

SECTION **EM**

ENGINE MECHANICAL

CONTENTS

QR		
PRECAUTIONS	5	
Precautions Necessary for Steering Wheel Rotation		
After Battery Disconnect	5	
OPERATION PROCEDURE	5	
Precautions for Drain Engine Coolant	5	
Precautions for Disconnecting Fuel Piping	5	
Precautions for Removal and Disassembly	5	
Precautions for Inspection, Repair and Replacement	5	
Precautions for Assembly and Installation	5	
Parts Requiring Angle Tightening	6	
Precautions For Liquid Gasket	6	
REMOVAL OF LIQUID GASKET	6	
LIQUID GASKET APPLICATION PROCEDURE	6	
PREPARATION	8	
Special Service Tools	8	
Commercial Service Tools	10	
NOISE, VIBRATION AND HARSHNESS (NVH)		
TROUBLESHOOTING	12	
NVH Troubleshooting — Engine Noise	12	
Use the Chart Below to Help You Find the Cause of the Symptom.	13	
DRIVE BELTS	14	
Checking Drive Belts	14	
Tension Adjustment	14	
Removal and Installation	14	
REMOVAL	14	
INSTALLATION	15	
Removal and Installation of Drive Belt Auto-Tensioner	15	
REMOVAL	15	
INSTALLATION	16	
AIR CLEANER AND AIR DUCT	17	
Removal and Installation	17	
REMOVAL	17	
INSPECTION AFTER REMOVAL	18	
INSTALLATION	18	
Changing Air Cleaner Filter	18	
REMOVAL	18	
INSTALLATION	18	
INTAKE MANIFOLD	19	
Removal and Installation	19	
REMOVAL	19	
INSTALLATION	21	
INSPECTION AFTER INSTALLATION	22	
EXHAUST MANIFOLD AND THREE WAY CATALYST	23	
Removal and Installation	23	
REMOVAL	23	
INSPECTION AFTER REMOVAL	24	
INSTALLATION	24	
OIL PAN AND OIL STRAINER	26	
Removal and Installation	26	
REMOVAL	26	
INSPECTION AFTER REMOVAL	28	
INSTALLATION	28	
INSPECTION AFTER INSTALLATION	30	
IGNITION COIL	31	
Removal and Installation	31	
REMOVAL	31	
INSTALLATION	31	
SPARK PLUG (PLATINUM-TIPPED TYPE)	32	
Removal and Installation	32	
REMOVAL	32	
INSPECTION AFTER REMOVAL	32	
INSTALLATION	33	
FUEL INJECTOR AND FUEL TUBE	34	
Removal and Installation	34	
REMOVAL	34	
INSTALLATION	36	
INSPECTION AFTER INSTALLATION	38	
ROCKER COVER	39	
Removal and Installation	39	
REMOVAL	39	
INSTALLATION	40	

CAMSHAFT	41	ING	92
Removal and Installation	41	HOW TO SELECT MAIN BEARING	95
REMOVAL	41	Inspection After Disassembly	99
INSPECTION AFTER REMOVAL	44	CRANKSHAFT END PLAY	99
INSTALLATION	47	CONNECTING ROD SIDE CLEARANCE	99
INSPECTION AFTER INSTALLATION	49	PISTON TO PISTON PIN OIL CLEARANCE	99
Valve Clearance	50	PISTON RING SIDE CLEARANCE	100
INSPECTION	50	PISTON RING END GAP	100
ADJUSTMENT	51	CONNECTING ROD BEND AND TORSION	101
TIMING CHAIN	53	CONNECTING ROD BIG END DIAMETER	101
Removal and Installation	53	CONNECTING ROD BUSHING OIL CLEAR- ANCE	101
REMOVAL	54	CYLINDER BLOCK DISTORTION	102
INSPECTION AFTER REMOVAL	57	MAIN BEARING HOUSING INNER DIAMETER	103
INSTALLATION	58	PISTON TO CYLINDER BORE CLEARANCE .	103
OIL SEAL	62	CRANKSHAFT MAIN JOURNAL DIAMETER ..	104
Removal and Installation of Valve Oil Seal	62	CRANKSHAFT PIN JOURNAL DIAMETER	105
REMOVAL	62	OUT-OF-ROUND AND TAPER OF CRANK- SHAFT	105
INSTALLATION	62	CRANKSHAFT RUNOUT	105
Removal and Installation of Front Oil Seal	63	CONNECTING ROD BEARING OIL CLEAR- ANCE	105
REMOVAL	63	MAIN BEARING OIL CLEARANCE	106
INSTALLATION	63	MAIN BEARING CRUSH HEIGHT	107
Removal and Installation of Rear Oil Seal	64	CONNECTING ROD BEARING CRUSH HEIGHT	107
REMOVAL	64	LOWER CYLINDER BLOCK MOUNTING BOLT OUTER DIAMETER	107
INSTALLATION	64	CONNECTING ROD BOLT OUTER DIAMETER	107
CYLINDER HEAD	65	SERVICE DATA AND SPECIFICATIONS (SDS) ...	108
On-Vehicle Service	65	Standard and Limit	108
CHECKING COMPRESSION PRESSURE	65	GENERAL SPECIFICATIONS	108
Removal and Installation	66	DRIVE BELT	108
REMOVAL	66	EXHAUST MANIFOLD	108
INSPECTION AFTER REMOVAL	67	SPARK PLUG	108
INSTALLATION	68	CYLINDER HEAD	108
INSPECTION AFTER INSTALLATION	68	VALVE	109
Disassembly and Assembly	70	CAMSHAFT AND CAMSHAFT BEARING	113
DISASSEMBLY	70	CYLINDER BLOCK	113
ASSEMBLY	71	PISTON, PISTON RING AND PISTON PIN	114
Inspection After Disassembly	72	CONNECTING ROD	115
VALVE DIMENSIONS	72	CRANKSHAFT	115
VALVE GUIDE CLEARANCE	73	MAIN BEARING	117
VALVE GUIDE REPLACEMENT	73	CONNECTING ROD BEARING	118
VALVE SEAT CONTACT	75		
VALVE SEAT REPLACEMENT	75		
VALVE SPRING SQUARENESS	76		
VALVE SPRING DIMENSIONS AND VALVE SPRING PRESSURE LOAD	76		
ENGINE ASSEMBLY	77		
Removal and Installation	77		
REMOVAL	78		
INSTALLATION	79		
INSPECTION AFTER INSTALLATION	80		
CYLINDER BLOCK	81		
Disassembly and Assembly	81		
DISASSEMBLY	82		
ASSEMBLY	86		
How to Select Piston and Bearing	91		
DESCRIPTION	91		
HOW TO SELECT PISTON	92		
HOW TO SELECT CONNECTING ROD BEAR- ING	92		

VQ

PRECAUTIONS	119
Precautions Necessary for Steering Wheel Rotation After Battery Disconnect	119
OPERATION PROCEDURE	119
Precautions for Drain Engine Coolant	119
Precautions for Disconnecting Fuel Piping	119
Precautions for Removal and Disassembly	119
Precautions for Inspection, Repair and Replace- ment	119
Precautions for Assembly and Installation	119

Parts Requiring Angle Tightening	120	FUEL INJECTOR AND FUEL TUBE	155	
Precautions for Liquid Gasket	120	Removal and Installation	155	A
REMOVAL OF LIQUID GASKET SEALING	120	REMOVAL	155	
LIQUID GASKET APPLICATION PROCEDURE	120	INSTALLATION	157	
PREPARATION	122	INSPECTION AFTER INSTALLATION	159	EM
Special Service Tools	122	ROCKER COVER	160	
Commercial Service Tools	124	Removal and Installation	160	
NOISE, VIBRATION AND HARSHNESS (NVH)		REMOVAL	160	C
TROUBLESHOOTING	126	INSTALLATION	161	
NVH Troubleshooting — Engine Noise	126	FRONT TIMING CHAIN CASE	163	
Use the Chart Below to Help You Find the Cause		Removal and Installation	163	D
of the Symptom.	127	REMOVAL	163	
DRIVE BELTS	128	INSTALLATION	166	
Checking Drive Belts	128	INSPECTION AFTER INSTALLATION	171	
Tension Adjustment	128	TIMING CHAIN	173	E
ALTERNATOR AND A/C COMPRESSOR BELT	129	Removal and Installation	173	
POWER STEERING OIL PUMP BELT	129	REMOVAL	174	
Removal and Installation	129	INSPECTION AFTER REMOVAL	180	F
REMOVAL	129	INSTALLATION	181	
INSTALLATION	129	INSPECTION AFTER INSTALLATION	191	
AIR CLEANER AND AIR DUCT	131	CAMSHAFT	192	G
Removal and Installation	131	Removal and Installation	192	
REMOVAL	131	REMOVAL	192	
INSPECTION AFTER REMOVAL	132	INSPECTION AFTER REMOVAL	194	
INSTALLATION	132	INSTALLATION	197	H
Changing Air Cleaner Filter	132	INSPECTION AFTER INSTALLATION	201	
REMOVAL	132	Valve Clearance	202	
INSTALLATION	132	INSPECTION	202	I
INTAKE MANIFOLD COLLECTOR	133	ADJUSTMENT	205	
Removal and Installation	133	OIL SEAL	207	
REMOVAL	134	Removal and Installation of Valve Oil Seal	207	J
INSPECTION AFTER REMOVAL	136	REMOVAL	207	
INSTALLATION	136	INSTALLATION	207	
INTAKE MANIFOLD	138	Removal and Installation of Front Oil Seal	208	
Removal and Installation	138	REMOVAL	208	K
REMOVAL	138	INSTALLATION	208	
INSPECTION AFTER REMOVAL	139	Removal and Installation of Rear Oil Seal	208	
INSTALLATION	139	REMOVAL	208	L
EXHAUST MANIFOLD AND THREE WAY CATA-		INSTALLATION	209	
LYST	140	CYLINDER HEAD	210	
Removal and Installation	140	On-Vehicle Service	210	M
REMOVAL	140	CHECKING COMPRESSION PRESSURE	210	
INSPECTION AFTER REMOVAL	142	Removal and Installation	211	
INSTALLATION	142	REMOVAL	211	
OIL PAN AND OIL STRAINER	145	INSPECTION AFTER REMOVAL	212	
Removal and Installation	145	INSTALLATION	213	
REMOVAL	145	INSPECTION AFTER INSTALLATION	215	
INSPECTION AFTER REMOVAL	148	Disassembly and Assembly	215	
INSTALLATION	148	DISASSEMBLY	216	
INSPECTION AFTER INSTALLATION	150	ASSEMBLY	216	
IGNITION COIL	152	Inspection After Disassembly	218	
Removal and Installation	152	VALVE DIMENSIONS	218	
REMOVAL	152	VALVE GUIDE CLEARANCE	218	
INSTALLATION	152	VALVE GUIDE REPLACEMENT	219	
SPARK PLUG (PLATINUM-TIPPED TYPE)	153	VALVE SEAT CONTACT	220	
Removal and Installation	153	VALVE SEAT REPLACEMENT	220	
REMOVAL	153	VALVE SPRING SQUARENESS	221	
INSPECTION AFTER REMOVAL	153	VALVE SPRING DIMENSIONS AND VALVE		
INSTALLATION	154	SPRING PRESSURE LOAD	221	

ENGINE ASSEMBLY	223	ANCE	251
Removal and Installation	223	MAIN BEARING OIL CLEARANCE	252
REMOVAL	224	CRUSH HEIGHT OF MAIN BEARING	253
INSTALLATION	226	CRUSH HEIGHT OF CONNECTING ROD	
INSPECTION AFTER INSTALLATION	226	BEARING	253
CYLINDER BLOCK	228	MAIN BEARING CAP BOLT OUTER DIAMETER	253
Disassembly and Assembly	228	CONNECTING ROD BOLT OUTER DIAMETER	253
DISASSEMBLY	229	DRIVE PLATE	254
ASSEMBLY	233	OIL JET (VQ35DE)	254
How to Select Piston and Bearing	239	OIL JET RELIEF VALVE (VQ35DE)	254
DESCRIPTION	239	SERVICE DATA AND SPECIFICATIONS (SDS) ...	255
HOW TO SELECT PISTON	240	Standard and Limit	255
HOW TO SELECT CONNECTING ROD BEAR-		GENERAL SPECIFICATIONS	255
ING	241	VALVE TIMING	255
HOW TO SELECT MAIN BEARING	242	DRIVE BELT	256
Inspection After Disassembly	245	INTAKE MANIFOLD COLLECTOR, INTAKE	
CRANKSHAFT END PLAY	245	MANIFOLD AND EXHAUST MANIFOLD	256
CONNECTING ROD SIDE CLEARANCE	245	SPARK PLUG	256
PISTON TO PISTON PIN OIL CLEARANCE ...	245	CAMSHAFT AND CAMSHAFT BEARING	257
PISTON RING SIDE CLEARANCE	246	CYLINDER HEAD	260
PISTON RING END GAP	246	CYLINDER BLOCK	264
CONNECTING ROD BEND AND TORSION	247	PISTON, PISTON RING AND PISTON PIN	265
CONNECTING ROD BIG END DIAMETER	247	CONNECTING ROD	266
CONNECTING ROD BUSHING OIL CLEAR-		CRANKSHAFT	267
ANCE	247	MAIN BEARING	268
CYLINDER BLOCK DISTORTION	248	CONNECTING ROD BEARING	269
MAIN BEARING HOUSING INNER DIAMETER	249		
PISTON TO CYLINDER BORE CLEARANCE .	249		
CRANKSHAFT MAIN JOURNAL DIAMETER ..	250		
CRANKSHAFT PIN JOURNAL DIAMETER	251		
CRANKSHAFT OUT-OF-ROUND AND TAPER	251		
CRANKSHAFT RUNOUT	251		
CONNECTING ROD BEARING OIL CLEAR-			

PRECAUTIONS

Precautions Necessary for Steering Wheel Rotation After Battery Disconnect

BBS005KH

NOTE:

- This Procedure is applied only to models with Intelligent Key system and NATS (NISSAN ANTI-THEFT SYSTEM).
- Remove and install all control units after disconnecting both battery cables with the ignition knob in the "LOCK" position.
- Always use CONSULT-II to perform self-diagnosis as a part of each function inspection after finishing work. If DTC is detected, perform trouble diagnosis according to self-diagnostic results.

For models equipped with the Intelligent Key system and NATS, an electrically controlled steering lock mechanism is adopted on the key cylinder.

For this reason, if the battery is disconnected or if the battery is discharged, the steering wheel will lock and steering wheel rotation will become impossible.

If steering wheel rotation is required when battery power is interrupted, follow the procedure below before starting the repair operation.

OPERATION PROCEDURE

1. Connect both battery cables.

NOTE:

Supply power using jumper cables if battery is discharged.

2. Use the Intelligent Key or mechanical key to turn the ignition switch to the "ACC" position. At this time, the steering lock will be released.
3. Disconnect both battery cables. The steering lock will remain released and the steering wheel can be rotated.
4. Perform the necessary repair operation.
5. When the repair work is completed, return the ignition switch to the "LOCK" position before connecting the battery cables. (At this time, the steering lock mechanism will engage.)
6. Perform a self-diagnosis check of all control units using CONSULT-II.

Precautions for Drain Engine Coolant

BBS005KI

Drain engine coolant when engine is cooled.

Precautions for Disconnecting Fuel Piping

BBS005KJ

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

Precautions for Removal and Disassembly

BBS005KK

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

Precautions for Inspection, Repair and Replacement

BBS005KL

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

Precautions for Assembly and Installation

BBS005KM

- Use torque wrench to tighten bolts or nuts to specification.

PRECAUTIONS

[QR]

- 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.
- Dowel pins are used for several parts alignment. When replacing and reassembling with dowel pins, make sure that dowel pins are installed in the original portion.
- Thoroughly wash, clean, and air-blow each part. Carefully check oil or coolant passages for any restriction and blockage.
- Avoid damaging sliding or mating surfaces. Completely remove foreign materials such as cloth lint or dust. Before assembly, oil sliding surfaces well.
- Release air within route when refilling after draining coolant.
- Before starting engine, apply fuel pressure to fuel lines with turning ignition switch "ON" (with engine stopped). Then make sure that there are no leaks at fuel line connections.
- After repairing, start engine and increase engine speed to check engine coolant, fuel, engine oil, and exhaust gases for leakage.

Parts Requiring Angle Tightening

BBS005KN

- Use angle wrench [SST: KV10112100] for the final tightening of the following engine parts.
 - Cylinder head bolts
 - Lower cylinder block bolts
 - Connecting rod cap bolts
 - Crankshaft pulley bolt (No angle wrench is required as the bolt flange is provided with notches for angle tightening)
 - Balancer unit
- Do not use a torque value for final tightening.
- The torque value for these parts are for a preliminary step.
- Ensure thread and seat surfaces are clean and coated with engine oil.

Precautions For Liquid Gasket

BBS005KO

REMOVAL OF LIQUID GASKET

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

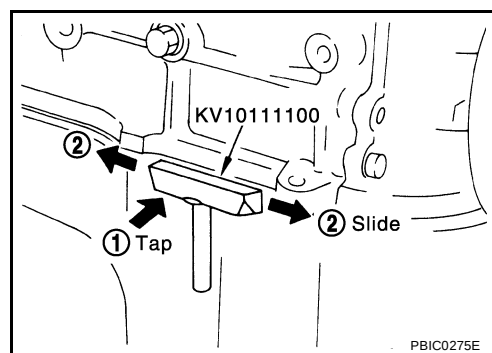
CAUTION:

Be careful not to damage the mating surfaces.

- Tap seal cutter to insert it, and then slide it by tapping on the side as shown in the figure.
- In areas where seal cutter is difficult to use, use plastic hammer to lightly tap the areas where the liquid gasket is applied.

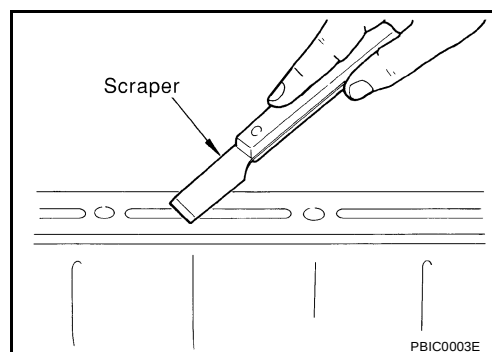
CAUTION:

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



LIQUID GASKET APPLICATION PROCEDURE

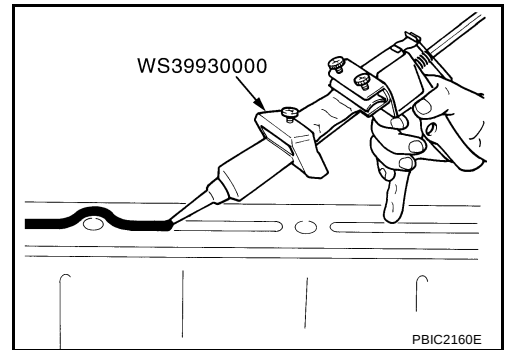
1. Using scraper, remove the old liquid gasket adhering to the liquid gasket application surface and the mating surface.
 - Remove the liquid gasket completely from the groove of the liquid gasket application surface, mounting bolts and bolt holes.
2. Wipe the liquid gasket application surface and the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



PRECAUTIONS

[QR]

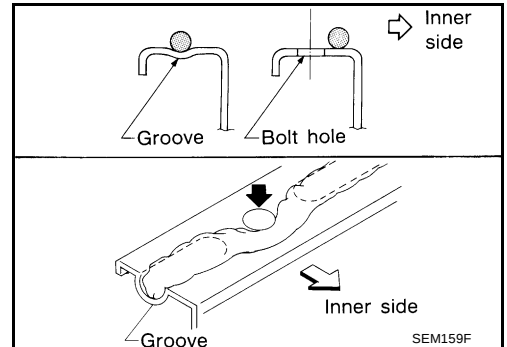
3. Attach liquid gasket tube to the tube presser (SST).
Use Genuine Liquid Gasket or equivalent.
4. Apply the liquid gasket without breaks to the specified location with the specified dimensions.
 - If there is a groove for the liquid gasket application, apply the liquid gasket to the groove.



- As for the bolt holes, normally apply the liquid gasket inside the holes. Occasionally, it should be applied outside the holes. Make sure to read the text of service manual.
- Within 5 minutes of liquid gasket application, install the mating component.
- If the liquid gasket protrudes, wipe it off immediately.
- Do not retighten mounting bolts or nut after the installation.
- Wait 30 minutes or more after installation before refilling engine oil and engine coolant.

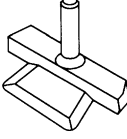
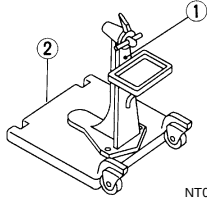
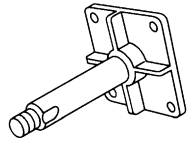
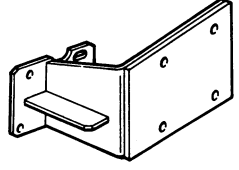
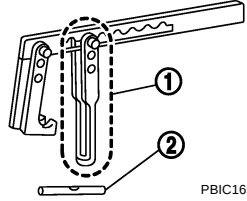
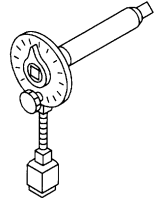
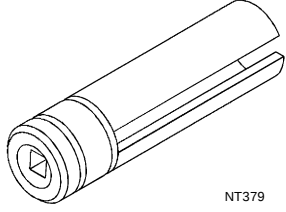
CAUTION:

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



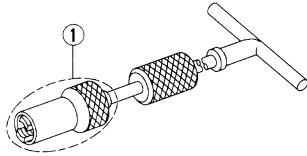
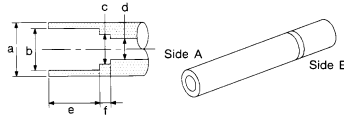
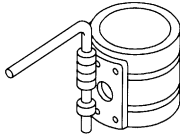
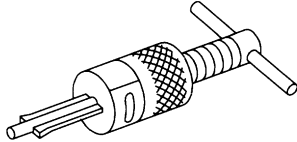
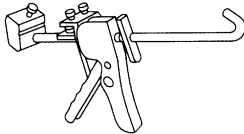
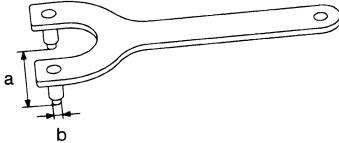
PREPARATION

Special Service Tools

Tool number Tool name		Description
KV10111100 Seal cutter	 S-NT046	Removing oil pan (lower and upper) and front cover, etc.
ST0501S000 Engine stand assembly 1. ST05011000 Engine stand 2. ST05012000 Base	 NT042	Disassembling and assembling engine
KV10106500 Engine stand shaft	 NT028	
KV10115300 Engine sub-attachment	 ZZA1078D	
KV10116200 Valve spring compressor 1. KV10115900 Attachment 2. KV10109220 Adapter	 PBIC1650E	Disassembling and assembling valve mechanism Part (1) is a component of KV10116200, but Part (2) is not so.
KV10112100 Angle wrench	 S-NT014	Tightening bolts for bearing cap, cylinder head, etc. in angle
KV10117100 Heated oxygen sensor wrench	 NT379	Loosening or tightening heated oxygen sensors For 22 mm (0.87 in) width hexagon nut

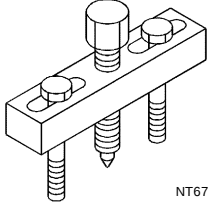
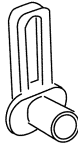
PREPARATION

[QR]

Tool number Tool name	Description	A
KV10107902 Valve oil seal puller 1. KV10116100 Valve oil seal puller adapter	Removing valve oil seal  S-NT605	EM C
KV10115600 Valve oil seal drift	Installing valve oil seal Use side A. a: 20 (0.79) dia. d: 8 (0.31) dia. b: 13 (0.51) dia. e: 10.7 (0.421) c: 10.3 (0.406) dia. f: 5 (0.20) Unit: mm (in)  S-NT603	D E
EM03470000 Piston ring compressor	Installing piston assembly into cylinder bore  S-NT044	F G
ST16610001 Pilot bushing puller	Removing pilot convertor  S-NT045	H I J
WS39930000 Tube presser	Pressing the tube of liquid gasket  S-NT052	K L
KV10109300 Pulley holder	Fixing crankshaft pulley a: 68 mm (2.68 in) b: 8 mm (0.31 in) dia.  NT628	M

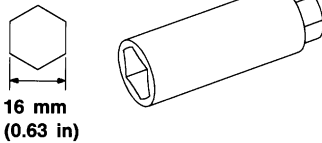
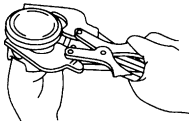
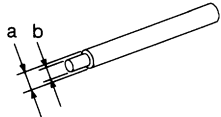
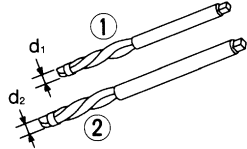
PREPARATION

[QR]

Tool number Tool name	Description
KV11103000 Pulley puller	Removing crankshaft pulley
 NT676	
Quick connector release	Removing fuel tube quick connectors in engine room (Available in SEC. 164 of PARTS CATALOG: Part No. 16441 6N210)
 PBIC0198E	

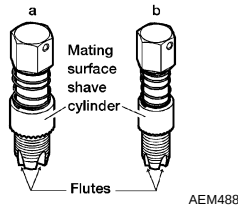
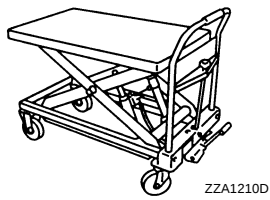
Commercial Service Tools

BBS0058P

Tool name	Description
Spark plug wrench	Removing and installing spark plug
 S-NT047	
Valve seat cutter set	Finishing valve seat dimensions
 S-NT048	
Piston ring expander	Removing and installing piston ring
 S-NT030	
Valve guide drift	Removing and installing valve guide Intake and Exhaust: a: 9.5 mm (0.374 in) dia. b: 5.5 mm (0.217 in) dia.
 S-NT015	
Valve guide reamer	(1): Reaming valve guide inner hole (2): Reaming hole for oversize valve guide Intake and Exhaust: d1 : 6.0 mm (0.236 in) dia. d2 : 10.2 mm (0.402 in) dia.
 NT016	

PREPARATION

[QR]

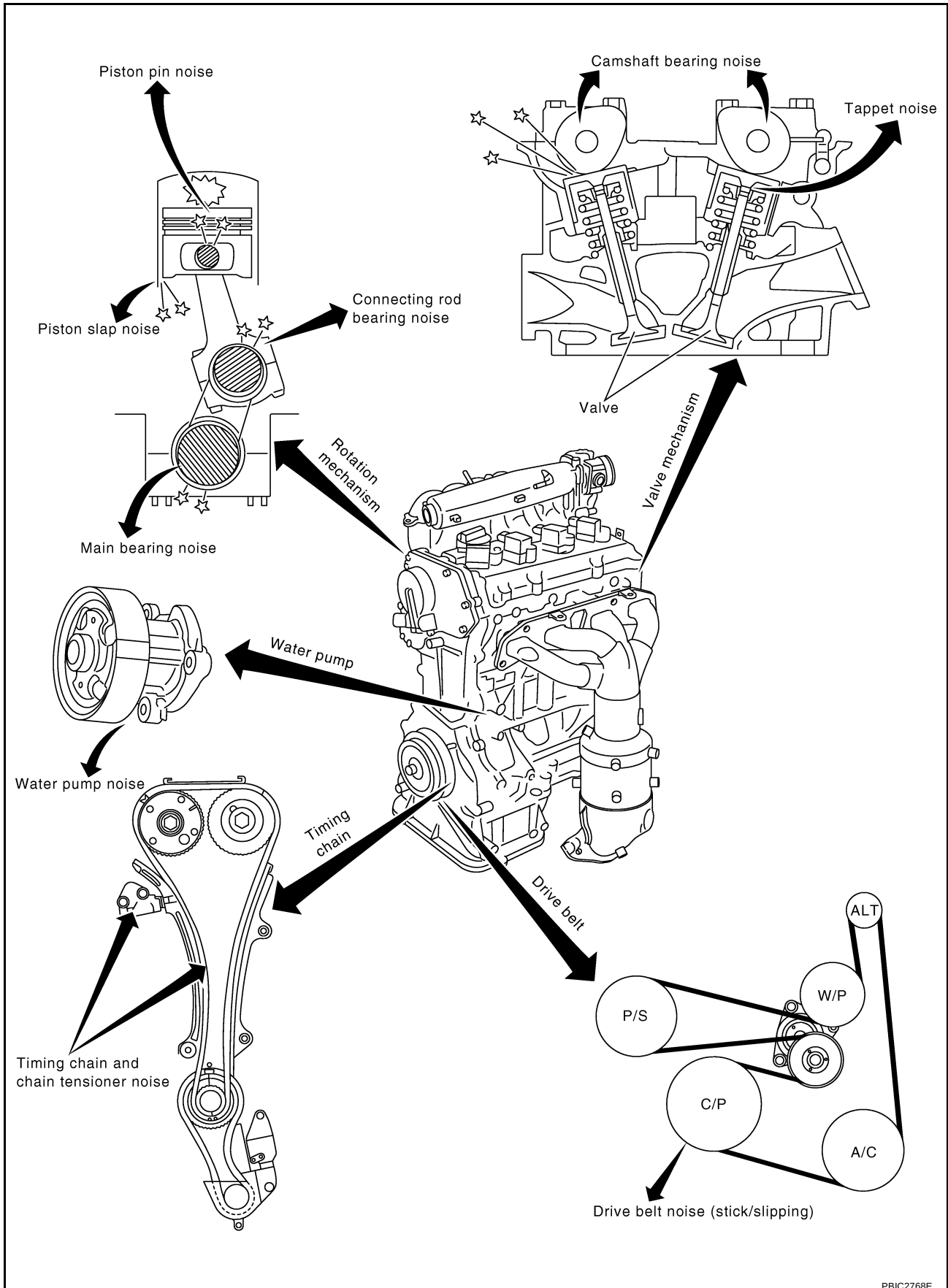
Tool name		Description	
Oxygen sensor thread cleaner	 AEM488	Reconditioning the exhaust system threads before installing a new heated oxygen sensor (Use with anti-seize lubricant shown below.) a = 18 mm (0.71 in) dia. for zirconia heated oxygen sensor b = 12 mm (0.47 in) dia. for titania heated oxygen sensor	A EM
Anti-seize lubricant (Permatex 133AR or equivalent meeting MIL specification MIL-A-907)	 AEM489	Lubricating oxygen sensor thread cleaning tool when reconditioning exhaust system threads	C D E
Manual lift table caddy	 ZZA1210D	Removing and installing engine	F G H I J K L M

NOISE, VIBRATION AND HARSHNESS (NVH) TROUBLESHOOTING

PF0:00003

NVH Troubleshooting — Engine Noise

BBS0058Q



PBIC2768E

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

BBS0058R

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

If necessary, repair or replace these parts.

Location of noise	Type of noise	Operating condition of engine						Source of noise	Check item	Reference page
		Before warm-up	After warm-up	When starting	When idling	When racing	While driving			
Top of engine Rocker cover Cylinder head	Ticking or clicking	C	A	—	A	B	—	Tappet noise	Valve clearance	EM-50
	Rattle	C	A	—	A	B	C	Camshaft bearing noise	Camshaft journal oil clearance Camshaft runout	EM-44 EM-44
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	EM-99 EM-101
	Slap or rap	A	—	—	B	B	A	Piston slap noise	Piston to cylinder bore clearance Piston ring side clearance Piston ring end gap Connecting rod bend and torsion	EM-104 EM-100 EM-100 EM-101
	Knock	A	B	C	B	B	B	Connecting rod bearing noise	Connecting rod bushing oil clearance Connecting rod bearing oil clearance	EM-101 EM-105
	Knock	A	B	—	A	B	C	Main bearing noise	Main bearing oil clearance Crankshaft runout	EM-106 EM-105
Front of engine Front cover	Tapping or ticking	A	A	—	B	B	B	Timing chain and chain tensioner noise	Timing chain cracks and wear Timing chain tensioner operation	EM-57 EM-53
Front of engine	Squeaking or fizzing	A	B	—	B	—	C	Drive belt (Sticking or slipping)	Drive belt deflection	EM-14
	Creaking	A	B	A	B	A	B	Drive belt (Slipping)	Idler pulley bearing operation	
	Squall Creak	A	B	—	B	A	B	Water pump noise	Water pump operation	CO-22 "WATER PUMP"

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

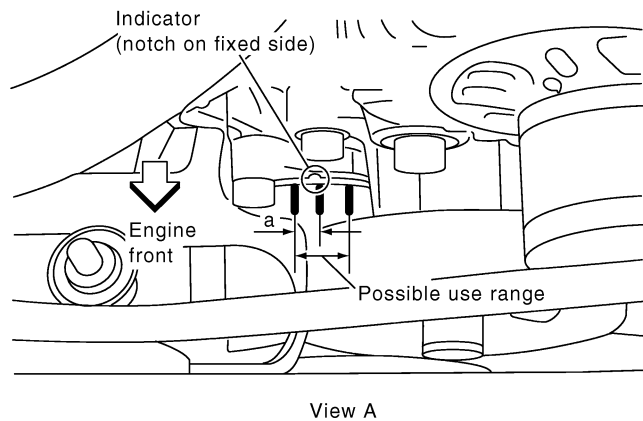
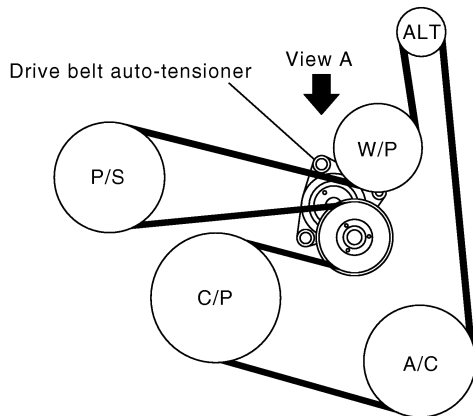
DRIVE BELTS

PFP:02117

Checking Drive Belts

BBS0058S

SEC. 117



PBIC2622E

WARNING:

Be sure to perform this step when the engine is stopped.

- Make sure that the indicator (notch on fixed side) of drive belt auto-tensioner is within the possible use range (between three line notches on moving side).

NOTE:

- Check the drive belt auto-tensioner indication when engine is cold.
- When new drive belt is installed, the indicator (notch on fixed side) should be within the range "a" in the figure.
- Visually check entire belt for wear, damage or cracks.
- If the indicator (notch on fixed side) is out of the possible use range or belt is damaged, replace drive belt.

Tension Adjustment

BBS0058T

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

Removal and Installation

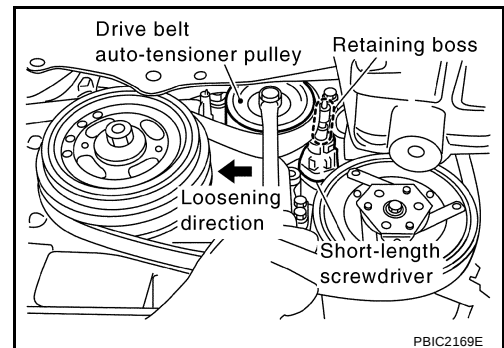
REMOVAL

BBS0058U

- Remove splash guard (RH).
- With box wrench, and while securely holding the hexagonal part in center of drive belt auto-tensioner pulley, move the wrench handle in the direction of arrow (loosening direction of tensioner).

CAUTION:

- Avoid placing hand in a location where pinching may occur if the holding tool accidentally comes off.
 - Do not loosen the hexagonal part in center of drive belt auto-tensioner pulley (Do not turn it counterclockwise). If turned counterclockwise, the complete drive belt auto-tensioner must be replaced as a unit, including the pulley.
- Insert a rod approximately 6 mm (0.24 in) in diameter such as short-length screwdriver into the hole of the retaining boss to fix drive belt auto-tensioner pulley.
 - Loosen drive belt from water pump pulley in sequence, and remove it.



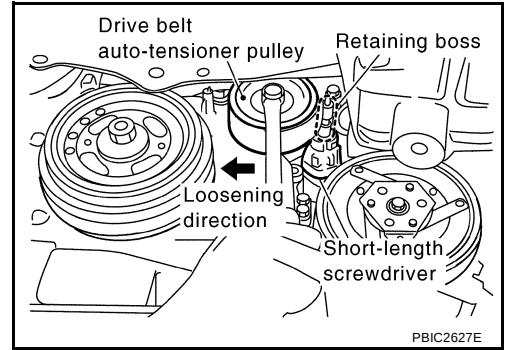
PBIC2169E

INSTALLATION

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

CAUTION:

- Avoid placing hand in a location where pinching may occur if the holding tool accidentally comes off.
- Do not loosen the hexagonal part in center of drive belt auto-tensioner pulley (Do not turn it counterclockwise). If turned counterclockwise, the complete drive belt auto-tensioner must be replaced as a unit, including the pulley.



