side.
  - d. Remove the intermediate fixed point, pull out engine connectors to the engine room side, then temporarily on the engine.

**CAUTION:**

- Pull out the harness and connectors carefully to avoid being damaged.
- After the temporary tacking, cover those connectors with plastic bags to avoid adhering foreign matters.

## Vehicle Underbody

1. Remove exhaust front tube with power tool. Refer to [EX-3, "Removal and Installation"](#) .
2. Remove front cross bar with power tool. Refer to [FSU-5, "FRONT SUSPENSION ASSEMBLY"](#) .
3. Disconnect rear propeller shaft with power tool. Refer to [PR-4, "REAR PROPELLER SHAFT"](#) .
4. Remove stabilizer bar connecting rod at upper side with power tool. Refer to [FSU-5, "FRONT SUSPENSION ASSEMBLY"](#) .
5. Remove steering outer socket from strut assembly. Refer to [FSU-5, "FRONT SUSPENSION ASSEMBLY"](#)
6. Remove suspension arm from strut assembly. Refer to [FSU-5, "FRONT SUSPENSION ASSEMBLY"](#) .

# ENGINE ASSEMBLY

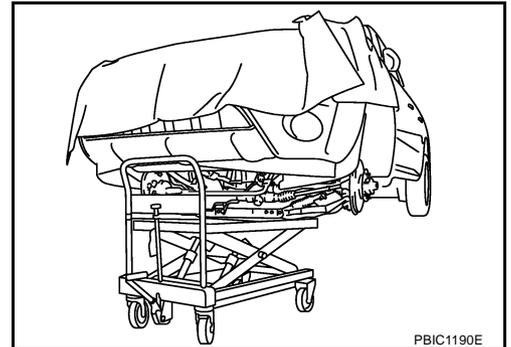
7. Disconnect steering lower joint. Then release steering shaft and steering gear assembly. Refer to [PS-15, "POWER STEERING GEAR"](#) .
8. Remove A/T fluid cooler tube. Refer to [AT-249, "TRANSMISSION ASSEMBLY"](#) .
9. Remove A/T control rod at transmission side. Refer to [AT-215, "SHIFT CONTROL SYSTEM"](#) .
10. Preparation for the separation work of transmission is as follows:
  - a. Remove crankshaft position sensor (POS) from transmission. Refer to [EM-83, "CYLINDER BLOCK"](#) .
  - b. Remove rear plate cover from oil pan. Then remove bolts fixing drive plate to torque converter. Refer to [EM-26, "OIL PAN AND OIL STRAINER"](#) and [AT-249, "TRANSMISSION ASSEMBLY"](#) .
  - c. Remove transmission joint bolts which pierce at oil pan lower rear side. Refer to [AT-249, "TRANSMISSION ASSEMBLY"](#) .

## Removal Work

1. Use a manual lift table cabby (commercial service tool) or equivalently rigid tool such as a transmission jack. Securely support bottom of suspension member and transmission oil pan.

### CAUTION:

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



2. Remove power steering oil pump from engine side. Refer to [PS-32, "HYDRAULIC LINE"](#) .
3. Remove rear member mounting bolts.
4. Remove suspension member mounting nuts and bolts. Refer to [FSU-5, "FRONT SUSPENSION ASSEMBLY"](#) .
5. Carefully lower engine, transmission and suspension member assembly. When performing work, observe the following caution.

### CAUTION:

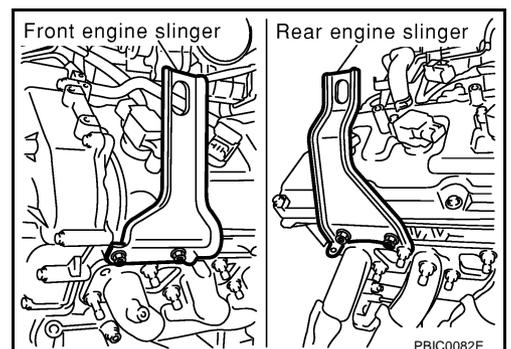
- Confirm there is no interference with vehicle.
- Make sure all connection points have been disconnected.
- Keep in mind the center of vehicle gravity changes. If necessary, use jack(s) to support vehicle at rear jacking point(s) to prevent it from falling off the lift.

## Separation Work

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

### Slinger bolts:

: 33.4 N·m (3.4 kg·m, 25 ft·lb)



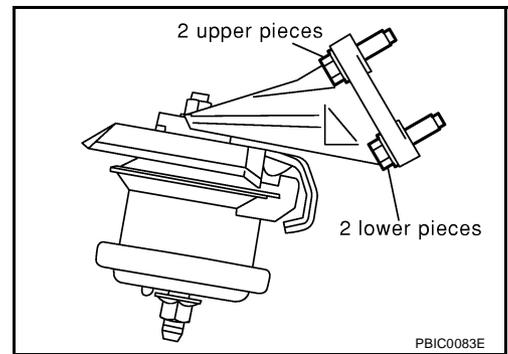
2. Remove engine mounting insulators (right and left) upper side nut.
3. Lift with hoist and separate engine and transmission assembly from suspension member.
4. Remove starter motor. Refer to [SC-9, "STARTING SYSTEM"](#) .
5. Separate engine from transmission assembly. Refer to [AT-249, "TRANSMISSION ASSEMBLY"](#) .

## INSTALLATION

Note the following, and install in the reverse order of removal.

# ENGINE ASSEMBLY

- Where positioning pin is used, be sure to securely insert it into the hole of mating part.
- When installing front engine mounting bracket to cylinder block, first tighten two bolts on upper side. Then, tighten two bolts on lower side. (The same applies to both right and left.)



## INSPECTION AFTER INSTALLATION

### inspection for Leaks

The following are procedures for checking fluids leak, lubricates leak and exhaust gases leak.

- Before starting engine, check oil/fluid levels including engine coolant and engine oil. If less than required quantity, fill to the specified level. Refer to [MA-10, "RECOMMENDED FLUIDS AND LUBRICANTS"](#) .
- Use procedure below to check for fuel leakage.
  - Turn ignition switch "ON" (with engine stopped). With fuel pressure applied to fuel piping, check for fuel leakage at connection points.
  - Start engine. With engine speed increased, check again for fuel leakage at connection points.
- Run engine to check for unusual noise and vibration.
- Warm up engine thoroughly to make sure there is no leakage of fuel, exhaust gas, or any oils/fluids including engine oil and engine coolant.
- Bleed air from passages in lines and hoses, such as in cooling system.
- After cooling down engine, again check oil/fluid levels including engine oil and engine coolant. Refill to specified level, if necessary.

### Summary of the inspection items:

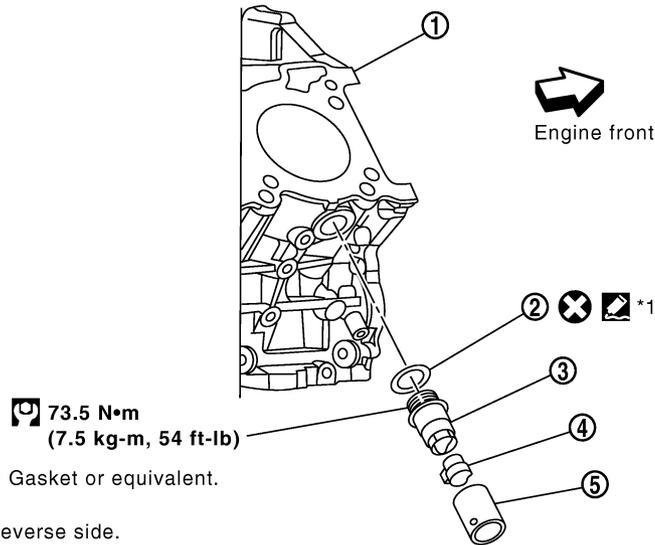
Item	Before starting engine	Engine running	After engine stopped
Engine coolant	Level	Leakage	Level
Engine oil	Level	Leakage	Level
Other oils and fluids *	Level	Leakage	Level
Fuel	Leakage	Leakage	Leakage
Exhaust gas	—	Leakage	—

\* Transmission/transaxle/CVT fluid, power steering fluid, brake fluid, etc.



# CYLINDER BLOCK

SEC. 110  
For Canada



: Apply Anaerobic Liquid Gasket or equivalent.  
Refer to GI section.

\*1 Sealing point: Front and reverse side.

: Always replace after every disassembly.

PBIC2805E

- |                   |                                    |                          |
|-------------------|------------------------------------|--------------------------|
| 1. Cylinder block | 2. Gasket                          | 3. Cylinder block heater |
| 4. Connector cap  | 5. Cylinder block heater protector |                          |

## CAUTION:

- Remove liquid gasket completely after removing cylinder block heater.
- Install hole of the block heater protector in a downward direction.

## DISASSEMBLY

### NOTE:

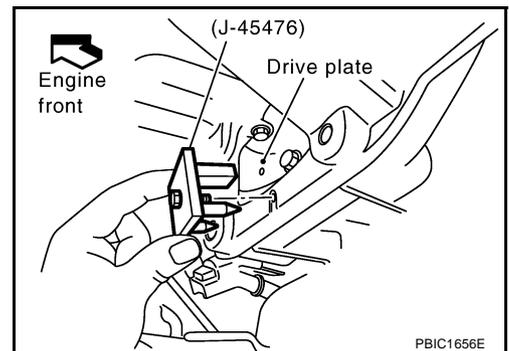
Explained here is how to disassemble with engine stand supporting transmission surface. When using different type of engine stand, note with difference in steps and etc.

1. Remove engine assembly. Refer to [EM-79, "ENGINE ASSEMBLY"](#).
2. Remove the parts that may restrict installation of engine to widely use engine stand.

### NOTE:

The procedure is described assuming that you use a widely use engine stand holding the surface, to which transmission is installed.

- a. Remove drive plate as follows:
  - i. Set the ring gear stopper (SST).



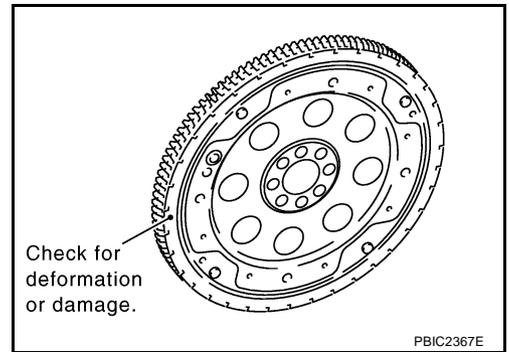
PBIC1656E

# CYLINDER BLOCK

- ii. Loosen mounting bolts diagonally.

**CAUTION:**

- Be careful not to damage drive plate. Especially, avoid deforming and damaging of signal plate teeth (circumference position).
- Place drive plate with signal plate surface facing other than downward.
- Keep magnetic materials away from signal plate.



- b. Remove engine rear plate.  
3. Lift the engine with hoist to install it onto the widely use engine stand.

**CAUTION:**

**Use an engine stand that has a load capacity [240 kg (529 pound) or more] large enough for supporting the engine weight.**

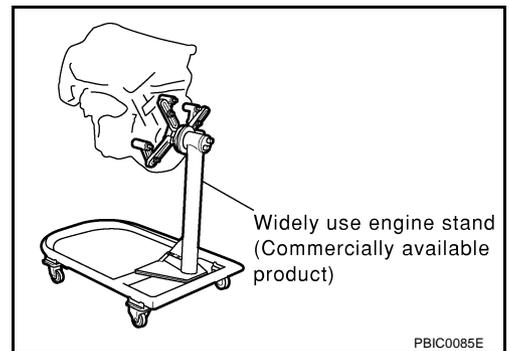
- If the load capacity of the stand is not adequate, remove the following parts beforehand to reduce the potential risk of overturning the stand.
  - Remove intake manifold (upper and lower). Refer to [EM-19, "INTAKE MANIFOLD"](#) .
  - Remove fuel injector and fuel tube assembly. Refer to [EM-32, "FUEL INJECTOR AND FUEL TUBE"](#) .
  - Remove ignition coil. Refer to [EM-29, "IGNITION COIL"](#) .
  - Remove rocker cover. Refer to [EM-37, "ROCKER COVER"](#) .
  - Remove exhaust manifold and three way catalyst. Refer to [EM-23, "EXHAUST MANIFOLD AND THREE WAY CATALYST"](#) .
  - Other removable brackets.

**NOTE:**

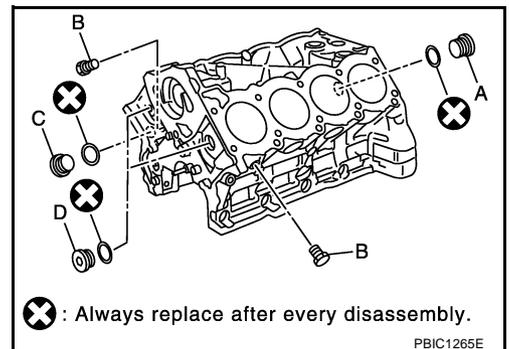
The figure shows an example of widely use engine stand that can hold mating surface of transmission with drive plate and rear plate removed.

**CAUTION:**

**Before removing the hanging chains, make sure the engine stand is stable and there is no risk of overturning.**



4. Drain engine oil. Refer to [LU-7, "Changing Engine Oil"](#) .  
5. Drain engine coolant from inside engine by removing water drain plugs "B" as shown in the figure.



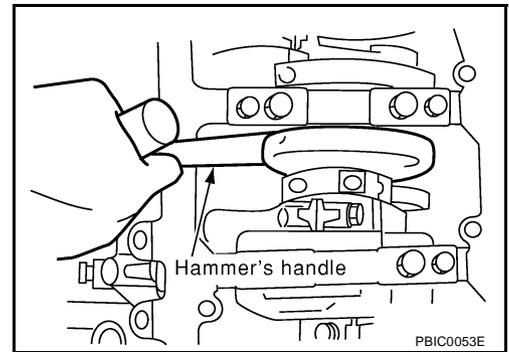
6. Remove oil pan and oil strainer. Refer to [EM-26, "OIL PAN AND OIL STRAINER"](#) .  
7. Remove crankshaft pulley as follows:

## CYLINDER BLOCK

- a. Lock crankshaft with a hammer handle or similar tool to loosen crankshaft bolt.
- b. Pull crankshaft pulley with both hands to remove it.

**CAUTION:**

- Do not remove crankshaft pulley bolt. Keep loosened crankshaft pulley bolt in place to protect removed crankshaft pulley from dropping.
- Do not remove balance weight (inner hexagon bolt) at the front of crankshaft pulley.



8. Remove the following components and associated parts (The parts listed in step 3 are not included here.)
  - Front cover and timing chain: Refer to [EM-39, "TIMING CHAIN"](#).
  - Camshaft: Refer to [EM-50, "CAMSHAFT"](#).
  - Cylinder head: Refer to [EM-67, "CYLINDER HEAD"](#).
9. Remove knock sensor.

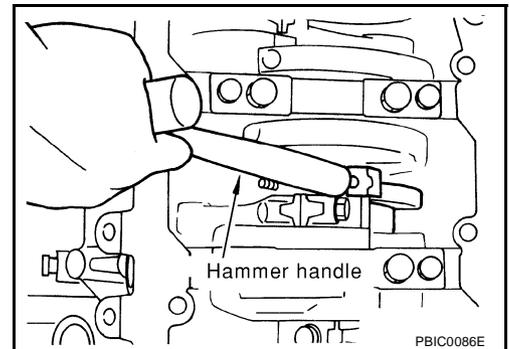
**CAUTION:**

**Carefully handle the sensor, avoiding shocks.**

10. Remove piston and connecting rod assembly.
  - Before removing piston and connecting rod assembly, check the connecting rod side clearance. Refer to [EM-100, "CONNECTING ROD SIDE CLEARANCE"](#).
- a. Position crankshaft pin corresponding to connecting rod to be removed onto the bottom dead center.
- b. Remove connecting rod bearing cap.
- c. Using a hammer handle or similar tool, push piston and connecting rod assembly out to the cylinder head side.

