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# SECTION **EM**

## ENGINE MECHANICAL

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# PRECAUTIONS

## PRECAUTIONS

PPF:00001

### Precautions for Drain Engine Coolant

ABS00A7M

Drain engine coolant when engine is cooled.

### Precautions for Disconnecting Fuel Piping

ABS00A7N

- 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

ABS00A7O

- When instructed to use SST, use 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 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 in the step.

### Precautions for Inspection, Repair and Replacement

ABS00A7P

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

### Precautions for Assembly and Installation

ABS00A7Q

- 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 gasket, packing, oil seal or O-ring.
- 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, oil sliding surfaces well.
- Release air within route when refilling after draining engine coolant.
- After repairing, start engine and increase engine speed to check engine coolant, fuel, engine oil, and exhaust gases for leakage.

### Parts Requiring Angle Tightening

ABS00A7R

- Use 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 bolts
  - Crankshaft pulley bolt (No angle wrench is required as 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

ABS00A7S

## Precautions for Liquid Gasket REMOVAL OF LIQUID GASKET SEALING

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

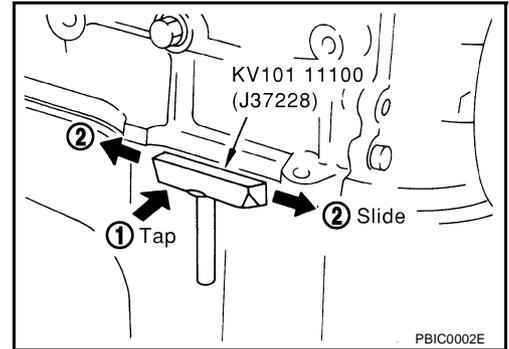
### CAUTION:

**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.

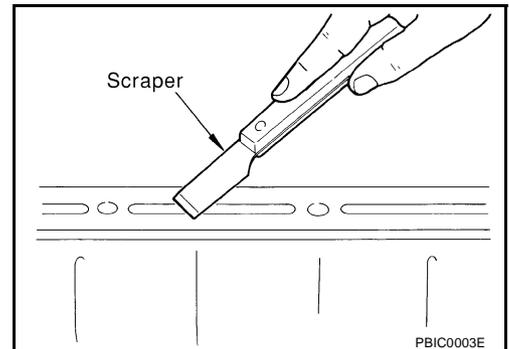
### CAUTION:

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



## LIQUID GASKET APPLICATION PROCEDURE

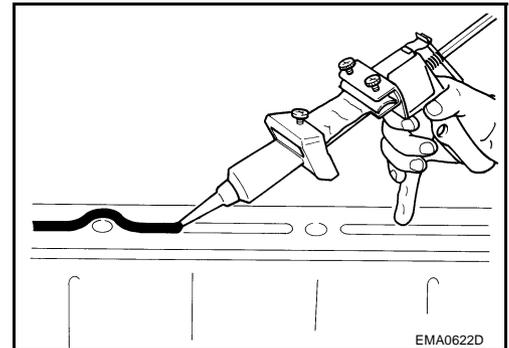
1. Using scraper, remove old liquid gasket adhering to the gasket application surface and the mating surface.
  - Remove liquid gasket completely from the groove of the gasket application surface, mounting bolts, and bolt holes.
2. Wipe the liquid gasket application surface and the mating surface with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



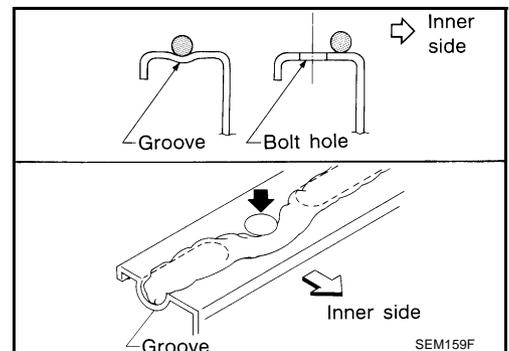
3. Attach liquid gasket tube to tube presser [SST: WS39930000 ( — )].

**Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-47. "RECOMMENDED CHEMICAL PRODUCTS AND SEALANTS"](#).**

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



- As for bolt holes, normally apply 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 liquid gasket protrudes, wipe it off immediately.
- Do not retighten mounting bolts or nuts after the installation.
- After 30 minutes or more have passed from the installation, fill engine oil and engine coolant.



### CAUTION:

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

# PREPARATION

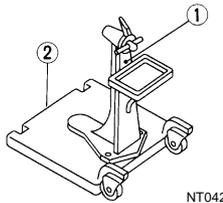
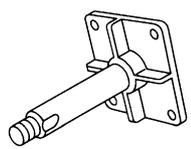
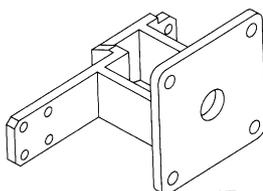
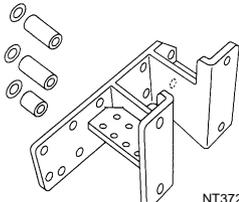
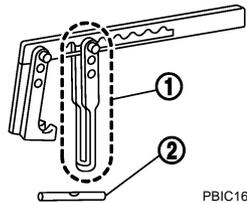
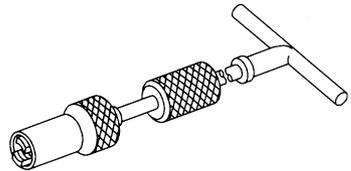
## PREPARATION

PPF:00002

### Special Service Tools

ABS00A7T

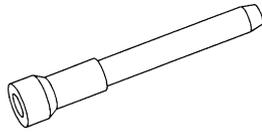
The actual shapes of Kent-Moore tools may differ from those of special service tools illustrated here.

Tool number (Kent-Moore No.) Tool name	Description
ST0501S000 ( — ) Engine stand assembly 1. ST05011000 ( — ) Engine stand 2. ST05012000 ( — ) Base	Disassembling and assembling engine  NT042
KV10106500 ( — ) Engine stand shaft	 NT028
KV10117000 (J41262) Engine sub-attachment	KV10117000 has been replaced with KV10117001 (KV10117000 is no longer in production, but it is usable).  NT373
KV10117001 ( — ) Engine sub-attachment	Installing on cylinder block  NT372
KV10116200 (J26336-A) Valve spring compressor 1. KV10115900 (J26336-20) Attachment 2. KV10109220 ( — ) Adapter	Disassembling valve mechanism Part (1) is a component of KV10116200 (J26336-A), but Part (2) is not so.  PBIC1650E
KV10107902 (J38959) Valve oil seal puller	Replacing valve oil seal  NT011

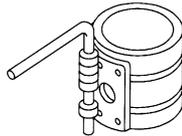
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# PREPARATION

Tool number (Kent-Moore No.) Tool name	Description
— (J39386) Valve oil seal drift	Installing valve oil seal
EM03470000 (J8037) Piston ring compressor	Installing piston assembly into cylinder bore
ST16610001 (J23907) Pilot bushing puller	Removing pilot converter
KV10111100 (J37228) Seal cutter	Removing oil pan (lower and upper), front and rear timing chain case, etc.
WS39930000 ( — ) Tube presser	Pressing the tube of liquid gasket
KV10112100 (BT8653-A) Angle wrench	Tightening bolts for bearing cap, cylinder head, etc. in angle
KV10117100 (J3647-A) Heated oxygen sensor wrench	Loosening or tightening air fuel ratio sensor 1 <b>For 22 mm (0.87 in) width hexagon nut</b>



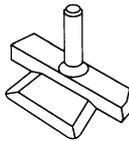
NT024



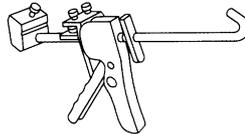
NT044



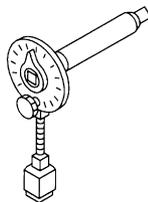
NT045



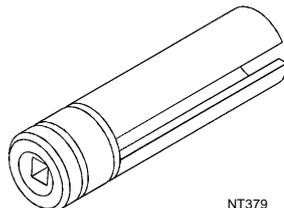
NT046



NT052

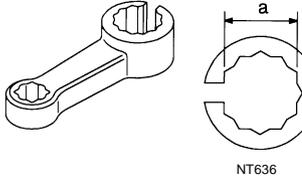
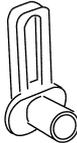
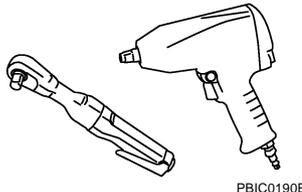
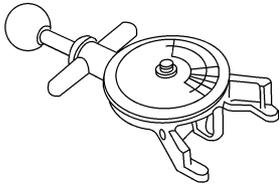
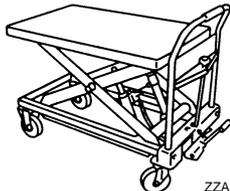
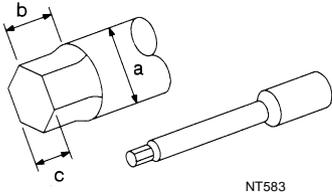


NT014

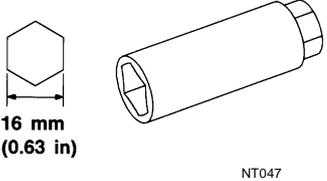
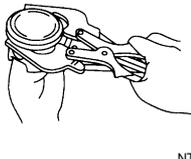
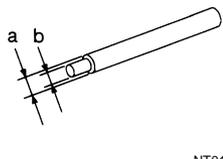
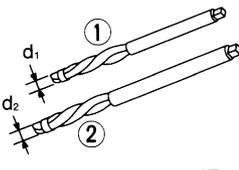
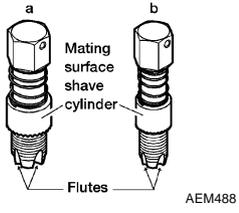


NT379

# PREPARATION

Tool number (Kent-Moore No.) Tool name	Description	A
KV10114400 (J38365) Heated oxygen sensor wrench <div data-bbox="604 308 906 485" style="text-align: center;">  <p>NT636</p> </div>	Loosening or tightening heated oxygen sensor 2 <b>a: 22 mm (0.87 in)</b>	EM
— (J-45488) Quick connector release <div data-bbox="730 540 807 683" style="text-align: center;">  <p>PBIC0198E</p> </div>	Removing fuel tube quick connectors in engine room	C D E
<b>Commercial Service Tools</b> <span style="float: right;">ABS00A7U</span>		
(Kent-Moore No.) Tool name	Description	F G
( — ) Power tool <div data-bbox="604 910 906 1102" style="text-align: center;">  <p>PBIC0190E</p> </div>	Loosening bolts and nuts	H I
(BT3373-F) Belt tension gauge <div data-bbox="595 1134 874 1321" style="text-align: center;">  <p>AMA126</p> </div>	Checking drive belt tension	J K
( — ) Manual lift table caddy <div data-bbox="636 1385 866 1576" style="text-align: center;">  <p>ZZA1210D</p> </div>	Removing and installing engine	L M
(J24239-01) Cylinder head bolt wrench <div data-bbox="595 1623 927 1815" style="text-align: center;">  <p>NT583</p> </div>	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)	

# PREPARATION

(Kent-Moore No.) Tool name	Description
( — ) Spark plug wrench 	Removing and installing spark plug NT047
( — ) Valve seat cutter set 	Finishing valve seat dimensions NT048
( — ) Piston ring expander 	Removing and installing piston ring NT030
( — ) Valve guide drift 	Removing and installing valve guide <b>Intake and Exhaust:</b> <b>a: 9.5 mm (0.374 in) dia.</b> <b>b: 5.5 mm (0.217 in) dia.</b> NT015
( — ) Valve guide reamer 	(1): Reaming valve guide inner hole (2): Reaming hole for oversize valve guide <b>Intake and Exhaust:</b> <b>d1 : 6.0 mm (0.236 in) dia.</b> <b>d2 : 10.2 mm (0.402 in) dia.</b> NT016
(J-43897-18) (J-43897-12) Oxygen sensor thread cleaner 	Reconditioning the exhaust system threads before installing a new heated oxygen sensor (Use with anti-seize lubricant shown below.) <b>a: J-43897-18 [18 mm (0.71 in) dia.] for zirconia heated oxygen sensor</b> <b>b: J-43897-12 [12 mm (0.47 in) dia.] for titania heated oxygen sensor</b> AEM488
( — ) Anti-seize lubricant (Permatex 133AR or equivalent meeting MIL specification MIL-A-907) 	Lubricating oxygen sensor thread cleaning tool when reconditioning exhaust system threads AEM489



# NOISE, VIBRATION AND HARSHNESS (NVH) TROUBLESHOOTING

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

ABS00A7V

1. Locate the area where noise occurs.
2. Confirm the type of noise.
3. Specify the operating condition of engine.
4. Check specified noise source.  
If necessary, repair or replace these parts.

Location of noise	Type of noise	Operating condition of engine						Source of noise	Check item	Reference page
		Before warm-up	After warm-up	When starting	When idling	When racing	While driving			
Top of engine Rocker cover Cylinder head	Ticking or clicking	C	A	—	A	B	—	Tappet noise	Valve clearance	<a href="#">EM-85</a>
	Rattle	C	A	—	A	B	C	Camshaft bearing noise	Camshaft runout Camshaft journal oil clearance	<a href="#">EM-79</a> <a href="#">EM-79</a>
Crankshaft pulley Cylinder block (Side of engine) Oil pan	Slap or knock	—	A	—	B	B	—	Piston pin noise	Piston to piston pin oil clearance Connecting rod bushing oil clearance	<a href="#">EM-127</a> <a href="#">EM-129</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-131</a> <a href="#">EM-128</a> <a href="#">EM-128</a> <a href="#">EM-129</a>
	Knock	A	B	C	B	B	B	Connecting rod bearing noise	Connecting rod bushing oil clearance Connecting rod bearing oil clearance	<a href="#">EM-129</a> <a href="#">EM-133</a>
	Knock	A	B	—	A	B	C	Main bearing noise	Main bearing oil clearance Crankshaft runout	<a href="#">EM-134</a> <a href="#">EM-133</a>
Front of engine Timing chain case	Tapping or ticking	A	A	—	B	B	B	Timing chain and chain tensioner noise	Timing chain cracks and wear Timing chain tensioner operation	<a href="#">EM-65</a> <a href="#">EM-58</a>
Front of engine	Squeaking or fizzing	A	B	—	B	—	C	Drive belts (Sticking or slipping)	Drive belts deflection	<a href="#">EM-11</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-22</a> <a href="#">"WATER PUMP"</a>

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

# DRIVE BELTS

## DRIVE BELTS

PF02117

### Checking Drive Belts

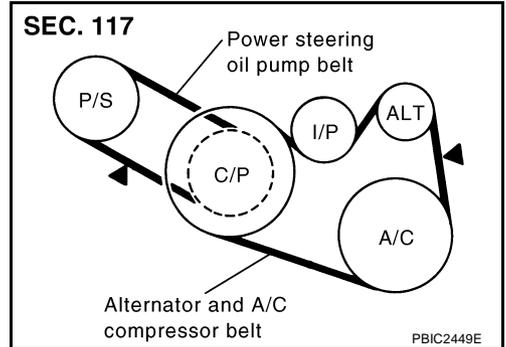
ABS00329

#### WARNING:

Be sure to perform when the engine is stopped.

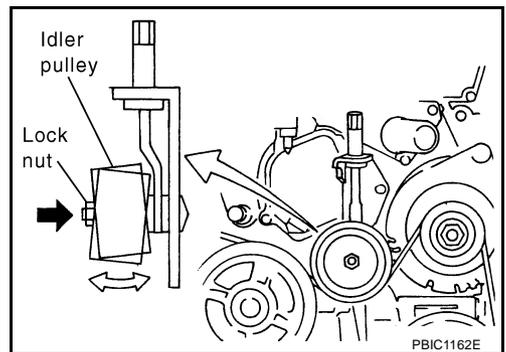
1. Inspect belts for cracks, fraying, wear and oil. If necessary, replace.
2. Inspect drive belt deflection or tension at a point on belt midway between pulleys.

- Inspection should be done only when engine is cold, or over 30 minutes after engine is stopped.
- Measure belt tension with tension gauge (BT3373-F or equivalent) at points marked ▼ shown in the figure.
- When measuring deflection, apply 98 N (10 kg, 22 lb) at the ▼ marked point.
- Adjust if belt deflection exceeds the limit or if belt tension is not within specifications.



#### CAUTION:

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



### Belt Deflection and Tension

	Deflection adjustment		Unit: mm (in)	Tension adjustment*		Unit: mm (in)
	Used belt		New belt	Used belt		New belt
	Limit	After adjustment		Limit	After adjustment	
Alternator and A/C compressor	7 (0.28)	4.2 - 4.6 (0.17 - 0.18)	3.7 - 4.1 (0.15 - 0.16)	294 (30, 66)	730 - 818 (74.5 - 83.5, 164 - 184)	838 - 926 (85.5 - 94.5, 188 - 208)
Power steering oil pump	11 (0.43)	7.3 - 8 (0.29 - 0.30)	6.5 - 7.2 (0.26 - 0.28)	196 (20, 44)	495 - 583 (50.5 - 59.5, 111 - 131)	603 - 691 (61.5 - 70.5, 135.6 - 155.4)
Applied pushing force	98 N (10 Kg, 22 lb)			—		

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

### Tension Adjustment

ABS0036V

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

#### CAUTION:

- When belt is replaced with a new one, adjust it to value for "New belt" to accommodate for insufficient adaptability with pulley grooves.

# DRIVE BELTS

- When deflection or tension of belt being used exceeds “Limit”, adjust it to value for “After adjustment”.
- When checking belt deflection or tension immediately after installation, first adjust it to the specified value. Then, after turning the crankshaft two turns or more, re-adjust to the specified value to avoid variation in deflection between pulleys.
- When installing belt, make sure that it is correctly engaged with pulley groove.
- Keep engine oil, working fluid and engine coolant away from belt.
- Do not twist or bend belt excessively.

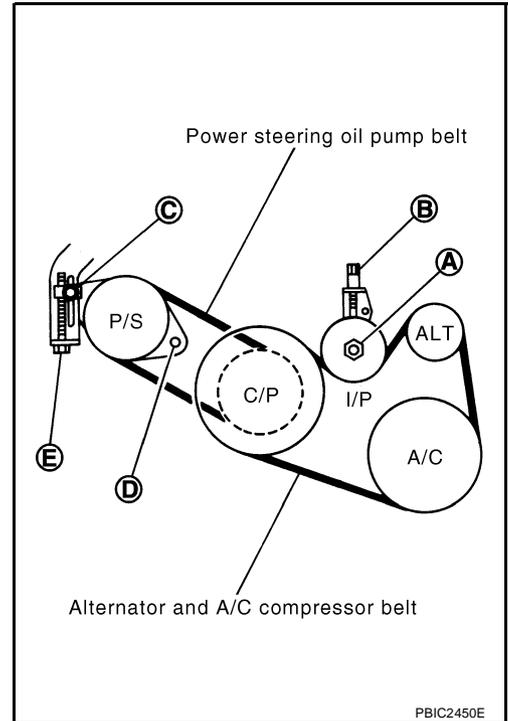
## ALTERNATOR AND A/C COMPRESSOR BELT

1. Remove splash guard (RH).
2. Loosen idler pulley lock nut (A) and adjust tension by turning adjusting nut (B).
  - For specified belt tension, refer to [EM-11, "Checking Drive Belts"](#).
3. Tighten lock nut (A).

 : 34.8 N·m (3.5 kg-m, 26 ft-lb)

4. Tighten adjusting nut (B).

 : 5.4 N·m (0.55 kg-m, 48 in-lb)



## POWER STEERING OIL PUMP BELT

1. Remove splash guard (RH).
2. Loosen lock bolt (C).
3. Loosen power steering oil pump mounting bolt (D).
  - Bolt head (D) is engine rear side.
4. Adjust tension by turning adjusting bolt (E).
  - For specified belt tension, refer to [EM-11, "Checking Drive Belts"](#).

### NOTE:

Adjusting bolt (E) is loosened with counterclockwise rotation.

5. Tighten lock bolt (C).

 : 28.0 N·m (2.9 kg-m, 21 ft-lb)

6. Tighten power steering oil pump mounting bolt (D).

 : 43.2 N·m (4.4 kg-m, 32 ft-lb)

## Removal and Installation

### REMOVAL

1. Remove splash guard (RH).
2. Fully loosen each belt by following the guidelines in [EM-11, "Tension Adjustment"](#). Remove alternator and A/C compressor belt and then power steering oil pump belt.

ABS0036W

# DRIVE BELTS

---

**CAUTION:**

Grease is applied to idler pulley adjusting bolt. Be careful to keep grease away from belt.

A

**INSTALLATION**

1. Install each belt to pulley in the reverse order of removal.

**CAUTION:**

- Make sure belt is correctly engaged with the pulley groove.
- Make sure that for engine oil, working fluid and engine coolant do not adhere to belt and each pulley groove.

EM

2. Adjust belt tension. Refer to [EM-11, "Tension Adjustment"](#) .
3. Tighten each nuts and bolts to the specified torque.
4. Make sure that tension of each belt is within the standard. Refer to [EM-11, "Checking Drive Belts"](#) .

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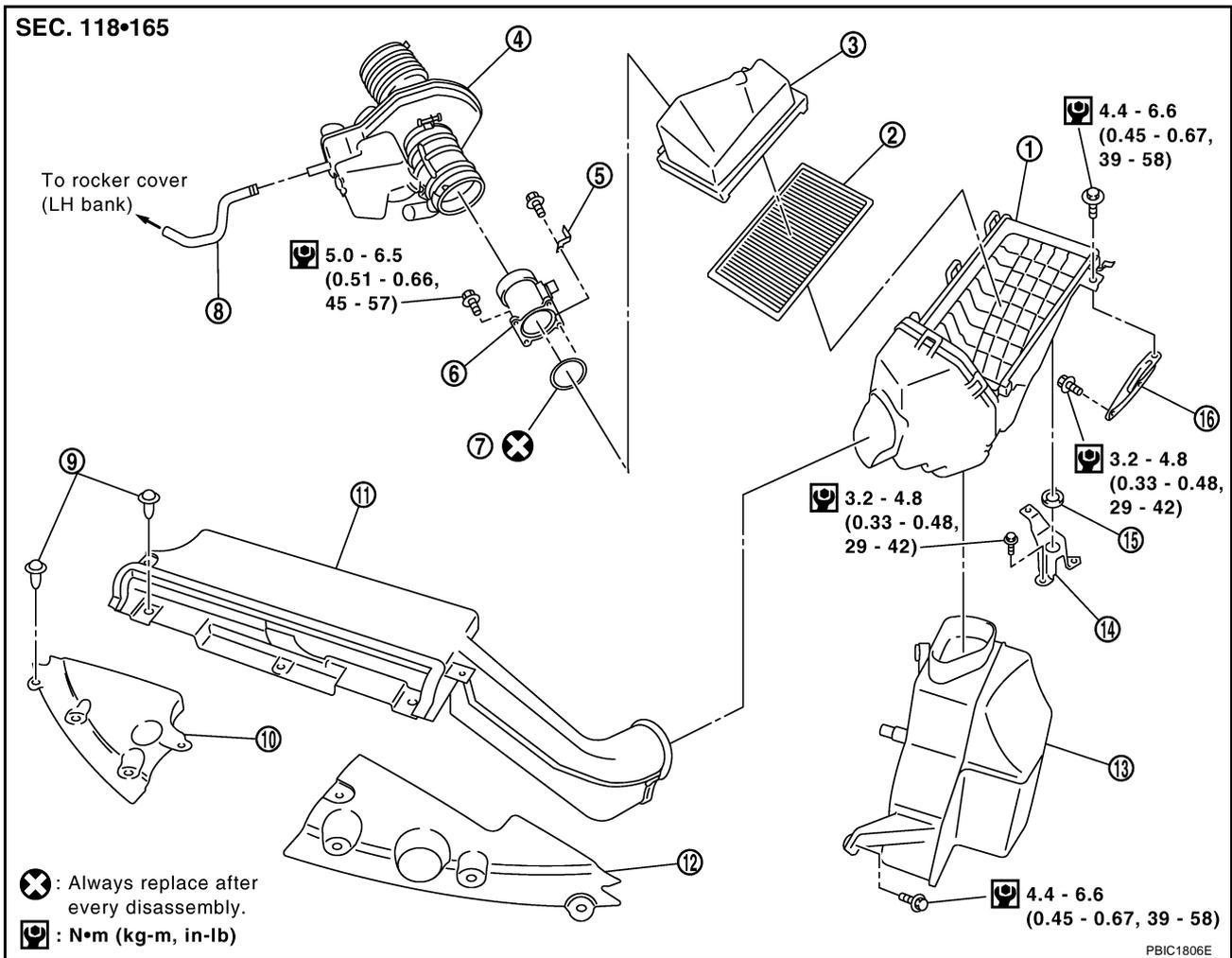
# AIR CLEANER AND AIR DUCT

PFP:16500

ABS0033C

## AIR CLEANER AND AIR DUCT

### Removal and Installation



- |                                       |                       |                                      |
|---------------------------------------|-----------------------|--------------------------------------|
| 1. Air cleaner case (lower)           | 2. Air cleaner filter | 3. Air cleaner case (upper)          |
| 4. Air duct assembly                  | 5. Harness bracket    | 6. Mass air flow sensor              |
| 7. O-ring                             | 8. PCV hose           | 9. Clip                              |
| 10. Radiator cover grill (right side) | 11. Air duct (inlet)  | 12. Radiator cover grill (left side) |
| 13. Resonator                         | 14. Bracket           | 15. Grommet                          |
| 16. Bracket                           |                       |                                      |

### REMOVAL

- Remove radiator cover grills (right and left side).
- Remove air duct (inlet).
- Disconnect harness connector from mass air flow sensor.
- Disconnect PCV hose.
- Remove air cleaner cases (upper and lower) with mass air flow sensor and air duct assembly disconnecting their joints.
  - Add mating marks as necessary for easier installation.
- Remove mass air flow sensor from air cleaner case (upper), as necessary.

### CAUTION:

Handle mass air flow sensor with following cares.

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

# AIR CLEANER AND AIR DUCT

7. Remove resonator, removing left side fender protector (front), as necessary.

## INSPECTION AFTER REMOVAL

Inspect air duct assembly for crack or tear.

- If anything found, replace air duct assembly.

## INSTALLATION

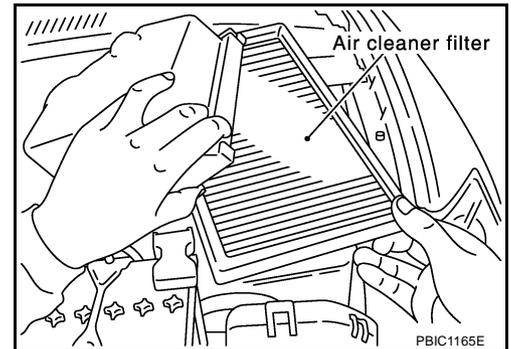
Note the following, and install in the reverse order of removal.

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

## Changing Air Cleaner Filter

### REMOVAL

1. Unhook air cleaner case (lower) side clips and lift up air cleaner case (upper).
2. Remove air cleaner filter.



## INSTALLATION

Install in the reverse order of removal.

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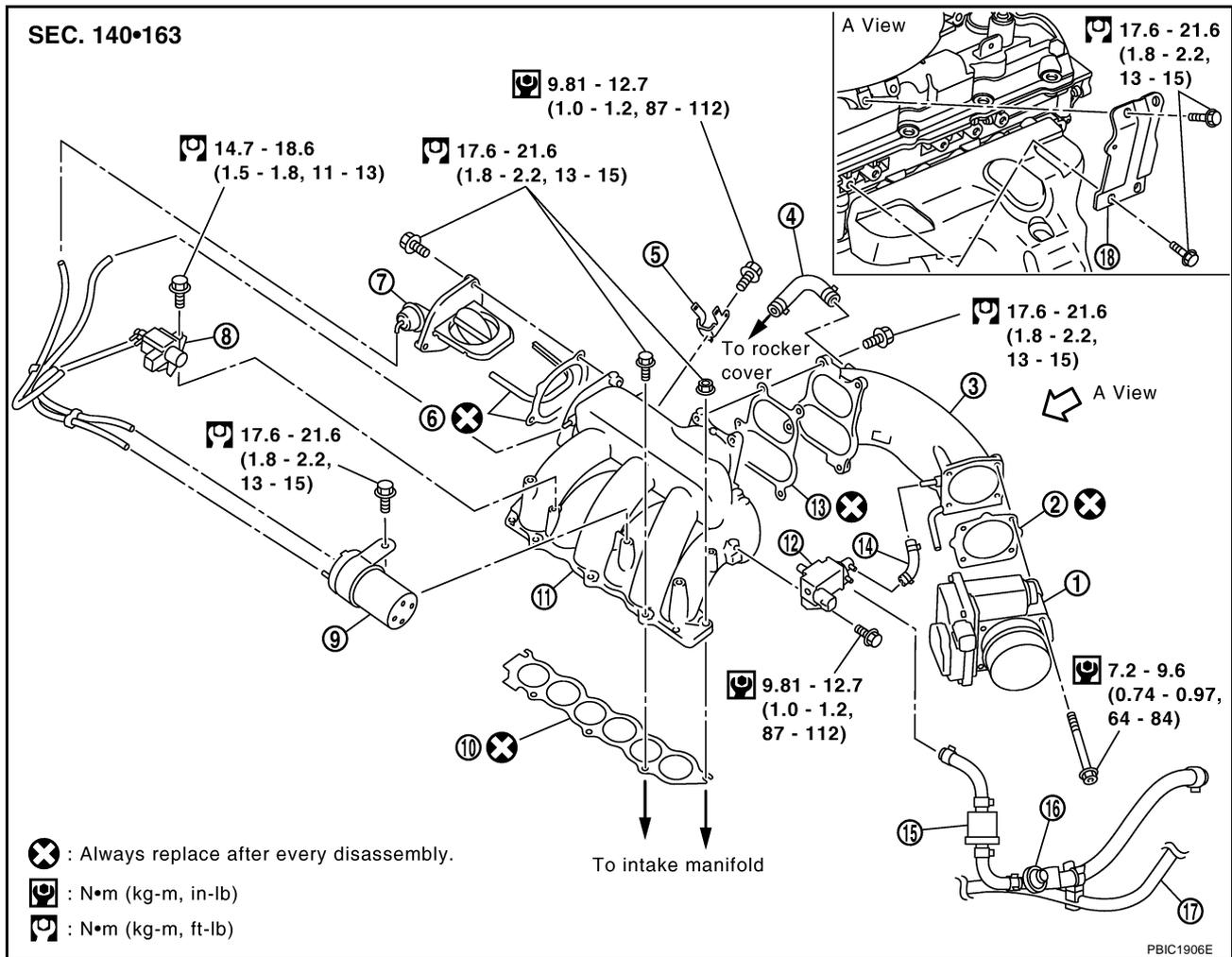
# INTAKE MANIFOLD COLLECTOR

## INTAKE MANIFOLD COLLECTOR

PFP:14003

### Removal and Installation

ABS00FPR



# INTAKE MANIFOLD COLLECTOR

## REMOVAL

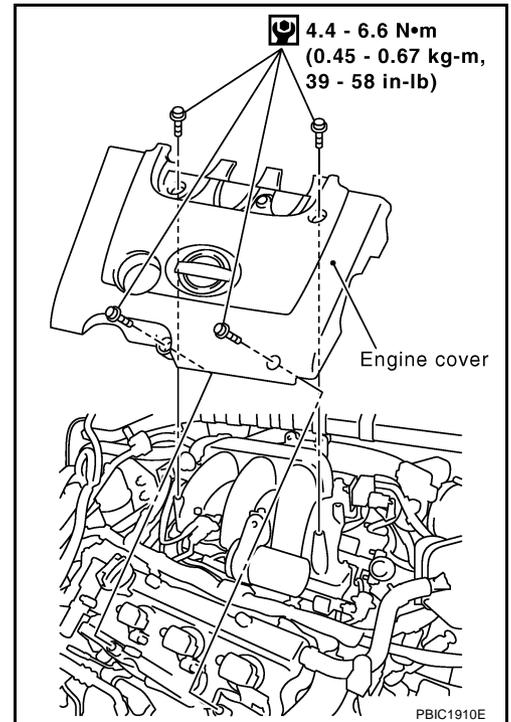
### WARNING:

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

1. Remove engine cover.

### CAUTION:

Be careful not to damage or scratch engine cover.



2. Remove air cleaner case (upper) with mass air flow sensor and air duct assembly. Refer to [EM-14, "AIR CLEANER AND AIR DUCT"](#).
3. Drain engine coolant, or when water hoses are disconnected, attach plug to prevent engine coolant leakage. Refer to [CO-9, "Changing Engine Coolant"](#).

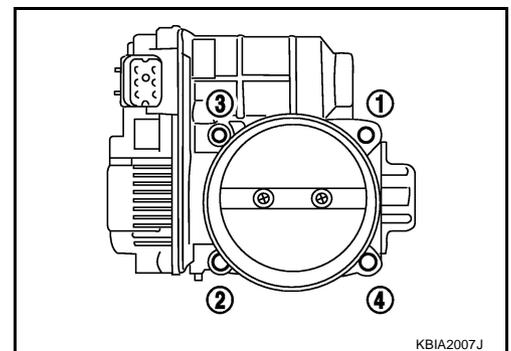
### CAUTION:

Perform when engine is cold.

4. Remove electric throttle control actuator as follows:
  - a. Disconnect harness connector.
  - b. Loosen mounting bolts in reverse order as shown in the figure.

### CAUTION:

- Handle carefully to avoid any shock to electric throttle control actuator.
- Do not disassemble.



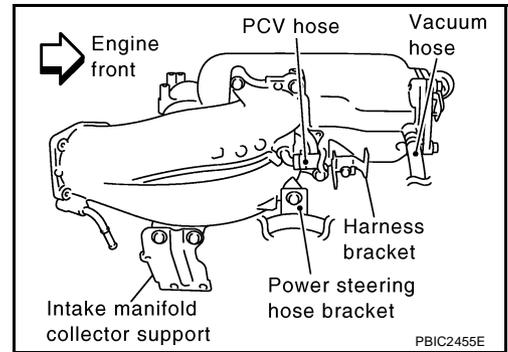
5. Disconnect water hoses from intake manifold collector (upper).
  - When engine coolant is not drained from radiator, attach plug to water hoses to prevent engine coolant leakage.

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# INTAKE MANIFOLD COLLECTOR

6. Remove the following parts:

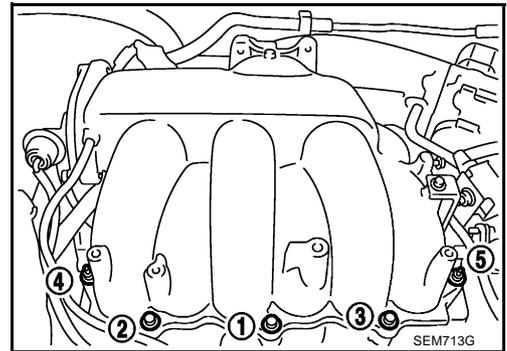
- Vacuum hose
- PCV hose
- Power steering hose bracket
- Intake manifold collector support
- Harness bracket



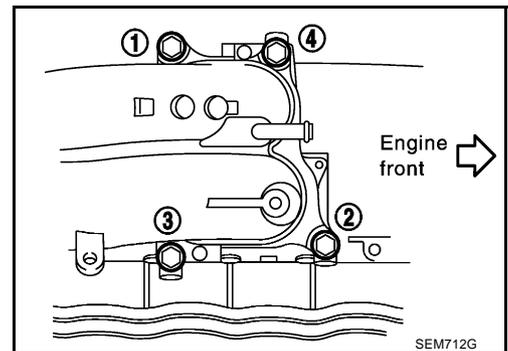
7. Disconnect EVAP hoses and harness connector from EVAP canister purge volume control solenoid valve.
8. Remove EVAP canister purge volume control solenoid valve.
9. Remove VIAS control solenoid valve and vacuum tank.
- Add mating marks as necessary for easier installation.
10. Loosen mounting nuts and bolts in reverse order as shown in the figure with power tool, and remove intake manifold collector (upper and lower) assembly and gasket.

**CAUTION:**

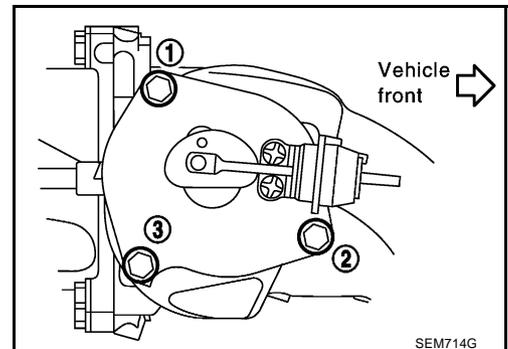
**Cover engine openings to avoid entry of foreign materials.**



11. Loosen mounting bolts in reverse order as shown in the figure to remove intake manifold collector (upper) from intake manifold collector (lower) with power tool.



12. Loosen mounting bolts in reverse order as shown in the figure to remove power valve from intake manifold collector (lower).



# INTAKE MANIFOLD COLLECTOR

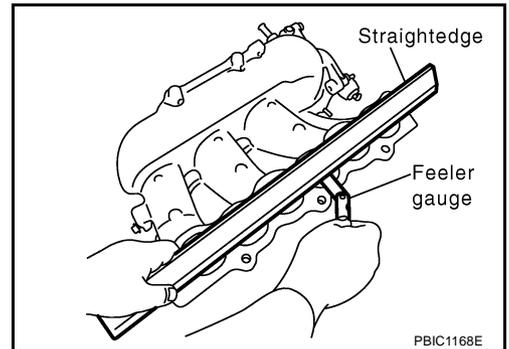
## INSPECTION AFTER REMOVAL

### Surface Distortion

- Check the surface distortion of intake manifold collector (lower) with straightedge and feeler gauge.

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

- If it exceeds the limit, replace intake manifold collector (lower).

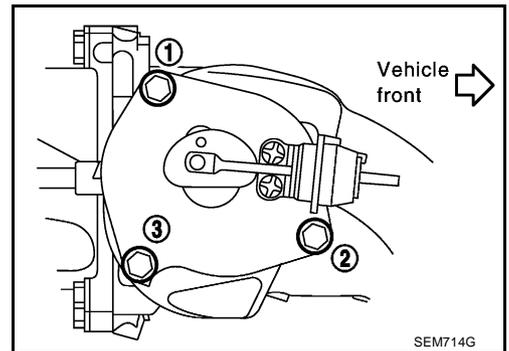


## INSTALLATION

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

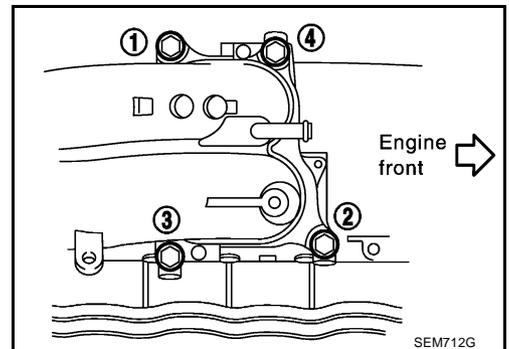
### Power Valve

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



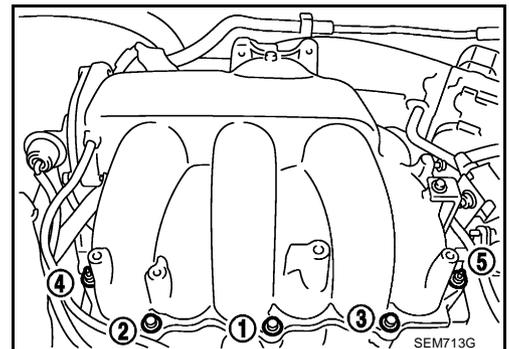
### Intake Manifold Collector (Upper)

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



### Intake Manifold Collector (Lower)

Tighten mounting nuts and bolts in numerical order as shown in the figure.



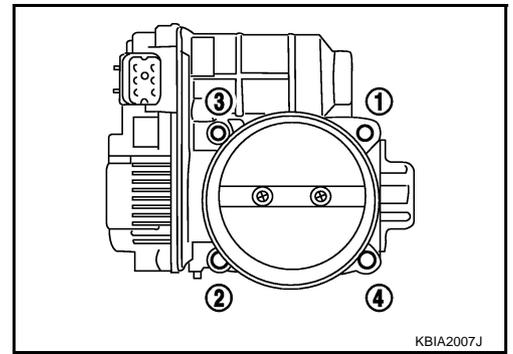
### Electric Throttle Control Actuator

- Install gasket with positioning no-protrusion surface upward or downward.

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## INTAKE MANIFOLD COLLECTOR

- Tighten mounting bolts in numerical order as shown in the figure.
- Perform the “Throttle Valve Closed Position Learning” when harness connector of electric throttle control actuator is disconnected. Refer to [EC-43, "Throttle Valve Closed Position Learning"](#).
- Perform the “Idle Air Volume Learning” and “Throttle Valve Closed Position Learning” when electric throttle control actuator is replaced. Refer to [EC-43, "Idle Air Volume Learning"](#).



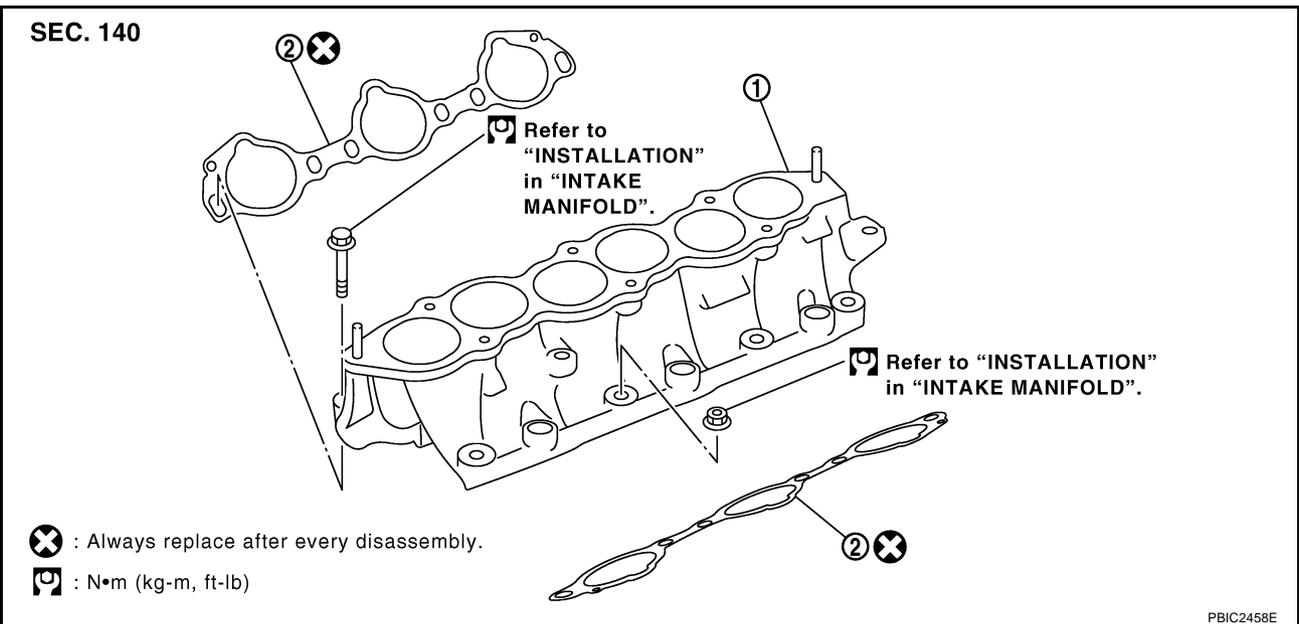
# INTAKE MANIFOLD

PFP:14003

## INTAKE MANIFOLD

### Removal and Installation

ABS0033D

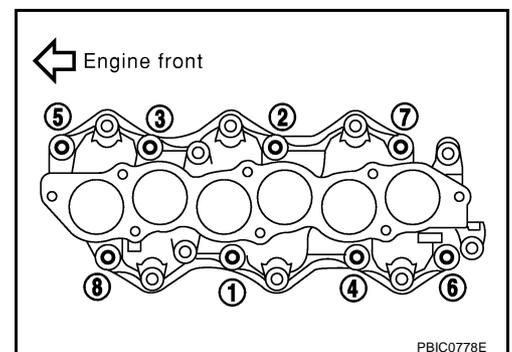


1. Intake manifold

2. Gasket

### REMOVAL

1. Release fuel pressure. Refer to [EC-45, "FUEL PRESSURE RELEASE"](#).
2. Remove intake manifold collectors (upper and lower). Refer to [EM-16, "INTAKE MANIFOLD COLLECTOR"](#).
3. Remove fuel tube and fuel injector assembly. Refer to [EM-40, "FUEL INJECTOR AND FUEL TUBE"](#).
4. Loosen mounting nuts and bolts in reverse order as shown in the figure to remove intake manifold with power tool.



5. Remove gaskets.

#### CAUTION:

Cover engine openings to avoid entry of foreign materials.

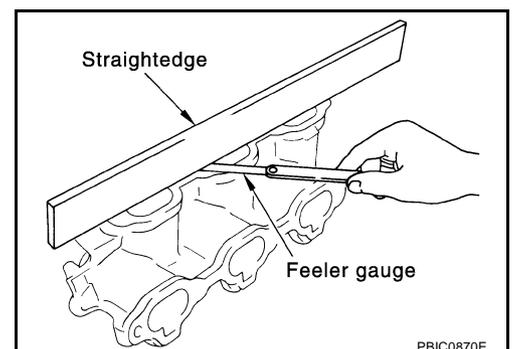
### INSPECTION AFTER REMOVAL

#### Surface Distortion

- Check the surface distortion of the intake manifold mating surfaces with straightedge and feeler gauge.

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

- If it exceeds the limit, replace intake manifold.



# INTAKE MANIFOLD

## INSTALLATION

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

### Intake Manifold

- If stud bolts were removed, install them and tighten to the specified torque below.

 : **9.8 - 11.8 N·m (1.0 - 1.2 kg·m, 87 - 104 in·lb)**

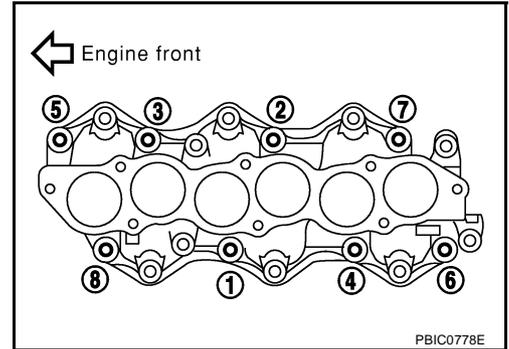
- Tighten all mounting nuts and bolts to the specified torque in two or more steps in numerical order shown in figure.

 **1st step**

: **4.9 - 9.8 N·m (0.5 - 1.0 kg·m, 4 - 7 ft·lb)**

 **2nd step and after**

: **26.5 - 31.4 N·m (2.7 - 3.2 kg·m, 20 - 23 ft·lb)**



# EXHAUST MANIFOLD AND THREE WAY CATALYST

PFP:14004

A

## EXHAUST MANIFOLD AND THREE WAY CATALYST

### Removal and Installation

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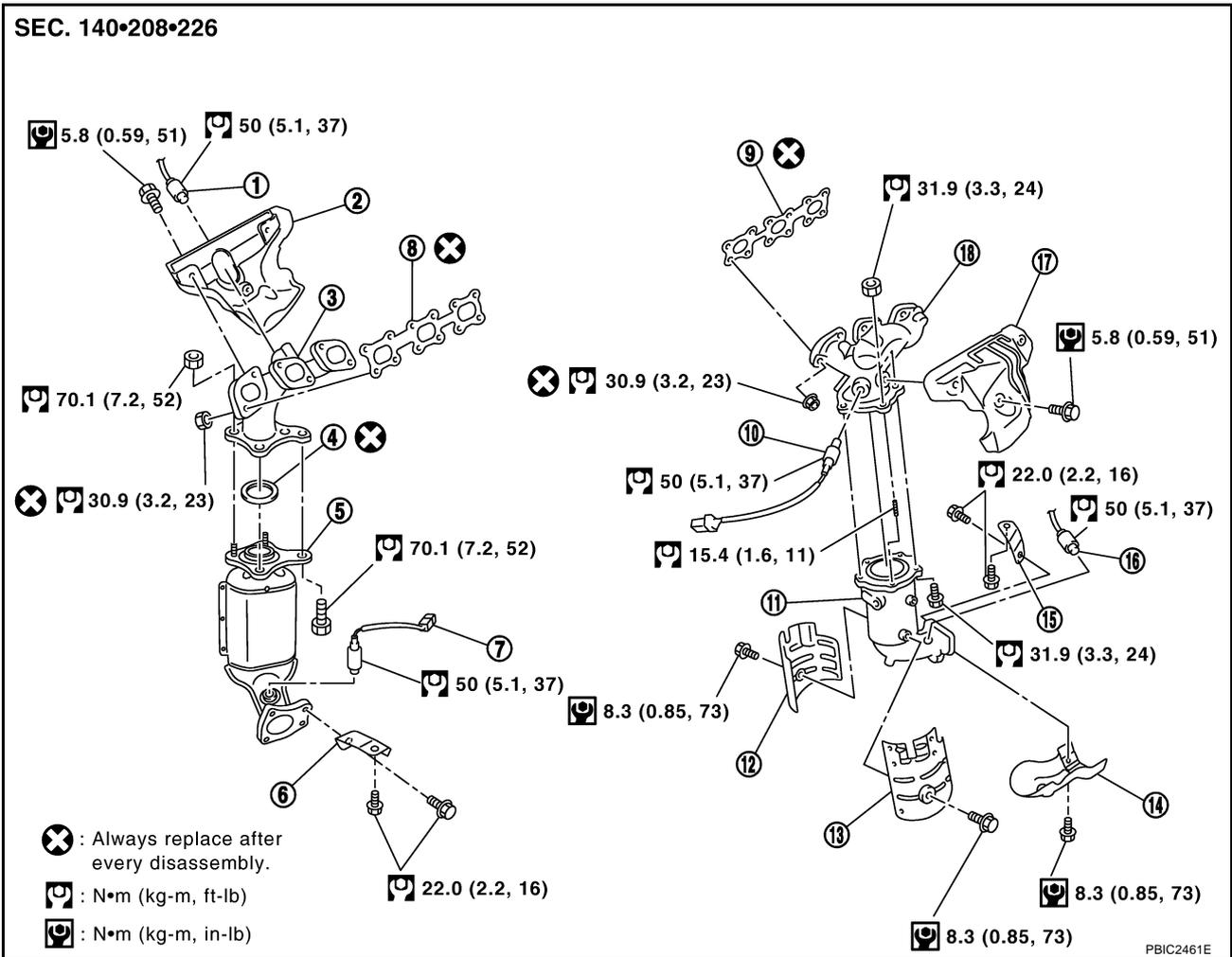
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- |                                      |  |  |
|--------------------------------------|--|--|
| 1. Air fuel ratio sensor 1 (bank 1)  | 2. Exhaust manifold cover (right bank) | 3. Exhaust manifold (right bank)           |
| 4. Ring gasket                       | 5. Three way catalyst (right bank)     | 6. Three way catalyst support (right bank) |
| 7. Heated oxygen sensor 2 (bank 1)   | 8. Gasket                              | 9. Gasket                                  |
| 10. Air fuel ratio sensor 1 (bank 2) | 11. Three way catalyst (left bank)     | 12. Three way catalyst cover               |
| 13. Three way catalyst cover         | 14. Three way catalyst cover           | 15. Three way catalyst support (left bank) |
| 16. Heated oxygen sensor 2 (bank 2)  | 17. Exhaust manifold cover (left bank) | 18. Exhaust manifold (left bank)           |

### REMOVAL

#### WARNING:

- Perform the work when the exhaust and cooling system have completely cooled down.
- When removing engine mounting through bolts and nuts, lift the engine up slightly for safety with transmission jack. Refer to [EM-105, "ENGINE ASSEMBLY"](#).

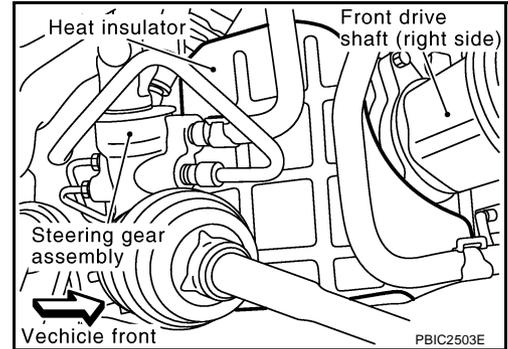
1. Drain engine coolant. Refer to [CO-9, "Changing Engine Coolant"](#).

#### CAUTION:

- Perform this step when engine is cold.
  - Do not spill engine coolant on drive belts.
2. Remove following parts:
    - Engine cover; Refer to [EM-16, "INTAKE MANIFOLD COLLECTOR"](#).
    - Radiator cover grilles, air duct (inlet), air cleaner cases (upper) with mass air flow sensor and air duct assembly; Refer to [EM-14, "AIR CLEANER AND AIR DUCT"](#).

# EXHAUST MANIFOLD AND THREE WAY CATALYST

- Undercover
  - Radiator and radiator cooling fan assembly; Refer to [CO-13, "RADIATOR"](#) .
3. Remove exhaust front tube mounting bracket and then remove exhaust front tube. Refer to [EX-3, "EXHAUST SYSTEM"](#) .
  4. Remove front wiper arm (RH) and cowl top cover (right) (when RH exhaust manifold and three way catalyst is removed). Refer to [WW-4, "FRONT WIPER AND WASHER SYSTEM"](#) and [EI-21, "COWL TOP"](#) .
  5. Remove heat insulator.