2. Insert a rod approximately 6 mm (0.24 in) in diameter such as short-length screwdriver into the hole of retaining boss to fix drive belt auto-tensioner pulley.
3. Hook drive belt onto all pulleys except for water pump, and then onto water pump pulley finally.

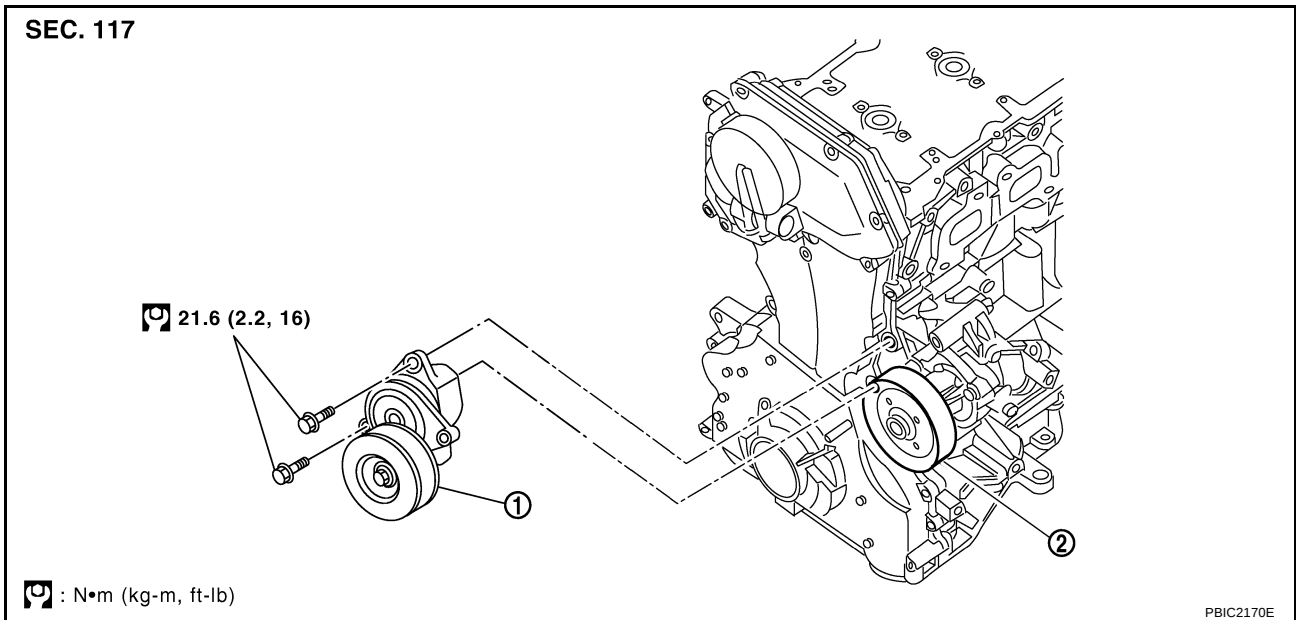
CAUTION:

- Confirm belt is completely set to pulleys.
- Check for engine oil, working fluid and engine coolant are not adhered to drive belt and each pulley groove.

4. Release drive belt auto-tensioner, and apply tension to drive belt.
5. Turn crankshaft pulley clockwise several times to equalize tension between each pulley.
6. Confirm tension of drive belt at indicator (notch on fixed side) is within the possible use range. Refer to [EM-14, "Checking Drive Belts"](#).

Removal and Installation of Drive Belt Auto-Tensioner

BBS0058V



1. Drive belt auto-tensioner
2. Water pump pulley

CAUTION:

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

REMOVAL

1. Remove splash guard (RH).
2. Remove drive belt. Refer to [EM-14, "Removal and Installation"](#).
3. Release the fixed drive belt auto-tensioner pulley.
4. Remove drive belt auto-tensioner.

CAUTION:

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

INSTALLATION

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

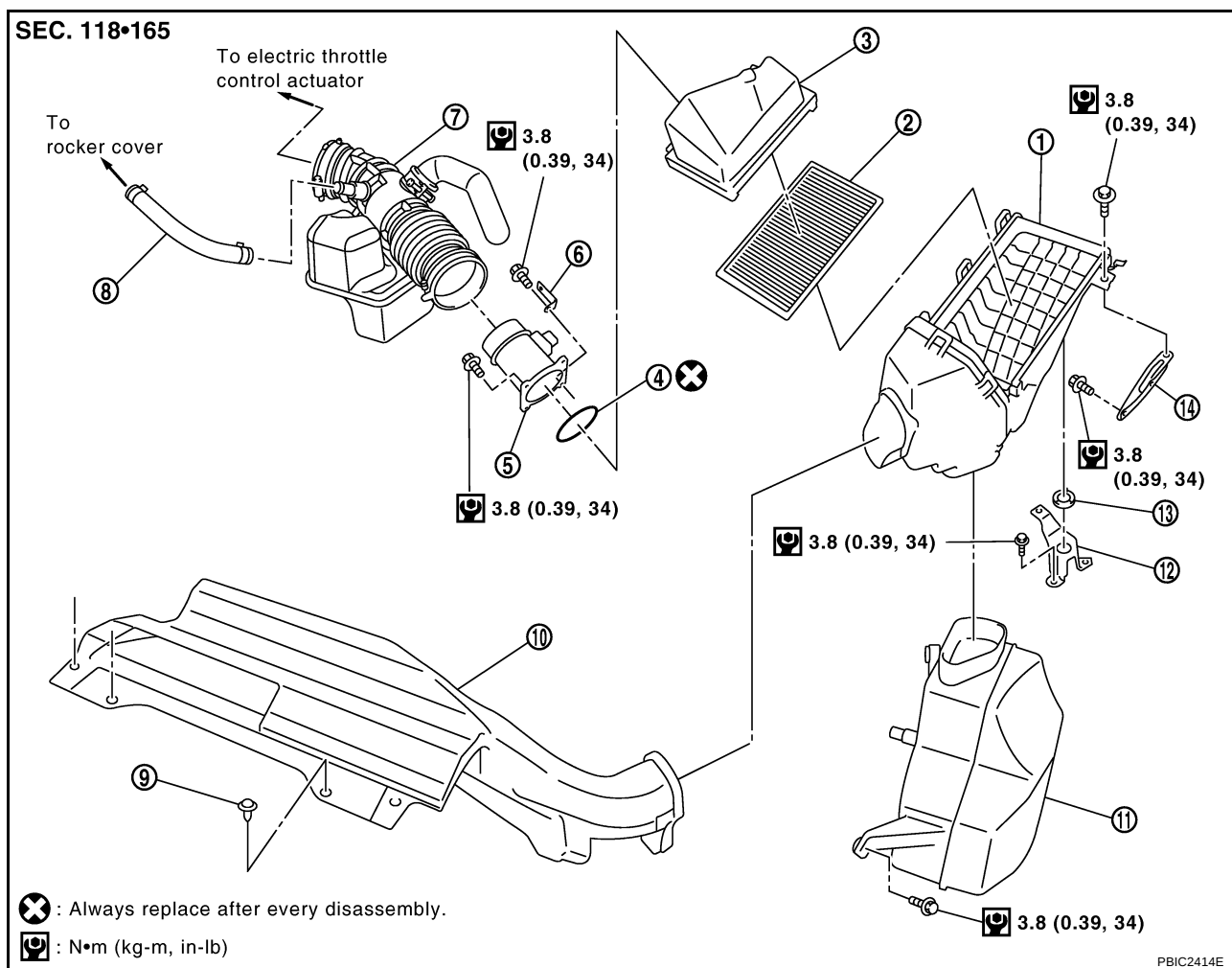
- When installing drive belt auto-tensioner, be careful not to interfere with water pump pulley.

CAUTION:

- If there is damage greater than peeled paint, replace drive belt auto-tensioner.
- Do not swap the pulley between new and old drive belt auto-tensioner.

AIR CLEANER AND AIR DUCT

Removal and Installation



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

REMOVAL

1. Remove air duct (inlet).
 2. Disconnect harness connector from mass air flow sensor.
 3. Disconnect PCV hose.
 4. 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.
 5. 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.**
6. Remove resonator, removing left side fender protector (front), as necessary.

INSPECTION AFTER REMOVAL

Inspect air duct assembly for crack or tear.

- Replace air duct assembly, if necessary.

INSTALLATION

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

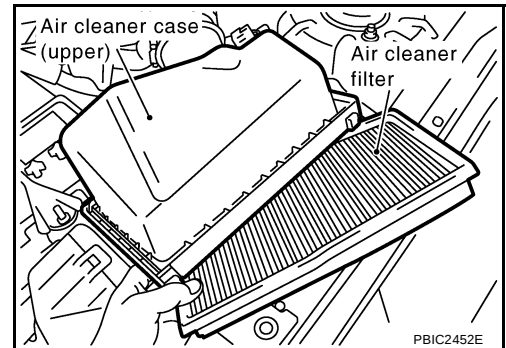
- Align marks. Attach each joint. Screw clamps firmly.

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.

BBS0058X



INSTALLATION

Installation is the reverse order of removal.

INTAKE MANIFOLD

PFP:14003

Removal and Installation

BBS0058Y

A

EM

C

D

E

F

G

H

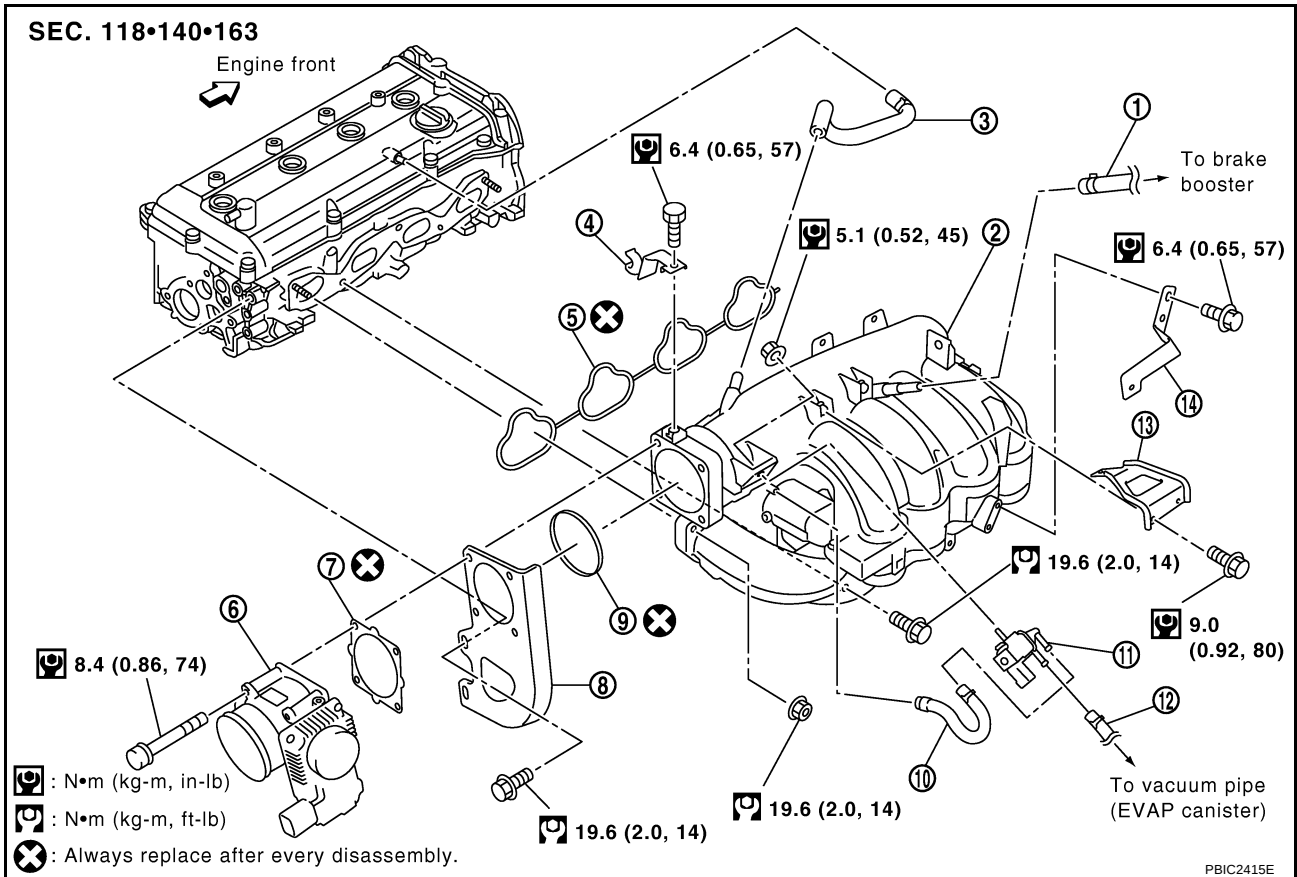
I

J

K

L

M



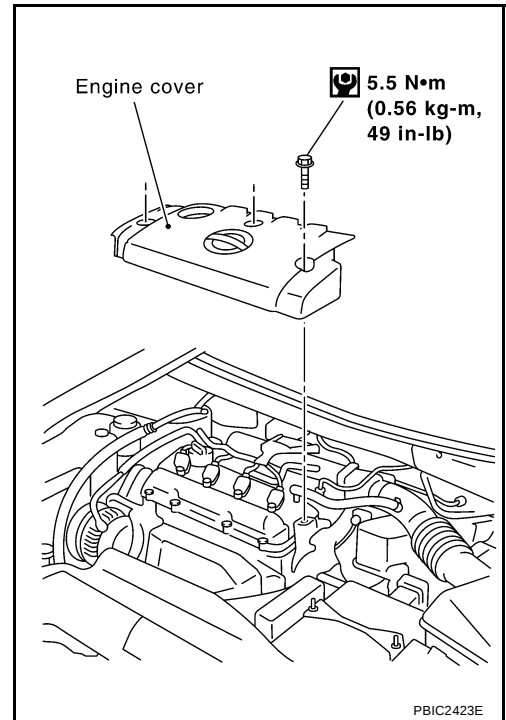
REMOVAL

1. Release fuel pressure. Refer to [EC-49, "FUEL PRESSURE RELEASE"](#) .

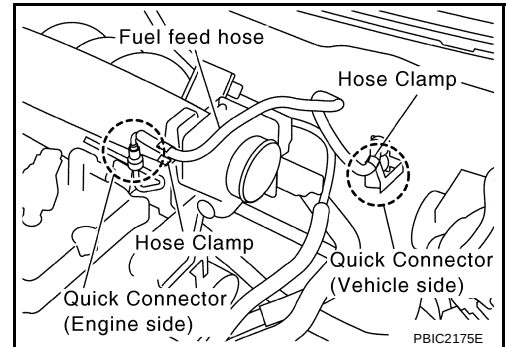
2. Remove engine cover.

CAUTION:

Be careful not to damage or scratch engine cover.



3. Remove air cleaner case (upper) with mass air flow sensor and air duct assembly. Refer to [EM-17, "AIR CLEANER AND AIR DUCT"](#) .
4. Remove quick connector cap, and disconnect quick connector at engine side. Refer to [EM-34, "FUEL INJECTOR AND FUEL TUBE"](#) .

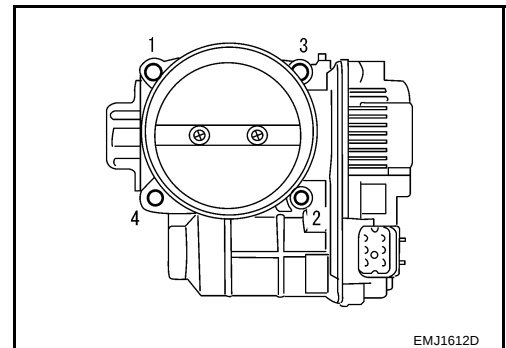


5. Remove electric throttle control actuator with the following procedure:

- a. Disconnect harness connector.
- b. Loosen mounting bolts in reverse order as shown in the figure, and remove electric throttle control actuator and gasket.

CAUTION:

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



6. Disconnect harness, power steering piping, vacuum hose and PCV hose from intake manifold, and move them aside.
7. Remove intake manifold support and gasket.
8. Disconnect sub-harness from fuel injector. Refer to [EM-34, "FUEL INJECTOR AND FUEL TUBE"](#) .
9. Remove fuel tube and fuel injector assembly from intake manifold. Refer to [EM-34, "FUEL INJECTOR AND FUEL TUBE"](#) .

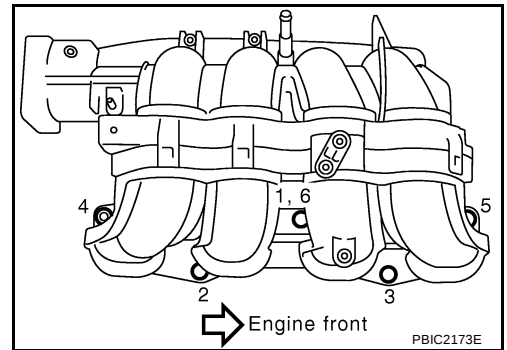
10. Loosen mounting nuts and bolts in reverse order as shown in the figure, and remove intake manifold (with fuel tube and fuel injector assembly) and gasket.

CAUTION:

- Do not disassemble intake manifold.
- Cover engine openings to avoid entry of foreign materials.

NOTE:

Disregard No. 6 when loosening.



INSTALLATION

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

Intake Manifold

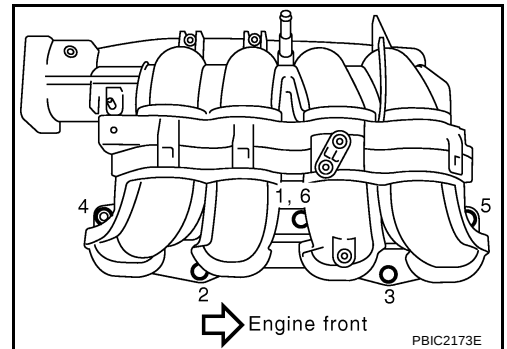
- If stud bolts were removed, install them and tighten to the specified torque below.

 : 10.8 N·m (1.1 kg-m, 8 ft-lb)

- Check if gasket is not dropped from the installation groove of intake manifold.
- Tighten in numerical order as shown in the figure.

NOTE:

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

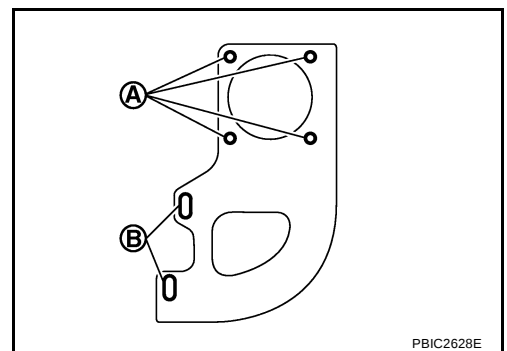


Intake Manifold Support

Tighten mounting bolt from “A” to “B” in order as shown in the figure.

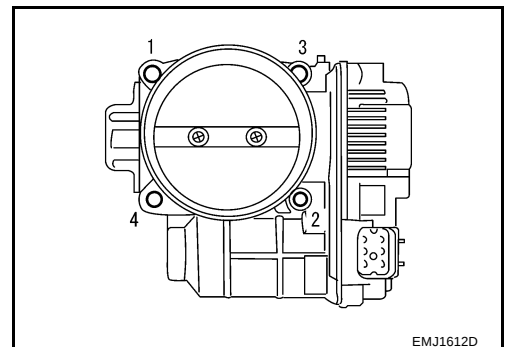
NOTE:

Tighten “A” in the figure together with electric throttle control actuator. Refer to [EM-21, "Electric Throttle Control Actuator"](#) for the tightening procedure.



Electric Throttle Control Actuator

- Tighten mounting bolts equally and diagonally in several steps and 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-47, "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-47, "Idle Air Volume Learning"](#).



INSPECTION AFTER INSTALLATION

Make sure there are no fuel leaks at connections with the following procedure:

1. Apply fuel pressure to fuel lines with turning ignition switch "ON" (with engine stopped). Then make sure there are no fuel leaks at connections.

NOTE:

Use mirrors for checking on invisible points.

2. Start engine. With engine speed increased, make sure again there are no fuel leaks at connections.

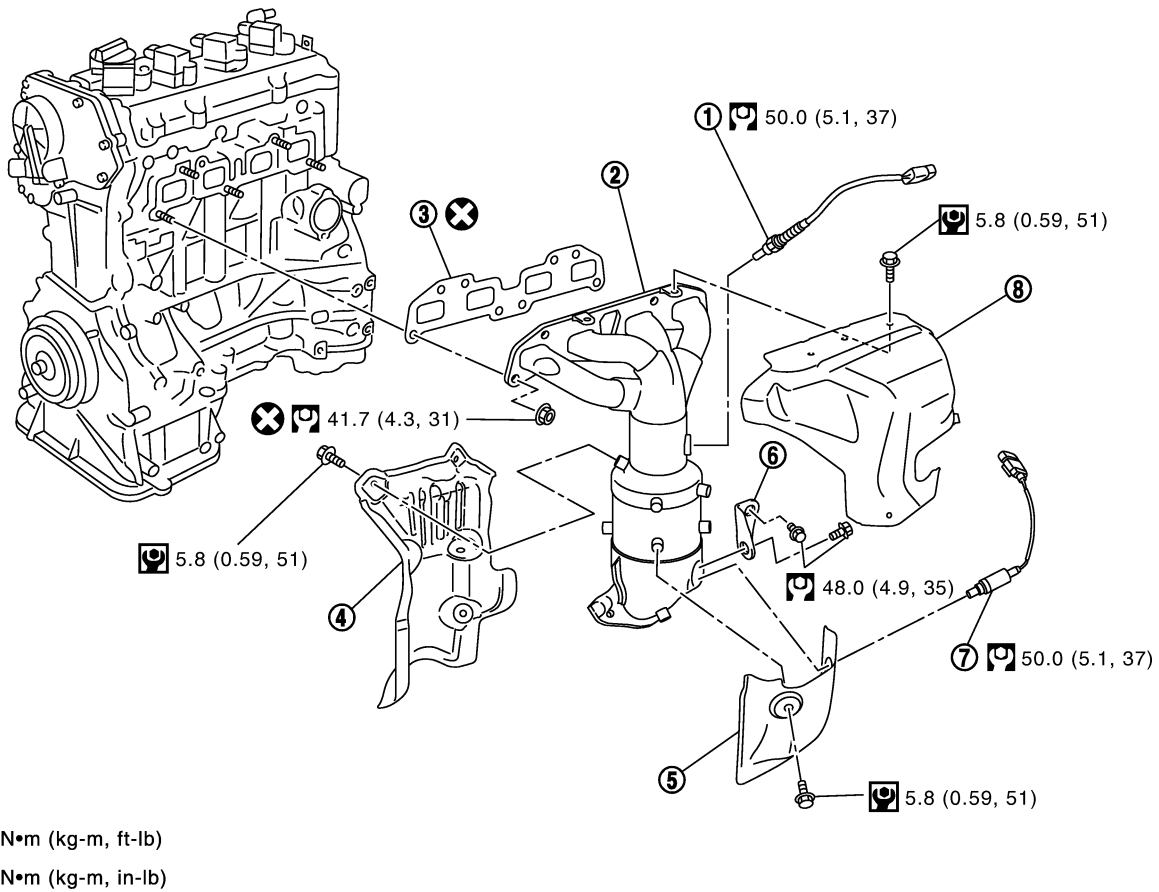
CAUTION:

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

EXHAUST MANIFOLD AND THREE WAY CATALYST

Removal and Installation

SEC. 111•140•226



PBIC4678E

- | | | |
|-----------------------------|---|--------------------------|
| 1. Heated oxygen sensor 1 | 2. Exhaust manifold and three way catalyst assembly | 3. Gasket |
| 4. Three way catalyst cover | 5. Exhaust manifold cover (lower) | 6. Exhaust manifold stay |
| 7. Heated oxygen sensor 2 | 8. Exhaust manifold cover (upper) | |

REMOVAL

- Remove undercover.
- Remove drive belt. Refer to [EM-14, "DRIVE BELTS"](#) .
- Remove exhaust front tube. Refer to [EX-2, "EXHAUST SYSTEM"](#) .
- Remove alternator. Refer to [SC-27, "CHARGING SYSTEM"](#) .
- Remove heated oxygen sensors with the following procedure:
 - Put marks to identify installation positions of each heated oxygen sensor.
 - Disconnect harness connector of each heated oxygen sensor, and harness from bracket and middle clamp.

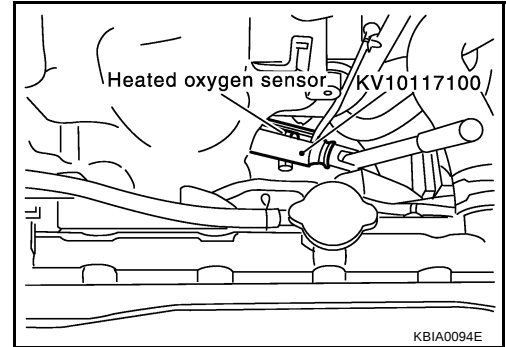
EXHAUST MANIFOLD AND THREE WAY CATALYST

[QR]

- c. Using heated oxygen sensor wrench (SST), remove heated oxygen sensors.

CAUTION:

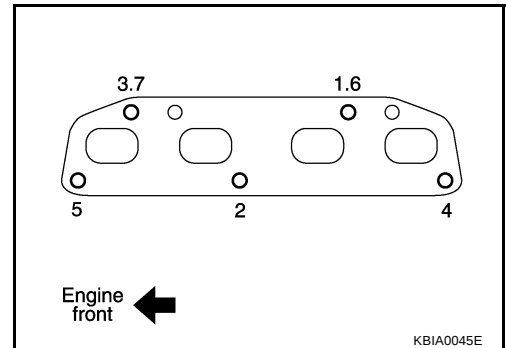
- Be careful not to damage heated oxygen sensor.
- Discard any heated oxygen sensor which has been dropped onto a hard surface such as a concrete floor; replace with a new one.



6. Remove exhaust manifold stay.
7. Remove exhaust manifold cover (upper).
8. Loosen nuts in reverse order as shown in the figure to remove exhaust manifold and three way catalyst assembly.

NOTE:

Disregard No. 6 and 7 when loosening.



9. Remove gasket.

CAUTION:

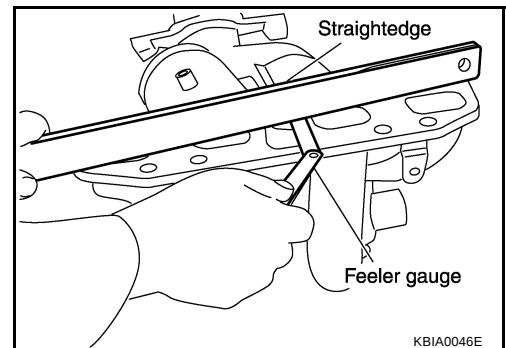
Cover engine openings to avoid entry of foreign materials.

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

INSPECTION AFTER REMOVAL

Surface Distortion

- Using straightedge and feeler gauge, check the surface distortion of exhaust manifold and three way catalyst assembly mating surface.
Limit : 0.3 mm (0.012 in)
- If it exceeds the limit, replace exhaust manifold and three way catalyst assembly.



INSTALLATION

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

Exhaust Manifold

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

 : 14.7 N·m (1.5 kg-m, 11 ft-lb)

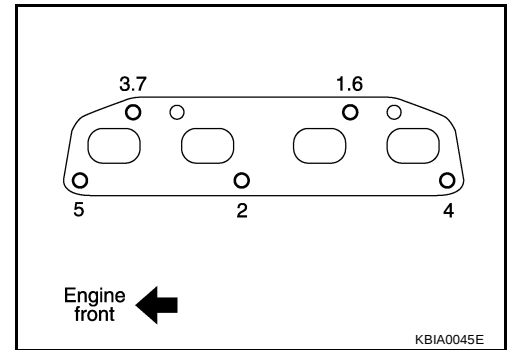
EXHAUST MANIFOLD AND THREE WAY CATALYST

[QR]

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

NOTE:

No. 6 and 7 mean double tightening of bolts No. 1 and 3.



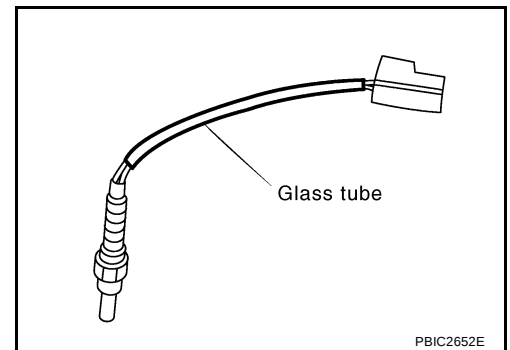
Heated Oxygen Sensor

- Install heated oxygen sensors in the original position.
- Install referring the following if the installation positions cannot be identified.

Glass tube color

Heated oxygen sensor 1 : Black

Heated oxygen sensor 2 : White



CAUTION:

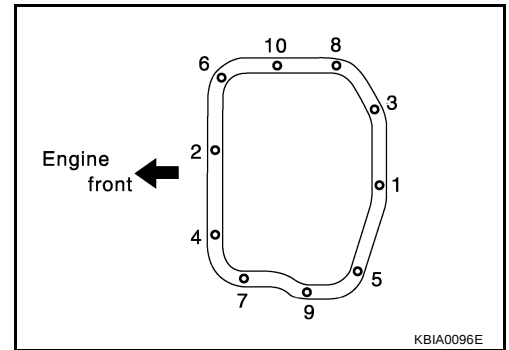
- Before installing a new heated oxygen sensor, clean exhaust system threads using heated oxygen sensor thread cleaner (commercial service tool) and apply anti-seize lubricant (commercial service tool).
- Do not exceed the specified torque heated oxygen sensor. Doing so may cause damage to heated oxygen sensor, resulting in the "MIL" coming on.

Removal and Installation

OIL PAN AND OIL STRAINER

[QR]

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

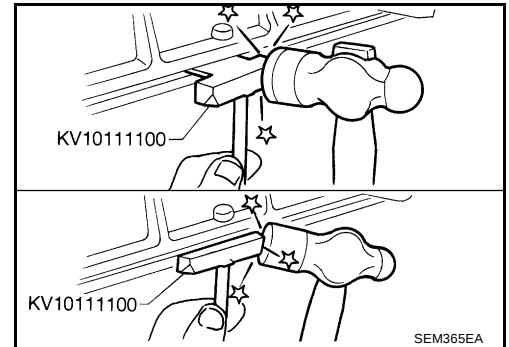


- b. Insert seal cutter (SST) between oil pan (upper) and oil pan (lower).

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.



9. Remove oil strainer.

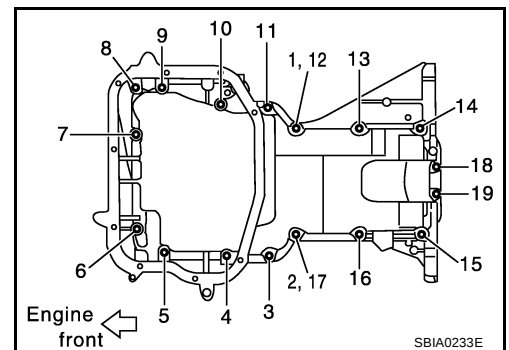
10. Remove oil pan (upper) with the following procedure:

- Remove rear plate cover, and four transaxle joint bolts. Refer to [AT-241, "TRANSAXLE ASSEMBLY"](#).
- Securely support bottom of transaxle with suitable transmission jack.
- Remove engine mounting related parts below. Refer to [EM-77, "ENGINE ASSEMBLY"](#).
 - RH engine mounting insulator bolts (vehicle side)
 - Front engine mounting through-bolt
 - Rear engine mounting through-bolt

- d. Loosen bolts in reverse order as shown in the figure.

NOTE:

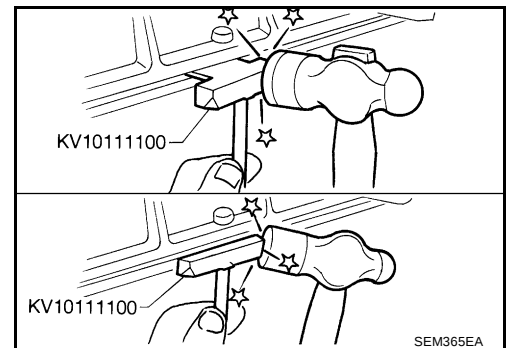
Disregard No.12 and 17 when loosening.



- e. Insert seal cutter (SST) between oil pan (upper) and cylinder block, and slide it by tapping on the side of the tool with hammer.

CAUTION:

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



- f. Lift up engine and transaxle assembly with transmission jack to make a room for pulling oil pan (upper) out.

- g. Pull oil pan (upper) out.
- 11. Remove O-rings at front cover side.

INSPECTION AFTER REMOVAL

Oil Strainer

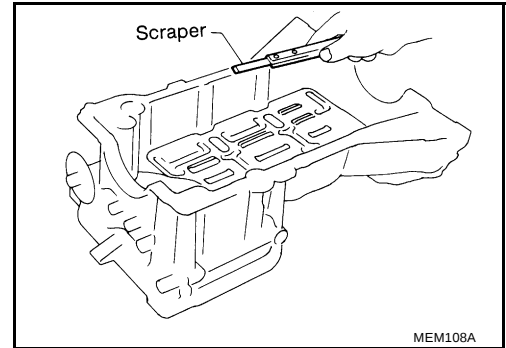
Clean oil strainer if any object attached.

INSTALLATION

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

CAUTION:

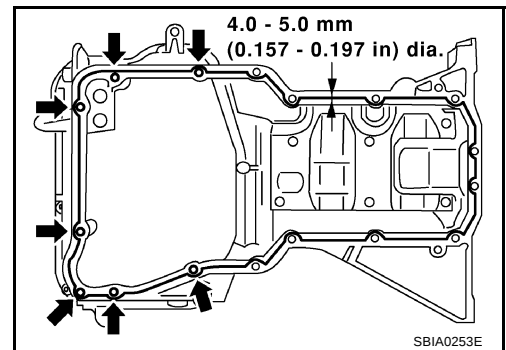
Do not scratch or damage the mating surfaces when cleaning off old liquid gasket.



- b. Apply a continuous bead of liquid gasket with tube presser [SST: WS39930000] as shown in the figure. Use Genuine Liquid Gasket or equivalent.

CAUTION:

- Apply liquid gasket to outside of bolt hole for the positions shown by arrows.
- Attaching should be done within 5 minutes after coating.

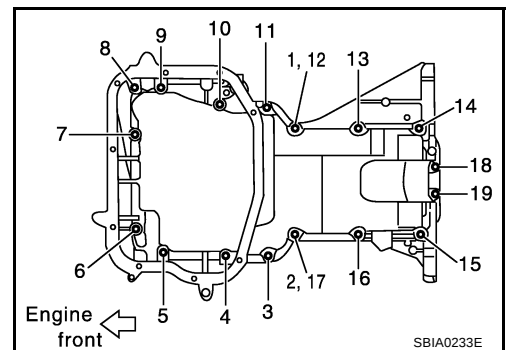


- c. Install new O-rings at front cover side.
 - d. Tighten bolts in numerical order as shown in the figure.

NOTE:

- No. 12 and 17 mean double tightening of bolts No. 1 and 2.
- Refer to the following for locating bolts.

M6 × 20 mm (0.79 in)	: No. 18, 19
M8 × 25 mm (0.98 in)	: No. 1, 2, 3, 11
M8 × 45 mm (1.77 in)	: No. 4, 10, 13, 14, 15, 16
M8 × 100 mm (3.97 in)	: No. 5, 6, 7, 8, 9



- e. Tighten transaxle joint bolts. Refer to [AT-241, "TRANSAXLE ASSEMBLY"](#).
 - f. Install rear plate cover.
 - g. Install engine mounting related parts below. Refer to [EM-77, "ENGINE ASSEMBLY"](#).
 - RH engine mounting insulator bolts (vehicle side)
 - Front engine mounting through-bolt
 - Rear engine mounting through-bolt
 - h. Release supporting with the transmission jack.
2. Install oil strainer.
3. Install oil pan (lower) with the following procedure:

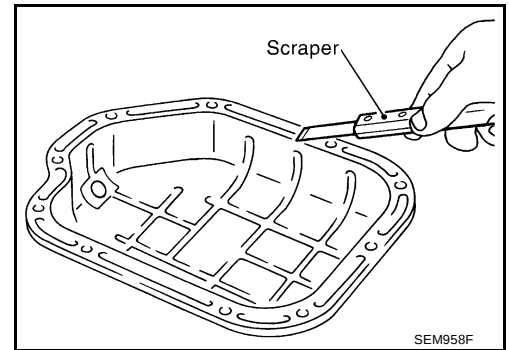
OIL PAN AND OIL STRAINER

[QR]

- 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:

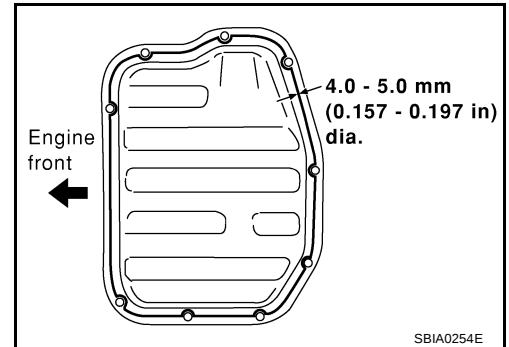
Do not scratch or damage the mating surfaces when cleaning off old liquid gasket.