**CAUTION:**

**Be careful not to damage the cylinder wall and crankshaft pin, resulting from an interference of connecting rod big end.**



11. Remove connecting rod bearings.

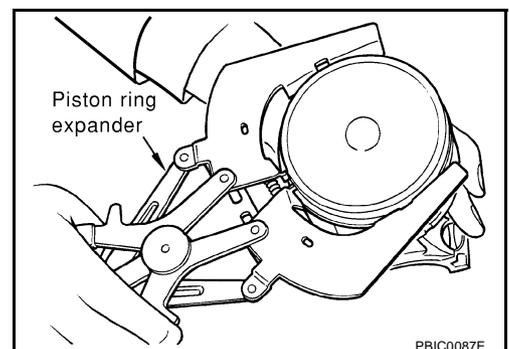
**CAUTION:**

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

12. Remove piston rings from piston.
  - Before removing piston rings, check the piston ring side clearance. Refer to [EM-101, "PISTON RING SIDE CLEARANCE"](#).
  - Use the piston ring expander (commercial service tool).

**CAUTION:**

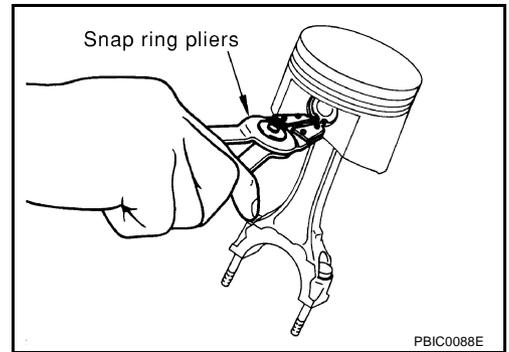
- When removing piston rings, be careful not to damage piston.
- Be careful not to damage piston rings by expanding them excessively.



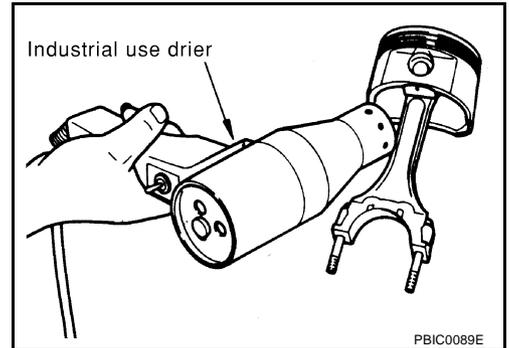
13. Remove piston from connecting rod as follows.

# CYLINDER BLOCK

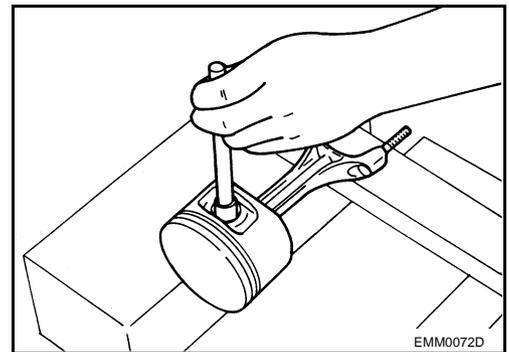
- a. Using the snap ring pliers, remove snap ring.



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



- c. Push out piston pin with stick of outer diameter approximately 20 mm (0.8 in).



14. Remove rear oil seal retainer from cylinder block.

- Insert a screwdriver or similar tool between the rear end of the crankshaft counter weight and rear oil seal retainer, and separate the liquid gasket to remove.

**CAUTION:**

**Be careful not to damage the mating surface.**

15. Using a screwdriver or similar tool, and lever off rear oil seal from rear oil seal retainer.

16. Remove main bearing cap as follows:

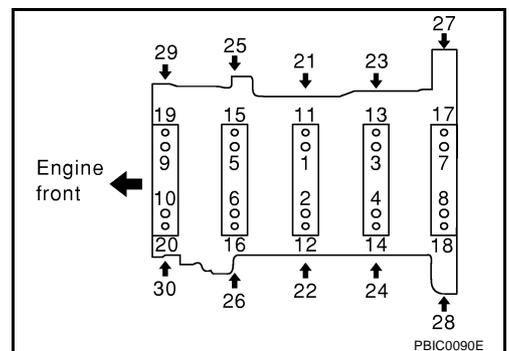
- Before loosening main bearing cap bolts, measure the crankshaft end play. Refer to [EM-100, "CRANK-SHAFT END PLAY"](#).
- Loosen main bearing cap bolts in several different steps.

- a. Remove cover attached to the rear right side of cylinder block (next to the starter motor housing).

**NOTE:**

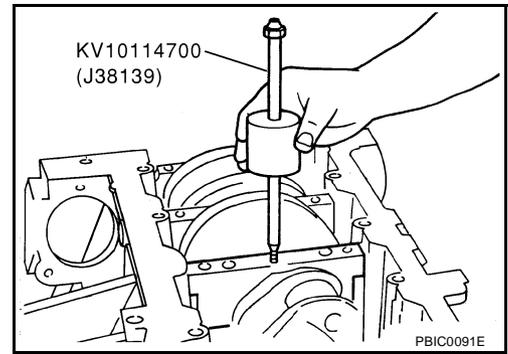
Bolts (No. 28 shown in the figure) are installed on the inside of cover.

- b. Loosen the side bolts (M10) starting from 30 to 21 to remove.
- c. Loosen main bearing cap sub bolts (M9) starting from 20 to 11 to remove.
- d. Loosen main bearing cap bolts (M12) starting from 10 to 1 to remove.



# CYLINDER BLOCK

- e. Using the main bearing cap remover (SST), remove main bearing cap.

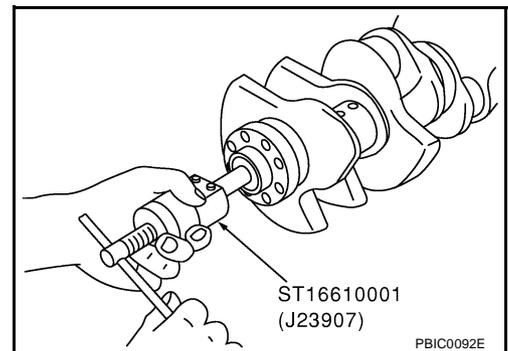


17. Remove crankshaft.  
18. Remove main bearings and thrust bearings from cylinder block and main bearing caps.

**CAUTION:**

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

19. If pilot converter must be removed, remove it from the rear end of crankshaft using the pilot bushing puller (SST).



## ASSEMBLY

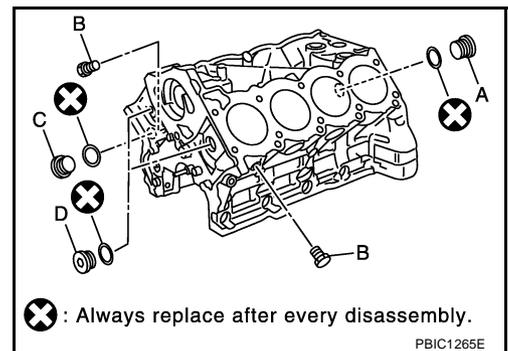
1. Fully air-blow engine coolant and engine oil passages in cylinder block, the cylinder bore, and crankcase to remove any foreign material.

**CAUTION:**

**Use a goggles to protect your eye.**

2. Install each plug to the cylinder block. (Only screwed-type plugs are shown in the figure.)

- Apply sealant to the thread of each plug "A" and "D".  
**Use Genuine High Strength Locking Sealant or equivalent. Refer to GI-45. "RECOMMENDED CHEMICAL PRODUCTS AND SEALANTS".**
- Apply sealant to the thread of each plug "B" and "C".  
**Use Anaerobic Liquid Gasket or equivalent. Refer to GI-45. "RECOMMENDED CHEMICAL PRODUCTS AND SEALANTS".**
- Replace copper washers with new ones.
- Tighten each plug as specified below.

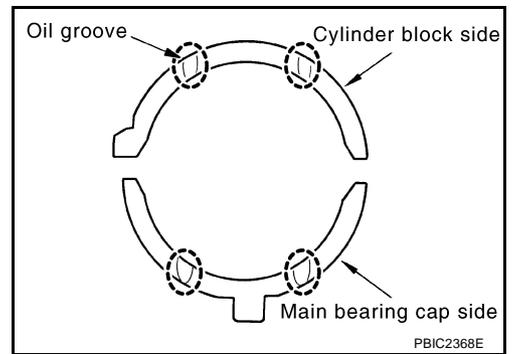


Part	Washer	Tightening torque
A	Yes	53.9 N·m (5.5 kg-m, 40 ft-lb)
B	No	19.6 N·m (2.0 kg-m, 15 ft-lb)
C	Yes	62.7 N·m (6.4 kg-m, 46 ft-lb)
D	Yes	62.7 N·m (6.4 kg-m, 46 ft-lb)

# CYLINDER BLOCK

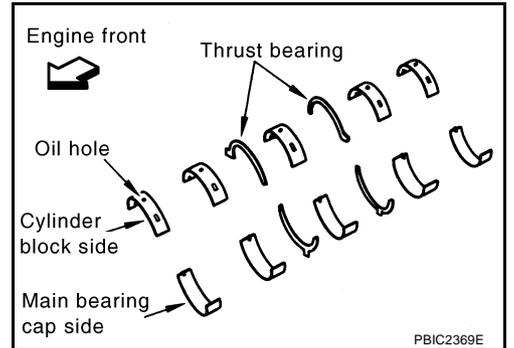
3. Install main bearings and thrust bearings as follows:

- a. Remove dust, dirt, and engine oil on the bearing mating surfaces of cylinder block and main bearing caps.
- b. Install thrust bearings to the both sides of the No. 3 journal housing on cylinder block and main bearing caps.
  - Install thrust bearings with the engine oil groove facing crankshaft arm (outside).
  - Install thrust bearings with a protrusion in the center on main bearing caps.



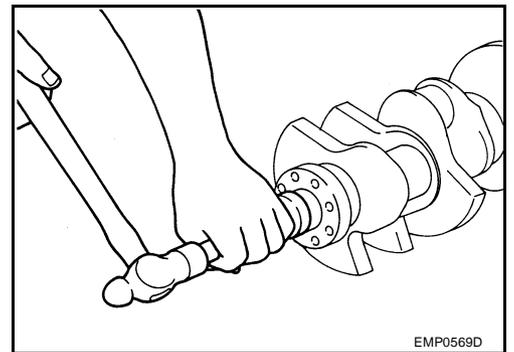
c. Install main bearings paying attention to the direction.

- Install the one with oil holes onto cylinder block and the one without oil holes onto main bearing cap.
- Before installing bearings, apply engine oil to the bearing surface (inside). Do not apply engine oil to the back surface, but thoroughly clean it.
- When installing, align the bearing stopper to the notch.
- Make sure that the oil holes on cylinder block and those on the corresponding bearing are aligned.

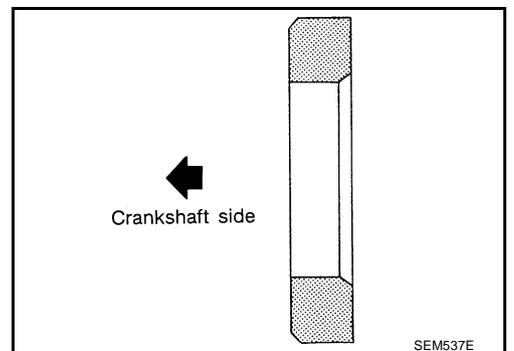


4. Install pilot converter to crankshaft.

- Using a drift approximately 35 mm (1.38 in) in outer diameter, drive pilot converter until its front end contacts crankshaft.



- Press-fit pilot converter with its chamfering side facing crankshaft as shown in the figure.
- It is acceptable to install it without the engine stand.



5. Install crankshaft to cylinder block.

- While turning crankshaft by hand, make sure that it turns smoothly.

A  
EM  
C  
D  
E  
F  
G  
H  
I  
J  
K  
L  
M

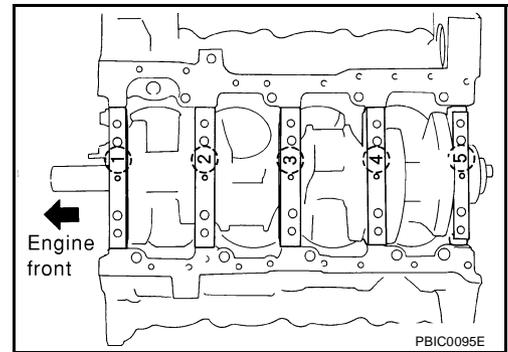
# CYLINDER BLOCK

6. Install main bearing caps.

- Align the identification number to the journal position to install.
- Install the upper side of the identification number facing the front of engine. (The number shall be read correctly from the rear of engine.)
- Using a plastic hammer or similar tool, tap them lightly to seat them on the installation position.

**NOTE:**

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



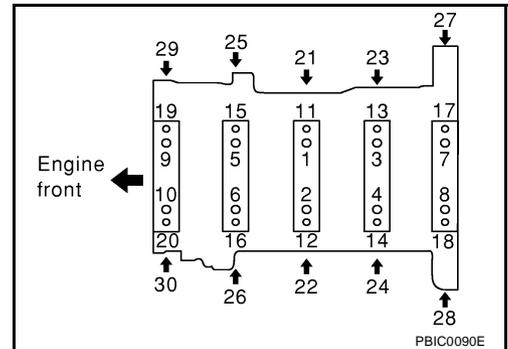
7. Install each main bearing cap bolt as follows:

- Apply new engine oil to threads and seating surface of main bearing cap bolts, and tighten all bolts temporarily.
- Tighten main bearing cap bolt (M12) in order of 1 to 10.

: 39.2 N·m (4.0 kg·m, 29 ft·lb)

- Tighten main bearing cap sub bolt (M9) in order of 11 to 20.

: 29.4 N·m (3.0 kg·m, 22 ft·lb)

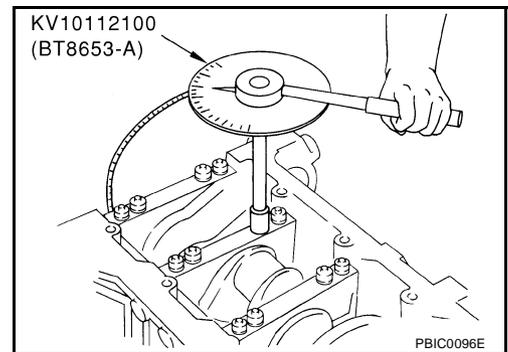


- Tighten main bearing cap bolt (M12) to 40 degrees clockwise in order of 1 to 10. (Angle tightening)

**CAUTION:**

Use angle wrench (SST) to check tightening angle in step “d” and “e”. Do not make judgment by visual inspection.

- Tighten main bearing cap sub bolt (M9) to 30 degrees clockwise in order of 11 to 20. (Angle tightening)



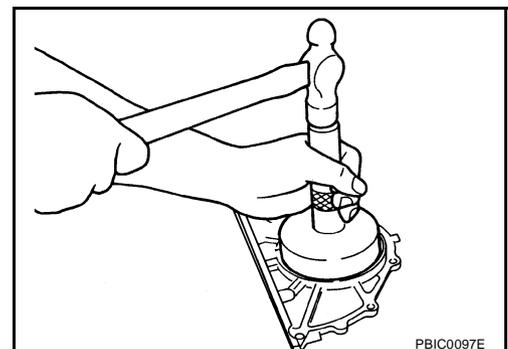
- Tighten side bolt (M10) in order of 21 to 30.