6. Support the transaxle bottom with jack. (AWD models) (when RH exhaust manifold and three way catalyst is removed)

**CAUTION:**

Put a piece of wood or something similar as the supporting surface, be careful not to damage transaxle.

7. Remove rear engine mounting insulator. (AWD models) Refer to [EM-105, "ENGINE ASSEMBLY"](#) .

8. Disconnect harness connector and remove air fuel ratio sensor 1 on both banks with heated oxygen sensor wrench [SST].

- Put marks to identify installation positions of each air fuel ratio sensor 1.

**CAUTION:**

- Be careful not to damage air fuel ratio sensor 1.
- Discard any air fuel ratio sensor 1 which has been dropped from a height of more than 0.5 m (19.7 in) onto a hard surface such as a concrete floor; replace with a new sensor.

**NOTE:**

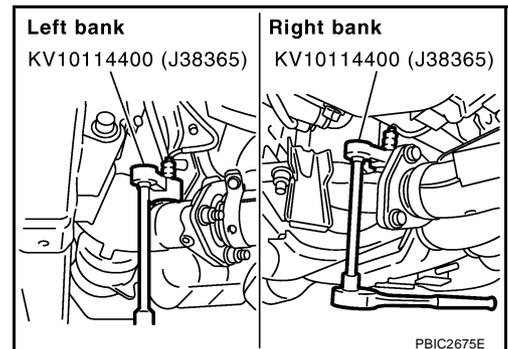
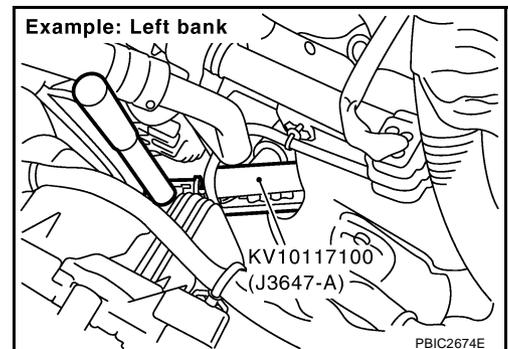
Figure is shown as an example of left bank.

9. Disconnect harness connector and remove heated oxygen sensor 2 on both banks with heated oxygen sensor wrench [SST].

- Put marks to identify installation positions of each heated oxygen sensor 2.

**CAUTION:**

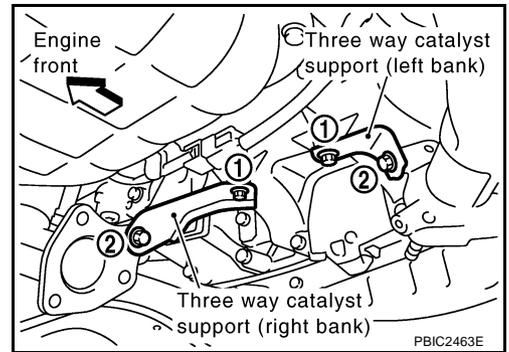
- Be careful not to damage heated oxygen sensor 2.
- Discard any heated oxygen sensor 2 which has been dropped from a height of more than 0.5 m (19.7 in) onto a hard surface such as a concrete floor; replace with a new sensor.



10. Remove exhaust manifold covers (right and left banks) and three way catalyst covers.

# EXHAUST MANIFOLD AND THREE WAY CATALYST

11. Remove mounting bolts in reverse order as shown in the figure to remove three way catalyst supports (right and left banks).

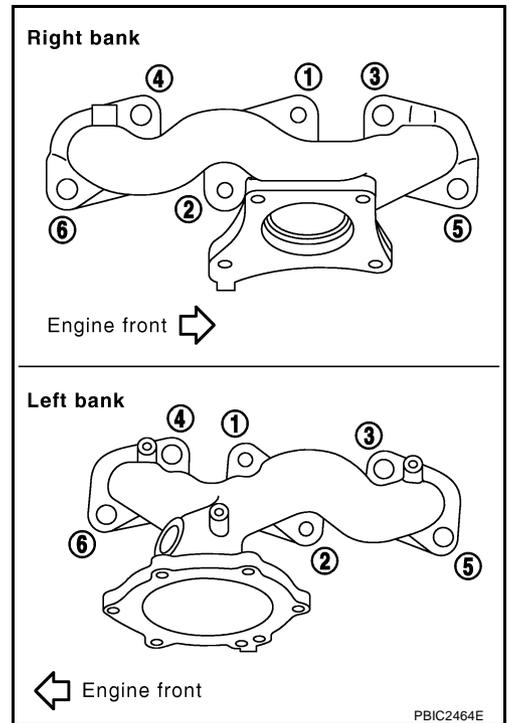


12. Remove three way catalysts (right and left banks) by loosening bolts first and then removing nuts.

**CAUTION:**

**Handle carefully to avoid any shock to three way catalyst.**

13. Loosen mounting nuts in reverse order as shown in the figure to remove exhaust manifolds (right and left banks).



14. Remove gaskets.

**CAUTION:**

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

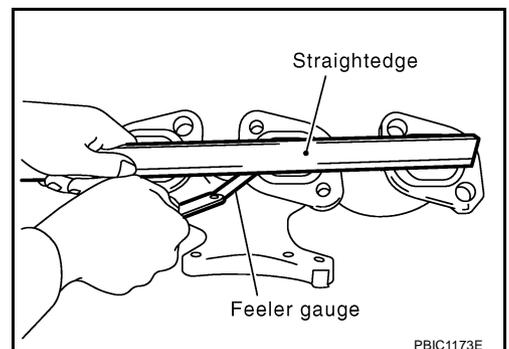
## INSPECTION AFTER REMOVAL

### Surface Distortion

- Check the surface distortion of the exhaust manifold mating surfaces with straightedge and feeler gauge.

**Limit : 0.3 mm (0.012 in)**

- If it exceeds the limit, replace exhaust manifold.



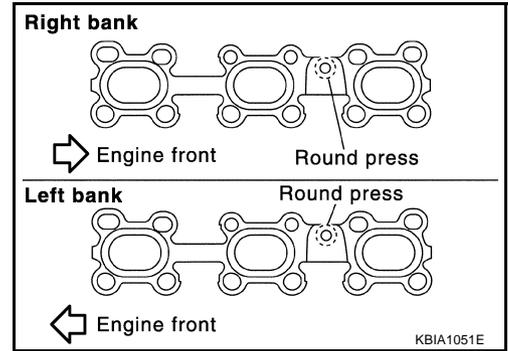
## INSTALLATION

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

# EXHAUST MANIFOLD AND THREE WAY CATALYST

## Exhaust Manifold Gasket

Install in the direction indicated in the figure.

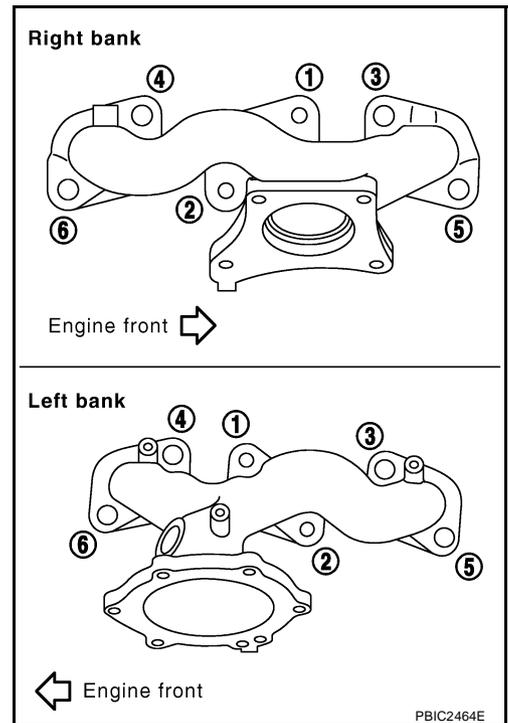


## Exhaust Manifold

- If stud bolts were removed, install them and tighten to the torque specified below.

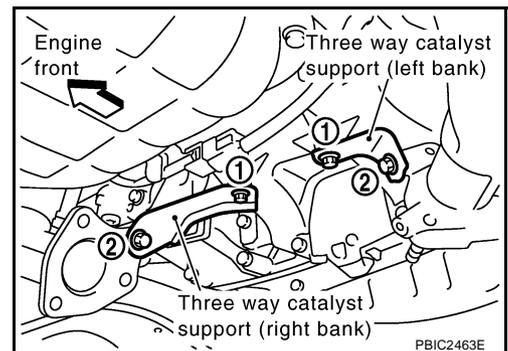
 : 14.2 - 16.6 N·m (1.5 - 1.6 kg·m, 11 - 12ft·lb)

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



## Three Way Catalyst Supports

1. Temporarily tighten three way catalyst support mounting bolts.
2. Tighten three way catalyst support mounting bolts to specified torque in numerical order as shown in the figure.



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

- Install air fuel ratio sensor 1 and heated oxygen sensor 2 in the original position.

## EXHAUST MANIFOLD AND THREE WAY CATALYST

- Install referring the following if the installation positions cannot be identified.

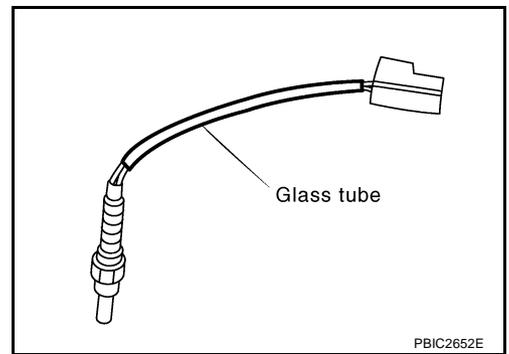
### Glass tube color

Air fuel ratio sensor 1 : Black

Heated oxygen sensor 2 : White

### CAUTION:

- Before installing a new heated oxygen sensor, clean exhaust system threads using oxygen sensor thread cleaner (commercial service tool: J-43897-18 or J43897-12) and apply anti-seize lubricant (commercial service tool).
- Do not over torque heated oxygen sensor. Doing so may cause damage to heated oxygen sensor, resulting in "MIL" coming on.



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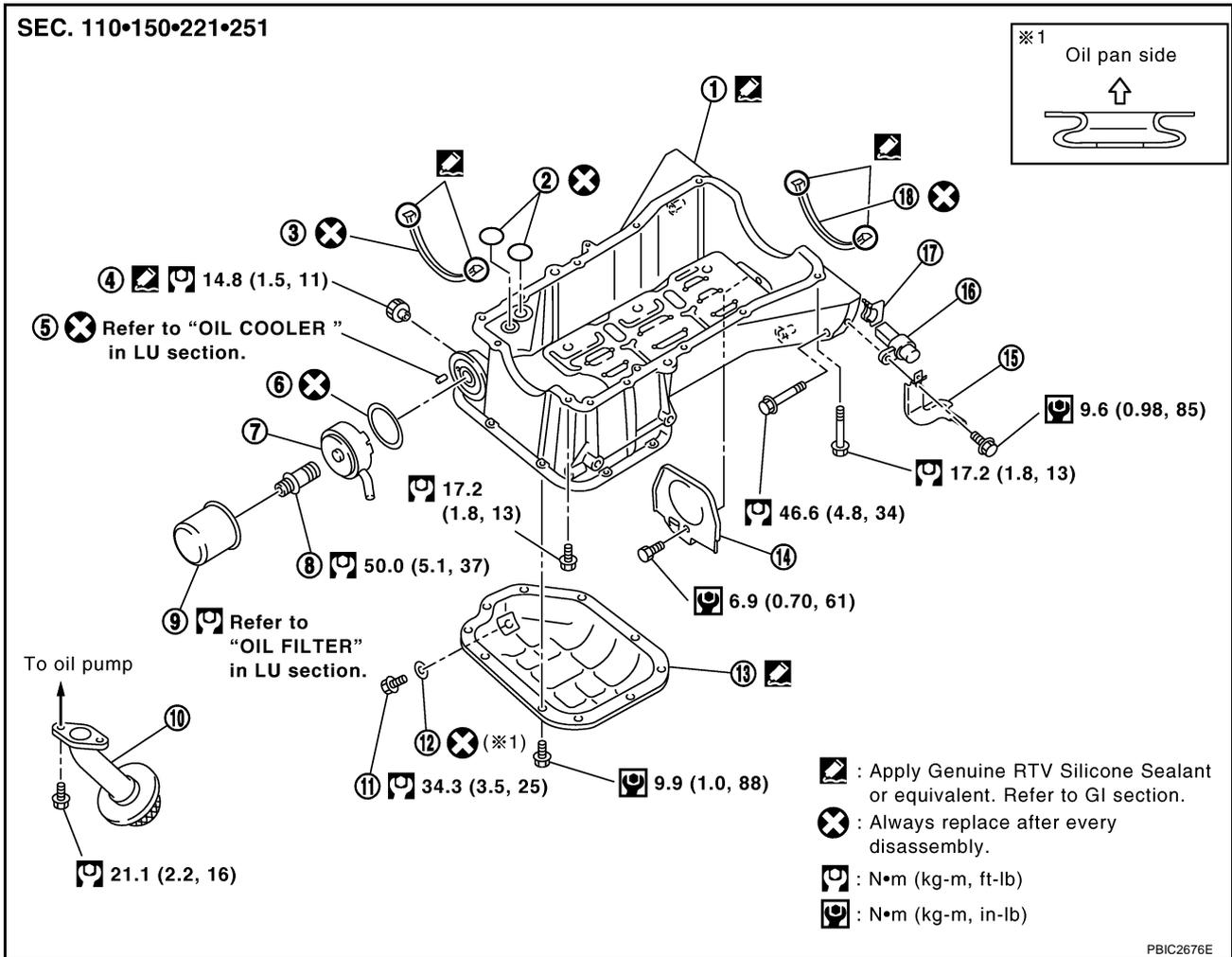
# OIL PAN AND OIL STRAINER

PF11110

## OIL PAN AND OIL STRAINER

### Removal and Installation

ABS00FPS



- |                                      |                      |                       |
|--------------------------------------|----------------------|-----------------------|
| 1. Oil pan (upper)                   | 2. O-ring            | 3. Oil pan gasket     |
| 4. Oil pressure switch               | 5. Relief valve      | 6. O-ring             |
| 7. Oil cooler                        | 8. Connector bolt    | 9. Oil filter         |
| 10. Oil strainer                     | 11. Drain plug       | 12. Drain plug washer |
| 13. Oil pan (lower)                  | 14. Rear plate cover | 15. Harness bracket   |
| 16. Crankshaft position sensor (POS) | 17. Seal rubber      | 18. Oil pan gasket    |

## REMOVAL

### 2WD Model

#### WARNING:

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

#### NOTE:

When removing oil pan (lower) or oil strainer only, take step 1 then step 10 and 11.

1. Drain engine oil. Refer to [LU-8, "Changing Engine Oil"](#).

#### CAUTION:

- Perform this step when engine is cold.
- Do not spill engine oil on drive belts.

2. Drain engine coolant. Refer to [CO-9, "Changing Engine Coolant"](#).

#### CAUTION:

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

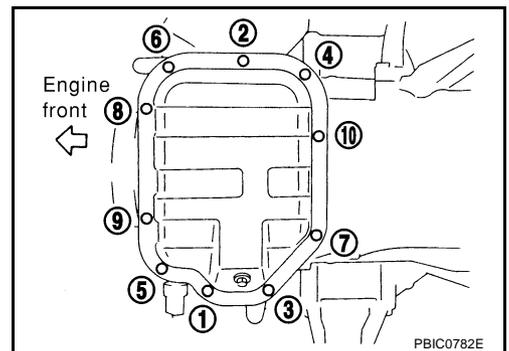
3. Remove following parts:

# OIL PAN AND OIL STRAINER

- Engine cover; Refer to [EM-16, "INTAKE MANIFOLD COLLECTOR"](#) .
  - Undercover
  - Splash guard (RH)
  - Exhaust front tube; Refer to [EX-3, "EXHAUST SYSTEM"](#) .
  - Drive belts; Refer to [EM-11, "DRIVE BELTS"](#) .
4. Remove A/C compressor with piping connected, and temporarily secure it to aside. Refer to [ATC-131, "Components"](#) .
  5. Remove three way catalysts (right and left banks) from exhaust manifolds (right and left banks). Refer to [EM-23, "EXHAUST MANIFOLD AND THREE WAY CATALYST"](#) .
  6. Remove oil pressure switch. Refer to [LU-7, "OIL PRESSURE CHECK"](#) .
  7. Remove crankshaft position sensor (POS).

**CAUTION:**

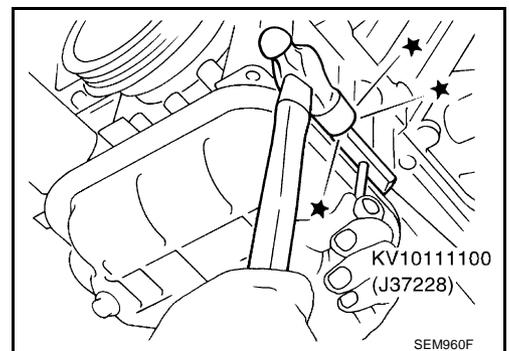
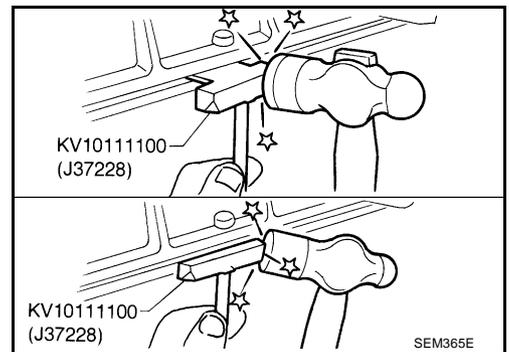
- Handle carefully to avoid dropping and shocks.
  - Do not disassemble.
  - Do not allow metal powder to adhere to magnetic part at sensor tip.
  - Do not place sensor in a location where it is exposed to magnetism.
8. Remove oil filter. Refer to [LU-9, "OIL FILTER"](#) .
  9. Remove oil cooler and water pipes. Refer to [LU-10, "OIL COOLER"](#) .
  10. Remove oil pan (lower) as follows:
    - a. Loosen mounting bolts in reverse order as shown in the figure.



- b. Insert seal cutter [SST] between oil pan (lower) and oil pan (upper).

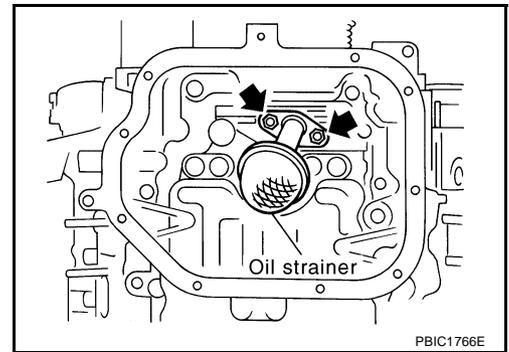
**CAUTION:**

- Be careful not to damage the mating surfaces.
  - Do not insert screwdriver, this will damage the mating surfaces.
- c. Slide seal cutter by tapping on the side of the tool with hammer. Remove oil pan (lower).



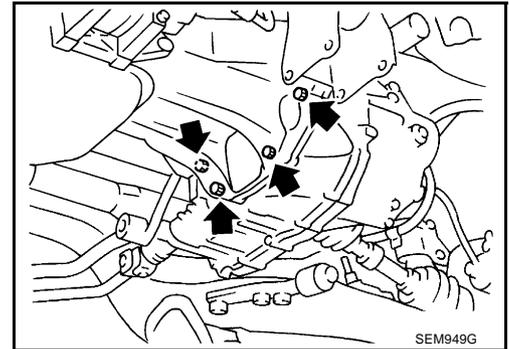
## OIL PAN AND OIL STRAINER

11. Remove oil strainer.

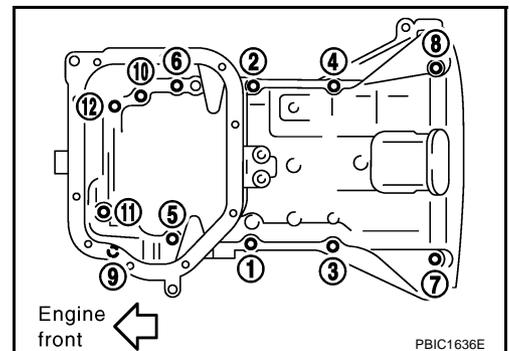


12. Remove oil pan (upper) as follows:

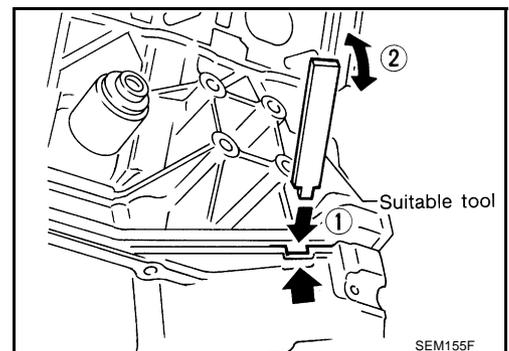
a. Remove transaxle joint bolts which pierce oil pan (upper). Refer to [CVT-224, "TRANSAXLE ASSEMBLY"](#).



b. Loosen mounting bolts in reverse order as shown in the figure.

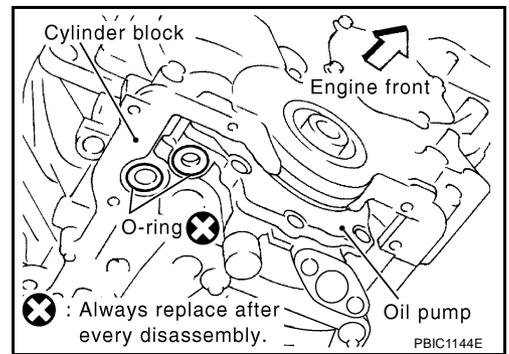


c. Insert suitable tool into the notch of oil pan (upper) as shown (1). Pry off oil pan (upper) by moving tool up and down as shown (2) to remove oil pan (upper).

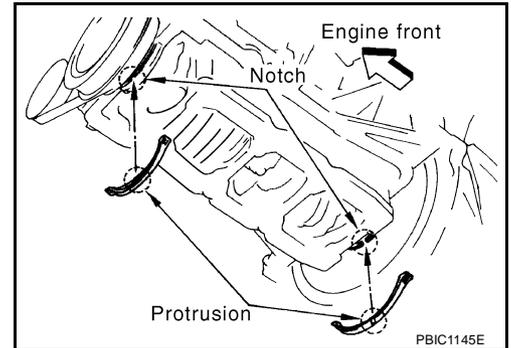


# OIL PAN AND OIL STRAINER

13. Remove O-rings from the bottom of cylinder block and oil pump.



14. Remove oil pan gaskets.



## AWD Model

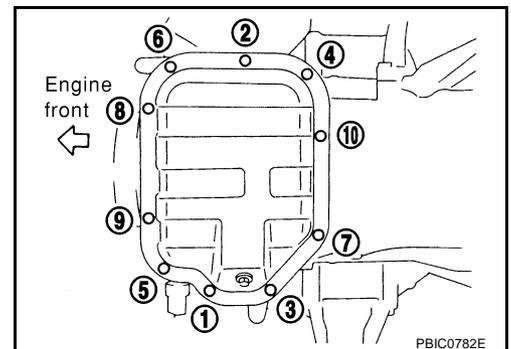
### WARNING:

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

### NOTE:

When removing oil pan (lower) or oil strainer only, take step 3 then step 8 and 9.

1. Remove engine assembly from vehicle, and separate front suspension member, transaxle and transfer assembly from engine. Refer to [EM-105, "ENGINE ASSEMBLY"](#).
2. install engine sub-attachment to right side of cylinder block, then lift engine, and mount it onto engine stand. Refer to [EM-110, "CYLINDER BLOCK"](#).
3. Drain engine oil. Refer to [LU-8, "Changing Engine Oil"](#).
4. Remove oil pressure switch. Refer to [LU-7, "OIL PRESSURE CHECK"](#).
5. Remove oil filter. Refer to [LU-9, "OIL FILTER"](#).
6. Remove oil cooler and water pipes. Refer to [LU-10, "OIL COOLER"](#).
7. Remove three way catalysts (right and left banks) from exhaust manifolds (right and left banks). Refer to [EM-23, "EXHAUST MANIFOLD AND THREE WAY CATALYST"](#).
8. Remove oil pan (lower) as follows:
  - a. Loosen mounting bolts in reverse order as shown in the figure.

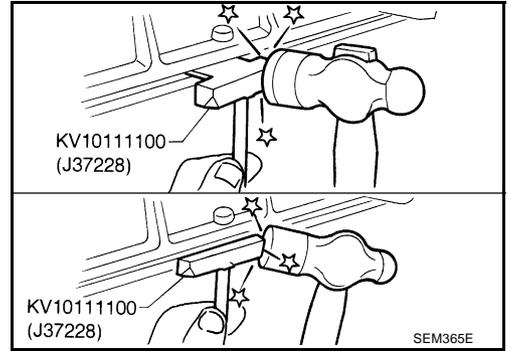


# OIL PAN AND OIL STRAINER

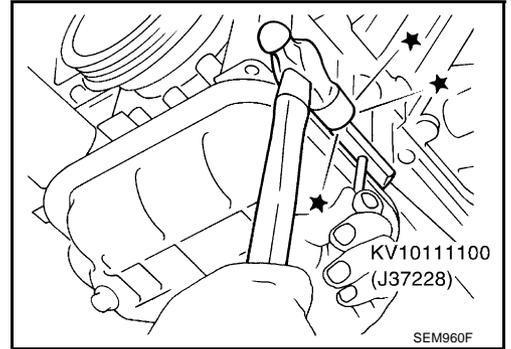
- b. Insert seal cutter [SST] between oil pan (lower) and oil pan (upper).

**CAUTION:**

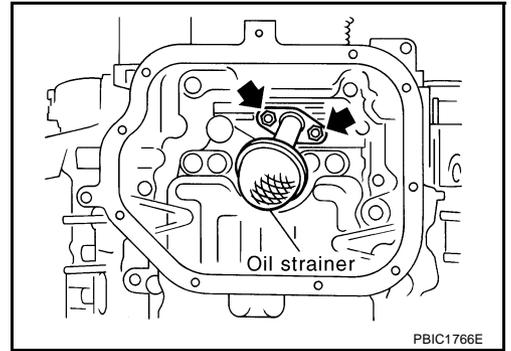
- Be careful not to damage the mating surfaces.
- Do not insert screwdriver, this will damage the mating surfaces.



- c. Slide seal cutter by tapping on the side of the tool with hammer. Remove oil pan (lower).

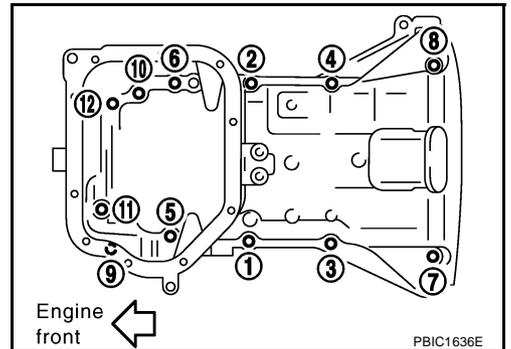


9. Remove oil strainer.



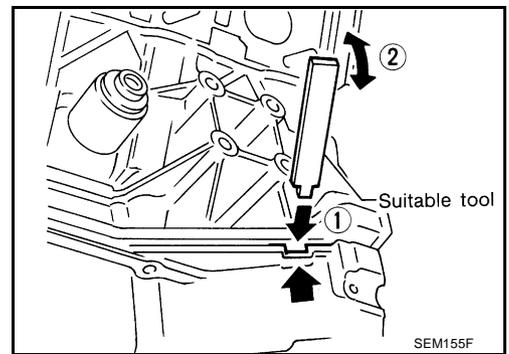
10. Remove oil pan (upper) as follows:

- a. Loosen mounting bolts in reverse order as shown in the figure.

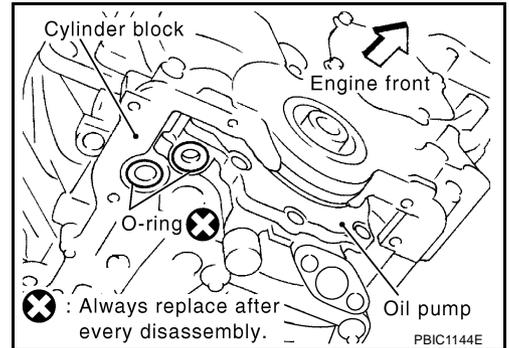


# OIL PAN AND OIL STRAINER

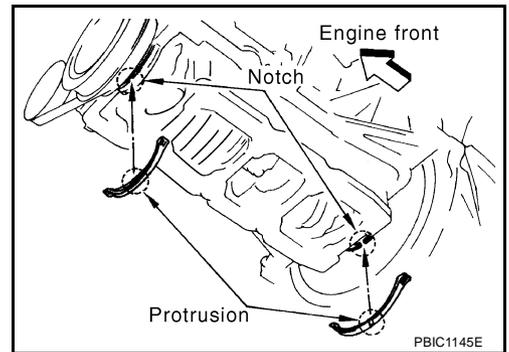
- b. Insert suitable tool into the notch of oil pan (upper) as shown (1). Pry off oil pan (upper) by moving tool up and down as shown (2) to remove oil pan (upper).



11. Remove O-rings from the bottom of cylinder block and oil pump.



12. Remove oil pan gaskets.



## INSPECTION AFTER REMOVAL

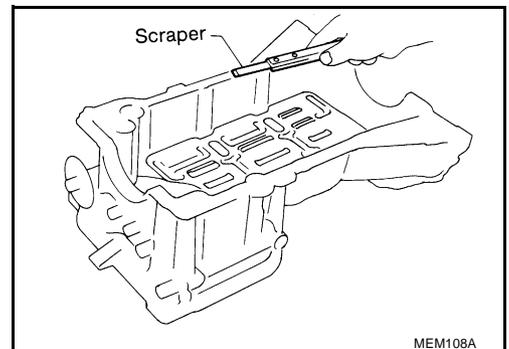
Clean oil strainer if any object attached.

## INSTALLATION

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

### CAUTION:

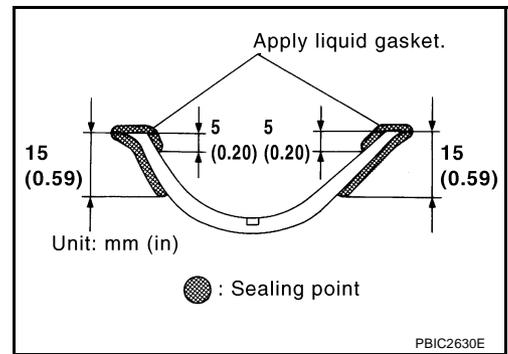
**Do not scratch or damage the mating surfaces when cleaning off old liquid gasket.**



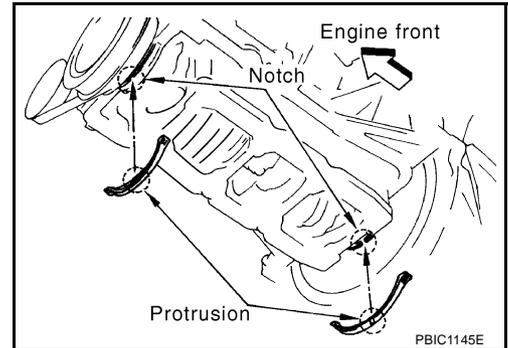
- b. Install new oil pan gaskets.

# OIL PAN AND OIL STRAINER

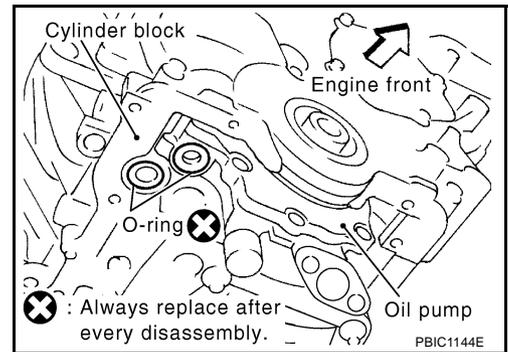
- Apply liquid gasket to new oil pan gaskets as shown in the figure.  
Use **Genuine RTV Silicone Sealant** or equivalent. Refer to [GI-47, "RECOMMENDED CHEMICAL PRODUCTS AND SEALANTS"](#) .



- To install, align protrusion of oil pan gasket with notches of front timing chain case and rear oil seal retainer.
- Install oil pan gasket with smaller arc to front timing chain case side.



- c. Install new O-rings on the bottom of cylinder block and oil pump.



- d. Apply a continuous bead of liquid gasket with tube presser [SST: WS39930000] to cylinder block mating surface of oil pan (upper) to a limited portion as shown in the figure.

Use **Genuine RTV Silicone Sealant** or equivalent. Refer to [GI-47, "RECOMMENDED CHEMICAL PRODUCTS AND SEALANTS"](#) .

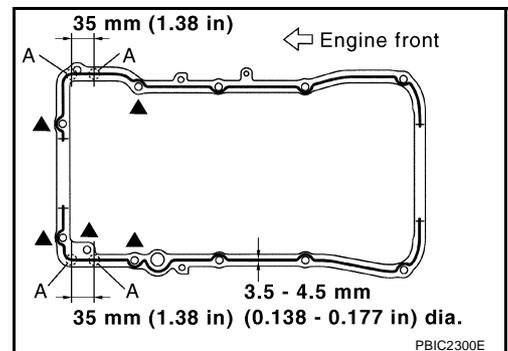
**CAUTION:**

- For bolt holes with ▲ marks (5 locations), apply liquid gasket outside the holes.
- Apply a bead of 4.5 to 5.5 mm (0.177 to 0.217 in) diameter to area "A".
- Attaching should be done within 5 minutes after coating.

- e. Install oil pan (upper).

**CAUTION:**

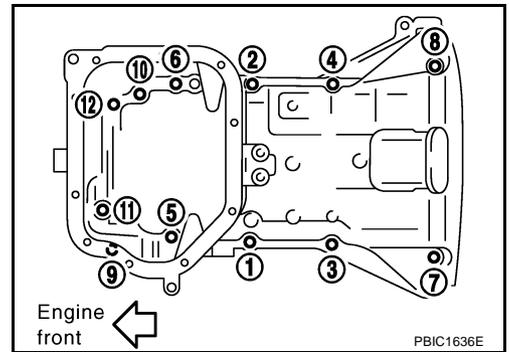
Install avoiding misalignment of both oil pan gasket and O-rings.



## OIL PAN AND OIL STRAINER

- Tighten mounting bolts in numerical order as shown in the figure.
- There are two types of mounting bolt. Refer to the following for locating bolts.

**M8 × 100 mm (3.97 in)** : 5, 7, 8, 11  
**M8 × 25 mm (0.98 in)** : Except the above



- f. Install transaxle joint bolts. (2WD models) Refer to [CVT-224, "TRANSAXLE ASSEMBLY"](#) .

2. Install oil strainer to oil pump.

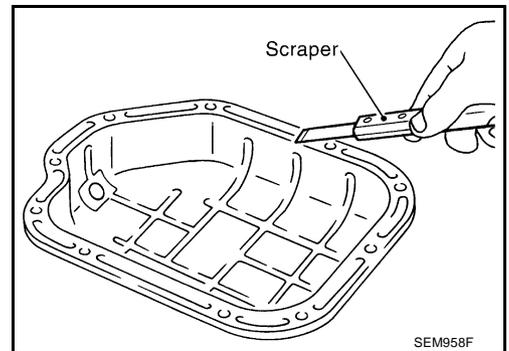
3. Install oil pan (lower) as follows:

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

- Also remove old liquid gasket from mating surface of oil pan (upper).
- Remove old liquid gasket from the bolt holes and thread.

**CAUTION:**

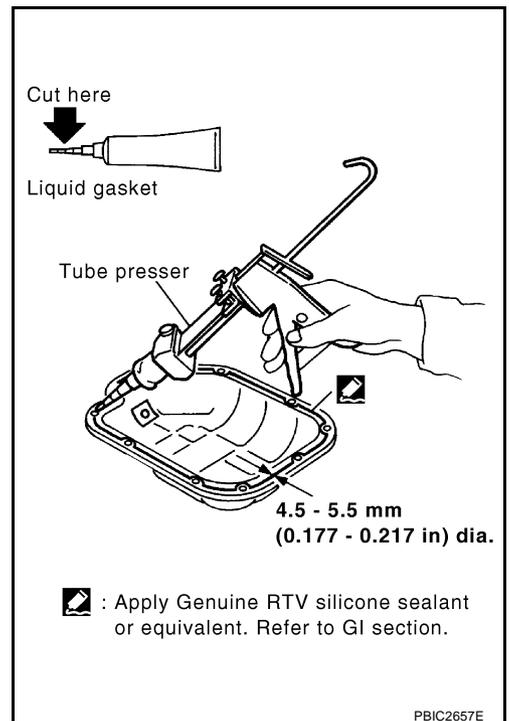
**Do not scratch or damage the mating surfaces when cleaning off old liquid gasket.**



- b. Apply a continuous bead of liquid gasket with tube presser [SST: WS39930000 ( — )] to oil pan (lower) as shown in the figure. **Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-47, "RECOMMENDED CHEMICAL PRODUCTS AND SEALANTS"](#) .**

**CAUTION:**

**Attaching should be done within 5 minutes after coating.**

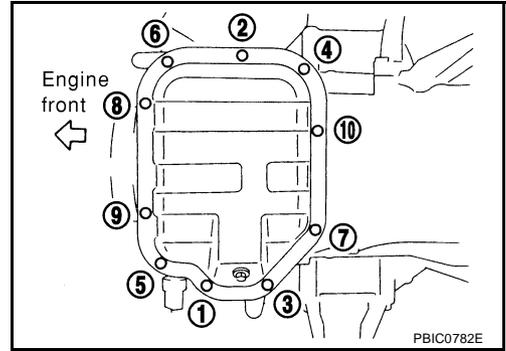


- c. Install oil pan (lower).

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

# OIL PAN AND OIL STRAINER

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



4. Install oil pan drain plug.
  - Refer to the figure of components of former page for installation direction of drain plug washer. Refer to [EM-28, "Removal and Installation"](#).
5. Install in the reverse order of removal after this step.

**NOTE:**

At least 30 minutes after oil pan is installed, pour engine oil.

**INSPECTION AFTER INSTALLATION**

- Before starting engine, check the levels of engine coolant, engine oil and working fluid. If less than required quantity, fill to the specified level.
- 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 engine coolant, engine oil, working fluid, fuel and exhaust gases.
- Bleed air from passages in pipes and tubes of applicable lines, such as in cooling system.
- After cooling down engine, again check levels of engine coolant, engine oil and working fluid. Refill to the 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
Working fluid	Level	Leakage	Level
Fuel	—	Leakage	—
Exhaust gases	—	Leakage	—

# IGNITION COIL

PFP:22448

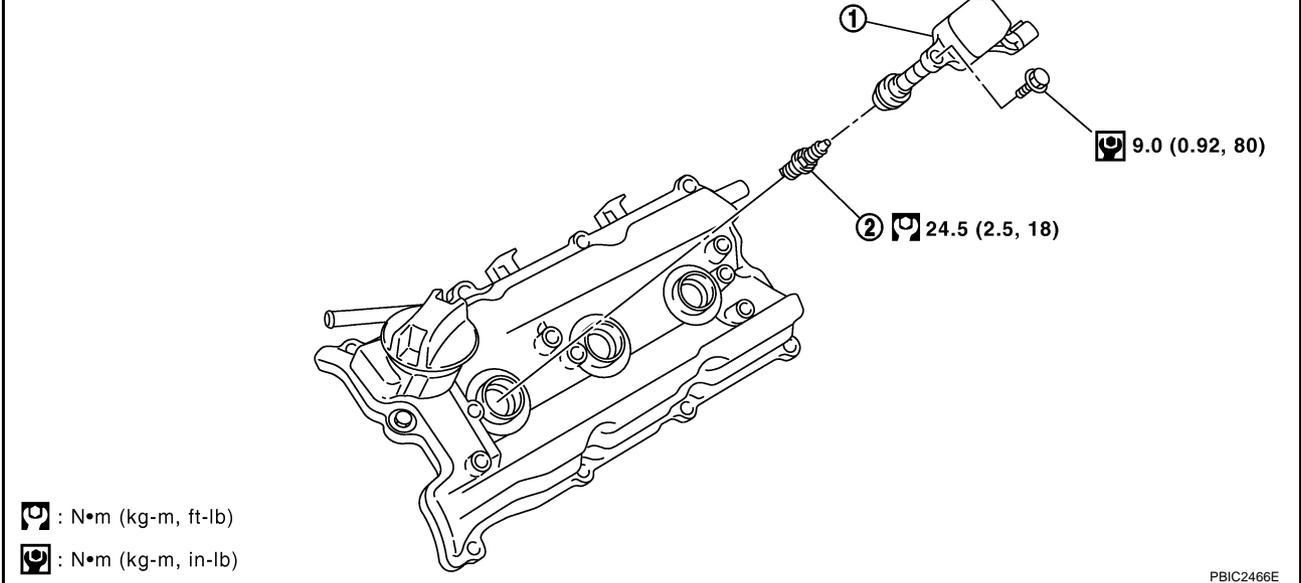
A

## IGNITION COIL

### Removal and Installation

ABS00321

SEC. 220



EM

C

D

E

F

G

### REMOVAL

1. Remove engine cover. Refer to [EM-16, "INTAKE MANIFOLD COLLECTOR"](#) .
2. Remove front wiper arm (RH) and cowl top cover (right). Refer to [WW-4, "FRONT WIPER AND WASHER SYSTEM"](#) and [EI-21, "COWL TOP"](#) .
3. Remove intake manifold collectors (upper and lower). (At the right bank side, remove ignition coil) Refer to [EM-16, "INTAKE MANIFOLD COLLECTOR"](#) .
4. Move aside harness, harness bracket, and hoses located above ignition coil.
5. Disconnect harness connector from ignition coil.
6. Remove ignition coil.

#### CAUTION:

**Do not drop or shock it.**

### INSTALLATION

Install in the reverse order of removal.

H

I

J

K

L

M

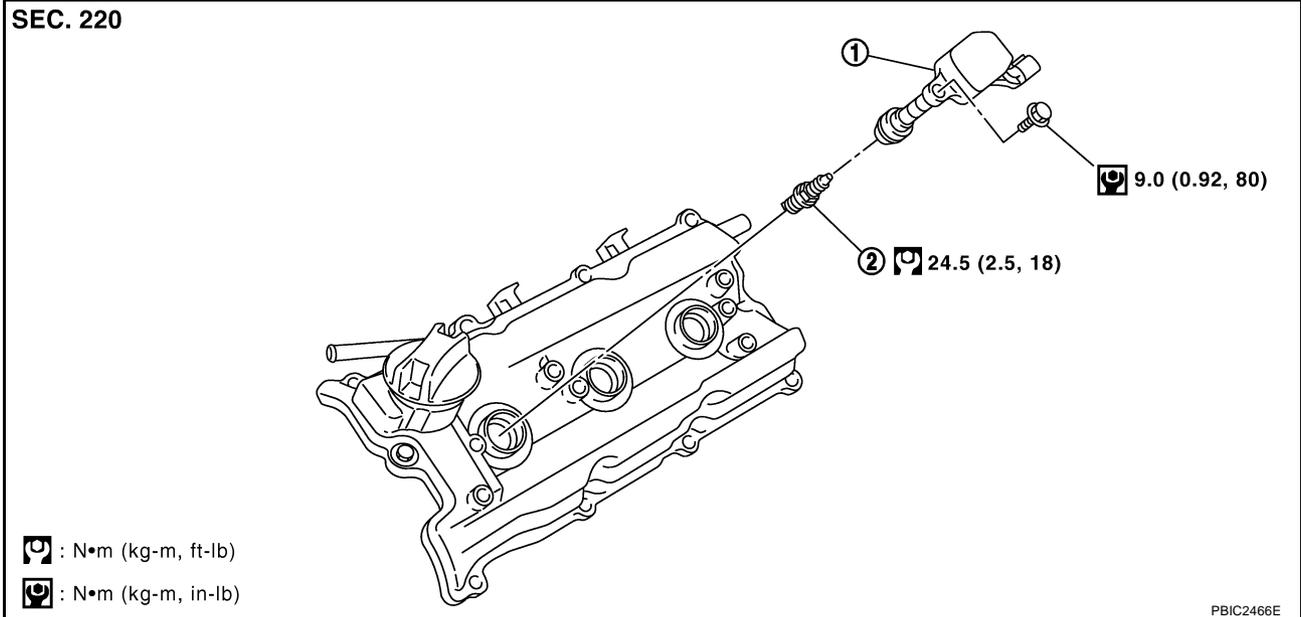
# SPARK PLUG (PLATINUM-TIPPED TYPE)

PF2:22401

## SPARK PLUG (PLATINUM-TIPPED TYPE)

### Removal and Installation

ABS0033P



1. Ignition coil

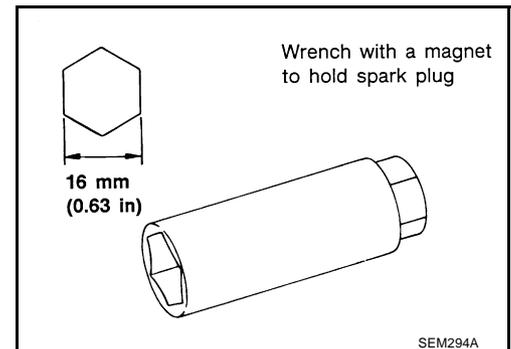
2. Spark plug

### REMOVAL

1. Remove engine cover. Refer to [EM-16, "INTAKE MANIFOLD COLLECTOR"](#).
2. Remove ignition coil. Refer to [EM-37, "IGNITION COIL"](#).
3. Remove spark plug using spark plug wrench (commercial service tool).

#### CAUTION:

Do not drop or shock it.



### INSPECTION AFTER REMOVAL

Use standard type spark plug for normal condition.

Hot type spark plug is suitable when fouling occurs with standard type spark plug under conditions such as:

- Frequent engine starts
- Low ambient temperatures

Cold type spark plug is suitable when spark plug knock occurs with standard type spark plug under conditions such as:

- Extended highway driving
- Frequent high engine revolution

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

Gap (Nominal) : 1.1 mm (0.043 in)

# SPARK PLUG (PLATINUM-TIPPED TYPE)

## CAUTION:

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

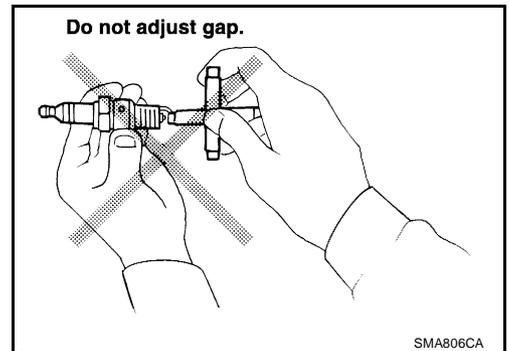
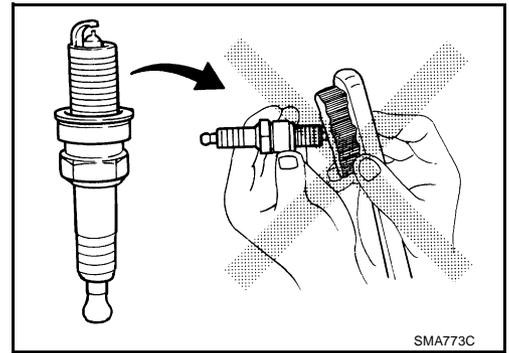
Cleaner air pressure:

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

Cleaning time:

Less than 20 seconds

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



## INSTALLATION

Install in the reverse order of removal.

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



# FUEL INJECTOR AND FUEL TUBE

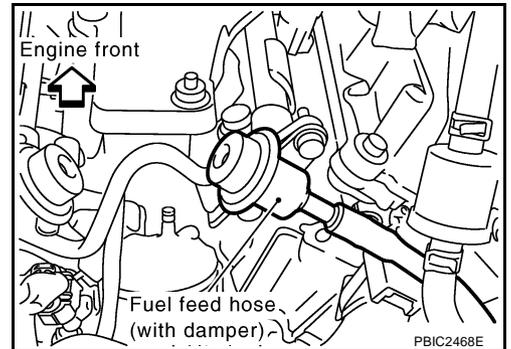
5. Remove radiator cover grilles, air duct (inlet), air cleaner case (upper) with mass air flow sensor and air duct assembly. Refer to [EM-14. "AIR CLEANER AND AIR DUCT"](#).
6. Remove intake manifold collectors (upper and lower). Refer to [EM-16. "INTAKE MANIFOLD COLLECTOR"](#).

- Intake manifold collector (upper) should be moved aside with water hoses connected.

7. Remove fuel feed hose (with damper) from fuel tube.

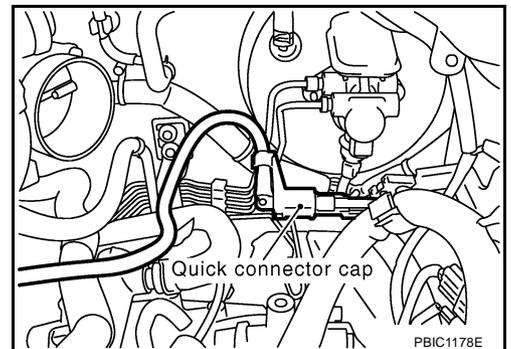
**CAUTION:**

- While hose disconnected, plug it to prevent fuel from draining.
- Do not separate fuel damper and fuel feed hose.



8. When separating fuel feed hose (with damper) and centralized under-floor piping connection, disconnect quick connector as follows:

- a. Remove quick connector cap from quick connector.

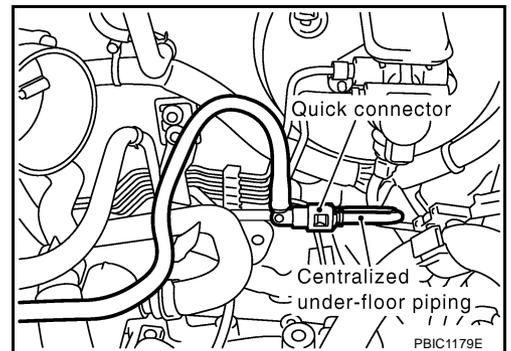


- b. Disconnect quick connector from centralized under-floor piping as follows:

**CAUTION:**

**Disconnect quick connector by using quick connector release [SST: J-45488], not by picking out retainer tabs.**

- i. With the sleeve side of quick connector release facing to quick connector, install quick connector release onto fuel tube.



- ii. Insert quick connector release into quick connector until sleeve contacts and goes no further. Hold quick connector release on that position.

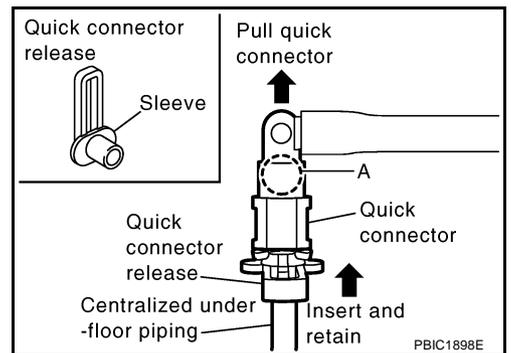
**CAUTION:**

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

- iii. Draw and pull out quick connector straight from centralized under-floor piping.

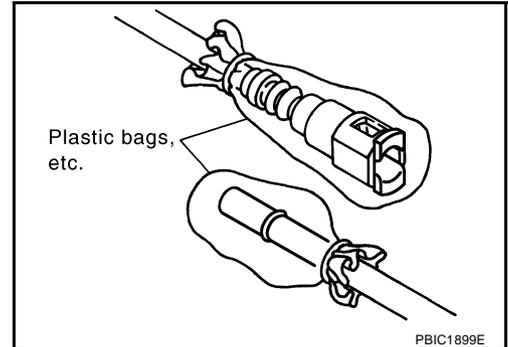
**CAUTION:**

- 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.



## FUEL INJECTOR AND FUEL TUBE

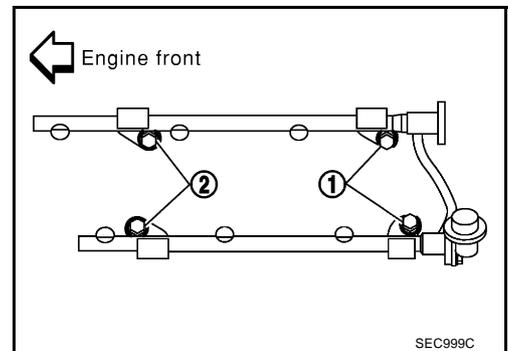
- Avoid fire and sparks.
- Keep parts away from heat source. Especially, be careful when welding is performed around them.
- Do not expose parts to battery electrolyte or other acids.
- Do not bend or twist connection between quick connector and fuel feed hose (with damper) during installation/removal.
- To keep clean the connecting portion and to avoid damage and foreign materials, cover them completely with plastic bags or something similar.



9. Disconnect harness connector from fuel injector.
10. Loosen mounting bolts in reverse order as shown in the figure, and remove fuel tube and fuel injector assembly.