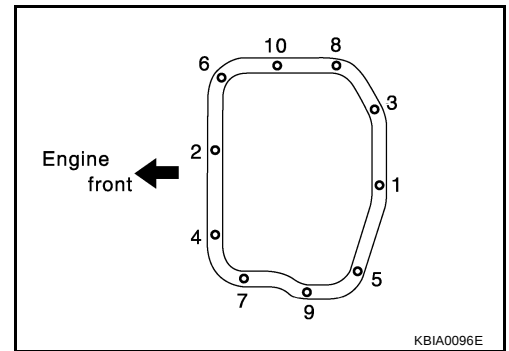
- b. Apply a continuous bead of liquid gasket with tube presser [SST: WS39930000] as shown in the figure.
Use Genuine Liquid Gasket or equivalent.

CAUTION:

Attaching should be done within 5 minutes after coating.



- c. Tighten 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 washer. Refer to [EM-26, "Removal and Installation"](#).

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

NOTE:

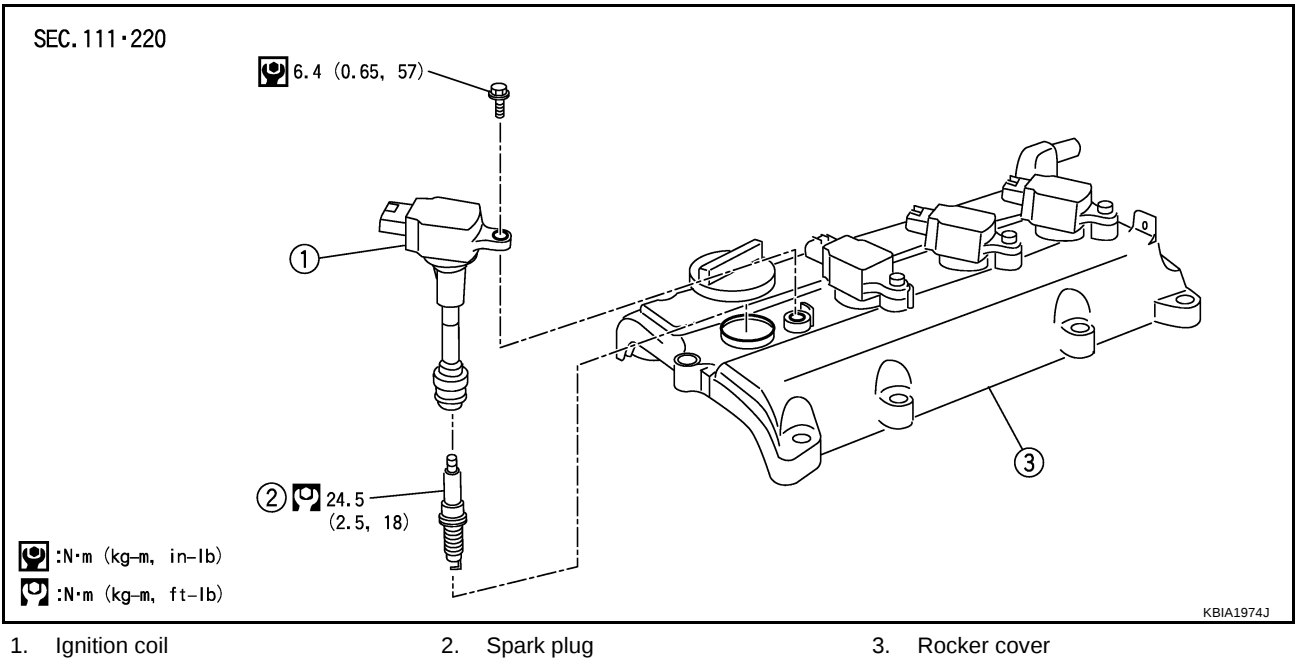
Pour engine oil at least 30 minutes after oil pan is installed.

INSPECTION AFTER INSTALLATION

1. Check engine oil level and adjust engine oil. Refer to [LU-7, "ENGINE OIL"](#) .
2. Start engine, and make sure there is no leaks of engine oil.
3. Stop engine and wait for 10 minutes.
4. Check engine oil level again. Refer to [LU-7, "ENGINE OIL"](#) .

IGNITION COIL

Removal and Installation



REMOVAL

1. Remove engine cover. Refer to [EM-19. "INTAKE MANIFOLD"](#) .
2. Disconnect harness connector from ignition coil.
3. Remove ignition coil.

CAUTION:

Do not drop or shock it.

INSTALLATION

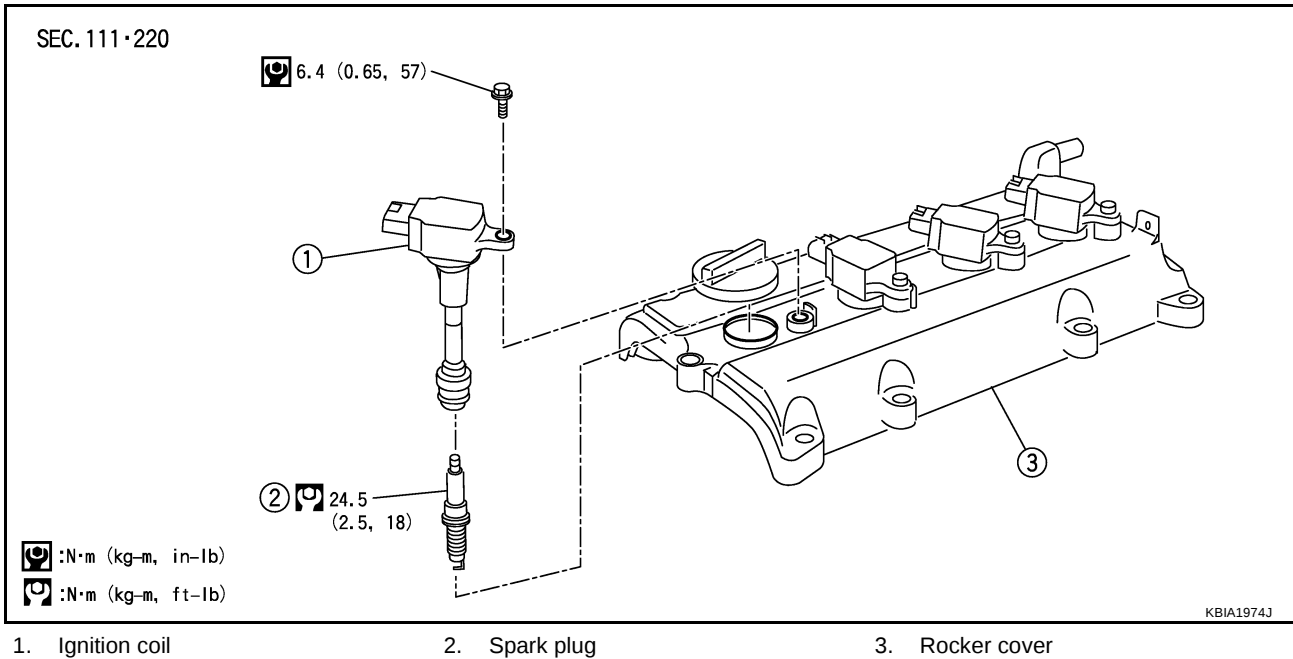
Installation is the reverse order of removal.

SPARK PLUG(PLATINUM-TIPPED TYPE)

PFP:22401

Removal and Installation

BBS00592

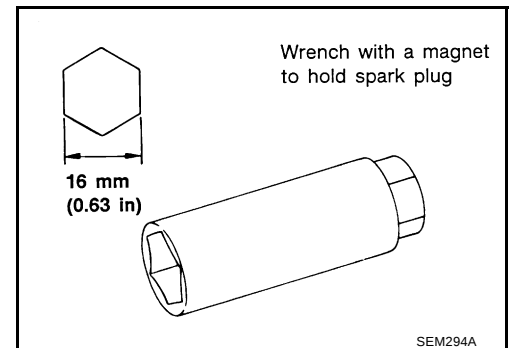


REMOVAL

1. Remove engine cover. Refer to [EM-19, "INTAKE MANIFOLD"](#) .
2. Remove ignition coil. Refer to [EM-31, "IGNITION COIL"](#) .
3. Remove spark plug with 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)

[QR]

CAUTION:

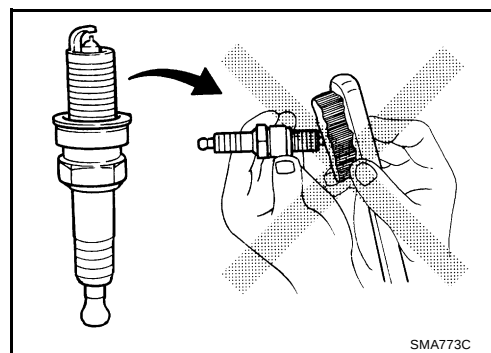
- Do not drop or shock spark plug.
- Do not use wire brush for cleaning.
- If plug tip is covered with carbon, spark plug cleaner may be used.

Cleaner air pressure:

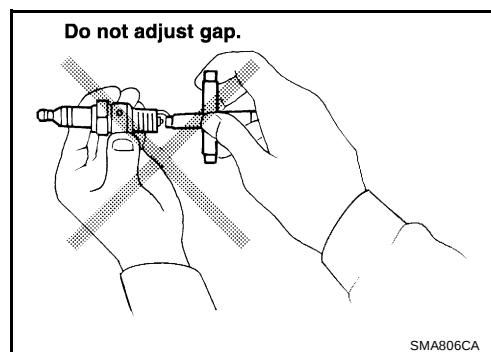
Less than 588 kPa (5.88 bar, 6 kg/cm² , 85 psi)

Cleaning time:

Less than 20 seconds



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



INSTALLATION

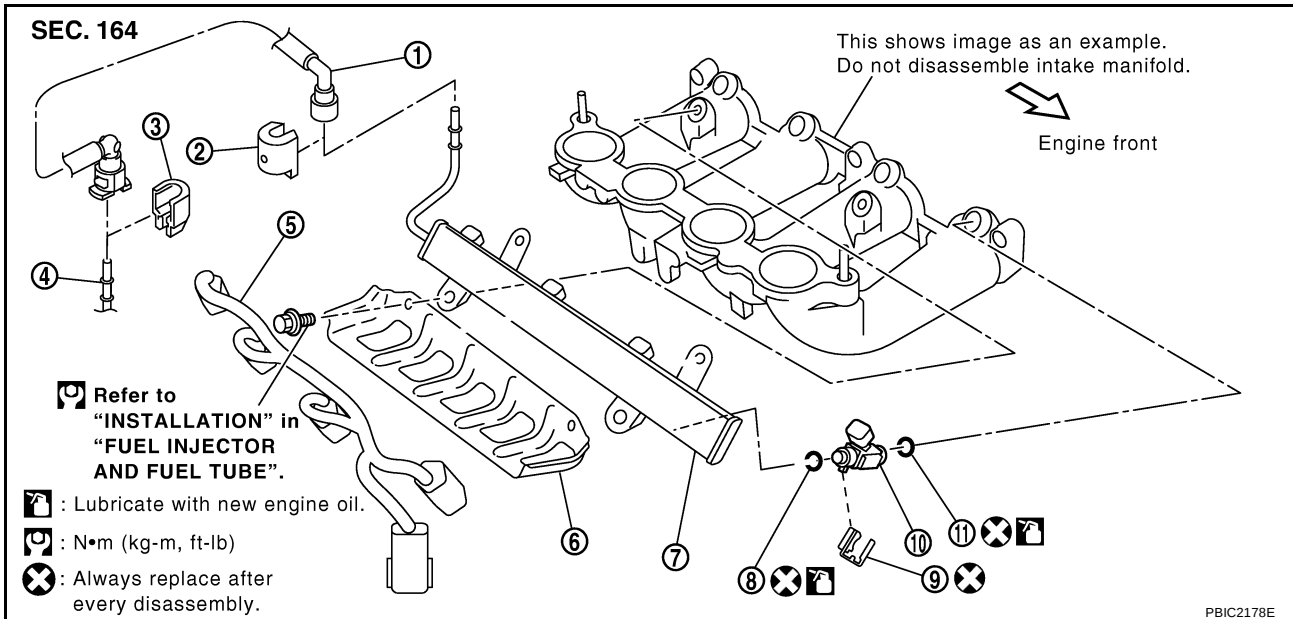
Installation is the reverse order of removal.

FUEL INJECTOR AND FUEL TUBE

PDF:16600

Removal and Installation

BBS00593



CAUTION:

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

REMOVAL

WARNING:

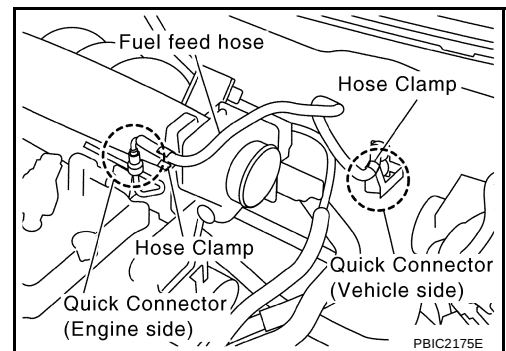
- Put a "CAUTION: FLAMMABLE" sign in the workshop.
 - Be sure to work in a well ventilated area and furnish workshop with a CO₂ fire extinguisher.
 - Do not smoke while servicing fuel system. Keep open flames and sparks away from the work area.
1. Release fuel pressure. Refer to [EC-49, "FUEL PRESSURE RELEASE"](#) .
 2. Remove air cleaner case (upper) with mass air flow sensor and air duct assembly. Refer to [EM-17, "AIR CLEANER AND AIR DUCT"](#) .
 3. Disconnect quick connectors at engine side and vehicle side as follows, and remove fuel feed hose.

CAUTION:

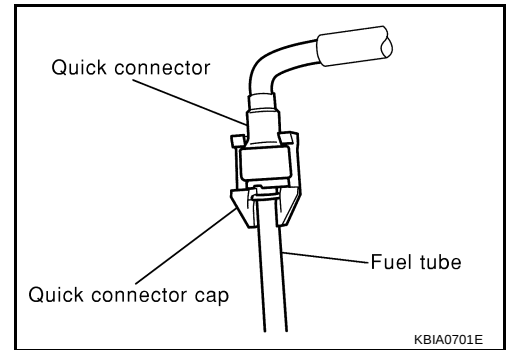
Disconnect quick connector by using quick connector release (SST), not by picking out retainer tabs.

NOTE:

There is quick connector for the engine side and for the vehicle side, and they have different shapes. But disconnection is same procedure. The following procedure shows the engine side.



- a. Remove quick connector cap (engine side).



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

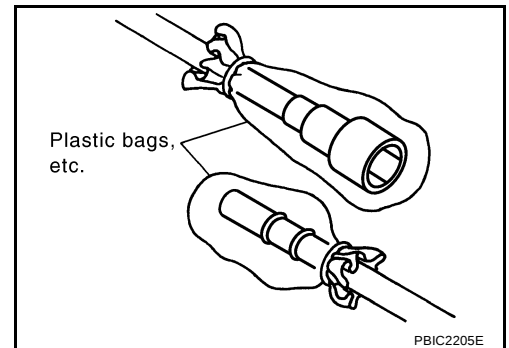
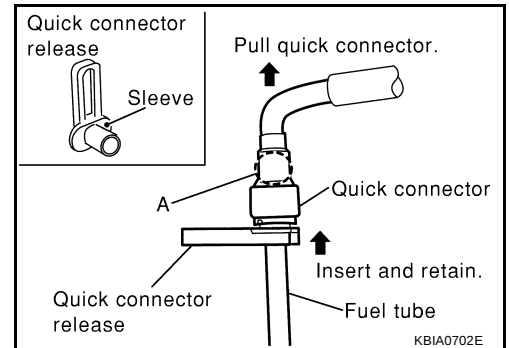
CAUTION:

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

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

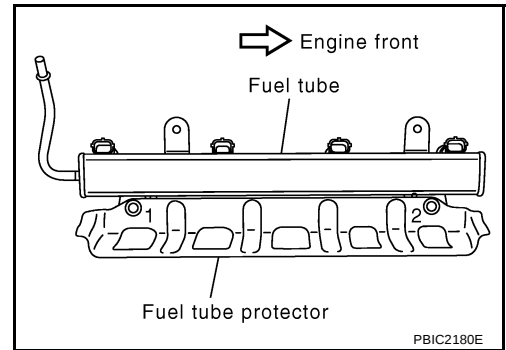
CAUTION:

- Pull quick connector holding "A" position in the figure.
- Do not pull with lateral force applied. O-ring inside quick connector may be damaged.
- Prepare container and cloth beforehand as fuel will leak out.
- Avoid fire and sparks.
- Keep parts away from heat source. Especially, be careful when welding is performed around them.
- Do not expose parts to battery electrolyte or other acids.
- Do not bend or twist connection between quick connector and fuel feed hose during installation/removal.
- To keep clean the connecting portion and to avoid damage and foreign materials, cover them completely with plastic bags or something similar.



4. Remove PCV hose. Refer to [EM-19, "INTAKE MANIFOLD"](#) .
5. Disconnect harness connector from ignition coil.
6. Remove sub-harness for fuel injector.
7. Remove electric throttle control actuator and intake manifold support. Refer to [EM-19, "INTAKE MANIFOLD"](#) .

8. Loosen mounting bolts in reverse order as shown in the figure.
9. Remove fuel tube protector.



10. Pull out fuel tube and fuel injector assembly rearward of engine.

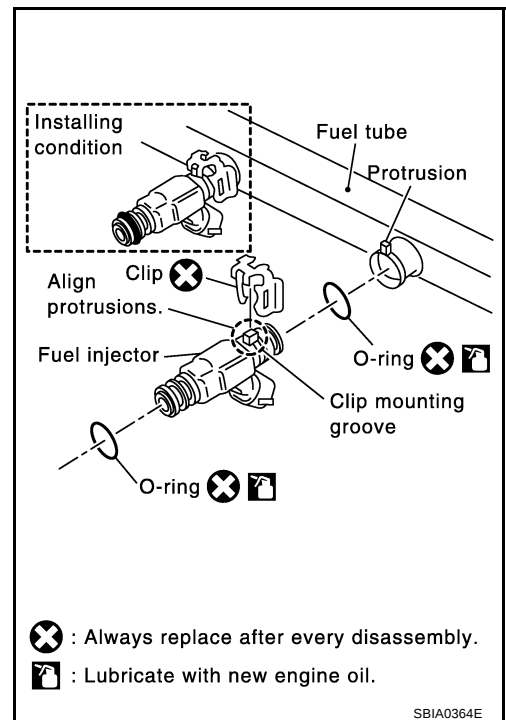
CAUTION:

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

11. Remove fuel injector from fuel tube with the following procedure:
 - 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 fuel injector nozzle during removal.
- Do not bump or drop fuel injector.
- Do not disassemble fuel injector.



INSTALLATION

1. Note the following, and install O-rings to fuel injector.

CAUTION:

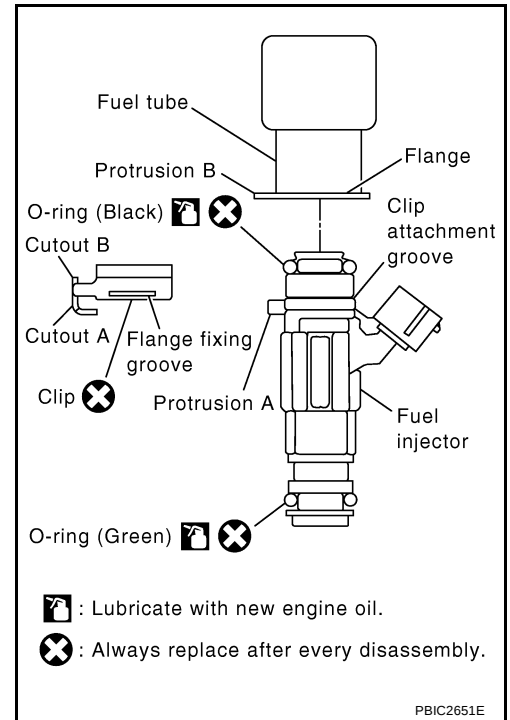
- Upper and lower O-rings are different. Be careful not to confuse them.

Fuel tube side : Black

Nozzle side : Green

- Handle O-ring with bare hands. Do not wear gloves.
- Lubricate O-ring with new engine oil.
- Do not clean O-ring with solvent.
- Make sure that O-ring and its mating part are free of foreign material.
- When installing O-ring, be careful not to scratch it with tool or fingernails. Also be careful not to twist or stretch O-ring. If O-ring was stretched while it was being attached, do not insert it quickly into fuel tube.
- Insert O-ring straight into fuel tube. Do not decenter or twist it.

2. Install fuel injector to fuel tube with the following procedure:
 - a. Insert clip into clip mounting groove on fuel injector.
 - Insert clip so that protrusion "A" of fuel injector matches cutout "A" of clip.
 - CAUTION:**
 - **Do not reuse clip. Replace it with a new one.**
 - **Be careful to keep clip from interfering with O-ring. If interference occurs, replace O-ring.**
 - b. Insert fuel injector into fuel tube with clip attached.
 - Insert it while matching it to the axial center.
 - Insert fuel injector so that 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.



3. From the engine rear side, set fuel tube and fuel injector assembly at its position for installation on intake manifold.

CAUTION:

When installing, be careful to avoid any interference with fuel injector.

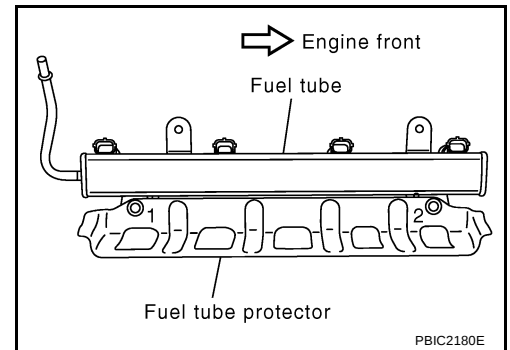
4. Set fuel tube protector onto fuel tube.
5. Tighten mounting bolts with the following procedure.
 - Tighten bolts evenly in two steps in numerical order as shown in the figure.

1st step

: 10.1 N·m (1.0 kg-m, 7 ft-lb)

2nd step

: 23.6 N·m (2.4 kg-m, 17 ft-lb)



6. Connect sub-harness for fuel injector.
7. Note the following, and connect quick connectors at engine side and vehicle side to install fuel feed hose.

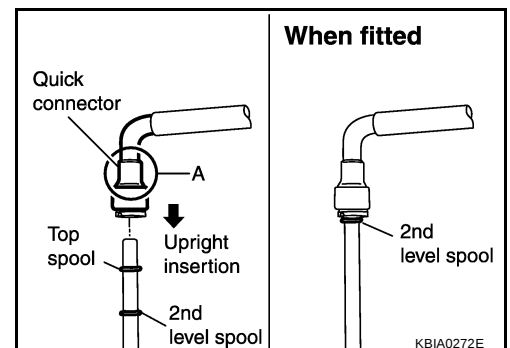
NOTE:

There is quick connector for the engine side and for the vehicle side, and they have different shapes. But connection is same procedure. The following procedure shows the engine side.

- a. Check the connection for foreign material and damage.
- b. Align center to insert quick connector straightly into fuel tube.
 - Insert quick connector to fuel tube until the top spool on fuel tube is inserted completely and the second level spool is positioned slightly below quick connector bottom end.

CAUTION:

- **Hold "A" position in the figure when inserting fuel tube into quick connector.**
- **Carefully align center to avoid inclined insertion to prevent damage to O-ring inside quick connector.**



- Insert until you hear a “click” sound and actually feel the engagement.
 - To avoid misidentification of engagement with a similar sound, be sure to perform the next step.
- c. Before clamping fuel feed hose with hose clamps, pull quick connector hard by hand holding “A” position. Make sure it is completely engaged (connected) so that it does not come out from fuel tube.
- d. Install quick connector cap to quick connector connection. (On both the engine side and the vehicle side)

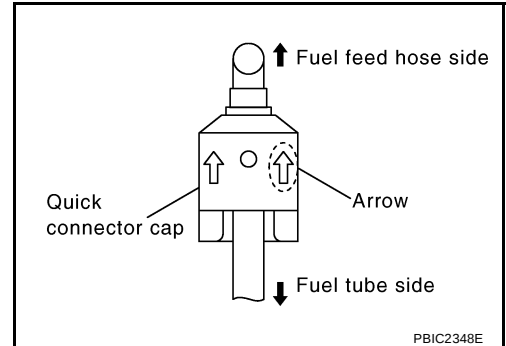
- Install so that the arrow mark on the side faces up.

CAUTION:

- Make sure that quick connector and fuel tube are securely fit into quick connector cap installation groove.
- If quick connector cap cannot be installed smoothly, quick connector may have not been installed correctly. Check connection again.

NOTE:

There is quick connector cap for the engine side and for the vehicle side, and they have different shapes. The figure shows engine side as an example.



8. Install fuel feed hose to hose clamp.
9. Install in the reverse order of removal after this step.

INSPECTION AFTER INSTALLATION

Check on Fuel Leaks

1. Apply fuel pressure to fuel lines with turning ignition switch “ON” (with engine stopped). Then make sure there are no fuel leaks at connections.

NOTE:

Use mirrors for checking on invisible points.

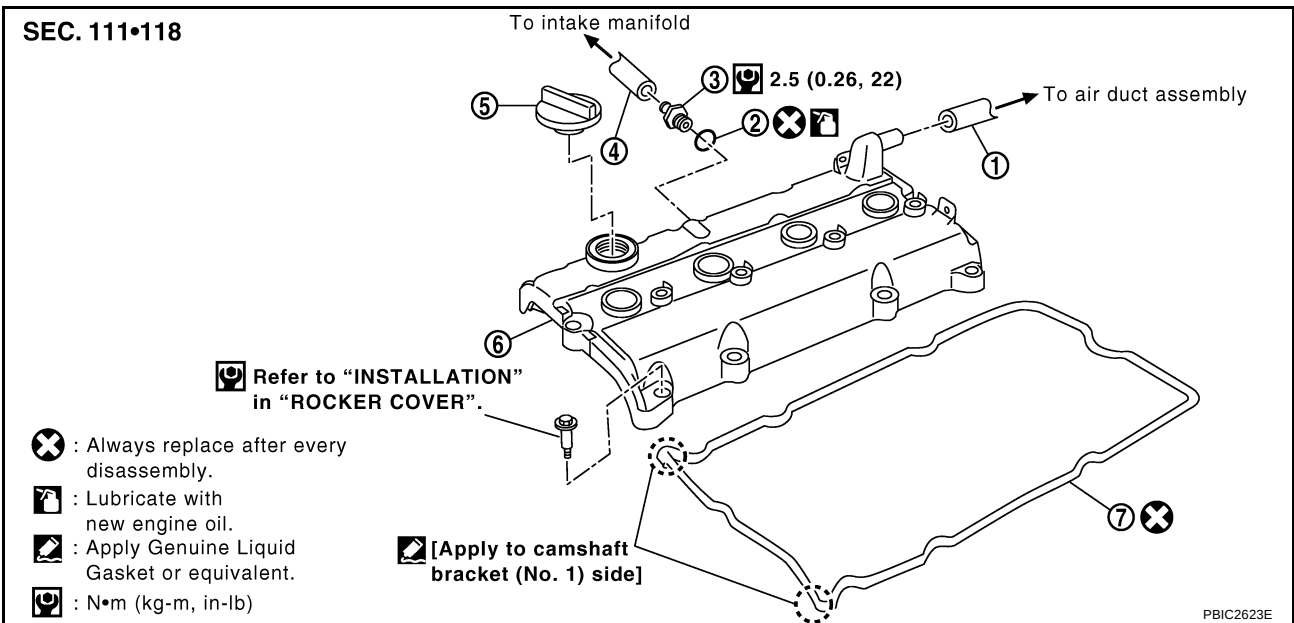
2. Start engine. With engine speed increased, make sure again there are no fuel leaks at connections.

CAUTION:

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

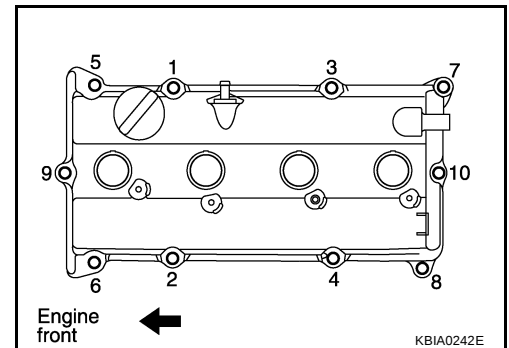
ROCKER COVER

Removal and Installation



REMOVAL

1. Remove engine cover. Refer to [EM-19, "INTAKE MANIFOLD"](#) .
2. Disconnect PCV hoses from rocker cover.
3. Remove ignition coil. Refer to [EM-31, "IGNITION COIL"](#) .
4. Remove PCV valve and O-ring from rocker cover, if necessary.
5. Remove oil filler cap from rocker cover, if necessary.
6. Loosen bolts in reverse order shown in the figure.



7. Remove rocker cover gasket from rocker cover.
8. Use scraper to remove all traces of liquid gasket from cylinder head and camshaft bracket (No. 1).

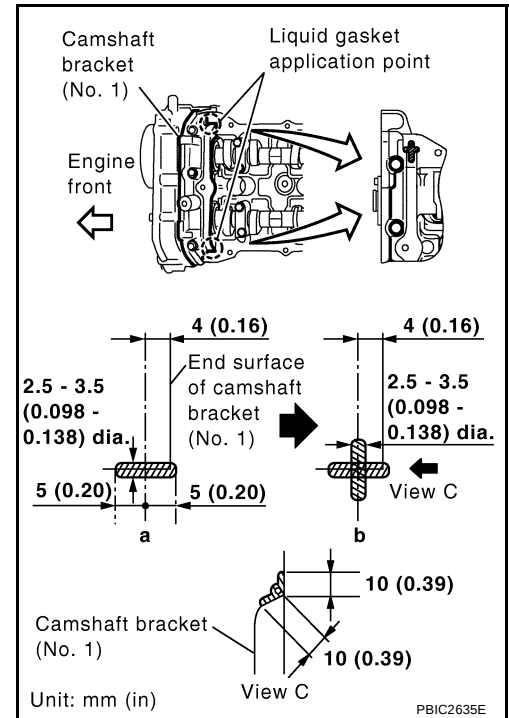
CAUTION:

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 the position shown in the figure with the following procedure:
 - 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 in 90 degrees to the figure "a".

Use Genuine Liquid Gasket or equivalent.



2. Install rocker cover gasket to rocker cover.
3. Install rocker cover.
 - Check if rocker cover gasket is not dropped from the installation groove of rocker cover.
4. Tighten bolts in two steps separately in numerical order as shown in the figure.



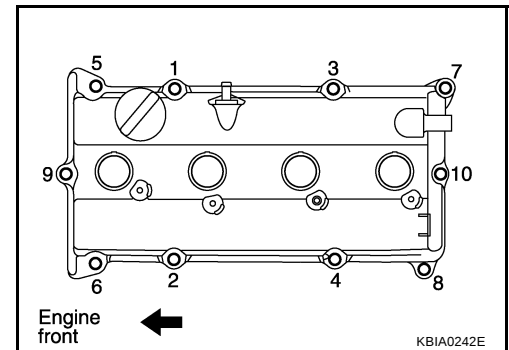
1st step

: 2.0 N·m (0.2 kg-m, 18 in-lb)



2nd step

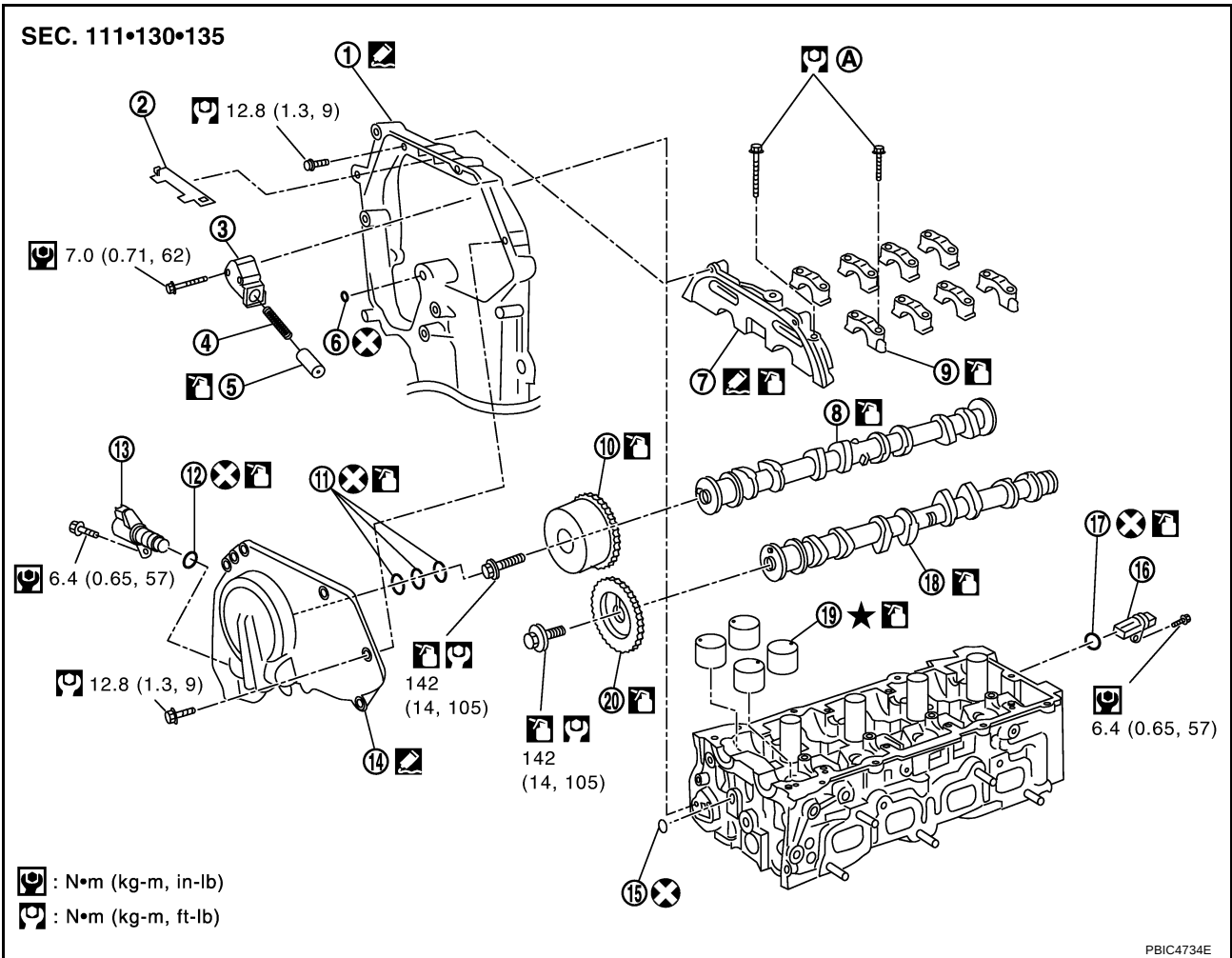
: 8.3 N·m (0.85 kg-m, 73 in-lb)



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

CAMSHAFT

Removal and Installation



- | | | |
|--|---------------------------------------|----------------------------------|
| 1. Front cover | 2. Chain guide | 3. Chain tensioner |
| 4. Spring | 5. Chain tensioner plunger | 6. O-ring |
| 7. Camshaft bracket (No. 1) | 8. Camshaft (INT) | 9. Camshaft bracket (No. 2 to 5) |
| 10. Camshaft sprocket (INT) | 11. Oil ring | 12. O-ring |
| 13. Intake valve timing control solenoid valve | 14. Intake valve timing control cover | 15. O-ring |
| 16. Camshaft position sensor (PHASE) | 17. O-ring | 18. Camshaft (EXH) |
| 19. Valve lifter | 20. Camshaft sprocket (EXH) | |

A. Refer to [EM-47](#)

- Refer to [GI-10, "Components"](#) for symbol marks in the figure.