: 49.0 N·m (5.0 kg·m, 36 ft·lb)

- After installing main bearing cap bolts, make sure that crankshaft can be rotated smoothly.
  - Check the crankshaft end play. Refer to [EM-100, "CRANKSHAFT END PLAY"](#).
- Install cover of cylinder block rear right side (next to the starter motor housing).

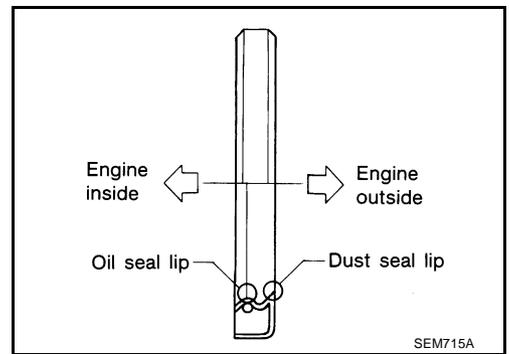
- Install rear oil seal using the rear oil seal drift (commercial service tool).

- Tap until flattened with front edge of rear oil seal retainer. Do not damage or scratch outer circumference of oil seal.



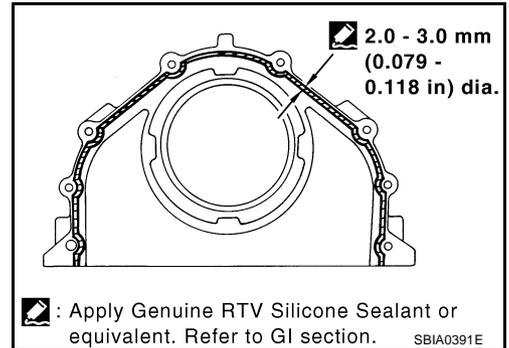
# CYLINDER BLOCK

- Install new rear oil seal in the direction shown in the figure.



9. Install rear oil seal retainer.

- Apply liquid gasket thoroughly to rear oil seal retainer. **Use Genuine RTV Silicone Sealant or equivalent. Refer to GI-45, "RECOMMENDED CHEMICAL PRODUCTS AND SEALANTS".**
- Apply new engine oil to both oil seal lip and dust seal lip. Do not touch.



10. Install piston to connecting rod.

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

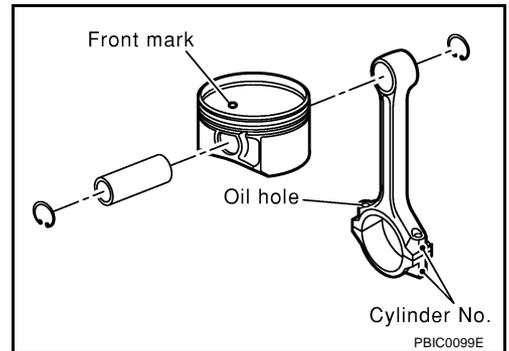
- Insert it fully into groove to install.

- b. Install piston to connecting rod.

- Using the industrial use drier or equivalent, heat the piston until 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 piston pin into piston and connecting rod.
- Assemble so that the front mark on the piston head and the oil holes and the cylinder No. on connecting rod are positioned as shown in the figure.

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

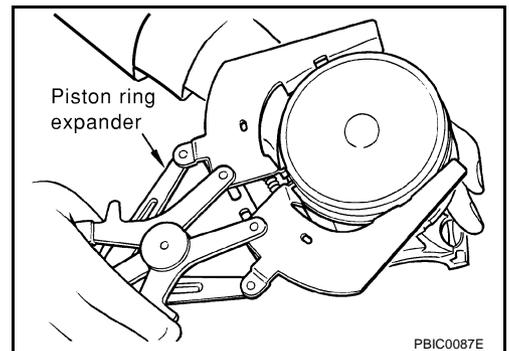
- Insert it fully into groove to install.
- After installing, make sure that connecting rod moves smoothly.



11. Using the piston ring expander (commercial service tool), install piston rings.

**CAUTION:**

- **When installing piston rings, be careful not to damage piston.**
- **Be careful not to damage piston rings by expending them excessively.**

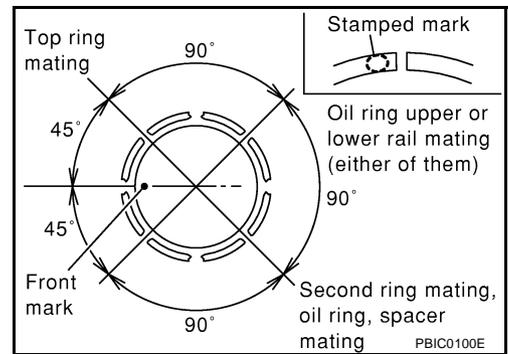


## CYLINDER BLOCK

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

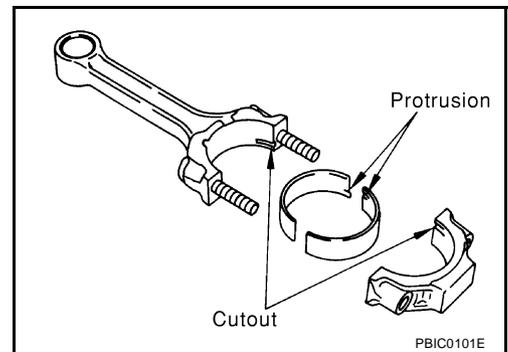
### Stamped mark

**Top ring** : R  
**Second ring** : 2R



### 12. Install connecting rod bearings to connecting rod and connecting rod cap.

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

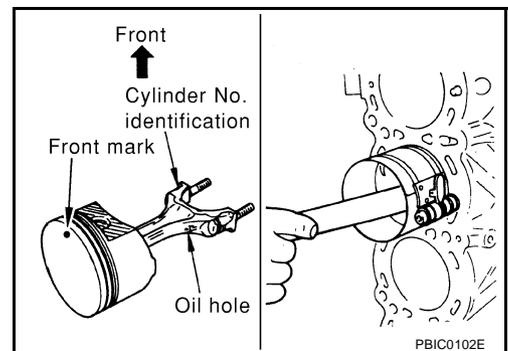


### 13. Install piston and connecting rod assembly to crankshaft.

- Position crankshaft pin corresponding to 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 connecting rod to install.
- Using the piston ring compressor [SST: EM03470000 (J-8037)], install piston with the front mark on the piston head facing the front of engine.

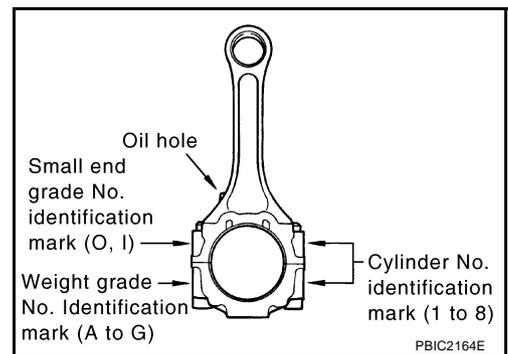
### CAUTION:

**Be careful not to damage the cylinder wall and crankshaft pin, resulting from an interference of connecting rod big end.**



### 14. Install connecting rod cap.

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



### 15. Tighten the connecting rod nuts as follows:

- Apply engine oil to the threads and seats of the connecting rod bolts and nuts.
- Tighten connecting rod nuts.

# CYLINDER BLOCK

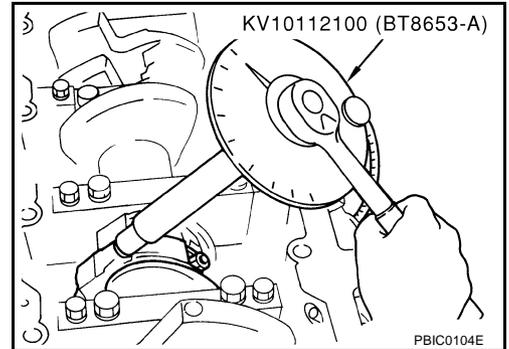
: 14.7 N·m (1.5 kg·m, 11 ft·lb)

- c. Put mating (with paint) on each nut and connecting rod cap, all in the same direction (when using a protractor).
- d. Then all nuts 60 degrees clockwise (angle tightening).

**CAUTION:**

Always use either the angle wrench (SST) or protractor. Avoid tightening based on visual check alone.

- After tightening the nuts, make sure that crankshaft rotates smoothly.
- Check the connecting rod side clearance. Refer to [EM-100](#), "[CONNECTING ROD SIDE CLEARANCE](#)".



16. Install knock sensor.

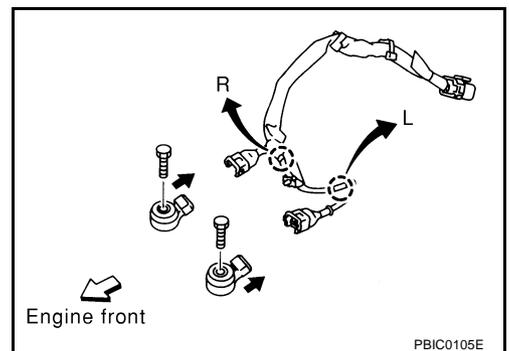
- Install it with its connector facing the rear of engine.
- Install the sub-harness with its shorter branch line to the right bank.

**CAUTION:**

- Do not tighten mounting bolts while holding connector.
- If any impact by dropping is applied to knock sensor, replace it with new one.

**NOTE:**

- Make sure that there is no foreign material on the cylinder block mating surface and the back surface of knock sensor.
- Make sure that knock sensor does not interfere with other parts.

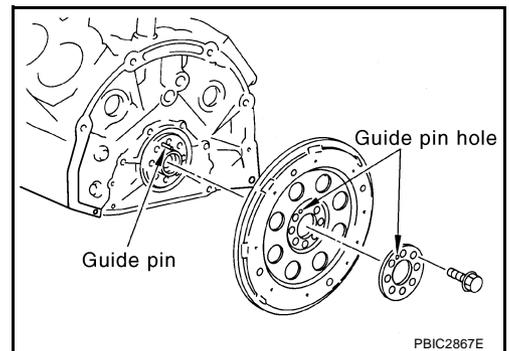


17. Install the following in the reverse order of removal.

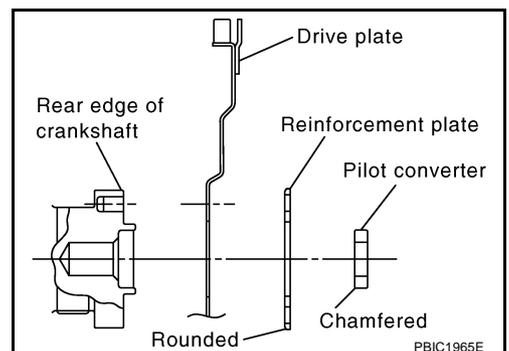
18. Remove engine assembly from engine stand.

19. Install drive plate.

- Align guide pin of crankshaft rear end with pin holes of each parts to install.



- Install drive plate, reinforcement plate and pilot converter (if not installed in step 4) as shown in the figure.
- Holding ring gear with the ring gear stopper (SST: J-45476).
- Using drift of 33 mm (1.30 in) dia, push pilot converter into the end.
- Face pilot converter chamfered or rounded edge side to crankshaft.



# CYLINDER BLOCK

NBS001P3

## How to Select Piston and Bearing DESCRIPTION

Connecting points	Connecting 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 main journal grade (outer diameter of main journal)
Between crankshaft to connecting rod	Connecting rod bearing	Connecting rod bearing grade (bearing thickness)	Connecting rod bearing grade = crankshaft pin journal (outer diameter of pin journal). No grade exists for inner diameter of 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 skirt 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.

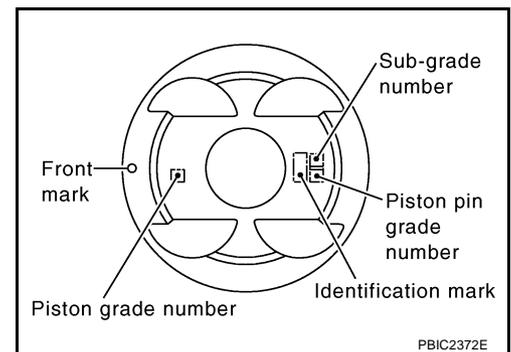
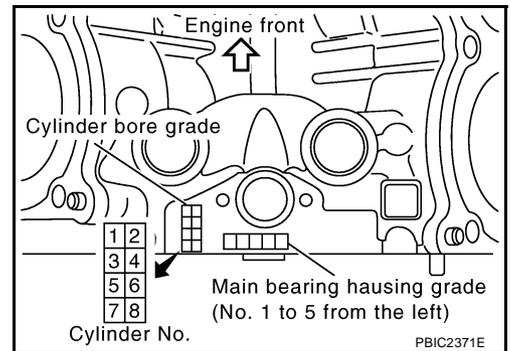
## HOW TO SELECT PISTON

### When New Cylinder Block is Used:

Check the cylinder bore grade ("1", "2" or "3") on the rear upper side between cylinder block banks, and select piston of the same grade.

### NOTE:

Piston is available with piston pin as a set for the service part. (Only "0" grade piston pin is available.)



### When Cylinder Block is Reused:

1. Measure the cylinder block bore inner diameter. Refer to [EM-104, "Cylinder Bore Inner Diameter"](#).

# CYLINDER BLOCK

- Determine the bore grade by comparing the measurement with the values under the "Cylinder bore inner diameter" of the "Piston Selection Table". Select piston of the same grade.

## Piston Selection Table

Unit: mm (in)

Grade number (Mark)	1	2 (or no mark)	3
Cylinder bore inner diameter	93.000-93.010 (3.6614-3.6618)	93.010-93.020 (3.6618-3.6622)	93.020-93.030 (3.6622-3.6626)
Piston skirt diameter	92.980-92.990 (3.6606-3.6610)	92.990-93.000 (3.6610-3.6614)	93.000-93.010 (3.6614-3.6618)

### NOTE:

- Piston is available together with piston pin as an assembly.
- Piston pin (piston pin hole) grade is provided only for the parts installed at the plant. For the service parts, no grades can be selected (Only "0" grade is available.).
- No second grade mark is available on piston.

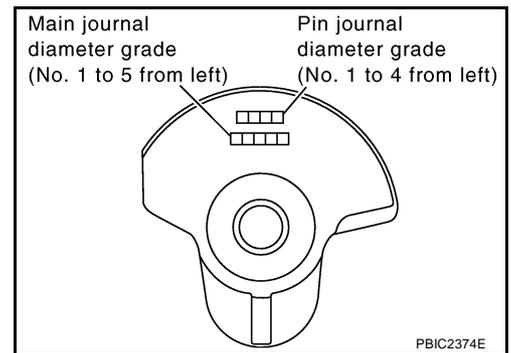
## HOW TO SELECT CONNECTING ROD BEARING

### When New Connecting Rod and Crankshaft are Used:

Check pin journal diameter grade ("0", "1" or "2") on front of crankshaft, and select connecting rod bearing of the same grade.

### NOTE:

There is no grading for connecting rod big end.