**CAUTION:**

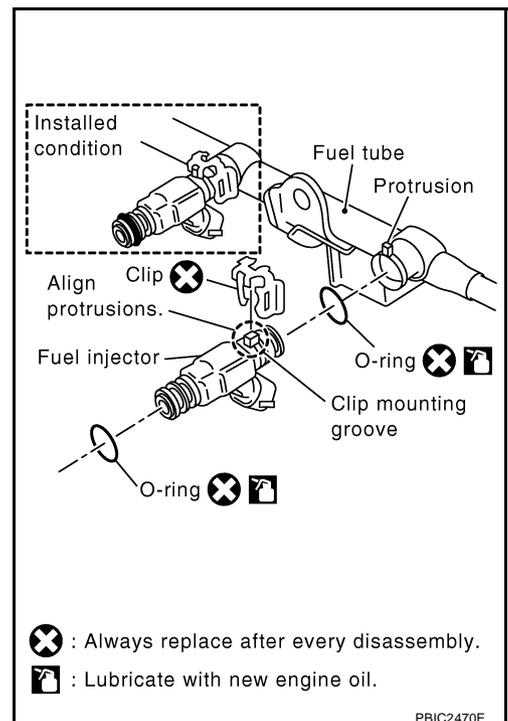
Do not tilt it, or remaining fuel in pipes may flow out from pipes.



11. Remove spacers on intake manifold.
12. Remove fuel injector from fuel tube as follows:
  - 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 nozzle during removal.
- Do not bump or drop fuel injector.
- Do not disassemble fuel injector.



13. Remove fuel damper from fuel tube.

# FUEL INJECTOR AND FUEL TUBE

## INSTALLATION

1. Install fuel damper.

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

### 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 new O-ring straight into fuel damper. Do not decenter or twist it.

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

2. Install new O-rings to fuel injector paying attention to the following.

### CAUTION:

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

Fuel tube side : Blue

Nozzle side : Brown

- Handle O-ring with bare hands. Never wear gloves.
- Lubricate O-ring with new engine oil.
- Do not clean O-ring with solvent.
- Make sure that O-ring and its mating part are free of foreign material.
- 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 injector. Do not decenter or twist it.

3. Install fuel injector to fuel tube as follows:

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

- Insert clip so that protrusion "A" of fuel injector matches cutout "A" of clip.

### CAUTION:

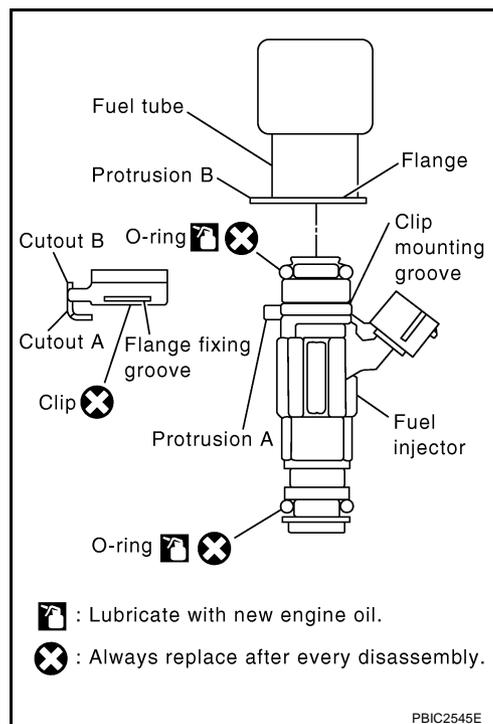
- Do not reuse clip. Replace it with new one.
- Be careful to keep clip from interfering with O-ring. If interference occurs, replace O-ring.

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

- Insert it while matching it to the axial center.
- Insert fuel injector so that protrusion "B" of fuel tube matches cutout "B" of clip.
- Make sure that fuel tube flange is securely fixed in flange fixing groove on clip.

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

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



## FUEL INJECTOR AND FUEL TUBE

4. Install spacers on intake manifold.
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.**

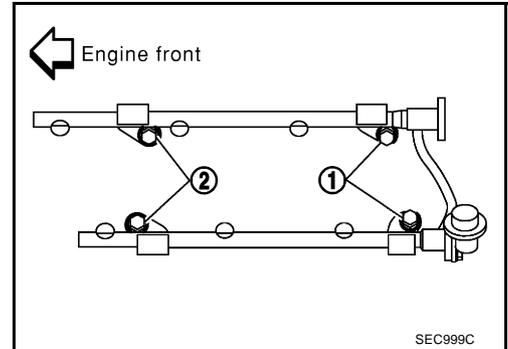
- Tighten mounting bolts in two steps in numerical order as shown in figure.

 **1st step**

: 9.3 - 10.8 N·m (0.95 - 1.1 kg·m, 6.9 - 7.9 ft·lb)

 **2nd step**

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

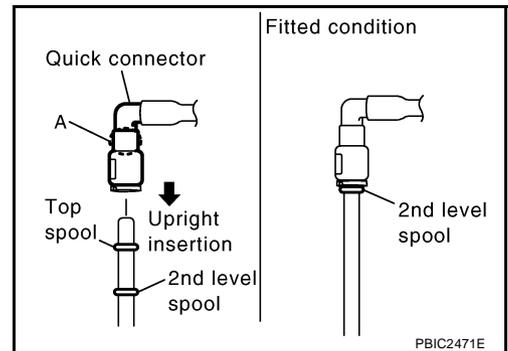


6. Connect fuel injector harness.
7. Install intake manifold collectors (upper and lower). Refer to [EM-16, "INTAKE MANIFOLD COLLECTOR"](#).
8. Connect fuel feed hose (with damper).
  - Handling procedure of O-ring is the same as that of fuel damper.
  - Insert fuel damper straight into fuel tube.
  - Tighten mounting bolts evenly in turn.
  - After tightening mounting bolts, make sure that there is no gap between flange and fuel tube.

9. Connect quick connector between fuel feed hose (with damper) and centralized under-floor piping connection with the following procedure:
  - a. Make sure no foreign substances are deposited in and around centralized under-floor piping and quick connector, and no damage on them.
  - b. Thinly apply new engine oil around centralized under-floor piping from tip end to spool end.
  - c. Align center to insert quick connector straightly into centralized under-floor piping.
    - Insert quick connector to centralized under-floor piping 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 centralized under-floor piping 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.

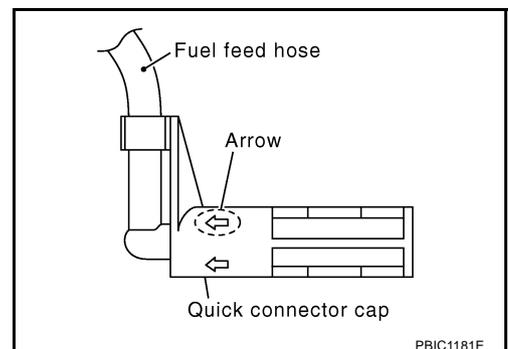


- d. Pull quick connector by hand holding "A" position. Make sure it is completely engaged (connected) so that it does not come out from centralized under-floor piping.
- e. Install quick connector cap to quick connector.
  - Install quick connector cap with arrow on surface facing in direction of quick connector [fuel feed hose (with damper) side].

**CAUTION:**

**If quick connector cap cannot be installed smoothly, quick connector may have not been installed correctly. Check connection again.**

- f. Secure fuel feed hose (with damper) to clamp of quick connector cap.



# FUEL INJECTOR AND FUEL TUBE

---

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

## 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.**

A

EM

C

D

E

F

G

H

I

J

K

L

M

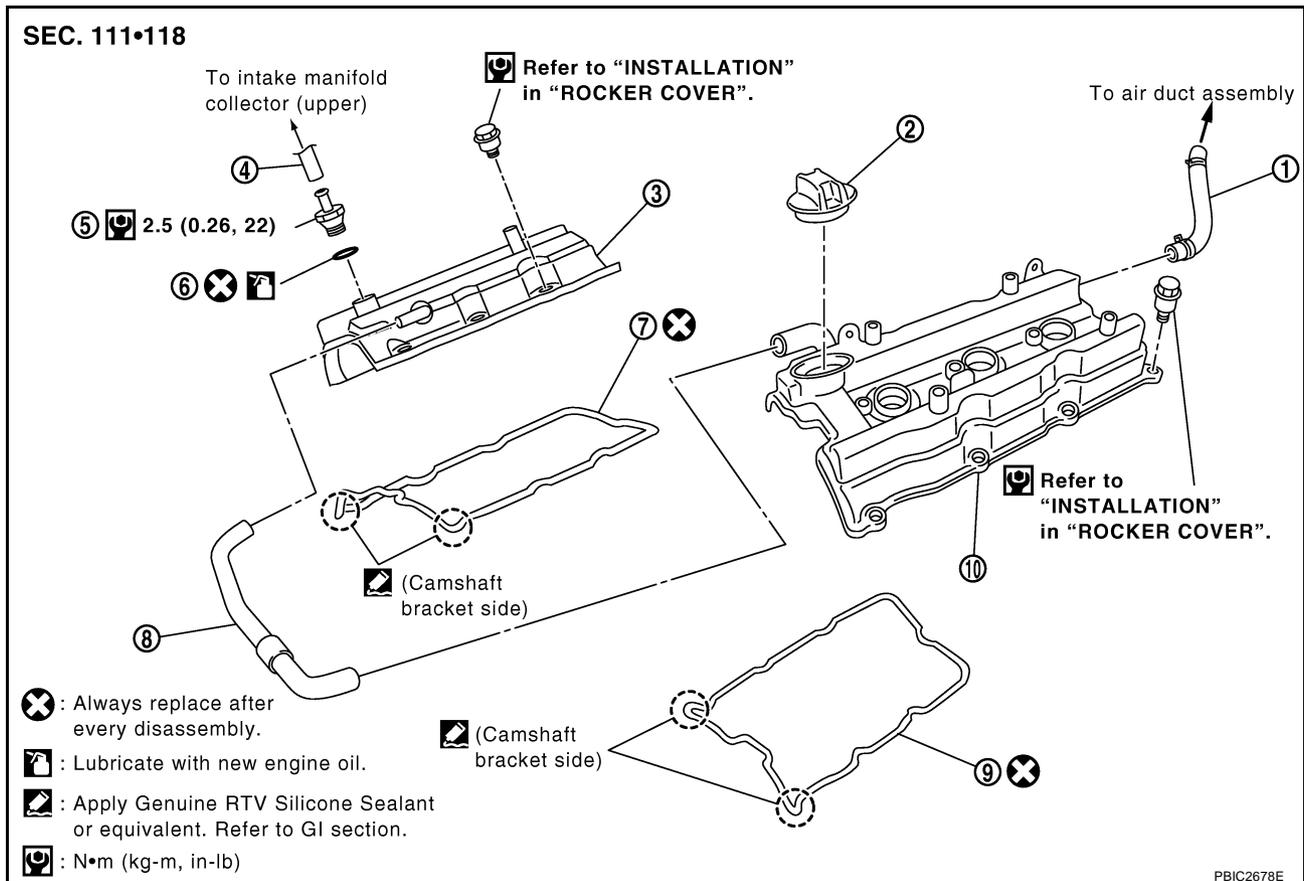
# ROCKER COVER

PFP:13264

## ROCKER COVER

### Removal and Installation

ABS0034R



- |                                     |                   |                                    |
|-------------------------------------|-------------------|------------------------------------|
| 1. PCV hose                         | 2. Oil filler cap | 3. Rocker cover (right bank)       |
| 4. PCV hose                         | 5. PCV valve      | 6. O-ring                          |
| 7. Rocker cover gasket (right bank) | 8. PCV hose       | 9. Rocker cover gasket (left bank) |
| 10. Rocker cover (left bank)        |                   |                                    |

### REMOVAL

1. Remove engine cover. Refer to [EM-16, "INTAKE MANIFOLD COLLECTOR"](#) .
2. Drain engine coolant, or when water hoses are disconnected, attach plug to prevent engine coolant leakage. Refer to [CO-9, "Changing Engine Coolant"](#) and [EM-16, "INTAKE MANIFOLD COLLECTOR"](#) .

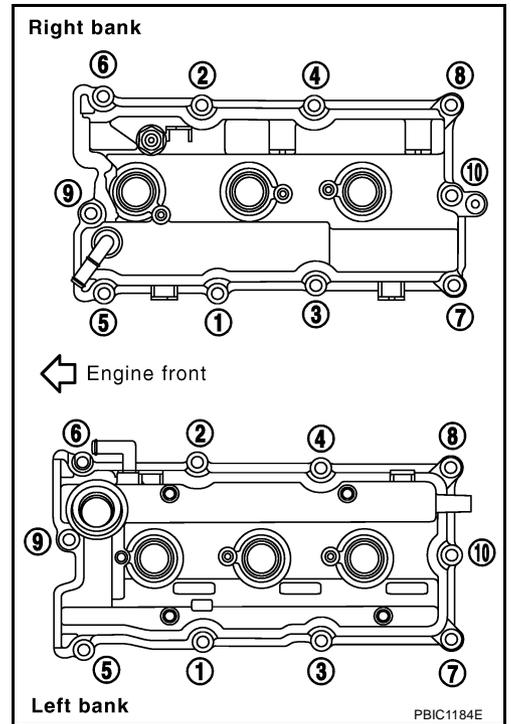
#### CAUTION:

**Perform this step when engine is cold.**

3. Remove front wiper arm (RH) and cowl top cover (right). Refer to [WW-4, "FRONT WIPER AND WASHER SYSTEM"](#) and [EI-21, "COWL TOP"](#) .
4. Remove intake manifold collectors (upper and lower). (At the right bank side remove) Refer to [EM-16, "INTAKE MANIFOLD COLLECTOR"](#) .
5. Remove ignition coil. Refer to [EM-37, "IGNITION COIL"](#) .
6. Remove PCV hoses from rocker covers.
7. Remove PCV valve and O-ring from rocker cover (right bank), if necessary.
8. Remove oil filler cap from rocker cover (left bank), if necessary.

# ROCKER COVER

9. Loosen mounting bolts in reverse order shown in the figure.



10. Remove rocker cover gaskets from rocker covers.
11. Use scraper to remove all traces of liquid gasket from cylinder head and camshaft bracket (No. 1).

**CAUTION:**

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

**INSTALLATION**

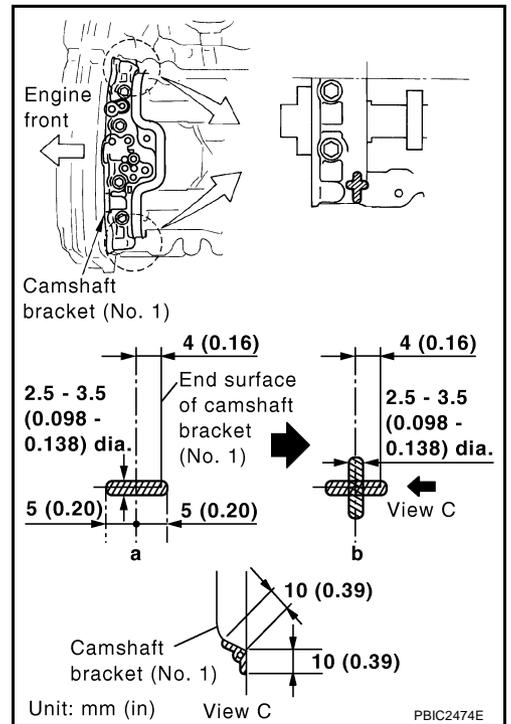
1. Apply liquid gasket with tube presser [SST: WS39930000 ( — )] to joint part among rocker cover, cylinder head and camshaft bracket (No. 1) as follows:

**Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-47, "RECOMMENDED CHEMICAL PRODUCTS AND SEALANTS"](#) .**

**NOTE:**

The figure shows an example of left bank side [zoomed in shows camshaft bracket (No. 1)].

- a. Refer to the figure "a" to apply liquid gasket to joint part of camshaft bracket (No. 1) and cylinder head.
- b. Refer to the figure "b" to apply liquid gasket to the figure "a" squarely.



2. Install new rocker cover gasket to rocker cover.
3. Install rocker cover.
  - Check if rocker cover gasket is not dropped from installation groove of rocker cover.

## ROCKER COVER

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



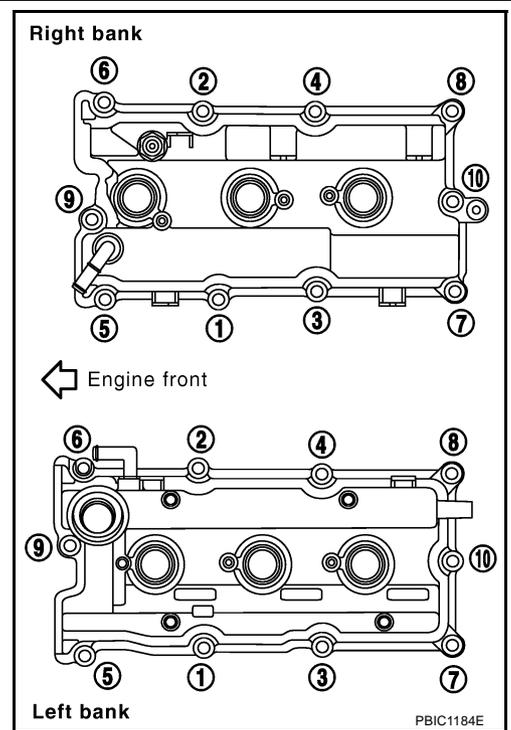
**1st step**

: 0.96 - 2.96 N·m (0.10 - 0.30 kg·m, 9 - 26 in·lb)



**2nd step**

: 7.33 - 9.33 N·m (0.75 - 0.95 kg·m, 65 - 82 in·lb)



5. Install oil filler cap to rocker cover (left bank), if removed.
6. Install new O-ring and PCV valve to rocker cover (right bank), if removed.
7. Install PCV hoses.
- Insert PCV hose by 25 to 30 mm (0.98 to 1.18 in) from connector end.
  - When installing, be careful not to twist or come in contact with other parts.
8. Install in the reverse order of removal after this step.

# FRONT TIMING CHAIN CASE

## FRONT TIMING CHAIN CASE

PPF:13599

### Removal and Installation

ABS0032M

#### NOTE:

- This section describes removal/installation procedure of front timing chain case and timing chain related parts without removing upper oil pan on vehicle.
- When upper oil pan needs to be removed or installed, or when rear timing chain case is removed or installed, remove oil pans (lower and upper) first. Then remove front timing chain case, timing chain related parts, and rear timing chain case in this order, and install in reverse order of removal. Refer to [EM-58, "TIMING CHAIN"](#) .
- Refer to [EM-58, "TIMING CHAIN"](#) for component parts location.

#### REMOVAL

1. Remove engine cover. Refer to [EM-16, "INTAKE MANIFOLD COLLECTOR"](#) .
2. Remove air duct (inlet), air cleaner case (upper) with mass air flow sensor and air duct assembly. Refer to [EM-14, "AIR CLEANER AND AIR DUCT"](#) .
3. Remove undercover and splash guard (RH).
4. Remove right side front road wheel and tire.
5. Drain engine oil. Refer to [LU-8, "Changing Engine Oil"](#) .

#### CAUTION:

- Perform this step when engine is cold.
  - Do not spill engine oil on drive belts.
6. Drain engine coolant from radiator. Refer to [CO-9, "Changing Engine Coolant"](#) .

#### CAUTION:

- Perform this step when engine is cold.
  - Do not spill engine coolant on drive belts.
7. Remove intake manifold collectors (upper and lower). Refer to [EM-16, "INTAKE MANIFOLD COLLECTOR"](#) .
  8. Remove drive belts. Refer to [EM-11, "DRIVE BELTS"](#) .
  9. Remove alternator. Refer to [SC-17, "CHARGING SYSTEM"](#) .
  10. Remove power steering oil pump from bracket with piping connected, and temporarily secure it to aside. Refer to [PS-28, "POWER STEERING OIL PUMP"](#) .
  11. Remove power steering oil pump bracket. Refer to [PS-28, "POWER STEERING OIL PUMP"](#) .
  12. Remove idler pulley and bracket. Refer to [EM-58, "TIMING CHAIN"](#) .
  13. Separate engine harnesses removing their brackets from front timing chain case.
  14. Remove rocker covers (right and left banks). Refer to [EM-46, "ROCKER COVER"](#) .

#### NOTE:

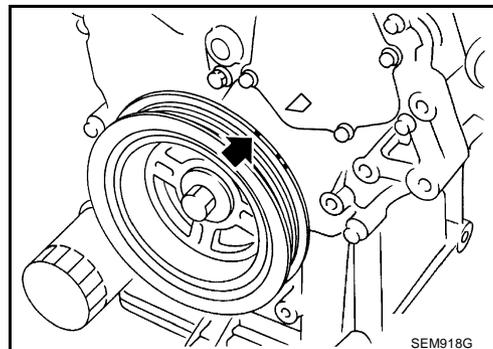
When only timing chain (primary) is removed, rocker cover does not need to be removed.

15. Obtain No. 1 cylinder at TDC of its compression stroke as follows:

#### NOTE:

When timing chain is not removed/installed, this step is not required.

- a. Rotate crankshaft pulley clockwise to align timing mark (grooved line without color) with timing indicator.

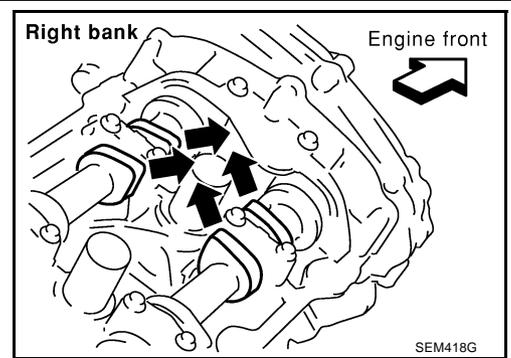


## FRONT TIMING CHAIN CASE

- b. Make sure that intake and exhaust cam noses on No. 1 cylinder (engine front side of right bank) are located as shown in the figure.
- If not, turn crankshaft one revolution (360 degrees) and align as shown in the figure.

**NOTE:**

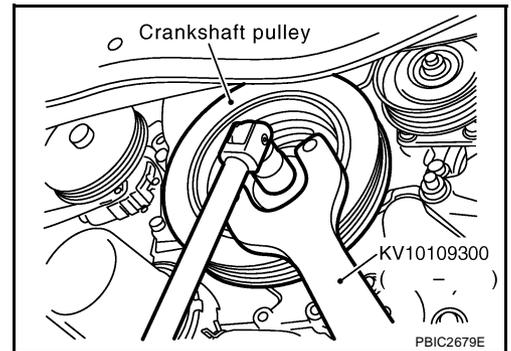
When only timing chain (primary) is removed, rocker cover does not need to be removed. To make sure that No. 1 cylinder is at its compression TDC, remove front timing chain case first. Then check mating marks on camshaft sprockets. Refer to [EM-66. "INSTALLATION"](#) .



16. Remove crankshaft pulley as follows:
- a. Fix crankshaft with pulley holder [SST].
- b. Loosen crankshaft pulley bolt and locate bolt seating surface at 10 mm (0.39 in) from its original position.

**CAUTION:**

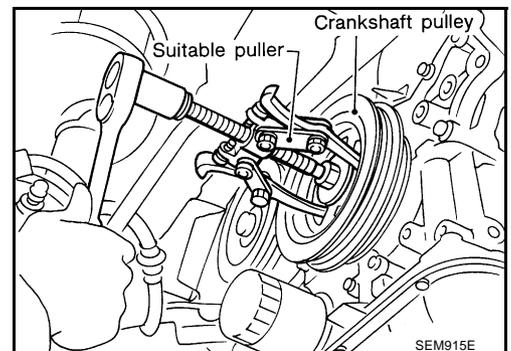
**Do not remove crankshaft pulley bolt as it will be used as a supporting point for suitable puller.**



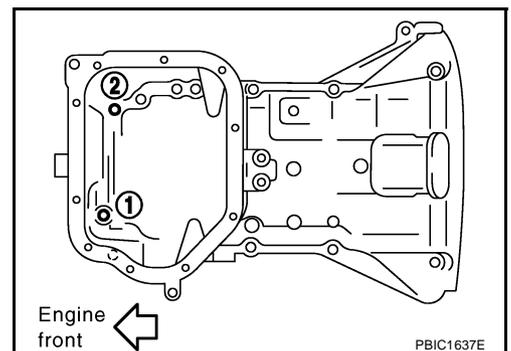
- c. Place suitable puller tab on holes of crankshaft pulley, and pull crankshaft pulley through.

**CAUTION:**

**Do not put suitable puller tab on crankshaft pulley periphery, as this will damage internal damper.**



17. Remove oil pan (lower). Refer to [EM-28. "OIL PAN AND OIL STRAINER"](#) .
18. Loosen two mounting bolts in front of oil pan (upper) in reverse order as shown in the figure.



19. Install oil pan (lower) temporarily.
- Applying liquid gasket is unnecessary.
20. Support the oil pan (lower) bottom with jack.
- Perform following operations with engine front-side supported with jack.

**CAUTION:**

**Put a piece of wood or something similar as the supporting surface, be careful not to damage oil pan (lower).**

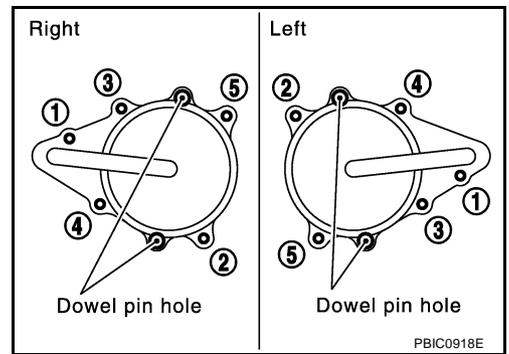
21. Remove right and left intake valve timing control covers.

## FRONT TIMING CHAIN CASE

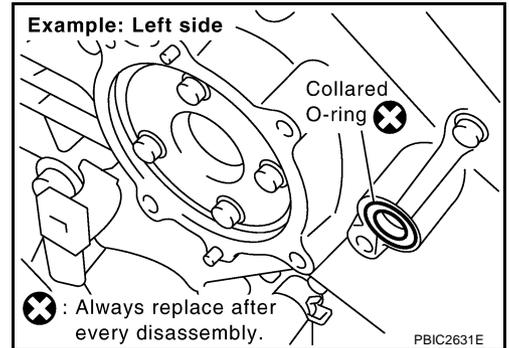
- Loosen mounting bolts in reverse order as shown in the figure.
- Use seal cutter [SST: KV10111100 (J37228)] to cut liquid gasket for removal.

**CAUTION:**

Shaft is internally jointed with camshaft sprocket (INT) center hole. When removing, keep it horizontal until it is completely disconnected.



22. Remove collared O-rings from front timing chain case oil holes (left and right sides).

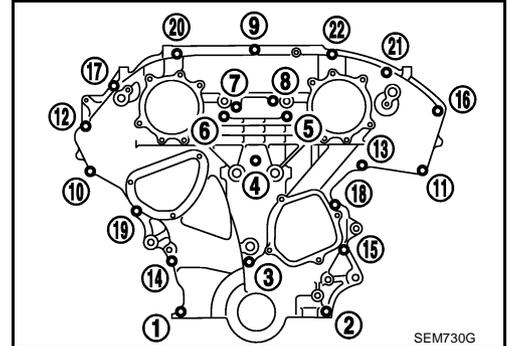


23. Remove engine mounting insulator (RH) and engine mounting bracket (RH). Refer to [EM-105, "ENGINE ASSEMBLY"](#).

24. Raise engine front-side with jack. (This secures workspace to remove front timing chain case.)

25. Remove front timing chain case as follows:

- a. Loosen mounting bolts in reverse order as shown in the figure.



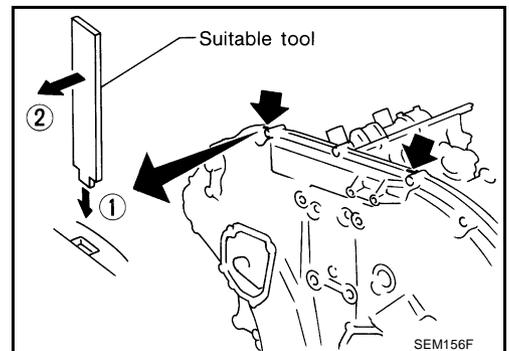
- b. Insert suitable tool into the notch at the top of front timing chain case as shown (1).

- c. Pry off case by moving tool as shown (2).

- Use seal cutter [SST: KV10111100 (J37228)] to cut liquid gasket for removal.

**CAUTION:**

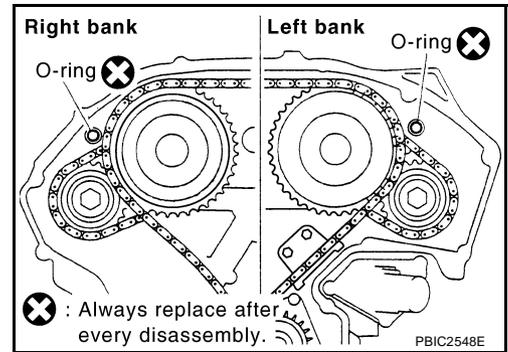
- Do not use screwdriver or something similar.
- After removal, handle front timing chain case carefully so it does not tilt, cant, or warp under a load.



26. Remove oil pan gasket. Refer to [EM-28, "OIL PAN AND OIL STRAINER"](#).

## FRONT TIMING CHAIN CASE

27. Remove O-rings from rear timing chain case.



28. Remove water pump cover and chain tensioner cover from front timing chain case.

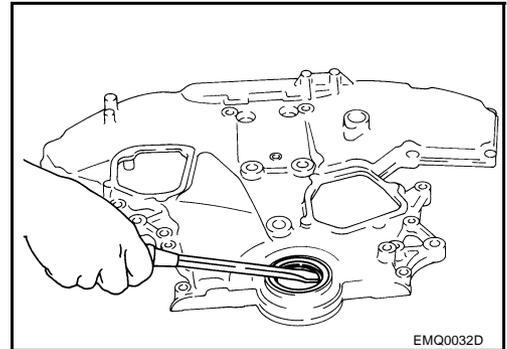
- Use seal cutter [SST: KV10111100 (J37228)] to cut liquid gasket for removal.

29. Remove front oil seal from front timing chain case using suitable tool.

- Use screwdriver for removal.

**CAUTION:**

**Be careful not to damage front timing chain case.**

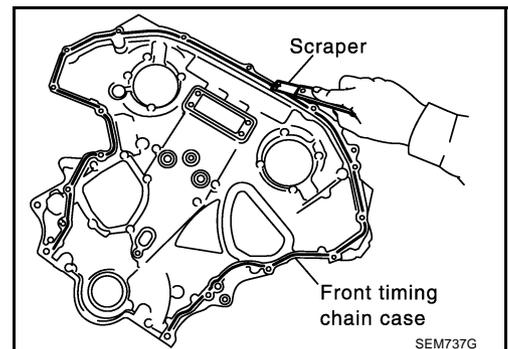


30. Remove timing chain and related parts. Refer to [EM-58, "TIMING CHAIN"](#).

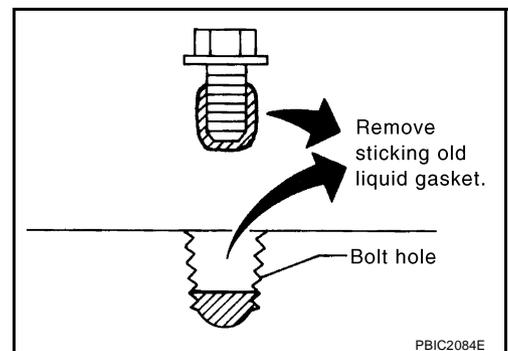
31. Use scraper to remove all traces of old liquid gasket from front and rear timing chain cases and oil pan (upper), and liquid gasket mating surfaces.

**CAUTION:**

**Be careful not to allow gasket fragments to enter oil pan.**



- Remove old liquid gasket from bolt hole and thread.

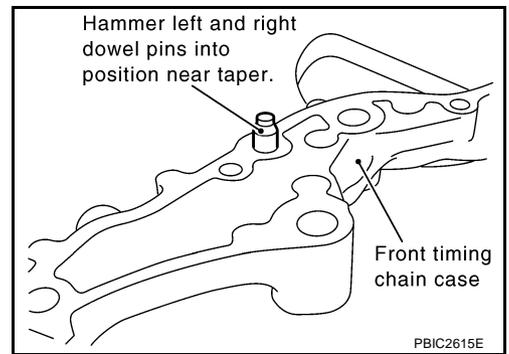


### INSTALLATION

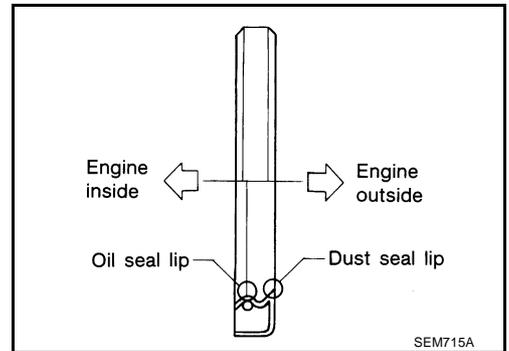
1. Install timing chain and related parts. Refer to [EM-58, "TIMING CHAIN"](#).

## FRONT TIMING CHAIN CASE

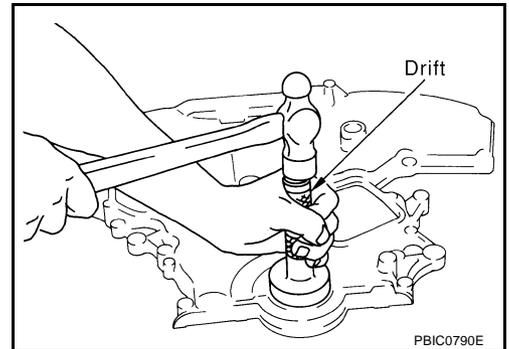
2. Hammer dowel pins (right and left) into front timing chain case up to a point close to taper in order to shorten protrusion length.



3. Install new front oil seal on front timing chain case.
- Apply new engine oil to both oil seal lip and dust seal lip.
  - Install it so that each seal lip is oriented as shown in the figure.



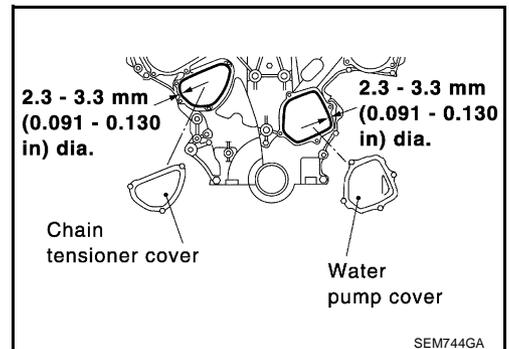
- Using suitable drift [outer diameter: 60 mm (2.36 in)], press-fit oil seal until it becomes flush with front timing chain case end face.
- Make sure the garter spring is in position and seal lip is not inverted.



4. Install water pump cover and chain tensioner cover to front timing chain case.

- Apply a continuous bead of liquid gasket with tube presser [SST: WS39930000 ( — )] to front timing chain case as shown in the figure.

**Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-47, "RECOMMENDED CHEMICAL PRODUCTS AND SEALANTS"](#).**

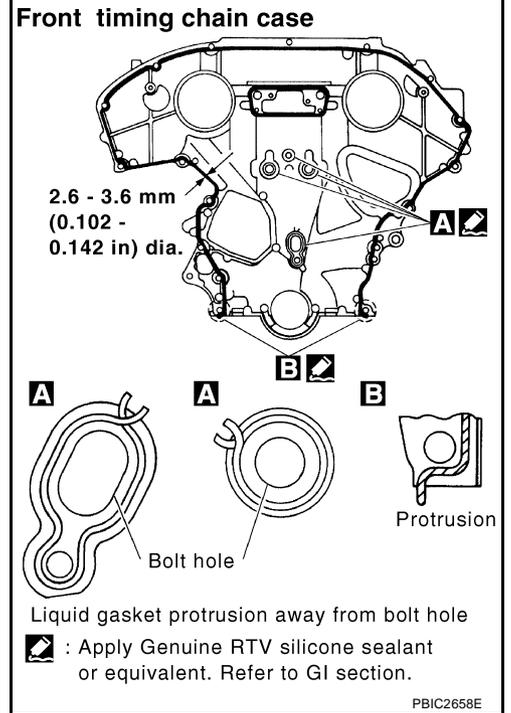


5. Install front timing chain case as follows:

# FRONT TIMING CHAIN CASE

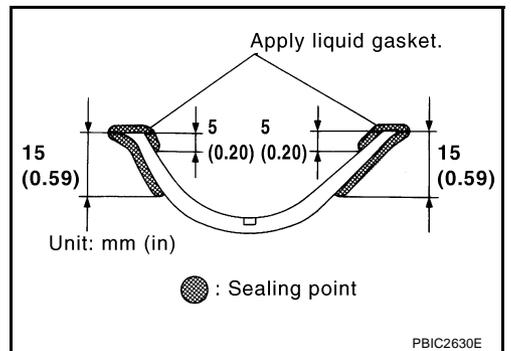
- a. Apply a continuous bead of liquid gasket with tube presser [SST: WS39930000 ( — )] to front timing chain case back side as shown in the figure.

**Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-47, "RECOMMENDED CHEMICAL PRODUCTS AND SEALANTS"](#) .**

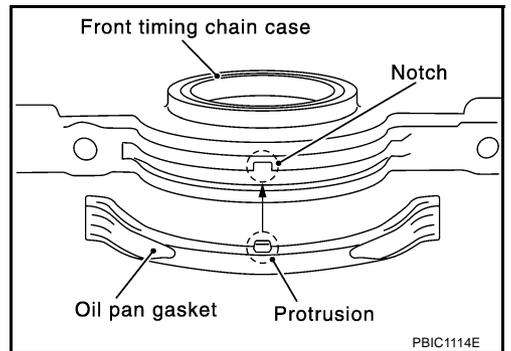


- b. Install new oil pan gasket.

- Apply liquid gasket to oil pan gasket as shown in the figure. **Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-47, "RECOMMENDED CHEMICAL PRODUCTS AND SEALANTS"](#) .**



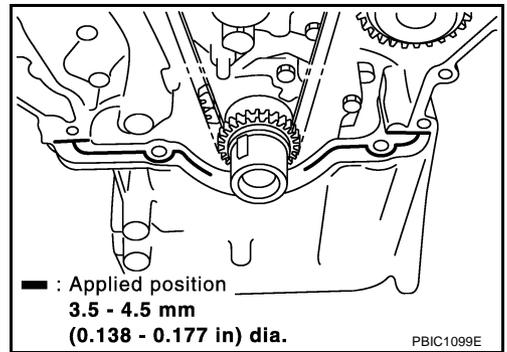
- Align notch of front timing chain case with protrusion of oil pan gasket.



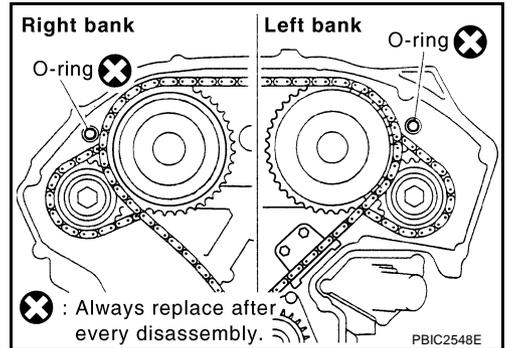
## FRONT TIMING CHAIN CASE

- Apply liquid gasket with tube presser [SST: WS39930000 ( — )] to top surface of oil pan (upper) as shown in the figure.

**Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-47, "RECOMMENDED CHEMICAL PRODUCTS AND SEALANTS"](#) .**



- c. Install new O-rings on rear timing chain case.

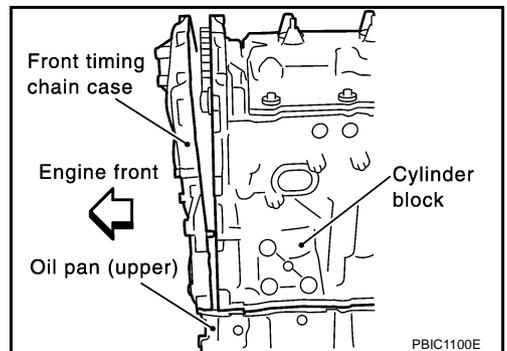


- d. Assemble front timing chain case as follows:

- i. Fit lower end of front timing chain case tightly onto top face of oil pan (upper). From the fitting point, make entire front timing chain case contact rear timing chain case completely.

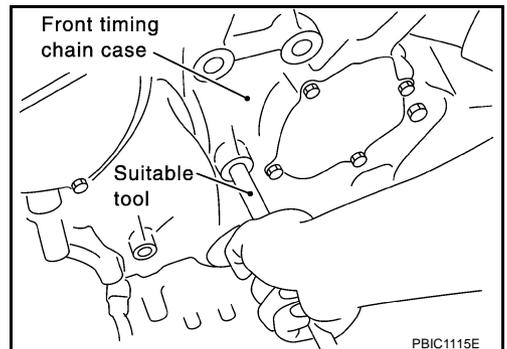
**CAUTION:**

**Be careful that oil pan gasket is in place.**



- ii. Since front timing chain case is offset for difference of bolt holes, tighten bolts temporarily with holding front timing chain case from front and top as shown in the figure.

- iii. Same as the step ii, insert dowel pin with holding front timing chain case from front and top completely.



## FRONT TIMING CHAIN CASE

- e. Tighten mounting bolts to the specified torque in numerical order as shown in the figure.
- There are two types of mounting bolt. Refer to the following for locating bolts.

**M8 bolts : 1, 2**

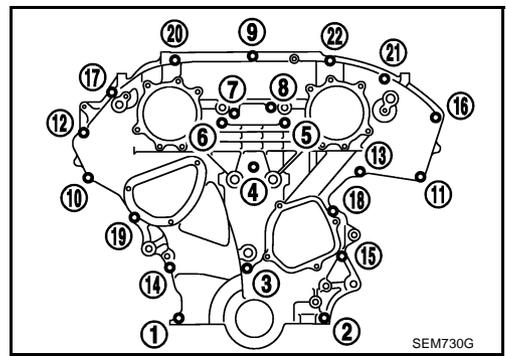
 : 25.5 - 31.3 N·m (2.6 - 3.2 kg·m, 19 - 23 ft·lb)

**M6 bolts : Except the above**

 : 11.7 - 13.7 N·m (1.2 - 1.4 kg·m, 9 - 10 ft·lb)

- f. After all bolts tightening, retighten them to the specified torque in numerical order as shown in the figure.
6. Install engine mounting bracket (RH) and engine mounting insulator (RH). Refer to [EM-105, "ENGINE ASSEMBLY"](#).
7. Remove jack which supports the oil pan (lower) bottom.
8. Remove oil pan (lower).
9. Install two mounting bolts in front of oil pan (upper) in numerical order as shown in the figure.

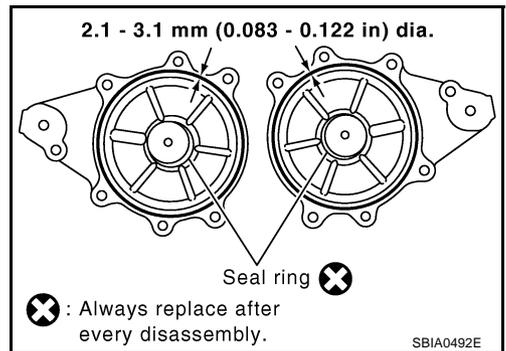
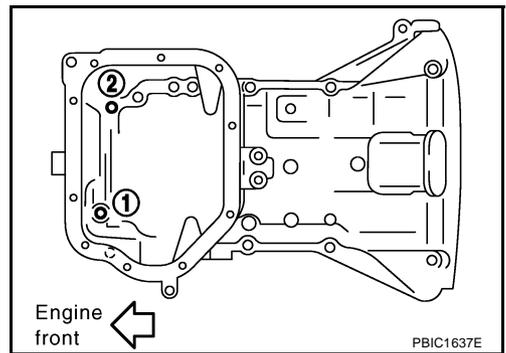
 : 17.2 N·m (1.8 kg·m, 13 ft·lb)



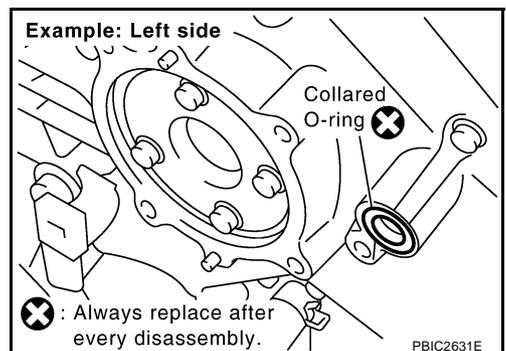
10. Install oil pan (lower). Refer to [EM-28, "OIL PAN AND OIL STRAINER"](#).
11. Install right and left intake valve timing control covers as follows:

- a. Install new seal rings in shaft grooves.
- b. Apply a continuous bead of liquid gasket with tube presser [SST: WS39930000 ( — )] to intake valve timing control covers as shown in the figure.

**Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-47, "RECOMMENDED CHEMICAL PRODUCTS AND SEALANTS"](#).**



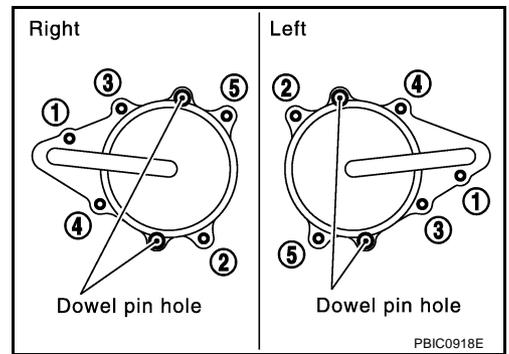
- c. Install new collared O-rings in front timing chain case oil holes (left and right sides).



- d. Being careful not to move seal rings from the installation grooves, align dowel pins on front timing chain case with the holes to install intake valve timing control covers.

# FRONT TIMING CHAIN CASE

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

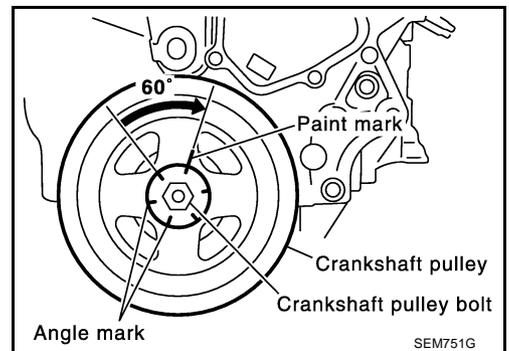


12. Install crankshaft pulley as follows:

- Install crankshaft pulley, taking care not to damage front oil seal.
  - When press-fitting crankshaft pulley with plastic hammer, tap on its center portion (not circumference).
- Fix crankshaft with pulley holder [SST: KV10109300 ( — )].
- Tighten crankshaft pulley bolt.

: 44.1 N·m (4.5 kg-m, 33 ft-lb)

- Put a paint mark on crankshaft pulley aligning with angle mark on crankshaft pulley bolt. Then, further retighten bolt by 60 degrees. (Angle tightening)



- Rotate crankshaft pulley in normal direction (clockwise when viewed from engine front) to confirm it turns smoothly.
- Install in the reverse order of removal after this step.

**NOTE:**

If hydraulic pressure inside timing chain tensioner drops after removal/installation, slack in the guide may generate a pounding noise during and just after engine start. However, this is normal. Noise will stop after hydraulic pressure rises.

## INSPECTION AFTER INSTALLATION

- Before starting engine, check the levels of engine coolant, lubrications and working fluid. If less than required quantity, fill to the specified level.
- Run engine to check for unusual noise and vibration.
- Warm up engine thoroughly to make sure there is no leakage of engine coolant, engine oil and working fluid.
- Bleed air from passages in pipes and tubes of applicable lines, such as in cooling system.
- After cooling down engine, again check levels of engine coolant, engine oil and working fluid. Refill to the 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
Working fluid	Level	Leakage	Level



# TIMING CHAIN

- |                                       |                                       |                                       |
|---------------------------------------|---------------------------------------|---------------------------------------|
| 1. Timing chain tensioner (secondary) | 2. Internal chain guide               | 3. Timing chain tensioner (secondary) |
| 4. Camshaft sprocket (EXH)            | 5. Timing chain (secondary)           | 6. Timing chain (primary)             |
| 7. Camshaft sprocket (INT)            | 8. Camshaft sprocket (EXH)            | 9. Timing chain (secondary)           |
| 10. Camshaft sprocket (INT)           | 11. Slack guide                       | 12. Crankshaft sprocket               |
| 13. Timing chain tensioner (primary)  | 14. Intake valve timing control cover | 15. Chain tensioner cover             |
| 16. Water hose clamp                  | 17. Water pump cover                  | 18. Intake valve timing control cover |
| 19. Front oil seal                    | 20. Crankshaft pulley                 | 21. Idler pulley                      |
| 22. Idler pulley bracket              | 23. Front timing chain case           | 24. Rear timing chain case            |
| 25. Water drain plug (front)          | 26. Tension guide                     | 27. O-ring                            |

## NOTE:

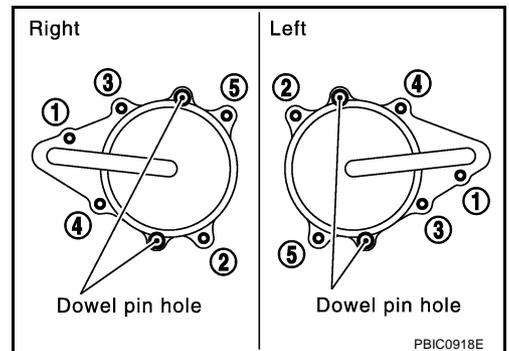
- This section describes procedures for removal/installation front timing chain case and timing chain related parts, and rear timing chain case, when oil pan (upper) needs to be removed/installed for engine overhaul, etc.
- To removal/installation front timing chain case, timing chain, and its related parts without removing oil pan (upper), refer to [EM-49, "FRONT TIMING CHAIN CASE"](#).

## REMOVAL

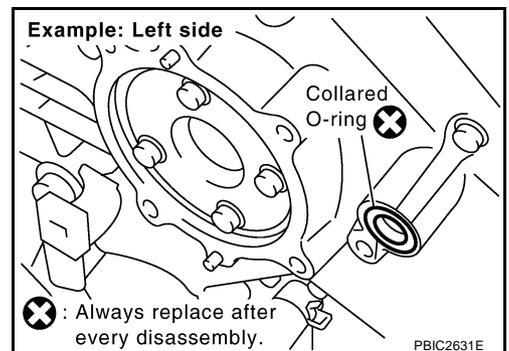
1. Remove engine assembly from vehicle, and separate front suspension member and transaxle from engine. Refer to [EM-105, "ENGINE ASSEMBLY"](#).
2. Install engine sub-attachment with engine stand shaft [SST: KV10117001 ( — ) and KV10106500 ( — )] to right side of cylinder block, then lift engine, and mount it onto engine stand [SST: ST0501S000 ( — )]. Refer to [EM-110, "CYLINDER BLOCK"](#).
3. Drain engine oil. Refer to [LU-8, "Changing Engine Oil"](#).
4. Drain engine coolant from inside engine. Refer to [EM-111, "DISASSEMBLY"](#).
5. Remove intake manifold collectors (upper and lower). Refer to [EM-16, "INTAKE MANIFOLD COLLECTOR"](#).
6. Remove rocker covers (right and left banks). Refer to [EM-46, "ROCKER COVER"](#).
7. Remove oil pans (lower and upper) and oil strainer. Refer to [EM-28, "OIL PAN AND OIL STRAINER"](#).
8. Remove idler pulley and bracket.
9. Separate engine harness removing their brackets from front timing chain case
10. Remove right and left intake valve timing control covers.
  - Loosen mounting bolts in reverse order as shown in the figure.
  - Use seal cutter [SST: KV10111100 (J37228)] to cut liquid gasket for removal.

### CAUTION:

**Shaft is internally jointed with camshaft sprocket (INT) center hole. When removing, keep it horizontal until it is completely disconnected.**



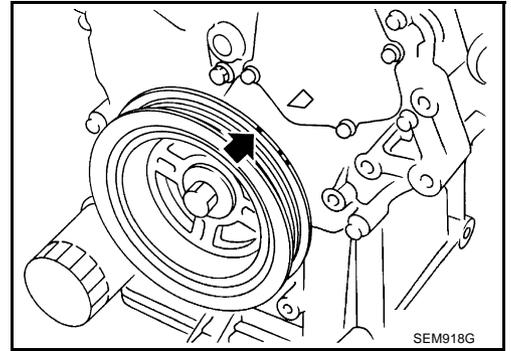
11. Remove collared O-ring from front timing chain case oil hole (left and right sides).



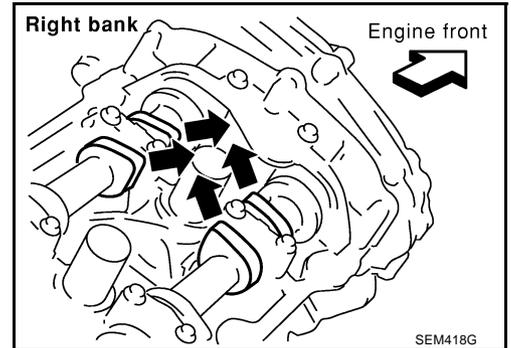
12. Obtain No. 1 cylinder at TDC of its compression stroke as follows:

## TIMING CHAIN

- a. Rotate crankshaft pulley clockwise to align timing mark (grooved line without color) with timing indicator.



- b. Make sure that intake and exhaust cam noses on No. 1 cylinder (engine front side of right bank) are located as shown in the figure.
- If not, turn crankshaft one revolution (360 degrees) and align as shown in the figure.