NOTE:

This section describes removal/installation procedure of camshaft without removing front cover. If front cover is removed or installed, removal of camshaft bracket (No. 1) is easier before step 9 and installation is easier after step 3. Regarding removal and installation of front cover, refer to [EM-53, "TIMING CHAIN"](#).

REMOVAL

- Release fuel pressure. Refer to [EC-49, "FUEL PRESSURE RELEASE"](#).
- Remove the following parts.
 - Engine cover; Refer to [EM-19, "INTAKE MANIFOLD"](#).
 - Ignition coil; Refer to [EM-31, "IGNITION COIL"](#).
 - Rocker cover; Refer to [EM-39, "ROCKER COVER"](#).
- Remove reservoir tank of radiator from bracket, and move it aside. Refer to [CO-13, "RADIATOR"](#).

4. Remove reservoir tank of power steering oil pump from bracket, and move power steering piping aside. Refer to [PS-39, "HYDRAULIC LINE"](#) .

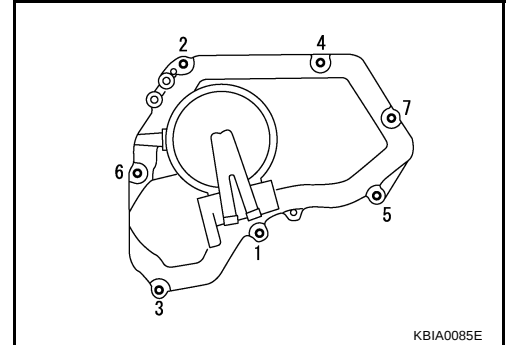
CAUTION:

To avoid power steering fluid leakage, temporarily fix reservoir tank of power steering oil pump vertically.

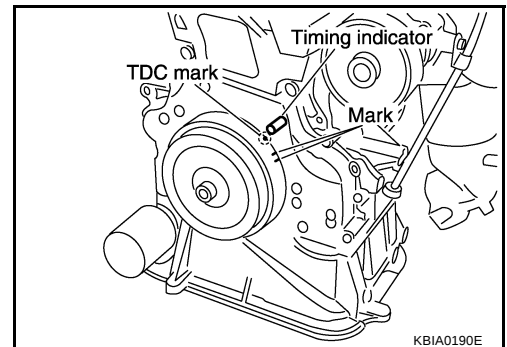
5. Remove intake valve timing control cover with the following procedure:
 - a. Disconnect intake valve timing control solenoid valve harness connector.
 - b. Disconnect ground cables and remove harness clip.
 - c. Remove intake valve timing control solenoid valve, if necessary.
 - d. Loosen bolts in reverse order as shown in the figure.
 - e. Use seal cutter [SST: KV10111100] or equivalent tool to cut liquid gasket for removal.

CAUTION:

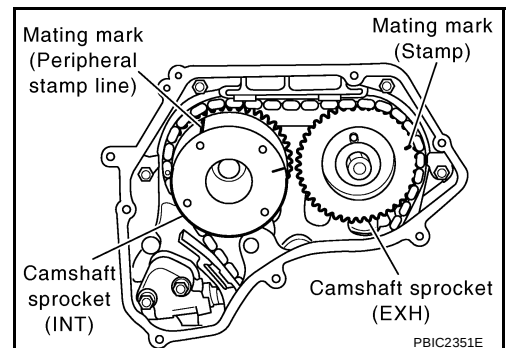
Be careful not to damage the mating surfaces.



6. Pull chain guide between camshaft sprockets out through front cover.
7. Set No. 1 cylinder at TDC on its compression stroke with the following procedure:
 - a. Remove splash guard (RH).
 - b. Rotate crankshaft pulley clockwise and align TDC mark to timing indicator on front cover.



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



8. Remove camshaft sprockets with the following procedure:
 - a. Put indelible paint marks on timing chain link plate aligning with the mating marks on camshaft sprockets.

CAMSHAFT

[QR]

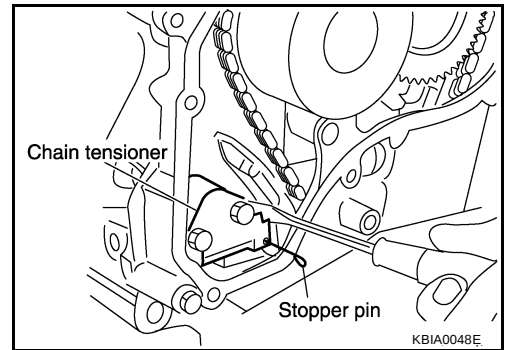
- b. Push in chain tensioner plunger. Insert a stopper pin into hole on chain tensioner body to secure chain tensioner plunger and remove chain tensioner.

CAUTION:

Be careful not to drop mounting bolts inside front cover.

NOTE:

Use approximately 0.5 mm (0.02 in) dia. hard metal pin as a stopper pin.



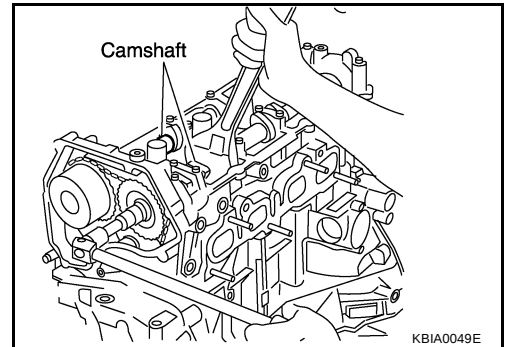
- c. Secure hexagonal part of camshaft with wrench. Loosen camshaft sprocket mounting bolts and remove camshaft sprockets.

CAUTION:

- Do not loosen mounting bolts with securing anything other than the camshaft hexagonal part or with tensioning timing chain.
- Do not rotate crankshaft or camshaft while timing chain is removed. It causes interference between valve and piston.

NOTE:

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



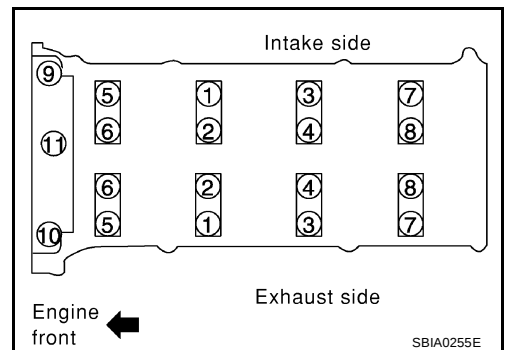
9. Remove camshaft position sensor (PHASE) from cylinder head back side.

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 sensor in a location where it is exposed to magnetism.

10. Loosen mounting bolts in reverse order as shown in the figure, and remove camshaft brackets.

- Remove camshaft bracket (No. 1) by slightly tapping it with plastic hammer.



11. Remove camshafts.

12. Remove valve lifters.

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

INSPECTION AFTER REMOVAL

Camshaft Runout

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

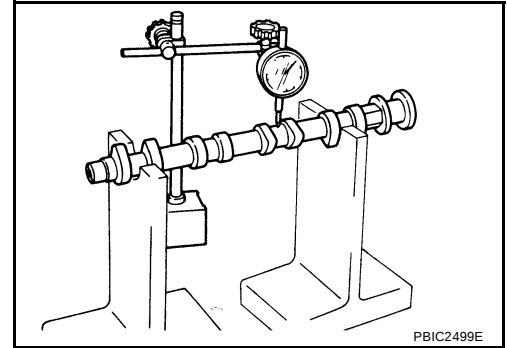
CAUTION:

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

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

Standard: Less than 0.02 mm (0.0008 in)

4. If out of the standard, replace camshaft.



Camshaft Cam Height

1. Measure the camshaft cam height with micrometer.

Standard:

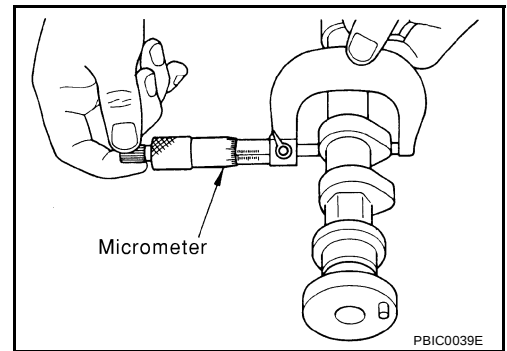
Intake : 45.015 - 45.205 mm (1.7722 - 1.7797 in)

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

Cam wear limit

: 0.2 mm (0.008 in)

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



Camshaft Journal Oil Clearance

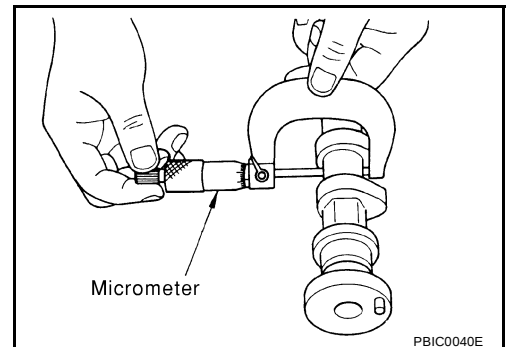
CAMSHAFT JOURNAL DIAMETER

- Measure the outer diameter of camshaft journal with micrometer.

Standard:

No. 1 : 27.935 - 27.955 mm (1.0998 - 1.1006 in)

No. 2, 3, 4, 5 : 23.435 - 23.455 mm (0.9226 - 0.9234 in)



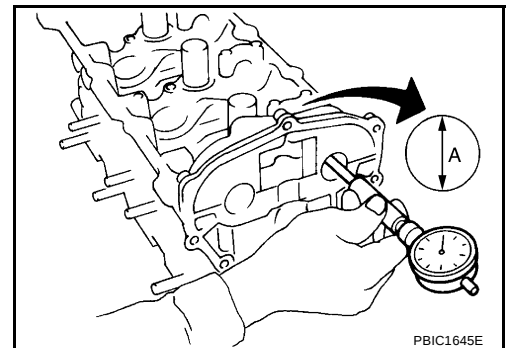
CAMSHAFT BRACKET INNER DIAMETER

- Tighten camshaft bracket bolts with specified torque. Refer to [EM-47, "INSTALLATION"](#) for the tightening procedure.
- Measure the inner diameter "A" of camshaft bracket with bore gauge.

Standard:

No. 1 : 28.000 - 28.021 mm (1.1024 - 1.1032 in)

No. 2, 3, 4, 5 : 23.500 - 23.521 mm (0.9252 - 0.9260 in)



CAMSHAFT JOURNAL OIL CLEARANCE

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

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

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

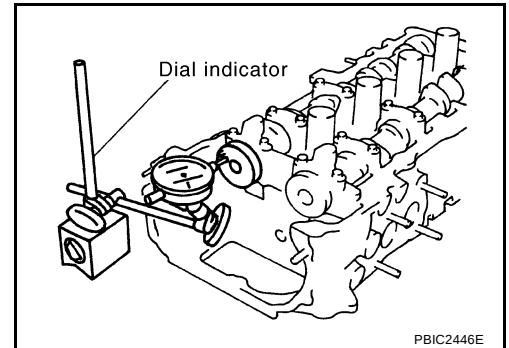
NOTE:

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

1. Install camshaft in cylinder head. Refer to [EM-47, "INSTALLATION"](#) for the tightening procedure.
2. Install dial indicator in thrust direction on front end of camshaft. Read 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)



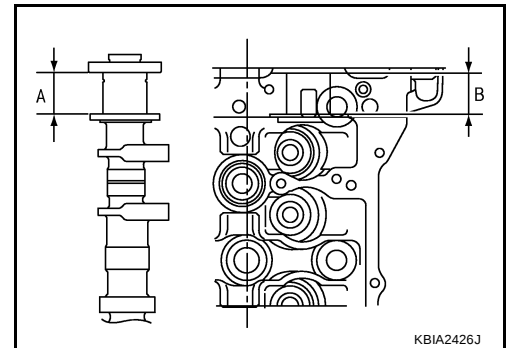
- Measure the following parts if out of the standard.
 - Dimension "A" for camshaft No. 1 journal

Standard : 25.800 - 25.848 mm (1.0157 - 1.0176 in)

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

Standard : 25.660 - 25.685 mm (1.0102 - 1.0112 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 5 journal of camshaft.

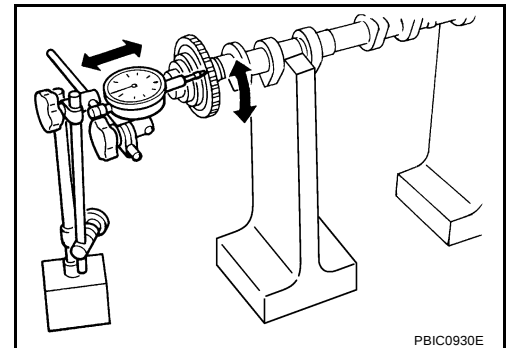
CAUTION:

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

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

Limit : 0.15 mm (0.0059 in)

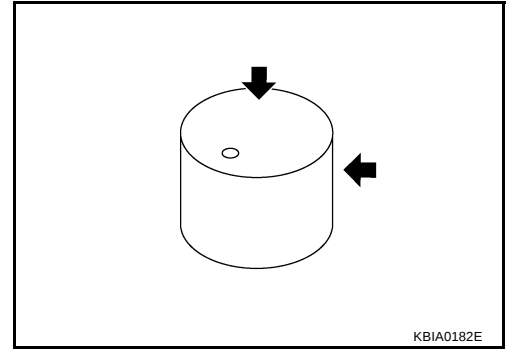
- If it exceeds the limit, replace camshaft sprocket.



Valve Lifter

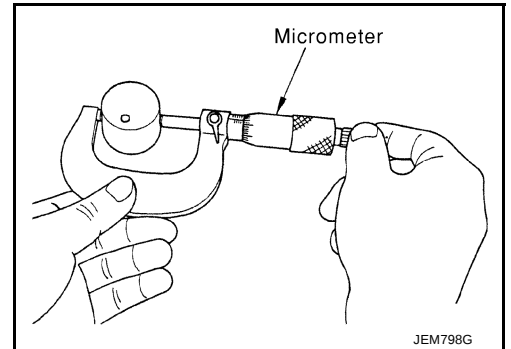
Check if surface of valve lifter has any wear or cracks.

- If anything above is found, replace valve lifter. Refer to [EM-50](#). "[Valve Clearance](#)".

**Valve Lifter Clearance****VALVE LIFTER OUTER DIAMETER**

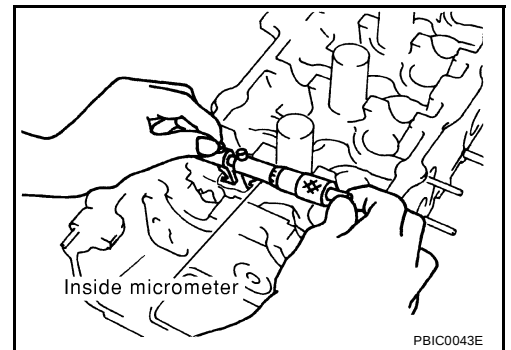
- Measure the outer diameter of valve lifter with micrometer.

Standard : 33.965 - 33.980 mm (1.3372 - 1.3378 in)

**VALVE LIFTER HOLE DIAMETER**

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

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

**VALVE LIFTER CLEARANCE**

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

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

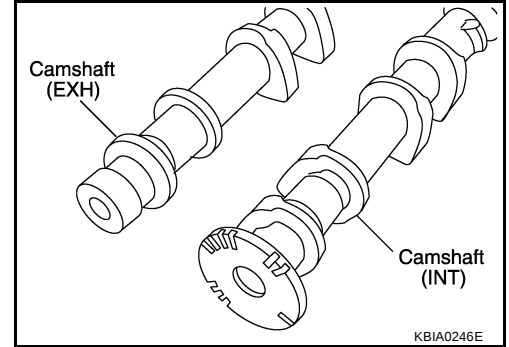
- If out of the standard, referring to the each standard of valve lifter outer diameter and valve lifter hole diameter, replace either or both valve lifter and cylinder head.

INSTALLATION

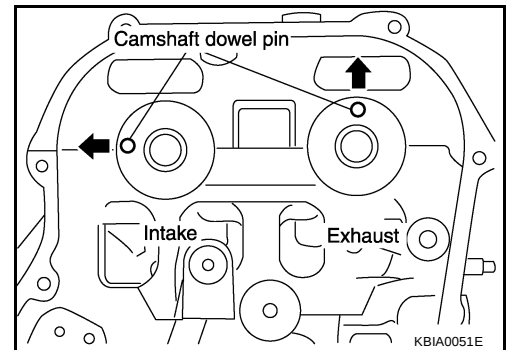
1. Install valve lifters.
 - Install them in the original positions.
2. Install camshafts.
 - Distinction between intake and exhaust camshafts is performed with the different shapes of rear end.

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

Exhaust : Cone end shape



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



3. Install camshaft brackets with the following procedure.

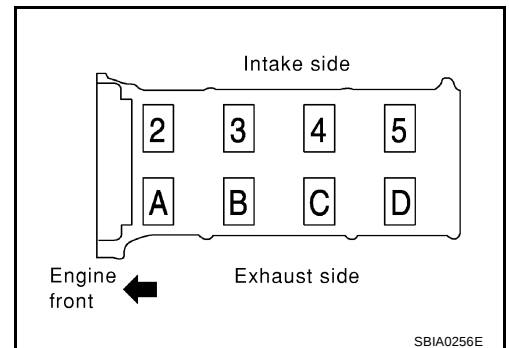
CAUTION:

Completely remove any foreign material on back surface of camshaft brackets and top surface of cylinder head.

- a. Install camshaft brackets (No. 2 to 5) aligning the identification marks on upper surface as shown in the figure.

NOTE:

Install so that identification mark can be correctly read when viewed from the exhaust side.

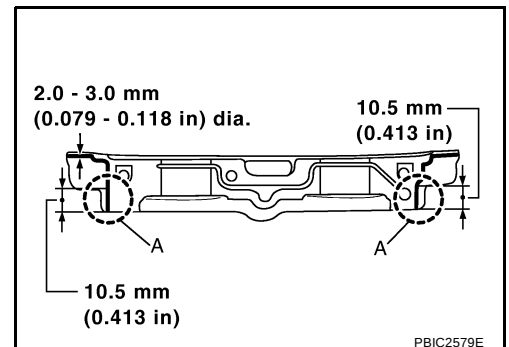


- b. Install camshaft bracket (No. 1) with the following procedure:
 - i. Apply liquid gasket to camshaft bracket (No. 1) as shown in the figure.

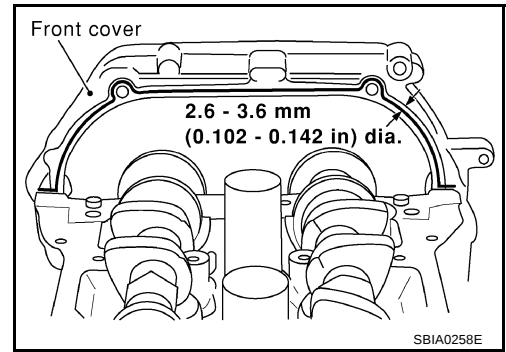
Use Genuine Liquid Gasket or equivalent.

CAUTION:

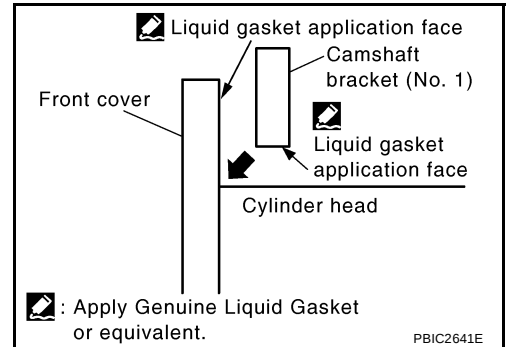
After installation, be sure to wipe off any excessive liquid gasket leaking from part "A".



- ii. Apply liquid gasket to camshaft bracket (No. 1) contact surface on the front cover backside.
Use Genuine Liquid Gasket or equivalent.
 - Apply liquid gasket to the outside of bolt hole on front cover.



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



4. Tighten mounting bolts of camshaft brackets in the following steps, in numerical order as shown in the figure.

- a. Tighten No. 9 to 11 in numerical order.

 : 2.0 N·m (0.2 kg-m, 1 ft-lb)

- b. Tighten No. 1 to 8 in numerical order.

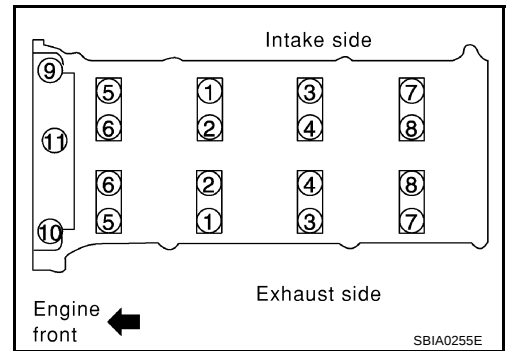
 : 2.0 N·m (0.2 kg-m, 1 ft-lb)

- c. Tighten all bolts in numerical order.

 : 5.9 N·m (0.6 kg-m, 4 ft-lb)

- d. Tighten all bolts in numerical order.

 : 10.4 N·m (1.1 kg-m, 8 ft-lb)



CAUTION:

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

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

5. Install camshaft position sensor (PHASE).

6. Install camshaft sprockets.

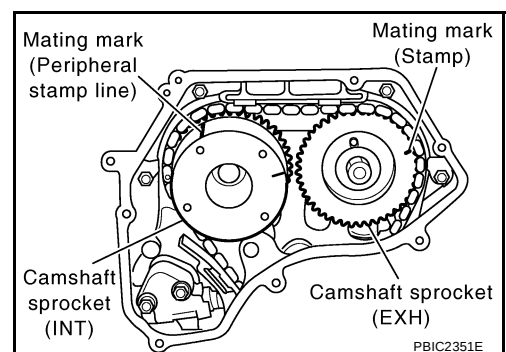
- Install them by aligning the mating marks on each camshaft sprocket with the paint marks on timing chain link plate during removal.

CAUTION:

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

NOTE:

Before installation of chain tensioner, it is possible to re-match the marks on timing chain with the ones on each sprocket.

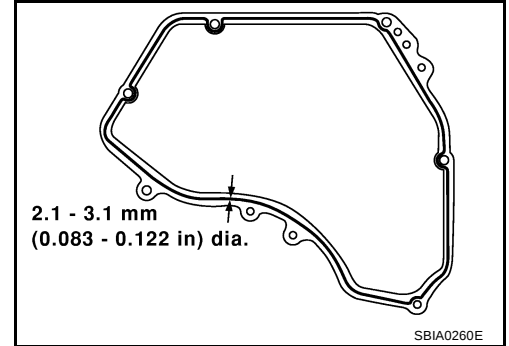


7. Install chain tensioner.

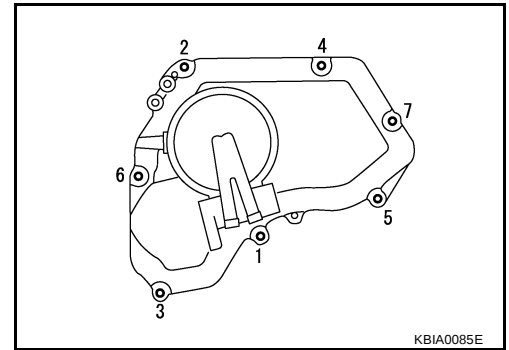
CAUTION:

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

8. Install chain guide.
9. Install intake valve timing control cover with the following procedure:
 - a. Install oil rings to the intake camshaft sprocket insertion points on backside of intake valve timing control cover.
 - b. Install O-ring to front cover.
 - c. Apply liquid gasket with tube presser [SST: WS39930000] to intake valve timing control cover as shown in the figure.
Use Genuine Liquid Gasket or equivalent.



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



- e. Install intake valve timing control solenoid valve to intake valve timing control cover if removed.
- f. Connect ground cables, and install harness clip.
10. Check and adjust valve clearance. Refer to [EM-50, "Valve Clearance"](#).
11. 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**Inspection of Camshaft Sprocket (INT) Oil Groove****CAUTION:**

- Perform this inspection only when DTC P0011 is detected in self-diagnostic results of CONSULT-II and it is directed according to inspection procedure of EC section. Refer to [EC-82, "SELF-DIAG RESULTS MODE"](#).
 - Check when the engine is cold so as to prevent burns from any splashing engine oil.
1. Check the engine oil level. Refer to [LU-7, "ENGINE OIL"](#).
 2. Perform the following procedure so as to prevent the engine from being unintentionally started while checking.
 - a. Release fuel pressure. Refer to [EC-49, "FUEL PRESSURE RELEASE"](#).
 - b. Disconnect ignition coil and injector harness connectors.
 3. Remove intake valve timing control solenoid valve. Refer to [EM-41, "CAMSHAFT"](#).

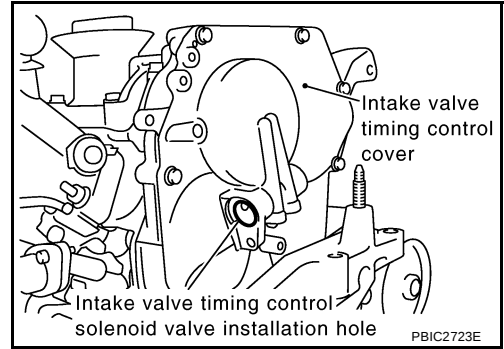
4. Crank the engine, and then make sure that engine oil comes out from intake valve timing control cover oil hole. End crank after checking.

WARNING:

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

CAUTION:

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



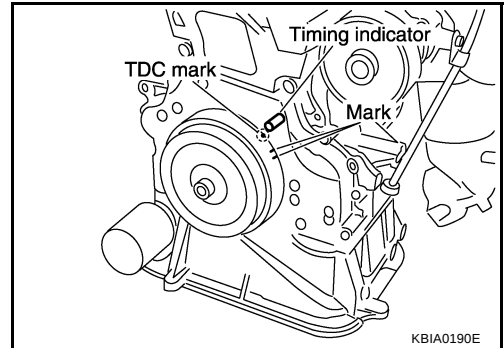
- Clean oil groove between oil strainer and intake valve timing control solenoid valve if engine oil does not come out from intake valve timing control cover oil hole. Refer to [LU-5, "LUBRICATION SYSTEM"](#).
5. Remove components between intake valve timing control solenoid valve and camshaft sprocket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

Valve Clearance INSPECTION

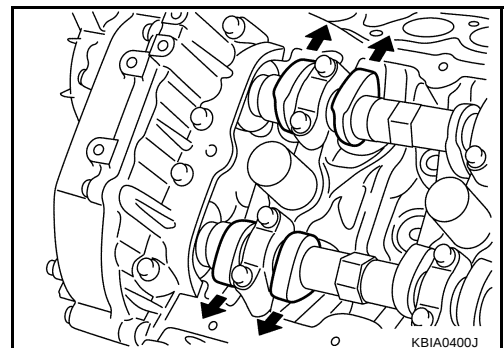
BBS00596

Perform inspection as follows after removal, installation or replacement of camshaft or valve-related parts, or if there is unusual engine conditions regarding valve clearance.

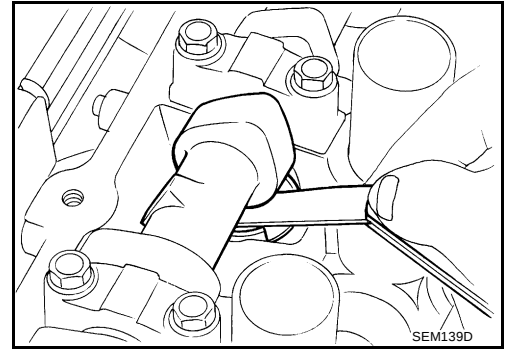
1. Remove rocker cover. Refer to [EM-39, "ROCKER COVER"](#).
 2. Open splash guard on RH undercover.
 3. Measure the valve clearance with the following procedure:
- a. Set No. 1 cylinder at TDC of its compression stroke.
 - Rotate crankshaft pulley clockwise and align TDC mark to timing indicator on front cover.



- At the same time, make sure that both intake and exhaust cam noses of No. 1 cylinder face outside as shown in the figure.
- If they do not face outside, rotate crankshaft pulley once more (360 degrees) and align as shown in the figure.



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



Valve clearance:

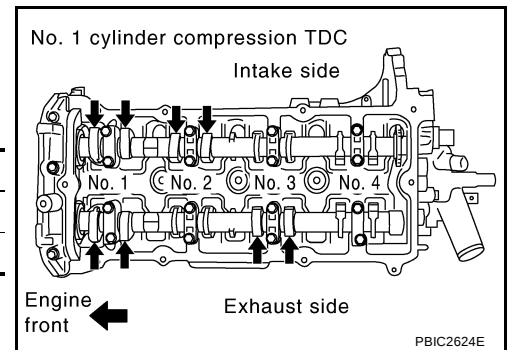
Unit: mm (in)

	Cold	Hot * (reference data)
Intake	0.24 - 0.32 (0.009 - 0.013)	0.304 - 0.416 (0.012 - 0.016)
Exhaust	0.26 - 0.34 (0.010 - 0.013)	0.308 - 0.432 (0.012 - 0.017)

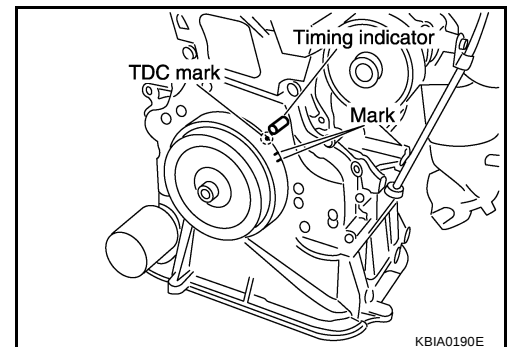
*: Approximately 80°C (176°F)

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

Measuring position		No. 1 CYL.	No. 2 CYL.	No. 3 CYL.	No. 4 CYL.
No. 1 cylinder at compression TDC	INT	x	x		
	EXH	x		x	

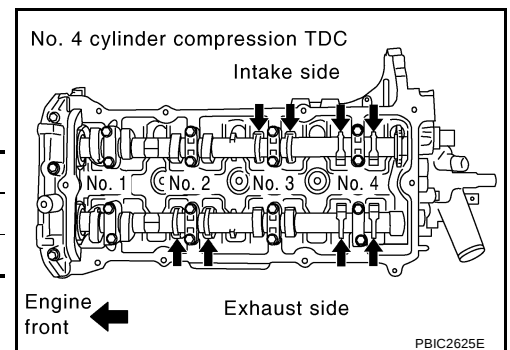


- c. Rotate crankshaft pulley one revolution (360 degrees) and align TDC mark to timing indicator on front cover.



- By referring to the figure, measure the valve clearance at locations marked "x" as shown in the table below (locations indicated with black arrow in the figure) with a feeler gauge.
- No. 4 cylinder compression TDC

Measuring position		No. 1 CYL.	No. 2 CYL.	No. 3 CYL.	No. 4 CYL.
No. 4 cylinder at compression TDC	INT			x	x
	EXH		x		x

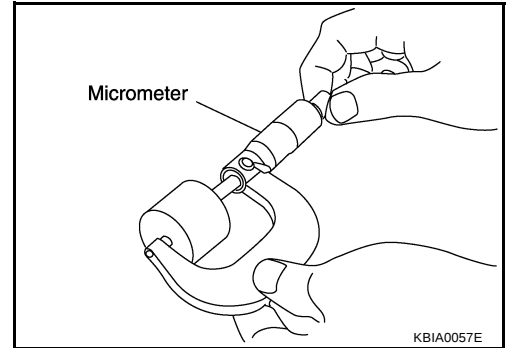


4. If out of standard, perform adjustment. Refer to [EM-51, "ADJUSTMENT"](#) .

ADJUSTMENT

- Perform adjustment depending on selected head thickness of valve lifter.

1. Remove camshaft. Refer to [EM-41, "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 a 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

t₁ = Removed valve lifter thickness

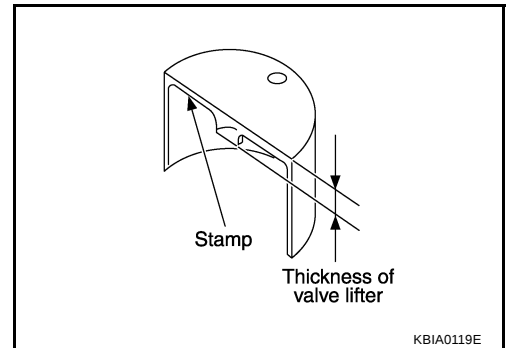
C₁ = Measured valve clearance

C₂ = Standard valve clearance:

Intake : 0.28 mm (0.011 in)

Exhaust : 0.30 mm (0.012 in)

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



NOTE:

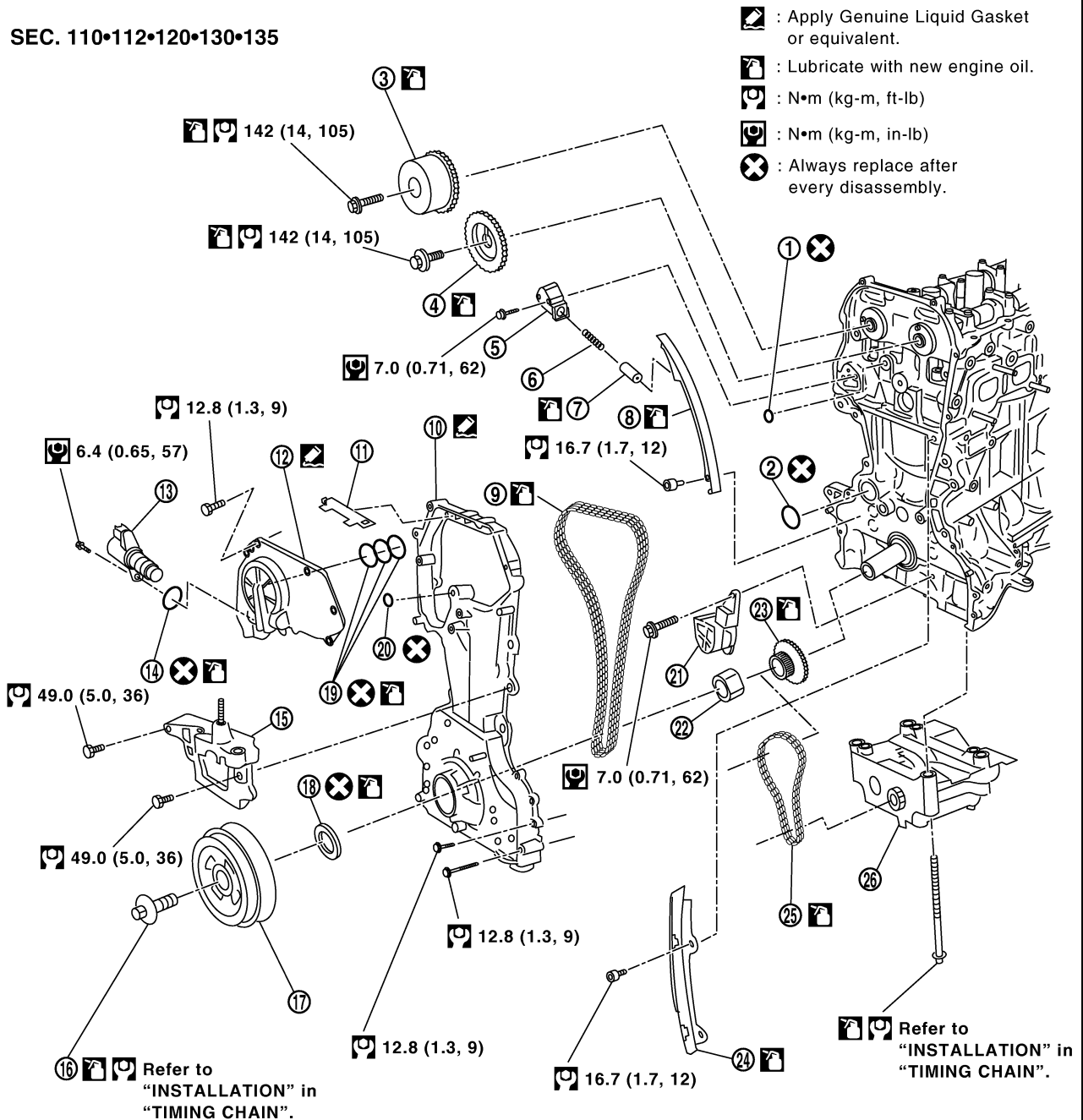
Available thickness of valve lifter: 26 sizes range 6.96 to 7.46 mm (0.2740 to 0.2937 in) in steps of 0.02 mm (0.0008 in) (when manufactured at factory). Refer to [EM-110, "Available Valve Lifter"](#) .