### When Crankshaft and Connecting Rod are Reused:

- Measure the connecting rod big end diameter. Refer to [EM-102, "CONNECTING ROD BIG END DIAMETER"](#).
- Make sure that the connecting rod big end diameter is within the standard value.
- Measure the crankshaft pin journal diameter. Refer to [EM-106, "CRANKSHAFT PIN JOURNAL DIAMETER"](#).
- Determine the grade of crankshaft pin diameter grade by corresponding to the measured dimension in "Crankshaft pin journal diameter" column of "Connecting Rod Bearing Selection Table".
- Select connecting rod bearing of the same grade.

## Connecting Rod Bearing Selection Table

Unit: mm (in)

Connecting rod big end diameter	55.000 - 55.013 (2.1654 - 2.1659)
---------------------------------	-----------------------------------

Unit: mm (in)

Crankshaft pin journal diameter	Grade (Mark)	Dimension (Bearing thickness range)	Bearing grade No.	Color
51.968 - 51.974 (2.0460 - 2.0462)	0	1.500 - 1.503 (0.0591 - 0.0592)	STD 0	No color
51.962 - 51.968 (2.0457 - 2.0460)	1	1.503 - 1.506 (0.0592 - 0.0593)	STD 1	Brown
51.956 - 51.962 (2.0455 - 2.0457)	2	1.506 - 1.509 (0.0593 - 0.0594)	STD 2	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 bearings, measure the connecting rod bearing inner diameters with bearings installed, and grind crankshaft pin so that the oil clearance satisfies the standard.

# CYLINDER BLOCK

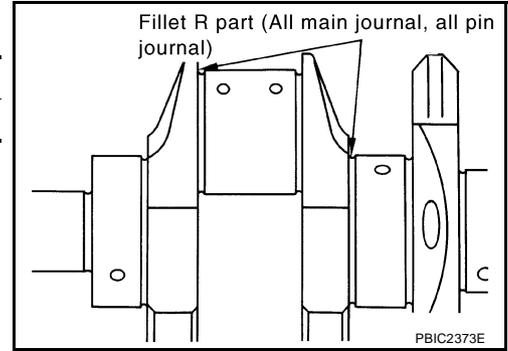
## Bearing undersize table

Unit: mm (in)

Size	Thickness
US 0.25 (0.0098)	1.626 - 1.634 (0.0640 - 0.0643)

### CAUTION:

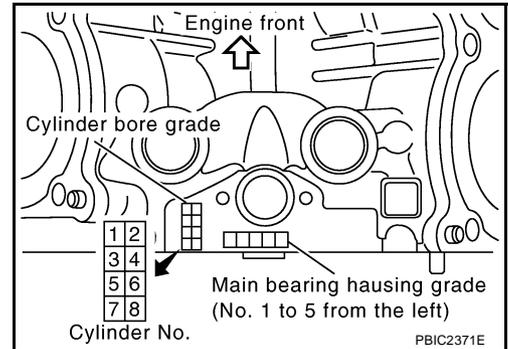
In grinding crankshaft pin journal to use undersize bearings, do not damage the fillet R [1.5 mm (0.059 in)]



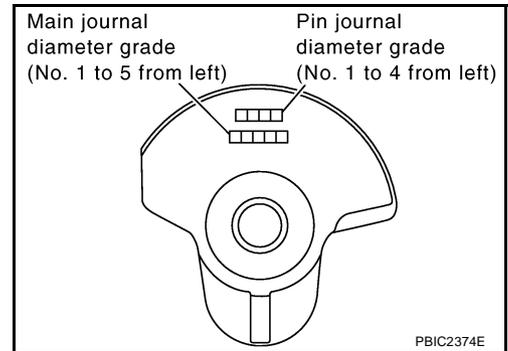
## HOW TO SELECT MAIN BEARING

### When New Cylinder Block and Crankshaft are Used:

1. "Main Bearings Selection Table" rows correspond to main bearing housing grade on rear upper side between cylinder block banks.



2. "Main Bearings Selection Table" columns correspond to main journal diameter grade on front side of crankshaft.



3. Select main bearing grade at the point where selected row and column meet in "Main Bearings Selection Table".

### CAUTION:

- Initial clearance for No. 1, 5 journal and No. 2, 3, 4 journal is different. Use two different selection table for each part.
- No. 1, 5 journal and No. 2, 3, 4 journal have the same signs but different grade measures. Do not confuse.

4. Apply sign at crossing in above step 3 to "Main Bearings Grade Table".

### NOTE:

- "Main Bearings Grade Table" applies to all journals.
- Service parts is available as a set of both upper and lower.

### When Cylinder Block and Crankshaft are Reused:

1. Measure the cylinder block main bearing housing inner diameter and the crankshaft main journal diameter. Refer to [EM-104, "MAIN BEARING HOUSING INNER DIAMETER"](#) and [EM-106, "CRANKSHAFT MAIN JOURNAL DIAMETER"](#).
2. Correspond the measured dimension in "Cylinder block main bearing housing inner diameter" row of "Main Bearings Selection Table".
3. Correspond the measured dimension in "Crankshaft main journal diameter" column of "Main Bearings Selection Table".

# CYLINDER BLOCK

4. Follow step 3 and later in "When New Cylinder Block and Crankshaft are Used."

**Main Bearings Selection Table (No.1 and No.5 journal)**

I.D. mark	Axle diameter Unit: mm (in)	Cylinder block main bearing housing inner diameter		Crankshaft main journal diameter		I.D. mark		Hole diameter Unit: mm (in)		A		B		C		D		E		F		G		H		J		K		L		M		N		P		R		S		T		U		V		W		X		Y		1		2	
		68.944 - 68.945 (2.7143 - 2.7144)	68.945 - 68.946 (2.7144 - 2.7144)	68.946 - 68.947 (2.7144 - 2.7144)	68.947 - 68.948 (2.7144 - 2.7145)	68.948 - 68.949 (2.7145 - 2.7145)	68.949 - 68.950 (2.7145 - 2.7146)	68.950 - 68.951 (2.7146 - 2.7146)	68.951 - 68.952 (2.7146 - 2.7146)	68.952 - 68.953 (2.7146 - 2.7147)	68.953 - 68.954 (2.7147 - 2.7147)	68.954 - 68.955 (2.7147 - 2.7148)	68.955 - 68.956 (2.7148 - 2.7148)	68.956 - 68.957 (2.7148 - 2.7148)	68.957 - 68.958 (2.7148 - 2.7149)	68.958 - 68.959 (2.7149 - 2.7149)	68.959 - 68.960 (2.7149 - 2.7150)	68.960 - 68.961 (2.7150 - 2.7150)	68.961 - 68.962 (2.7150 - 2.7150)	68.962 - 68.963 (2.7150 - 2.7151)	68.963 - 68.964 (2.7151 - 2.7151)	68.964 - 68.965 (2.7151 - 2.7152)	68.965 - 68.966 (2.7152 - 2.7152)	68.966 - 68.967 (2.7152 - 2.7152)	68.967 - 68.968 (2.7152 - 2.7153)																																
G	63.964 - 63.963 (2.5183 - 2.5182)	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	78	78	78	8	8	8	8									
H	63.963 - 63.962 (2.5182 - 2.5182)	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	78	78	78	8	8	8	8										
J	63.962 - 63.961 (2.5182 - 2.5181)	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	78	78	78	8	8	8	8											
K	63.961 - 63.960 (2.5181 - 2.5181)	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	78	78	78	8	8	8	8												
L	63.960 - 63.959 (2.5181 - 2.5181)	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	78	78	78	8	8	8	8													
M	63.959 - 63.958 (2.5181 - 2.5180)	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	78	78	78	8	8	8	8														
N	63.958 - 63.957 (2.5180 - 2.5180)	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	78	78	78	8	8	8	8															
P	63.957 - 63.956 (2.5180 - 2.5179)	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	78	78	78	8	8	8	8																
R	63.956 - 63.955 (2.5179 - 2.5179)	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	78	78	78	8	8	8	8																	
S	63.955 - 63.954 (2.5179 - 2.5179)	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	78	78	78	8	8	8	8																		
T	63.954 - 63.953 (2.5179 - 2.5178)	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	78	78	78	8	8	8	8																			
U	63.953 - 63.952 (2.5178 - 2.5178)	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	78	78	78	8	8	8	8																				
V	63.952 - 63.951 (2.5178 - 2.5178)	3	3	34	34	34	4	4	4	45	45	45	5	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	78	78	78	8	8	8	8																						
W	63.951 - 63.950 (2.5178 - 2.5177)	3	34	34	34	4	4	4	45	45	45	5	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	78	78	78	8	8	8	8																							
X	63.950 - 63.949 (2.5177 - 2.5177)	34	34	34	4	4	4	45	45	45	5	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	78	78	78	8	8	8	8																								
Y	63.949 - 63.948 (2.5177 - 2.5176)	34	34	4	4	4	45	45	45	5	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	78	78	78	8	8	8	8																									
1	63.948 - 63.947 (2.5176 - 2.5176)	34	4	4	4	45	45	45	5	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	78	78	78	8	8	8	8																										
2	63.947 - 63.946 (2.5176 - 2.5176)	4	4	4	45	45	45	5	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	78	78	78	8	8	8	8																											
3	63.946 - 63.945 (2.5176 - 2.5175)	4	4	45	45	45	5	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	78	78	78	8	8	8	8																												
4	63.945 - 63.944 (2.5175 - 2.5175)	4	45	45	45	5	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	78	78	78	8	8	8	8																													
5	63.944 - 63.943 (2.5175 - 2.5174)	45	45	45	5	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	78	78	78	8	8	8	8																														
6	63.943 - 63.942 (2.5174 - 2.5174)	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	78	78	78	8	8	8	8																																
7	63.942 - 63.941 (2.5174 - 2.5174)	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	78	78	78	8	8	8	8																																	
9	63.941 - 63.940 (2.5174 - 2.5173)	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	78	78	78	8	8	8	8																																		

PBIC2375E

# CYLINDER BLOCK

## Main Bearings Selection Table (No.2, 3 and 4 journal)

I.D. mark	Cylinder block main bearing housing inner diameter	Crankshaft main journal diameter	I.D. mark		Hole diameter Unit: mm (in)																						
			A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	S	T	U	V	W	X	Y	1	2	
Axle diameter Unit: mm (in)			68.944 - 68.945 (2.7143 - 2.7144)	68.945 - 68.946 (2.7144 - 2.7144)	68.946 - 68.947 (2.7144 - 2.7144)	68.947 - 68.948 (2.7144 - 2.7145)	68.948 - 68.949 (2.7145 - 2.7145)	68.949 - 68.950 (2.7145 - 2.7146)	68.950 - 68.951 (2.7146 - 2.7146)	68.951 - 68.952 (2.7146 - 2.7146)	68.952 - 68.953 (2.7146 - 2.7147)	68.953 - 68.954 (2.7147 - 2.7147)	68.954 - 68.955 (2.7147 - 2.7148)	68.955 - 68.956 (2.7148 - 2.7148)	68.956 - 68.957 (2.7148 - 2.7148)	68.957 - 68.958 (2.7148 - 2.7149)	68.958 - 68.959 (2.7149 - 2.7149)	68.959 - 68.960 (2.7149 - 2.7150)	68.960 - 68.961 (2.7150 - 2.7150)	68.961 - 68.962 (2.7150 - 2.7150)	68.962 - 68.963 (2.7150 - 2.7151)	68.963 - 68.964 (2.7151 - 2.7151)	68.964 - 68.965 (2.7151 - 2.7152)	68.965 - 68.966 (2.7152 - 2.7152)	68.966 - 68.967 (2.7152 - 2.7152)	68.967 - 68.968 (2.7152 - 2.7153)	
A	63.964 - 63.963 (2.5183 - 2.5182)	0	0	01	01	01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4
B	63.963 - 63.962 (2.5182 - 2.5182)	0	01	01	01	1	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	
C	63.962 - 63.961 (2.5182 - 2.5181)	01	01	01	1	1	1	12	12	12	2	2	2	23	23	23	23	3	3	3	34	34	34	4	4	4	
D	63.961 - 63.960 (2.5181 - 2.5181)	01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	4	45	
E	63.960 - 63.959 (2.5181 - 2.5181)	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	4	45	45	
F	63.959 - 63.958 (2.5181 - 2.5180)	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	4	45	45	45	
G	63.958 - 63.957 (2.5180 - 2.5180)	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	4	45	45	45	5	
H	63.957 - 63.956 (2.5180 - 2.5179)	1	12	12	12	2	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	4	45	45	45	5	5
J	63.956 - 63.955 (2.5179 - 2.5179)	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	34	4	4	4	4	45	45	45	5	5	5
K	63.955 - 63.954 (2.5179 - 2.5179)	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	4	45	45	45	5	5	5	5	56
L	63.954 - 63.953 (2.5179 - 2.5178)	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	4	45	45	45	5	5	5	5	56	56
M	63.953 - 63.952 (2.5178 - 2.5178)	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	4	45	45	45	5	5	5	5	56	56	56
N	63.952 - 63.951 (2.5178 - 2.5178)	2	2	23	23	23	3	3	3	34	34	34	4	4	4	4	45	45	45	5	5	5	5	56	56	56	6
P	63.951 - 63.950 (2.5178 - 2.5177)	2	23	23	23	3	3	3	34	34	34	4	4	4	4	45	45	45	5	5	5	5	56	56	56	6	6
R	63.950 - 63.949 (2.5177 - 2.5177)	23	23	23	3	3	3	34	34	34	4	4	4	4	45	45	45	5	5	5	5	56	56	56	6	6	6
S	63.949 - 63.948 (2.5177 - 2.5176)	23	23	3	3	3	34	34	34	4	4	4	4	45	45	45	5	5	5	5	56	56	56	6	6	6	67
T	63.948 - 63.947 (2.5176 - 2.5176)	23	3	3	3	34	34	34	4	4	4	4	45	45	45	5	5	5	5	56	56	56	6	6	6	67	67
U	63.947 - 63.946 (2.5176 - 2.5176)	3	3	3	34	34	34	4	4	4	4	45	45	45	5	5	5	5	56	56	56	6	6	6	67	67	67
V	63.946 - 63.945 (2.5176 - 2.5175)	3	3	34	34	34	4	4	4	4	45	45	45	5	5	5	5	56	56	56	6	6	6	67	67	67	7
W	63.945 - 63.944 (2.5175 - 2.5175)	3	34	34	34	4	4	4	4	45	45	45	5	5	5	5	56	56	56	6	6	6	67	67	67	7	7
X	63.944 - 63.943 (2.5175 - 2.5174)	34	34	34	4	4	4	45	45	45	5	5	5	5	56	56	56	6	6	6	6	67	67	67	7	7	7
Y	63.943 - 63.942 (2.5174 - 2.5174)	34	34	4	4	4	45	45	45	5	5	5	5	56	56	56	6	6	6	6	67	67	67	7	7	7	78
1	63.942 - 63.941 (2.5174 - 2.5174)	34	4	4	4	45	45	45	5	5	5	5	56	56	56	6	6	6	6	67	67	67	7	7	7	78	78
2	63.941 - 63.940 (2.5174 - 2.5173)	4	4	4	45	45	45	5	5	5	5	56	56	56	6	6	6	6	67	67	67	7	7	7	78	78	78

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# CYLINDER BLOCK

## Main Bearings Grade Table (All Journals)

Unit: mm (in)

Grade number	Thickness	Identification color	Remarks	
0	2.483 - 2.486 (0.0978 - 0.0979)	Black	Grade and color are the same for upper and lower bearings.	
1	2.486 - 2.489 (0.0979 - 0.0980)	Brown		
2	2.489 - 2.492 (0.0980 - 0.0981)	Green		
3	2.492 - 2.495 (0.0981 - 0.0982)	Yellow		
4	2.495 - 2.498 (0.0982 - 0.0983)	Blue		
5	2.498 - 2.501 (0.0983 - 0.0985)	Pink		
6	2.501 - 2.504 (0.0985 - 0.0986)	Purple		
7	2.504 - 2.507 (0.0986 - 0.0987)	White		
8	2.507 - 2.510 (0.0987 - 0.0988)	Red		
01	UPR	2.483 - 2.486 (0.0978 - 0.0979)	Black	Grade and color are different for upper and lower bearings.
	LWR	2.486 - 2.489 (0.0979 - 0.0980)	Brown	
12	UPR	2.486 - 2.489 (0.0979 - 0.0980)	Brown	
	LWR	2.489 - 2.492 (0.0980 - 0.0981)	Green	
23	UPR	2.489 - 2.492 (0.0980 - 0.0981)	Green	
	LWR	2.492 - 2.495 (0.0981 - 0.0982)	Yellow	
34	UPR	2.492 - 2.495 (0.0981 - 0.0982)	Yellow	
	LWR	2.495 - 2.498 (0.0982 - 0.0983)	Blue	
45	UPR	2.495 - 2.498 (0.0982 - 0.0983)	Blue	
	LWR	2.498 - 2.501 (0.0983 - 0.0985)	Pink	
56	UPR	2.498 - 2.501 (0.0983 - 0.0985)	Pink	
	LWR	2.501 - 2.504 (0.0985 - 0.0986)	Purple	
67	UPR	2.501 - 2.504 (0.0985 - 0.0986)	Purple	
	LWR	2.504 - 2.507 (0.0986 - 0.0987)	White	
78	UPR	2.504 - 2.507 (0.0986 - 0.0987)	White	
	LWR	2.507 - 2.510 (0.0987 - 0.0988)	Red	

### 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 main bearing inner diameter of bearing installed and grind main journal until oil clearance falls within specification.