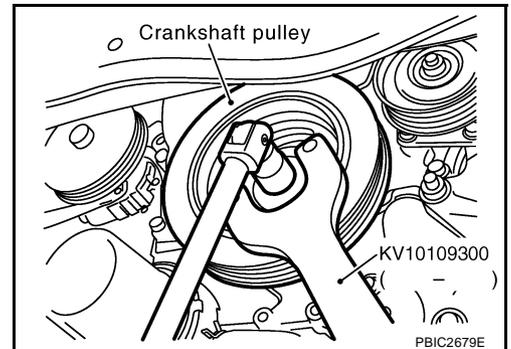


13. Remove crankshaft pulley as follows:

- a. Fix crankshaft with pulley holder [SST].
- b. Loosen crankshaft pulley bolt and locate bolt seating surface at 10 mm (0.39 in) from its original position.

**CAUTION:**

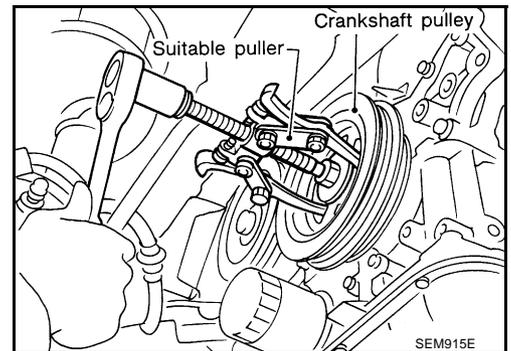
**Do not remove crankshaft pulley bolt as it will be used as a supporting point for suitable puller.**



- c. Place suitable puller tab on holes of crankshaft pulley, and pull crankshaft pulley through.

**CAUTION:**

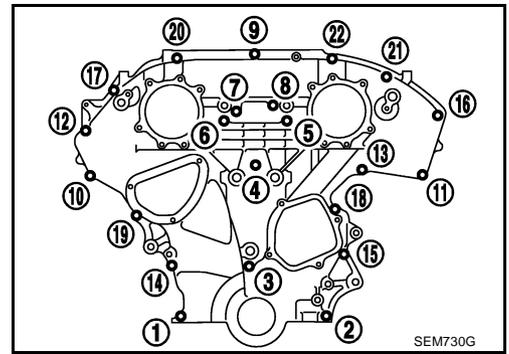
**Do not put suitable puller tab on crankshaft pulley periphery, as this will damage internal damper.**



14. Remove front timing chain case as follows:

# TIMING CHAIN

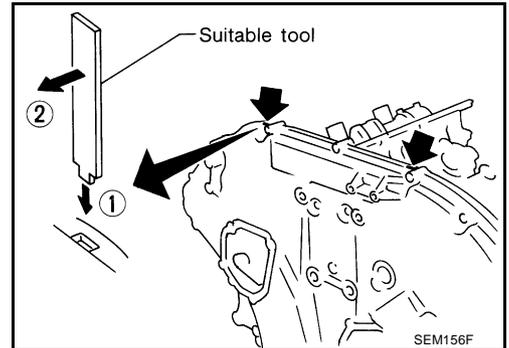
a. Loosen mounting bolts in reverse order as shown in the figure.



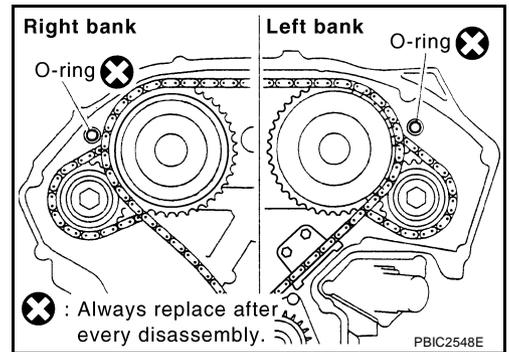
- b. Insert suitable tool into the notch at the top of front timing chain case as shown (1).
- c. Pry off case by moving tool as shown (2).
- Use seal cutter [SST: KV10111100 (J37228)] to cut liquid gasket for removal.

**CAUTION:**

- Do not use screwdrivers or something similar.
- After removal, handle front timing chain case carefully so it does not tilt, cant, or warp under a load.



15. Remove O-rings from rear timing chain case.



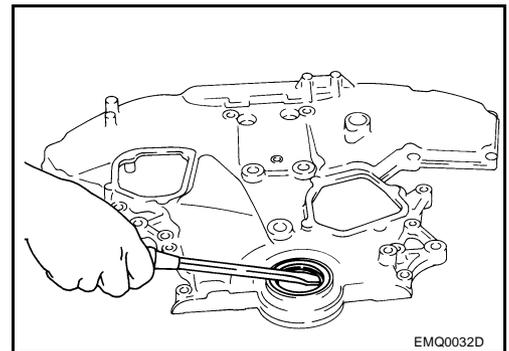
16. Remove water pump cover and chain tensioner cover from front timing chain case.
- Use seal cutter [SST: KV10111100 (J37228)] to cut liquid gasket for removal.

17. Remove front oil seal from front timing chain case using suitable tool.

- Use screwdriver for removal.

**CAUTION:**

**Be careful not to damage front timing chain case.**



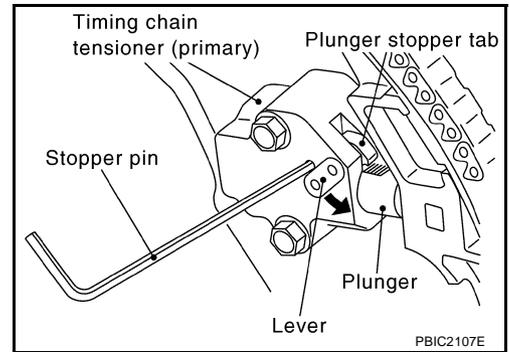
18. Remove timing chain tensioner (primary) as follows:

## TIMING CHAIN

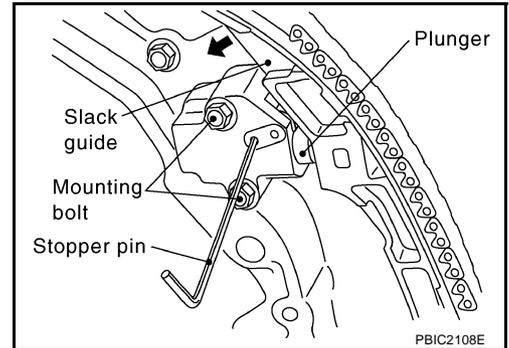
- a. Pull lever down and release plunger stopper tab.
  - Plunger stopper tab can be pushed up to release (coaxial structure with lever).
- b. Insert stopper pin into tensioner body hole to hold lever, and keep tab released.

**NOTE:**

Allen wrench [2.5 mm (0.098 in)] is used for a stopper pin as an example.



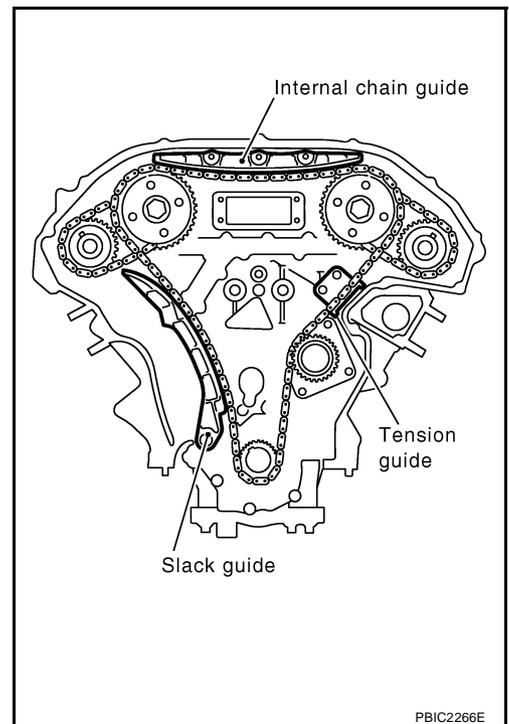
- c. Insert plunger into tensioner body by pressing slack guide.
- d. Keep slack guide pressed and hold it by pushing stopper pin through the lever hole and body hole.
- e. Remove mounting bolts and remove timing chain tensioner (primary).



19. Remove internal chain guide, tension guide and slack guide.

**NOTE:**

Tension guide can be removed after removing timing chain (primary).



20. Remove timing chain (primary) and crankshaft sprocket.

**CAUTION:**

**After removing timing chain (primary), do not turn crankshaft and camshaft separately, or valves will strike the piston heads.**

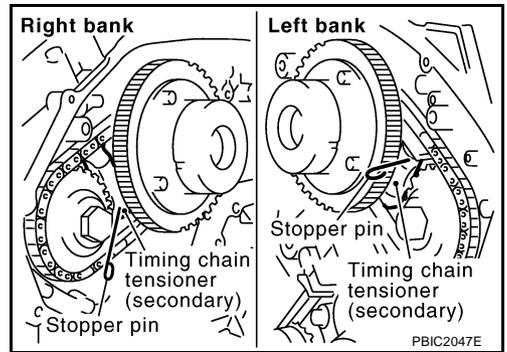
21. Remove timing chain (secondary) and camshaft sprockets as follows:

# TIMING CHAIN

- a. Attach suitable stopper pin to the right and left timing chain tensioners (secondary).

**NOTE:**

- Use approximately 0.5 mm (0.02 in) dia. hard metal pin as a stopper pin.
- For removal of timing chain tensioner (secondary), refer to [EM-77, "CAMSHAFT"](#) . [Removing camshaft bracket (No. 1) is required.]

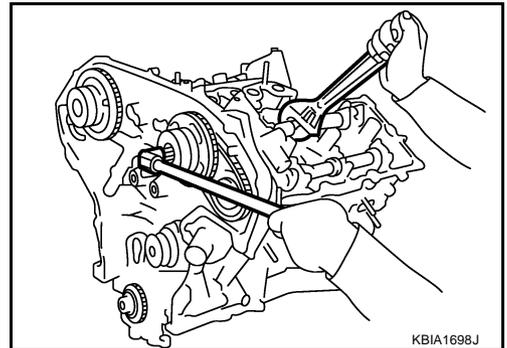


- b. Remove camshaft sprockets (INT and EXH) mounting bolts.

- Secure the hexagonal portion of camshaft using wrench to loosen mounting bolts.

**CAUTION:**

**Do not loosen mounting bolts with securing anything other than the camshaft hexagonal portion or with tensioning the timing chain.**



- c. Remove timing chain (secondary) together with camshaft sprockets.

- Turn camshaft slightly to secure slackness of timing chain on timing chain tensioner (secondary) side.

- Insert 0.5 mm (0.020 in)-thick metal or resin plate between timing chain and timing chain tensioner plunger (guide). Remove timing chain (secondary) together with camshaft sprockets with timing chain loose from guide groove.

**CAUTION:**

**Be careful of plunger coming-off when removing timing chain (secondary). This is because plunger of timing chain tensioner (secondary) moves during operation, leading to coming-off of fixed stopper pin.**

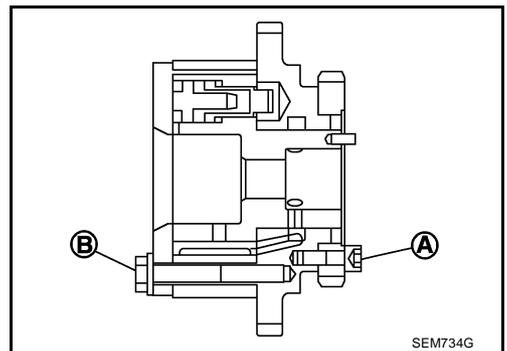
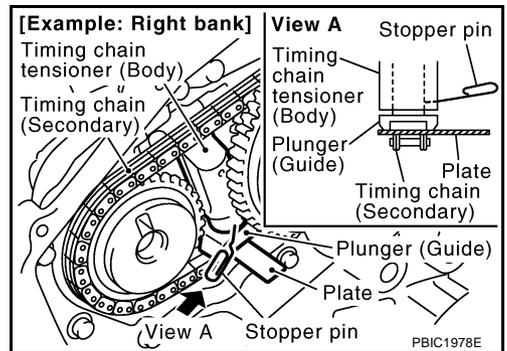
**NOTE:**

Camshaft sprocket (INT) is two-for-one structure of sprockets for timing chain (primary) and for timing chain (secondary).

- When handling camshaft sprocket (INT), be careful of the following caution:

**CAUTION:**

- Handle carefully to avoid any shock to camshaft sprocket.
- Do not disassemble. (Do not loosen bolts "A" and "B" as shown in the figure).

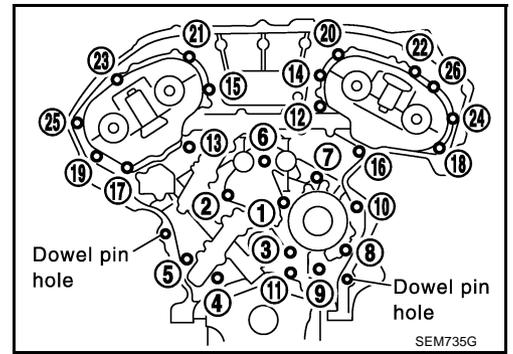


22. Remove water pump. Refer to [CO-22, "WATER PUMP"](#) .

23. Remove rear timing chain case as follows:

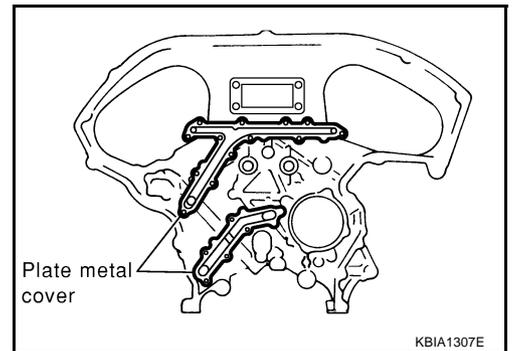
## TIMING CHAIN

- a. Loosen and remove mounting bolts in reverse order as shown in the figure.
- b. Cut liquid gasket using seal cutter [SST: KV10111100 (J37228)] and remove rear timing chain case.

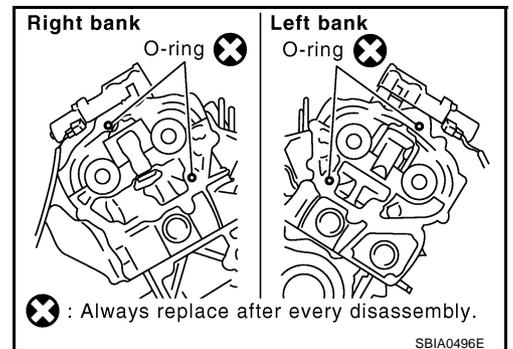


### CAUTION:

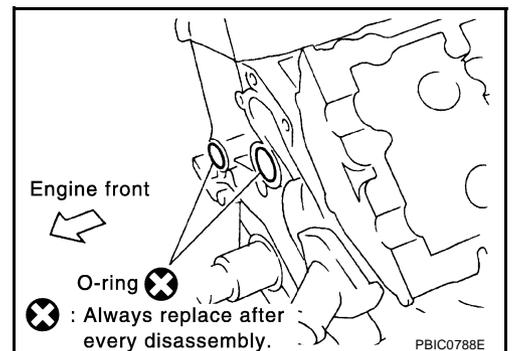
- Do not remove plate metal cover of oil passage.
- After removal, handle rear timing chain case carefully so it does not tilt, cant, or warp under a load.



24. Remove O-rings from cylinder head.



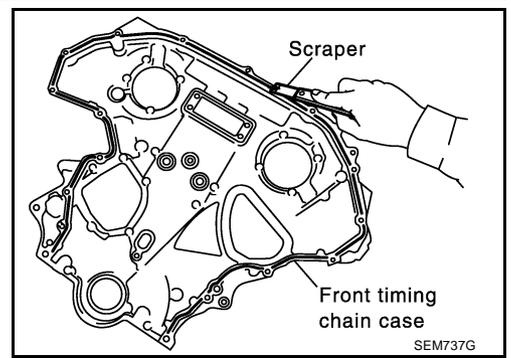
25. Remove O-rings from cylinder block.



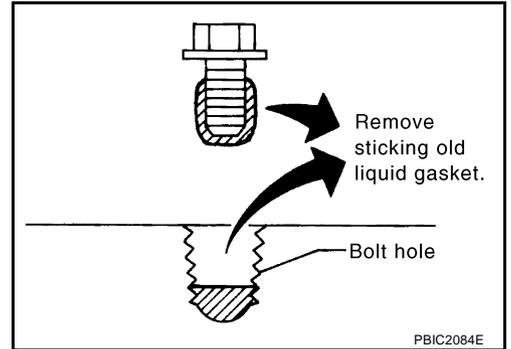
26. Remove timing chain tensioners (secondary) from cylinder head as follows, if necessary.
  - a. Remove camshaft brackets (No. 1). Refer to [EM-77, "REMOVAL"](#).
  - b. Remove timing chain tensioners (secondary) with stopper pin attached.

# TIMING CHAIN

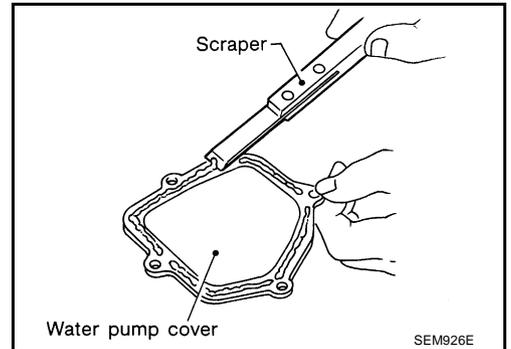
27. Use scraper to remove all traces of old liquid gasket from front and rear timing chain cases, and opposite mating surfaces.



- Remove old liquid gasket from bolt hole and thread.



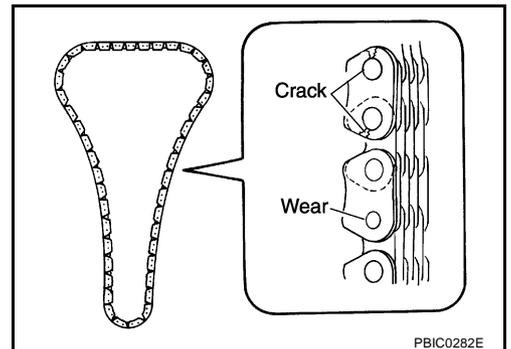
28. Use scraper to remove all traces of old liquid gasket from water pump cover, chain tensioner cover and intake valve timing control covers.



## INSPECTION AFTER REMOVAL

### Timing Chain

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



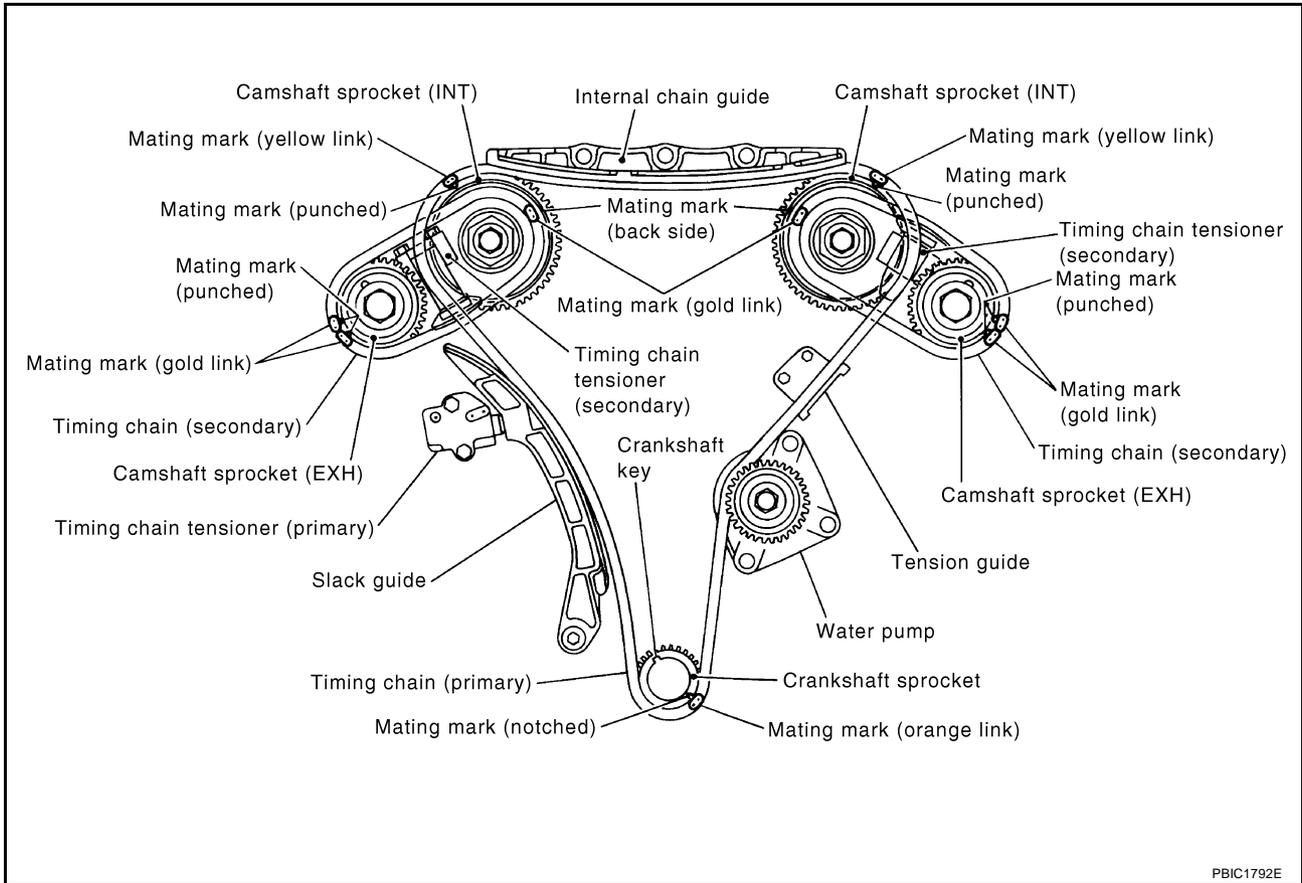
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# TIMING CHAIN

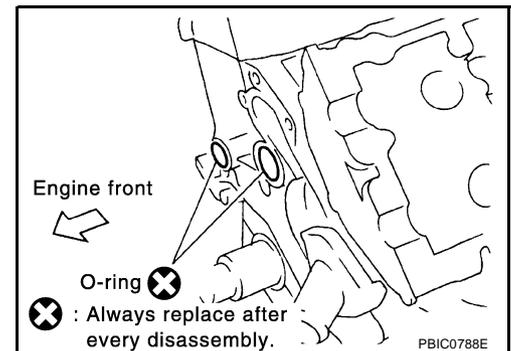
## INSTALLATION

### NOTE:

The below figure shows the relationship between the mating mark on each timing chain and that on the corresponding sprocket, with the components installed.

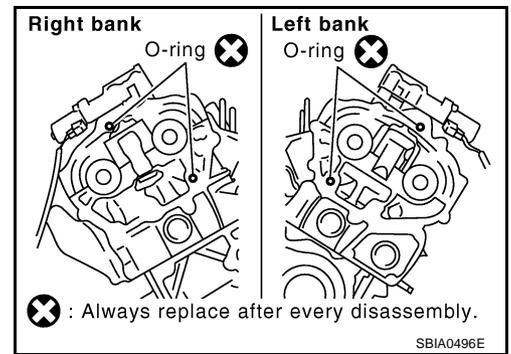


1. Install timing chain tensioners (secondary) to cylinder head as follows if removed. Refer to [EM-82, "INSTALLATION"](#).
  - a. Install timing chain tensioners (secondary) with stopper pin attached and new O-ring.
  - b. Install camshaft brackets (No. 1). Refer to [EM-82, "INSTALLATION"](#).
2. Install rear timing chain case as follows:
  - a. Install new O-rings onto cylinder block.



# TIMING CHAIN

b. Install new O-rings to cylinder head.

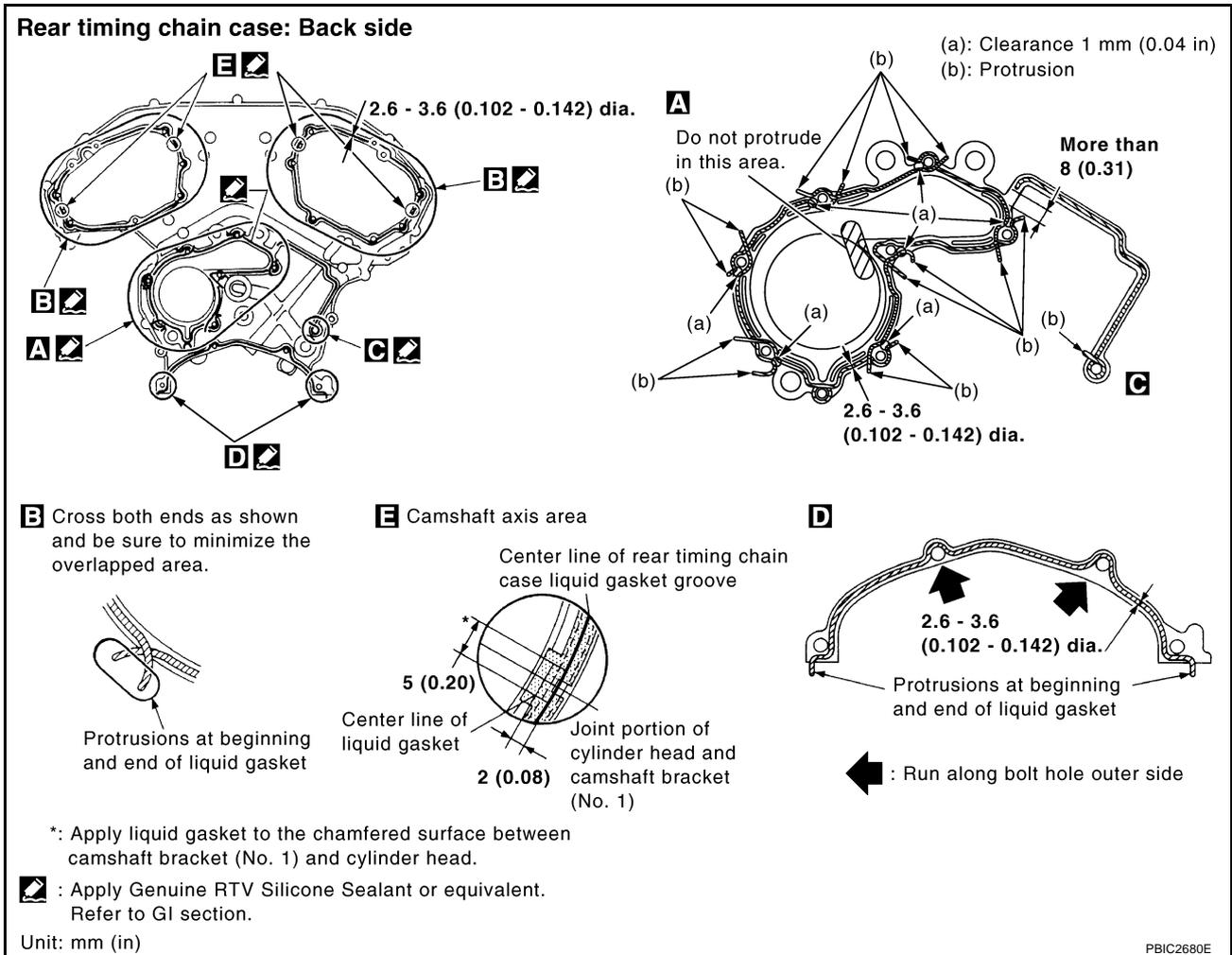


c. Apply liquid gasket with tube presser [SST: WS39930000 ( — )] to rear timing chain case back side as shown in the figure.

Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-47, "RECOMMENDED CHEMICAL PRODUCTS AND SEALANTS"](#) .

**CAUTION:**

- For "A" in the figure, completely wipe out liquid gasket extended on a portion touching at engine coolant.
- Apply liquid gasket on installation position of water pump and cylinder head very completely.



d. Align rear timing chain case and water pump assembly with dowel pins (right and left) on cylinder block and install rear timing chain case.

- Make sure O-rings stay in place during installation to cylinder block and cylinder head.

## TIMING CHAIN

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

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

Bolt length:	Bolt position
20 mm (0.79 in)	: 1, 2, 3, 6, 7, 8, 9, 10
16 mm (0.63 in)	: Except the above

 : 11.7 - 13.7 N·m (1.2 - 1.4 kg·m, 9 - 10 ft·lb)

- f. After all bolts tightening, retighten them to the specified in numerical order as shown in the figure.

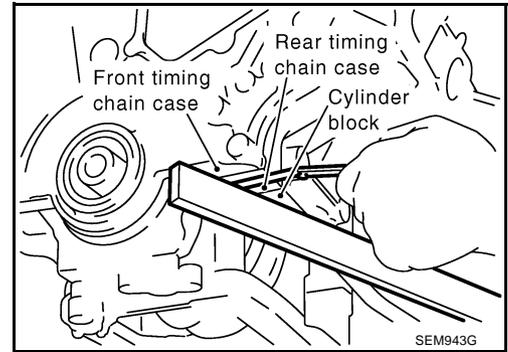
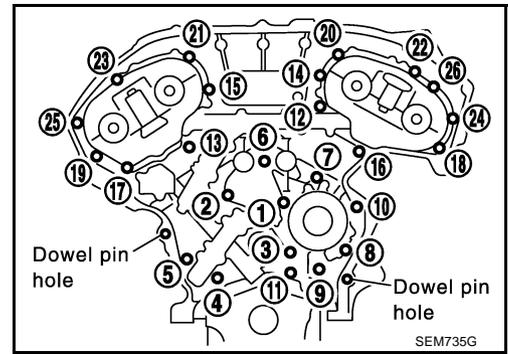
- If liquid gasket protrudes, wipe it off immediately.

- g. After installing rear timing chain case, check the surface height difference between the following parts on the oil pan (upper) mounting surface.

### Standard

**Rear timing chain case to cylinder block:**  
-0.24 to 0.14 mm (-0.009 to 0.006 in)

- If not within the standard, repeat the installation procedure.



3. Install water pump with new O-rings. Refer to [CO-22, "WATER PUMP"](#) .
4. Make sure that dowel pin hole, dowel pin and crankshaft key are located as shown in the figure. (No. 1 cylinder at compression TDC)

### NOTE:

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

### Camshaft dowel pin hole (intake side)

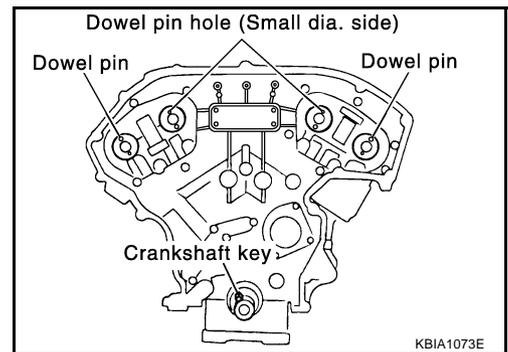
: At cylinder head upper face side in each bank

### Camshaft dowel pin (exhaust side)

: At cylinder head upper face side in each bank

### Crankshaft key

: At cylinder head side of right bank



### CAUTION:

Hole on small dia. side must be used for intake side dowel pin hole. Do not misidentify (ignore big dia. side).

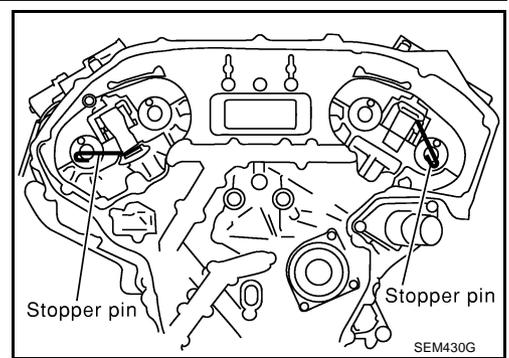
5. Install timing chain (secondary) and camshaft sprockets (INT and EXH) as follows:

### CAUTION:

Mating marks between timing chain and sprockets slip easily. Confirm all mating mark positions repeatedly during the installation process.

# TIMING CHAIN

- a. Push plunger of timing chain tensioner (secondary) and keep it pressed in with stopper pin.



- b. Install timing chain (secondary) and camshaft sprockets (INT and EXH).

- Align the mating marks on timing chain (secondary) (gold link) with the ones on camshaft sprockets (INT and EXH) (punched), and install them.

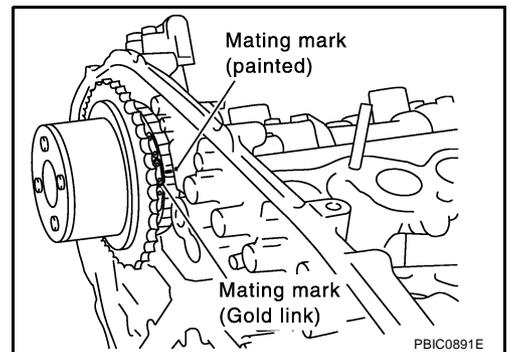
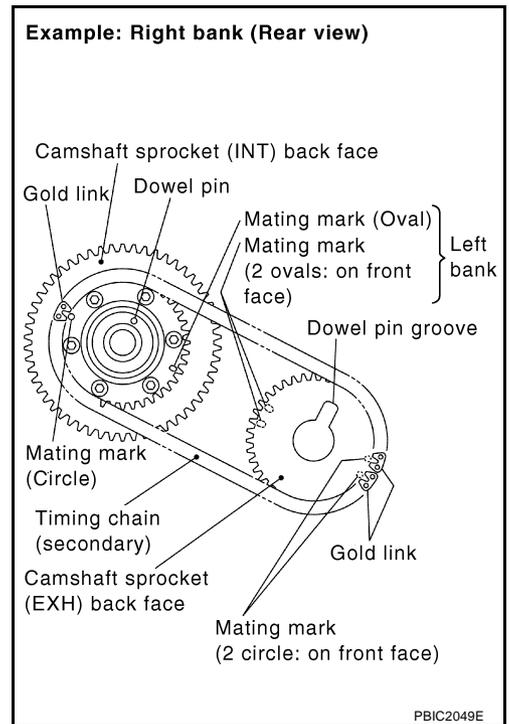
**NOTE:**

- Mating marks for camshaft sprocket (INT) are on the back side of camshaft sprocket (secondary).
- There are two types of mating mark, circle and oval types. They should be used for the right and left banks, respectively.

**Right bank : Use circle type.**

**Left bank : Use oval type.**

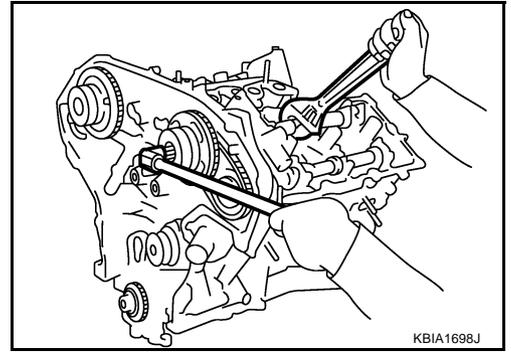
- Align dowel pin and pin hole on camshafts with the groove and dowel pin on sprockets, and install them.
- On the intake side, align pin hole on the small diameter side of the camshaft front end with dowel pin on the back side of camshaft sprocket, and install them.
- On the exhaust side, align dowel pin on camshaft front end with pin groove on camshaft sprocket, and install them.
- In case that positions of each mating mark and each dowel pin are not fit on mating parts, make fine adjustment to the position holding the hexagonal portion on camshaft with wrench or equivalent.
- Mounting bolts for camshaft sprockets must be tightened in the next step. Tightening them by hand is enough to prevent the dislocation of dowel pins.
- It may be difficult to visually check the dislocation of mating marks during and after installation. To make the matching easier, make a mating mark on the top of sprocket teeth and its extended line in advance with paint.



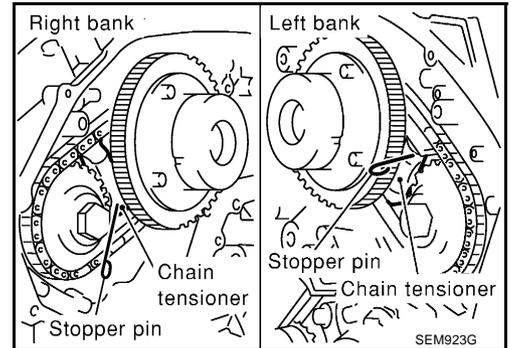
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## TIMING CHAIN

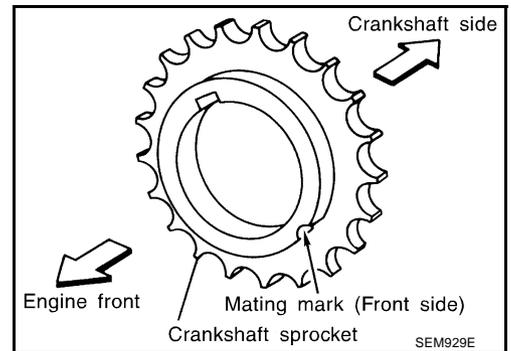
- c. After confirming the mating marks are aligned, tighten camshaft sprocket mounting bolts.
- Secure camshaft using wrench at the hexagonal portion to tighten mounting bolts.



- d. Pull stopper pins out from timing chain tensioners (secondary).



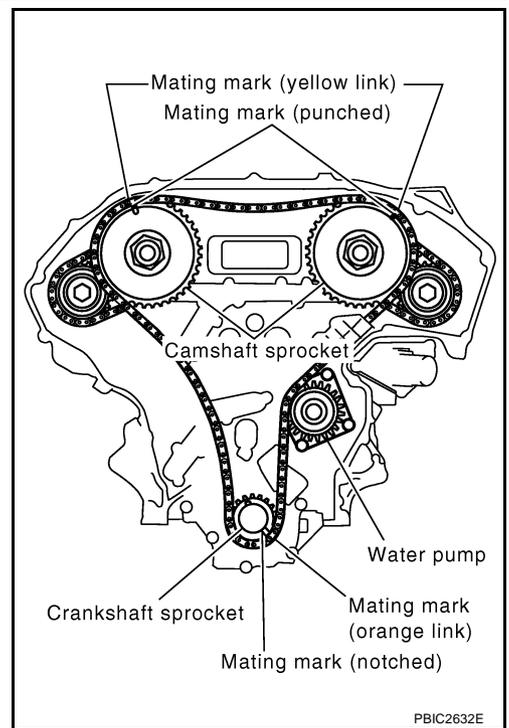
6. Install tension guide.
7. Install timing chain (primary) as follows:
- a. Install crankshaft sprocket.
- Make sure the mating marks on crankshaft sprocket face the front of engine.



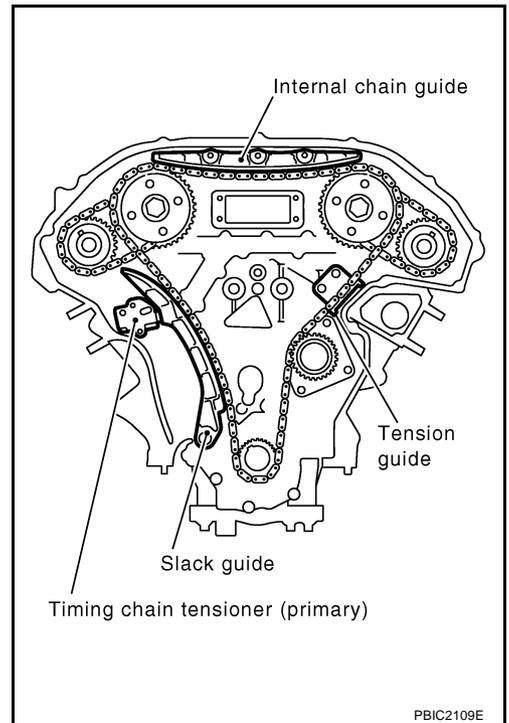
- b. Install timing chain (primary).

# TIMING CHAIN

- Install timing chain (primary) so the mating mark (punched) on camshaft sprocket (INT) is aligned with the yellow link on timing chain, while the mating mark (notched) on crankshaft sprocket is aligned with the orange one on timing chain, as shown in the figure.
- When it is difficult to align mating marks of timing chain (primary) with each sprocket, gradually turn camshaft using wrench on the hexagonal portion to align it with the mating marks.
- During alignment, be careful to prevent dislocation of mating mark alignments of timing chains (secondary).



8. Install internal chain guide, slack guide and timing chain tensioner (primary).

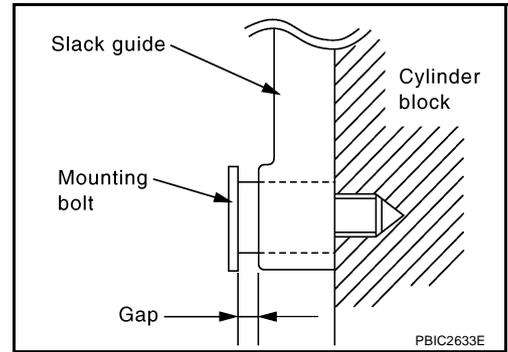


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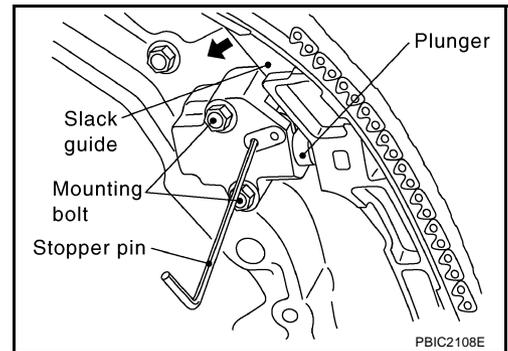
# TIMING CHAIN

## CAUTION:

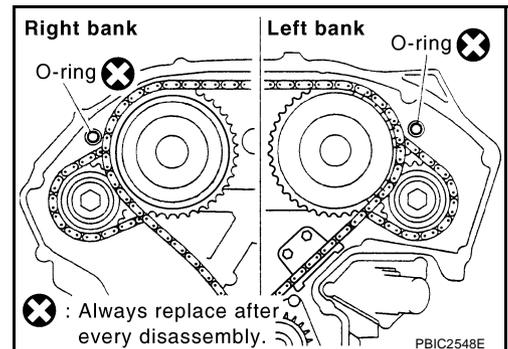
Do not overtighten slack guide mounting bolt. It is normal for a gap to exist under the bolt seat when mounting bolt is tightened to specification.



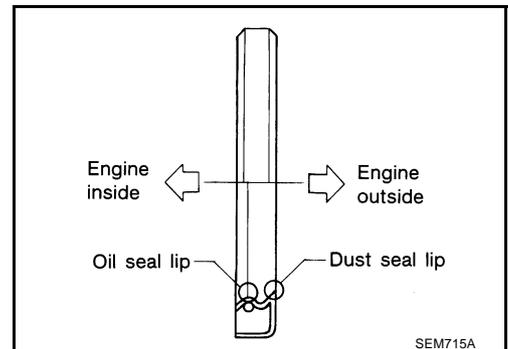
- When installing timing chain tensioner (primary), push in plunger and keep it pressed in with stopper pin.
- Remove any dirt and foreign materials completely from the back and the mounting surfaces of timing chain tensioner (primary).
- After installation, pull out stopper pin by pressing slack guide.



9. Make sure again that the mating marks on each sprocket and each timing chain have not slipped out of alignment.
10. Install new O-rings on rear timing chain case.

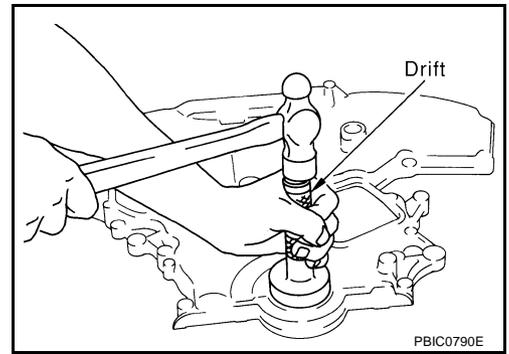


11. Install new front oil seal on front timing chain case.
  - Apply new engine oil to both oil seal lip and dust seal lip.
  - Install it so that each seal lip is oriented as shown in the figure.



# TIMING CHAIN

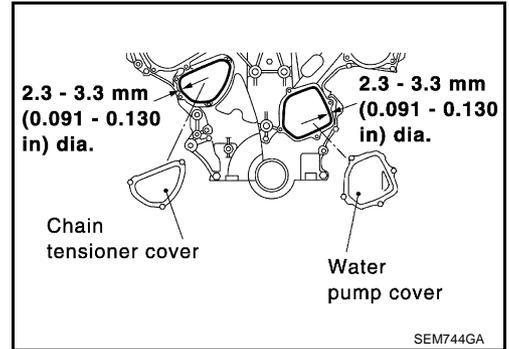
- Using suitable drift [outer diameter: 60 mm (2.36 in)], press-fit oil seal until it becomes flush with front timing chain case end face.
- Make sure the garter spring is in position and seal lip is not inverted.



12. Install water pump cover and chain tensioner cover to front timing chain case.

- Apply a continuous bead of liquid gasket with tube presser [SST: WS39930000 ( — )] to front timing chain case as shown in the figure.

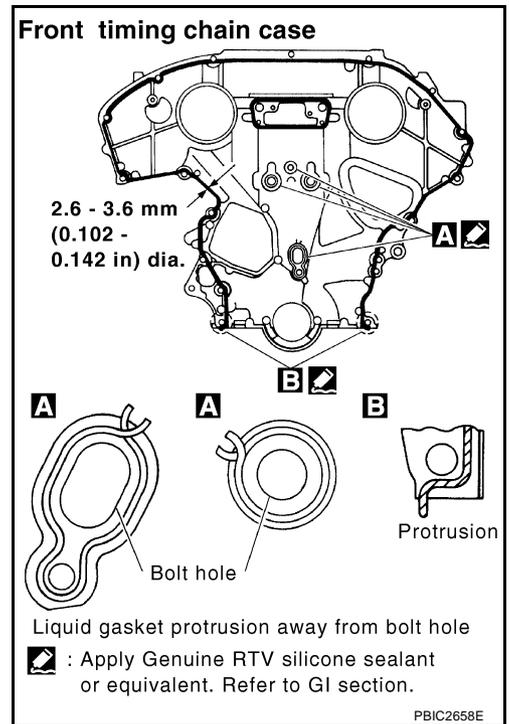
**Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-47, "RECOMMENDED CHEMICAL PRODUCTS AND SEALANTS"](#).**



13. Install front timing chain case as follows:

- a. Apply a continuous bead of liquid gasket with tube presser [SST: WS39930000 ( — )] to front timing chain case back side as shown in the figure.

**Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-47, "RECOMMENDED CHEMICAL PRODUCTS AND SEALANTS"](#).**



- b. Install front timing chain case as to fit its dowel pin hole together dowel pin on rear timing chain case.

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# TIMING CHAIN

- c. Tighten mounting bolts to the specified torque in numerical order as shown in the figure.
- There are two types of mounting bolt. Refer to the following for locating bolts.

**M8 bolts** : 1, 2

 : 25.5 - 31.3 N·m (2.6 - 3.2 kg·m, 19 - 23 ft·lb)

**M6 bolts** : Except the above

 : 11.7 - 13.7 N·m (1.2 - 1.4 kg·m, 9 - 10 ft·lb)

- d. After all bolts tightening, retighten them to the specified torque in numerical order as shown in the figure.

**CAUTION:**

**Be sure to wipe off any excessive liquid gasket leaking on surface mating with oil pan (upper).**

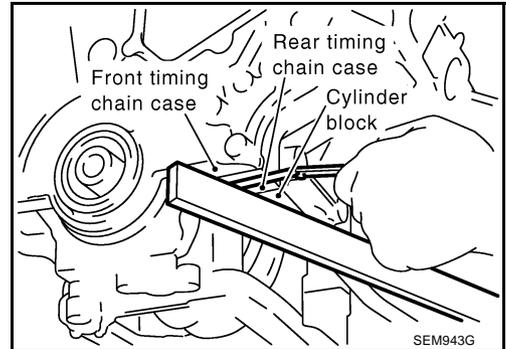
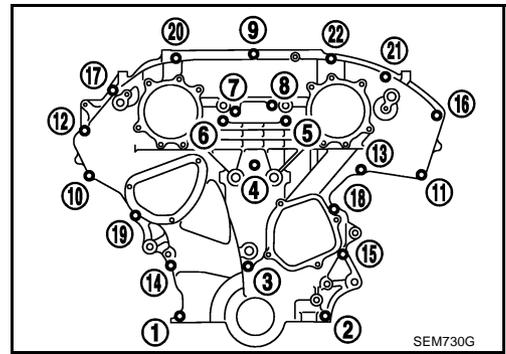
- e. After installing front timing chain case, check the surface height difference between the following parts on the oil pan (upper) mounting surface.

**Standard**

**Front timing chain case to rear timing chain case:**

**-0.14 to 0.14 mm (-0.006 to 0.006 in)**

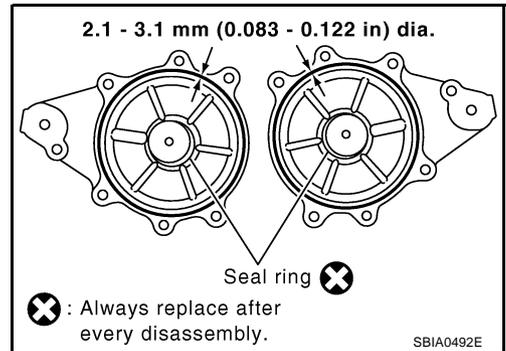
- If not within the standard, repeat the installation procedure.



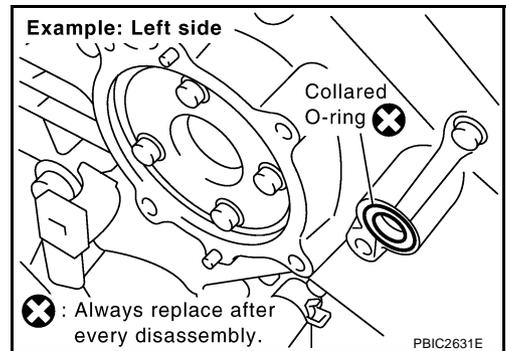
14. Install right and left intake valve timing control covers as follows:

- Install new seal rings in shaft grooves.
- Apply a continuous bead of liquid gasket with tube presser [SST: WS39930000 ( — )] to intake valve timing control covers as shown in the figure.

**Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-47, "RECOMMENDED CHEMICAL PRODUCTS AND SEALANTS"](#).**



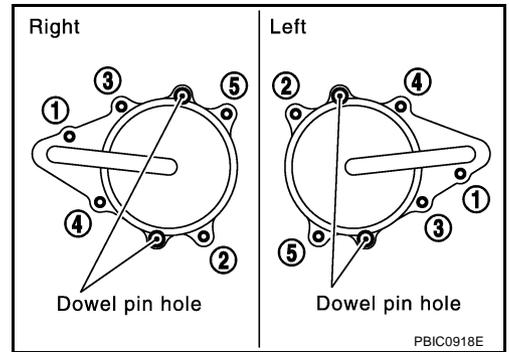
- Install new collared O-rings in front timing chain case oil hole (left and right sides).



- Being careful not to move seal rings from the installation grooves, align dowel pins on front timing chain case with the holes to install intake valve timing control covers.

# TIMING CHAIN

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

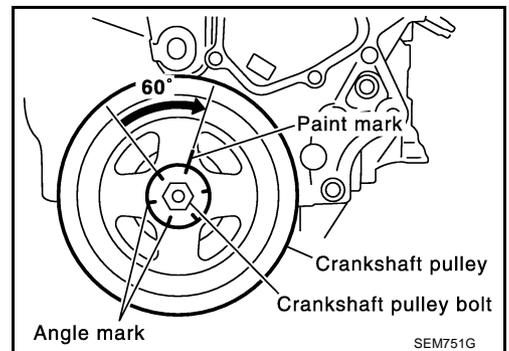


15. Install crankshaft pulley as follows:

- a. Install crankshaft pulley, taking care not to damage front oil seal.
  - When press-fitting crankshaft pulley with plastic hammer, tap on its center portion (not circumference).
- b. Fix crankshaft with pulley holder [SST: KV10109300 ( — )].
- c. Tighten crankshaft pulley bolt.

 : 44.1 N·m (4.5 kg-m, 33 ft-lb)

- d. Put a paint mark on crankshaft pulley aligning with angle mark on crankshaft pulley bolt. Then, further retighten bolt by 60 degrees. (Angle tightening)



16. Rotate crankshaft pulley in normal direction (clockwise when viewed from engine front) to confirm it turns smoothly.
17. Install in the reverse order of removal after this step.

**NOTE:**

If hydraulic pressure inside timing chain tensioner drops after removal/installation, slack in the guide may generate a pounding noise during and just after engine start. However, this is normal. Noise will stop after hydraulic pressure rises.

## INSPECTION AFTER INSTALLATION

- Before starting engine, check the levels of engine coolant, engine oil and working fluid. If less than required quantity, fill to the specified level.
- 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 engine coolant, engine oil, working fluid, fuel and exhaust gases.
- Bleed air from passages in pipes and tubes of applicable lines, such as in cooling system.
- After cooling down engine, again check levels of engine coolant, engine oil and working fluid. Refill to the specified level, if necessary.