5. Install the selected valve lifter.
6. Install camshaft. Refer to [EM-47, "INSTALLATION"](#) .
7. Manually rotate crankshaft pulley a few rotations.
8. Make sure that valve clearances for cold engine are within specifications by referring to the specified values. Refer to [EM-50, "INSPECTION"](#) .
9. Install all removed parts in the reverse order of removal. Refer to [EM-47, "INSTALLATION"](#) .
10. Warm up the engine, and check for unusual noise and vibration.

TIMING CHAIN

Removal and Installation

SEC. 110•112•120•130•135



PBIC2419E

REMOVAL

1. Remove the following parts.
 - RH front road wheel and tire
 - Undercover and splash guard (RH)
 - PCV hose; Refer to [EM-19, "INTAKE MANIFOLD"](#) .
 - Ignition coil; Refer to [EM-31, "IGNITION COIL"](#) .
 - Rocker cover; Refer to [EM-39, "ROCKER COVER"](#) .
 - Reservoir tank of radiator; Refer to [CO-13, "RADIATOR"](#) .
 - Drive belt; Refer to [EM-14, "DRIVE BELTS"](#) .
 - Alternator; Refer to [SC-27, "CHARGING SYSTEM"](#) .
 - Drive belt auto-tensioner; Refer to [EM-15, "Removal and Installation of Drive Belt Auto-Tensioner"](#) .
 - Exhaust front tube; Refer to [EX-2, "EXHAUST SYSTEM"](#) .

2. Drain engine oil. Refer to [LU-9, "Changing Engine Oil"](#) .

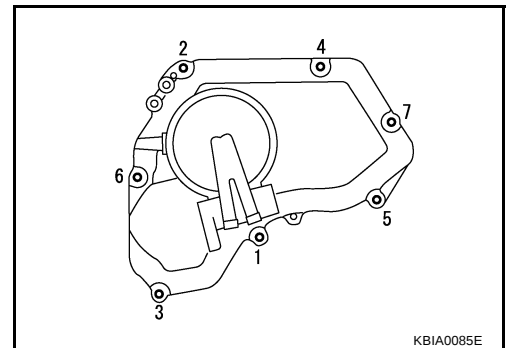
CAUTION:

Perform this step when engine is cold.

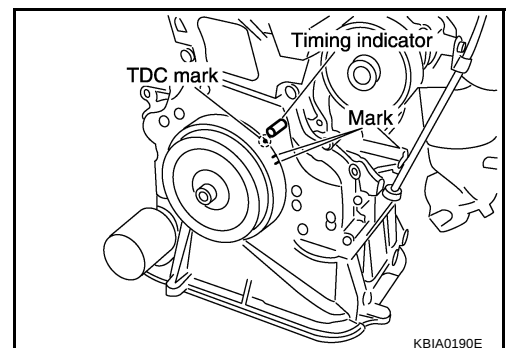
3. Remove A/C compressor with piping connected. Temporarily secure A/C compressor to vehicle side with a rope to avoid putting a load on them. Refer to [ATC-134, "Removal and Installation of Compressor"](#) .
4. Remove power steering oil pump with piping connected, and secure it to vehicle side temporarily. Refer to [PS-39, "HYDRAULIC LINE"](#) .
5. Securely support bottom of transaxle with suitable transmission jack.
6. Remove RH engine mounting insulator. Refer to [EM-77, "ENGINE ASSEMBLY"](#) .
7. Remove oil pans (upper and lower), and oil strainer. Refer to [EM-26, "OIL PAN AND OIL STRAINER"](#) .
8. To support engine, temporarily tighten removed front and rear engine mounting through-bolts for removing oil pans (upper and lower). Refer to [EM-77, "ENGINE ASSEMBLY"](#) .
9. Remove intake valve timing control cover with the following procedure:
 - a. Disconnect intake valve timing control solenoid valve harness connector.
 - b. Disconnect ground cables and remove harness clip.
 - c. Remove intake valve timing control solenoid valve, if necessary.
 - d. Loosen bolts in reverse order as shown in the figure.
 - e. Use seal cutter [SST: KV10111100] or equivalent tool to cut liquid gasket for removal.

CAUTION:

Be careful not to damage the mating surfaces.



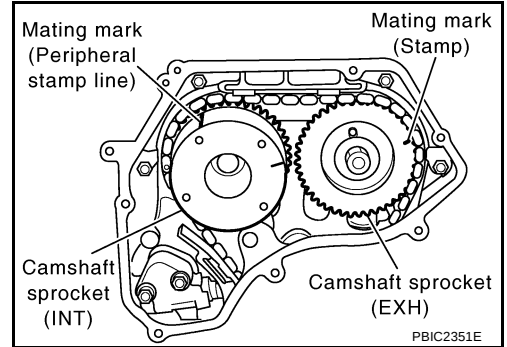
10. Pull chain guide between camshaft sprockets out through front cover.
11. Set No. 1 cylinder at TDC on its compression stroke with the following procedure:
 - a. Rotate crankshaft pulley clockwise and align TDC mark to timing indicator on front cover.



TIMING CHAIN

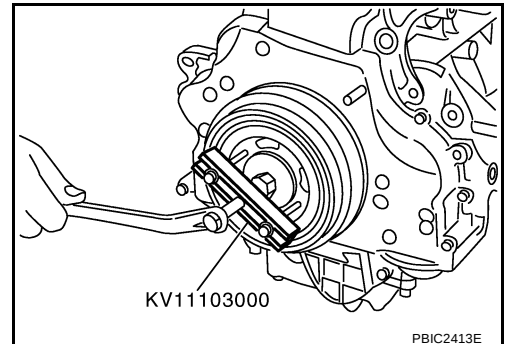
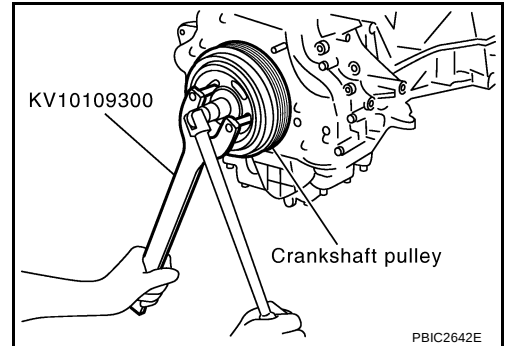
[QR]

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



12. Remove crankshaft pulley with the following procedure:

- a. Fix crankshaft pulley with pulley holder (SST), loosen crankshaft pulley bolt, and locate bolt seating surface at 10 mm (0.39 in) from its original position.
- Use pulley holder after aligning two external holding projections with bores of crankshaft pulley and grinding the projections.
- b. Attach pulley puller (SST) in the M 6 thread hole on crankshaft pulley, and remove crankshaft pulley.



13. Remove front cover and RH engine mounting bracket with the following procedure:

- a. Loosen mounting bolts in reverse order as shown in the figure, and remove RH engine mounting bracket.
- b. Use seal cutter [SST: KV10111100] or equivalent tool to cut liquid gasket for removing front cover.

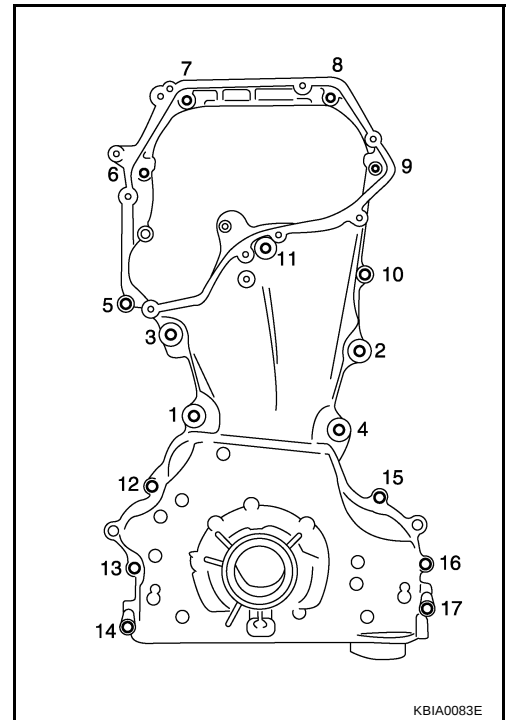
CAUTION:

Be careful not to damage the mating surfaces.

- c. Pull out downward front cover.

CAUTION:

Do not let A/C and power steering pipings interfere with upper part of front cover.



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

CAUTION:

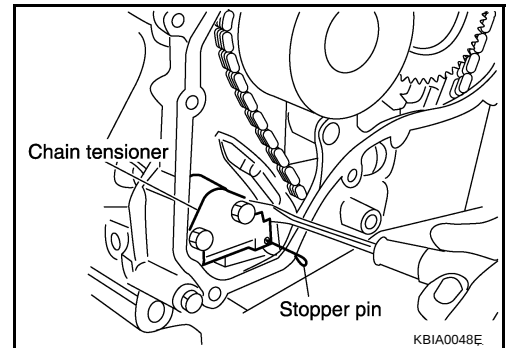
Be careful not to damage front cover.

15. Remove timing chain with the following procedure:

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

NOTE:

Use approximately 0.5 mm (0.02 in) dia. hard metal pin as a stopper pin.



- b. Remove timing chain.

CAUTION:

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

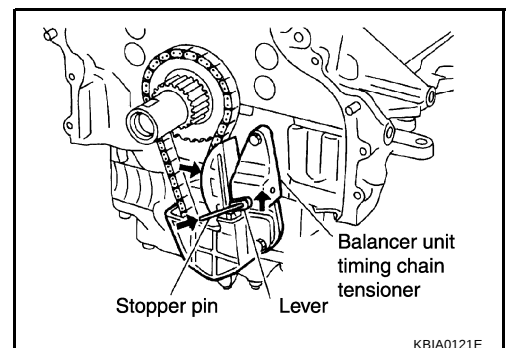
16. Remove camshaft sprockets. Refer to [EM-41, "CAMSHAFT"](#).
17. Remove timing chain slack guide, timing chain tension guide and oil pump drive spacer.
18. Remove balancer unit timing chain tensioner with the following procedure:

- a. Lift lever up, and release ratchet claw for return proof.
- b. Push tensioner sleeve in, and hold it.
- c. Matching the hole on lever with the one on body, insert a stopper pin to secure tensioner sleeve.

NOTE:

Use approximately 1 mm (0.04 in) dia. hard metal pin as a stopper pin.

- d. Remove balancer unit timing chain tensioner.



TIMING CHAIN

[QR]

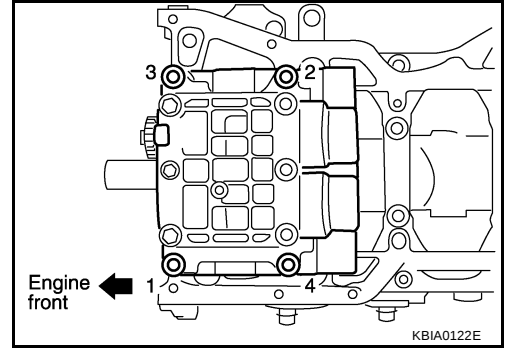
19. Remove balancer unit timing chain and crankshaft sprocket.
20. Loosen mounting bolts in reverse order as shown in the figure, and remove balancer unit.

CAUTION:

Do not disassemble balancer unit.

NOTE:

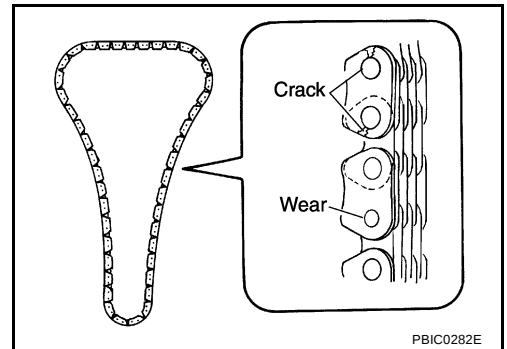
Use TORX socket (size E14).



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.

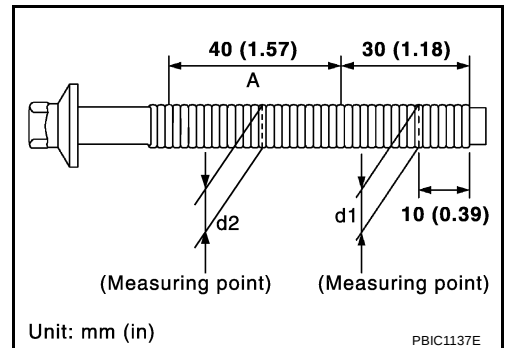


Balancer Unit Mounting Bolt Outer Diameter

- 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") : 0.15 mm (0.0059 in)

- If it exceeds the limit (large difference in dimensions), replace balancer unit mounting bolt with a new one.

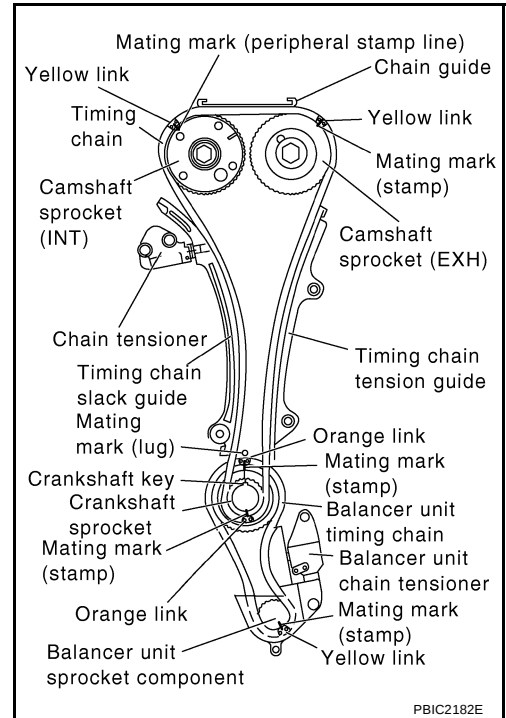


INSTALLATION

NOTE:

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

1. Make sure that crankshaft key points straight up.



2. Tighten mounting bolts in numerical order as shown in the figure with the following procedure to install balancer unit.

CAUTION:

If mounting bolts are re-used, check their outer diameter before installation. Refer to [EM-57, "Balancer Unit Mounting Bolt Outer Diameter"](#).

- a. Apply new engine oil to threads and seat surfaces of mounting bolts.
- b. Tighten all bolts.

 : 48.1 N·m (4.9 kg-m, 35 ft-lb)

- c. Turn all bolts 90 degrees clockwise (angle tightening).

CAUTION:

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

- d. Completely loosen.

 : 0 N·m (0 kg-m, 0 ft-lb)

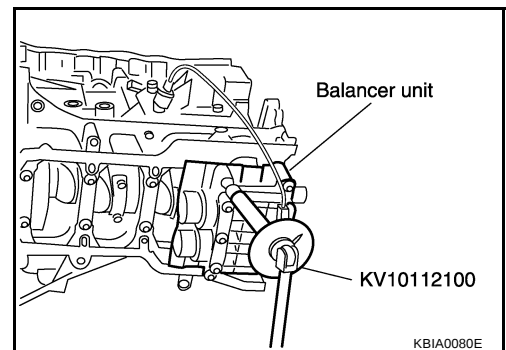
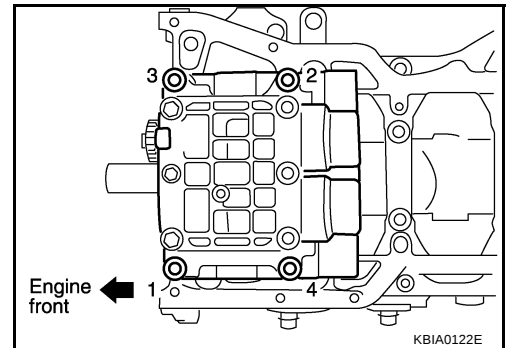
CAUTION:

In this step, loosen bolts in reverse order as shown in the figure.

- e. Tighten all bolts.

 : 48.1 N·m (4.9 kg-m, 35 ft-lb)

- f. Turn them another 90 degrees clockwise (angle tightening).

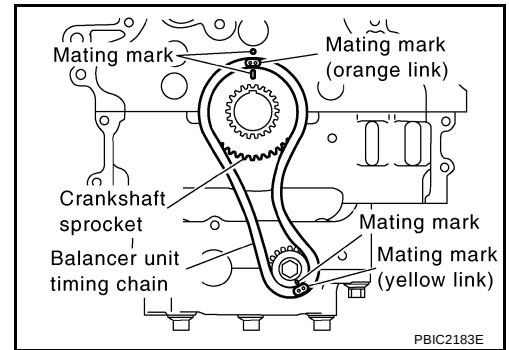


TIMING CHAIN

[QR]

3. Install crankshaft sprocket and balancer unit timing chain.

- Make sure that crankshaft sprocket is positioned with mating marks on cylinder block and crankshaft sprocket meeting at the top.
- Install balancer unit timing chain by aligning mating marks on each sprocket and balancer unit timing chain.

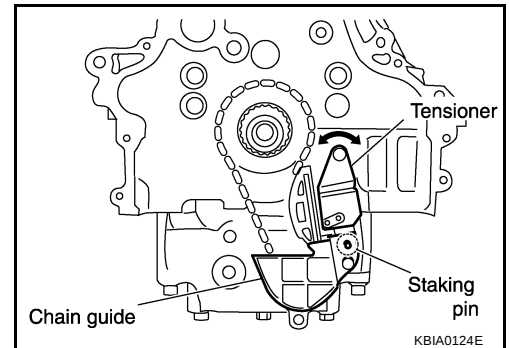


4. Install balancer unit timing chain tensioner.

NOTE:

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

- Be careful not to let mating marks of each sprocket and timing chain slip.
- After installation, make sure the mating marks have not slipped, then remove stopper pin and release tensioner sleeve.



5. Install timing chain and related parts.

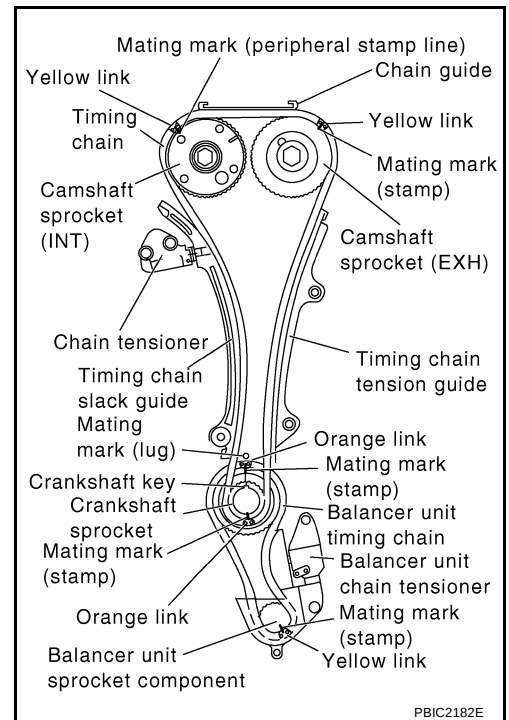
- Install by aligning mating marks on each sprocket and timing chain.
- Before and after installing chain tensioner, check again to make sure that mating marks have not slipped.
- After installing chain tensioner, remove stopper pin, and make sure that tensioner moves freely.

CAUTION:

- For the following note, after the mating marks are aligned, keep them aligned by holding them with a hand.
- To avoid skipped teeth, do not rotate crankshaft and camshaft until front cover is installed.

NOTE:

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



6. Install front oil seal to front cover. Refer to [EM-63, "Removal and Installation of Front Oil Seal"](#) .

7. Install front cover with the following procedure:

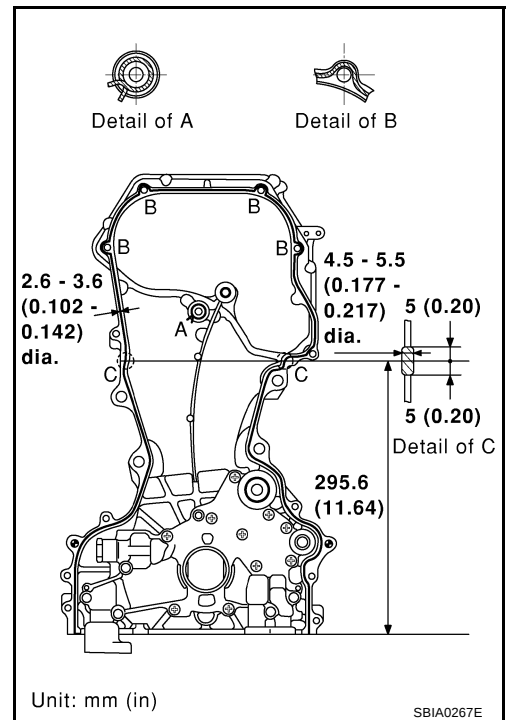
- Install O-rings to cylinder head and cylinder block.

- b. Apply a continuous bead of liquid gasket with tube presser [SST: WS39930000] to front cover as shown in the figure.
Use Genuine Liquid Gasket or equivalent.

NOTE:

Application instruction differs depending on the position.

- Detail of A** : Cross over the start of the application and the end.
- Detail of B** : Apply liquid gasket outside of bolt holes. (For all bolt holes other than B, apply to the inside.)
- Detail of C** : Between here only, apply 4.5 - 5.5 mm (0.177 - 0.217 in) dia.



- c. Make sure that mating marks of timing chain and each sprocket are still aligned. Then install front cover.
- When installing, align flat faces at oil pump drive spacer and oil pump inner rotor.

CAUTION:

- Do not let A/C and power steering pipings interfere with upper part of front cover.
- Be careful not to damage front oil seal by interference with front end of crankshaft.

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

- Refer to the following for locating M6 bolts.

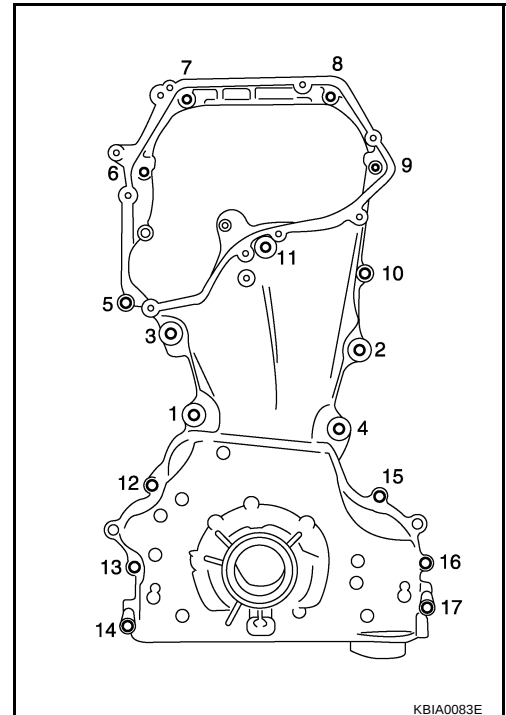
Bolt length:	Bolt position
45 mm (1.77 in)	: 5, 14, 17
20 mm (0.79 in)	: Except the above (Except 1 to 4)

- At the same time, install RH engine mounting bracket. (Bolt positions 1 to 4 in the figure)

- e. After all bolts are tightened, retighten them to specified torque in numerical order as shown in the figure.

CAUTION:

Be sure to wipe off any excessive liquid gasket leaking to surface for fitting oil pan (upper).



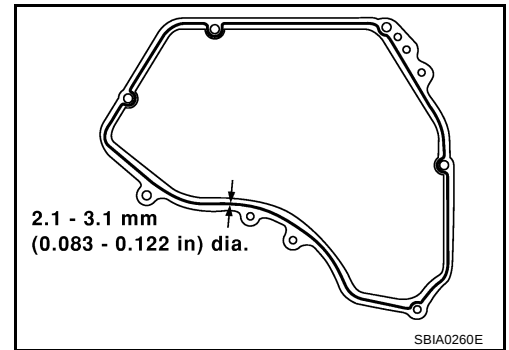
8. Install chain guide between camshaft sprockets.
9. Install intake valve timing control cover with the following procedure:
- Install oil rings to the camshaft sprocket (INT) insertion points on backside of intake valve timing control cover.
 - Install O-ring to front cover.

TIMING CHAIN

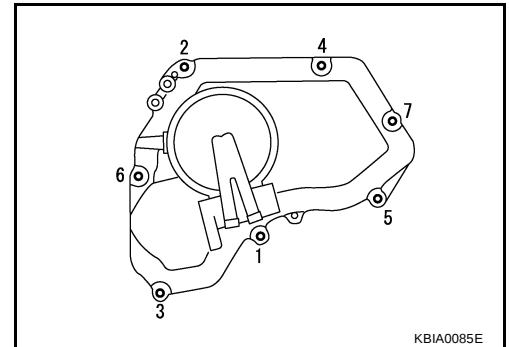
[QR]

- c. Apply a continuous bead of liquid gasket with tube presser [SST: WS39930000] to intake valve timing control cover as shown in the figure.

Use Genuine Liquid Gasket or equivalent.



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



- e. Install intake valve timing control solenoid valves to intake valve timing control cover if removed.
 f. Connect ground cables, and install harness clip.
 10. Insert crankshaft pulley by aligning with crankshaft key.
 • When inserting crankshaft pulley with plastic hammer, tap on its center portion (not circumference).

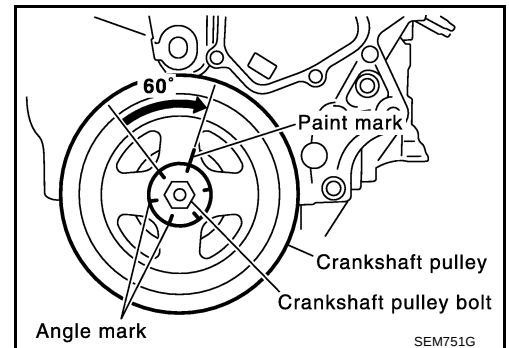
CAUTION:

Install protecting front oil seal lip section from any damage.

11. Tighten crankshaft pulley bolt with the following procedure.
 • Secure crankshaft pulley with pulley holder [SST: KV10109300], and tighten crankshaft pulley bolt.
 a. Apply new engine oil to thread and seat surfaces of crankshaft pulley bolt.
 b. Tighten crankshaft pulley bolt.

 : 42.1 N·m (4.3 kg-m, 31 ft-lb)

- c. Put a paint mark on crankshaft pulley, mating with any one of six easy to recognize angle marks on bolt flange.
 d. Turn another 60 degrees clockwise (angle tightening).
 • Check the tightening angle with movement of one angle mark.



12. Install all removed parts in the reverse order of removal.

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.

OIL SEAL

Removal and Installation of Valve Oil Seal
REMOVAL

1. Remove camshafts. Refer to [EM-41, "CAMSHAFT"](#) .
2. Remove valve lifters. Refer to [EM-41, "CAMSHAFT"](#) .
3. Rotate crankshaft, and set piston whose valve oil seal is to be removed to TDC. This will prevent valve from dropping into cylinder.

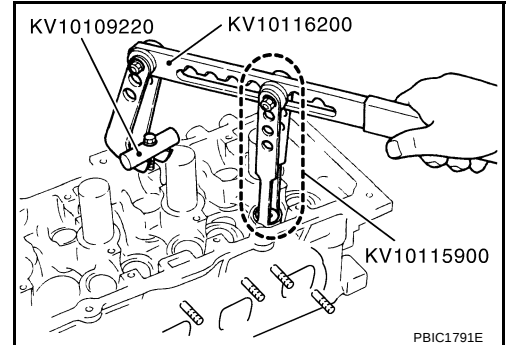
CAUTION:

When rotating crankshaft, be careful to avoid scarring front cover with timing chain.

4. Remove valve collet.
 - Compress valve spring with valve spring compressor, attachment and adapter (SST). Remove valve collet with magnet hand.

CAUTION:

When working, be careful not to damage valve lifter holes.

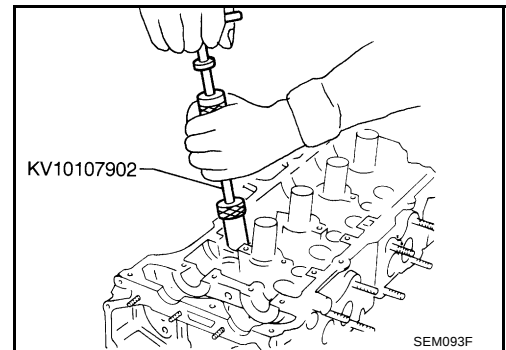


5. Remove valve spring retainer and valve spring (with valve spring seat).

CAUTION:

Do not remove valve spring seat from valve spring.

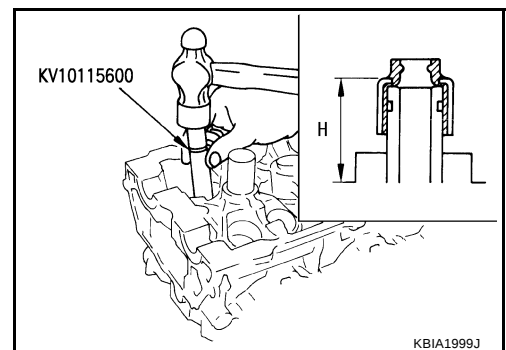
6. Remove valve oil seal with valve oil seal puller (SST).



INSTALLATION

1. Apply new engine oil to new valve oil seal joint surface and seal lip.
2. Press in valve oil seal to the height "H" shown in the figure with valve oil seal drift (SST).

Height "H" : 11.8 - 12.4 mm (0.465 - 0.488 in)



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

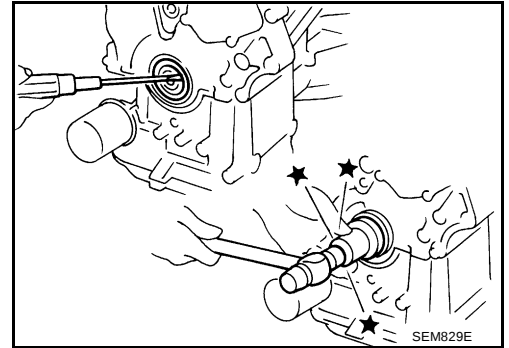
Removal and Installation of Front Oil Seal

REMOVAL

- Remove the following parts.
 - Undercover and splash guard (RH)
 - RH front road wheel and tire
 - Drive belt; Refer to [EM-14, "DRIVE BELTS"](#) .
 - Crankshaft pulley; Refer to [EM-53, "TIMING CHAIN"](#) .
- Remove front oil seal with suitable tool.

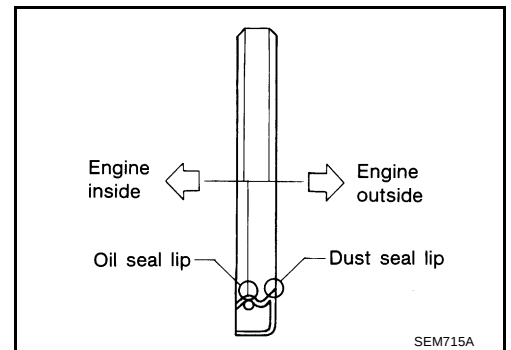
CAUTION:

Be careful not to damage front cover and crankshaft.



INSTALLATION

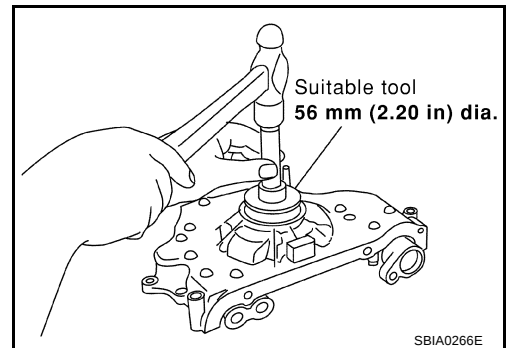
- Apply new engine oil to new front oil seal joint surface and seal lip.
- Install front oil seal so that each seal lip is oriented as shown in the figure.



- Press-fit front oil seal until it is flush with front end surface of front cover with suitable tool.

CAUTION:

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



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

Removal and Installation of Rear Oil Seal

REMOVAL

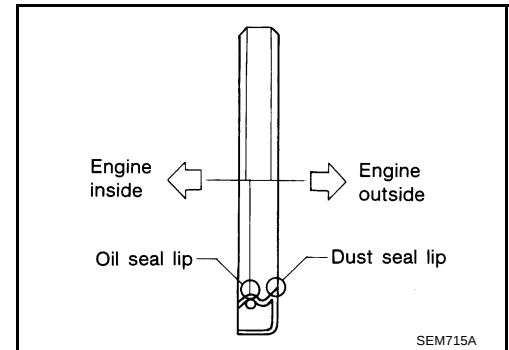
1. Remove engine assembly from vehicle, and separate front suspension member and transaxle from engine. Refer to [EM-77, "ENGINE ASSEMBLY"](#) .
2. Install engine sub-attachment with engine stand shaft [SST: KV10115300 and KV10106500] to right side of cylinder block, then lift engine, and mount it onto engine stand [SST: ST0501S000]. Refer to [EM-81, "CYLINDER BLOCK"](#) .
3. Remove drive plate. Refer to [EM-81, "CYLINDER BLOCK"](#) .
4. Remove rear oil seal with suitable tool.

CAUTION:

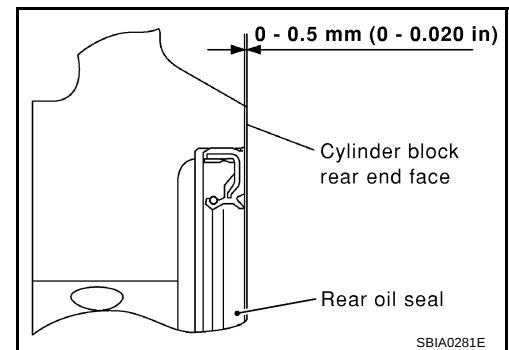
Be careful not to damage crankshaft and cylinder block.

INSTALLATION

1. Apply new engine oil to new rear oil seal joint surface and seal lip.
2. Install rear oil seal so that each seal lip is oriented as shown in the figure.



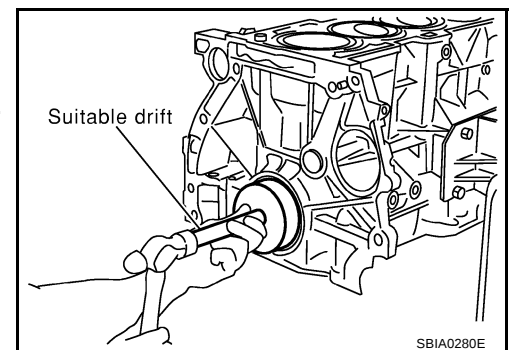
- Press in rear oil seal to the position as shown in the figure.



- Press-fit rear oil seal with suitable drift [outside diameter 102 mm (4.02 in), inside diameter 86 mm (3.39 in)].

CAUTION:

- **Be careful not to damage crankshaft and cylinder block.**
- **Press-fit oil seal straight to avoid causing burrs or tilting.**
- **Do not touch grease applied onto oil seal lip.**



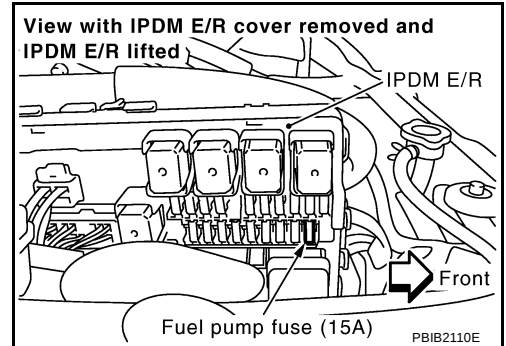
3. Install in the reverse order of removal after this step.

CYLINDER HEAD

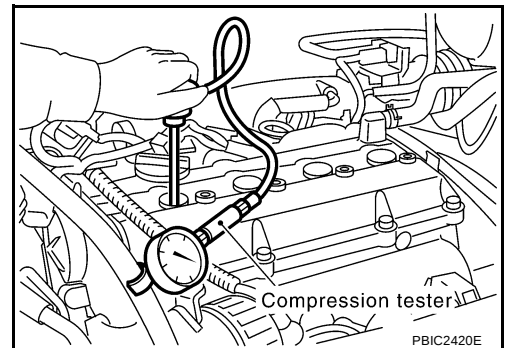
On-Vehicle Service

CHECKING COMPRESSION PRESSURE

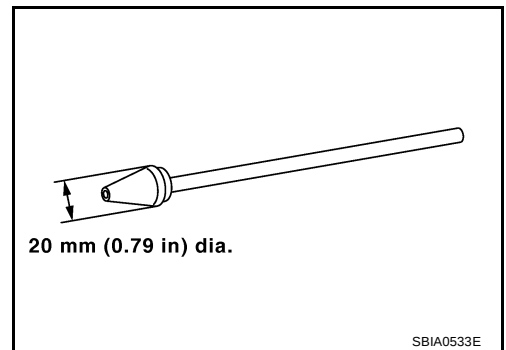
1. Warm up engine thoroughly. Then, stop it.
2. Release fuel pressure. Refer to [EC-49, "FUEL PRESSURE RELEASE"](#) .
3. Disconnect fuel pump fuse to avoid fuel injection during measurement.