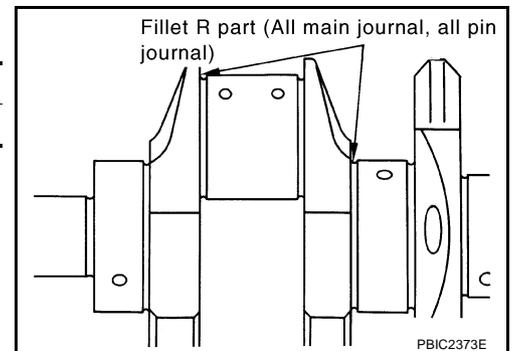
### Bearing undersize table

Unit: mm (in)

Size	Thickness
US 0.25 (0.0098)	2.618 - 2.626 (0.1031 - 0.1034)

### CAUTION:

Do not damage fillet R [1.5 mm (0.059 in)] when grinding crankshaft main journal in order to use undersized bearing.



# CYLINDER BLOCK

NBS001P4

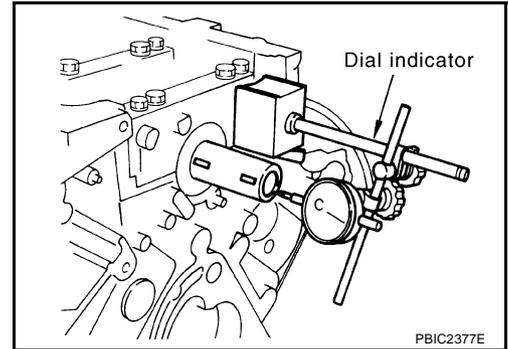
## Inspection After Disassembly CRANKSHAFT END PLAY

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

**Standard : 0.10 - 0.25 mm (0.0039 - 0.0098 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 crankshaft also.



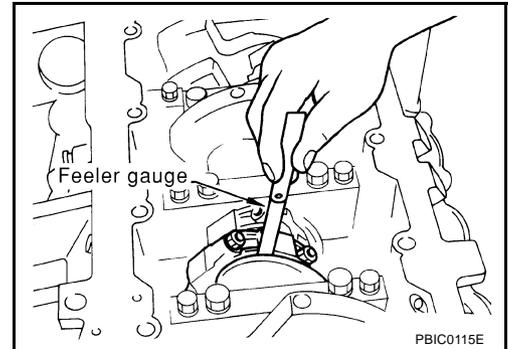
## CONNECTING ROD SIDE CLEARANCE

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

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

**Limit : 0.40 mm (0.0157 in)**

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

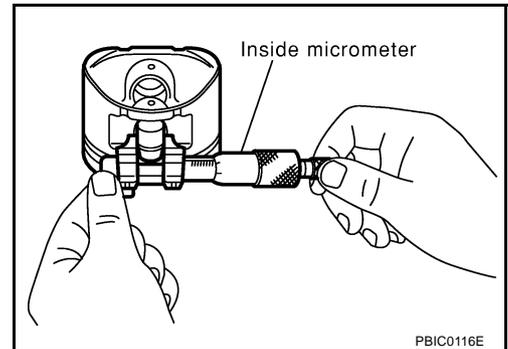


## PISTON TO PISTON PIN CLEARANCE

### Piston Pin Hole Diameter

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

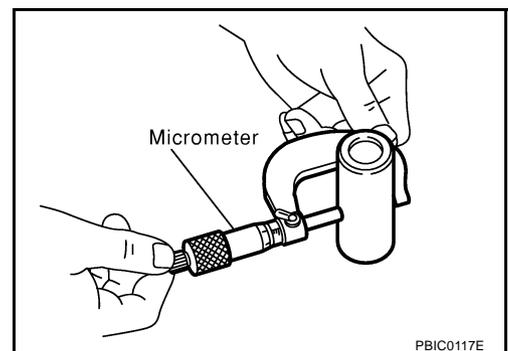
**Standard : 21.993 - 22.005 mm (0.8659 - 0.8663 in)**



### Piston Pin Outer Diameter

Measure the outer diameter of piston pin with a micrometer.

**Standard : 21.989 - 22.001 mm (0.8657 - 0.8662 in)**



# CYLINDER BLOCK

## Piston To Piston Pin Clearance

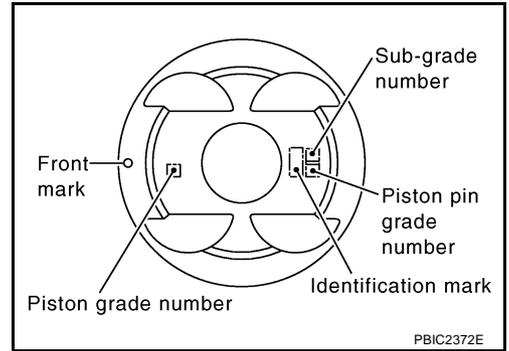
(Piston to piston pin clearance) = (Piston pin hole diameter) – (Piston pin outer diameter)

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

- If out of the standard, replace piston/piston pin assembly.
- Refer to piston selection table to replace piston/piston pin assembly. Refer to [EM-94, "HOW TO SELECT PISTON"](#) .

### NOTE:

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



## PISTON RING SIDE CLEARANCE

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

### Standard:

**Top ring : 0.045 - 0.080 mm (0.0018 - 0.0031 in)**

**2nd ring : 0.030 - 0.070 mm (0.0012 - 0.0028 in)**

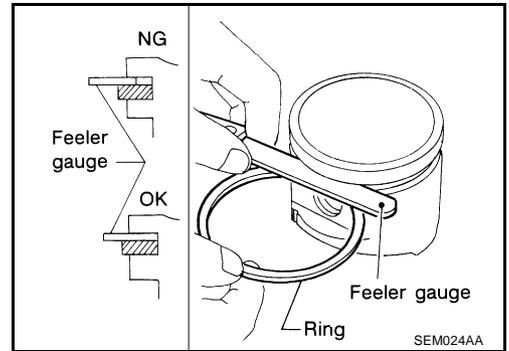
**Oil ring : 0.065 - 0.135 mm (0.0026 - 0.0053 in)**

### Limit:

**Top ring : 0.11 mm (0.0043 in)**

**2nd ring : 0.10 mm (0.0039 in)**

- If the measured value exceeds the limit, replace piston ring, and measure again. If it still exceeds the limit, replace piston.



## PISTON RING END GAP

- Check if the inner diameter of cylinder bore is within the specification. Refer to [EM-105, "Piston to Cylinder Bore Clearance"](#) .
- Lubricate with new engine oil to piston and piston ring, and then insert piston ring until middle of cylinder with piston, and measure piston ring end gap with a feeler gauge.

### Standard:

**Top ring 0.22 - 0.32 mm (0.0087 - 0.0126 in)**

**2nd ring 0.22 - 0.32 mm (0.0087 - 0.0126 in)**

**Oil ring 0.20 - 0.50 mm (0.0079 - 0.0197 in)**

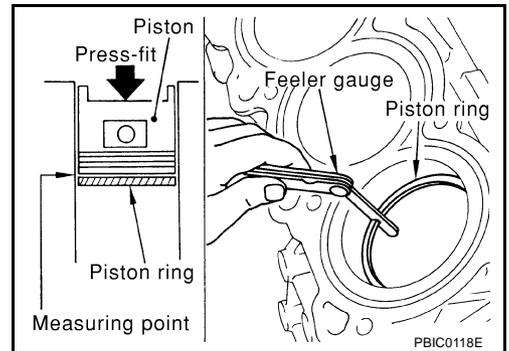
### Limit:

**Top ring 0.56 mm (0.0220 in)**

**2nd ring 0.56 mm (0.0220 in)**

**Oil ring 0.86 mm (0.0339 in)**

- If the measured value exceeds the limit, replace piston ring, and measure again. If it still exceeds the limit, re-bore cylinder and use oversize piston and piston rings.



# CYLINDER BLOCK

## CONNECTING ROD BEND AND TORSION

- Check with connecting rod aligner.

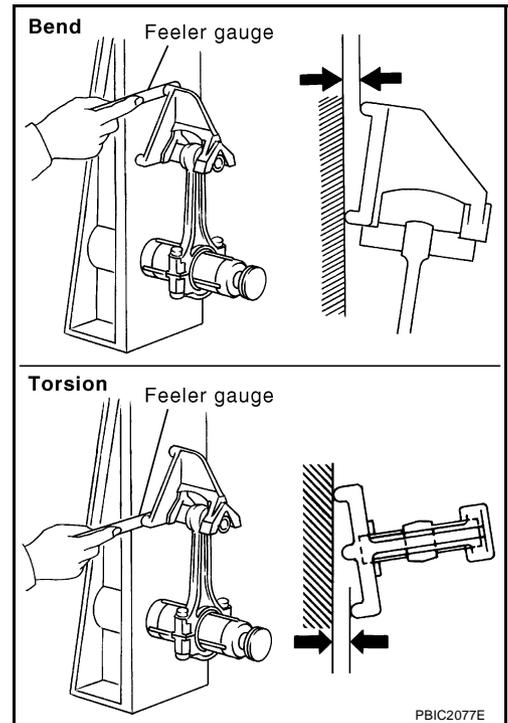
### Bend:

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.

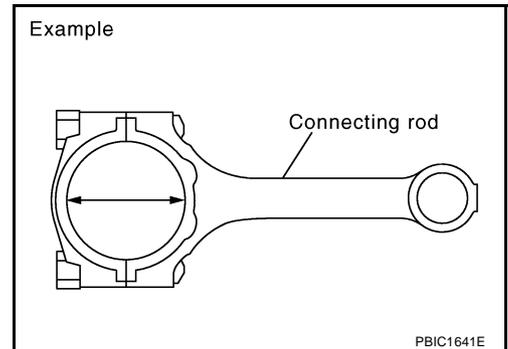


## CONNECTING ROD BIG END DIAMETER

- Install connecting rod bearing cap without installing connecting rod bearing, and tighten connecting rod bolts to the specified torque. Refer to [EM-88, "ASSEMBLY"](#) for the tightening procedure.
- Measure the inner diameter of connecting rod big end with an inside micrometer.

Standard : 55.000 - 55.013 mm (2.1654 - 2.1659 in)

- If out of the standard, replace connecting rod assembly.

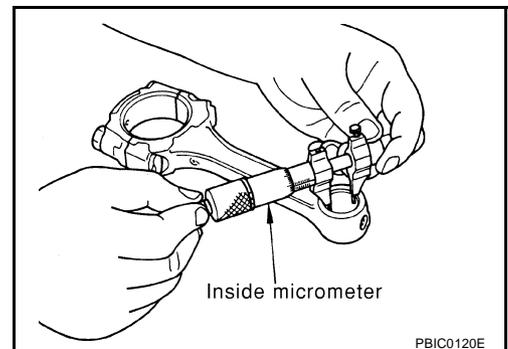


## CONNECTING ROD BUSHING OIL CLEARANCE

### Connecting Rod Bushing Inner Diameter

Measure the inner diameter of connecting rod bushing with an inside micrometer.

Standard : 22.000 - 22.012 mm (0.8661 - 0.8666 in)

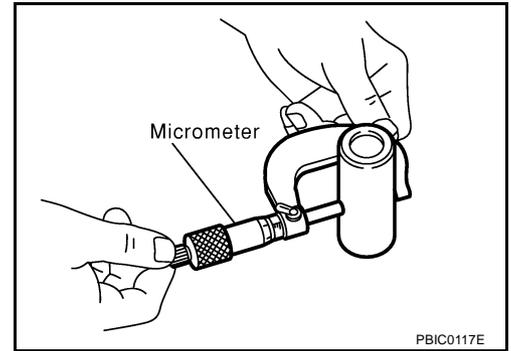


# CYLINDER BLOCK

## Piston Pin Outer Diameter

Measure the outer diameter of piston pin with a micrometer.

**Standard : 21.989 - 22.001 mm (0.8657 - 0.8662 in)**



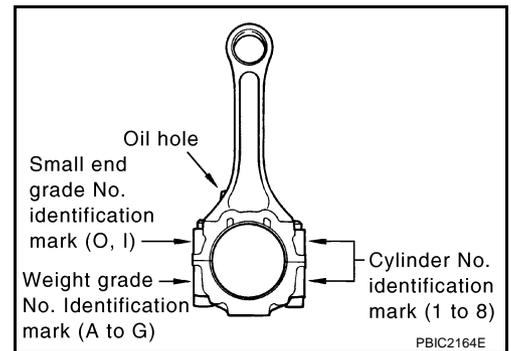
## Connecting Rod Bushing Oil Clearance

(Connecting rod bushing oil clearance) = (Connecting rod bushing inner diameter) – (Piston pin outer diameter)

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

**Limit : 0.030 mm (0.0012 in)**

- If the calculated value exceeds the limit, replace connecting rod assembly and/or piston and piston pin assembly.
- If replacing piston and piston pin assembly, refer to [EM-94, "HOW TO SELECT PISTON"](#) .
- If replacing connecting rod assembly, refer to [EM-107, "CONNECTING ROD BEARING OIL CLEARANCE"](#) to select the connecting rod bearing.

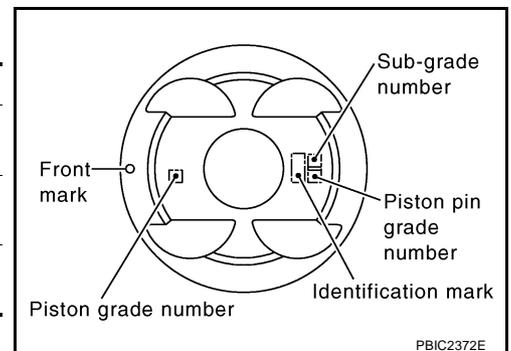


## Factory installed parts grading:

- Service parts apply only to grade "0".