**Summary of the inspection items:**

Item	Before starting engine	Engine running	After engine stopped
Engine coolant	Level	Leakage	Level

## TIMING CHAIN

Engine oil	Level	Leakage	Level
Working fluid	Level	Leakage	Level
Fuel	—	Leakage	—
Exhaust gases	—	Leakage	—

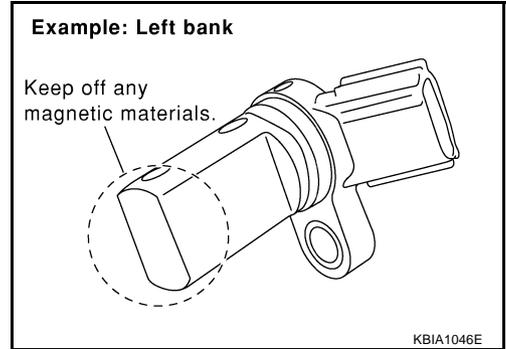


# CAMSHAFT

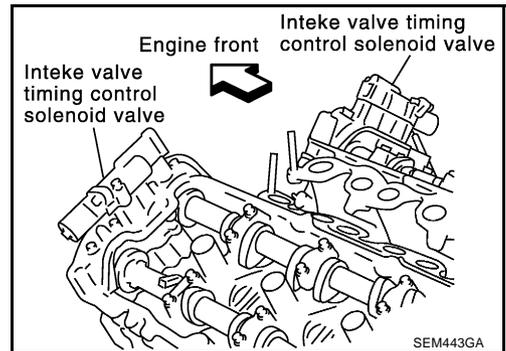
2. Install engine sub-attachment with engine stand shaft [SST: KV10117001 ( — ) and KV10106500 ( — )] to right side of cylinder block, then lift engine, and mount it onto engine stand [SST: ST0501S000 ( — )]. Refer to [EM-110, "CYLINDER BLOCK"](#) .
3. Remove front timing chain case, camshaft sprocket, timing chain and rear timing chain case. Refer to [EM-58, "TIMING CHAIN"](#) .
4. Remove camshaft position sensor (PHASE) (right and left banks) from cylinder head back side.

**CAUTION:**

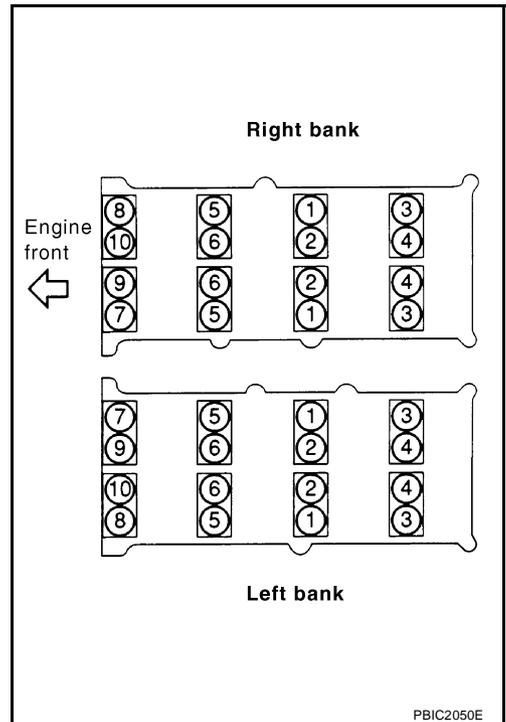
- Handle carefully to avoid dropping and shocks.
- Do not disassemble.
- Do not allow metal powder to adhere to magnetic part at sensor tip.
- Do not place sensors in a location where they are exposed to magnetism.



5. Remove intake valve timing control solenoid valves.
  - Discard intake valve timing control solenoid valve gaskets and use new gaskets for installation.



6. Remove camshaft brackets.
  - Mark camshafts, camshaft brackets and bolts so they are placed in the same position and direction for installation.
  - Equally loosen camshaft bracket bolts in several steps in reverse order as shown in the figure.



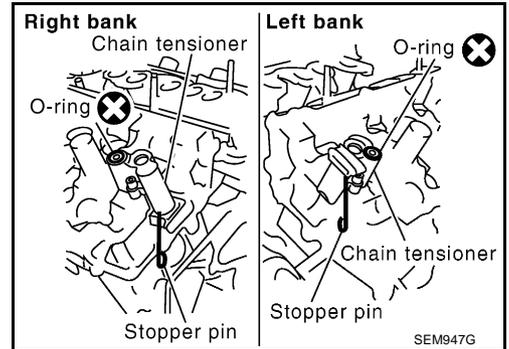
7. Remove camshafts.
8. Remove valve lifters.

# CAMSHAFT

- Identify installation positions, and store them without mixing them up.
- Remove chain tensioner (secondary) from cylinder head.
    - Remove timing chain tensioner (secondary) with its stopper pin attached.

**NOTE:**

Stopper pin was attached when timing chain (secondary) was removed.



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## INSPECTION AFTER REMOVAL

### Camshaft Runout

- Put V-block on precise flat table, and support No. 2 and 4 journal of camshaft.

**CAUTION:**

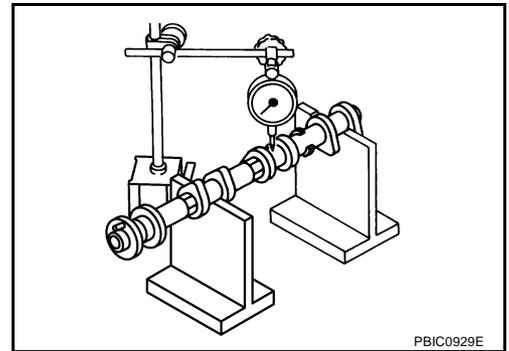
Do not support journal No. 1 (on the side of camshaft sprocket) because it has a different diameter from the other three locations.

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

**Standard** : Less than 0.02 mm (0.001 in)

**Limit** : 0.05 mm (0.002 in)

- If it exceeds the limit, replace camshaft.



### Camshaft Cam Height

- Measure the camshaft cam height with micrometer.

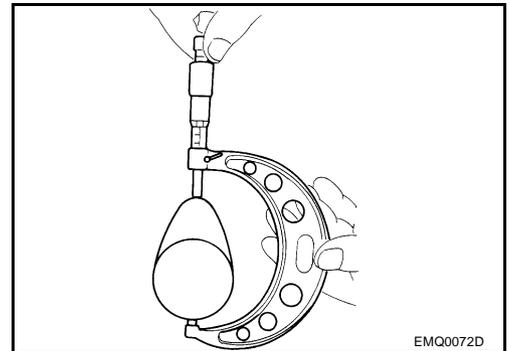
**Standard cam height (intake and exhaust)**

: 44.865 - 45.055 mm (1.7663 - 1.7738 in)

**Cam wear limit**

: 0.2 mm (0.008 in)

- If wear is beyond the limit, replace camshaft.



### Camshaft Journal Oil Clearance

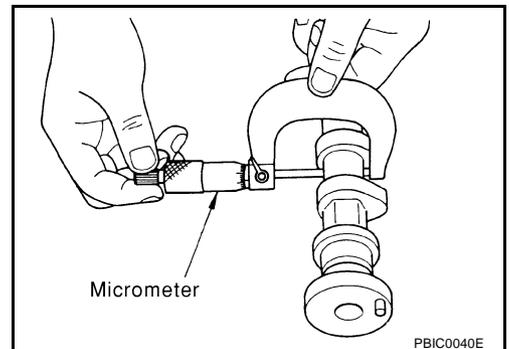
#### CAMSHAFT JOURNAL DIAMETER

- Measure the outer diameter of camshaft journal with micrometer.

**Standard:**

**No. 1** : 25.935 - 25.955 mm (1.0211 - 1.0218 in)

**No. 2, 3, 4** : 23.445 - 23.465 mm (0.9230 - 0.9238 in)



# CAMSHAFT

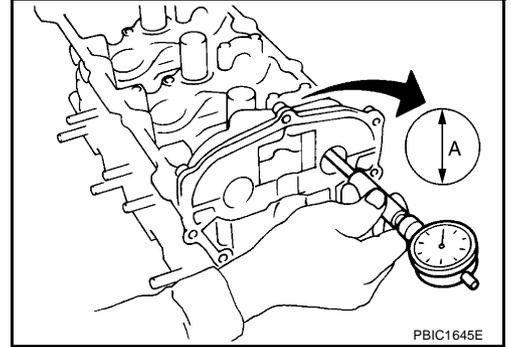
## CAMSHAFT BRACKET INNER DIAMETER

- Tighten camshaft bracket bolt with the specified torque. Refer to [EM-82, "INSTALLATION"](#) for the tightening procedure.
- Measure the inner diameter "A" of camshaft bracket with bore gauge.

### Standard:

No. 1 : 26.000 - 26.021 mm (1.0236 - 1.0244 in)

No. 2, 3, 4 : 23.500 - 23.521 mm (0.9252 - 0.9260 in)



## CAMSHAFT JOURNAL OIL CLEARANCE

- (Oil clearance) = (Camshaft bracket inner diameter) – (Camshaft journal diameter).

### Standard:

No. 1 : 0.045 - 0.086 mm (0.0018 - 0.0034 in)

No. 2, 3, 4 : 0.035 - 0.076 mm (0.0014 - 0.0030 in)

Limit : 0.15 mm (0.0059 in)

- If the calculated value exceeds the limit, replace either or both camshaft and cylinder head.

### NOTE:

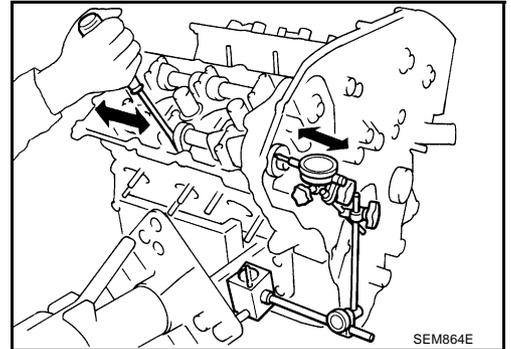
Camshaft bracket cannot be replaced as a single part, because it is machined together with cylinder head. Replace whole cylinder head assembly.

## Camshaft End Play

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

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

Limit : 0.24 mm (0.0094 in)



- Measure the following parts if out of the limit.

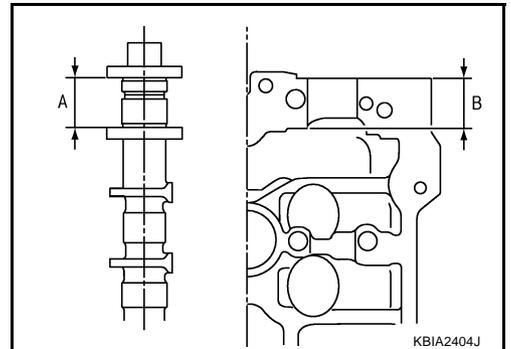
- Dimension "A" for camshaft No. 1 journal

Standard : 27.500 - 27.548 mm (1.0827 - 1.0846 in)

- Dimension "B" for cylinder head No. 1 journal bearing

Standard : 27.360 - 27.385 mm (1.0772 - 1.0781 in)

- Refer to the standards above, and then replace camshaft and/or cylinder head.



## Camshaft Sprocket Runout

1. Put V-block on precise flat table, and support No. 2 and 4 journal of camshaft.

### CAUTION:

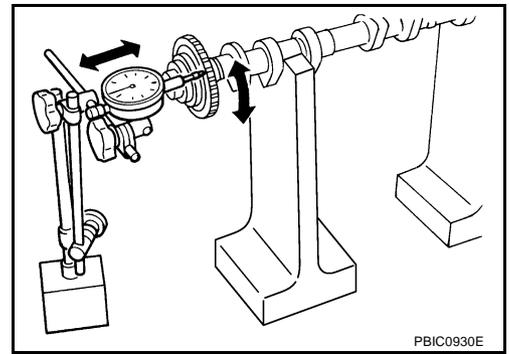
Do not support journal No. 1 (on the side of camshaft sprocket) because it has a different diameter from the other three locations.

# CAMSHAFT

2. Measure the camshaft sprocket runout with dial indicator. (Total indicator reading)

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

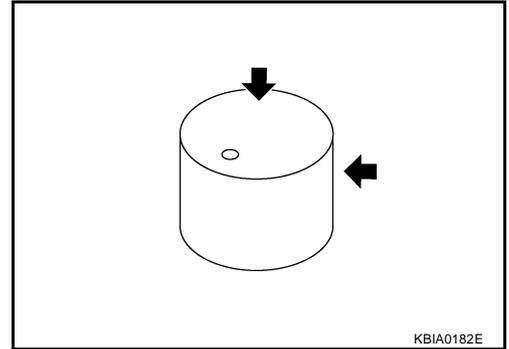
- If it exceeds the limit, replace camshaft sprocket.



## Valve Lifter

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

- If anything above is found, replace valve lifter. Refer to [EM-140](#), "[Available Valve Lifter](#)".



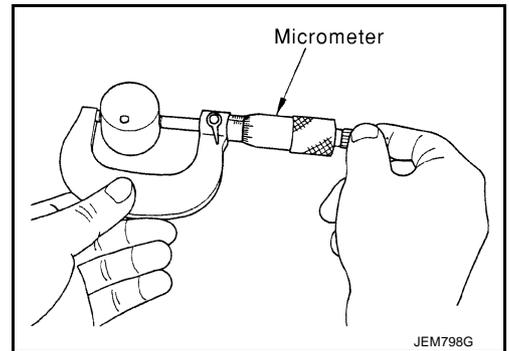
## Valve Lifter Clearance

### VALVE LIFTER OUTER DIAMETER

- Measure the outer diameter at 1/2 height of valve lifter with micrometer since valve lifter is in barrel shape.

**Standard (Intake and exhaust)**

**: 33.977 - 33.987 mm (1.3377 - 1.3381 in)**

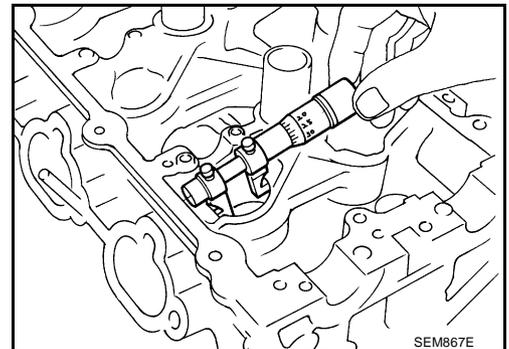


### VALVE LIFTER HOLE DIAMETER

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

**Standard (Intake and exhaust)**

**: 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 (Intake and exhaust)**

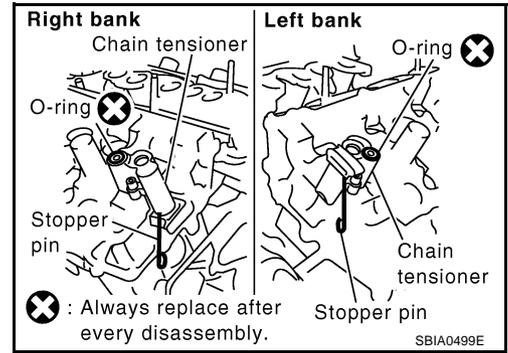
**: 0.013 - 0.039 mm (0.0005 - 0.0015 in)**

- If the calculated value is 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.

# CAMSHAFT

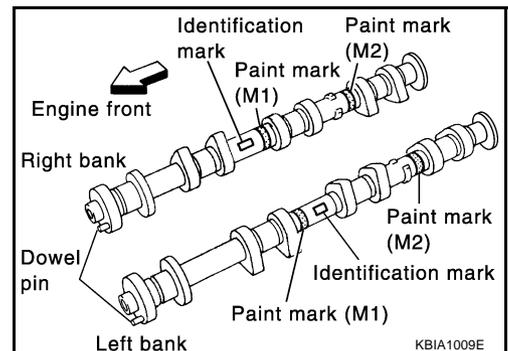
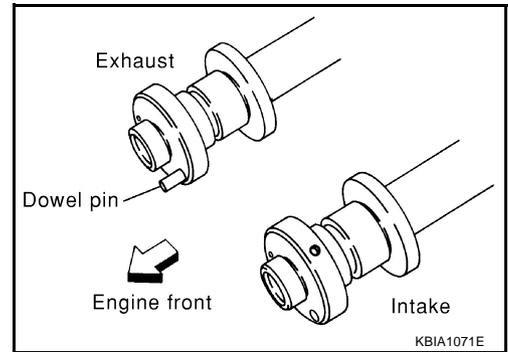
## INSTALLATION

1. Install timing chain tensioners (secondary) on both sides of cylinder head.
  - Install timing chain tensioner with its stopper pin attached.
  - Install timing chain tensioner with sliding part facing downward on right-side cylinder head, and with sliding part facing upward on left-side cylinder head.
  - Install new O-rings as shown in the figure.
2. Install valve lifters.
  - Install it in the original position.
3. Install camshafts.
  - Install camshaft with dowel pin attached to its front end face on the exhaust side.



- Follow your identification marks made during removal, or follow the identification marks that are present on new camshafts for proper placement and direction.

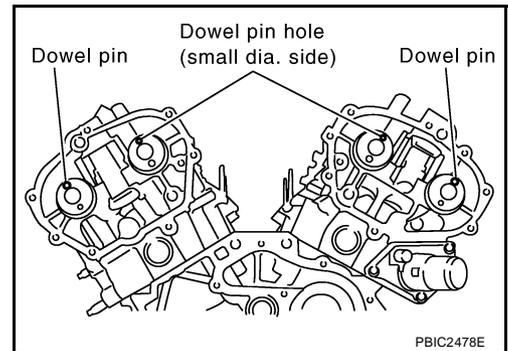
Bank	INT/EXH	Dowel pin	Paint marks		ID mark
			M1	M2	
RH	INT	No	Pink	No	RE
	EXH	Yes	No	Orange	RE
LH	INT	No	Pink	No	LH
	EXH	Yes	No	Orange	LH



- Install camshaft so that dowel pin hole and dowel pin on front end face are positioned as shown in figure. (No. 1 cylinder TDC on its compression stroke)

### NOTE:

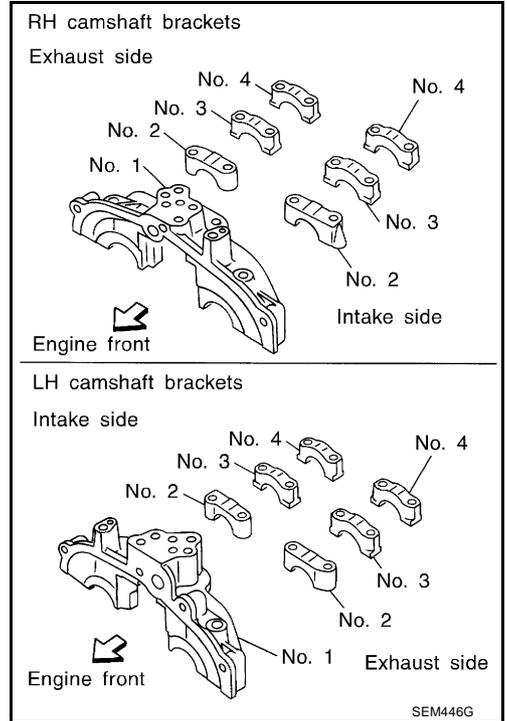
- Large and small pin holes are located on front end face of camshaft (INT), at intervals of 180 degrees. Face small dia. side pin hole upward (in cylinder head upper face direction).
- Though camshaft does not stop at the portion as shown in the figure, for the placement of cam nose, it is generally accepted camshaft is placed for the same direction of the figure.



# CAMSHAFT

## 4. Install camshaft brackets.

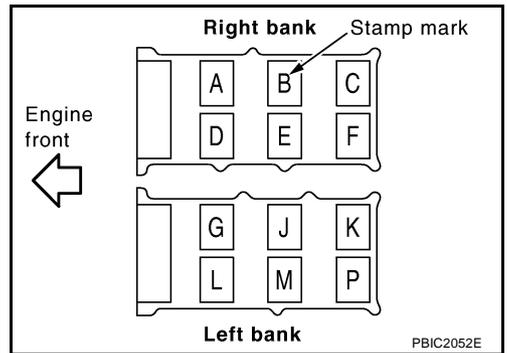
- Remove foreign material completely from camshaft bracket backside and from cylinder head installation face.
- Install camshaft bracket in original position and direction as shown in figure.



- Install camshaft brackets (No. 2 to 4) aligning the stamp marks as shown in the figure.

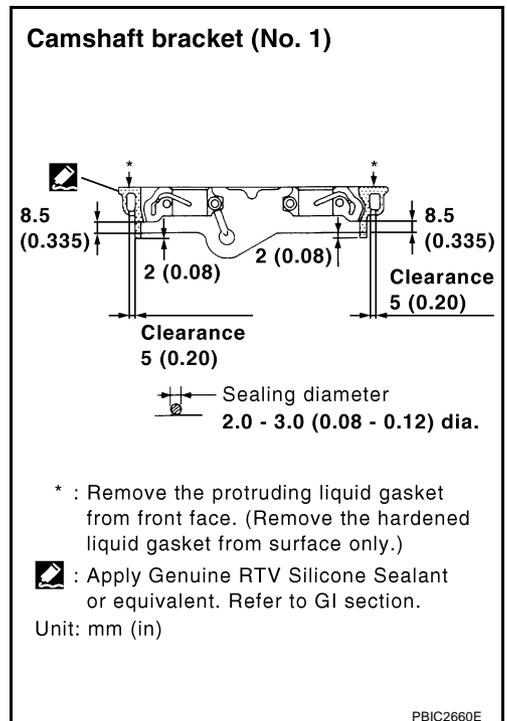
### NOTE:

There are no identification marks indicating left and right for camshaft bracket (No. 1).



- Apply liquid gasket to mating surface of camshaft bracket (No. 1) as shown on right and left banks.

**Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-47, "RECOMMENDED CHEMICAL PRODUCTS AND SEALANTS"](#).**



# CAMSHAFT

5. Tighten camshaft bracket bolts in the following steps, in numerical order as shown in the figure.
  - a. Tighten No. 7 to 10 in order as shown.

 : 2.0 N·m (0.20 kg·m, 1 ft·lb)

- b. Tighten No. 1 to 6 in order as shown.

 : 2.0 N·m (0.20 kg·m, 1 ft·lb)

- c. Tighten No. 1 to 10 in numerical order as shown.

 : 5.9 N·m (0.60 kg·m, 4 ft·lb)

- d. Tighten No. 1 to 6 in numerical order as shown.

 : 10.4 N·m (1.1 kg·m, 8 ft·lb)

- e. Tighten No. 7 to 10 in numerical order as shown.

 : 9.3 N·m (0.95 kg·m, 7 ft·lb)

### CAUTION:

After tightening mounting bolts of camshaft brackets (No. 1), be sure to wipe off excessive liquid gasket from the parts list below.

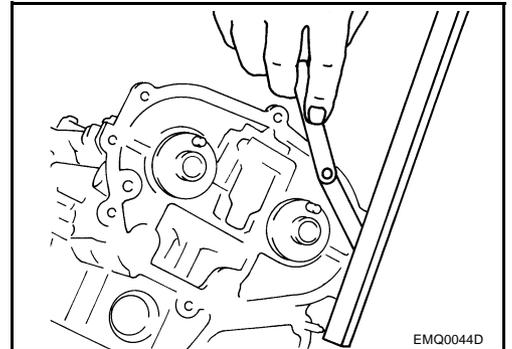
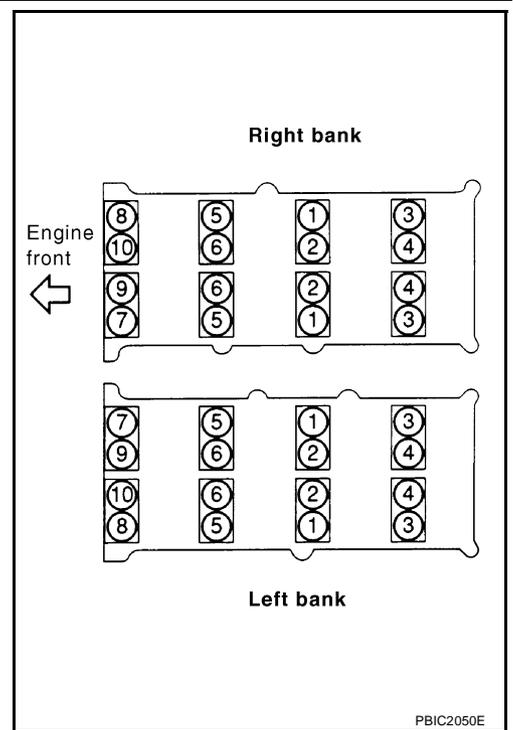
- Mating surface of rocker cover
- Mating surface of rear timing chain case

6. Measure difference in levels between front end faces of No. 1 camshaft bracket (No. 1) and cylinder head.

**Standard** : -0.14 to 0.14 mm (-0.0055 to 0.0055 in)

- Measure two positions (both intake and exhaust side) for a single bank.
- If the measured value is out of the standard, re-install camshaft bracket (No. 1).

7. Inspect and adjust the valve clearance. Refer to [EM-85, "Valve Clearance"](#).
8. Install in the reverse order of removal after this step.



# CAMSHAFT

## INSPECTION AFTER INSTALLATION

- Before starting engine, check the levels of engine coolant, engine oil and working fluid. If less than required quantity, fill to the specified level.
- 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 engine coolant, engine oil, working fluid, fuel and exhaust gases.
- Bleed air from passages in pipes and tubes of applicable lines, such as in cooling system.
- After cooling down engine, again check levels of engine coolant, engine oil and working fluid. Refill to the specified level, if necessary.

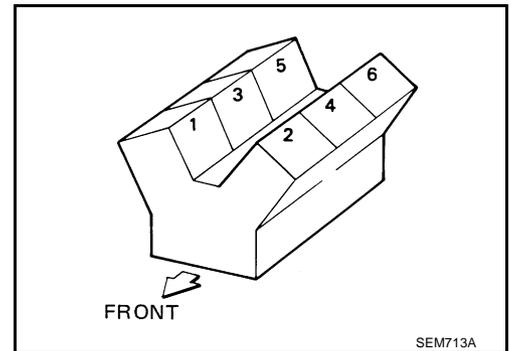
### Summary of the inspection items:

Item	Before starting engine	Engine running	After engine stopped
Engine coolant	Level	Leakage	Level
Engine oil	Level	Leakage	Level
Working fluid	Level	Leakage	Level
Fuel	—	Leakage	—
Exhaust gases	—	Leakage	—

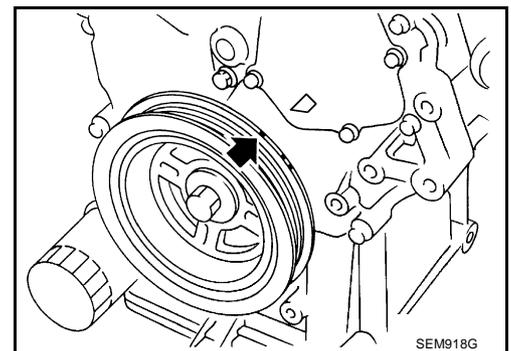
## Valve Clearance INSPECTION

ABS003MI

In cases of removing/installing or replacing camshaft and valve-related parts, or of unusual engine conditions due to changes in valve clearance (found malfunctions during stating, idling or causing noise), perform inspection as follows:

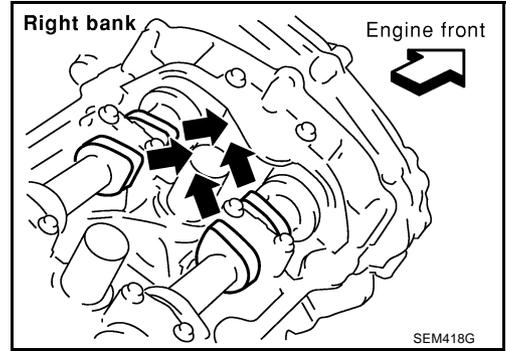


1. Remove rocker covers (right and left banks). Refer to [EM-46. "ROCKER COVER"](#) .
2. Measure the valve clearance as follows:
  - a. Set No. 1 cylinder at TDC of its compression stroke.
    - Rotate crankshaft pulley clockwise to align timing mark (grooved line without color) with timing indicator.



# CAMSHAFT

- Make sure that intake and exhaust cam noses on No. 1 cylinder (engine front side of right bank) are located as shown in the figure.
- If not, turn crankshaft one revolution (360 degrees) and align as shown in the figure.

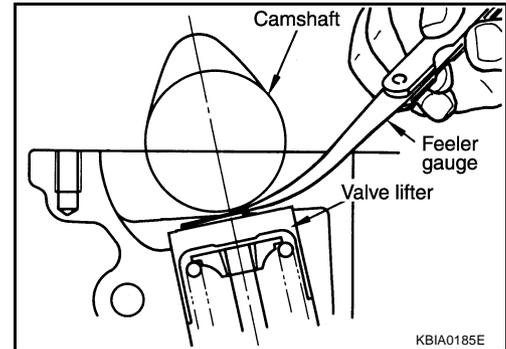
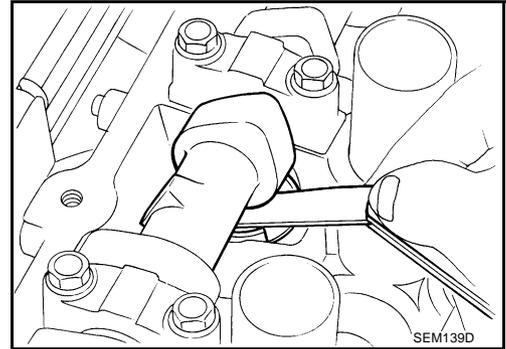


- b. Use feeler gauge, measure the clearance between valve lifter and camshaft.

**Valve clearance standard:**

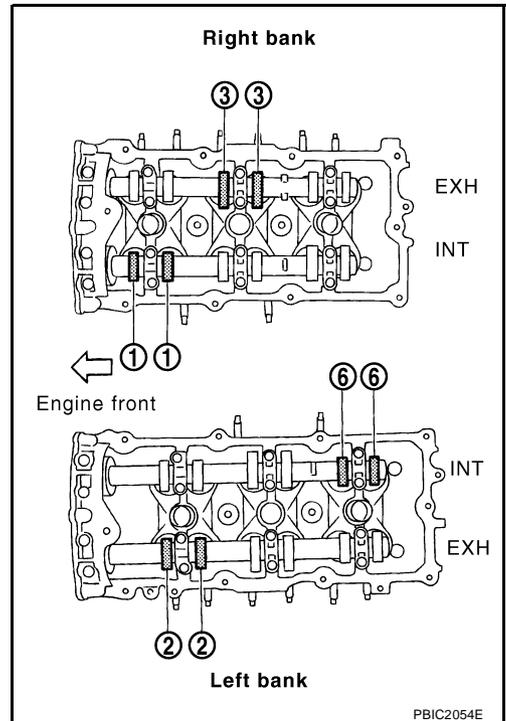
- Cold**    **Intake**    : 0.26 - 0.34 mm (0.010 - 0.013 in)  
               **Exhaust**    : 0.29 - 0.37 mm (0.011 - 0.015 in)  
**Hot\***    **Intake**    : 0.304 - 0.416 mm (0.012 - 0.016 in)  
               **Exhaust**    : 0.308 - 0.432 mm (0.012 - 0.017 in)

\*: Approximately 80°C (176°F) (Reference data)



- By referring to the figure, measure the valve clearances at locations marked "x" as shown in the table below (locations indicated in the figure) with feeler gauge.
- No. 1 cylinder at compression TDC

Measuring position (right bank)		No. 1 CYL.	No. 3 CYL.	No. 5 CYL.
No. 1 cylinder at compression TDC	EXH		×	
	INT	×		
Measuring position (left bank)		No. 2 CYL.	No. 4 CYL.	No. 6 CYL.
No. 1 cylinder at compression TDC	INT			×
	EXH	×		

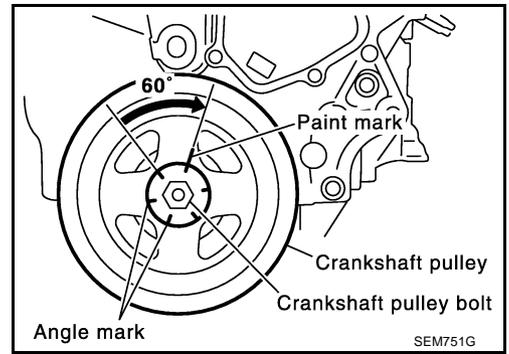


# CAMSHAFT

- c. Rotate crankshaft by 240 degrees clockwise (when viewed from engine front) to align No. 3 cylinder at TDC of its compression stroke.

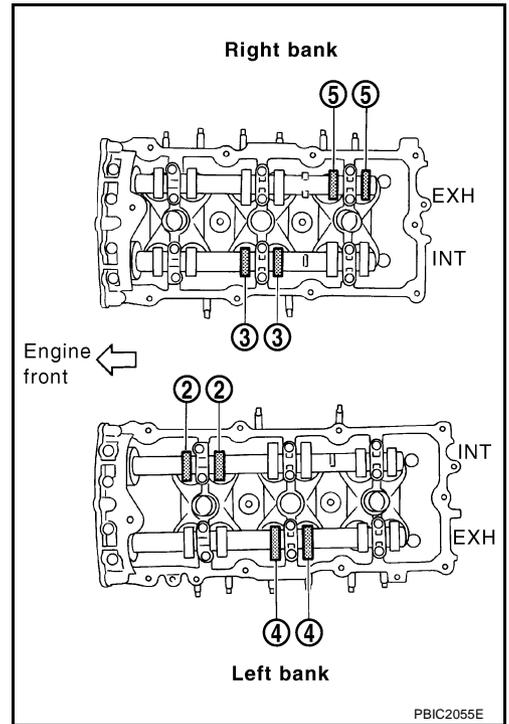
**NOTE:**

Crankshaft pulley mounting bolt flange has a stamped line every 60 degrees. They can be used as a guide to rotation angle.

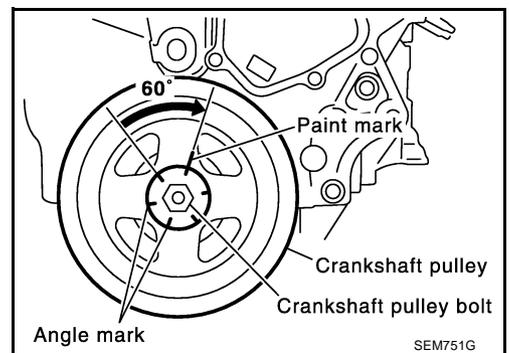


- By referring to the figure, measure the valve clearances at locations marked "x" as shown in the table below (locations indicated in the figure) with feeler gauge.
- No. 3 cylinder at compression TDC

Measuring position (right bank)		No. 1 CYL.	No. 3 CYL.	No. 5 CYL.
No. 3 cylinder at compression TDC	EXH			x
	INT		x	
Measuring position (left bank)		No. 2 CYL.	No. 4 CYL.	No. 6 CYL.
No. 3 cylinder at compression TDC	INT	x		
	EXH		x	



- d. Rotate crankshaft by 240 degrees clockwise (when viewed from engine front) to align No. 5 cylinder at TDC of compression stroke.

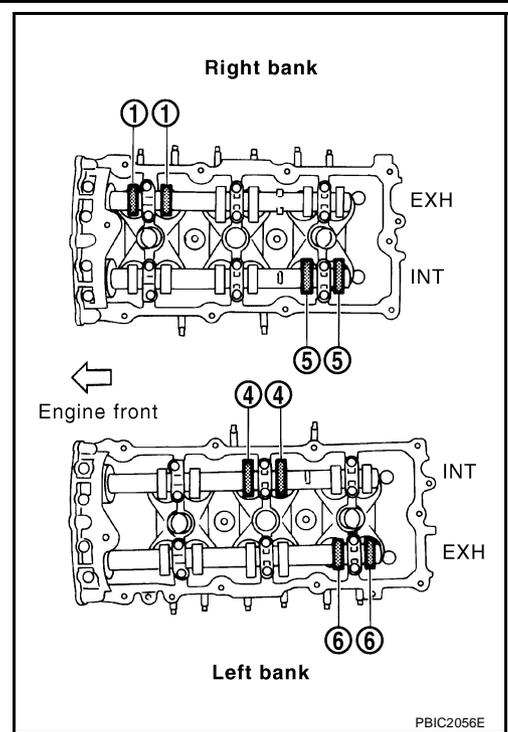


A  
EM  
C  
D  
E  
F  
G  
H  
I  
J  
K  
L  
M

# CAMSHAFT

- By referring to the figure, measure the valve clearances at locations marked "x" as shown in the table below (locations indicated in the figure) with feeler gauge.
- No. 5 cylinder at compression TDC

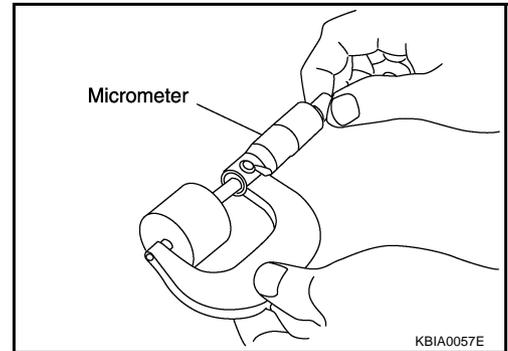
Measuring position (right bank)		No. 1 CYL.	No. 3 CYL.	No. 5 CYL.
No. 5 cylinder at compression TDC	EXH	x		
	INT			x
Measuring position (left bank)		No. 2 CYL.	No. 4 CYL.	No. 6 CYL.
No. 5 cylinder at compression TDC	INT		x	
	EXH			x



3. For the measured value are out of the standard, perform adjustment below.

## ADJUSTMENT

- Perform adjustment depending on selected head thickness of valve lifter.
1. Remove camshaft. Refer to [EM-77, "REMOVAL"](#).
  2. Remove valve lifters at the locations that are out of the standard.
  3. Measure the center thickness of the removed valve lifters with micrometer.



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

**Valve lifter thickness calculation:  $t = t_1 + (C_1 - C_2)$**

**t = Valve lifter thickness to be replaced**

**t<sub>1</sub> = Removed valve lifter thickness**

**C<sub>1</sub> = Measured valve clearance**

**C<sub>2</sub> = Standard valve clearance:**

**Intake : 0.30 mm (0.012 in)\***

**Exhaust : 0.33 mm (0.013 in)\***

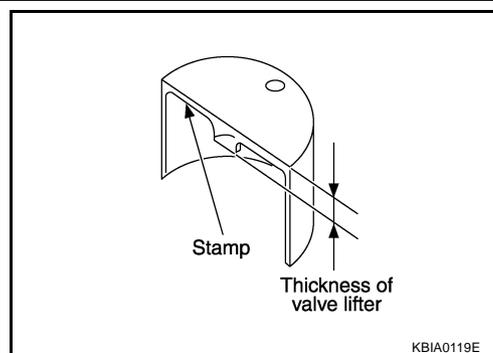
**\*: Approximately 20°C (68°F)**

# CAMSHAFT

- Thickness of new valve lifter can be identified by stamp marks on the reverse side (inside the cylinder). Stamp mark 788U or 788R indicates 7.88 mm (0.3102 in) in thickness.

**NOTE:**

Two types of stamp marks are used for parallel setting and for manufacturer identification.



Available thickness of valve lifter: 27 sizes with range 7.88 to 8.40 mm (0.3102 to 0.3307 in) in steps of 0.02 mm (0.0008 in) (when manufactured at factory).

5. Install selected valve lifter.
6. Install camshaft. Refer to [EM-82, "INSTALLATION"](#) .
7. Manually turn crankshaft pulley a few turns.
8. Make sure that the valve clearances for cold engine are within the specifications by referring to the specified values.

**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 - 0.016)

\*: Approximately 80°C (176°F)

## OIL SEAL

PFP:00100

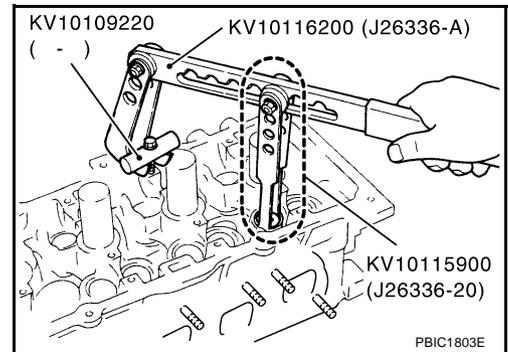
### Removal and Installation of Valve Oil Seal REMOVAL

ABS003MJ

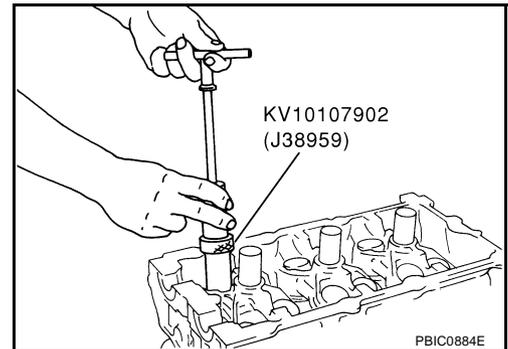
1. Remove engine assembly from vehicle, and separate front suspension member, transaxle and transfer (AWD models) assembly from engine. Refer to [EM-105, "ENGINE ASSEMBLY"](#) .
2. Install engine sub-attachment with engine stand shaft [SST: KV10117001 ( — ) and KV10106500 ( — )] to right side of cylinder block, then lift engine, and mount it onto engine stand [SST: ST0501S000 ( — )]. Refer to [EM-110, "CYLINDER BLOCK"](#) .
3. Remove camshaft relating to valve oil seal to be removed. Refer to [EM-77, "CAMSHAFT"](#) .
4. Remove valve lifters. Refer to [EM-77, "CAMSHAFT"](#) .
5. Turn crankshaft until the cylinder requiring new oil seals is at TDC. This will prevent valve from dropping into cylinder.
6. Remove valve collet.
  - Compress valve spring with valve spring compressor, attachment, adapter [SST]. Remove valve collet with magnet hand.

**CAUTION:**

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



7. Remove valve spring retainer and valve spring.
8. Remove valve oil seal using valve oil seal puller [SST].



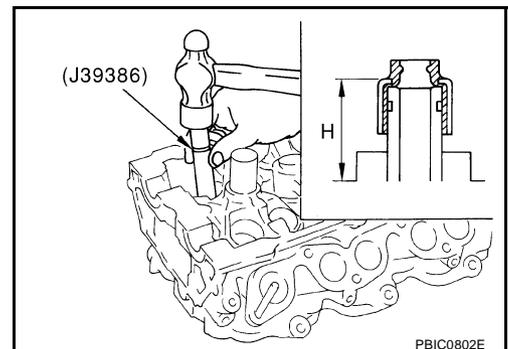
### INSTALLATION

1. Apply new engine oil on new valve oil seal joint and seal lip.
2. Using valve oil seal drift [SST], press fit valve seal to height "H" shown in figure.

**NOTE:**

Dimension "H": Height measured before valve spring seat installation

**Intake and exhaust : 14.3 - 14.9 mm (0.563 - 0.587 in)**



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

# OIL SEAL

ABS003MK

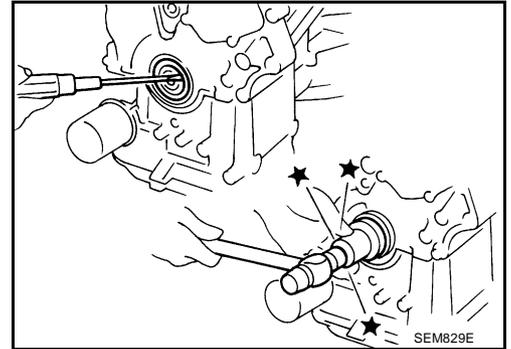
## Removal and Installation of Front Oil Seal

### REMOVAL

1. Remove the following parts:
  - Right side front road wheel and tire
  - Splash guard (RH)
  - Drive belts; Refer to [EM-11, "DRIVE BELTS"](#) .
  - Crankshaft pulley; Refer to [EM-58, "TIMING CHAIN"](#) .
2. Remove front oil seal using suitable tool.

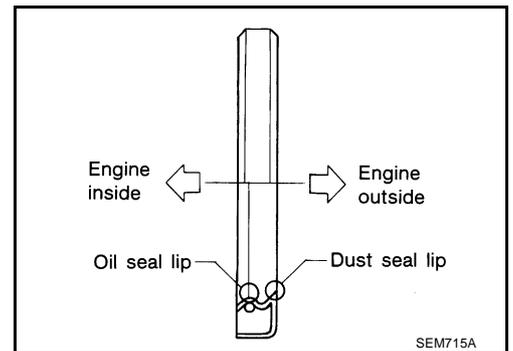
#### CAUTION:

**Be careful not to damage front timing chain case and crankshaft.**



### INSTALLATION

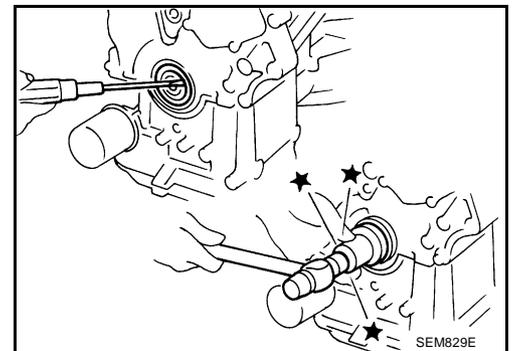
1. Apply new engine oil to both oil seal lip and dust seal lip of new front oil seal.
2. Install front oil seal.
  - Install front oil seal so that each seal lip is oriented as shown in the figure.



- Using suitable drift, press-fit until the height of front oil seal is level with the mounting surface.
- Suitable drift: outer diameter 60 mm (2.36 in), inner diameter 50 mm (1.97 in).

#### CAUTION:

- **Be careful not to damage front timing chain case and crankshaft.**
- **Press-fit straight and avoid causing burrs or tilting oil seal.**



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

## Removal and Installation of Rear Oil Seal

ABS003ML

### REMOVAL

1. Remove engine assembly from vehicle, and separate front suspension member, transaxle and transfer (AWD models) assembly from engine. Refer to [EM-105, "ENGINE ASSEMBLY"](#) .
2. Install engine sub-attachment with engine stand shaft [SST: KV10117001 ( — ) and KV10106500 ( — )] to right side of cylinder block, then lift engine, and mount it onto engine stand [SST: ST0501S000 ( — )]. Refer to [EM-110, "CYLINDER BLOCK"](#) .
3. Remove drive plate. Refer to [EM-110, "CYLINDER BLOCK"](#) .
4. Remove oil pan (upper). Refer to [EM-28, "OIL PAN AND OIL STRAINER"](#) .

## OIL SEAL

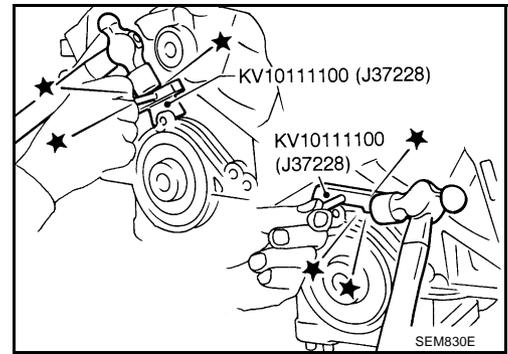
5. Use seal cutter [SST] to cut away liquid gasket and remove rear oil seal retainer.

**CAUTION:**

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

**NOTE:**

Regard both rear oil seal and retainer as an assembly.



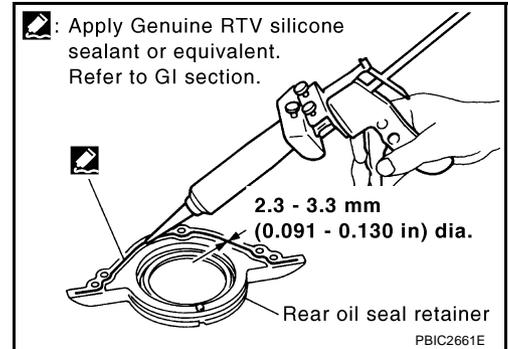
### INSTALLATION

1. Remove old liquid gasket on mating surfaces of cylinder block and upper oil pan using scraper.
2. Apply new engine oil to both oil seal lip and dust seal lip of new rear oil seal retainer.
3. Apply a continuous bead of liquid gasket with tube presser [SST: WS39930000 ( — )] to rear oil seal retainer as shown in the figure.

**Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-47, "RECOMMENDED CHEMICAL PRODUCTS AND SEALANTS"](#).**

**CAUTION:**

**Attaching should be done within 5 minutes after coating.**



4. Install rear oil seal retainer to cylinder block. Refer to [EM-110, "CYLINDER BLOCK"](#).
5. Install in the reverse order of removal after this step.

# CYLINDER HEAD

## CYLINDER HEAD

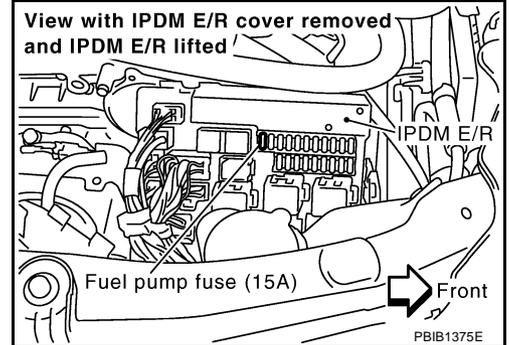
PFP:11041

### On-Vehicle Service

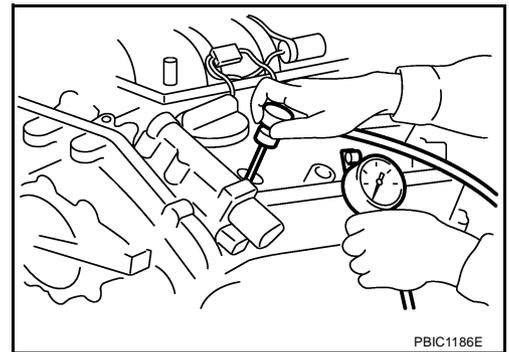
ABS00A3P

### CHECKING COMPRESSION PRESSURE

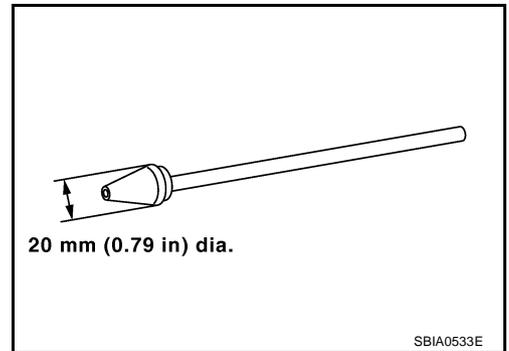
1. Warm up engine thoroughly. Then, stop it.
2. Release fuel pressure. Refer to [EC-45, "FUEL PRESSURE RELEASE"](#) .
3. Disconnect fuel pump fuse to avoid fuel injection during measurement.



4. Remove engine cover. Refer to [EM-16, "INTAKE MANIFOLD COLLECTOR"](#) .
5. Remove ignition coil and spark plug from each cylinder. Refer to [EM-37, "IGNITION COIL"](#) and [EM-38, "SPARK PLUG \(PLATINUM-TIPPED TYPE\)"](#) .
6. Connect engine tachometer (not required in use of CONSULT-II).
7. Install compression tester with adapter onto spark plug hole.



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



8. 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
1,275 (13.0, 185) / 300	981 (10.0, 142) / 300	98 (1.0, 14) / 300

#### CAUTION:

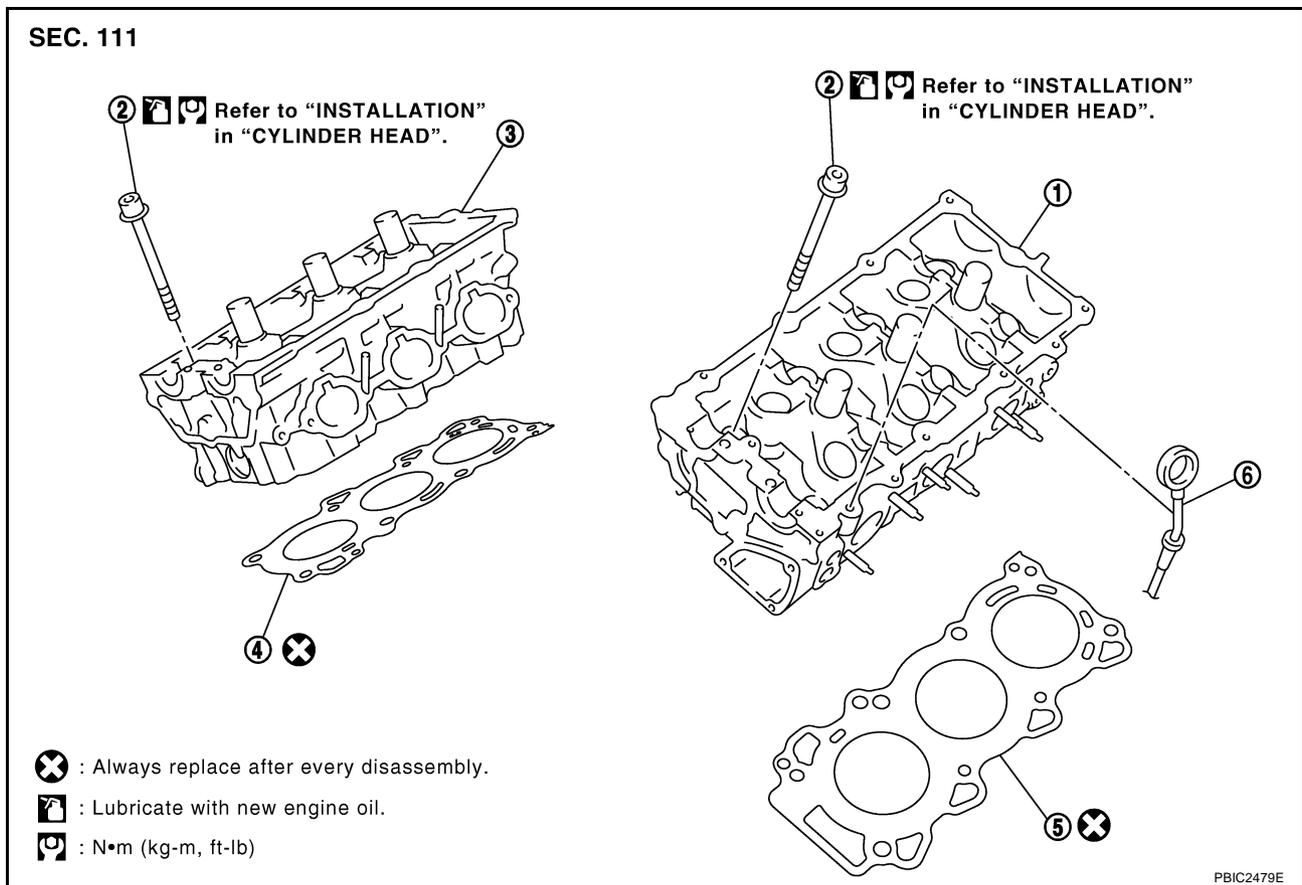
Always use a fully charged battery to obtain specified engine speed.