4. Remove engine cover. Refer to [EM-19, "INTAKE MANIFOLD"](#) .
5. Remove ignition coil and spark plug from each cylinder. Refer to [EM-31, "IGNITION COIL"](#) and [EM-32, "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 (bar, kg/cm² , psi) /rpm

Standard	Minimum	Differential limit between cylinders
1,190 (11.9, 12.1, 173) / 250	990 (9.9, 10.1, 144) / 250	100 (1.0, 1.0, 14) / 250

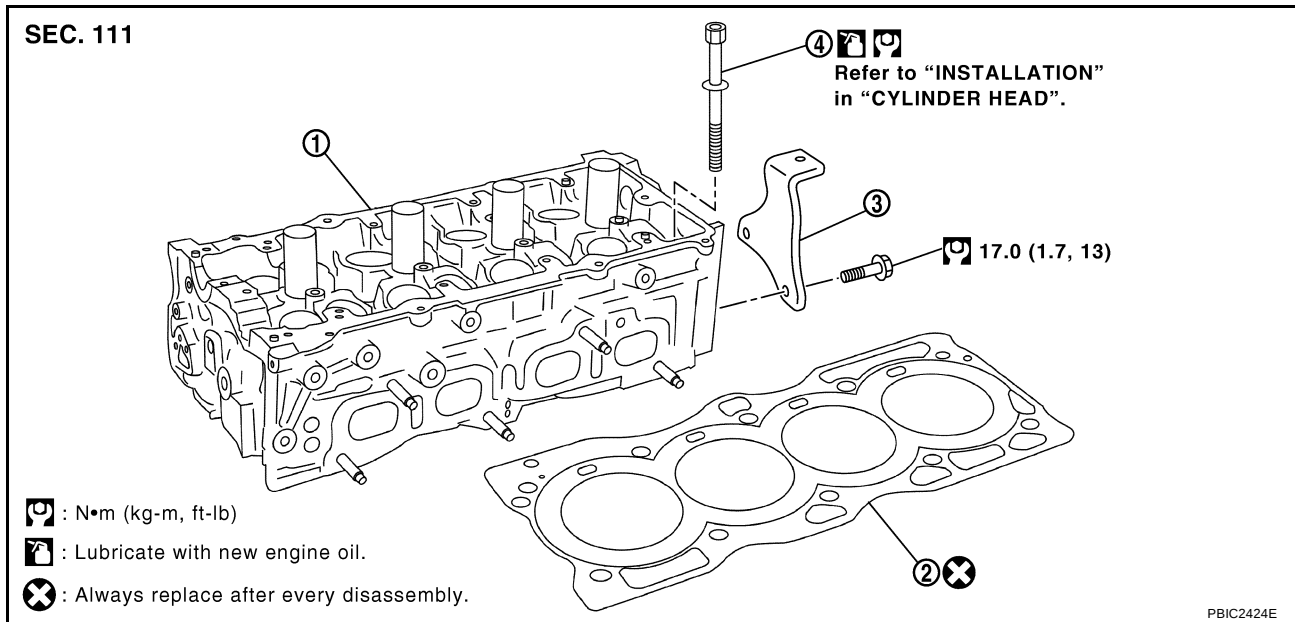
CAUTION:

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

- If the engine speed is out of specified range, check battery liquid for proper gravity. Check engine speed again with normal battery gravity.
 - If compression pressure is below minimum value, check valve clearances and parts associated with combustion chamber (Valve, valve seat, piston, piston ring, cylinder bore, cylinder head, cylinder head gasket). After the checking, measure the compression pressure again.
 - If some cylinders have low compression pressure, pour small amount of engine oil into the spark plug hole of the cylinder to re-check it for compression.
 - If the added engine oil improves the compression, 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 gasket is leaking. In such a case, replace cylinder head gasket.
9. After inspection is completed, install removed parts.
 10. Start engine, and confirm that engine runs smoothly.
 11. Perform trouble diagnosis. If DTC appears, erase it. Refer to [EC-52, "TROUBLE DIAGNOSIS"](#) .

Removal and Installation

BBS0059C



1. Cylinder head assembly
2. Cylinder head gasket
3. Engine cover bracket (rear)
4. Cylinder head bolt

REMOVAL

1. Release fuel pressure. Refer to [EC-49, "FUEL PRESSURE RELEASE"](#) .
 2. Drain engine coolant and engine oil. Refer to [CO-10, "Changing Engine Coolant"](#) and [LU-9, "Changing Engine Oil"](#) .
- CAUTION:**
- Perform this step when engine is cold.
 - Do not spill engine coolant and engine oil on drive belt.
3. Remove the following components and related parts.
 - Exhaust manifold and three way catalyst assembly; Refer to [EM-23, "EXHAUST MANIFOLD AND THREE WAY CATALYST"](#) .
 - Intake manifold and fuel tube assembly; Refer to [EM-19, "INTAKE MANIFOLD"](#) .
 - Water control valve and housing (water outlet); Refer to [CO-24, "THERMOSTAT AND WATER CONTROL VALVE"](#) .

NOTE:

Can be removed and installed even when assembled with cylinder head.

4. Remove front cover and timing chain. Refer to [EM-53, "TIMING CHAIN"](#) .
5. Remove camshafts. Refer to [EM-41, "CAMSHAFT"](#) .
6. Remove cylinder head loosening bolts in reverse order as shown in the figure.
 - Using the following tool, loosen cylinder head bolts.

Bolt with washer

: Hexagonal wrench [size 10 mm (0.39 in)]

Flange bolt

: TORX socket (size E20)

NOTE:

There are two types of cylinder head bolt because of parallel manufacture.

7. Remove cylinder head gasket.

INSPECTION AFTER REMOVAL

Cylinder Head Bolts Outer Diameter

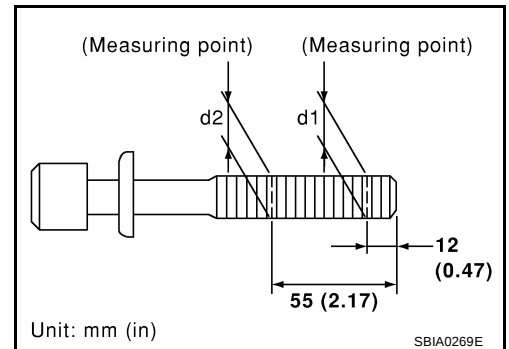
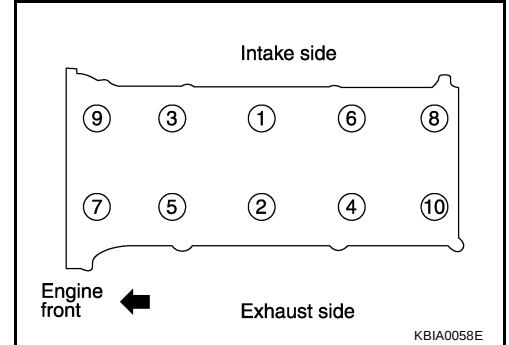
- Cylinder head bolts are tightened by plastic zone tightening method. Whenever the size difference between "d1" and "d2" exceeds the limit, replace them with a new one.

Limit ("d1" – "d2"): 0.23 mm (0.0091 in)

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

NOTE:

When replacing any cylinder head bolts, it is possible to use them with mixing flange bolt and bolt with washer.



Cylinder Head Distortion

NOTE:

When performing this inspection, cylinder block distortion should be also checking. Refer to [EM-102, "CYLINDER BLOCK DISTORTION"](#) .

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

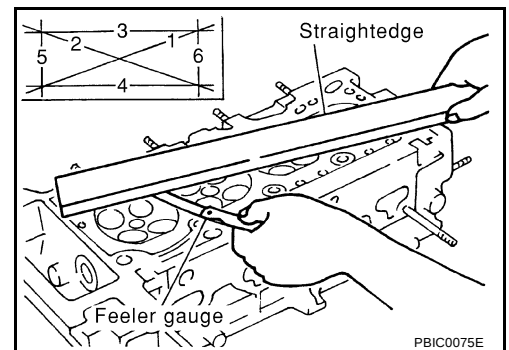
CAUTION:

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 gasket.
2. Tighten cylinder head bolts in numerical order as shown in the figure with the following procedure to install cylinder head.

CAUTION:

If cylinder head bolts are re-used, check their outer diameters before installation. Refer to [EM-67, "Cylinder Head Bolts Outer Diameter"](#) .

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

 : 50.0 N·m (5.1 kg-m, 37 ft-lb)

- c. Turn all bolts 60 degrees clockwise (angle tightening).

CAUTION:

Check and confirm the tightening angle by using angle wrench (SST) or protractor. Avoid judgment by visual inspection without the tool.

- d. Completely loosen.

 : 0 N·m (0 kg-m, 0 ft-lb)

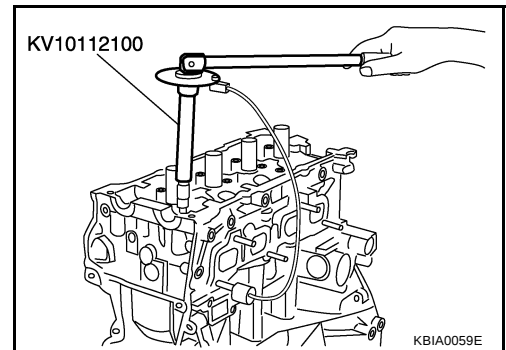
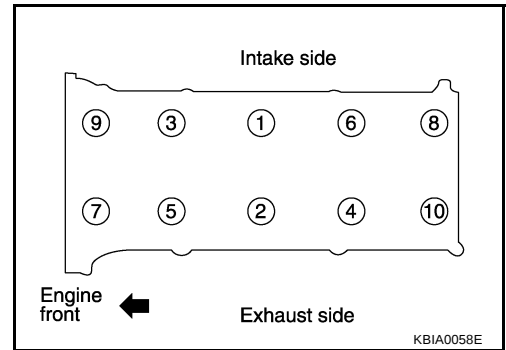
CAUTION:

In this step, loosen bolts in reverse order of that indicated in the figure.

- e. Tighten all bolts.

 : 39.2 N·m (4.0 kg-m, 29 ft-lb)

- f. Turn all bolts 75 degrees clockwise (angle tightening).
- g. Turn all bolts 75 degrees clockwise again (angle tightening).
3. Install in the reverse order of removal after this step.



INSPECTION AFTER INSTALLATION

Inspection for Leaks

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

- Before starting engine, check oil/fluid levels including engine coolant and engine oil. If less than required quantity, fill to the specified level. Refer to [MA-14, "RECOMMENDED FLUIDS AND LUBRICANTS"](#) .
- Use procedure below to check for fuel leakage.
 - Turn ignition switch "ON" (with engine stopped). With fuel pressure applied to fuel piping, check for fuel leakage at connection points.
 - Start engine. With engine speed increased, check again for fuel leakage at connection points.
- Run engine to check for unusual noise and vibration.
- Warm up engine thoroughly to make sure there is no leakage of fuel, exhaust gases, or any oil/fluids including engine oil and engine coolant.
- Bleed air from lines and hoses of applicable lines, such as in cooling system.
- After cooling down engine, again check oil/fluid levels including engine oil and engine coolant. Refill to the specified level, if necessary.

CYLINDER HEAD

[QR]

Summary of the inspection items:

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

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

A

EM

C

D

E

F

G

H

I

J

K

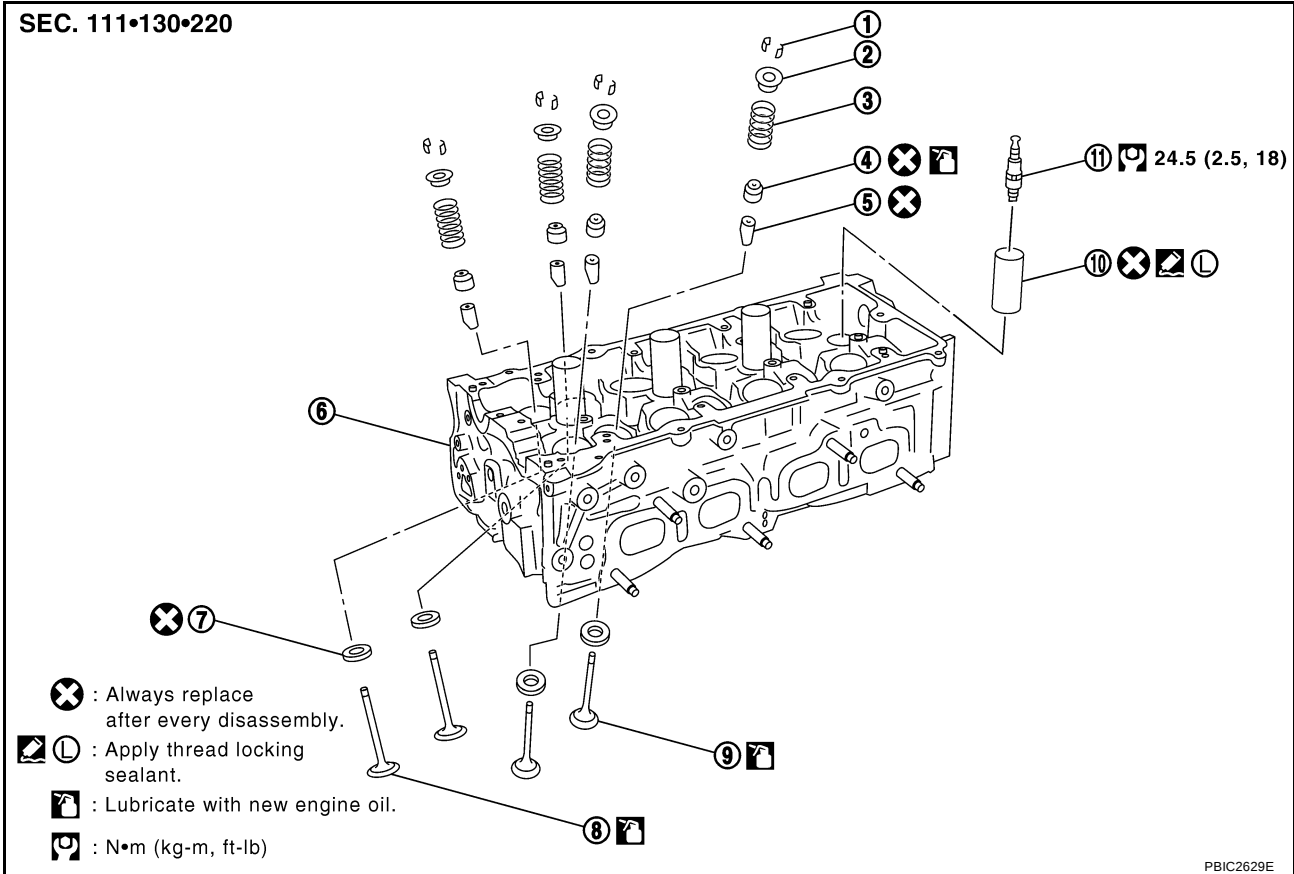
L

M

Disassembly and Assembly

BBS0059D

SEC. 111•130•220



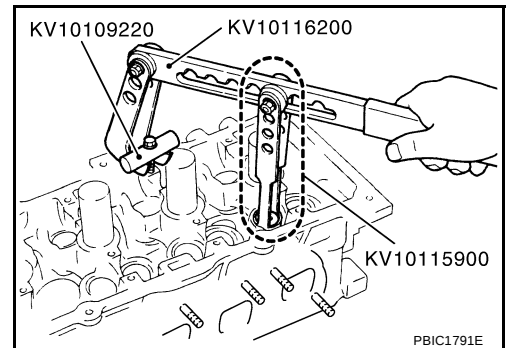
- | | | |
|---------------------|--------------------------|--|
| 1. Valve collet | 2. Valve spring retainer | 3. Valve spring (with valve spring seat) |
| 4. Valve oil seal | 5. Valve guide | 6. Cylinder head |
| 7. Valve seat | 8. Valve (INT) | 9. Valve (EXH) |
| 10. Spark plug tube | 11. Spark plug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

DISASSEMBLY

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

CAUTION:

When working, be careful not to damage valve lifter holes.



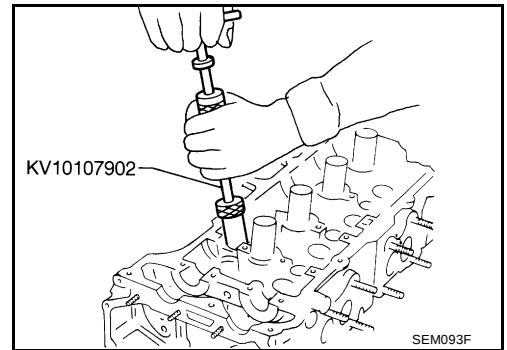
- Remove valve spring retainer and valve spring (with valve spring seat).

CAUTION:

Do not remove valve spring seat from valve spring.

- Push valve stem to combustion chamber side, and remove valve.
 - Identify installation positions, and store them without mixing them up.

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



7. When valve seat must be replaced, refer to [EM-75, "VALVE SEAT REPLACEMENT"](#) to removal.
8. When valve guide must be replaced, refer to [EM-73, "VALVE GUIDE REPLACEMENT"](#) to removal.
9. Remove spark plug tube, if necessary.
 - Using pliers, remove it from cylinder head.

CAUTION:

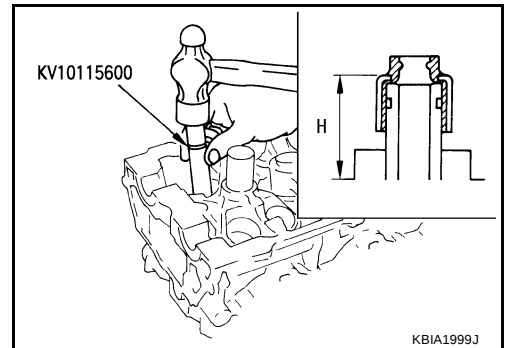
 - Be careful not to damage cylinder head.
 - Do not remove spark plug tube if not necessary. Once removed, spark plug tube cannot be reused because of deformation.

ASSEMBLY

1. Install valve guide if removed. Refer to [EM-73, "VALVE GUIDE REPLACEMENT"](#) .
2. Install valve seat if removed. Refer to [EM-75, "VALVE SEAT REPLACEMENT"](#) .
3. Install valve oil seal.

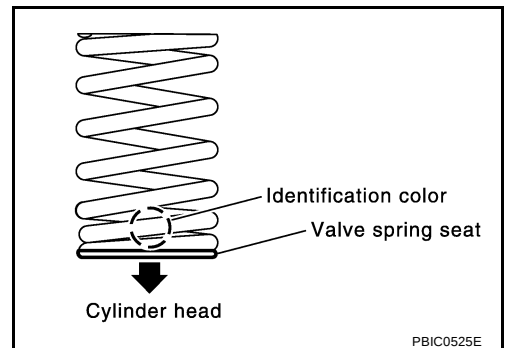
- Install with valve oil seal drift (SST) to match dimension in the figure.

Height "H" : 11.8 - 12.4 mm (0.465 - 0.488 in)



4. Install valve.
 - Install larger diameter to intake side.
5. Install valve spring (with valve spring seat).
 - Install smaller pitch (valve spring seat side) to cylinder head side.
 - Confirm identification color of valve spring.

Intake : Blue
Exhaust : Yellow



6. Install valve spring retainer.
7. Install valve collet.

CYLINDER HEAD

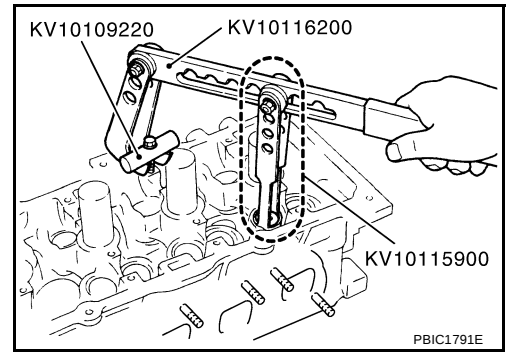
[QR]

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

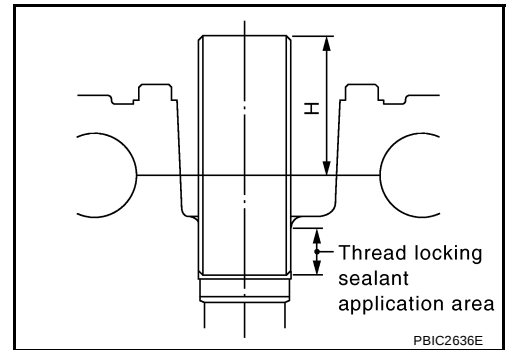
CAUTION:

When working, be careful not to damage valve lifter holes.

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



8. Install valve lifter.
 - Install it in the original position.
9. Install spark plug tube if removed.
 - Press-fit it into cylinder head with the following procedure:
 - a. Remove old liquid gasket from cylinder head side installation hole.
 - b. Apply sealant all round on spark plug tube within approximately 12 mm (0.47 in) width from edge of spark plug tube on the press-fit side.
Use Thread Locking Sealant or equivalent.
 - c. Using drift, press-fit spark plug tube so that height is as same as "H" shown in the figure.



Standard press-fit height "H"

: 41.2 - 42.2 mm (1.622 - 1.661 in)

CAUTION:

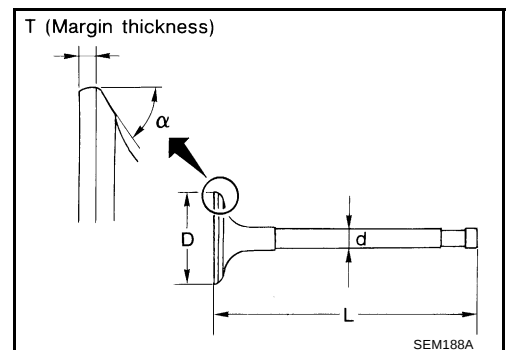
- When press-fitting, be careful not to deform spark plug tube.
- After press-fitting, wipe off any protruding thread locking sealant on top surface of cylinder head.

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

Inspection After Disassembly VALVE DIMENSIONS

BBS0059E

- Check dimensions of each valve. For dimensions, refer to [EM-109, "Valve Dimensions"](#).
- If dimensions are out of the standard, replace valve.



VALVE GUIDE CLEARANCE

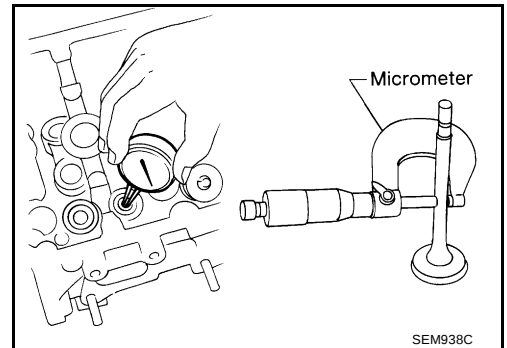
Valve Stem Diameter

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 bore gauge.

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)

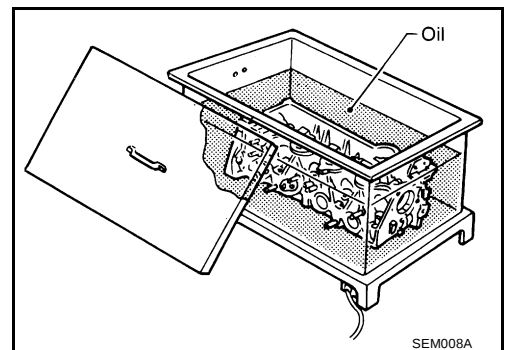
Exhaust : 0.09 mm (0.004 in)

- If it exceeds the limit, replace valve guide and/or valve. When valve guide must be replaced, refer to [EM-73, "VALVE GUIDE REPLACEMENT"](#).

VALVE GUIDE REPLACEMENT

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

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



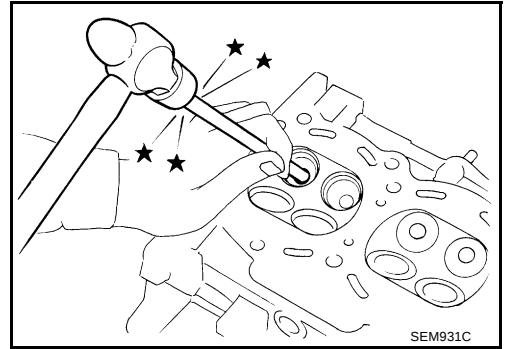
CYLINDER HEAD

[QR]

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

CAUTION:

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

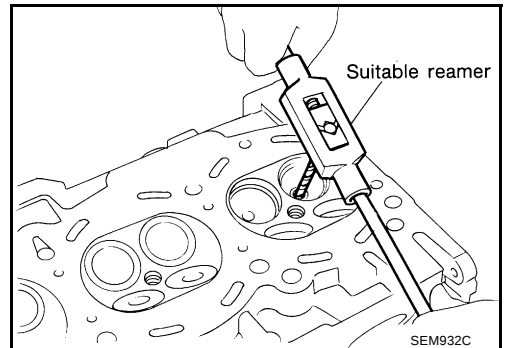


3. Ream cylinder head valve guide hole with valve guide reamer (commercial service tool).

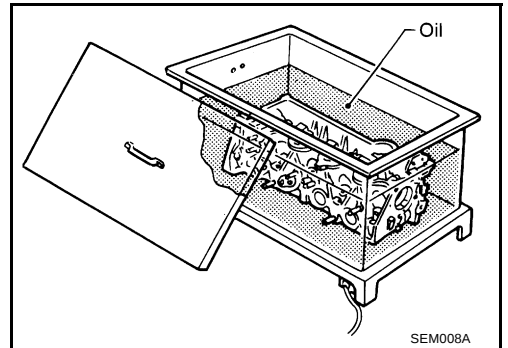
Valve guide hole diameter (for service parts):

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 dimensions as shown in the figure.

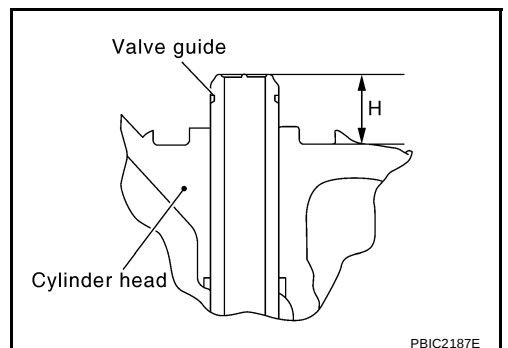
Projection "H":

Intake : 10.1 - 10.3 mm (0.398 - 0.406 in)

Exhaust : 10.0 - 10.4 mm (0.394 - 0.409 in)

CAUTION:

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



CYLINDER HEAD

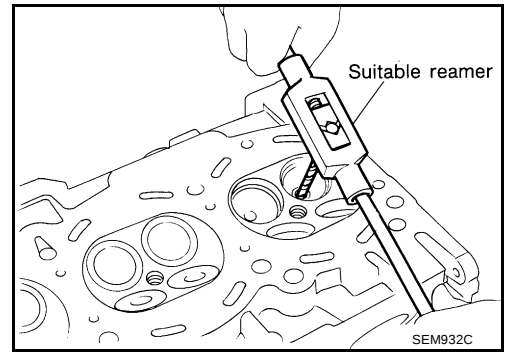
[QR]

6. Apply reamer finish to valve guide with valve guide reamer (commercial service tool).

Standard

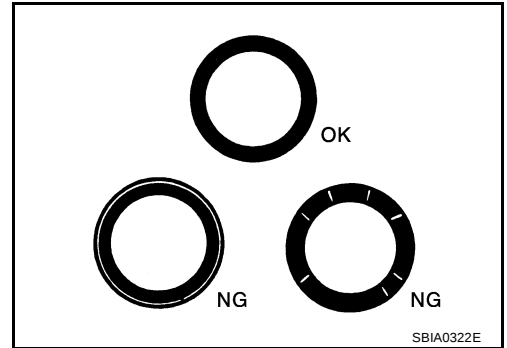
Intake and exhaust

: 6.000 - 6.018 mm (0.2362 - 0.2369 in)



VALVE SEAT CONTACT

- After confirming that the dimensions of valve guides and valves are within specifications, perform this procedure.
- Apply prussian blue (or white lead) onto contacting surface of valve seat to check the condition of the valve contact on the surface.
- Check if the contact area band is continuous all around the circumference.
- If not, grind to adjust valve fitting and check again. If the contacting surface still has NG conditions even after the re-check, replace valve seat. Refer to [EM-75. "VALVE SEAT REPLACEMENT"](#).



VALVE SEAT REPLACEMENT

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

1. Bore out old seat until it collapses. Boring should not continue beyond the bottom face of the seat recess in cylinder head. Set the machine depth stop to ensure this. Refer to [EM-112. "Valve Seat"](#).

CAUTION:

Prevent to scratch cylinder head by excessive boring.

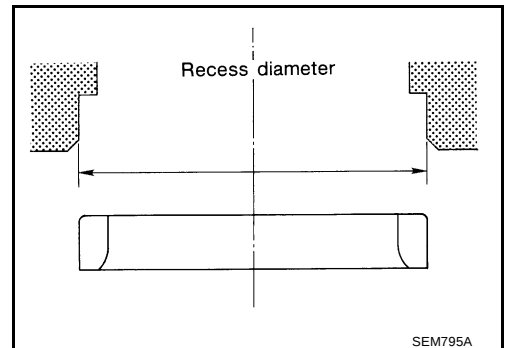
2. Ream cylinder head recess diameter for service valve seat.

Oversize [0.5 mm (0.020 in)]

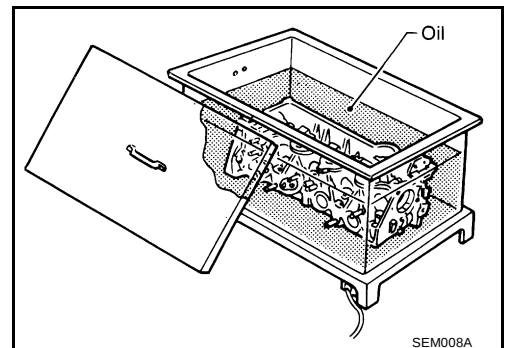
Intake : 37.000 - 37.016 mm (1.4567 - 1.4573 in)

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

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



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



4. Provide valve seat cooled well with dry ice. Press-fit valve seat into cylinder head.

CAUTION:

- Avoid directly touching cold valve seats.

CYLINDER HEAD

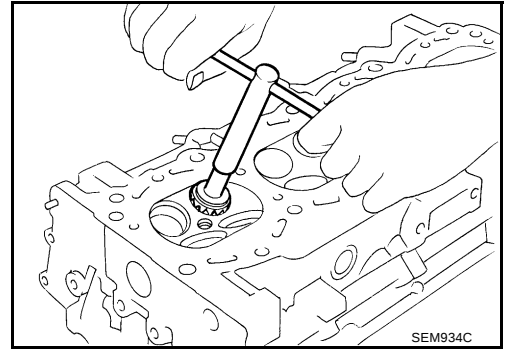
[QR]

- 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 valve seat to the specified dimensions. For dimensions, refer to [EM-112, "Valve Seat"](#) .

CAUTION:

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



6. Using compound, grind to adjust valve fitting.

7. Check again for normal contact. Refer to [EM-75, "VALVE SEAT CONTACT"](#) .

VALVE SPRING SQUARENESS

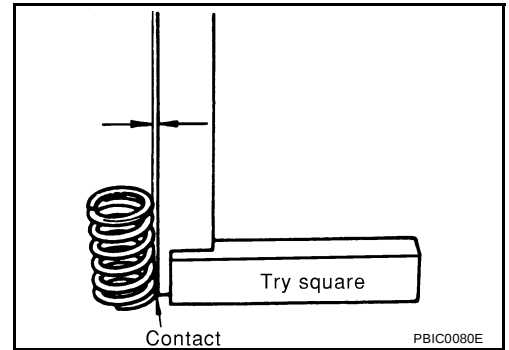
- Set try square along the side of valve spring and rotate spring. Measure the maximum clearance between the top face of spring and try square.

CAUTION:

Do not remove valve spring seat from valve spring.

Limit : 1.9 mm (0.075 in)

- If it exceeds the limit, replace valve spring (with valve spring seat).

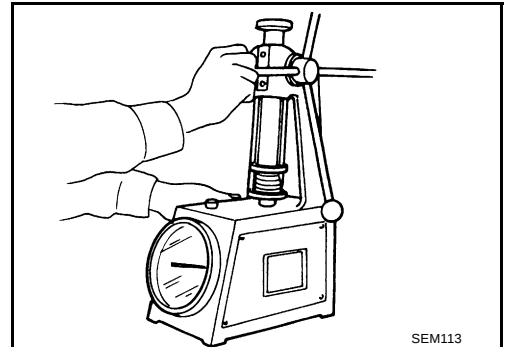


VALVE SPRING DIMENSIONS AND VALVE SPRING PRESSURE LOAD

- Check valve spring each load at specified spring height.

CAUTION:

Do not remove valve spring seat from valve spring.



Standard:

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

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

ENGINE ASSEMBLY

PFP:10001

Removal and Installation

BBS0059F

A

EM

C

D

E

F

G

H

I

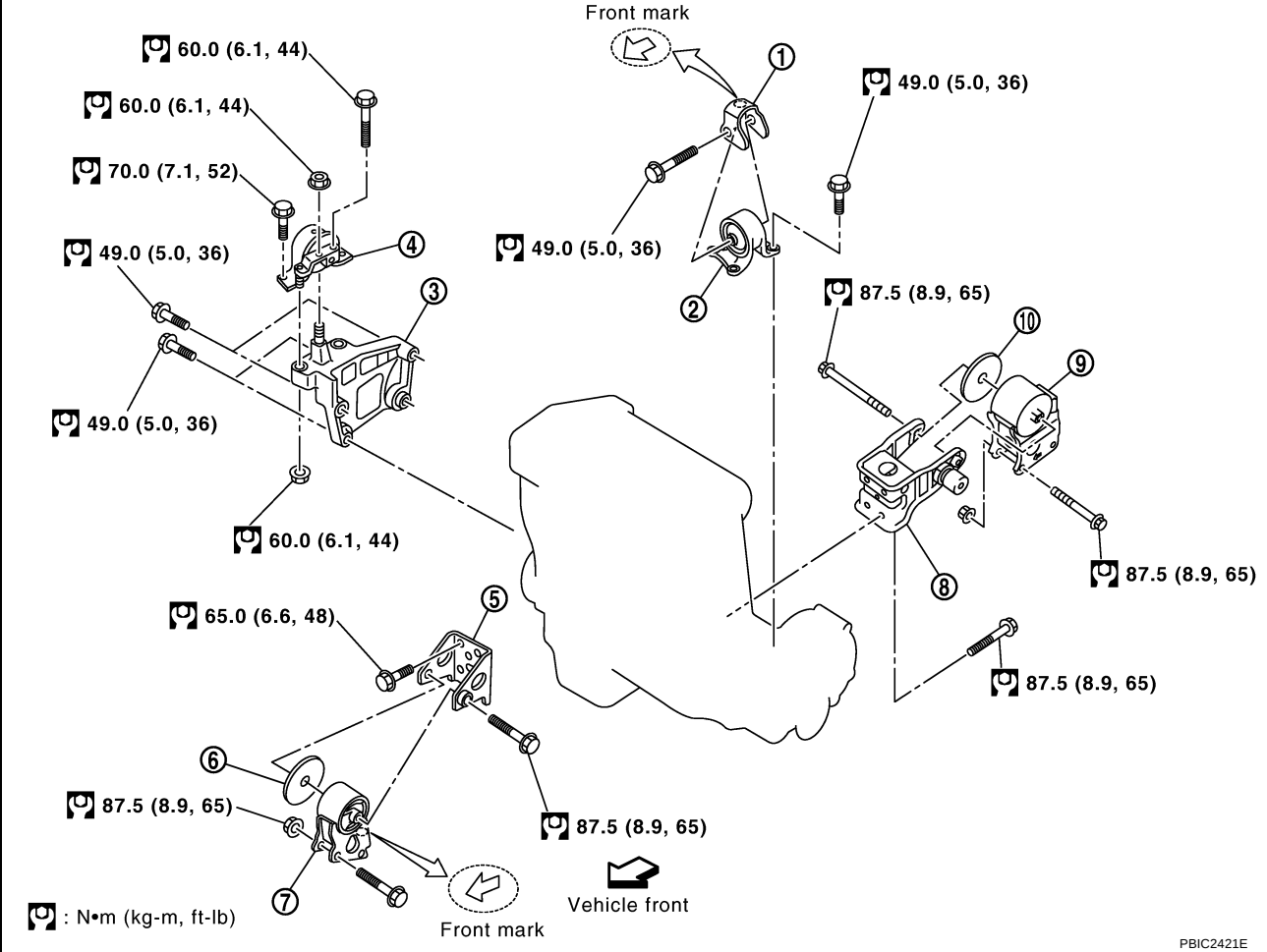
J

K

L

M

SEC. 112



PBIC2421E

- | | | |
|------------------------------------|----------------------------------|-----------------------------------|
| 1. Stopper | 2. LH engine mounting insulator | 3. RH engine mounting bracket |
| 4. RH engine mounting insulator | 5. Front engine mounting bracket | 6. Stopper |
| 7. Front engine mounting insulator | 8. Rear engine mounting bracket | 9. Rear engine mounting insulator |
| 10. Stopper | | |

WARNING:

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

CAUTION:

- Always be careful to work safely, avoid forceful or uninstructed operations.
- Do not start working until exhaust system and engine coolant are cool enough.
- If items or work required are not covered by the engine section, refer to the applicable sections.
- Always use the support point specified for lifting.
- Use either 2-pole lift type or separate type lift as best you can. If board-on type is used for unavoidable reasons, support at the rear axle jacking point with transmission jack or similar tool before starting work, in preparation for the backward shift of center of gravity.
- For supporting points for lifting and jacking point at rear axle, refer to [GI-37, "Garage Jack and Safety Stand and 2-Pole Lift"](#) .