Grade	Unit: mm (in)	
	0	1
Connecting rod bushing inner diameter *	22.000 - 22.006 (0.8661 - 0.8664)	22.006 - 22.012 (0.8664 - 0.8666)
Piston pin hole diameter	21.993 - 21.999 (0.8659 - 0.8661)	21.999 - 22.005 (0.8661 - 0.8663)
Piston pin outer diameter	21.989 - 21.995 (0.8657 - 0.8659)	21.995 - 22.001 (0.8659 - 0.8662)

\*: After installing in connecting rod



## CYLINDER BLOCK DISTORTION

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

### CAUTION:

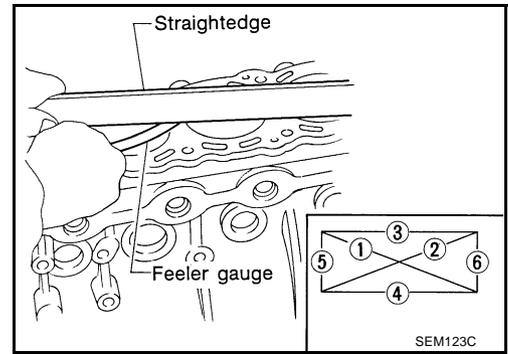
**Be careful not to allow gasket flakes to enter the engine oil or engine coolant passages.**

# CYLINDER BLOCK

- Measure the distortion on the cylinder block upper face at some different points in six directions with a straightedge and a feeler gauge.

**Limit : 0.1 mm (0.004 in)**

- If it exceeds the limit, replace cylinder block.



## MAIN BEARING HOUSING INNER DIAMETER

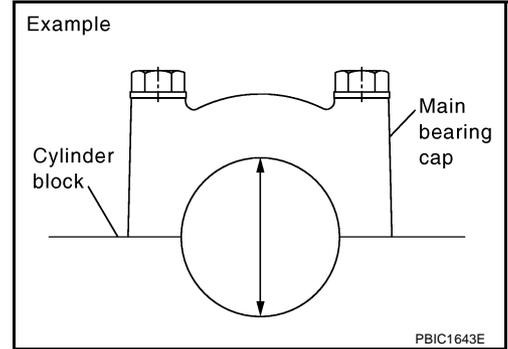
- Install main bearing caps without installing main bearings, and tighten main bearing cap bolts to the specified torque. Refer to [EM-88, "ASSEMBLY"](#) for the tightening procedure.
- Using a bore gauge, measure the inner diameter of the main bearing housing.

**Standard : 68.944 - 68.968 mm (2.7143 - 2.7153 in)**

- If out of the standard, replace cylinder block and main bearing caps as an assembly.

**NOTE:**

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



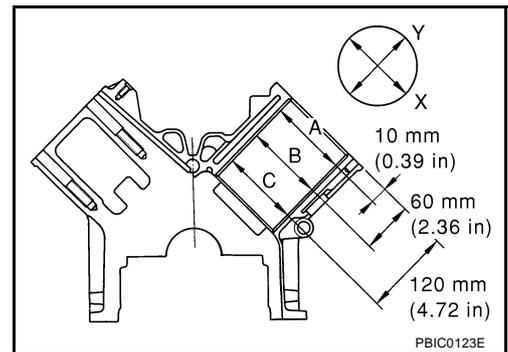
## PISTON TO CYLINDER BORE CLEARANCE

### Cylinder Bore Inner Diameter

- Using a bore gauge, measure the cylinder bore diameter for wear, out-of-round and taper at six different points on each cylinder. ("X" and "Y" directions at "A", "B" and "C")

**NOTE:**

When determining cylinder bore grade, measure the cylinder bore at B position.



**Standard inner diameter**

**: 93.000 - 93.030 mm (3.6614 - 3.6626 in)**

**Wear limit**

**: 0.20 mm (0.0079 in)**

**Out-of-round limit (Difference between "X" and "Y")**

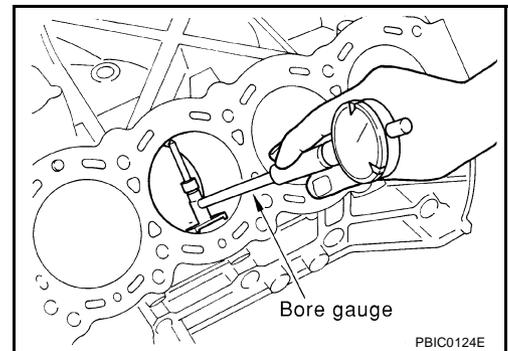
**: 0.015 mm (0.0006 in)**

**Taper limit (Difference between "A" and "C")**

**: 0.010 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 bore the inner wall.
- Oversize piston is provided. When using oversize piston, hone cylinder so that the clearance between piston and cylinder satisfies the standard.

**Oversize (OS) : 0.2 mm (0.008 in)**



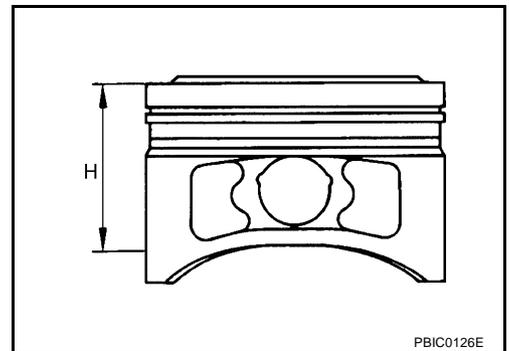
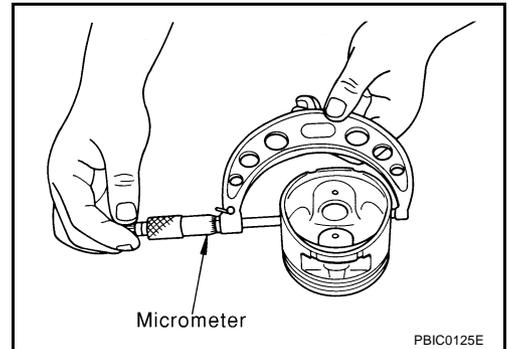
# CYLINDER BLOCK

## CAUTION:

If oversize piston is used, use it for all cylinders with oversize piston rings.

## Piston Skirt Diameter

- Measure outer diameter of piston skirt with a micrometer.  
**Standard : 92.980 - 93.010 mm (3.6606 - 3.6618 in)**
- Measure point "H"(Distance from the top): 42 mm (1.65 in)



## Piston to Cylinder Bore Clearance

- Calculate by piston skirt diameter and cylinder bore inner diameter (direction "X", position "B").  
(Clearance) = (Cylinder bore inner diameter) – (Piston skirt diameter)  
**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. Refer to [EM-94, "HOW TO SELECT PISTON"](#).

## Re-boring Cylinder Bore

1. Cylinder bore size is determined by adding piston to cylinder bore clearance to piston skirt diameter.

**Rebored size calculation:  $D = A + B - C$**

where,

**D: Bored diameter**

**A: Piston skirt 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. Refer to [EM-88, "ASSEMBLY"](#).
  3. Cut the cylinder bores.
- NOTE:**
- When any cylinder needs boring, all other cylinders must also be bored.
  - Do not cut too much out of the 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 the specified piston to cylinder bore clearance.
  5. Measure finished the cylinder bore for out-of-round and taper.

## NOTE:

Measurement should be done after the cylinder bore cools down.

# CYLINDER BLOCK

## CRANKSHAFT MAIN JOURNAL DIAMETER

- Measure the outer diameter of crankshaft main journal with a micrometer.

**Standard : 63.940 - 63.964 mm (2.5173 - 2.5183 in)**

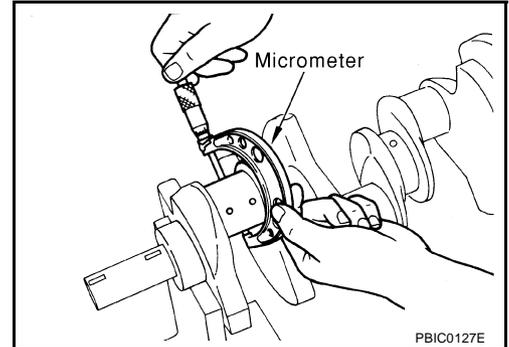
- If out of the standard, measure the main bearing oil clearance. Then use the undersize bearing. Refer to [EM-107, "CONNECTING ROD BEARING OIL CLEARANCE"](#) .

## CRANKSHAFT PIN JOURNAL DIAMETER

- Measure the outer diameter of crankshaft pin journal with a micrometer.

**Standard : 51.956 - 51.974 mm (2.0455 - 2.0462 in)**

- If out of the standard, measure the connecting rod bearing oil clearance. Then use the undersize bearing. Refer to [EM-107, "CONNECTING ROD BEARING OIL CLEARANCE"](#) .



## CRANKSHAFT OUT-OF-ROUND AND TAPER

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

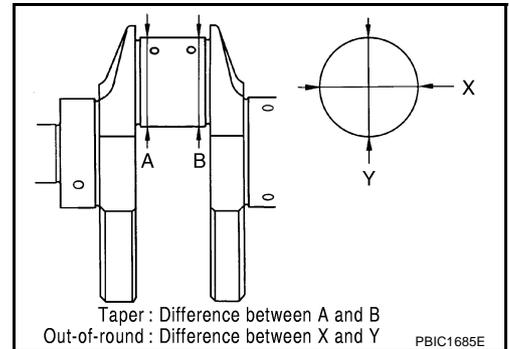
### Limit:

**Out-of-round (Difference between "X" and "Y")**

**: 0.015 mm (0.0006 in)**

**Taper (Difference between "A" and "B")**

**: 0.010 mm (0.0004 in)**



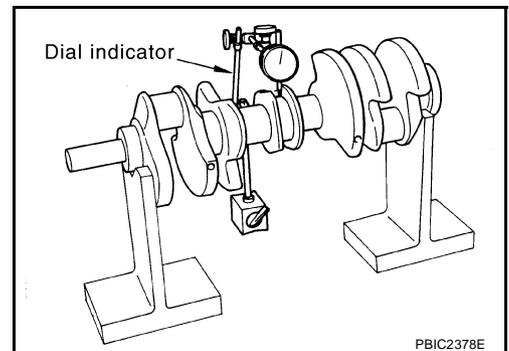
- If the measured value exceeds the limit, correct or replace crankshaft.
- If corrected, measure the bearing oil clearance of the corrected main journal and/or pin journal. Then select main bearing and/or connecting rod bearing. Refer to [EM-107, "MAIN BEARING OIL CLEARANCE"](#) and/or [EM-107, "CONNECTING ROD BEARING OIL CLEARANCE"](#) .

## CRANKSHAFT RUNOUT

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

**Limit: : 0.10 mm (0.0039 in)**

- If it exceeds the limit, replace crankshaft.



# CYLINDER BLOCK

## CONNECTING ROD BEARING OIL CLEARANCE

### Method by Calculation

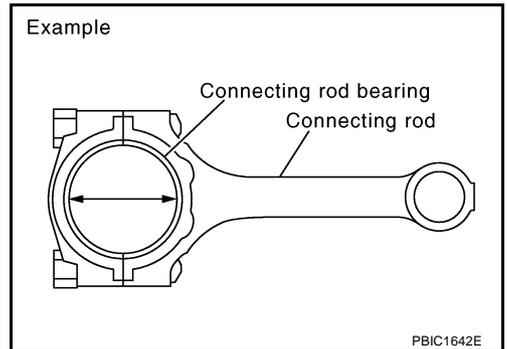
- Install connecting rod bearings to connecting rod and cap, and tighten connecting rod nuts to the specified torque. Refer to [EM-88, "ASSEMBLY"](#) for the tightening procedure.
- Measure the inner diameter of connecting rod bearing with an inside micrometer.

(Bearing oil clearance) = (Connecting rod bearing inner diameter) – (Crankshaft pin journal diameter)

**Standard** : 0.020 - 0.045 mm (0.0008 - 0.0018 in)

**Limit** : 0.055 mm (0.0022 in)

- If the calculated value exceeds the limit, select proper connecting rod bearing according to connecting rod big end diameter and crankshaft pin journal diameter to obtain the specified bearing oil clearance. Refer to [EM-95, "HOW TO SELECT CONNECTING ROD BEARING"](#).



### Method of Using Plastigage

- Remove oil and dust on crankshaft pin journal and the surfaces of each bearing completely.
- Cut plastigage slightly shorter than the bearing width, and place it in crankshaft axial direction, avoiding oil holes.
- Install connecting rod bearings to connecting rod and cap, and tighten connecting rod nuts to the specified torque. Refer to [EM-88, "ASSEMBLY"](#) for the tightening procedure.

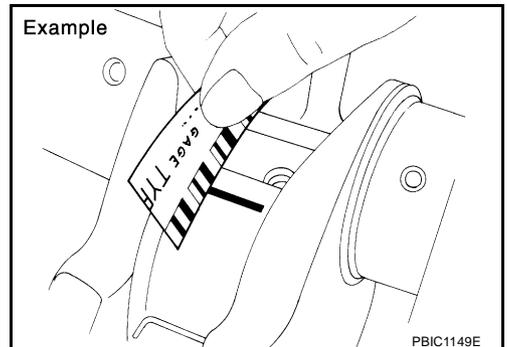
#### CAUTION:

**Do not rotate crankshaft.**

- Remove connecting rod bearing cap and bearing, and using scale on plastigage bag, measure the plastigage width.

#### NOTE:

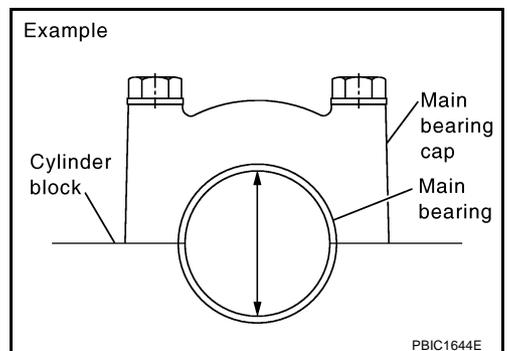
The procedure when the measured value exceeds the limit is same as that described in the "Method by Calculation".



## MAIN BEARING OIL CLEARANCE

### Method by Calculation

- Install main bearings to cylinder block and main bearing caps, and tighten main bearing cap bolts to the specified torque. Refer to [EM-88, "ASSEMBLY"](#) for the tightening procedure.
- Measure the inner diameter of main bearing with a bore gauge.



(Bearing clearance) = (Main bearing inner diameter) – (Crankshaft main journal diameter)

#### Standard

**No. 1 and 5 journal** : 0.001 - 0.011 mm (0.00004 - 0.0004 in)

**No. 2, 3 and 4 journal** : 0.007 - 0.017 mm (0.0003 - 0.0007 in)

#### Limit

# CYLINDER BLOCK

No. 1 and 5 journal : 0.021 mm (0.0008 in)

No. 2, 3 and 4 journal : 0.027 mm (0.0011 in)

- If the calculated value exceeds the limit, select proper main bearing according to main bearing inner diameter and crankshaft main journal diameter to obtain the specified bearing oil clearance. Refer to [EM-96, "HOW TO SELECT MAIN BEARING"](#).

## Method of Using Plastigage

- Remove oil and dust on crankshaft main journal and the surfaces of each bearing completely.
- Cut plastigage slightly shorter than the bearing width, and place it in crankshaft axial direction, avoiding oil holes.
- Install main bearings to cylinder block and main bearing caps, and tighten main bearing bolts to the specified torque. Refer to [EM-88, "ASSEMBLY"](#) for the tightening procedure.