# CYLINDER HEAD

- 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 spark plug hole of cylinder to re-check it for compression.
    - If the added engine oil improves the compression, 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.
9. After inspection is completed, install removed parts.
10. Start engine, and make sure that engine runs smoothly.
11. Perform trouble diagnosis. If DTC appears, erase it. Refer to [EC-71, "TROUBLE DIAGNOSIS"](#) .

## Removal and Installation

ABS00A3Q



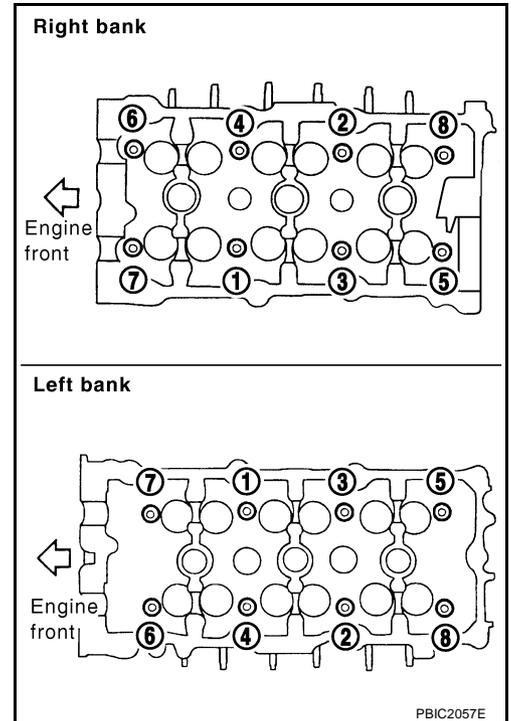
- |                                      |                                     |                               |
|--------------------------------------|-------------------------------------|-------------------------------|
| 1. Cylinder head (left bank)         | 2. Cylinder head bolt               | 3. Cylinder head (right bank) |
| 4. Cylinder head gasket (right bank) | 5. Cylinder head gasket (left bank) | 6. Oil level gauge            |

## REMOVAL

1. Remove engine assembly from vehicle, and separate front suspension member and transaxle from engine. Refer to [EM-105, "ENGINE ASSEMBLY"](#) .
2. Install engine sub-attachment with engine stand shaft [SST: KV10117001 and KV10106500] to right side of cylinder block, then lift engine, and mount it onto engine stand [SST: ST0501S000]. Refer to [EM-110, "CYLINDER BLOCK"](#) .
3. Remove camshaft. Refer to [EM-77, "CAMSHAFT"](#) .

# CYLINDER HEAD

4. Remove engine slingers.
5. Remove the following parts:
  - Fuel tube and fuel injector assembly; Refer to [EM-40, "FUEL INJECTOR AND FUEL TUBE"](#) .
  - Intake manifold; Refer to [EM-21, "INTAKE MANIFOLD"](#) .
  - Exhaust manifold; Refer to [EM-23, "EXHAUST MANIFOLD AND THREE WAY CATALYST"](#) .
  - Water inlet and thermostat assembly; Refer to [CO-27, "WATER INLET AND THERMOSTAT ASSEMBLY"](#) .
  - Water outlet, water bypass pipe, heater pipe and water connector; Refer to [CO-29, "WATER OUTLET AND WATER PIPING"](#) .
6. Remove cylinder head bolts in reverse order as shown in the figure with cylinder head bolt wrench (commercial service tool) to remove cylinder heads (right and left banks).



7. Remove cylinder head gaskets.

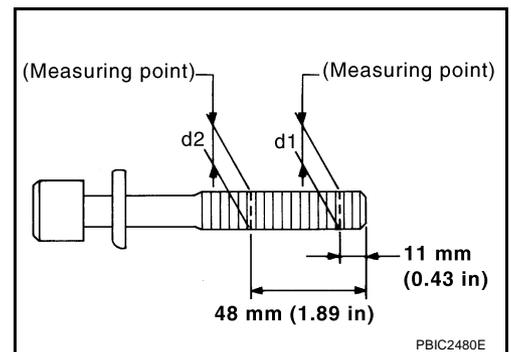
## INSPECTION AFTER REMOVAL

### 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") : 0.11 mm (0.0043 in)**

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



# CYLINDER HEAD

## Cylinder Head Distortion

### NOTE:

When performing this inspection, cylinder block distortion should be also checking. Refer to [EM-130, "CYLINDER BLOCK DISTORTION"](#) .

1. Wipe off oil and remove scale, gasket, sealant and carbon deposits from surface of cylinder head with scraper.

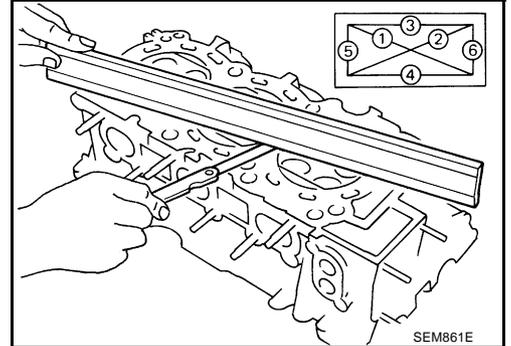
### CAUTION:

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

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

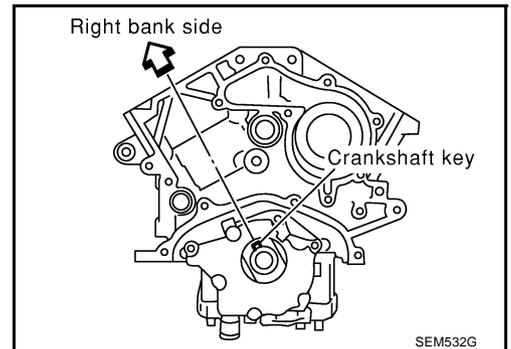
**Limit : 0.1 mm (0.004 in)**

- If it exceeds the limit, replace cylinder head.



## INSTALLATION

1. Install new cylinder head gaskets.
2. Turn crankshaft until No. 1 piston is set at TDC.
  - Crankshaft key should line up with the right 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.

- a. Apply new engine oil to threads and seat surfaces 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.

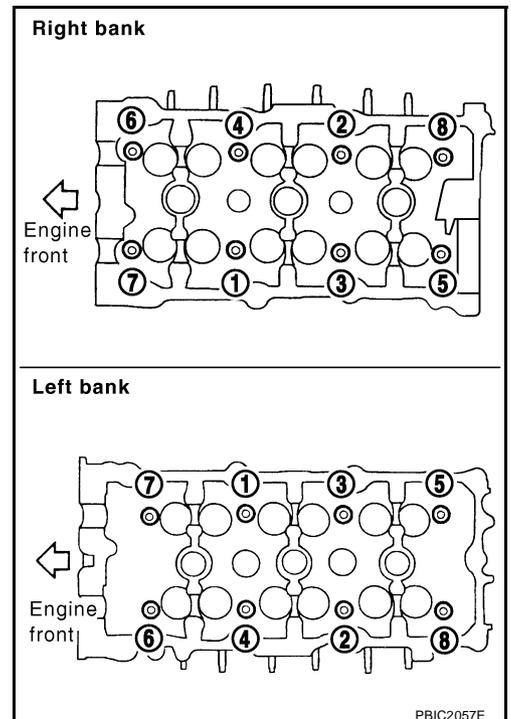
 : **0 N·m (0 kg-m, 0 ft-lb)**

### CAUTION:

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

- d. Tighten all cylinder head bolts.

 : **39.2 N·m (4.0 kg-m, 29 ft-lb)**



## CYLINDER HEAD

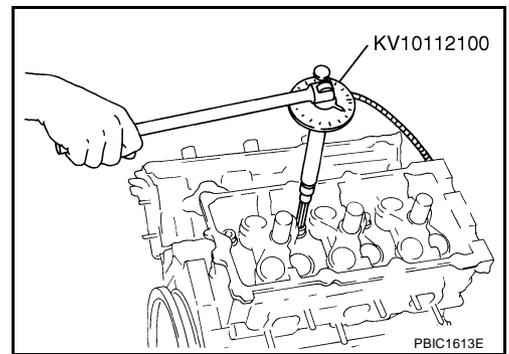
- e. Turn all cylinder head bolts 90 degrees clockwise. (Angle tightening)

**CAUTION:**

**Check the tightening angle by using angle wrench [SST].  
Avoid judgment by visual inspection without tool.**

- Check tightening angle indicated on angle wrench [SST] indicator plate.

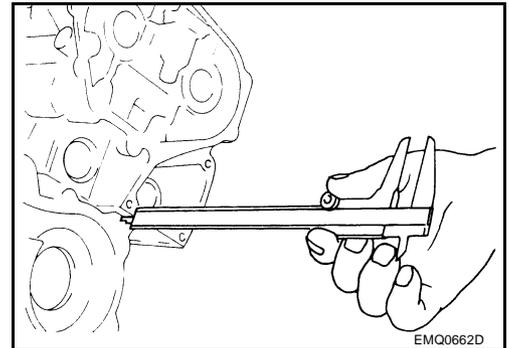
- f. Turn all cylinder head bolts 90 degrees clockwise again. (Angle tightening)



4. After installing cylinder head, measure distance between front end faces of cylinder block and cylinder head (left and right banks).

**Standard : 14.1 - 14.9 mm (0.555 - 0.587 in)**

- If the measured value is out of the standard, re-install cylinder head.



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

A

EM

C

D

E

F

G

H

I

J

K

L

M

# CYLINDER HEAD

## INSPECTION AFTER INSTALLATION

- Before starting engine, check the levels of engine coolant, engine oil and working fluid. If less than required quantity, fill to the specified level.
- 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 engine coolant, engine oil, working fluid, fuel and exhaust gases.
- Bleed air from passages in pipes and tubes of applicable lines, such as in cooling system.
- After cooling down engine, again check levels of engine coolant, engine oil and working fluid. Refill to the specified level, if necessary.

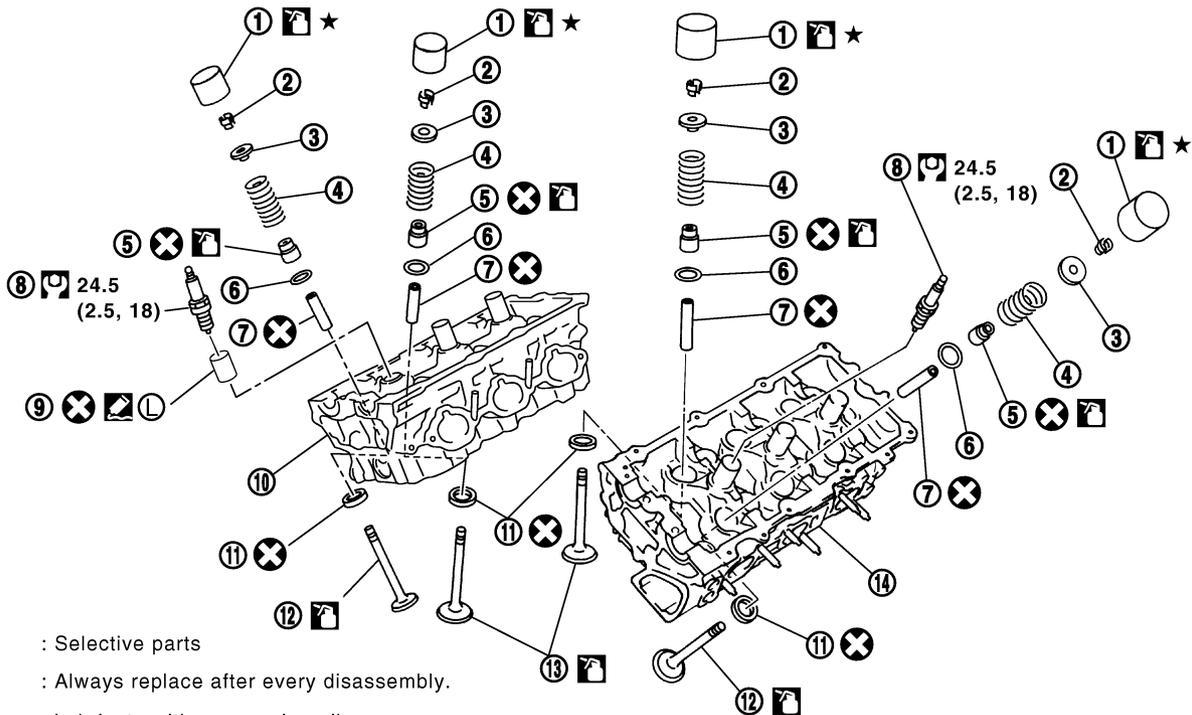
### Summary of the inspection items:

Item	Before starting engine	Engine running	After engine stopped
Engine coolant	Level	Leakage	Level
Engine oil	Level	Leakage	Level
Working fluid	Level	Leakage	Level
Fuel	—	Leakage	—
Exhaust gases	—	Leakage	—

## Disassembly and Assembly

ABS00A3R

### SEC. 111•130•220



★ : Selective parts

⊗ : Always replace after every disassembly.

🛢 : Lubricate with new engine oil.

🔧 : Apply Genuine High Strength Locking Sealant or equivalent. Refer to GI section.

Ⓜ : N•m (kg-m, ft-lb)

PBIC2637E

1. Valve lifter

2. Valve collet

3. Valve spring retainer

4. Valve spring

5. Valve oil seal

6. Valve spring seat

7. Valve guide

8. Spark plug

9. Spark plug tube

# CYLINDER HEAD

- 10. Cylinder head (right bank)
- 13. Valve (INT)

- 11. Valve seat
- 14. Cylinder head (left bank)

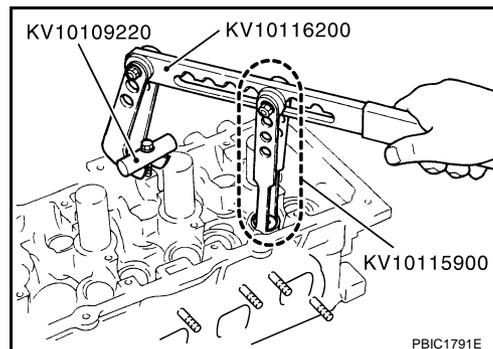
- 12. Valve (EXH)

## DISASSEMBLY

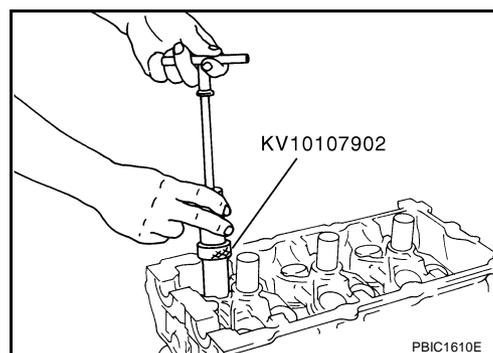
1. Remove spark plug with spark plug wrench (commercial service tool).
2. Remove valve lifter.
  - Identify installation positions, and store them without mixing them up.
3. Remove valve collet.
  - Compress valve spring with valve spring compressor, attachment and adapter [SST]. Remove valve collet with magnet hand.

### CAUTION:

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



4. Remove valve spring retainer, valve spring and valve spring seat.
5. Push valve stem to combustion chamber side, and remove valve.
  - Identify installation positions, and store them without mixing them up.
6. Remove valve oil seal with valve oil seal puller [SST].



7. If valve seat must be replaced, refer to [EM-103, "VALVE SEAT REPLACEMENT"](#).
8. If valve guide must be replaced, refer to [EM-101, "VALVE GUIDE REPLACEMENT"](#).
9. Remove spark plug tube, as necessary.
  - Using pliers, pull spark plug tube out of cylinder head.

### CAUTION:

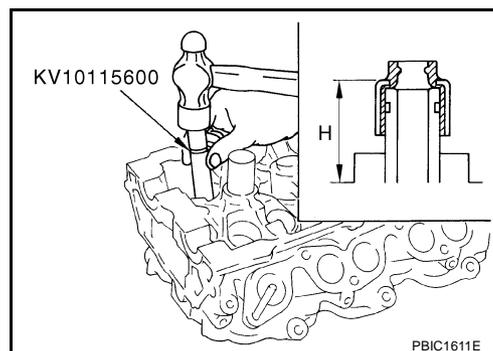
- Take care not to damage cylinder head.
- Once removed, spark plug tube will be deformed and cannot be reused. Do not remove it unless absolutely necessary.

## ASSEMBLY

1. When valve guide is removed, install it. Refer to [EM-101, "VALVE GUIDE REPLACEMENT"](#).
2. When valve seat is removed, install it. Refer to [EM-103, "VALVE SEAT REPLACEMENT"](#).
3. Install valve oil seal.
  - Install with valve oil seal drift [SST] to match dimension in the figure.

Height "H" (Without valve spring seat installed)

Intake and exhaust : 14.3 - 14.9 mm (0.563 - 0.587 in)



# CYLINDER HEAD

4. Install valve spring seat.
5. Install valve.
  - Install it in the original position.

**NOTE:**

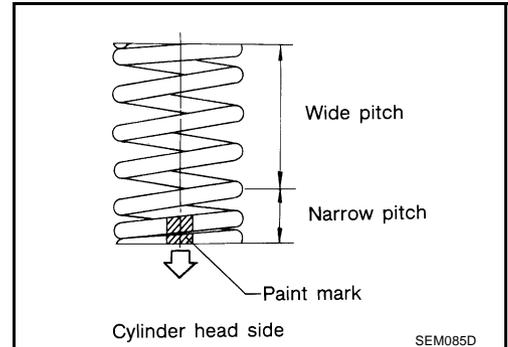
Larger diameter valves are for intake side.

6. Install valve spring (uneven pitch type).
  - Install narrow pitch end (paint mark) to cylinder head side (valve spring seat side).
  - Intake side and exhaust side valve springs are different. Install them referring to the following paint mark collar.

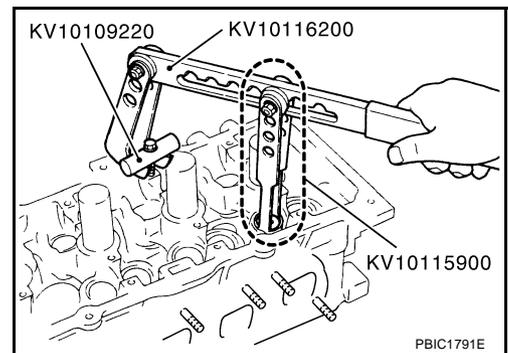
**Paint mark collar**

**Intake : White**

**Exhaust : Blue**



7. Install valve spring retainer.
  8. Install valve collet.
    - Compress valve spring with valve spring compressor, attachment and adapter [SST]. Install valve collet with magnet hand.
- CAUTION:**  
**When working, take care not to damage valve lifter holes.**
- Tap valve stem edge lightly with plastic hammer after installation to check its installed condition.



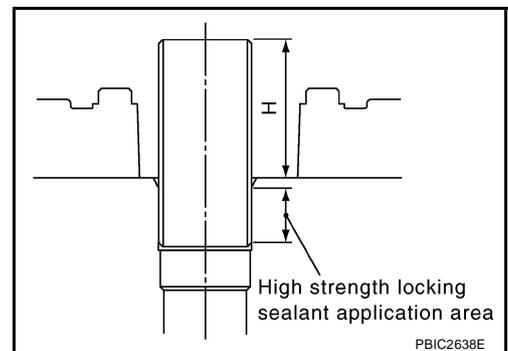
9. Install valve lifter.
  - Install it in the original position.
10. Install spark plug tube.
  - Press-fit spark plug tube as follows:
    - a. Remove old liquid gasket adhering to cylinder head mounting hole.
    - b. Apply sealant to area within approximately 12 mm (0.47 in) from edge of spark plug tube press-fit side. **Use Genuine High Strength Locking Sealant or equivalent. Refer to [GI-47, "RECOMMENDED CHEMICAL PRODUCTS AND SEALANTS"](#).**
    - c. Using drift, press-fit spark plug tube so that its height "H" is as specified in the figure.

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

**: 38.1 - 39.1 mm (1.500 - 1.539 in)**

**CAUTION:**

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



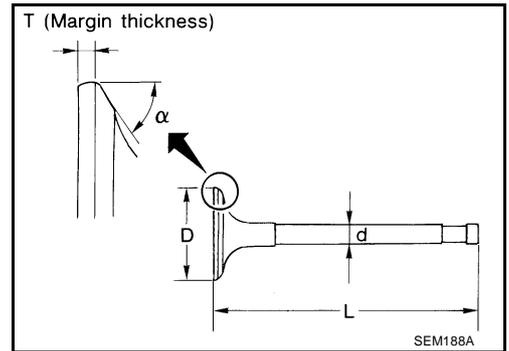
11. Install spark plug with spark plug wrench (commercial service tool).

# CYLINDER HEAD

ABS00A3S

## Inspection After Disassembly VALVE DIMENSIONS

- Check dimensions of each valve. For dimensions, refer to [EM-141, "Valve Dimensions"](#).
- If dimensions are out of the standard, replace valve and check valve seat contact. Refer to [EM-103, "VALVE SEAT CONTACT"](#).



## VALVE GUIDE CLEARANCE

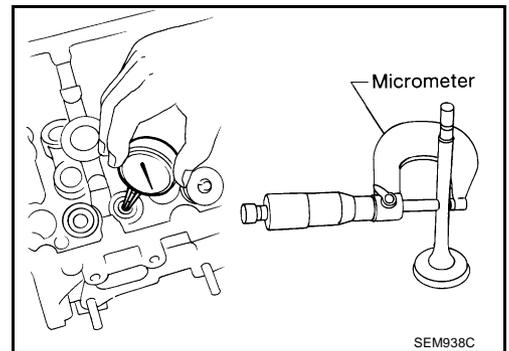
### Valve Stem Diameter

Measure the diameter of valve stem with micrometer.

#### Standard

**Intake** : 5.965 - 5.980 mm (0.2348 - 0.2354 in)

**Exhaust** : 5.955 - 5.970 mm (0.2344 - 0.2350 in)



### Valve Guide Inner Diameter

Measure the 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 - 0.053 mm (0.0008 - 0.0021 in)

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

##### Limit

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

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

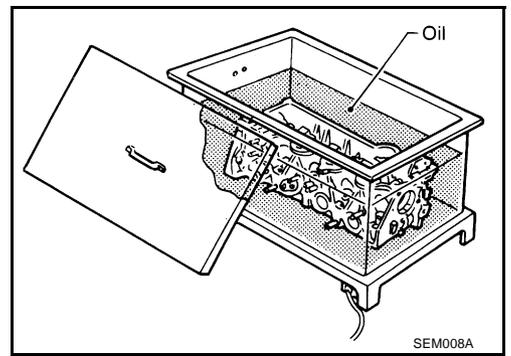
- If the calculated value exceeds the limit, replace valve and/or valve guide. When valve guide must be replaced, refer to [EM-101, "VALVE GUIDE REPLACEMENT"](#).

## VALVE GUIDE REPLACEMENT

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

# CYLINDER HEAD

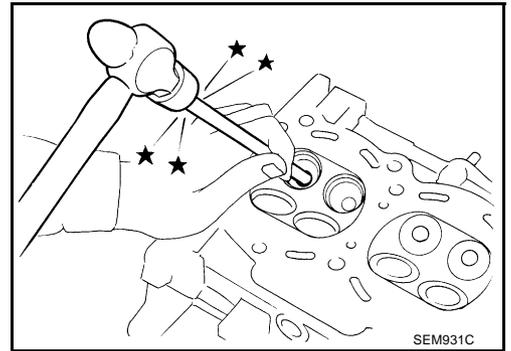
1. To remove valve guide, heat cylinder head to 110 to 130°C (230 to 266°F) by soaking in heated oil.



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 valve guide drift (commercial service tool).

**CAUTION:**

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

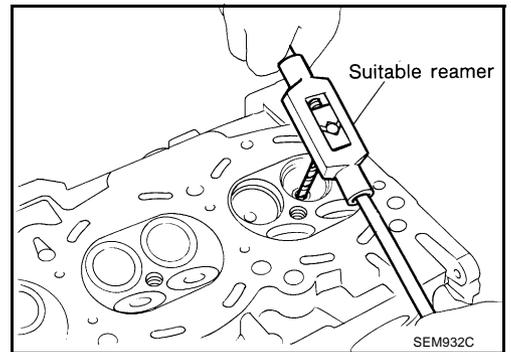


3. Using valve guide reamer (commercial service tool), ream cylinder head valve guide hole.

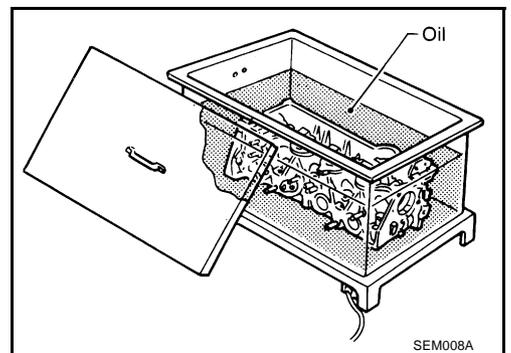
**Valve guide hole diameter (for service parts):**

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

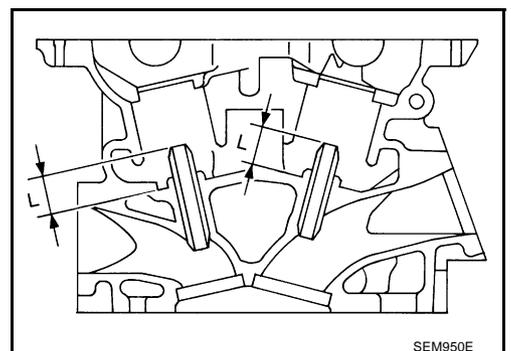
**Projection "L"**

**Intake and exhaust**

**: 12.6 - 12.8 mm (0.496 - 0.504 in)**

**CAUTION:**

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



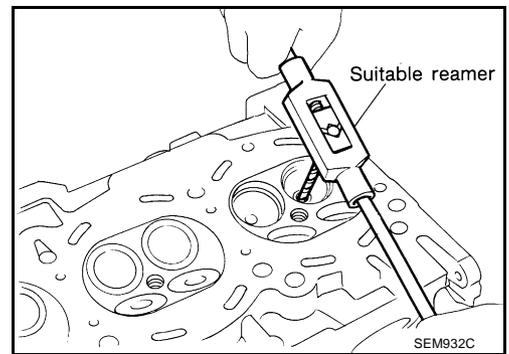
# CYLINDER HEAD

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

**Standard:**

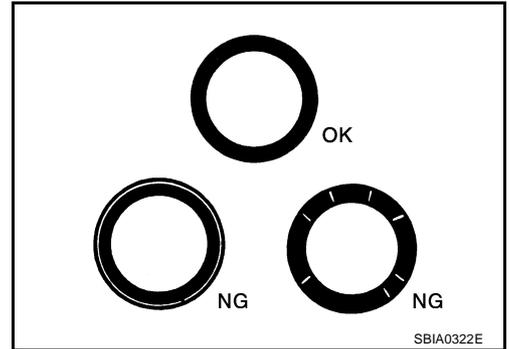
**Intake and exhaust**

**: 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 the specifications, perform this procedure.
- Apply prussian blue (or white lead) onto contacting surface of valve seat to check the condition of the valve contact on the surface.
- Check if the contact area band is continuous all around the circumference.
- If not, grind to adjust valve fitting and check again. If the contacting surface still has "NG" conditions even after the re-check, replace valve seat. Refer to [EM-103, "VALVE SEAT REPLACEMENT"](#).



## VALVE SEAT REPLACEMENT

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

- 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. Refer to [EM-143, "Valve Seat"](#).

**CAUTION:**

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

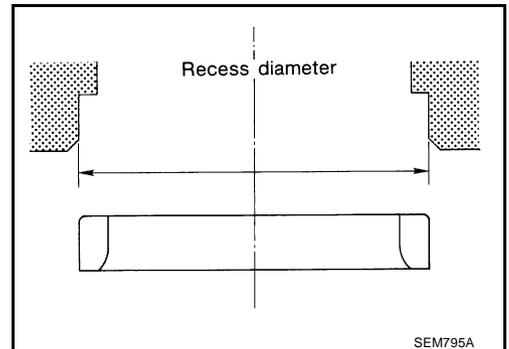
- Ream cylinder head recess diameter for service valve seat.

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

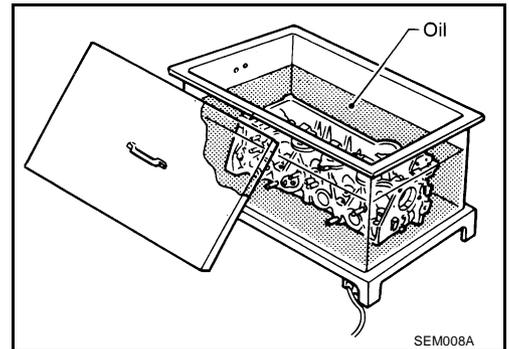
**Intake : 38.500 - 38.516 mm (1.5157 - 1.5164 in)**

**Exhaust : 32.700 - 32.716 mm (1.2874 - 1.2880 in)**

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



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



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

**CAUTION:**

- Avoid directly touching cold valve seats.**

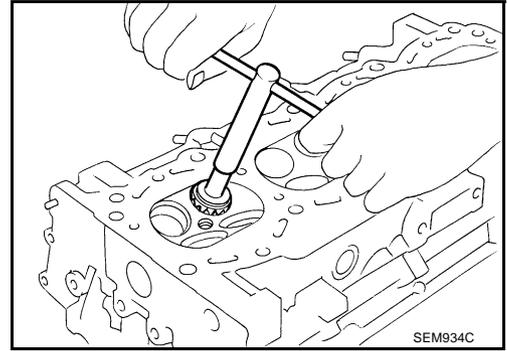
# CYLINDER HEAD

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

5. Using valve seat cutter set (commercial service tool) or valve seat grinder, finish seat to the specified dimensions. Refer to [EM-143, "Valve Seat"](#) .

**CAUTION:**

When using valve seat cutter, firmly grip 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 cutter or cutting many different times may result in stage valve seat.



6. Using compound, grind to adjust valve fitting.

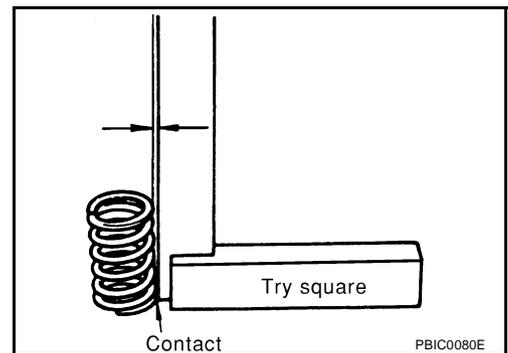
7. Check again for normal contact. Refer to [EM-103, "VALVE SEAT CONTACT"](#) .

## VALVE SPRING SQUARENESS

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

**Limit : 2.1 mm (0.083 in)**

- If it exceeds the limit, replace valve spring.



## VALVE SPRING DIMENSIONS AND VALVE SPRING PRESSURE LOAD

- Check valve spring pressure at the specified spring height.

**Standard:**

**Intake and exhaust**

**Free height**

**: 47.07 mm (1.8531 in)**

**Installation height**

**: 37.00 mm (1.4567 in)**

**Installation load**

**: 166 - 188 N (16.9 - 19.2 kg, 37 - 42 lb)**

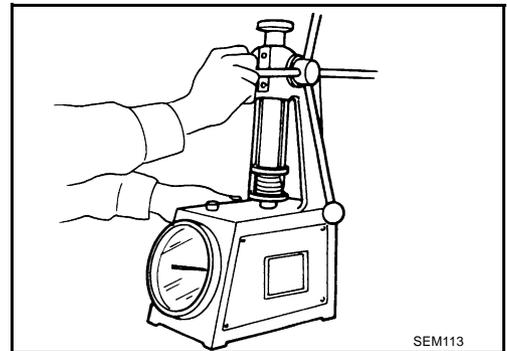
**Height during valve open**

**: 27.2 mm (1.0709 in)**

**Load with valve open**

**: 373 - 421 N (38.0 - 42.9 kg, 84 - 95 lb)**

- If the installation load or load with valve open is out of the standard, replace valve spring.



# ENGINE ASSEMBLY

## ENGINE ASSEMBLY

PFP:10001

### Removal and Installation

ABS00330

A

EM

C

D

E

F

G

H

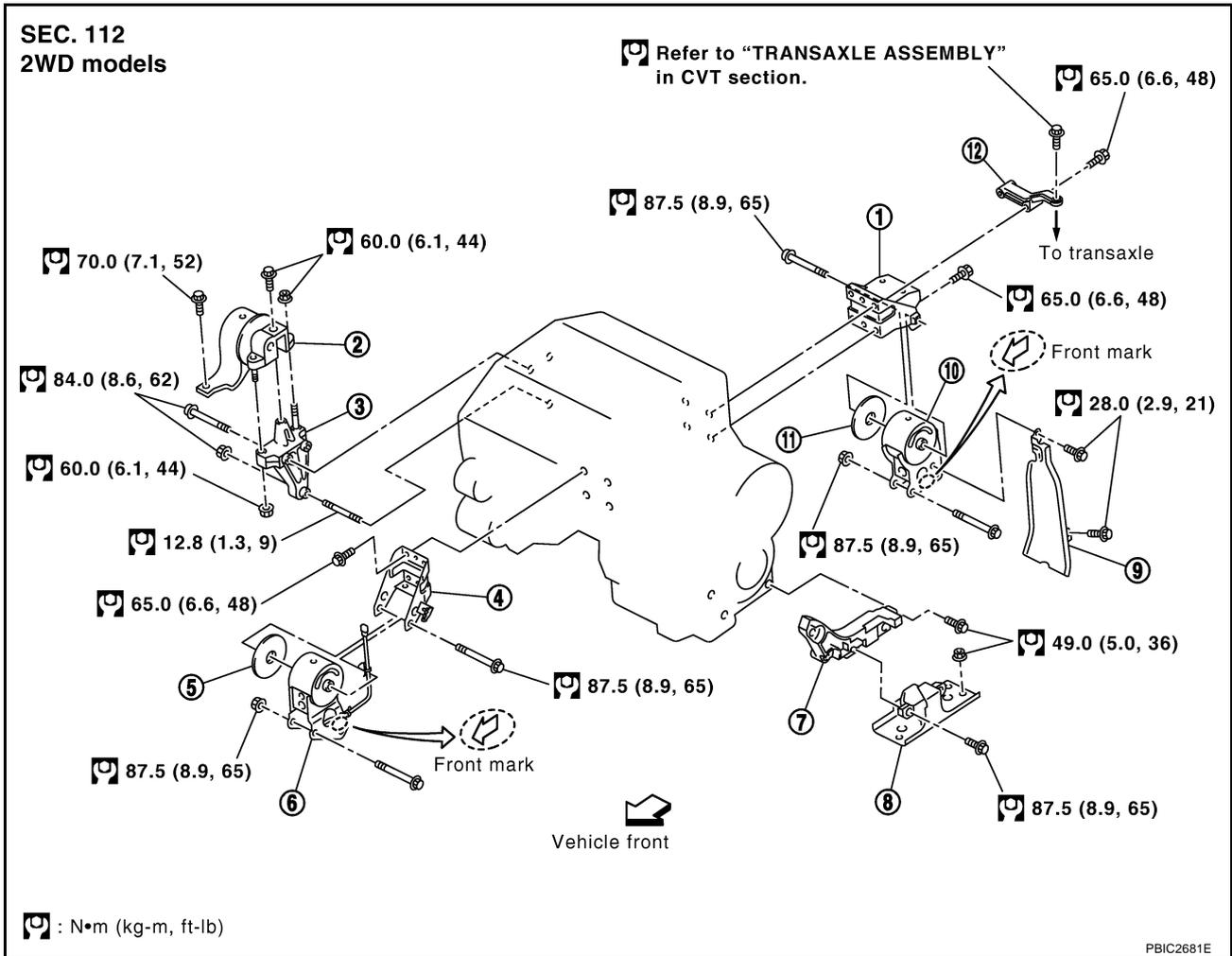
I

J

K

L

M



- |                                    |                                 |                                    |
|------------------------------------|---------------------------------|------------------------------------|
| 1. Rear engine mounting bracket    | 2. RH engine mounting insulator | 3. RH engine mounting bracket      |
| 4. Front engine mounting bracket   | 5. Stopper                      | 6. Front engine mounting insulator |
| 7. LH engine mounting bracket      | 8. LH engine mounting insulator | 9. Engine mounting air guide       |
| 10. Rear engine mounting insulator | 11. Stopper                     | 12. Bracket                        |



# ENGINE ASSEMBLY

## Preparation

1. Release fuel pressure. Refer to [EC-45, "FUEL PRESSURE RELEASE"](#) .
2. Drain engine coolant. Refer to [CO-9, "Changing Engine Coolant"](#) .  
**CAUTION:**
  - Perform this step when engine is cold.
  - Do not spill engine coolant on drive belts.
3. Remove the following parts:
  - Engine cover; Refer to [EM-16, "INTAKE MANIFOLD COLLECTOR"](#) .
  - Hood assembly; Refer to [BL-12, "HOOD"](#) .
  - Front road wheel and tires
  - Undercover and splash guards (RH and LH)
  - Air duct (inlet), air cleaner case (upper) with mass air flow sensor and air duct assembly; Refer to [EM-14, "AIR CLEANER AND AIR DUCT"](#) .
  - Battery, battery tray and battery tray bracket; Refer to [SC-4, "BATTERY"](#) .
  - Drive belts; Refer to [EM-11, "DRIVE BELTS"](#) .
  - Radiator, reservoir tank of radiator, and system hoses. Refer to [CO-13, "RADIATOR"](#) .
  - Front wiper arm; Refer to [WW-4, "FRONT WIPER AND WASHER SYSTEM"](#) .
  - Cowl top cover; Refer to [EI-21, "COWL TOP"](#) .
4. Disconnect engine room harness at the ECM side.  
**CAUTION:**  
**To keep clean harness connector and avoid damage and foreign materials, cover them completely with plastic bags or something similar.**

## Engine Room

1. Disconnect heater hoses. Refer to [CO-29, "WATER OUTLET AND WATER PIPING"](#) .
  - Install plug to avoid leakage of engine coolant.
2. Remove EVAP hose. Refer to [EM-16, "INTAKE MANIFOLD COLLECTOR"](#) .
3. Disconnect fuel feed hose (with fuel damper) quick connector at centralized under-floor piping side. Refer to [EM-40, "FUEL INJECTOR AND FUEL TUBE"](#) .
  - Install plug to avoid leakage of fuel.
4. Disconnect transaxle shift control cable at transaxle side. Refer to [CVT-207, "SHIFT CONTROL SYSTEM"](#) .
5. Disconnect brake booster vacuum hose at engine side. Refer to [EM-16, "INTAKE MANIFOLD COLLECTOR"](#) .
6. Remove alternator. Refer to [SC-17, "CHARGING SYSTEM"](#) .
7. Remove A/C compressor with piping connected, and temporarily secure it to aside. Refer to [ATC-131, "Components"](#) .
8. Disconnect suction hoses of power steering oil pump at reservoir tank side. Refer to [PS-34, "HYDRAULIC LINE"](#) .
  - Install plug to avoid leakage of power steering fluid.

## Vehicle Underbody

1. Remove front drive shafts (right and left sides). Refer to [FAX-7, "FRONT DRIVE SHAFT"](#) .
2. Remove front exhaust tube. Refer to [EX-3, "EXHAUST SYSTEM"](#) .
3. Disconnect steering lower joint at power steering gear assembly side, and release steering lower shaft. Refer to [PS-14, "POWER STEERING GEAR AND LINKAGE"](#) .
4. Disconnect front stabilizer connecting rod. Refer to [FSU-14, "STABILIZER BAR"](#) .
5. Remove propeller shaft (AWD models). Refer to [PR-4, "REAR PROPELLER SHAFT"](#) .
6. Disconnect power steering piping at a point between vehicle and engine. Refer to [PS-34, "HYDRAULIC LINE"](#) .
  - Install plug to avoid leakage of power steering fluid.
7. Remove rear plate cover from oil pan (upper). Then remove bolts fixing drive plate to torque converter. Refer to [EM-28, "OIL PAN AND OIL STRAINER"](#) and [CVT-224, "TRANSAXLE ASSEMBLY"](#) .

# ENGINE ASSEMBLY

8. Remove transaxle joint bolts which pierce at oil pan (upper) lower rear side. Refer to [CVT-224, "TRAN-SAXLE ASSEMBLY"](#).
9. Remove crankshaft position sensor (POS).

## CAUTION:

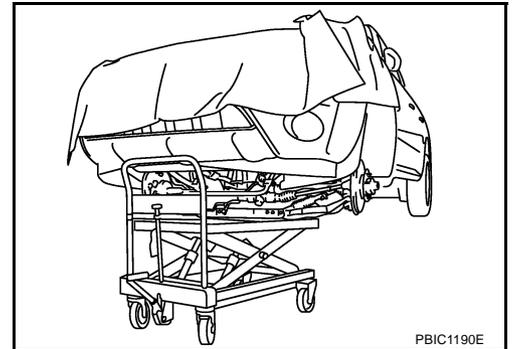
- Handle carefully to avoid dropping and shocks.
- Do not disassemble.
- Do not allow metal powder to adhere to magnetic part at sensor tip.
- Do not place sensors in a location where they are exposed to magnetism.

## Removal Work

1. Use manual lift table caddy (commercial service tool) or equivalently rigid tool such as transmission jack. Securely support bottom of front suspension member.

## CAUTION:

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



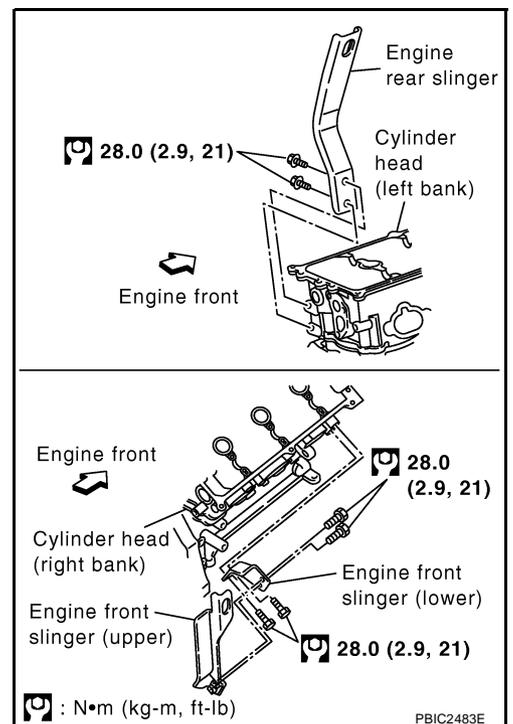
2. Remove RH engine mounting insulator and RH engine mounting bracket.
3. Remove mounting bolt between transverse link and front suspension member with power tool.
4. Remove front suspension member mounting nuts and bolts. Refer to [FSU-5, "FRONT SUSPENSION ASSEMBLY"](#).
5. Carefully lower engine, transaxle, transfer (AWD models) and front 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 cylinder head (right bank) and rear of cylinder head (left bank).



# ENGINE ASSEMBLY

2. Remove power steering oil pump, power steering piping and power steering bracket from engine, transaxle and transfer (AWD models) assembly. Refer to [PS-34, "HYDRAULIC LINE"](#) .
3. Remove starter motor. Refer to [SC-9, "STARTING SYSTEM"](#) .
4. Disconnect harness connector of front engine mounting insulator and rear engine mounting insulator.
5. Lift with hoist and separate engine, transaxle and transfer (AWD models) assembly from suspension member.

## CAUTION:

- **Before and during this lifting, always check if any harnesses are left connected.**
  - **Avoid damage to and oil/grease smearing or spills onto engine mounting insulator.**
6. Remove each engine mounting insulator and each engine mounting bracket from engine, transaxle and front suspension member.
  7. Separate engine, transaxle and transfer (AWD models) assembly. Refer to [CVT-224, "TRANSAXLE ASSEMBLY"](#) .

## INSTALLATION

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

- Do not allow engine mounting insulator to be damage and careful no oil gets on it.
- For a path with a specified installation orientation, refer to component figure in [EM-105, "Removal and Installation"](#) .
- Make sure all mounting insulators are seated properly, then tighten mounting nuts and bolts.

## INSPECTION AFTER INSTALLATION

- Before starting engine, check the levels of engine coolant, engine oil and working fluid. If less than required quantity, fill to the specified level.
- 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 engine coolant, engine oil, working fluid, fuel and exhaust gases.
- Bleed air from passages in pipes and tubes of applicable lines, such as in cooling system.
- After cooling down engine, again check levels of engine coolant, engine oil and working fluid. Refill to the 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
Working fluid	Level	Leakage	Level
Fuel	—	Leakage	—
Exhaust gases	—	Leakage	—

# CYLINDER BLOCK

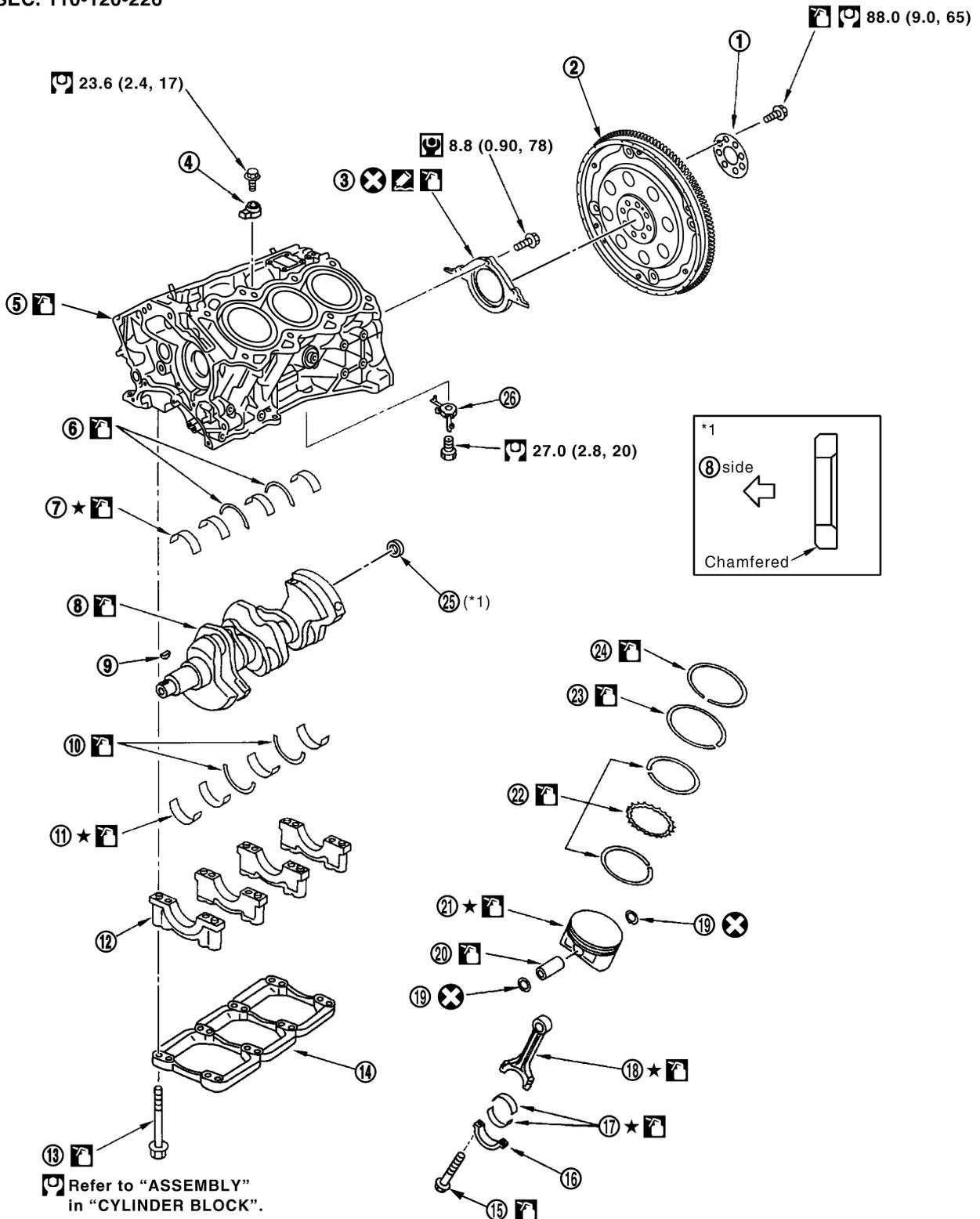
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## CYLINDER BLOCK

### Disassembly and Assembly

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SEC. 110•120•226

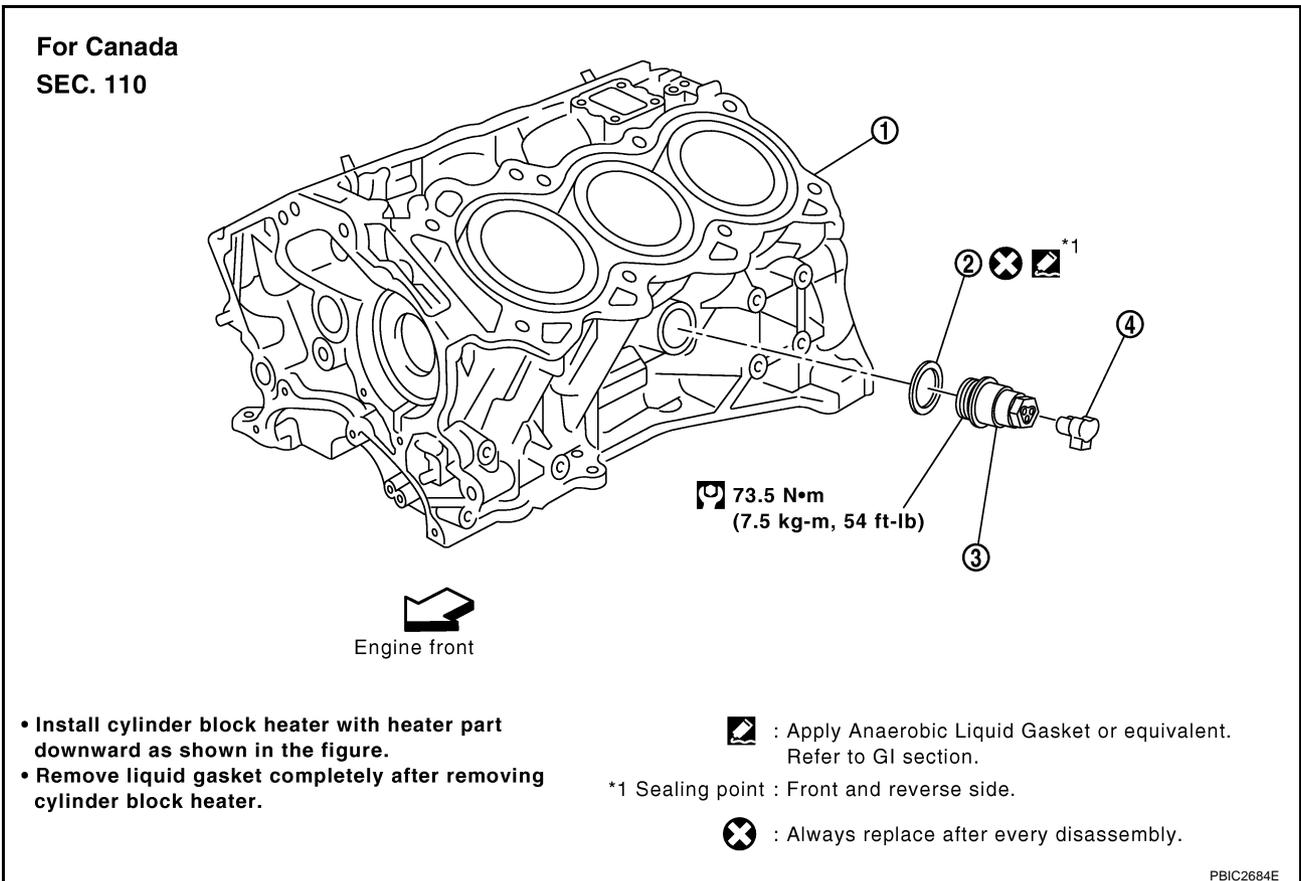


- ⊗ : Always replace after every disassembly.
- ★ : Selective parts
- 🔧 : N•m (kg-m, ft-lb)
- 🔧 : N•m (kg-m, in-lb)
- 🔧 : Apply Genuine RTV Silicone Sealant or equivalent. Refer to GI section.
- 🔧 : Lubricate with new engine oil.