REMOVAL

Outline

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

Preparation

1. Release fuel pressure. Refer to [EC-49, "FUEL PRESSURE RELEASE"](#) .
2. Drain engine coolant from radiator. Refer to [CO-10, "Changing Engine Coolant"](#) .

CAUTION:

- Perform this step when engine is cold.
 - Do not spill engine coolant on drive belt.
3. Remove the following parts.
 - Hood assembly; Refer to [BL-13, "HOOD"](#) .
 - Undercover and splash guards (RH and LH)
 - Front road wheels and tires
 - Battery, battery tray and battery tray bracket; Refer to [SC-4, "BATTERY"](#) .
 - Drive belt; Refer to [EM-14, "DRIVE BELTS"](#) .
 - Air duct (inlet); Refer to [EM-17, "AIR CLEANER AND AIR DUCT"](#) .
 - Air cleaner case (upper) with mass air flow sensor and air duct assembly; Refer to [EM-17, "AIR CLEANER AND AIR DUCT"](#) .
 - Alternator and alternator bracket; Refer to [SC-27, "CHARGING SYSTEM"](#) .
 - Radiator and radiator cooling fan assembly, reservoir tank of radiator and system hoses; Refer to [CO-13, "RADIATOR"](#) .
 4. Disconnect engine room harness connector from ECM side and set it aside for easier work.
 5. Disconnect all vacuum hoses and air hoses connected to vehicle side at engine side.

Engine Room LH

1. Disconnect heater hose, and install plug it to prevent engine coolant from draining. Refer to [CO-24, "THERMOSTAT AND WATER CONTROL VALVE"](#) .
2. Disconnect fuel feed hose, and plug it to prevent fuel from draining. Refer to [EM-34, "FUEL INJECTOR AND FUEL TUBE"](#) .
3. Disconnect control cable from transaxle. Refer to [AT-213, "SHIFT CONTROL SYSTEM"](#) .
4. Disconnect B terminal harness of starter motor. Refer to [SC-14, "STARTING SYSTEM"](#) .

Engine Room RH

1. Remove IPDM E/R and bracket. Refer to [PG-17, "IPDM E/R \(INTELLIGENT POWER DISTRIBUTION MODULE ENGINE ROOM\)"](#) .
2. Remove A/C compressor with piping connected from engine. Temporarily secure it on vehicle side with a rope to avoid putting load on it. Refer to [ATC-134, "Removal and Installation of Compressor"](#) .
3. Remove reservoir tank of power steering oil pump. Temporarily secure it on engine side with a rope. Refer to [PS-39, "HYDRAULIC LINE"](#) .

Vehicle Underbody

1. Remove RH and LH front drive shafts. Refer to [FAX-8, "FRONT DRIVE SHAFT"](#) .
2. Remove exhaust front tube. Refer to [EX-2, "EXHAUST SYSTEM"](#) .
3. Remove rear plate cover from oil pan (upper). Then remove bolts fixing drive plate to torque converter. Refer to [EM-26, "OIL PAN AND OIL STRAINER"](#) and [AT-241, "TRANSAXLE ASSEMBLY"](#) .
4. Remove transaxle joint bolts which pierce at oil pan (upper) lower rear side. Refer to [AT-241, "TRANSAXLE ASSEMBLY"](#) .
5. Disconnect connecting rod for front stabilizer. Refer to [FSU-5, "FRONT SUSPENSION ASSEMBLY"](#) .
6. Remove steering lower joint from steering gear. Refer to [PS-12, "STEERING COLUMN"](#) .
7. Remove power steering fluid piping from front suspension member. Refer to [PS-39, "HYDRAULIC LINE"](#) .
8. Disconnect power steering fluid piping at a point between vehicle and engine, and install plug it to prevent power steering fluid. Refer to [PS-39, "HYDRAULIC LINE"](#) .

Removal

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

- Use alternator bracket mounting bolt holes for the front side.

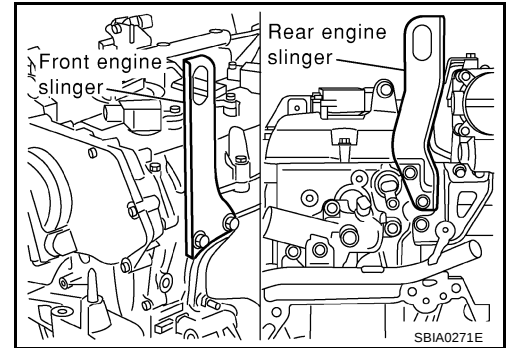
Slinger bolts:

Front

 : 57.9 N·m (5.9 kg-m, 43 ft-lb)

Rear

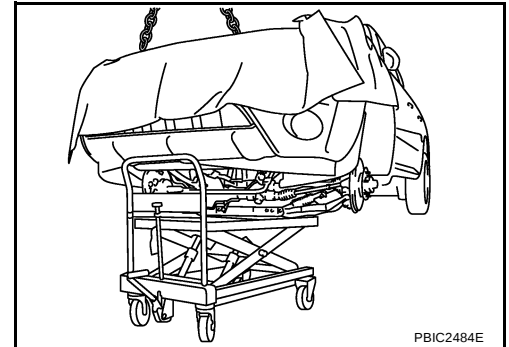
 : 28.0 N·m (2.9 kg-m, 21 ft-lb)



2. Lift with hoist and secure engine in position.
3. Use manual lift table caddy (commercial service tool) or equivalently rigid tool such as transmission jack. Securely support bottom of front suspension member, and simultaneously adjust hoist tension.

CAUTION:

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



4. Separate RH engine mounting insulator and RH engine mounting bracket.
5. Pull LH engine mounting through-bolt out.
6. Remove front suspension member mounting nuts and bolts. Refer to [FSU-5, "FRONT SUSPENSION ASSEMBLY"](#) .
7. Remove engine and transaxle assembly with front suspension member from vehicle downward by carefully operating supporting tools.

CAUTION:

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

8. Remove power steering oil pump with piping connected from engine. Refer to [PS-29, "POWER STEERING OIL PUMP"](#) .
9. Remove front engine mounting and rear engine mounting through-bolts to remove front suspension member.
10. Remove starter motor. Refer to [SC-14, "STARTING SYSTEM"](#) .
11. Remove each engine mounting insulator and each engine mounting bracket from engine, transaxle and front suspension member.
12. Separate engine and transaxle. Refer to [AT-241, "TRANSAXLE ASSEMBLY"](#) .

INSTALLATION

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

- Do not allow engine oil to get on engine mounting insulator. Be careful not to damage engine mounting insulator.
- When installation directions are specified, install parts according to the direction marks on them referring to the figure of components. Refer to [EM-77, "Removal and Installation"](#) .
- Make sure that each engine mounting insulator is seated properly, and tighten mounting nuts and bolts.

INSPECTION AFTER INSTALLATION

Inspection for Leaks

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

- Before starting engine, check oil/fluid levels including engine coolant and engine oil. If less than required quantity, fill to the specified level. Refer to [MA-14, "RECOMMENDED FLUIDS AND LUBRICANTS"](#) .
- Use procedure below to check for fuel leakage.
 - Turn ignition switch “ON” (with engine stopped). With fuel pressure applied to fuel piping, check for fuel leakage at connection points.
 - Start engine. With engine speed increased, check again for fuel leakage at connection points.
- Run engine to check for unusual noise and vibration.
- Warm up engine thoroughly to make sure there is no leakage of fuel, exhaust gases, or any oil/fluids including engine oil and engine coolant.
- Bleed air from lines and hoses of applicable lines, such as in cooling system.
- After cooling down engine, again check oil/fluid levels including engine oil and engine coolant. 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
Other oils and fluid*	Level	Leakage	Level
Fuel	Leakage	Leakage	Leakage
Exhaust gases	—	Leakage	—

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

CYLINDER BLOCK

Disassembly and Assembly

A

EM

C

D

E

F

G

H

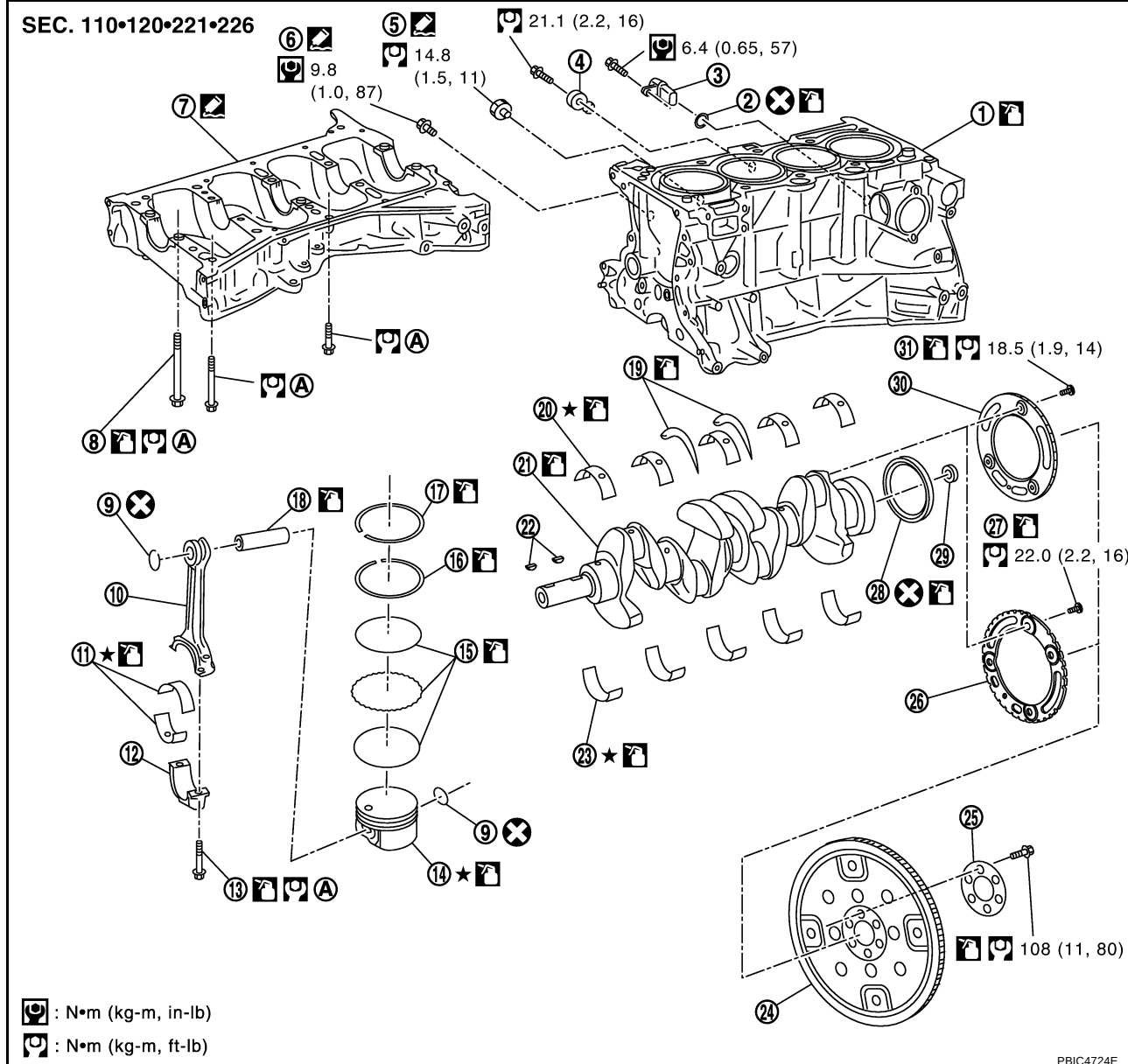
I

J

K

L

M



- | | | |
|---|------------------------------|---|
| 1. Cylinder block | 2. O-ring | 3. Crankshaft position sensor (POS) |
| 4. Knock sensor | 5. Oil pressure switch | 6. Water drain plug |
| 7. Lower cylinder block | 8. Lower cylinder block bolt | 9. Snap ring |
| 10. Connecting rod | 11. Connecting rod bearing | 12. Connecting rod bearing cap |
| 13. Connecting rod bolt | 14. Piston | 15. Oil ring |
| 16. Second ring | 17. Top ring | 18. Piston pin |
| 19. Thrust bearing | 20. Main bearing (upper) | 21. Crankshaft |
| 22. Crankshaft key | 23. Main bearing (lower) | 24. Drive plate |
| 25. Reinforcement plate | 26. Signal plate (type 1) | 27. Signal plate mounting bolt (type 1) |
| 28. Rear oil seal | 29. Pilot convertor | 30. Signal plate (type 2) |
| 31. Signal plate mounting bolt (type 2) | | |

A. Refer to [EM-86](#)

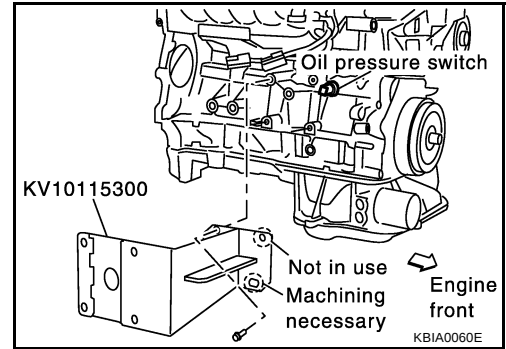
- Refer to [GI-10, "Components"](#) for symbol marks in the figure.

NOTE:

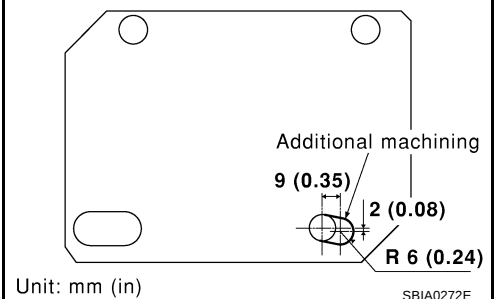
There exist different signal plates because of concurrent settings. Consequently, there are two kinds of crank shafts and signal plate bolts.

DISASSEMBLY

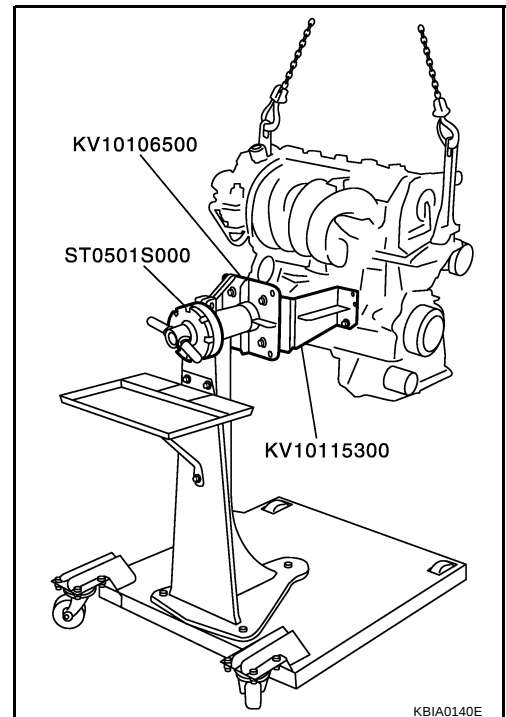
1. Remove engine and transaxle assembly from vehicle, and separate transaxle from engine. Refer to [EM-77, "ENGINE ASSEMBLY"](#) .
2. Mount engine on engine stand [SST: ST0501S000] with the following procedure:
 - a. Remove oil pressure switch on right side of cylinder block. Refer to [LU-7, "OIL PRESSURE CHECK"](#) .
 - b. Remove rear engine mounting bracket. Refer to [EM-77, "ENGINE ASSEMBLY"](#) .
 - c. Install engine sub-attachment (SST) and engine stand shaft [SST: KV10106500] to right side of cylinder block.
 - Do not use bolt hole at the upper right looking from bolt insertion side as shown in the figure.



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

[Viewd from the bolt insertion side]

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



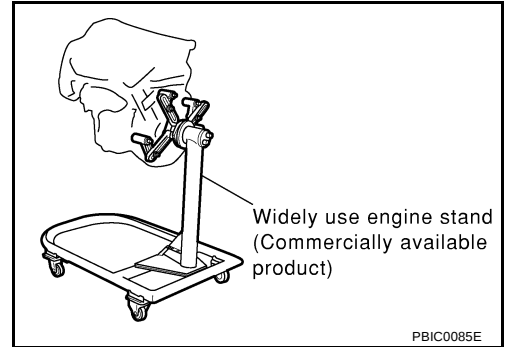
- A widely use engine stand can be used.

CAUTION:

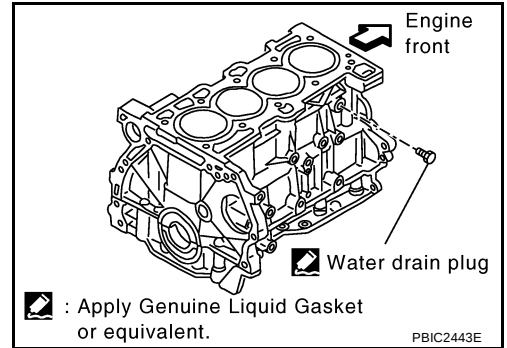
Use engine stand that has a load capacity [approximately 150 kg (331 lb) or more] large enough for supporting the engine weight.

NOTE:

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



3. Drain engine oil. Refer to [LU-9, "Changing Engine Oil"](#) .
4. Drain engine coolant by removing water drain plug from inside of engine.



5. Remove cylinder head. Refer to [EM-65, "CYLINDER HEAD"](#) .
6. Remove knock sensor.

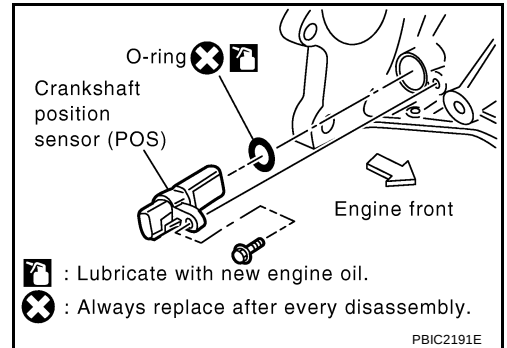
CAUTION:

Carefully handle knock sensor avoiding shocks.

7. Remove crankshaft position sensor (POS).

CAUTION:

- Avoid impacts such as a dropping.
- Do not disassemble.
- Keep it away from metal particles.
- Do not place sensor in a location where it is exposed to magnetism.



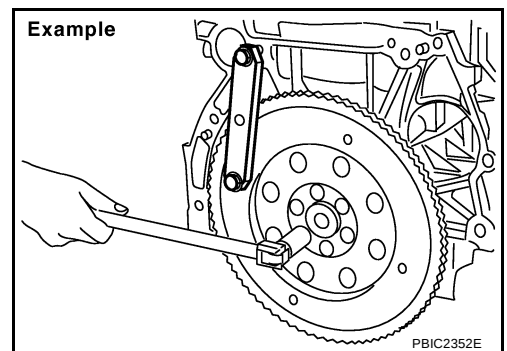
8. Remove drive plate.
 - Secure drive plate with stopper plate, and remove mounting bolts.

NOTE:

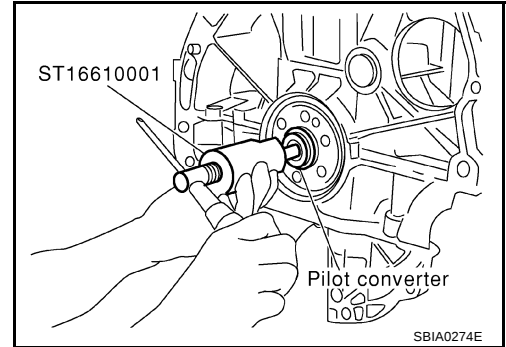
Use TORX socket (size E20).

CAUTION:

Be careful not to damage or scratch drive plate.



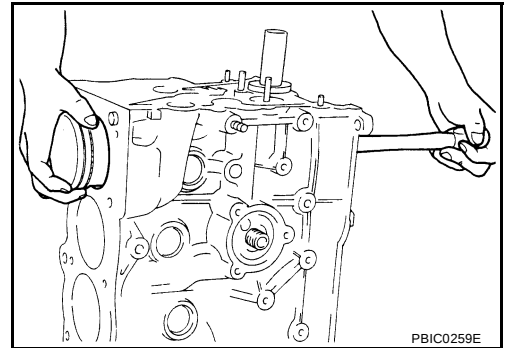
9. Remove pilot converter using pilot bushing puller (SST) or suitable tool.



10. 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-99, "CONNECTING ROD SIDE CLEARANCE"](#).
 - a. Position crankshaft pin corresponding to connecting rod to be removed onto the bottom dead center.
 - b. Remove connecting rod 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.



11. Remove connecting rod bearings.

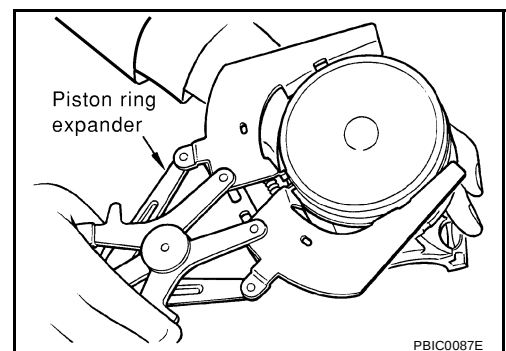
CAUTION:

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

12. Remove piston rings from piston.
 - Before removing piston rings, check the piston ring side clearance. Refer to [EM-100, "PISTON RING SIDE CLEARANCE"](#).
 - Use piston ring expander (commercial service tool).

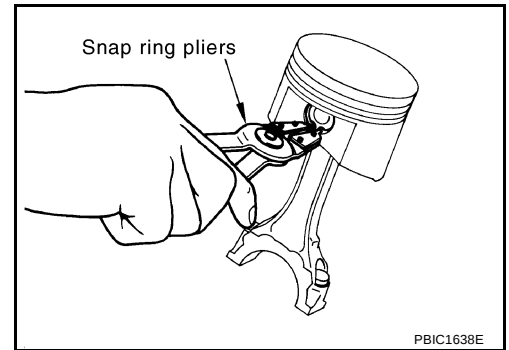
CAUTION:

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

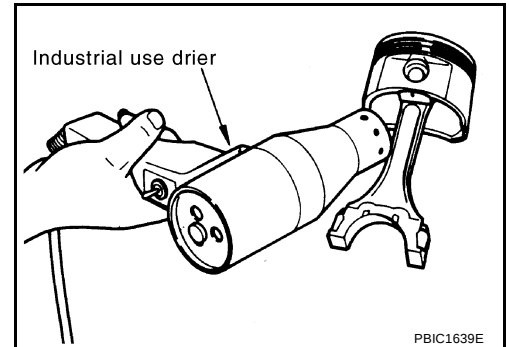


13. Remove piston from connecting rod with the following procedure:

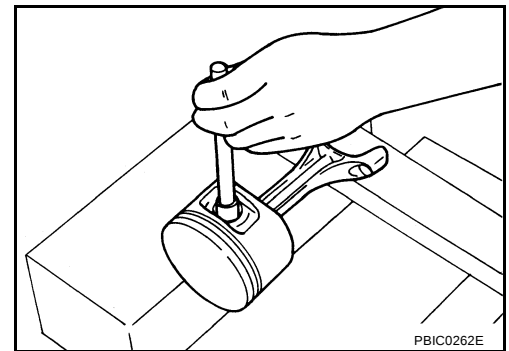
- a. Using snap ring pliers, remove snap ring.



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



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

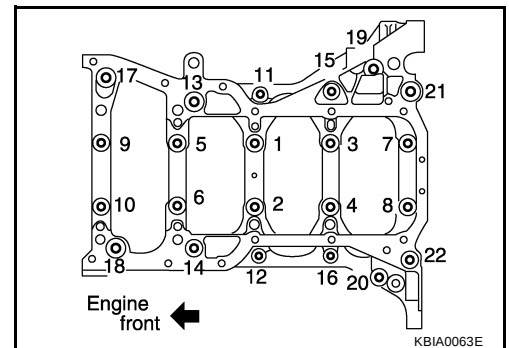


14. Remove lower cylinder block mounting bolts.

- Before loosening lower cylinder block mounting bolts, measure crankshaft end play. Refer to [EM-99, "CRANKSHAFT END PLAY"](#).
- Loosen them in reverse order as shown in the figure, and remove them.

NOTE:

Use TORX socket (size E14) for bolts No. 1 to 10.



15. Remove lower cylinder block.

- Use seal cutter [SST: KV10111100] or equivalent tool to cut liquid gasket for removal.

CAUTION:

Be careful not to damage the mating surfaces.

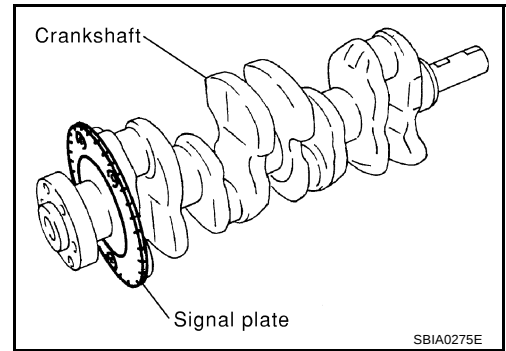
16. Remove crankshaft.

CAUTION:

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

NOTE:

When removing or installing signal plate, use TORX socket (size T30).



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

CAUTION:

Be careful not to damage crankshaft.

NOTE:

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

18. Remove main bearings and thrust bearings from cylinder block and lower cylinder block.

CAUTION:

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

ASSEMBLY

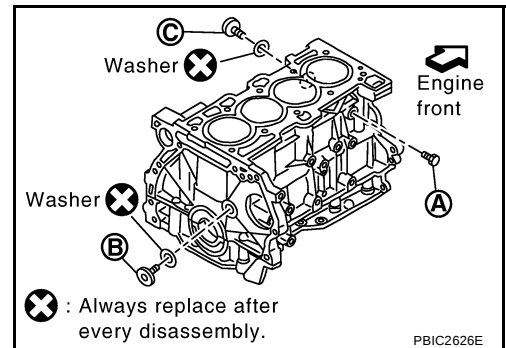
1. Fully air-blow engine coolant and engine oil passages in cylinder block, cylinder bore and crankcase to remove any foreign material.

CAUTION:

Use a goggles to protect your eye.

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

- Apply liquid gasket to the thread of water drain plug "A".
Use Genuine Liquid Gasket or equivalent.
- Apply liquid gasket to the thread of plug "C".
Use Anaerobic Liquid Gasket or equivalent.
- Tighten each plug as specified below.

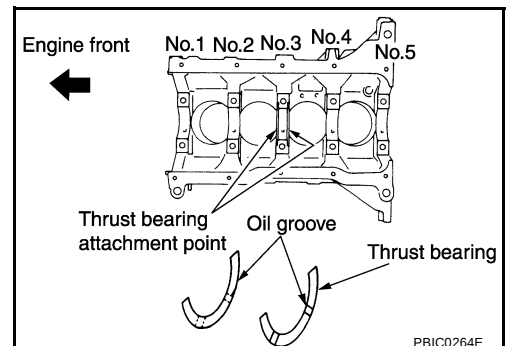


Part	Washer	Tightening torque
A	No	9.8 N·m (1.0 kg-m, 87 in-lb)
B	Yes	53.9 N·m (5.5 kg-m, 40 ft-lb)
C	Yes	62.8 N·m (6.4 kg-m, 46 ft-lb)

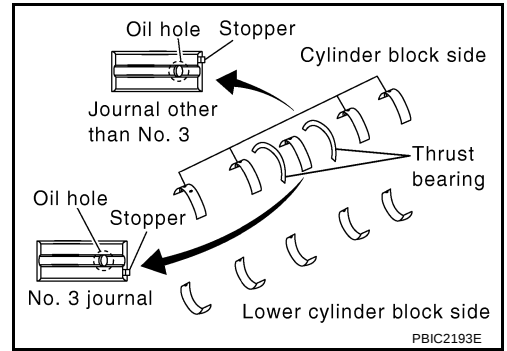
NOTE:

Do not apply liquid gasket to the thread of plug "B".

3. Install main bearings and thrust bearings with the following procedure:
- Remove dust, dirt, and engine oil on the bearing mating surfaces of cylinder block and lower cylinder block.
 - Install thrust bearings to the both sides of the No. 3 journal housing on cylinder block.
 - Install thrust bearings with the oil groove facing crankshaft arm (outside).



- c. Install main bearings paying attention to the direction.
 - Main bearing with an oil hole and groove goes on cylinder block. The one without them goes on lower cylinder block.
 - Only main bearing (on cylinder block) for No. 3 journal has different specifications.
 - Before installing main bearings, apply new 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 to the notch.
 - Ensure the oil holes on cylinder block and those on the corresponding bearing are aligned.



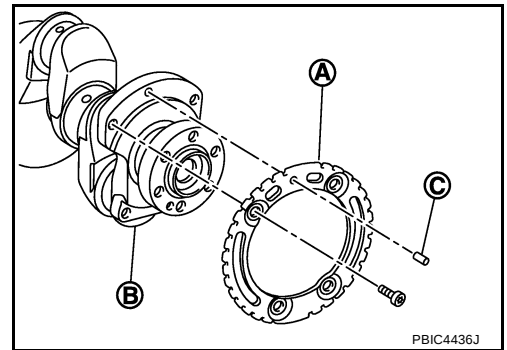
4. Install signal plate to crankshaft if removed.

- A : Signal plate
- B : Crank shaft
- C : Dowel pin (used to position the signal plate)

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

NOTE:

- Dowel pin of crankshaft and signal plate is provided as a set for each. If dowel pin is not available (when reusing crankshaft and signal plate), use M6 bolt [length 10 mm (0.39 in) or more] as a substitute.



- Figure shows an example of type 1.

- b. Remove dowel pin.

CAUTION:

Be sure to remove dowel pin.

5. Install crankshaft to cylinder block.

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

CAUTION:

Do not install rear oil seal yet.

6. Inspect outer diameter of lower cylinder block mounting bolts. Refer to [EM-107, "LOWER CYLINDER BLOCK MOUNTING BOLT OUTER DIAMETER"](#).

7. Install lower cylinder block with the following procedure:

- a. Apply liquid gasket with tube presser [SST: WS39930000] to lower cylinder block as shown in the figure.

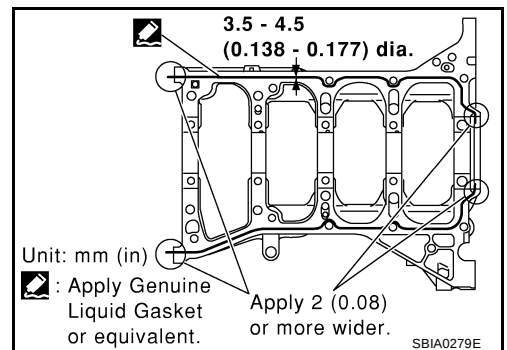
Use Genuine Liquid Gasket or equivalent.

CAUTION:

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

NOTE:

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



- b. Tighten lower cylinder block mounting bolts with the following procedure:
 - i. Apply new engine oil to threads and seat surfaces of mounting bolts.

- ii. Tighten M8 bolts in numerical order from No. 11 to 22 in the figure.

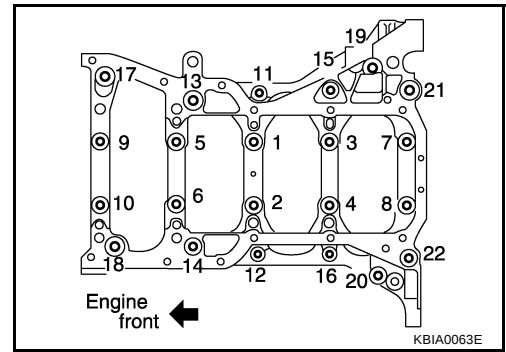
 : 25.1 N·m (2.6 kg-m, 19 ft-lb)

CAUTION:

Wipe off completely any protruding liquid gasket on rear oil seal installation surface.

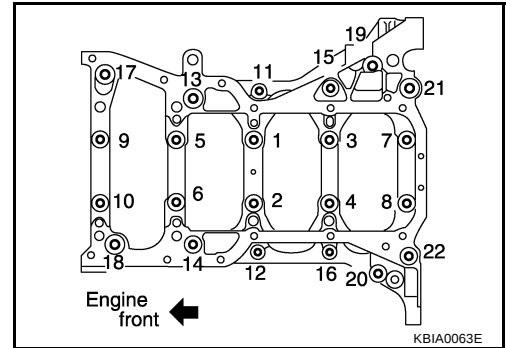
NOTE:

There are more processes to complete the tightening of mounting bolts. However stop procedure here to install rear oil seal.



- c. Install rear oil seal. Refer to [EM-64, "Removal and Installation of Rear Oil Seal"](#) .
- d. Restart tightening of lower cylinder block bolts with the following procedure:
- i. Tighten M10 bolts in numerical order from No. 1 to 10 in the figure.

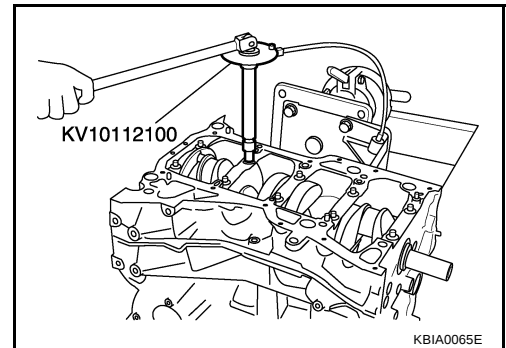
 : 39.2 N·m (4.0 kg-m, 29 ft-lb)



- ii. Turn M10 bolts 60 degrees clockwise (angle tightening) in numerical order from No. 1 to 10 in the figure.

CAUTION:

Check and confirm the tightening angle by using angle wrench (SST) or protractor. Avoid judgment by visual inspection without the tool.

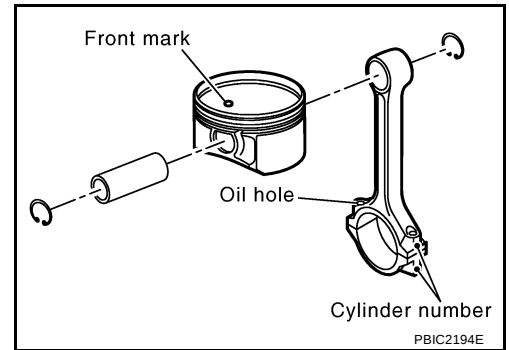


- After installing mounting bolts, make sure that crankshaft can be rotated smoothly by hand.
 - Wipe off completely any protruding liquid gasket on front side of engine.
 - Check crankshaft end play. Refer to [EM-99, "CRANKSHAFT END PLAY"](#) .
8. Install piston to connecting rod with the following procedure:
- Using snap ring pliers, install new snap ring to the groove of the piston rear side.
 - Insert it fully into groove to install.
 - Assemble piston to connecting rod.
 - Using industrial drier or similar tool, heat the piston until the piston pin can be pushed in by hand without excess force [approximately 60 to 70 °C (140 to 158 °F)]. From the front to the rear, insert piston pin into piston and connecting rod.