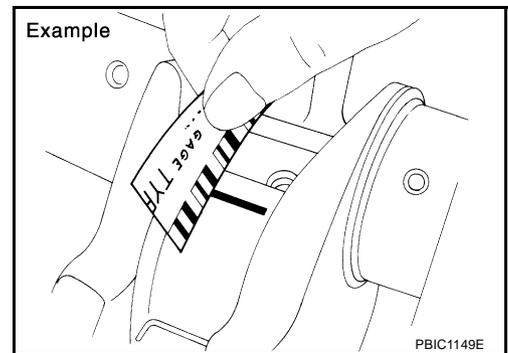
### CAUTION:

**Do not rotate crankshaft.**

- Remove main bearing caps and bearings, and using scale on 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".

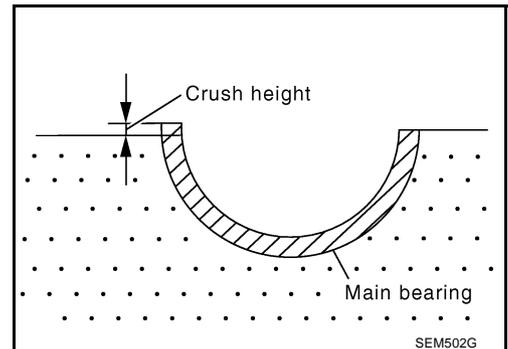


## CRUSH HEIGHT OF MAIN BEARING

- When main bearing cap is removed after being tightened to the specified torque with main bearings installed, the tip end of bearing must protrude. Refer to [EM-88, "ASSEMBLY"](#) for the tightening procedure.

**Standard : There must be crush height.**

- If out of the standard, replace main bearings.

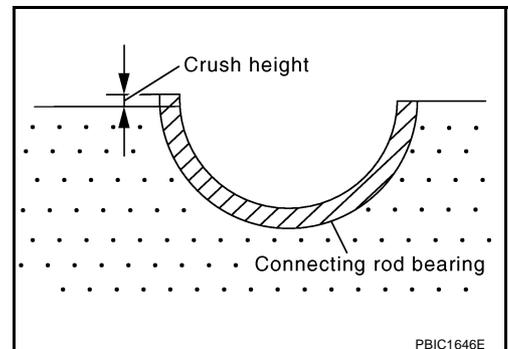


## CRUSH HEIGHT OF CONNECTING ROD BEARING

- When connecting rod bearing cap is removed after being tightened to the specified torque with connecting rod bearings installed, the tip end of bearing must protrude. Refer to [EM-88, "ASSEMBLY"](#) for the tightening procedure.

**Standard : There must be crush height.**

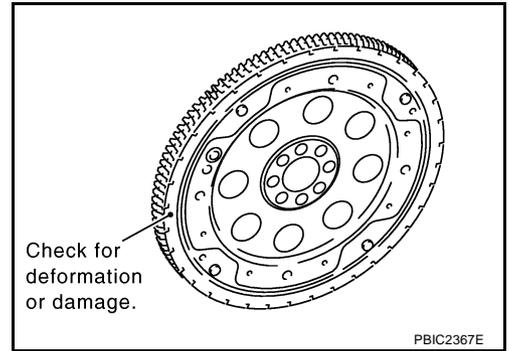
- If out of the standard, replace connecting rod bearings.



# CYLINDER BLOCK

## DRIVE PLATE

- Check drive plate and signal plate for deformation or cracks.
  - CAUTION:**
    - Do not disassemble drive plate.
    - Do not place drive plate with signal plate facing down.
    - When handling signal plate, take care not to damage or scratch it.
    - Handle signal plate in a manner that prevents it from becoming magnetized.
- If anything is found, replace drive plate.



A

EM

C

D

E

F

G

H

I

J

K

L

M

# SERVICE DATA AND SPECIFICATIONS (SDS)

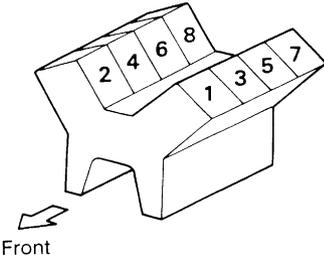
## SERVICE DATA AND SPECIFICATIONS (SDS)

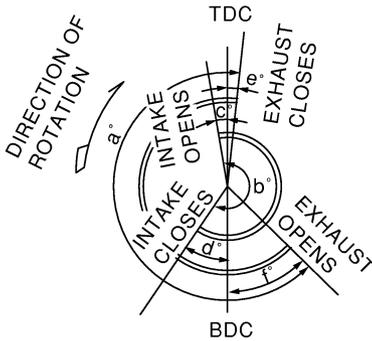
PFP:00030

### Standard and Limit GENERAL SPECIFICATIONS

NBS001P5

Cylinder arrangement		V-8
Displacement cm <sup>3</sup> (cu in)		4,494 (274.22)
Bore and stroke mm (in)		93 x 82.7 (3.66 x 3.256)
Valve arrangement		DOHC
Firing order		1-8-7-3-6-5-4-2
Number of piston rings	Compression	2
	engine oil	1
Number of main bearings		5
Compression ratio		10.5
Compression pressure kPa (kg/cm <sup>2</sup> , psi)/300 rpm	Standard	1,320 (13.5, 191)
	Minimum	1,130 (11.5, 164)
	Differential limit between cylinders	98 (1.0, 14)

Cylinder number	 <p style="text-align: center;">SEM957C</p>
-----------------	--

Valve timing	 <p style="text-align: center;">PBIC0187E</p>
--------------	---

Unit: degree					
a	b	c	d	e	f
228	240	0	60	0	48

### DRIVE BELTS

Tension of drive belts	Auto adjustment by auto tensioner
------------------------	-----------------------------------

### INTAKE MANIFOLD AND EXHAUST MANIFOLD

Unit: mm (in)

Item		Limit
Surface distortion	Intake manifold (upper and lower)	0.1 (0.004)
	Exhaust manifold	0.3 (0.012)

# SERVICE DATA AND SPECIFICATIONS (SDS)

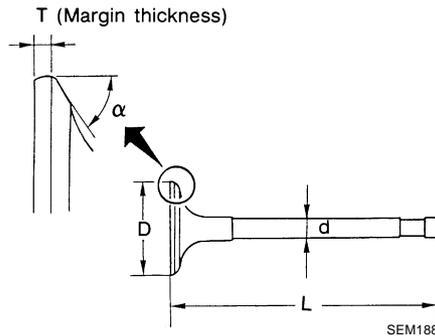
## SPARK PLUG (PLATINUM-TIPPED TYPE)

Make		NGK
Type	Standard	PLFR5A-11
	Hot	PLFR4A-11
	Cold	PLFR6A-11
Plug gap (Nominal)		1.1 mm (0.043 in)

## VALVE

### Valve Dimensions

Unit: mm (in)



Valve head diameter "D"	Intake	36.0 - 36.3 (1.417 - 1.429)
	Exhaust	31.2 - 31.5 (1.228 - 1.240)
Valve length "L"	Intake	96.57 (3.8020)
	Exhaust	94.50 (3.720)
Valve stem diameter "d"	Intake	5.972 - 5.980 (0.2351 - 0.2354)
	Exhaust	5.962 - 5.970 (0.2347 - 0.2350)
Valve seat angle "α"	Intake	45 degrees 15' - 45 degrees 45'
	Exhaust	
Valve margin "T"	Intake	1.15 - 1.45 (0.0453 - 0.0571)
	Exhaust	1.85 - 2.50 (0.0728 - 0.0846)

# SERVICE DATA AND SPECIFICATIONS (SDS)

## Valve Clearance

Unit: mm (in)

Items	Cold	Hot* (reference data)
Intake	0.26 - 0.34 (0.010 - 0.013)	0.304 - 0.416 (0.012 - 0.016)
Exhaust	0.29 - 0.37 (0.011 - 0.015)	0.308 - 0.432 (0.012 - 0.017)

\*: Approximately 80°C (176 °F)

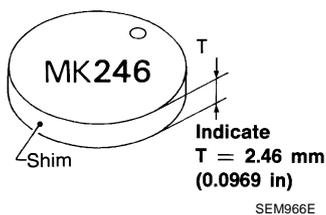
## Available Shims

Thickness mm (in)	Identification mark
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
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
2.67 (0.1051)	267
2.68 (0.1055)	268

# SERVICE DATA AND SPECIFICATIONS (SDS)

Thickness mm (in)	Identification mark
2.69 (0.1059)	269
2.70 (0.1063)	270
2.71 (0.1067)	271
2.72 (0.1071)	272
2.73 (0.1075)	273
2.74 (0.1079)	274
2.75 (0.1083)	275
2.76 (0.1087)	276
2.77 (0.1091)	277
2.78 (0.1094)	278
2.79 (0.1098)	279
2.80 (0.1102)	280
2.81 (0.1106)	281
2.82 (0.1110)	282
2.83 (0.1114)	283
2.84 (0.1118)	284
2.85 (0.1122)	285
2.86 (0.1126)	286
2.87 (0.1130)	287
2.88 (0.1134)	288
2.89 (0.1138)	289
2.90 (0.1142)	290
2.91 (0.1146)	291
2.92 (0.1150)	292
2.93 (0.1154)	293
2.94 (0.1157)	294
2.95 (0.1161)	295

A  
EM  
C  
D  
E  
F  
G  
H  
I  
J  
K  
L  
M



## Valve Lifter

Unit: mm (in)

Items	Standard
Valve lifter outer diameter	33.965 - 33.975 (1.3372 - 1.3376)
Valve lifter hole diameter	34.000 - 34.016 (1.3386 - 1.3392)
Valve lifter clearance	0.025 - 0.051 (0.0010 - 0.0020)

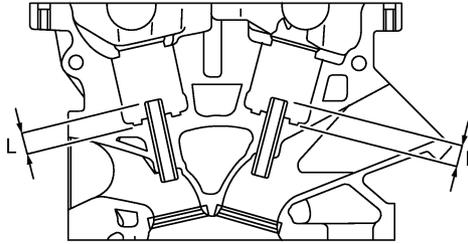
## Valve Spring

Free height mm (in)	46.35 - 46.85 (1.8247 - 1.8444)	
Load N (kg, lb) at height mm (in)	Installation	165 - 189 (16.8 - 19.3, 37 - 42) at 33.8 (1.331)
	Valve open	290 - 330 (29.6 - 33.7, 65 - 74) at 24.4 (0.961)
Squareness mm (in)	Limit	2.0 (0.079)

# SERVICE DATA AND SPECIFICATIONS (SDS)

## Valve Guide

Unit: mm (in)

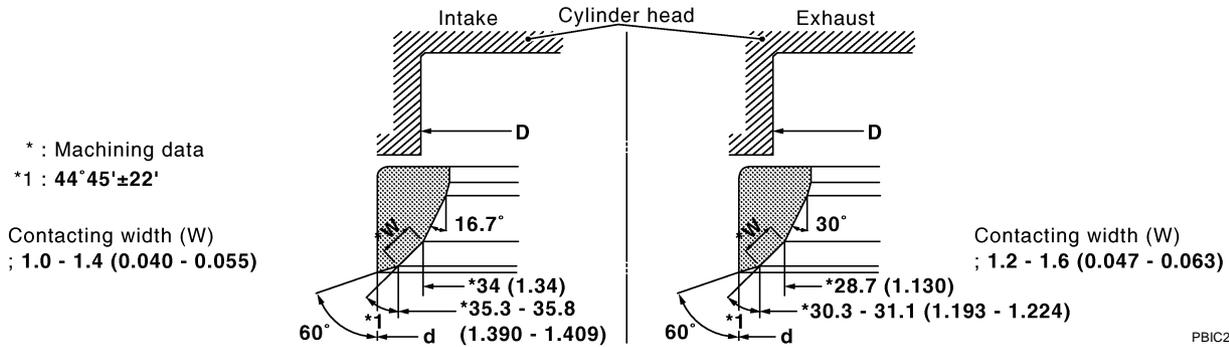


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Items		Standard	Service
Valve guide	Outer diameter	10.023 - 10.034 (0.3946 - 0.3950)	10.223 - 10.234 (0.4025 - 0.4029)
	Inner diameter (Finished size)	6.000 - 6.018 (0.2362 - 0.2369)	
Cylinder head valve guide hole diameter		9.975 - 9.996 (0.3927 - 0.3935)	10.175 - 10.196 (0.4006 - 0.4014)
Interference fit of valve guide		0.027 - 0.059 (0.0011 - 0.0023)	
		Standard	Limit
Valve guide clearance	Intake	0.020 - 0.046 (0.0008 - 0.0018)	0.08 (0.003)
	Exhaust	0.030 - 0.056 (0.0012 - 0.0022)	0.10 (0.004)
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)

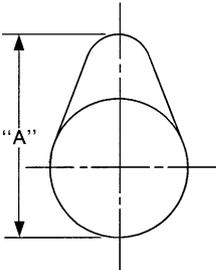


Items		Standard	Service
Cylinder head seat recess diameter (D)	Intake	37.000 - 37.016 (1.4567 - 1.4573)	37.500 - 37.516 (1.4764 - 1.4770)
	Exhaust	32.200 - 32.216 (1.2677 - 1.2683)	32.700 - 32.716 (1.2874 - 1.2880)
Valve seat interference fit	Intake	0.081 - 0.113 (0.0032 - 0.0044)	
	Exhaust	0.064 - 0.096 (0.0025 - 0.0038)	
Valve seat outer diameter (d)	Intake	37.097 - 37.113 (1.4605 - 1.4611)	37.597 - 37.613 (1.4802 - 1.4808)
	Exhaust	32.280 - 32.296 (1.2709 - 1.2715)	32.780 - 32.796 (1.2905 - 1.2912)

# SERVICE DATA AND SPECIFICATIONS (SDS)

## CAMSHAFT AND CAMSHAFT BEARING

Unit: mm (in)

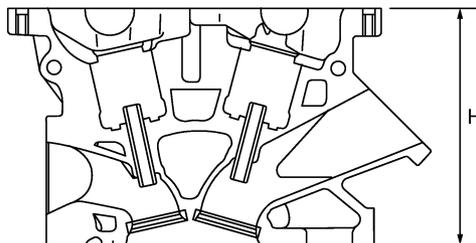
Items	Standard	Limit
Camshaft runout [TIR*]	—	0.02 (0.0008)
 <p style="text-align: center; margin-top: 5px;">SEM671</p>		
Cam height "A"	Intake	44.865 - 45.055 (1.7663 - 1.7738)
	Exhaust	43.925 - 44.115 (1.7293 - 1.7368)
Camshaft journal outer diameter	No.1	25.938 - 25.955 (1.0212 - 1.0218)
	No.2, 3, 4, 5	25.953 - 25.970 (1.0218 - 1.0224)
Camshaft bracket inner diameter	26.000 - 26.021 (1.0236 - 1.0244)	
Camshaft journal oil clearance	No.1	0.045 - 0.083 (0.0018 - 0.0033)
	No.2, 3, 4, 5	0.030 - 0.068 (0.0012 - 0.0027)
Camshaft end play	0.115 - 0.188 (0.0045 - 0.0074)	
Camshaft sprocket runout [TIR*]	—	0.15 (0.0059)

\*: Total indicator reading

## CYLINDER HEAD

Unit: mm (in)

Items	Standard	Limit
Cylinder head distortion	Less than 0.03 (0.0012)	0.1 (0.004)