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# CYLINDER BLOCK

- |                                |                            |                           |
|--------------------------------|----------------------------|---------------------------|
| 1. Reinforcement plate         | 2. Drive plate             | 3. Rear oil seal retainer |
| 4. Knock sensor                | 5. Cylinder block          | 6. Thrust bearing (upper) |
| 7. Main bearing (upper)        | 8. Crankshaft              | 9. Key                    |
| 10. Thrust bearing (lower)     | 11. Main bearing (lower)   | 12. Main bearing cap      |
| 13. Main bearing cap bolt      | 14. Main bearing beam      | 15. Connecting rod bolt   |
| 16. Connecting rod bearing cap | 17. Connecting rod bearing | 18. Connecting rod        |
| 19. Snap ring                  | 20. Piston pin             | 21. Piston                |
| 22. Oil ring                   | 23. Second ring            | 24. Top ring              |
| 25. Pilot converter            | 26. Oil jet                |                           |



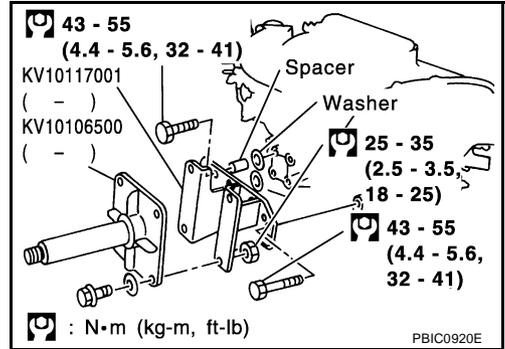
- |                            |           |                          |
|----------------------------|-----------|--------------------------|
| 1. Cylinder block          | 2. Gasket | 3. Cylinder block heater |
| 4. Connector protector cap |           |                          |

## DISASSEMBLY

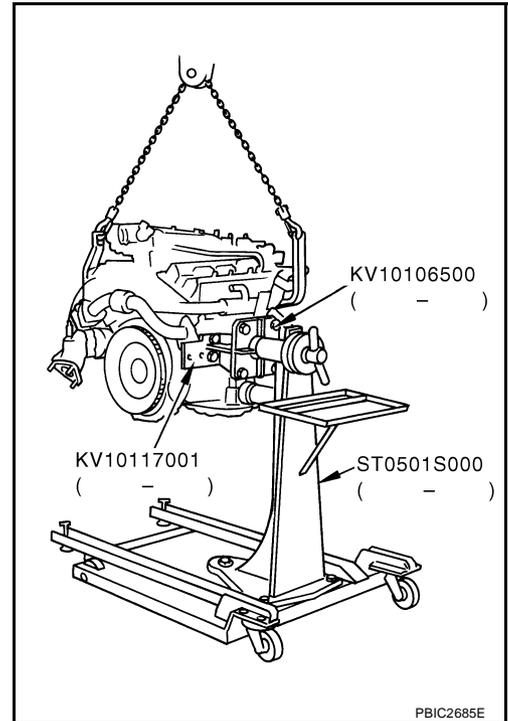
1. Remove engine assembly from vehicle, and separate front suspension member, transaxle and transfer (AWD models) assembly from engine. Refer to [EM-105, "ENGINE ASSEMBLY"](#).
2. Remove exhaust manifolds (right and left banks). Refer to [EM-23, "EXHAUST MANIFOLD AND THREE WAY CATALYST"](#).
3. Remove oil cooler, water pipes and water hoses. Refer to [LU-10, "OIL COOLER"](#).
  - When removing water drain plug, engine coolant remaining in the engine is drained. Use tray to collect it.

# CYLINDER BLOCK

4. Install engine sub-attachment with engine stand shaft [SST] to right side of cylinder block.
  - Use spacer to engine front side.



5. Lift engine, and mount it onto engine stand [SST].



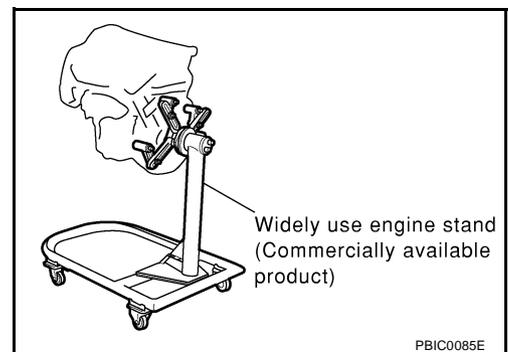
- A widely use engine stand can be used.

**CAUTION:**

Use engine stand that has a load capacity [approximately 220 kg (441 lb) or more] large enough for supporting the engine weight.

**NOTE:**

This example is engine stand for holding at transaxle mounting side with drive plate removed.



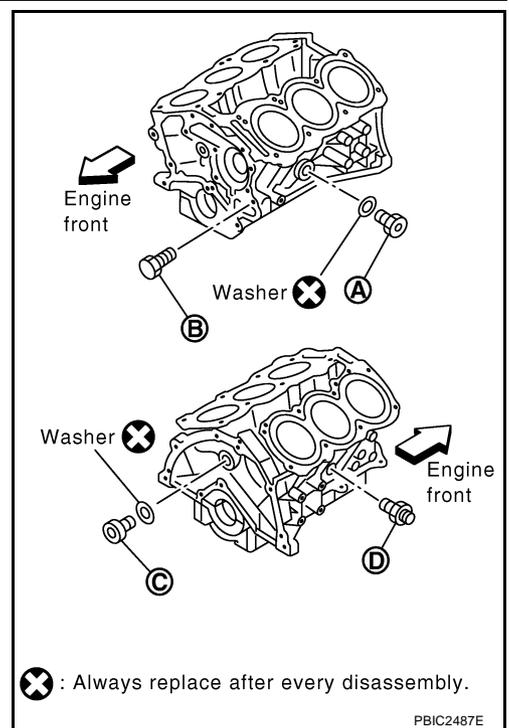
6. Drain engine oil. Refer to [LU-8, "Changing Engine Oil"](#).

# CYLINDER BLOCK

7. Drain engine coolant by removing water drain plug "A", "B" and connector bolt "D" from cylinder block as shown in the figure.

**NOTE:**

For Canada, "A" in the figure is not water drain plug but block heater.

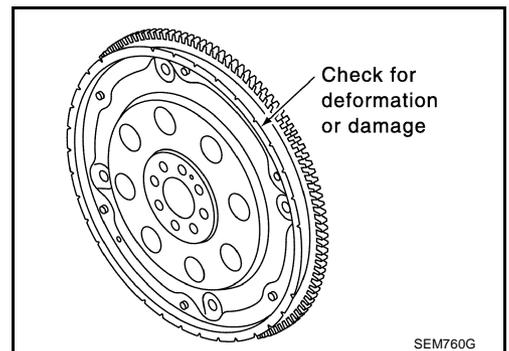


8. Remove drive plate. Fix crankshaft pulley with pulley holder [SST: KV10109300 ( — )], and remove mounting bolts.

- Loosen mounting bolts in diagonal order.

**CAUTION:**

- Do not disassemble drive plate.
- Never 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.



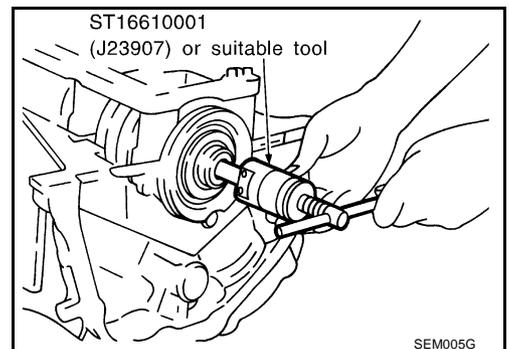
9. Remove cylinder head. Refer to [EM-93, "CYLINDER HEAD"](#).

10. Remove knock sensor.

**CAUTION:**

**Carefully handle sensor avoiding shocks.**

11. Remove pilot converter using pilot bushing puller [SST] as necessary.



12. Remove rear oil seal retainer.

- Remove by inserting screwdriver between main bearing cap and rear oil seal retainer.

# CYLINDER BLOCK

**CAUTION:**

If rear oil seal retainer is removed, replace it with new one.

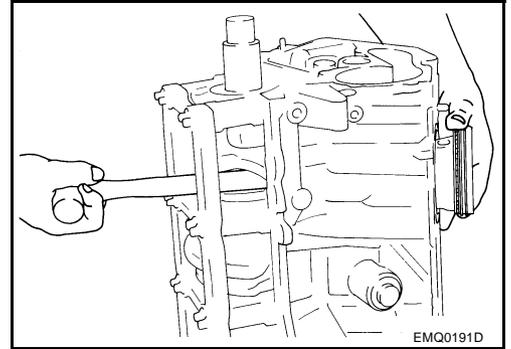
**NOTE:**

Regard both rear oil seal and retainer as an assembly.

13. Remove piston and connecting rod assembly with the following procedure:
  - Before removing piston and connecting rod assembly, check the connecting rod side clearance. Refer to [EM-127, "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 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 the connecting rod big end.



14. Remove connecting rod bearings from connecting rod and connecting rod bearing cap.

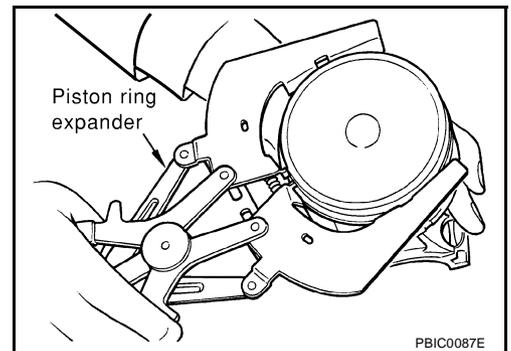
**CAUTION:**

Identify installation position, and store them without mixing them up.

15. Remove piston rings from piston.
  - Before removing piston rings, check the piston ring side clearance. Refer to [EM-128, "PISTON RING SIDE CLEARANCE"](#).
  - Use piston ring expander (commercial service tool).

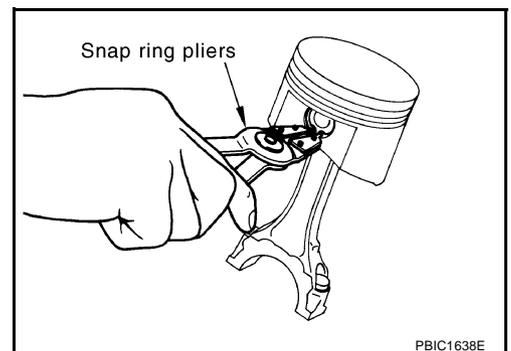
**CAUTION:**

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



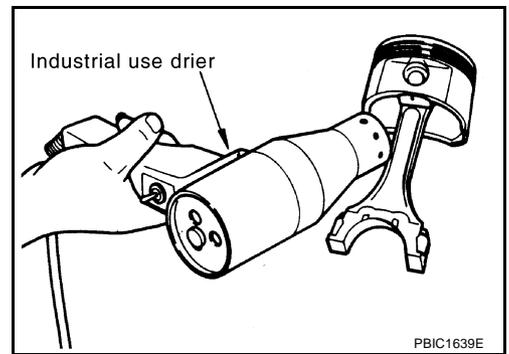
16. Remove piston from connecting rod as follows:

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

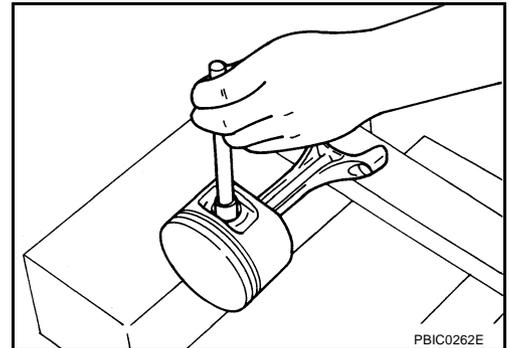


# CYLINDER BLOCK

- 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 (0.79 in).

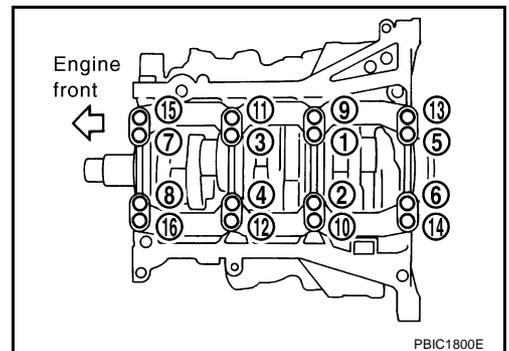


17. Remove main bearing cap bolts.

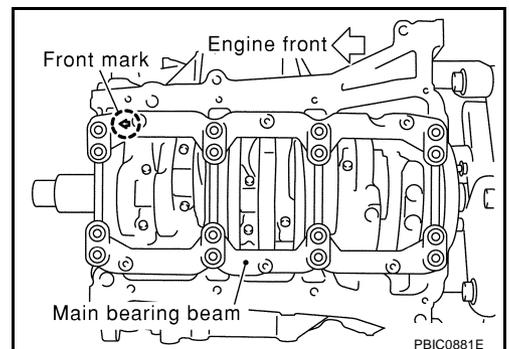
**NOTE:**

Use TORX socket (size E14).

- Before loosening main bearing cap bolts, measure the crankshaft end play. Refer to [EM-127, "CRANK-SHAFT END PLAY"](#).
- Loosen main bearing cap bolts in the reverse order shown in the figure in several different steps.



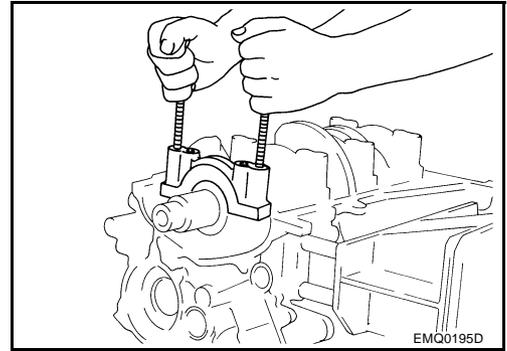
18. Remove main bearing beam.



# CYLINDER BLOCK

## 19. Remove main bearing caps.

- Using main bearing cap bolts, remove main bearing cap while shaking it back-and-forth.



## 20. Remove crankshaft.

## 21. Remove main bearings and thrust bearings from cylinder block and main bearing caps.

### CAUTION:

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

## 22. Remove oil jet.

## ASSEMBLY

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

### CAUTION:

Use a goggles to protect your eye.

### 2. Install each plug to cylinder block as shown in the figure.

- Apply sealant to the thread of water drain plug "A".  
Use Anaerobic Liquid Gasket or equivalent. Refer to [GI-47, "RECOMMENDED CHEMICAL PRODUCTS AND SEALANTS"](#).

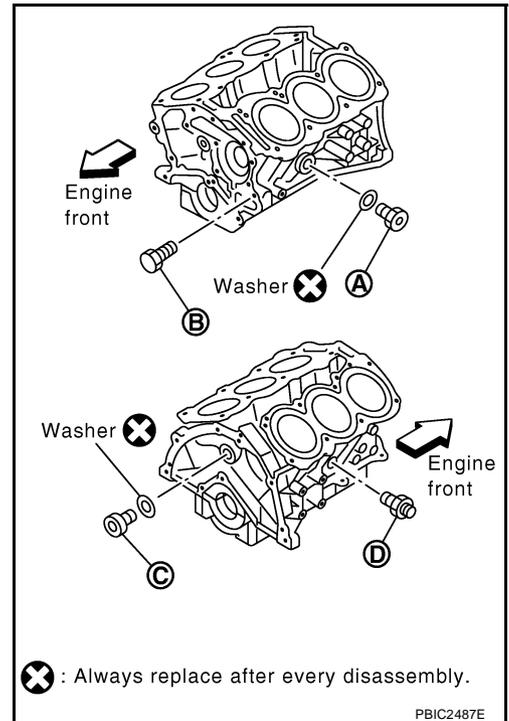
#### NOTE:

For Canada, "A" in the figure is not water drain plug but block heater. Refer to [EM-110, "Disassembly and Assembly"](#).

- Apply sealant to the thread of water drain plug "B" and connector bolt "D".

Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-47, "RECOMMENDED CHEMICAL PRODUCTS AND SEALANTS"](#).

- Apply sealant to the thread of plug "C".  
Use Genuine High Strength Locking Sealant or equivalent. Refer to [GI-47, "RECOMMENDED CHEMICAL PRODUCTS AND SEALANTS"](#).
- Replace washers with new one.



⊗ : Always replace after every disassembly.

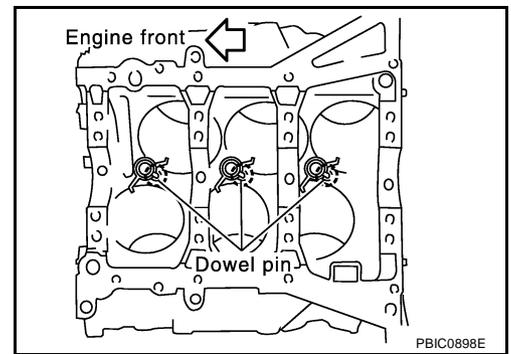
- Tighten each plug and connector bolt as specified below.

Part	Washer	Tightening torque
A	Yes	62.0 N·m (6.3 kg-m, 46 ft-lb)
B	No	9.8 N·m (1.0 kg-m, 87 in-lb)
C	Yes	62.0 N·m (6.3 kg-m, 46 ft-lb)
D	No	39.2 N·m (4.0 kg-m, 29 ft-lb)

# CYLINDER BLOCK

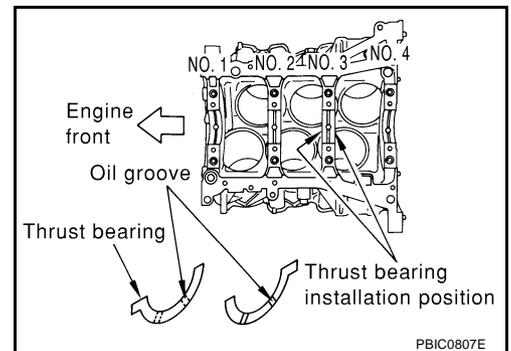
## 3. Install oil jet.

- Insert oil jet dowel pin into cylinder block dowel pin hole, and tighten mounting bolts.

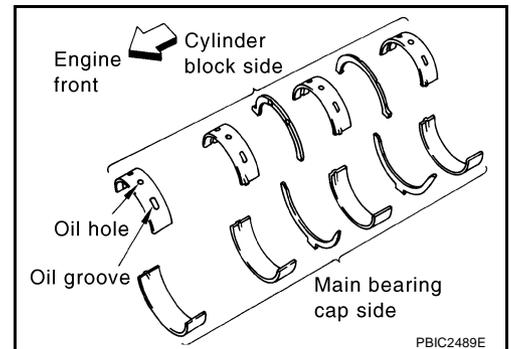


## 4. Install main bearings and thrust bearings as follow:

- Remove dust, dirt, and engine oil on bearing mating surfaces of cylinder block and main bearing caps.
- Install thrust bearings to the both sides of the No. 3 journal housing on cylinder block and main bearing cap.
  - Install thrust bearings with the oil groove facing crankshaft arm (outside).
  - Install thrust bearing with a projection on one end on cylinder block, and thrust bearing with a projection at center on main bearing cap. Align each projection with mating notch.



- Install main bearings paying attention to the direction.
  - Main bearing with oil hole and groove goes on cylinder block. The one without them goes on main bearing cap.
  - Before installing main 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 main bearing stopper protrusion to cut-out of cylinder block and main bearing caps.
  - Ensure the oil holes on cylinder block and those on the corresponding bearing are aligned.



## 5. Install crankshaft to cylinder block.

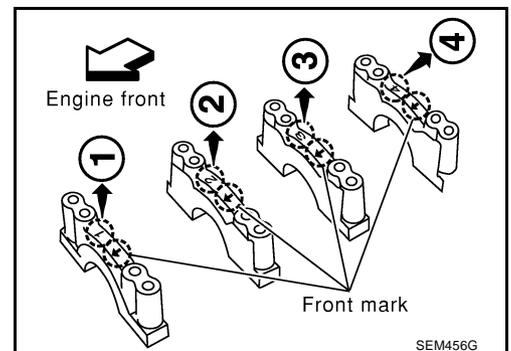
- While turning crankshaft by hand, check that it turns smoothly.

## 6. Install main bearing caps.

- Main bearing caps are identified by identification mark cast on them. For installation, face front mark to front side.

**NOTE:**

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



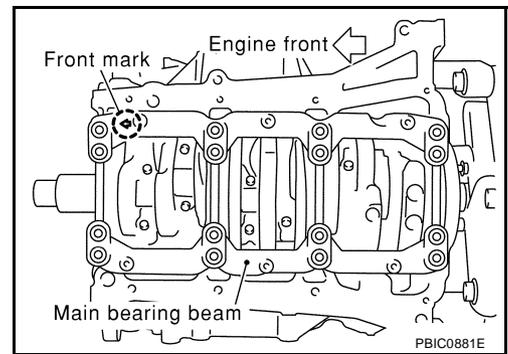
## 7. Install main bearing beam.

- Install main bearing beam with front mark facing downward (oil pan side).

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# CYLINDER BLOCK

- Install main bearing beam with front mark facing front of engine.

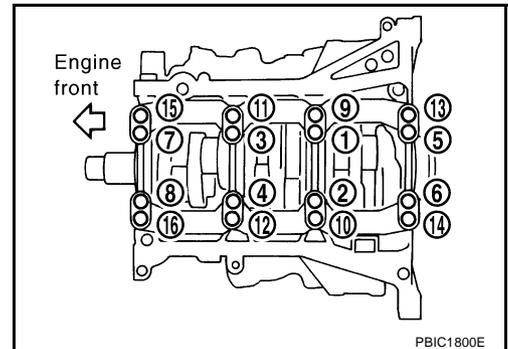


8. Inspect the outer diameter of main bearing cap bolt. Refer to [EM-135, "MAIN BEARING CAP BOLT OUTER DIAMETER"](#).

9. Install main bearing cap bolts in numerical order as shown in the figure as follows:

- a. Apply new engine oil to threads and seat surfaces of main bearing cap bolts.
- b. Tighten main bearing cap bolts in several different steps.

 : 35.3 N·m (3.6 kg·m, 26 ft·lb)

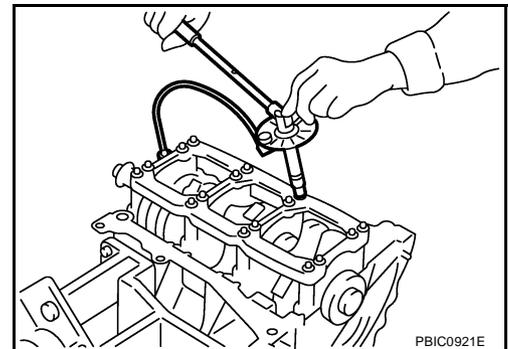


- c. Turn all main bearing cap bolts 90 degrees clockwise (Angle tightening).

**CAUTION:**

Use angle wrench [SST: KV10112100 (BT8653-A)] to check tightening angle. Do not make judgment by visual inspection.

- After installing mounting bolts, make sure that crankshaft can be rotated smoothly by hand.
- Check the crankshaft end play. Refer to [EM-127, "CRANK-SHAFT END PLAY"](#).



10. Inspect the outer diameter of connecting rod bolt. Refer to [EM-136, "CONNECTING ROD BOLT OUTER DIAMETER"](#).

11. Install piston to connecting rod as follows:

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

- Insert it fully into groove to install.

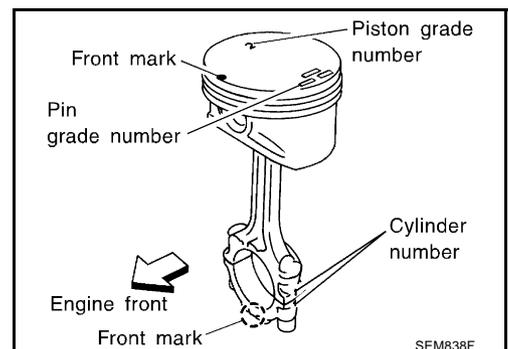
- b. Install piston to connecting rod.

- Using industrial drier or similar tool, heat 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 crown and the cylinder number on connecting rod are positioned as shown in the figure.

- c. Install new snap ring to the groove of the piston front side.

- Insert it fully into groove to install.

- After installing, make sure that connecting rod moves smoothly.

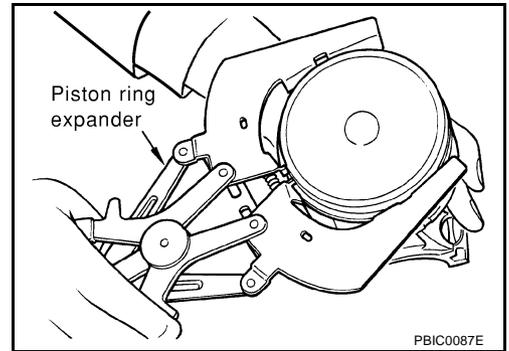


# CYLINDER BLOCK

12. Using 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.



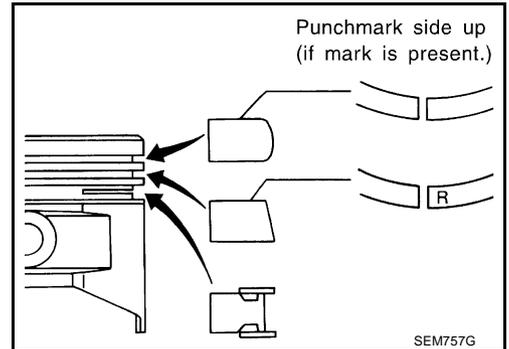
- If there is stamped mark on ring, mount it with marked side up.

**NOTE:**

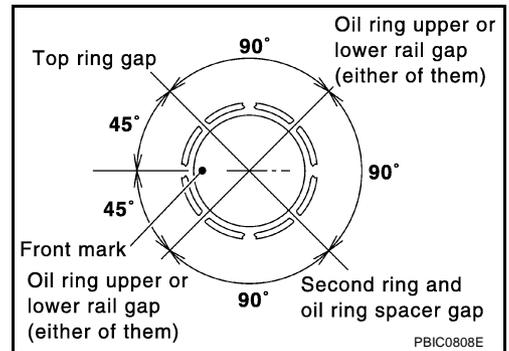
If there is no stamp on ring, no specific orientation is required for installation.

**Stamped mark:**

- Top ring : —
- Second ring : R



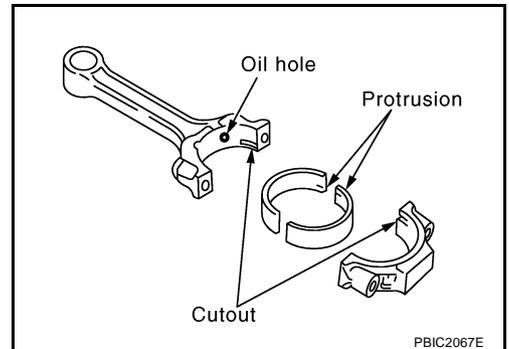
- Position each ring with the gap as shown in the figure referring to the piston front mark.



- Check the piston rings side clearance. Refer to [EM-128. "PISTON RING SIDE CLEARANCE"](#).

13. Install connecting rod bearings to connecting rod and connecting rod bearing cap.

- Before 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 connecting rod bearing stopper protrusion with cutout of connecting rod and connecting rod bearing cap to install.
- Ensure the oil hole on connecting rod and that on the corresponding bearing are aligned.



14. Install piston and connecting rod assembly to crankshaft.

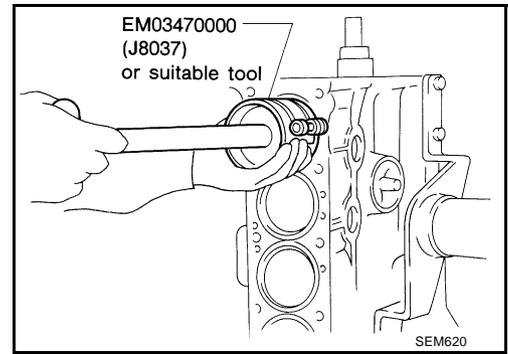
- Position crankshaft pin corresponding to connecting rod to be installed onto the bottom dead center.
- Apply engine oil sufficiently to the cylinder bore, piston and crankshaft pin journal.
- Match the cylinder position with the cylinder number on connecting rod to install.
- Be sure that front mark on piston crown is facing front of engine.

# CYLINDER BLOCK

- Using piston ring compressor [SST] or suitable tool, install piston with the front mark on the piston crown facing the front of engine.

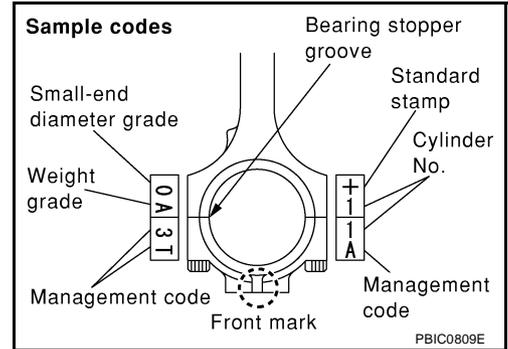
**CAUTION:**

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



15. Install connecting rod bearing cap.

- Match the stamped cylinder number marks on connecting rod with those on connecting rod bearing cap to install.
- Be sure that front mark on connecting rod bearing cap is facing front of engine.



16. Tighten connecting rod bolt as follows:

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

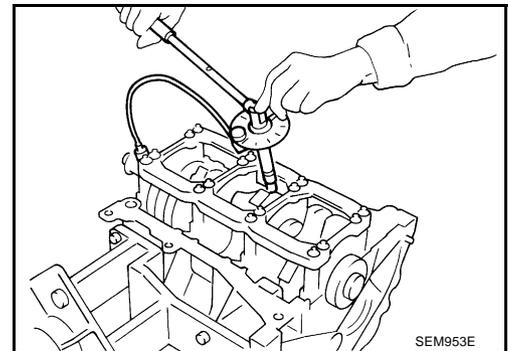
 : 19.6 N·m (2.0 kg·m, 14 ft·lb)

- Then tighten all connecting rod bolts 90 degrees clockwise (Angle tightening).

**CAUTION:**

**Always use angle wrench [SST: KV10112100 (BT8653-A)]. Avoid tightening based on visual check alone.**

- After tightening connecting rod bolts, make sure that crankshaft rotates smoothly.
- Check the connecting rod side clearance. Refer to [EM-127](#), "[CONNECTING ROD SIDE CLEARANCE](#)".



17. Install new rear oil seal retainer to cylinder block.

- Apply new engine oil to the oil and dust seal lips.
- Apply a continuous bead of liquid gasket with tube presser [SST: WS39930000 ( — )] to rear oil seal retainer as shown in the figure.

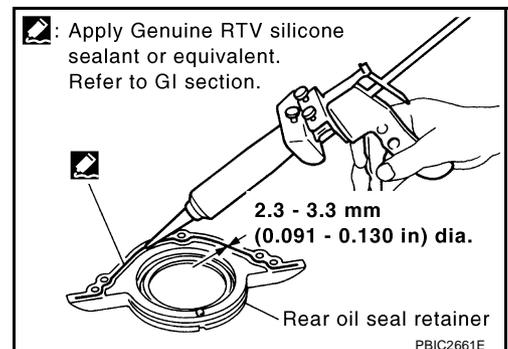
**Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-47](#), "[RECOMMENDED CHEMICAL PRODUCTS AND SEALANTS](#)".**

**CAUTION:**

- Replace with a new parts.
- Attaching should be done within 5 minutes after coating.

**NOTE:**

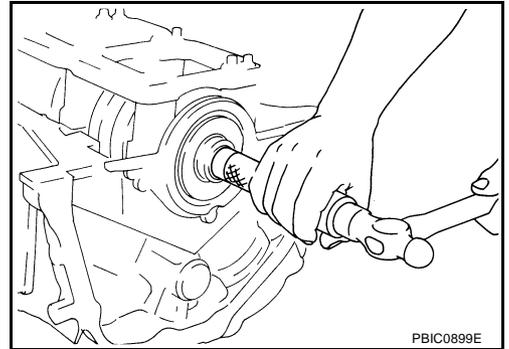
Regard both rear oil seal and retainer as an assembly.



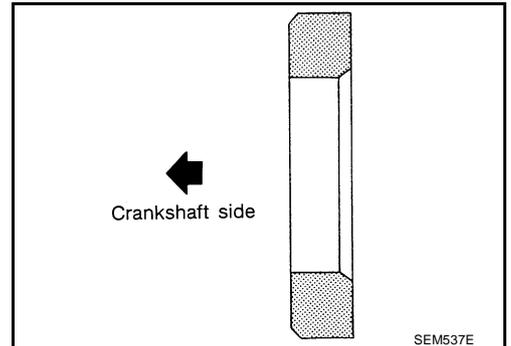
# CYLINDER BLOCK

## 18. Install pilot converter.

- With drift [outer diameter: approx. 33 mm (1.30 in)], press-fit as far as it will go.



- Press-fit pilot converter with its chamfer facing crankshaft as shown in the figure.



## 19. Install knock sensor.

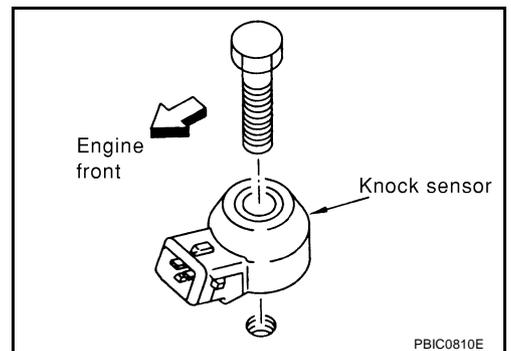
- Install knock sensor so that connector faces front of engine.
- After installing knock sensor, connect harness connector, and lay it out to rear of engine.

### 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:

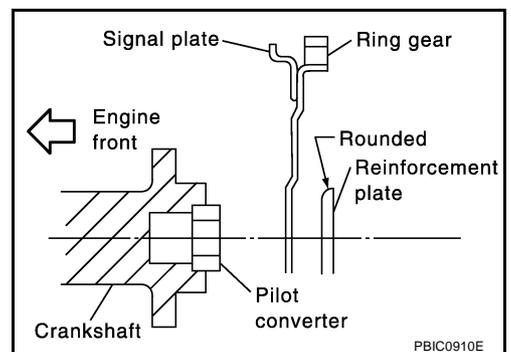
- Make sure that there is no foreign material on the cylinder block mating surface and the back surface of knock sensor.
- Make sure that knock sensor does not interfere with other parts.



## 20. Note the following, assemble in the reverse order of disassembly after this step.

### Drive plate

- Install drive plate and reinforcement plate as shown in the figure.
- Holding ring gear with pulley holder [SST: KV10109300 ( — )].
- Tighten mounting bolts crosswise over several times.



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# CYLINDER BLOCK

ABS00A3U

## How to Select Piston and Bearing DESCRIPTION

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

\*: For the service parts, the grade for fitting cannot be selected between piston pin and 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.

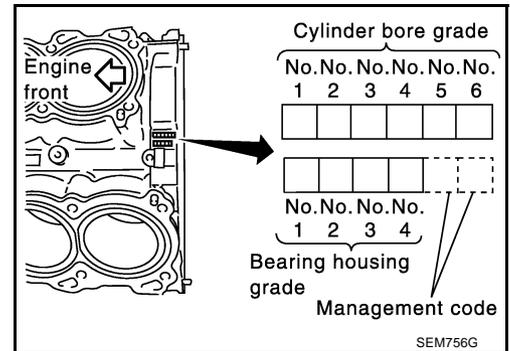
### HOW TO SELECT PISTON

#### When New Cylinder Block is Used

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

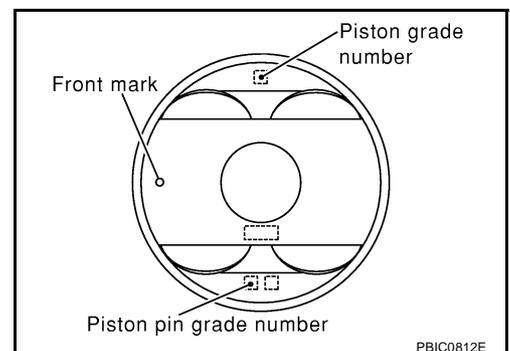
#### NOTE:

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 bore inner diameter. Refer to [EM-131, "Cylinder Bore Inner Diameter"](#).
2. Determine the bore grade by comparing the measurement with the values under the cylinder bore inner diameter of the "Piston Selection Table".



3. Select piston of the same grade.

# CYLINDER BLOCK

## Piston Selection Table

Unit: mm (in)

Grade	1	2 (or no mark)	3
Cylinder bore inner diameter	95.500 - 95.510 (3.7598 - 3.7602)	95.510 - 95.520 (3.7602 - 3.7606)	95.520 - 95.530 (3.7606 - 3.7610)
Piston skirt diameter	95.480 - 95.490 (3.7590 - 3.7594)	95.490 - 95.500 (3.7594 - 3.7598)	95.500 - 95.510 (3.7598 - 3.7602)

### 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 piston pin grades can be selected. (Only "0" grade is available.)
- No second grade mark is available on piston.

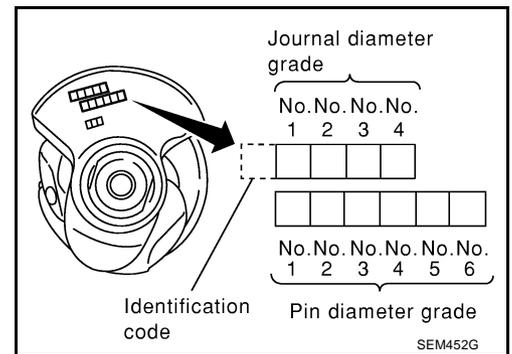
## HOW TO SELECT CONNECTING ROD BEARING

### When New Connecting Rod and Crankshaft are Used

Check pin 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 diameter.



### When Crankshaft and Connecting Rod are Reused

1. Measure the connecting rod big end diameter. Refer to [EM-129, "CONNECTING ROD BIG END DIAMETER"](#).
2. Make sure that the connecting rod big end diameter is within the standard value.
3. Measure the crankshaft pin journal diameter. Refer to [EM-133, "CRANKSHAFT PIN JOURNAL DIAMETER"](#).
4. 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".
5. 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		Connecting rod bearing		
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	Black
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

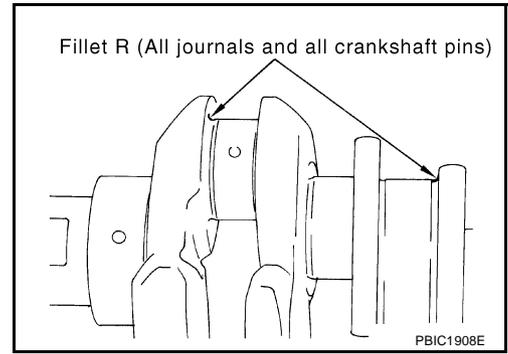
## Undersize Bearings Usage Guide

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

# CYLINDER BLOCK

**CAUTION:**

In grinding crankshaft pin to use undersize bearings, keep the fillet R [1.5 mm (0.059 in)].



**Bearing undersize table**

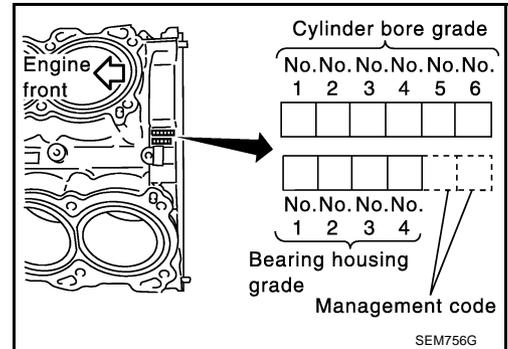
Unit: mm (in)

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

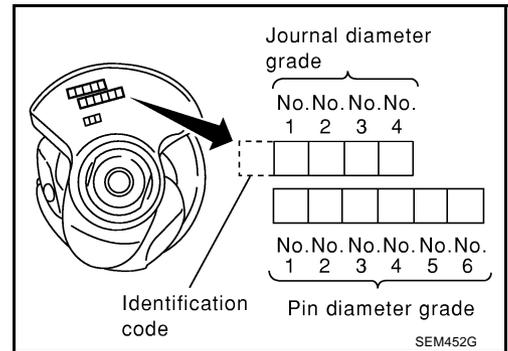
**HOW TO SELECT MAIN BEARING**

**When New Cylinder Block and Crankshaft are Used**

1. "Main Bearing Selection Table" rows correspond to bearing housing grade on rear left side of cylinder block.



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



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

**When Cylinder Block and Crankshaft are Reused**

1. Measure cylinder block main bearing housing inner diameter and crankshaft main journal diameter. Refer to [EM-131, "MAIN BEARING HOUSING INNER DIAMETER"](#) and [EM-132, "CRANKSHAFT MAIN JOURNAL DIAMETER"](#).
2. Correspond the measured dimension in "Cylinder block main bearing housing inner diameter" row of "Main Bearing Selection Table".
3. Correspond the measured dimension in "Crankshaft main journal diameter" column of "Main Bearing Selection Table".
4. Select main bearing grade at the point where selected row and column meet in following selection table.

# CYLINDER BLOCK

## Main Bearing Selection Table

Cylinder block main bearing housing inner diameter Unit: mm (in)  Crankshaft main journal diameter Unit: mm (in)		Hole diameter																								
		Mark	A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	S	T	U	V	W	X	Y	4	7
Mark	Axle diameter																									
A	59.975 - 59.974 (2.3612 - 2.3612)	0	0	0	01	01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	34
B	59.974 - 59.973 (2.3612 - 2.3611)	0	0	01	01	01	1	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	34
C	59.973 - 59.972 (2.3611 - 2.3611)	0	01	01	01	1	1	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	34
D	59.972 - 59.971 (2.3611 - 2.3611)	01	01	01	1	1	1	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	34
E	59.971 - 59.970 (2.3611 - 2.3610)	01	01	1	1	1	1	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	34
F	59.970 - 59.969 (2.3610 - 2.3610)	01	1	1	1	1	1	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	34
G	59.969 - 59.968 (2.3610 - 2.3609)	1	1	1	1	1	1	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	34
H	59.968 - 59.967 (2.3609 - 2.3609)	1	1	1	1	1	1	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	34
J	59.967 - 59.966 (2.3609 - 2.3609)	1	1	1	1	1	1	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	34
K	59.966 - 59.965 (2.3909 - 2.3608)	12	12	12	2	2	2	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	45
L	59.965 - 59.964 (2.3608 - 2.3608)	12	12	2	2	2	2	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	45
M	59.964 - 59.963 (2.3608 - 2.3607)	12	2	2	2	2	2	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	45
N	59.963 - 59.962 (2.3607 - 2.3607)	2	2	2	2	2	2	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	45
P	59.962 - 59.961 (2.3607 - 2.3607)	2	2	2	2	2	2	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	45
R	59.961 - 59.960 (2.3607 - 2.3606)	2	2	2	2	2	2	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	45
S	59.960 - 59.959 (2.3606 - 2.3606)	23	23	23	3	3	3	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	56
T	59.959 - 59.958 (2.3606 - 2.3605)	23	23	3	3	3	3	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	56
U	59.958 - 59.957 (2.3605 - 2.3605)	23	3	3	3	3	3	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	56
V	59.957 - 59.956 (2.3605 - 2.3605)	3	3	3	3	3	3	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	56
W	59.956 - 59.955 (2.3605 - 2.3604)	3	3	3	3	3	3	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	56
X	59.955 - 59.954 (2.3604 - 2.3604)	3	3	3	3	3	3	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	56
Y	59.954 - 59.953 (2.3604 - 2.3603)	34	34	34	4	4	4	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	67
4	59.953 - 59.952 (2.3603 - 2.3603)	34	34	4	4	4	4	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	67
7	59.952 - 59.951 (2.3603 - 2.3603)	34	4	4	4	4	4	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	67

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# CYLINDER BLOCK

**Main Bearing Grade Table (All Journals)**

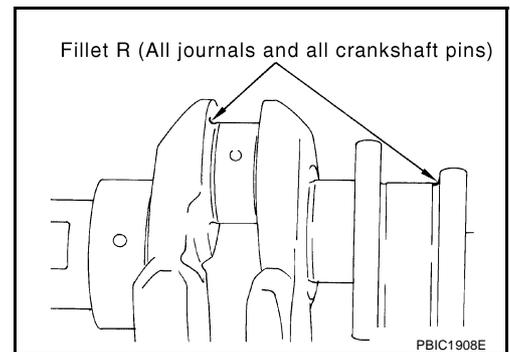
Grade number		Thickness Unit: mm (in)	Width Unit: mm (in)	Identification color	Remarks
0		2.000 - 2.003 (0.0787 - 0.0789)	19.9 - 20.1 (0.783 - 0.791)	Black	Grade and color are the same for upper and lower bearings.
1		2.003 - 2.006 (0.0789 - 0.0790)		Brown	
2		2.006 - 2.009 (0.0790 - 0.0791)		Green	
3		2.009 - 2.012 (0.0791 - 0.0792)		Yellow	
4		2.012 - 2.015 (0.0792 - 0.0793)		Blue	
5		2.015 - 2.018 (0.0793 - 0.0794)		Pink	
6		2.018 - 2.021 (0.0794 - 0.0796)		Purple	
7		2.021 - 2.024 (0.0796 - 0.0797)		White	Grade and color are different for upper and lower bearings.
01	UPP	2.003 - 2.006 (0.0789 - 0.0790)		Brown	
	LWR	2.000 - 2.003 (0.0787 - 0.0789)		Black	
12	UPR	2.006 - 2.009 (0.0790 - 0.0791)		Green	
	LWR	2.003 - 2.006 (0.0789 - 0.0790)		Brown	
23	UPR	2.009 - 2.012 (0.0791 - 0.0792)		Yellow	
	LWR	2.006 - 2.009 (0.0790 - 0.0791)		Green	
34	UPR	2.012 - 2.015 (0.0792 - 0.0793)	Blue		
	LWR	2.009 - 2.012 (0.0791 - 0.0792)	Yellow		
45	UPR	2.015 - 2.018 (0.0793 - 0.0794)	Pink		
	LWR	2.012 - 2.015 (0.0792 - 0.0793)	Blue		
56	UPR	2.018 - 2.021 (0.0794 - 0.0796)	Purple		
	LWR	2.015 - 2.018 (0.0793 - 0.0794)	Pink		
67	UPR	2.021 - 2.024 (0.0796 - 0.0797)	White		
	LWR	2.018 - 2.021 (0.0794 - 0.0796)	Purple		

**Undersize Bearing Usage Guide**

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

**CAUTION:**

**In grinding crankshaft main journal to use undersize bearings, keep the fillet R [1.5 mm (0.059 in)].**



**Bearing undersize table**

Unit: mm (in)

Size	Thickness
US 0.25 (0.0098)	2.132 - 2.140 (0.0839 - 0.0843)

# CYLINDER BLOCK

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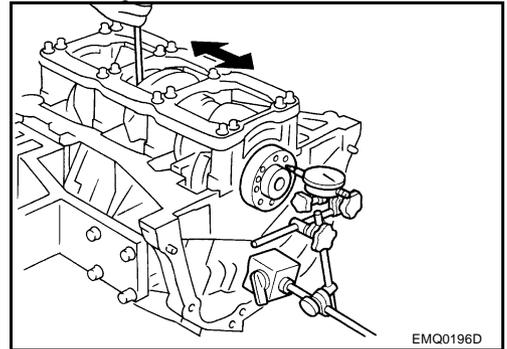
## Inspection After Disassembly CRANKSHAFT END PLAY

- Measure the clearance between thrust bearings and crankshaft arm when crankshaft is moved fully forward or backward with dial indicator.

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



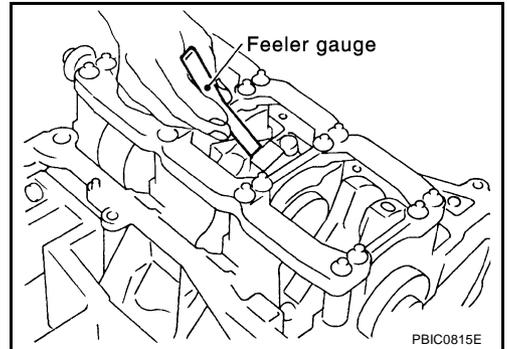
## CONNECTING ROD SIDE CLEARANCE

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

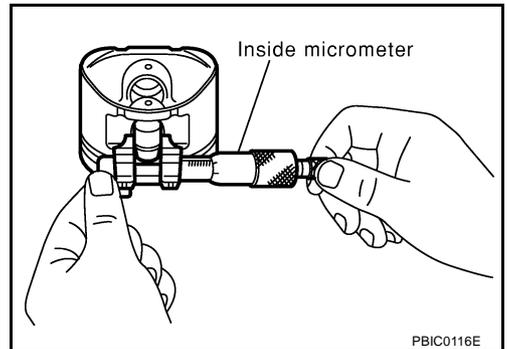


## PISTON TO PISTON PIN OIL CLEARANCE

### Piston Pin Hole Diameter

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

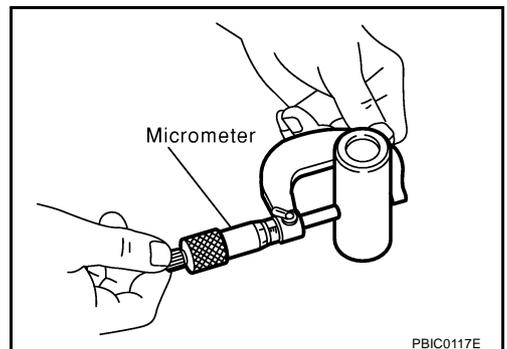
**Standard** : 21.993 - 22.005 mm (0.8659 - 0.8663 in)



### Piston Pin Outer Diameter

Measure the outer diameter of piston pin with micrometer.

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



### Piston to Piston Pin Oil Clearance

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

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

- If clearance is out of the standard, replace piston and piston pin assembly.

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

# CYLINDER BLOCK

- When replacing piston and piston pin assembly, refer to [EM-122, "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 piston pin grades can be selected. (Only "0" grade is available.)

## PISTON RING SIDE CLEARANCE

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

### Standard:

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

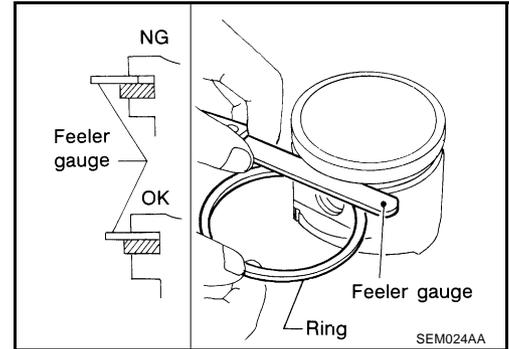
**2nd ring** : 0.030 - 0.070 mm (0.0012 - 0.0028 in)

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

### Limit:

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

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



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

## PISTON RING END GAP

- Make sure that the cylinder bore inner diameter is within the specification. Refer to [EM-131, "Cylinder Bore Inner Diameter"](#) .
- 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 feeler gauge.

### Standard:

**Top ring** : 0.23 - 0.33 mm (0.0091 - 0.0130 in)

**2nd ring** : 0.33 - 0.48 mm (0.0130 - 0.0189 in)

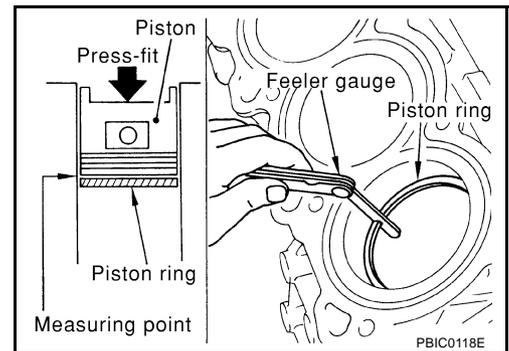
**Oil ring** : 0.20 - 0.50 mm (0.0079 - 0.0197 in)

### Limit:

**Top ring** : 0.54 mm (0.0213 in)

**2nd ring** : 0.80 mm (0.0315 in)

**Oil ring** : 0.95 mm (0.0374 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.

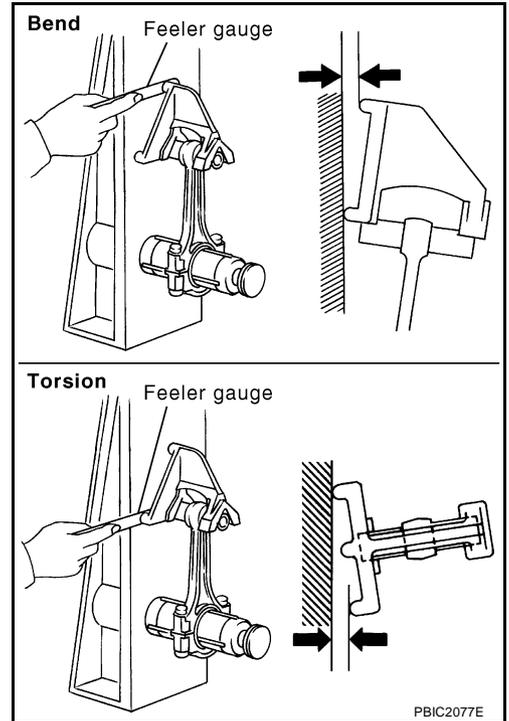
### Bend:

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

### Torsion:

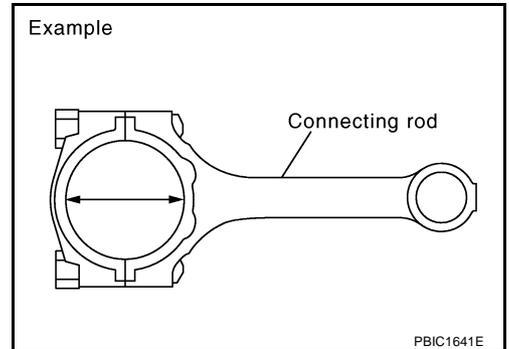
Limit : 0.30 mm (0.0118 in) per 100 mm (3.94 in) length

- 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 tightening connecting rod bolts to the specified torque. Refer to [EM-116, "ASSEMBLY"](#) for the tightening procedure.
  - Measure the inner diameter of connecting rod big end with inside micrometer.
- Standard : 55.000 - 55.013 mm (2.1654 - 2.1659 in)
- If out of the standard, replace connecting rod assembly.