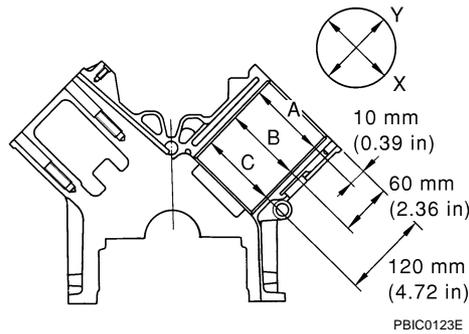
Nominal cylinder head height:  
H = 126.4 mm (4.98 in)

PBIC0183E

# SERVICE DATA AND SPECIFICATIONS (SDS)

## CYLINDER BLOCK

Unit: mm (in)



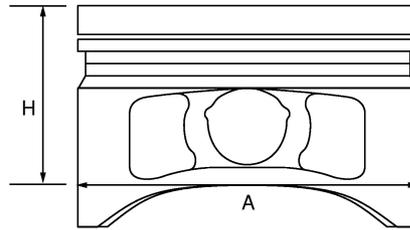
Distortion	Standard		Less than 0.03 (0.0012)
	Limit		0.1 (0.004)
Cylinder bore	Inner diameter	Standard	Grade No. 1 93.000 - 93.010 (3.6614 - 3.6618)
			Grade No. 2 93.010 - 93.020 (3.6618 - 3.6622)
			Grade No. 3 93.020 - 93.030 (3.6622 - 3.6626)
	Wear limit		0.20 (0.0079)
Out-of-round (Difference between "X" and "Y")			0.015 (0.0006)
Taper (Difference between "A" and "C")			0.010 (0.0004)
Cylinder block main bearing housing inner diameter grade (Without bearing)	Grade No. A		68.944 - 68.945 (2.7143 - 2.7144)
	Grade No. B		68.945 - 68.946 (2.7144 - 2.7144)
	Grade No. C		68.946 - 68.947 (2.7144 - 2.7144)
	Grade No. D		68.947 - 68.948 (2.7144 - 2.7145)
	Grade No. E		68.948 - 68.949 (2.7145 - 2.7145)
	Grade No. F		68.949 - 68.950 (2.7145 - 2.7146)
	Grade No. G		68.950 - 68.951 (2.7146 - 2.7146)
	Grade No. H		68.951 - 68.952 (2.7146 - 2.7146)
	Grade No. J		68.952 - 68.953 (2.7146 - 2.7147)
	Grade No. K		68.953 - 68.954 (2.7147 - 2.7147)
	Grade No. L		68.954 - 68.955 (2.7147 - 2.7148)
	Grade No. M		68.955 - 68.956 (2.7148 - 2.7148)
	Grade No. N		68.956 - 68.957 (2.7148 - 2.7148)
	Grade No. P		68.957 - 68.958 (2.7148 - 2.7149)
	Grade No. R		68.958 - 68.959 (2.7149 - 2.7149)
	Grade No. S		68.959 - 68.960 (2.7149 - 2.7150)
	Grade No. T		68.960 - 68.961 (2.7150 - 2.7150)
	Grade No. U		68.961 - 68.962 (2.7150 - 2.7150)
	Grade No. V		68.962 - 68.963 (2.7150 - 2.7151)
	Grade No. W		68.963 - 68.964 (2.7151 - 2.7151)
Grade No. X		68.964 - 68.965 (2.7151 - 2.7152)	
Grade No. Y		68.965 - 68.966 (2.7152 - 2.7152)	
Grade No. 1		68.966 - 68.967 (2.7152 - 2.7152)	
Grade No. 2		68.967 - 68.968 (2.7152 - 2.7153)	
Difference in inner diameter between cylinders	Standard		0.03 (0.0012)

# SERVICE DATA AND SPECIFICATIONS (SDS)

## PISTON, PISTON RING AND PISTON PIN

### Available Piston

Unit: mm (in)



PBIC0188E

Piston skirt diameter "A"	Standard	Grade No. 1	92.980 - 92.990 (3.6606 - 3.6610)
		Grade No. 2	92.990 - 93.000 (3.6610 - 3.6614)
		Grade No. 3	93.000 - 93.010 (3.6614 - 3.6618)
	0.20 (0.008) oversize (Service)		93.180 - 93.210 (3.6685 - 3.6697)
"H" dimension			42 (1.65)
Piston pin hole diameter	Grade No.0		21.993 - 21.999 (0.8659 - 0.8661)
	Grade No.1		21.999 - 22.005 (0.8661 - 0.8663)
Piston to cylinder bore clearance	Standard		0.010 - 0.030 (0.0004 - 0.0012)
	Limit		0.08 (0.0031)

### Piston Ring

Unit: mm (in)

Items		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 (0.0039)
	Oil ring	0.065 - 0.135 (0.0026 - 0.0053)	—
End gap	Top	0.22 - 0.32 (0.0087 - 0.0126)	0.56 (0.0220)
	2nd	0.22 - 0.32 (0.0087 - 0.0126)	0.56 (0.0220)
	Oil (rail ring)	0.20 - 0.50 (0.0079 - 0.0197)	0.86 (0.0339)

### Piston Pin

Unit: mm (in)

Piston pin outer diameter	Grade No.0	21.989 - 21.995 (0.8657 - 0.8659)
	Grade No.1	21.995 - 22.001 (0.8659 - 0.8662)
Piston to piston pin clearance	Standard	0.002 - 0.006 (0.0001 - 0.0002)
Connecting rod bushing oil clearance	Standard	0.005 - 0.017 (0.0002 - 0.0007)

# SERVICE DATA AND SPECIFICATIONS (SDS)

## CONNECTING ROD

Unit: mm (in)

Center distance		146.95 - 147.05 (5.79 - 5.79)
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*	Grade No. 0	22.000 - 22.006 (0.8661 - 0.8664)
	Grade No. 1	22.006 - 22.012 (0.8664 - 0.8666)
Connecting rod big end inner diameter		55.000 - 55.013 (2.1654 - 2.1659)
Side clearance	Standard	0.20 - 0.35 (0.0079 - 0.0138)
	Limit	0.40 (0.0157)

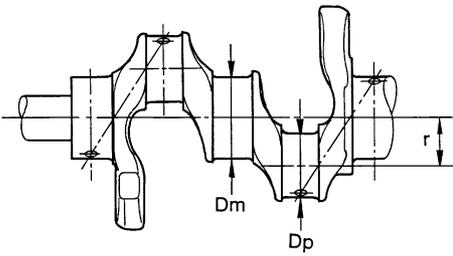
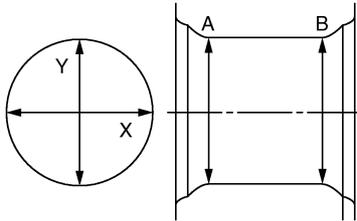
\*: After installing in connecting rod

## CRANKSHAFT

Unit: mm (in)

Crankshaft main journal diameter. "Dm" grade (No.1 and 5)	Grade No. G	63.963 - 63.964 (2.5182 - 2.5183)
	Grade No. H	63.962 - 63.963 (2.5182 - 2.5182)
	Grade No. J	63.961 - 63.962 (2.5181 - 2.5182)
	Grade No. K	63.960 - 63.961 (2.5181 - 2.5181)
	Grade No. L	63.959 - 63.960 (2.5181 - 2.5181)
	Grade No. M	63.958 - 63.959 (2.5180 - 2.5181)
	Grade No. N	63.957 - 63.958 (2.5180 - 2.5180)
	Grade No. P	63.956 - 63.957 (2.5179 - 2.5180)
	Grade No. R	63.955 - 63.956 (2.5179 - 2.5179)
	Grade No. S	63.954 - 63.955 (2.5179 - 2.5179)
	Grade No. T	63.953 - 63.954 (2.5178 - 2.5179)
	Grade No. U	63.952 - 63.953 (2.5178 - 2.5178)
	Grade No. V	63.951 - 63.952 (2.5178 - 2.5178)
	Grade No. W	63.950 - 63.951 (2.5177 - 2.5178)
	Grade No. X	63.949 - 63.950 (2.5177 - 2.5177)
	Grade No. Y	63.948 - 63.949 (2.5176 - 2.5177)
	Grade No. 1	63.947 - 63.948 (2.5176 - 2.5176)
	Grade No. 2	63.946 - 63.947 (2.5176 - 2.5176)
	Grade No. 3	63.945 - 63.946 (2.5175 - 2.5176)
	Grade No. 4	63.944 - 63.945 (2.5175 - 2.5175)
Grade No. 5	63.943 - 63.944 (2.5174 - 2.5175)	
Grade No. 6	63.942 - 63.943 (2.5174 - 2.5174)	
Grade No. 7	63.941 - 63.942 (2.5174 - 2.5174)	
Grade No. 9	63.940 - 63.941 (2.5173 - 2.5174)	
Crankshaft main journal diameter. "Dm" grade (No.2, 3 and 4)	Grade No. A	63.963 - 63.964 (2.5182 - 2.5183)
	Grade No. B	63.962 - 63.963 (2.5182 - 2.5182)
	Grade No. C	63.961 - 63.962 (2.5181 - 2.5182)
	Grade No. D	63.960 - 63.961 (2.5181 - 2.5181)
	Grade No. E	63.959 - 63.960 (2.5181 - 2.5181)
	Grade No. F	63.958 - 63.959 (2.5180 - 2.5181)
	Grade No. G	63.957 - 63.958 (2.5180 - 2.5180)
	Grade No. H	63.956 - 63.957 (2.5179 - 2.5180)
	Grade No. J	63.955 - 63.956 (2.5179 - 2.5179)
	Grade No. K	63.954 - 63.955 (2.5179 - 2.5179)
	Grade No. L	63.953 - 63.954 (2.5178 - 2.5179)
	Grade No. M	63.952 - 63.953 (2.5178 - 2.5178)
	Grade No. N	63.951 - 63.952 (2.5178 - 2.5178)
	Grade No. P	63.950 - 63.951 (2.5177 - 2.5178)
	Grade No. R	63.949 - 63.950 (2.5177 - 2.5177)
	Grade No. S	63.948 - 63.949 (2.5176 - 2.5177)
	Grade No. T	63.947 - 63.948 (2.5176 - 2.5176)
	Grade No. U	63.946 - 63.947 (2.5176 - 2.5176)
	Grade No. V	63.945 - 63.946 (2.5175 - 2.5176)
	Grade No. W	63.944 - 63.945 (2.5175 - 2.5175)
Grade No. X	63.943 - 63.944 (2.5174 - 2.5175)	
Grade No. Y	63.942 - 63.943 (2.5174 - 2.5174)	
Grade No. 1	63.941 - 63.942 (2.5174 - 2.5174)	
Grade No. 2	63.940 - 63.941 (2.5173 - 2.5174)	

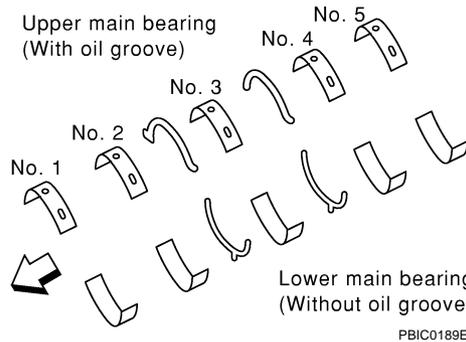
# SERVICE DATA AND SPECIFICATIONS (SDS)

Crankshaft pin journal diameter. "Dp"	Grade No. 0	51.968 - 51.974 (2.0460 - 2.0462)	
	Grade No. 1	51.962 - 51.968 (2.0457 - 2.0460)	A
	Grade No. 2	51.956 - 51.962 (2.0455 - 2.0457)	
Center distance "r"		41.31 - 41.39 (1.6264 - 1.6295)	EM
Out-of-round (Difference between "X" and "Y")	Limit	0.015 (0.0006)	
Taper (Difference between "A" and "B")	Limit	0.010 (0.0004)	C
Runout [TIR*]	Limit	0.10 (0.0039)	
End play	Standard	0.10 - 0.25 (0.0039 - 0.0098)	D
	Limit	0.30 (0.0118)	
		Out-of-round : Difference between X and Y. Taper : Difference between A and B.	
SEM645			
		PBIC1686E	

\*: Total indicator reading

## MAIN BEARING

Unit: mm (in)



Grade number	Thickness	Identification color	Remarks
0	2.483 - 2.486 (0.0978 - 0.0979)	Black	Grade and color are the same for upper and lower bearings.
1	2.486 - 2.489 (0.0979 - 0.0980)	Brown	
2	2.489 - 2.492 (0.0980 - 0.0981)	Green	
3	2.492 - 2.495 (0.0981 - 0.0982)	Yellow	
4	2.495 - 2.498 (0.0982 - 0.0983)	Blue	
5	2.498 - 2.501 (0.0983 - 0.0985)	Pink	
6	2.501 - 2.504 (0.0985 - 0.0986)	Purple	
7	2.504 - 2.507 (0.0986 - 0.0987)	White	
8	2.507 - 2.510 (0.0987 - 0.0988)	Red	

## SERVICE DATA AND SPECIFICATIONS (SDS)

01	UPR	2.483 - 2.486 (0.0978 - 0.0979)	Black	Grade and color are different for upper and lower bearings.
	LWR	2.486 - 2.489 (0.0979 - 0.0980)	Brown	
12	UPR	2.486 - 2.489 (0.0979 - 0.0980)	Brown	
	LWR	2.489 - 2.492 (0.0980 - 0.0981)	Green	
23	UPR	2.489 - 2.492 (0.0980 - 0.0981)	Green	
	LWR	2.492 - 2.495 (0.0981 - 0.0982)	Yellow	
34	UPR	2.492 - 2.495 (0.0981 - 0.0982)	Yellow	
	LWR	2.495 - 2.498 (0.0982 - 0.0983)	Blue	
45	UPR	2.495 - 2.498 (0.0982 - 0.0983)	Blue	
	LWR	2.498 - 2.501 (0.0983 - 0.0985)	Pink	
56	UPR	2.498 - 2.501 (0.0983 - 0.0985)	Pink	
	LWR	2.501 - 2.504 (0.0985 - 0.0986)	Purple	
67	UPR	2.501 - 2.504 (0.0985 - 0.0986)	Purple	
	LWR	2.504 - 2.507 (0.0986 - 0.0987)	White	
78	UPR	2.504 - 2.507 (0.0986 - 0.0987)	White	
	LWR	2.507 - 2.510 (0.0987 - 0.0988)	Red	

### Undersize

Unit: mm (in)

Undersize	Thickness	Main journal diameter
0.25 (0.0098)	2.618 - 2.626 (0.1031 - 0.1034)	Grind so that bearing clearance is the specified value.

### Bearing Oil Clearance

Unit: mm (in)

Main bearing oil clearance	Standard	No.1 and 5	0.001 - 0.011 (0.00004 - 0.0004)
		No.2, 3 and 4	0.007 - 0.017 (0.0003 - 0.0007)
	Limit	No.1 and 5	0.021 (0.0008)
		No.2, 3 and 4	0.027 (0.0011)

### CONNECTING ROD BEARING

Grade number	Thickness "T" mm (in)	Identification color (mark)
0	1.500 - 1.503 (0.0591 - 0.0592)	No color
1	1.503 - 1.506 (0.0592 - 0.0593)	Brown
2	1.506 - 1.509 (0.0593 - 0.0594)	Green

### Undersize

Unit: mm (in)

Undersize	Thickness	Crankshaft pin journal diameter "Dp"
0.25 (0.0098)	1.626 - 1.634 (0.0640 - 0.0643)	Grind so that bearing clearance is the specified value.

### Bearing Oil Clearance

Unit: mm (in)

Connecting rod bearing oil clearance	Standard	0.020 - 0.045 (0.0008 - 0.0018)
	Limit	0.055 (0.0022)