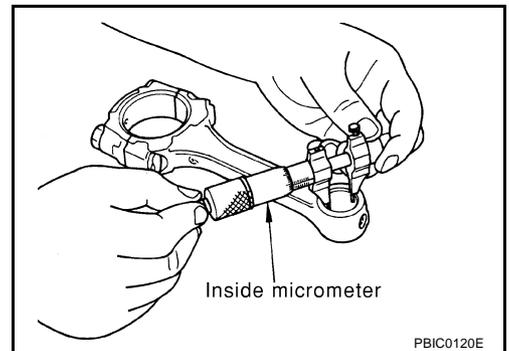


## CONNECTING ROD BUSHING OIL CLEARANCE

### Connecting Rod Bushing Inner Diameter

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

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

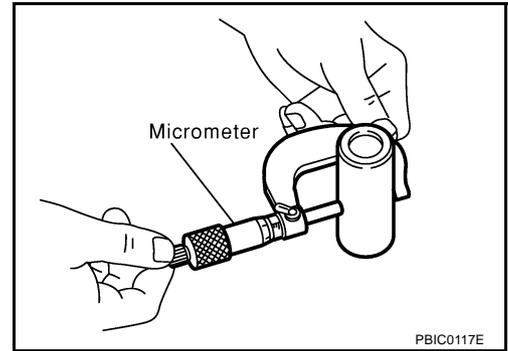


# CYLINDER BLOCK

## Piston Pin Outer Diameter

Measure the outer diameter of piston pin with micrometer.

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



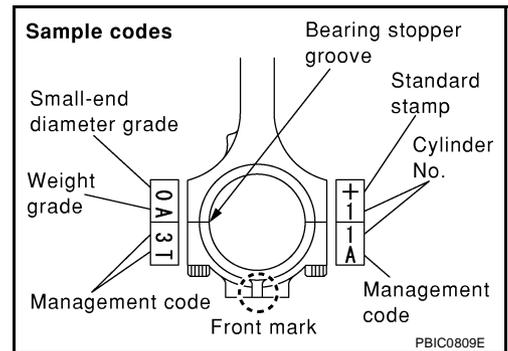
## Connecting Rod Bushing Oil Clearance

(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-122, "HOW TO SELECT PISTON"](#) .
- If replacing connecting rod assembly, refer to [EM-133, "CONNECTING ROD BEARING OIL CLEARANCE"](#) to select the connecting rod bearing.

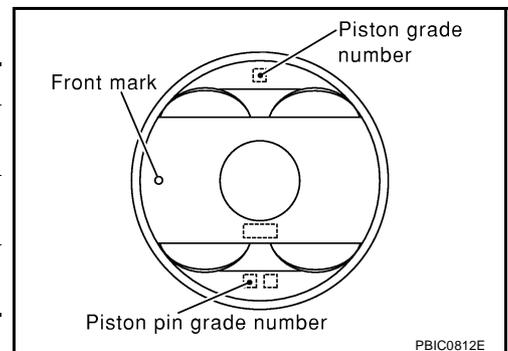


## Factory installed parts grading:

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

### CAUTION:

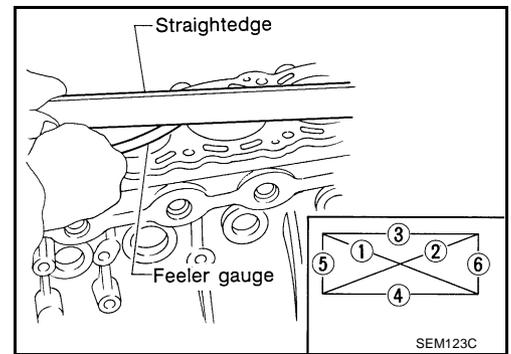
**Be careful not to allow gasket flakes to enter engine oil or engine coolant passages.**

# CYLINDER BLOCK

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

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

- If it exceeds the limit, replace cylinder block.



## MAIN BEARING HOUSING INNER DIAMETER

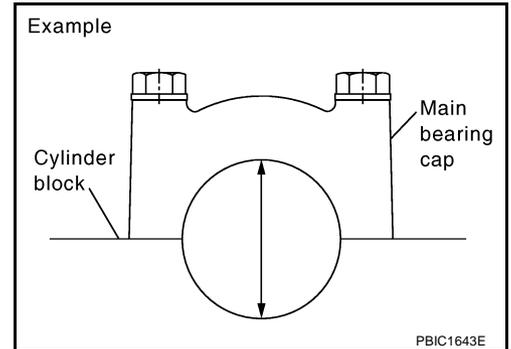
- Install main bearing caps and main bearing beam without installing main bearings, and tighten main bearing cap bolts to the specified torque. Refer to [EM-116, "ASSEMBLY"](#) for the tightening procedure.
- Measure the inner diameter of main bearing housing with bore gauge.

**Standard : 63.993 - 64.017 mm (2.5194 - 2.5203 in)**

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

### NOTE:

Cylinder block cannot be replaced as a single part, because it is machined together with main bearing caps.



## PISTON TO CYLINDER BORE CLEARANCE

### Cylinder Bore Inner Diameter

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

### Standard inner diameter:

**95.500 - 95.530 mm (3.7598 - 3.7610 in)**

### Wear limit:

**0.2 mm (0.008 in)**

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

**0.015 mm (0.0006 in)**

### Taper limit (Difference between "A" and "C"):

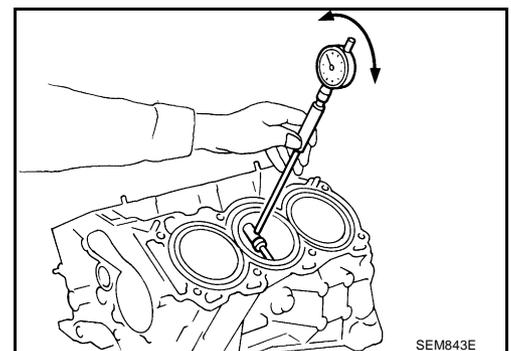
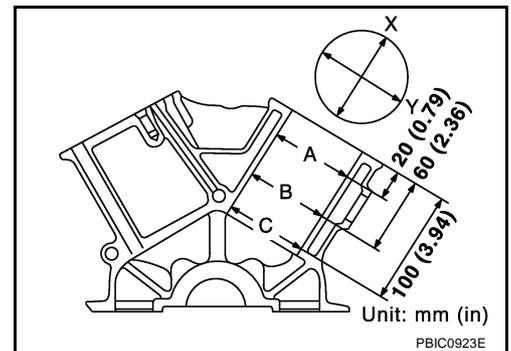
**0.01 mm (0.0004 in)**

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

### CAUTION:

When using oversize piston, use oversize pistons for all cylinders with oversize piston rings.

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



# CYLINDER BLOCK

## Piston Skirt Diameter

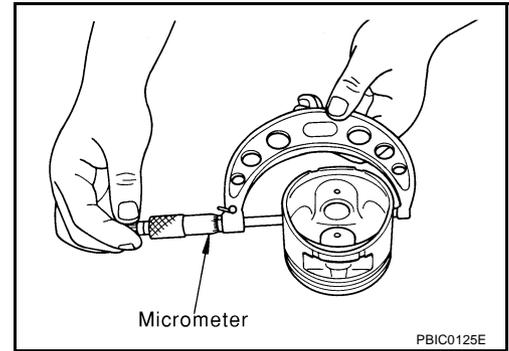
Measure the outer diameter of piston skirt with micrometer.

### Measure point

: Distance from the top 41.0 mm (1.614 in)

### Standard

: 95.480 - 95.510 mm (3.7590 - 3.7602 in)



## Piston to Cylinder Bore Clearance

Calculate by piston skirt diameter and cylinder bore inner diameter (direction "Y", 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 the calculated value exceeds the limit, replace piston and piston pin assembly. Refer to [EM-122, "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.

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

where,

**D: Bored diameter**

**A: Piston skirt diameter as measured**

**B: Piston to cylinder bore clearance (standard value)**

**C: Honing allowance 0.02 mm (0.0008 in)**

2. Install main bearing caps and main bearing beam, and tighten to the specified torque. Otherwise, cylinder bores may be distorted in final assembly.
3. Cut cylinder bores.

### NOTE:

- When any cylinder needs boring, all other cylinders must also be bored.
- Do not cut too much out of cylinder bore at a time. Cut only 0.05 mm (0.0020 in) or so in diameter at a time.

4. Hone cylinders to obtain the specified piston to cylinder bore clearance.
5. Measure finished cylinder bore for the out-of-round and taper.

### NOTE:

Measurement should be done after cylinder bore cools down.

## CRANKSHAFT MAIN JOURNAL DIAMETER

- Measure the outer diameter of crankshaft main journals with micrometer.

**Standard** : 59.951 - 59.975 mm (2.3603 - 2.3612 in) dia.

- If out of the standard, measure the main bearing oil clearance. Then use undersize bearing. Refer to [EM-134, "MAIN BEARING OIL CLEARANCE"](#).

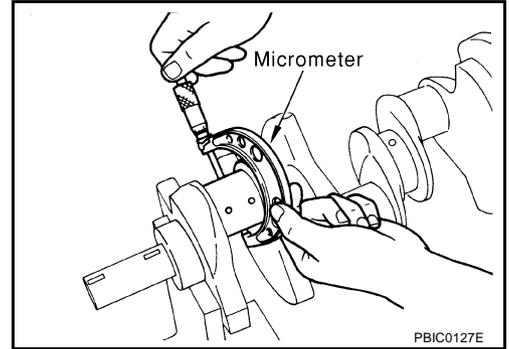
# CYLINDER BLOCK

## CRANKSHAFT PIN JOURNAL DIAMETER

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

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

- If out of the standard, measure the connecting rod bearing oil clearance. Then use undersize bearing. Refer to [EM-133](#), "[CONNECTING ROD BEARING OIL CLEARANCE](#)".



## CRANKSHAFT OUT-OF-ROUND AND TAPER

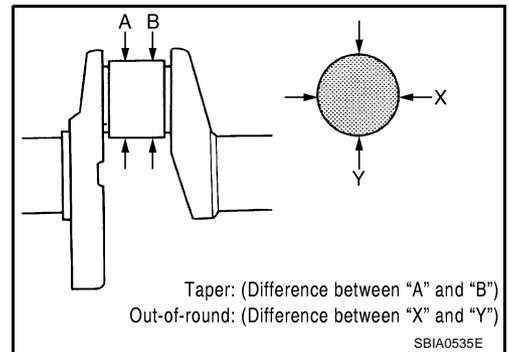
- Measure the dimensions at four different points as shown in the figure on each main journal and pin journal with micrometer.
- Out-of-round is indicated by the difference in the dimensions between "X" and "Y" at "A" and "B".
- Taper is indicated by the difference in the dimensions between "A" and "B"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

**Limit:**

**Out-of-round (Difference between "X" and "Y")  
: 0.002 mm (0.0001 in)**

**Taper (Difference between "A" and "B")  
: 0.002 mm (0.0001 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 the main bearing and/or connecting rod bearing. Refer to [EM-134](#), "[MAIN BEARING OIL CLEARANCE](#)" and/or [EM-133](#), "[CONNECTING ROD BEARING OIL CLEARANCE](#)".



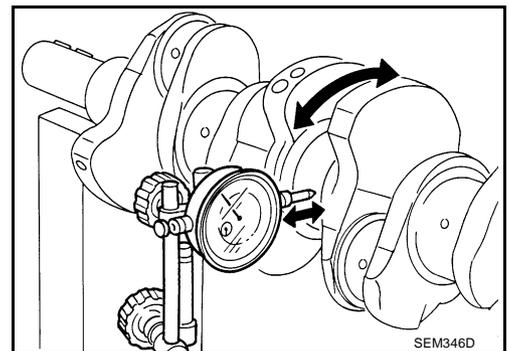
## CRANKSHAFT RUNOUT

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

**Standard : Less than 0.05 mm (0.002 in)**

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

- If it exceeds the limit, replace crankshaft.



## CONNECTING ROD BEARING OIL CLEARANCE

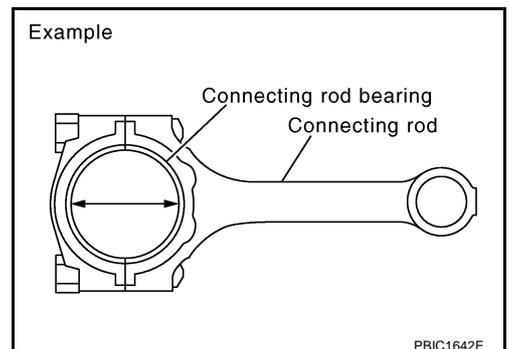
### Method by Calculation

- Install connecting rod bearings to connecting rod and cap, and tighten connecting rod bolts to the specified torque. Refer to [EM-116](#), "[ASSEMBLY](#)" for the tightening procedure.
- Measure the inner diameter of connecting rod bearing with inside micrometer.

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

**Standard : 0.034 - 0.059 mm (0.0013 - 0.0023 in)  
(actual clearance)**

**Limit : 0.070 mm (0.0028 in)**



# CYLINDER BLOCK

- 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-123, "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 bolts to the specified torque. Refer to [EM-116, "ASSEMBLY"](#) for the tightening procedure.

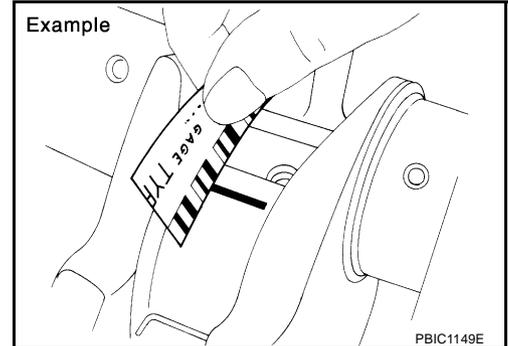
### CAUTION:

**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 with main bearing beam to the specified torque. Refer to [EM-116, "ASSEMBLY"](#) for the tightening procedure.
- Measure the inner diameter of main bearing with bore gauge.  
(Bearing clearance) = (Main bearing inner diameter) – (Crankshaft main journal diameter)

**Standard : 0.035 - 0.045 mm (0.0014 - 0.0018 in)**  
**(actual clearance)**

**Limit : 0.065 mm (0.0026 in)**

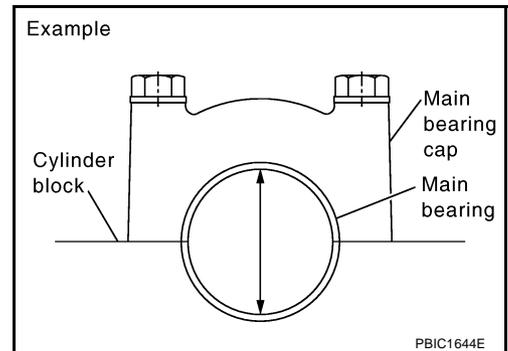
- If the calculated value exceeds the limit, select proper main bearing according to main bearing inner diameter and crankshaft main journal diameter to obtain the specified bearing oil clearance. Refer to [EM-124, "HOW TO SELECT MAIN BEARING"](#).

### 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 with main bearing beam to the specified torque. Refer to [EM-116, "ASSEMBLY"](#) for the tightening procedure.

### CAUTION:

**Do not rotate crankshaft.**

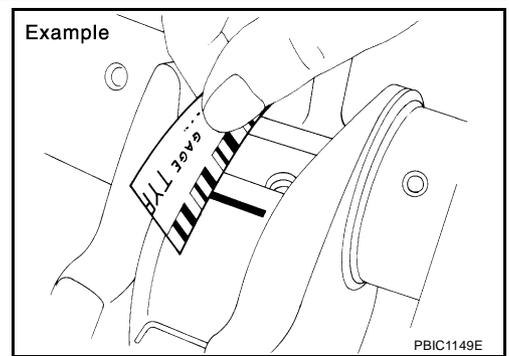


# CYLINDER BLOCK

- 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".

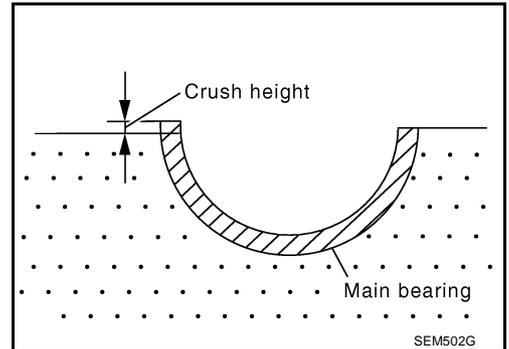


## CRUSH HEIGHT OF MAIN BEARING

- 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-116, "ASSEMBLY"](#) for the tightening procedure.

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

- If the standard is not met, replace main bearings.

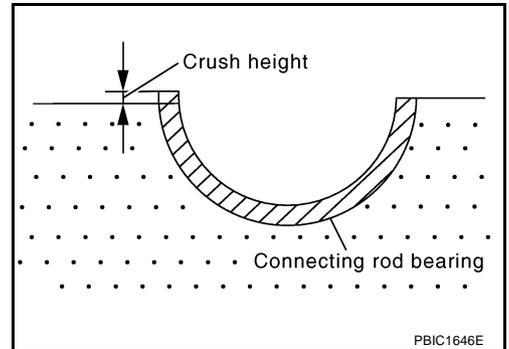


## CRUSH HEIGHT OF CONNECTING ROD BEARING

- 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-116, "ASSEMBLY"](#) for the tightening procedure.

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

- If the standard is not met, replace connecting rod bearings.

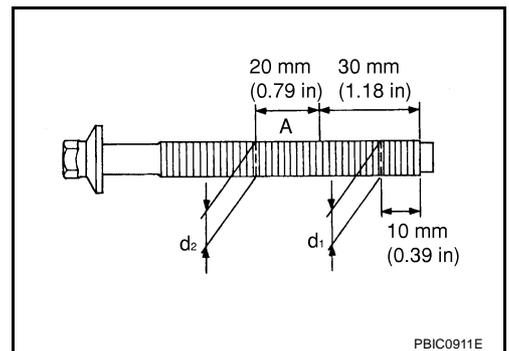


## MAIN BEARING CAP BOLT OUTER DIAMETER

- Measure the outer diameters ("d1", "d2") at two positions as shown in the figure.
- If reduction appears in "A" range, regard it as "d2".

**Limit ("d1" - "d2")** : 0.11 mm (0.0051 in)

- If it exceeds the limit (large difference in dimensions), replace main bearing cap bolt with new one.



# CYLINDER BLOCK

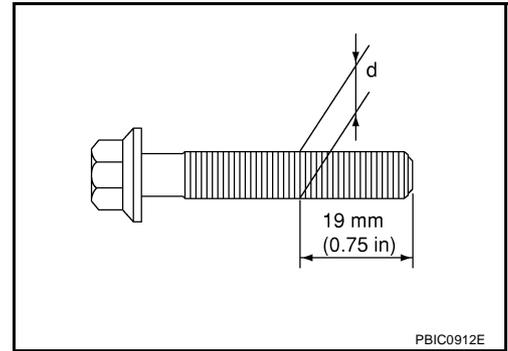
## CONNECTING ROD BOLT OUTER DIAMETER

- Measure the outer diameter "d" at position shown in the figure.
- If the reduction appears in a position other than "d", regard it as "d".

**Standard : 7.90 - 8.00 mm (0.3110 - 0.3150 in)**

**Limit : 7.75 mm (0.3051 in)**

- When "d" exceeds the limit (when it becomes thinner), replace connecting rod bolt with new one.

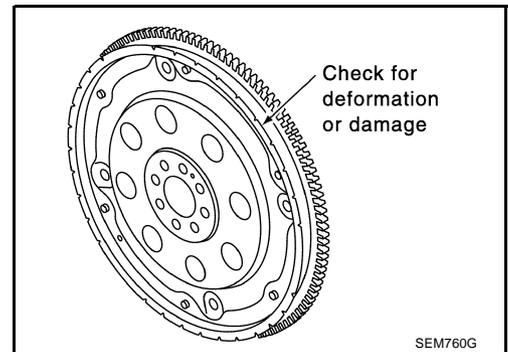


## DRIVE PLATE

- 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.

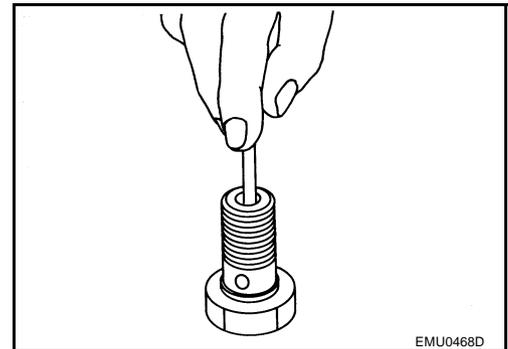


## OIL JET

- Check nozzle for deformation and damage.
- Blow compressed air from nozzle, and check for clogs.
- If it is not satisfied, clean or replace oil jet.

## OIL JET RELIEF VALVE

- Using clean plastic stick, press check valve in oil jet relief valve. Make sure that valve moves smoothly with proper reaction force.
- If it is not satisfied, replace oil jet relief valve.



# SERVICE DATA AND SPECIFICATIONS (SDS)

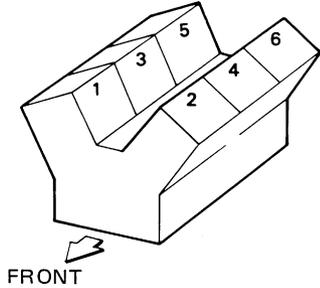
## SERVICE DATA AND SPECIFICATIONS (SDS)

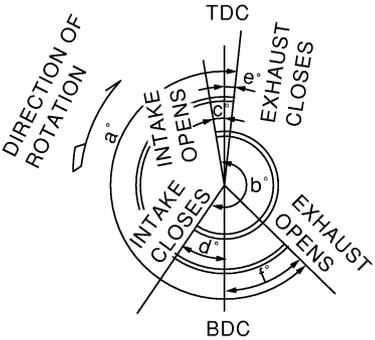
PFP:00100

### Standard and Limit GENERAL SPECIFICATIONS

ABS00A3W

Cylinder arrangement		V-6
Displacement cm <sup>3</sup> (cu in)		3,498 (213.45)
Bore and stroke mm (in)		95.5 x 81.4 (3.76 x 3.205)
Valve arrangement		DOHC
Firing order		1-2-3-4-5-6
Number of piston rings	Compression	2
	Oil	1
Number of main bearings		4
Compression ratio		10.3
Compression pressure kPa (kg/cm <sup>2</sup> , psi)/300 rpm	Standard	1,275 (13.0, 185)
	Minimum	981 (10.0, 142)
	Differential limit between cylinders	98 (1.0, 14)

Cylinder number	 <p style="text-align: right;">SEM713A</p>
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Valve timing (Intake valve timing control - "OFF")	 <p style="text-align: right;">PBIC0187E</p>
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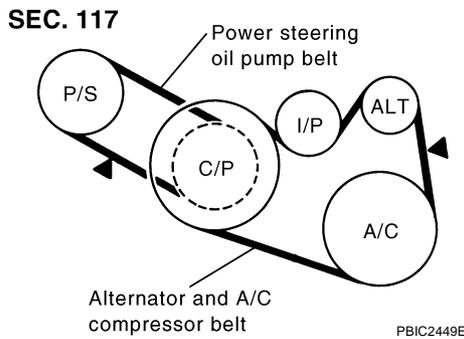
Unit: degree

a	b	c	d	e	f
240	238	- 6	64	8	52

# SERVICE DATA AND SPECIFICATIONS (SDS)

## DRIVE BELT

	Deflection adjustment		Unit: mm (in)	Tension adjustment*		Unit: N (kg, lb)
	Used belt		New belt	Used belt		New belt
	Limit	After adjustment		Limit	After adjustment	
Alternator and A/C compressor	7 (0.28)	4.2 - 4.6 (0.17 - 0.18)	3.7 - 4.1 (0.15 - 0.16)	294 (30, 66)	730 - 818 (74.5 - 83.5, 164 - 184)	838 - 926 (85.5 - 94.5, 188 - 208)
Power steering oil pump	11 (0.43)	7.3 - 8 (0.29 - 0.30)	6.5 - 7.2 (0.26 - 0.28)	196 (20, 44)	495 - 583 (50.5 - 59.5, 111 - 131)	603 - 691 (61.5 - 70.5, 135.6 - 155.4)
Applied pushing force	98 N (10 kg, 22 lb)			—		



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

## INTAKE MANIFOLD COLLECTOR, INTAKE MANIFOLD AND EXHAUST MANIFOLD

Unit: mm (in)

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

## SPARK PLUG

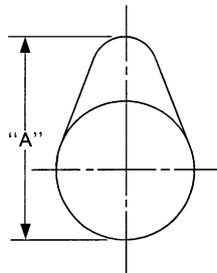
Make	NGK
Standard type	PLFR5A-11
Hot type	PLFR4A-11
Cold type	PLFR6A-11
Gap (nominal)	1.1 mm (0.043 in)

# SERVICE DATA AND SPECIFICATIONS (SDS)

## CAMSHAFT AND CAMSHAFT BEARING

Unit: mm (in)

Items		Standard	Limit
Camshaft journal oil clearance	No. 1	0.045 - 0.086 (0.0018 - 0.0034)	0.15 (0.0059)
	No. 2, 3, 4	0.035 - 0.076 (0.0014 - 0.0030)	
Camshaft bracket inner diameter	No. 1	26.000 - 26.021 (1.0236 - 1.0244)	—
	No. 2, 3, 4	23.500 - 23.521 (0.9252 - 0.9260)	—
Camshaft journal diameter	No. 1	25.935 - 25.955 (1.0211 - 1.0218)	—
	No. 2, 3, 4	23.445 - 23.465 (0.9230 - 0.9238)	—
Camshaft end play		0.115 - 0.188 (0.0045 - 0.0074)	0.24 (0.0094)
Camshaft cam height "A"	Intake and exhaust	44.865 - 45.055 (1.7663 - 1.7738)	0.2 (0.008)* <sup>1</sup>
Camshaft runout [TIR* <sup>2</sup> ]		Less than 0.02 mm (0.001)	0.05 (0.002)
Camshaft sprocket runout [TIR* <sup>2</sup> ]		—	0.15 (0.0059)



SEM671

\*<sup>1</sup> : Cam wear limit

\*<sup>2</sup> : Total indicator reading

## Valve Lifter

Unit: mm (in)

Items	Standard
Valve lifter outer diameter	33.977 - 33.987 (1.3377 - 1.3381)
Valve lifter hole diameter	34.000 - 34.016 (1.3386 - 1.3392)
Valve lifter clearance	0.013 - 0.039 (0.0005 - 0.0015)

## 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)

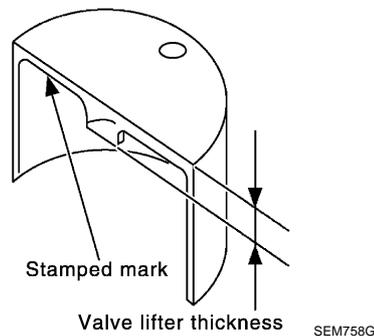
\*: Approximately 80°C (176°F)

# SERVICE DATA AND SPECIFICATIONS (SDS)

## Available Valve Lifter

Unit: mm (in)

Identification (stamped) mark	Thickness
788U or 788R	7.88 (0.3102)
790U or 790R	7.90 (0.3110)
792U or 792R	7.92 (0.3118)
794U or 794R	7.94 (0.3126)
796U or 796R	7.96 (0.3134)
798U or 798R	7.98 (0.3142)
800U or 800R	8.00 (0.3150)
802U or 802R	8.02 (0.3157)
804U or 804R	8.04 (0.3165)
806U or 806R	8.06 (0.3173)
808U or 808R	8.08 (0.3181)
810U or 810R	8.10 (0.3189)
812U or 812R	8.12 (0.3197)
814U or 814R	8.14 (0.3205)
816U or 816R	8.16 (0.3213)
818U or 818R	8.18 (0.3220)
820U or 820R	8.20 (0.3228)
822U or 822R	8.22 (0.3236)
824U or 824R	8.24 (0.3244)
826U or 826R	8.26 (0.3252)
828U or 828R	8.28 (0.3260)
830U or 830R	8.30 (0.3268)
832U or 832R	8.32 (0.3276)
834U or 834R	8.34 (0.3283)
836U or 836R	8.36 (0.3291)
838U or 838R	8.38 (0.3299)
840U or 840R	8.40 (0.3307)

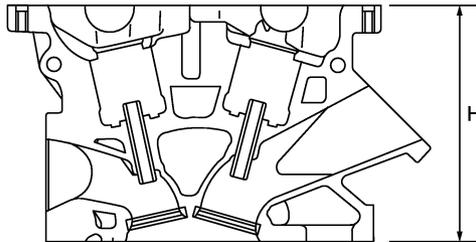


# SERVICE DATA AND SPECIFICATIONS (SDS)

## CYLINDER HEAD

Unit: mm (in)

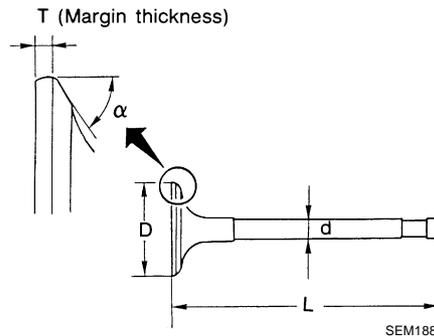
Items	Standard	Limit
Head surface distortion	Less than 0.03 (0.0012)	0.1 (0.004)
Normal cylinder head height "H"	126.3 - 126.5 (4.972 - 4.980)	—



PBIC0924E

## Valve Dimensions

Unit: mm (in)

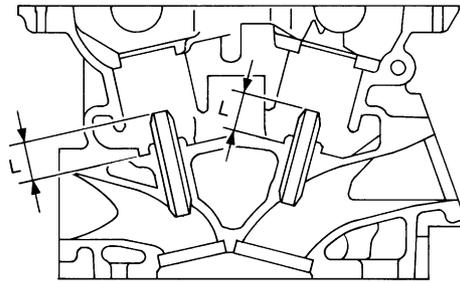


Valve head diameter "D"	Intake	37.0 - 37.3 (1.4567 - 1.4685)
	Exhaust	31.2 - 31.5 (1.228 - 1.240)
Valve length "L"	Intake	96.37 (3.794)
	Exhaust	93.99 (3.700)
Valve stem diameter "d"	Intake	5.965 - 5.980 (0.2348 - 0.2354)
	Exhaust	5.955 - 5.970 (0.2344 - 0.2350)
Valve seat angle " $\alpha$ "	Intake	45°15' - 45°45'
	Exhaust	
Valve margin "T"	Intake	1.1 (0.043)
	Exhaust	1.3 (0.051)
Valve margin "T" limit		0.5 (0.020)
Valve stem end surface grinding limit		0.2 (0.008)

# SERVICE DATA AND SPECIFICATIONS (SDS)

## Valve Guide

Unit: mm (in)



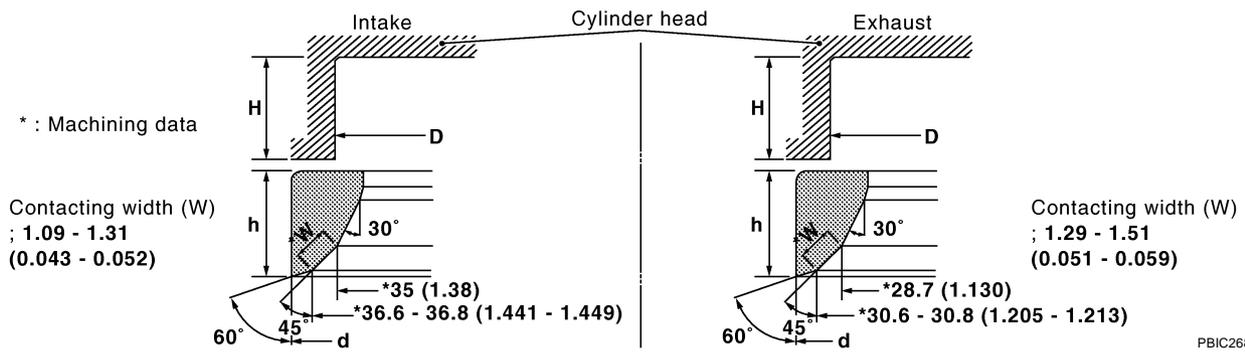
SEM950E

Items		Standard	0.2 (0.008) oversize (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)	
Items		Standard	Limit
Valve guide clearance	Intake	0.020 - 0.053 (0.0008 - 0.0021)	0.08 (0.003)
	Exhaust	0.030 - 0.063 (0.0012 - 0.0025)	0.09 (0.004)
Projection length "L"		12.6 - 12.8 (0.496 - 0.504)	

# SERVICE DATA AND SPECIFICATIONS (SDS)

## Valve Seat

Unit: mm (in)



Items		Standard	Oversize [0.5 (0.020)] (Service)
Cylinder head seat recess diameter "D"	Intake	38.000 - 38.016 (1.4961 - 1.4967)	38.500 - 38.516 (1.5157 - 1.5164)
	Exhaust	32.200 - 32.216 (1.2677 - 1.2683)	32.700 - 32.716 (1.2874 - 1.2880)
Valve seat outer diameter "d"	Intake	38.097 - 38.113 (1.4999 - 1.5005)	38.597 - 38.613 (1.5196 - 1.5202)
	Exhaust	32.280 - 32.296 (1.2709 - 1.2715)	32.780 - 32.796 (1.2905 - 1.2912)
Valve seat interference fit	Intake	0.081 - 0.113 (0.0032 - 0.0044)	
	Exhaust	0.064 - 0.096 (0.0025 - 0.0038)	
Items		Standard	Service
Height "h"	Intake	5.9 - 6.0 (0.232 - 0.236)	5.05 - 5.15 (0.1988 - 0.2028)
	Exhaust	5.9 - 6.0 (0.232 - 0.236)	4.95 - 5.05 (0.1949 - 0.1988)
Depth "H"		6.0 (0.246)	

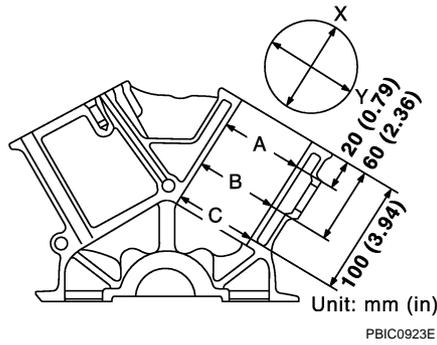
## Valve Spring

Free height	mm (in)	47.07 (1.8531)
Pressure	N (kg, lb) at height mm (in)	166 - 188 (16.9 - 19.2, 37.3 - 42.3) at 37.00 (1.4567)
		373 - 421 (38.0 - 42.9, 83.9 - 94.6) at 27.20 (1.0709)
Out-of-square	mm (in)	Limit 2.1 (0.083)

# SERVICE DATA AND SPECIFICATIONS (SDS)

## CYLINDER BLOCK

Unit: mm (in)



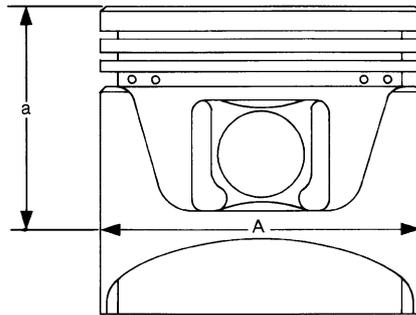
Surface flatness		Standard		Less than 0.03 (0.0012)
		Limit		0.1 (0.004)
Main bearing housing inner diameter		Standard		63.993 - 64.017 (2.5194 - 2.5203)
Cylinder bore	Inner diameter	Standard	Grade No. 1	95.500 - 95.510 (3.7598 - 3.7602)
			Grade No. 2	95.510 - 95.520 (3.7602 - 3.7606)
			Grade No. 3	95.520 - 95.530 (3.7606 - 3.7610)
		Wear limit		0.2 (0.008)
Out-of-round (Difference between "X" and "Y")		Limit	0.015 (0.0006)	
Taper (Difference between "A" and "C")			0.01 (0.0004)	
Main bearing housing inner diameter (Without bearing)		Grade No. A		63.993 - 63.994 (2.5194 - 2.5194)
		Grade No. B		63.994 - 63.995 (2.5194 - 2.5195)
		Grade No. C		63.995 - 63.996 (2.5195 - 2.5195)
		Grade No. D		63.996 - 63.997 (2.5195 - 2.5196)
		Grade No. E		63.997 - 63.998 (2.5196 - 2.5196)
		Grade No. F		63.998 - 63.999 (2.5196 - 2.5196)
		Grade No. G		63.999 - 64.000 (2.5196 - 2.5197)
		Grade No. H		64.000 - 64.001 (2.5197 - 2.5197)
		Grade No. J		64.001 - 64.002 (2.5197 - 2.5198)
		Grade No. K		64.002 - 64.003 (2.5198 - 2.5198)
		Grade No. L		64.003 - 64.004 (2.5198 - 2.5198)
		Grade No. M		64.004 - 64.005 (2.5198 - 2.5199)
		Grade No. N		64.005 - 64.006 (2.5199 - 2.5199)
		Grade No. P		64.006 - 64.007 (2.5199 - 2.5200)
		Grade No. R		64.007 - 64.008 (2.5200 - 2.5200)
		Grade No. S		64.008 - 64.009 (2.5200 - 2.5200)
		Grade No. T		64.009 - 64.010 (2.5200 - 2.5201)
Grade No. U		64.010 - 64.011 (2.5201 - 2.5201)		
Grade No. V		64.011 - 64.012 (2.5201 - 2.5202)		
Grade No. W		64.012 - 64.013 (2.5202 - 2.5202)		
Grade No. X		64.013 - 64.014 (2.5202 - 2.5202)		
Grade No. Y		64.014 - 64.015 (2.5202 - 2.5203)		
Grade No. 4		64.015 - 64.016 (2.5203 - 2.5203)		
Grade No. 7		64.016 - 64.017 (2.5203 - 2.5203)		
Difference in inner diameter between cylinders		Standard		Less than 0.03 (0.0012)

# SERVICE DATA AND SPECIFICATIONS (SDS)

## PISTON, PISTON RING AND PISTON PIN

### Available Piston

Unit: mm (in)



SEM882E

Items		Standard	0.20 (0.0079) oversize
Piston skirt diameter "A"	Grade No. 1	95.480 - 95.490 (3.7590 - 3.7594)	—
	Grade No. 2	95.490 - 95.500 (3.7594 - 3.7598)	—
	Grade No. 3	95.500 - 95.510 (3.7598 - 3.7602)	—
	Service	—	95.680 - 95.710 (3.7669 - 3.7681)
Items		Standard	Limit
"a" dimension		41.0 (1.614)	—
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		0.010 - 0.030 (0.0004 - 0.0012)	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	0.23 - 0.33 (0.0091 - 0.0130)	0.54 (0.0213)
	2nd	0.33 - 0.48 (0.0130 - 0.0189)	0.80 (0.0315)
	Oil (rail ring)	0.20 - 0.50 (0.0079 - 0.0197)	0.95 (0.0374)

### Piston Pin

Unit: mm (in)

Items		Standard	Limit
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 oil clearance		0.002 - 0.006 (0.0001 - 0.0002)	—
Connecting rod bushing oil clearance		0.005 - 0.017 (0.0002 - 0.0007)	0.030 (0.0012)

# SERVICE DATA AND SPECIFICATIONS (SDS)

## CONNECTING ROD

Unit: mm (in)

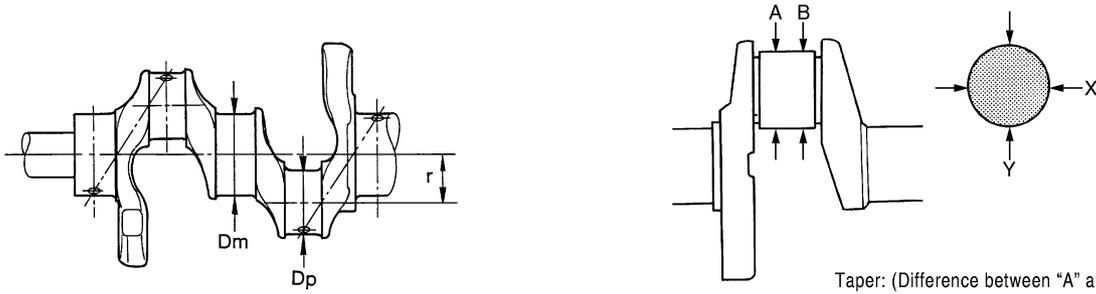
Items	Standard	Limit
Center distance	144.15 - 144.25 (5.6752 - 5.6791)	—
Bend [per 100 (3.94)]	—	0.15 (0.0059)
Torsion [per 100 (3.94)]	—	0.30 (0.0118)
Connecting rod bushing inner diameter*	Grade No. 0	22.000 - 22.006 (0.8661 - 0.8664)
	Grade No. 1	22.006 - 22.012 (0.8664 - 0.8666)
Connecting rod big end diameter (Without bearing)	55.000 - 55.013 (2.1654 - 2.1659)	—
Side clearance	0.20 - 0.35 (0.0079 - 0.0138)	0.40 (0.0157)

\*: After installing in connecting rod

# SERVICE DATA AND SPECIFICATIONS (SDS)

## CRANKSHAFT

Unit: mm (in)



SEM645

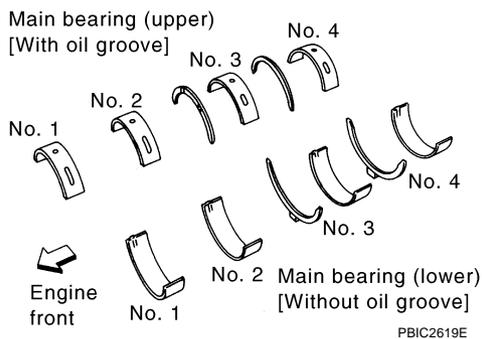
SBIA0535E

Main journal diameter. "Dm" grade	Standard	Grade No. A	59.974 - 59.975 (2.3612 - 2.3612)
		Grade No. B	59.973 - 59.974 (2.3611 - 2.3612)
		Grade No. C	59.972 - 59.973 (2.3611 - 2.3611)
		Grade No. D	59.971 - 59.972 (2.3611 - 2.3611)
		Grade No. E	59.970 - 59.971 (2.3610 - 2.3611)
		Grade No. F	59.969 - 59.970 (2.3610 - 2.3610)
		Grade No. G	59.968 - 59.969 (2.3609 - 2.3610)
		Grade No. H	59.967 - 59.968 (2.3609 - 2.3609)
		Grade No. J	59.966 - 59.967 (2.3609 - 2.3609)
		Grade No. K	59.965 - 59.966 (2.3608 - 2.3609)
		Grade No. L	59.964 - 59.965 (2.3608 - 2.3608)
		Grade No. M	59.963 - 59.964 (2.3607 - 2.3608)
		Grade No. N	59.962 - 59.963 (2.3607 - 2.3607)
		Grade No. P	59.961 - 59.962 (2.3607 - 2.3607)
		Grade No. R	59.960 - 59.961 (2.3606 - 2.3607)
		Grade No. S	59.959 - 59.960 (2.3606 - 2.3606)
		Grade No. T	59.958 - 59.959 (2.3605 - 2.3606)
Grade No. U	59.957 - 59.958 (2.3605 - 2.3605)		
Grade No. V	59.956 - 59.957 (2.3605 - 2.3605)		
Grade No. W	59.955 - 59.956 (2.3604 - 2.3605)		
Grade No. X	59.954 - 59.955 (2.3604 - 2.3604)		
Grade No. Y	59.953 - 59.954 (2.3603 - 2.3604)		
Grade No. 4	59.952 - 59.953 (2.3603 - 2.3603)		
Grade No. 7	59.951 - 59.952 (2.3603 - 2.3603)		
Pin journal diameter. "Dp"	Standard	Grade No. 0	51.968 - 51.974 (2.0460 - 2.0462)
		Grade No. 1	51.962 - 51.968 (2.0457 - 2.0460)
		Grade No. 2	51.956 - 51.962 (2.0455 - 2.0457)
Center distance "r"			40.66 - 40.74 (1.6008 - 1.6039)
Taper (Difference between "A" and "B")	Limit		0.002 (0.0001)
Out-of-round (Difference between "X" and "Y")			0.002 (0.0001)
Crankshaft runout [TIR*]	Standard		Less than 0.05 (0.002)
	Limit		0.10 (0.0039)
Crankshaft end play	Standard		0.10 - 0.25 (0.0039 - 0.0098)
	Limit		0.30 (0.0118)

\*: Total indicator reading

# SERVICE DATA AND SPECIFICATIONS (SDS)

## MAIN BEARING



Grade number	UPR/LWR	Thickness "T" mm (in)	Width "W" mm (in)	Identification color	Remarks
0	—	2.000 - 2.003 (0.0787 - 0.0789)	19.9 - 20.1 (0.783 - 0.791)	Black	Grade is the same for upper and lower bearings.
1	—	2.003 - 2.006 (0.0789 - 0.0790)		Brown	
2	—	2.006 - 2.009 (0.0790 - 0.0791)		Green	
3	—	2.009 - 2.012 (0.0791 - 0.0792)		Yellow	
4	—	2.012 - 2.015 (0.0792 - 0.0793)		Blue	
5	—	2.015 - 2.018 (0.0793 - 0.0794)		Pink	
6	—	2.018 - 2.021 (0.0794 - 0.0796)		Purple	
7	—	2.021 - 2.024 (0.0796 - 0.0797)		White	Grade is different for upper and lower bearings.
01	UPP	2.003 - 2.006 (0.0789 - 0.0790)		Brown	
	LWR	2.000 - 2.003 (0.0787 - 0.0789)		Black	
12	UPR	2.006 - 2.009 (0.0790 - 0.0791)		Green	
	LWR	2.003 - 2.006 (0.0789 - 0.0790)		Brown	
23	UPR	2.009 - 2.012 (0.0791 - 0.0792)		Yellow	
	LWR	2.006 - 2.009 (0.0790 - 0.0791)		Green	
34	UPR	2.012 - 2.015 (0.0792 - 0.0793)	Blue		
	LWR	2.009 - 2.012 (0.0791 - 0.0792)	Yellow		
45	UPR	2.015 - 2.018 (0.0793 - 0.0794)	Pink		
	LWR	2.012 - 2.015 (0.0792 - 0.0793)	Blue		
56	UPR	2.018 - 2.021 (0.0794 - 0.0796)	Purple		
	LWR	2.015 - 2.018 (0.0793 - 0.0794)	Pink		
67	UPR	2.021 - 2.024 (0.0796 - 0.0797)	White		
	LWR	2.018 - 2.021 (0.0794 - 0.0796)	Purple		

### Undersize

Unit: mm (in)

Items	Thickness	Main journal diameter
0.25 (0.0098)	2.132 - 2.140 (0.0839 - 0.0843)	Grind so that bearing clearance is the specified value.

### Main Bearing Oil Clearance

Unit: mm (in)

Items	Standard	Limit
Main bearing oil clearance	0.035 - 0.045 (0.0014 - 0.0018)*	0.065 (0.0026)

\*: Actual clearance

# SERVICE DATA AND SPECIFICATIONS (SDS)

## CONNECTING ROD BEARING

Grade number	Thickness mm (in)	Identification color (mark)
0	1.500 - 1.503 (0.0591 - 0.0592)	Black
1	1.503 - 1.506 (0.0592 - 0.0593)	Brown
2	1.506 - 1.509 (0.0593 - 0.0594)	Green

## Undersize

Unit: mm (in)

Items	Thickness	Crank pin journal diameter
0.25 (0.0098)	1.626 - 1.634 (0.0640 - 0.0643)	Grind so that bearing clearance is the specified value.

## Connecting Rod Bearing Oil Clearance

Unit: mm (in)

Items	Standard	Limit
Connecting rod bearing oil clearance	0.034 - 0.059 (0.0013 - 0.0023)*	0.070 (0.0028)

\*: Actual clearance

## Tightening Torque

ABS00A3X

\*1: Parts to be tightened in particular orders.

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

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

Mass air flow sensor	5.0 - 6.5 (0.51 - 0.66, 45 - 57)*2
Engine cover	4.4 - 6.6 (0.45 - 0.67, 39 - 58)*2
*1 Intake manifold collector (upper)	17.6 - 21.6 (1.8 - 2.2, 13 - 15)
*1 Intake manifold collector (lower)	17.6 - 21.6 (1.8 - 2.2, 13 - 15)
*1 Electric throttle control actuator	7.2 - 9.6 (0.74 - 0.97, 64 - 84)*2
EVAP canister purge volume control solenoid valve	9.81 - 12.7 (1.0 - 1.2, 87 - 112)*2
*1 Intake manifold	1) 4.9 - 9.8 (0.5 - 1.0, 4 - 7) 2) 26.5 - 31.4 (2.7 - 3.2, 20 - 23)
Exhaust manifold cover	5.8 (0.59, 51)*2
*1 Exhaust manifold	30.9 (3.2, 23)
Air fuel ratio sensor 1	50 (5.1, 37)
Heated oxygen sensor 2	50 (5.1, 37)
*1 Oil pan (lower)	9.9 (1.0, 88)*2
*1 Oil pan (upper)	17.2 (1.8, 13)
Oil strainer	21.1 (2.2, 16)
Oil pan drain plug	34.3 (3.5, 25)
Rear cover plate	6.9 (0.70, 61)*2
Crankshaft position sensor (POS)	9.6 (0.98, 85)*2
Ignition coil	9.0 (0.92, 80)*2
Spark plug	24.5 (2.5, 18)
Fuel damper	11.0 (1.1, 8)*2
Fuel feed hose (with damper)	11.0 (1.1, 8)*2
*1 Fuel tube	1) 9.3 - 10.8 (0.95 - 1.1, 6.9 - 7.9) 2) 20.6 - 26.5 (2.1 - 2.7, 16 - 19)
*1 Rocker cover	1) 0.96 - 2.96 (0.10 - 0.30, 9 - 26)*2

## SERVICE DATA AND SPECIFICATIONS (SDS)

PCV valve		2) 7.33 - 9.33 (0.75 - 0.95, 65 - 82)* <sup>2</sup> 2.5 (0.26, 22)* <sup>2</sup>
*1 Intake valve timing control cover		9.81 - 12.7 (1.0 - 1.3, 87 - 112)* <sup>2</sup>
Camshaft sprocket (INT)		98 - 108 (10 - 11, 73 - 79)
Camshaft sprocket (EXH)		118 - 128 (12.0 - 13.1, 87 - 94)
Timing chain tensioner (primary)		6.9 - 9.3 (0.70 - 0.95, 61 - 82)* <sup>2</sup>
Timing chain tensioner (secondary)		7.0 - 10.0 (0.71 - 1.02, 62 - 88)* <sup>2</sup>
Internal chain guide		6.9 - 9.3 (0.70 - 0.95, 61 - 82)* <sup>2</sup>
Tension guide		19.6 - 23.5 (2.0 - 2.3, 15 - 17)
Slack guide		12.7 - 18.6 (1.3 - 1.8, 10 - 13)
Crankshaft pulley		1) 44.1 (4.5, 33) 2) 60° (angle tightening)
Chain tensioner cover		9.8 - 12.8 (1.0 - 1.3, 87 - 112)* <sup>2</sup>
Water pump cover		9.8 - 12.8 (1.0 - 1.3, 87 - 112)* <sup>2</sup>
*1 Front timing chain case	M6 bolt	11.7 - 13.7 (1.2 - 1.4, 9 - 10)
	M8 bolt	25.5 - 31.3 (2.6 - 3.2, 19 - 23)
*1 Rear timing chain case		11.7 - 13.7 (1.2 - 1.4, 9 - 10)
*1 Camshaft bracket		1) 2.0 (0.20, 1) 2) 2.0 (0.20, 1) 3) 5.9 (0.6, 4) 4) 10.4 (1.1, 8) 5) 9.3 (0.95, 7)
Camshaft position sensor (PHASE)		8.4 - 10.8 (0.86 - 1.1, 75 - 95)* <sup>2</sup>
Intake valve timing control solenoid valve		9.8 - 12.7 (1.0 - 1.3, 87 - 112)* <sup>2</sup>
*1 Cylinder head		1) 98.1 (10, 72) 2) 0 (0, 0) 3) 39.2 (4.0, 29) 4) 90° (angle tightening) 5) 90° (angle tightening)
*1 Main bearing cap		1) 32.3 - 38.3 (3.3 - 3.9, 24 - 28) 2) 90° - 95° (angle tightening)
Connecting rod		1) 18.6 - 20.6 (1.9 - 2.1, 14 - 15) 2) 90° - 95° (angle tightening)
Oil jet		27.0 (2.8, 20)
Knock sensor		23.6 (2.4, 17)
Drive plate		88.0 (9.0, 65)
Rear oil seal retainer		8.8 (0.90, 78)* <sup>2</sup>