CYLINDER BLOCK

[QR]

- Assemble so that the front mark on the piston head and the oil holes 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.



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

CAUTION:

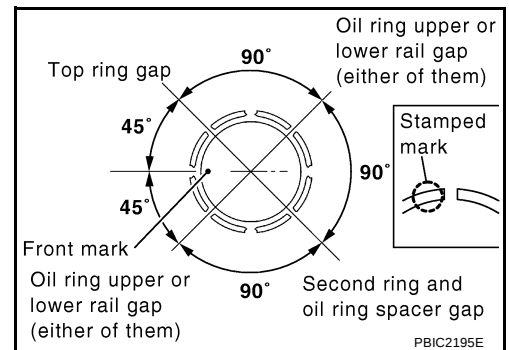
- Be careful not to damage piston.
- Be careful not to damage piston rings by expanding them excessively.
- Position each ring with the gap as shown in the figure referring to the piston front mark.
- Install second ring with the stamped surface facing upward.

Stamped mark:

Top ring : —
Second ring : 2F

NOTE:

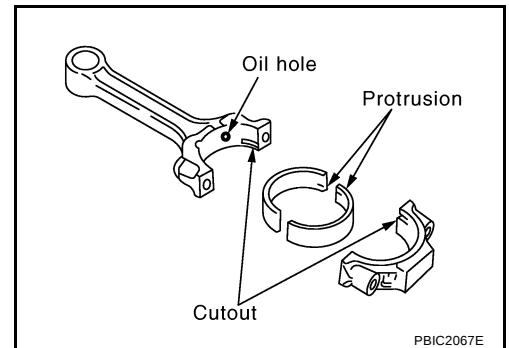
If there is no stamped mark on piston ring, no specific orientation is required for installation.



10. Inspect outer diameter of connecting rod bolts. Refer to [EM-107, "CONNECTING ROD BOLT OUTER DIAMETER"](#) .

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

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



12. Install piston and connecting rod assembly to crankshaft.

- Position crankshaft pin corresponding to connecting rod to be installed onto the bottom dead center.
- Apply new 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.

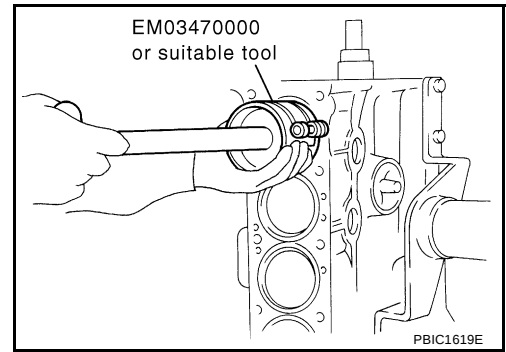
CYLINDER BLOCK

[QR]

- Using piston ring compressor (SST) or suitable tool, install piston with the front mark on the piston head facing the front of the engine.

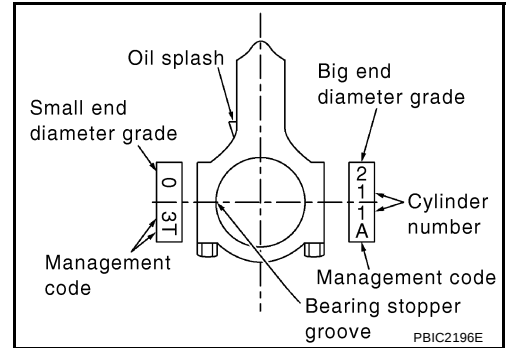
CAUTION:

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



13. Install connecting rod cap.

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



14. Tighten connecting rod bolts with the following procedure:

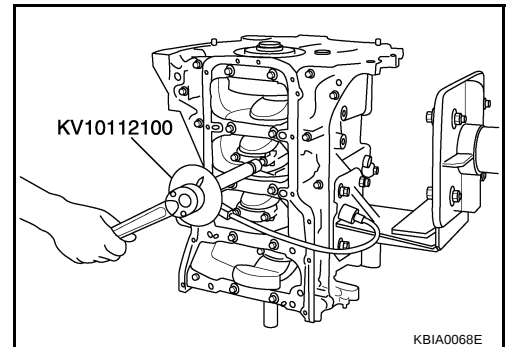
- Apply new engine oil to the threads and seats of connecting rod bolts.
- Tighten bolts.

 : 19.6 N·m (2.0 kg-m, 14 ft-lb)

- Then turn all bolts 90 degrees clockwise (Angle tightening).

CAUTION:

Check and confirm the tightening angle by using angle wrench (SST) or protractor. Avoid judgement by visual inspection without the tool.



- After tightening connecting rod bolts, make sure that crankshaft rotates smoothly.
- Check the connecting rod side clearance. Refer to [EM-99, "CONNECTING ROD SIDE CLEARANCE"](#) .

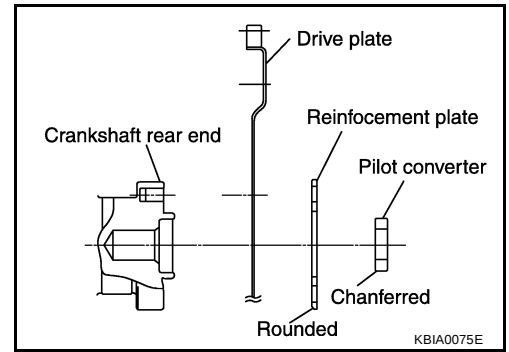
15. Install drive plate.

- Secure drive plate with stopper plate, and tighten mounting bolts crosswise over several times.

CYLINDER BLOCK

[QR]

- Install drive plate, reinforcement plate and pilot converter as shown in the figure.
- Using drift of 33 mm (1.30 in) in diameter, press-fit pilot converter into the end of crankshaft until it stops.



16. Install knock sensor.

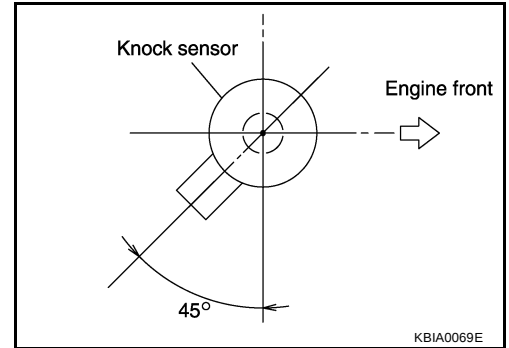
- Install knock sensor with connector facing lower left by 45 degrees as shown in the figure.

CAUTION:

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

NOTE:

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



17. Install crankshaft position sensor (POS).

18. Assemble in the reverse order of disassembly after this step.

How to Select Piston and Bearing

BBS0059H

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 an assembly.)	Piston grade (piston skirt diameter)	Piston grade = cylinder bore grade (inner diameter of bore)
Between piston and connecting rod*	—	—	—

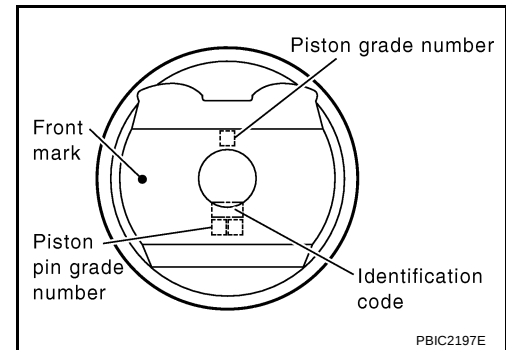
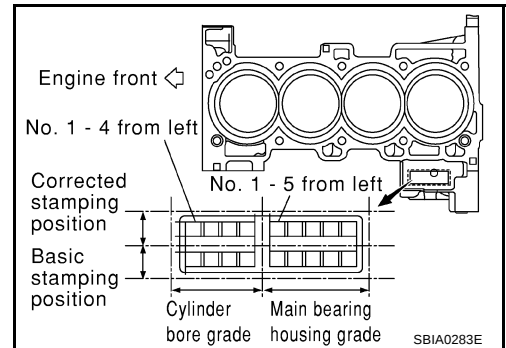
*For the service parts, the grade for fitting cannot be selected between piston pin and connecting rod. (Only grade "0" is available.) The information at the shipment from the plant is described as a reference.

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

HOW TO SELECT PISTON

When New Cylinder Block is Used

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



When Cylinder Block is Reused

1. Measure the cylinder bore inner diameter. Refer to [EM-103, "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.

Piston Selection Table

Unit: mm (in)

Grade number (Mark)	2 (or no mark)	3
Cylinder bore Inner diameter	89.010 - 89.020 (3.5043 - 3.5047)	89.020 - 89.030 (3.5047 - 3.5051)
Piston skirt diameter	88.990 - 89.000 (3.5035 - 3.5039)	89.000 - 89.010 (3.5039 - 3.5043)

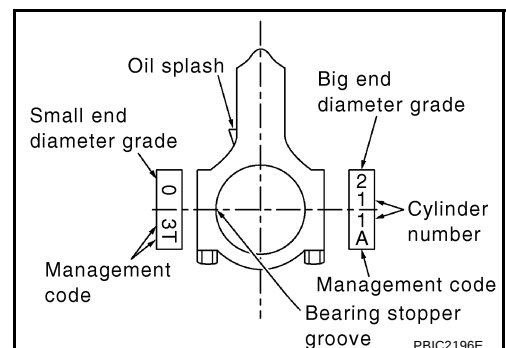
NOTE:

- There is no piston grade "1".
- Piston is available together with piston pin as an assembly.
- The piston pin (piston pin hole) grade is provided only for the parts installed at the plant. For service parts, no grades can be selected. (Only grade "0" is available.)

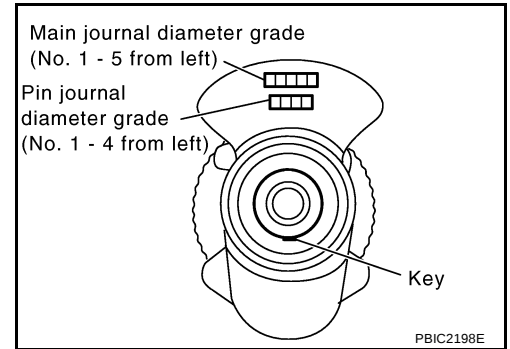
HOW TO SELECT CONNECTING ROD BEARING

When New Connecting Rod and Crankshaft are Used

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



2. Apply crankshaft pin journal diameter grade stamped on crankshaft front side to the column in the "Connecting Rod Bearing Selection Table".



3. Read the symbol at the cross point of selected row and column in the "Connecting Rod Bearing Selection Table".
4. Apply the symbol obtained to the "Connecting Rod Bearing Grade Table" to select connecting rod bearing.

When Crankshaft and Connecting Rod are Reused

1. Measure the dimensions of the connecting rod big end diameter and crankshaft pin journal diameter individually. Refer to [EM-101, "CONNECTING ROD BIG END DIAMETER"](#) and [EM-105, "CRANKSHAFT PIN JOURNAL DIAMETER"](#).
2. Apply the measured dimension to the "Connecting Rod Bearing Selection Table".
3. Read the symbol at the cross point of selected row and column in the "Connecting Rod Bearing Selection Table".
4. Apply the symbol obtained to the "Connecting Rod Bearing Grade Table" to select connecting rod bearing.

Connecting Rod Bearing Selection Table

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

PBIC2199E

Connecting Rod Bearing Grade Table

Unit: mm (in)

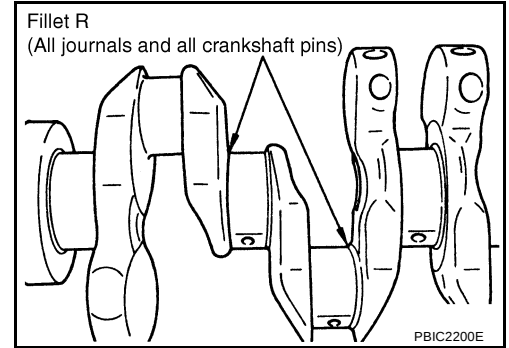
Grade number	0	1	2	3
Thickness	1.495 - 1.499 (0.0589 - 0.0590)	1.499 - 1.503 (0.0590 - 0.0592)	1.503 - 1.507 (0.0592 - 0.0593)	1.507 - 1.511 (0.0593 - 0.0595)
Identification color	Black	Brown	Green	Yellow

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 the crankshaft pin so that the connecting rod bearing oil clearance satisfies the standard.

CAUTION:

In grinding crankshaft pin to use undersize bearings, keep the fillet R [1.5 - 1.7 mm (0.059 - 0.067 in)].

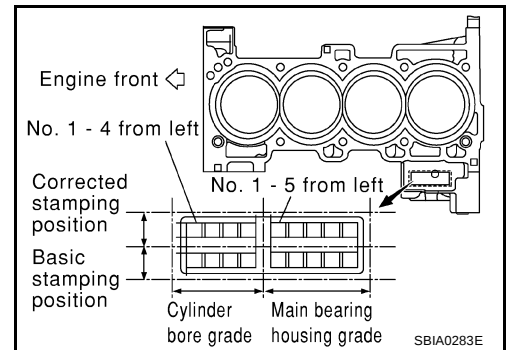
**Bearing undersize table**

Unit: mm (in)

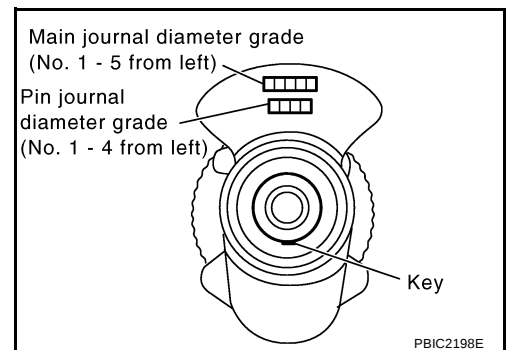
Size	Thickness
US 0.25 (0.0098)	1.624 - 1.632 (0.0639 - 0.0643)

HOW TO SELECT MAIN BEARING**When New Cylinder Block and Crankshaft are Used**

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



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



3. Read the symbol at the cross point of selected row and column in the "Main Bearing Selection Table".

CAUTION:

There are two main bearing selection tables. One is for odd-numbered journals (No. 1, 3 and 5) and the other is for even-numbered journals (No. 2 and 4). Make certain to use the appropriate table. This is due to differences in the specified clearances.

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

NOTE:

Service part is available as a set of both upper and lower.

When Cylinder Block and Crankshaft are Reused

1. Measure the dimensions of the cylinder block main bearing housing inner diameter and crankshaft main journal diameter individually. Refer to [EM-103, "MAIN BEARING HOUSING INNER DIAMETER"](#) and [EM-104, "CRANKSHAFT MAIN JOURNAL DIAMETER"](#).
2. Apply the measured dimension to the "Main Bearing Selection Table".

CYLINDER BLOCK

[QR]

- Read the symbol at the cross point of selected row and column in the "Main Bearing Selection Table".

CAUTION:

There are two main bearing selection tables. One is for odd-numbered journals (No. 1, 3 and 5) and the other is for even-numbered journals (No. 2 and 4). Make certain to use the appropriate table. This is due to differences in the specified clearances.

- Apply the symbol obtained to the "Main Bearing Grade Table" to select main bearing.

NOTE:

Service part is available as a set of both upper and lower.

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

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

PBIC2201E

CYLINDER BLOCK

[QR]

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

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

PBIC2202E

CYLINDER BLOCK

[QR]

Main Bearing Grade Table (All Journals)

Unit: mm (in)

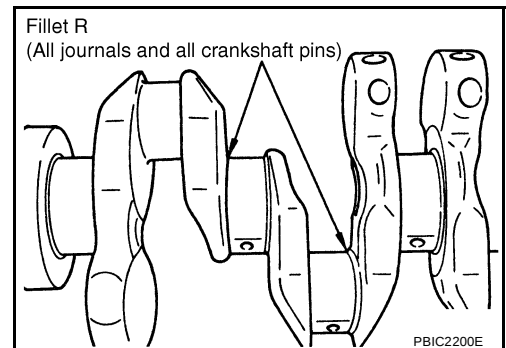
Grade number		Thickness	Identification color	Remarks
0		1.973 - 1.976 (0.0777 - 0.0778)	Black	Grade and color are the same for upper and lower bearings.
1		1.976 - 1.979 (0.0778 - 0.0779)	Brown	
2		1.979 - 1.982 (0.0779 - 0.0780)	Green	
3		1.982 - 1.985 (0.0780 - 0.0781)	Yellow	
4		1.985 - 1.988 (0.0781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

Use Undersize Bearing Usage Guide

- When the specified main bearing oil clearance is not obtained with standard size main bearings, use undersize (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 - 1.7 mm (0.059 - 0.067 in)].



Bearing undersize table

Unit: mm (in)

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

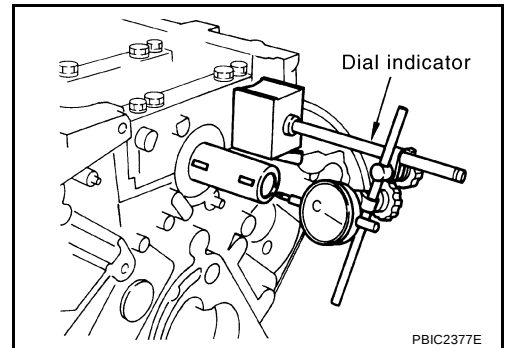
Inspection After Disassembly CRANKSHAFT END PLAY

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

Standard : 0.10 - 0.26 mm (0.0040 - 0.0102 in)

Limit : 0.3 mm (0.012 in)

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



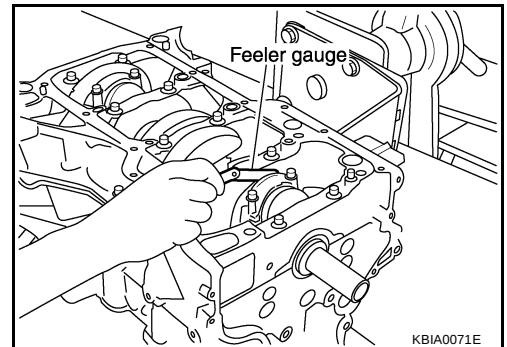
CONNECTING ROD SIDE CLEARANCE

- 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 : 0.5 mm (0.020 in)

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

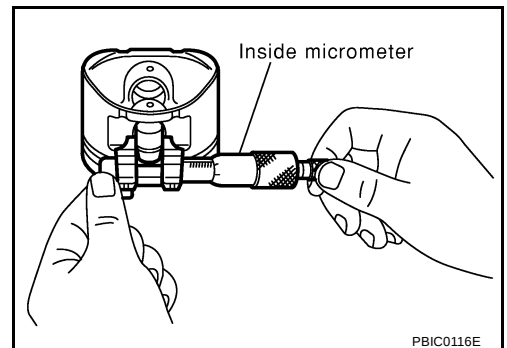


PISTON TO PISTON PIN OIL CLEARANCE

Piston Pin Hole Diameter

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

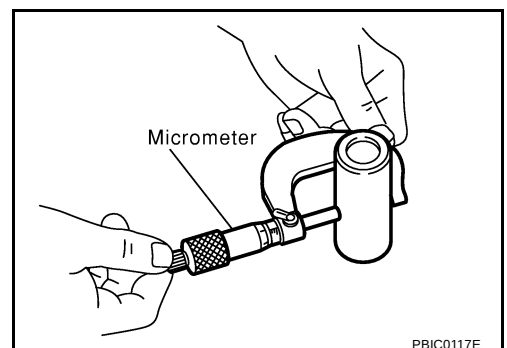
Standard: 19.993 - 20.005 mm (0.7871 - 0.7876 in)



Piston Pin Outer Diameter

Measure the outer diameter of piston pin with micrometer.

Standard: 19.989 - 20.001 mm (0.7870 - 0.7874 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 oil clearance is out of the standard, replace piston and piston pin assembly.

- When replacing piston and piston pin assembly, refer to [EM-92, "HOW TO SELECT PISTON"](#) .

NOTE:

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

PISTON RING SIDE CLEARANCE

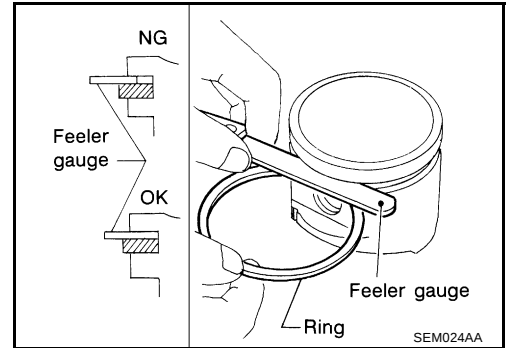
- Measure the side clearance of piston ring and piston ring groove with feeler gauge.

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 (0.0040 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

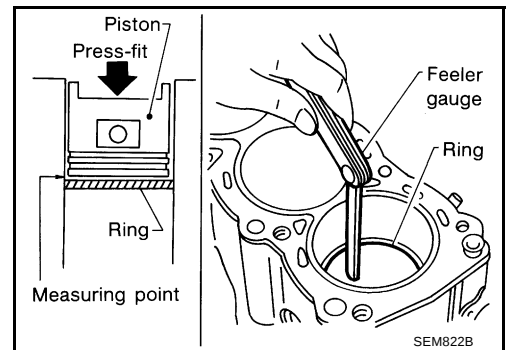
- Make sure that cylinder bore inner diameter is within specification. Refer to [EM-103, "Cylinder Bore Inner Diameter"](#) .
- Lubricate with new engine oil to piston and piston ring, and then insert piston ring until middle of cylinder with piston, and measure piston ring end gap with feeler gauge.

Standard:

Top ring	: 0.21 - 0.31 mm (0.0083 - 0.0122 in)
2nd ring	: 0.32 - 0.47 mm (0.0126 - 0.0185 in)
Oil ring (rail ring)	: 0.20 - 0.60 mm (0.0080 - 0.0240 in)

Limit:

Top ring	: 0.54 mm (0.0213 in)
2nd ring	: 0.67 mm (0.0264 in)
Oil ring (rail 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 inner wall and use oversized piston and piston rings.

CONNECTING ROD BEND AND TORSION

- Check with connecting rod aligner.

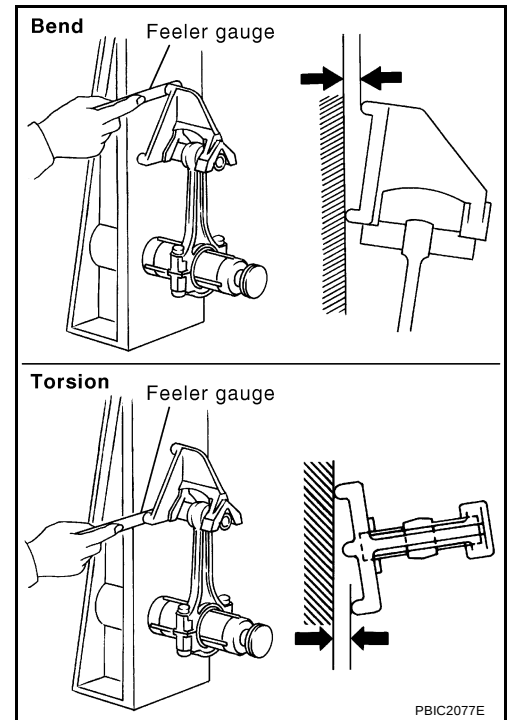
bend:

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

Torsion:

Limit: 0.30 mm (0.012 in) per 100 mm (3.94 in) length

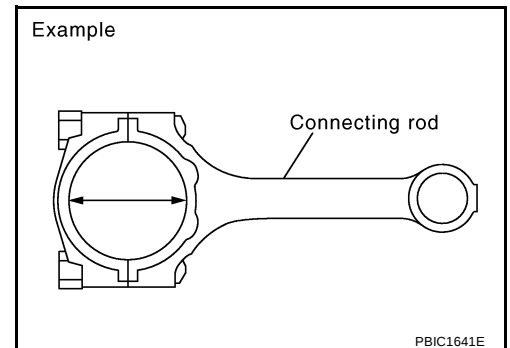
- If it exceeds the limit, replace connecting rod assembly.

**CONNECTING ROD BIG END DIAMETER**

- Install connecting rod cap without connecting rod bearing installed, and tightening connecting rod bolts to the specified torque. Refer to [EM-86, "ASSEMBLY"](#) for the tightening procedure.
- Measure the inner diameter of connecting rod big end with inside micrometer.

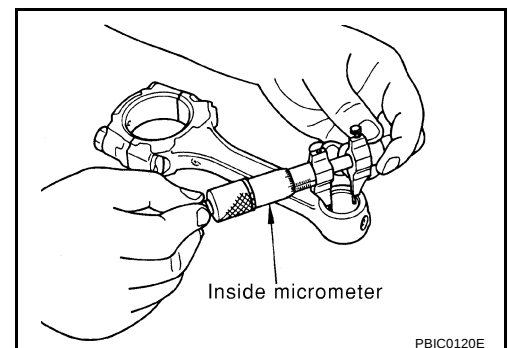
Standard: 48.000 - 48.013 mm (1.8898 - 1.8903 in)

- 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.

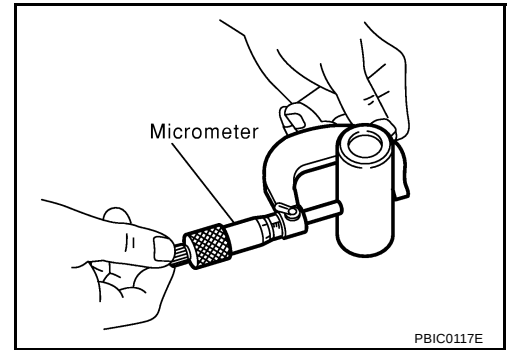
Standard: 20.000 - 20.012 mm (0.7874 - 0.7879 in)



Piston Pin Outer Diameter

Measure the outer diameter of piston pin with micrometer.

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

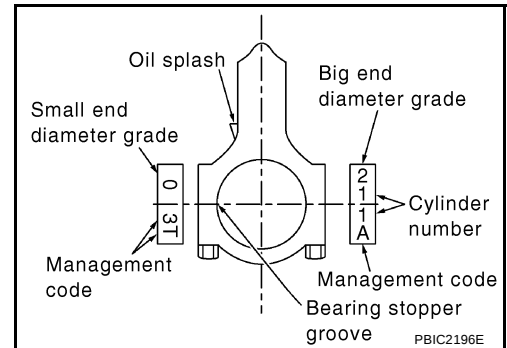


Connecting Rod Bushing Oil Clearance

(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)

- If the measured value is out of the standard, replace connecting rod assembly and/or piston and piston pin assembly.
- If replacing piston and piston pin assembly, refer to [EM-92, "HOW TO SELECT PISTON"](#) .
- If replacing connecting rod assembly, refer to [EM-105, "CONNECTING ROD BEARING OIL CLEARANCE"](#) to select connecting rod bearing.

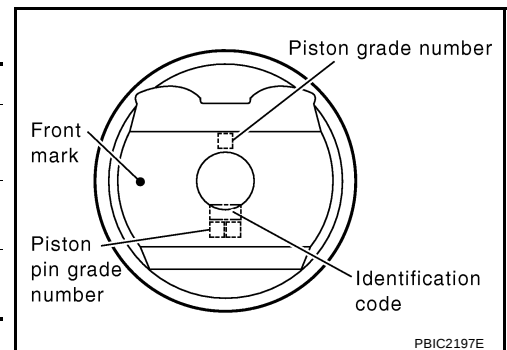


Factory installed parts grading:

- Service parts apply only to grade "0".

Unit: mm (in)		
Grade	0	1
Connecting rod bushing inner diameter*	20.000 - 20.006 (0.7874 - 0.7876)	20.006 - 20.012 (0.7876 - 0.7879)
Piston pin hole diameter	19.993 - 19.999 (0.7871 - 0.7874)	19.999 - 20.005 (0.7874 - 0.7876)
Piston pin outer diameter	19.989 - 19.995 (0.7870 - 0.7872)	19.995 - 20.001 (0.7872 - 0.7874)

* : 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

[QR]

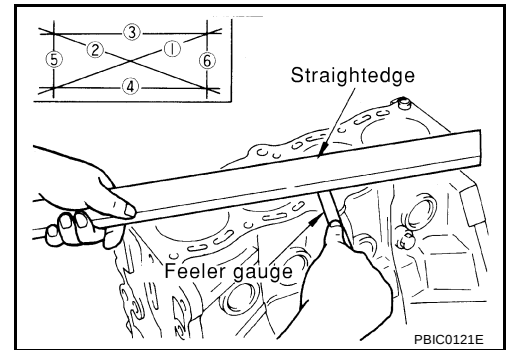
- Measure the distortion on the cylinder block upper face at some different points in six directions with straight edge and feeler gauge.

Limit: 0.1 mm (0.004 in)

- If it exceeds the limit, replace cylinder block and lower cylinder block assembly.

NOTE:

Cylinder block cannot be replaced as a single, because it is machined together with lower cylinder block.



MAIN BEARING HOUSING INNER DIAMETER

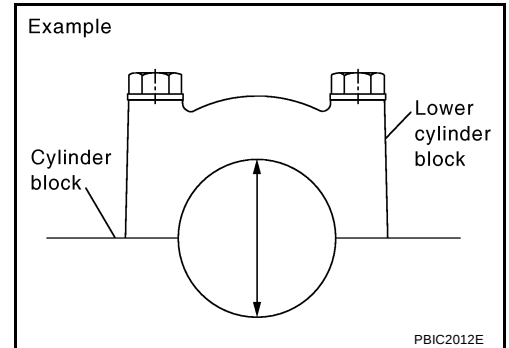
- Install lower cylinder block without main bearings installed, and tighten lower cylinder mounting bolts to the specified torque. Refer to [EM-86, "ASSEMBLY"](#) for the tightening procedure.
- Measure the inner diameter of main bearing housing with bore gauge.

Standard: 58.944 - 58.968 mm (2.3206 - 2.3216 in)

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

NOTE:

Cylinder block cannot be replaced as a single, because it is machined together with lower cylinder block.



PISTON TO CYLINDER BORE CLEARANCE

Cylinder Bore Inner Diameter

- Using bore gauge, measure the 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)

NOTE:

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

Standard inner diameter

: 89.010 - 89.030 mm (3.5043 - 3.5051 in)

Wear limit

: 0.2 mm (0.008 in)

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

: 0.015 mm (0.0006 in)

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

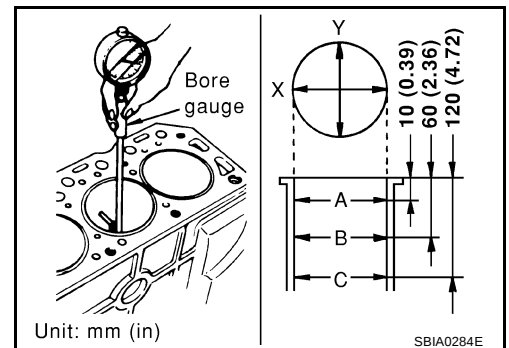
: 0.01 mm (0.0004 in)

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

CAUTION:

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

Oversize (OS): 0.2 mm (0.008 in)



Piston Skirt Diameter

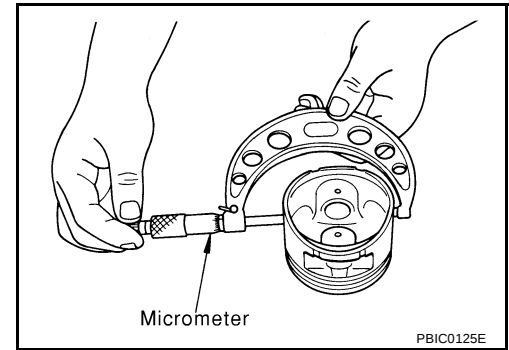
Measure the outer diameter of piston skirt with micrometer.

Measure point

: Distance from the top 42.0 mm (1.654 in)

Standard

: 88.990 - 89.010 mm (3.5035 - 3.5043 in)



Piston to Cylinder Bore Clearance

Calculate by piston skirt diameter and cylinder bore inner diameter (direction "X", position "B").
(Clearance) = (Cylinder bore inner diameter) – (Piston skirt diameter)

Standard : 0.01 - 0.03 mm (0.0004 - 0.0012 in)

Limit : 0.08 mm (0.0031 in)

- If it exceeds the limit, replace piston and piston pin assembly. Refer to [EM-92, "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 lower cylinder block, and tighten mounting bolts to the specified torque. Otherwise, cylinder bores may be distorted in final assembly. Refer to [EM-86, "ASSEMBLY"](#) for the tightening procedure.
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 specified piston to cylinder bore clearance.
5. Measure the finished cylinder bore for out-of-round and taper.

NOTE:

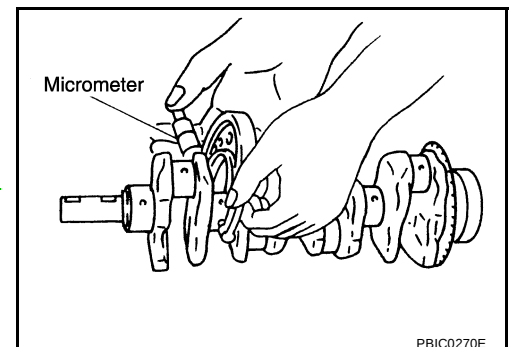
Measurement should be done after cylinder bore cools down.

CRANKSHAFT MAIN JOURNAL DIAMETER

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

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

- If out of the standard, measure the main bearing oil clearance. Then use undersize bearing. Refer to [EM-106, "MAIN BEARING OIL CLEARANCE"](#).



CRANKSHAFT PIN JOURNAL DIAMETER

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

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

- If out of the standard, measure the connecting rod bearing oil clearance. Then use undersize bearing. Refer to [EM-105, "CONNECTING ROD BEARING OIL CLEARANCE"](#).

OUT-OF-ROUND AND TAPER OF CRANKSHAFT

- 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 dimensions between "X" and "Y" at "A" and "B".
- Taper is indicated by the difference in dimension between "A" and "B" at "X" and "Y".

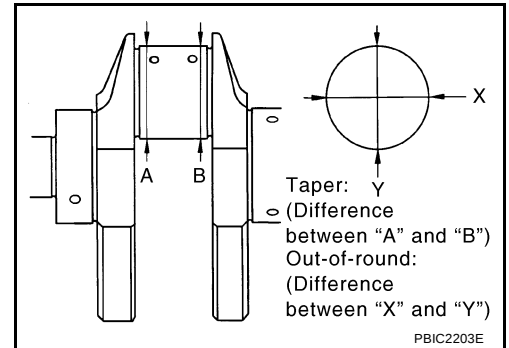
Limit:

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

: 0.005 mm (0.0002 in)

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

: 0.005 mm (0.0002 in)



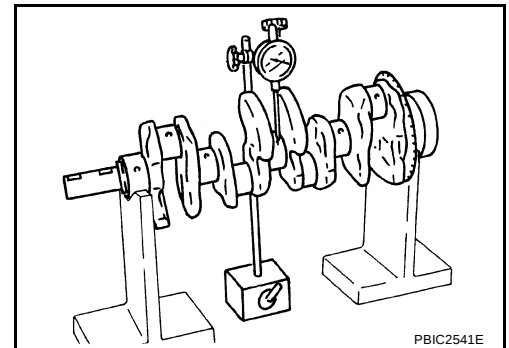
- If the measured value exceeds the limit, correct or replace crankshaft.
- If corrected, measure the bearing oil clearance of the corrected main journal and/or pin journal. Then select main bearing and/or connecting rod bearing. Refer to [EM-106, "MAIN BEARING OIL CLEARANCE"](#) and/or [EM-105, "CONNECTING ROD BEARING OIL CLEARANCE"](#).

CRANKSHAFT RUNOUT

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

Limit : 0.03 mm (0.0012 in)

- If it exceeds the limit, replace crankshaft.

**CONNECTING ROD BEARING OIL CLEARANCE****Method by Calculation**

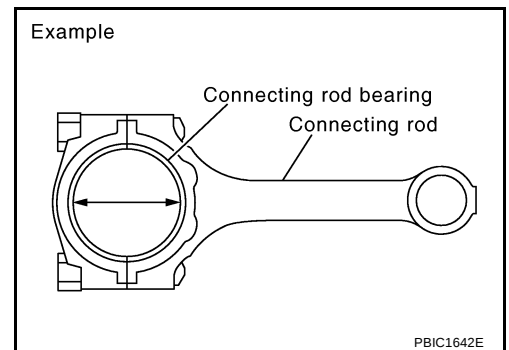
- Install connecting rod bearings to connecting rod and cap, and tighten connecting rod bolts to the specified torque. Refer to [EM-86, "ASSEMBLY"](#) for the tightening procedure.
- Measure the inner diameter of connecting rod bearing with inside micrometer.

$$(\text{Bearing oil clearance}) = (\text{Connecting rod bearing inner diameter}) - (\text{Crankshaft pin journal diameter})$$

Standard : 0.028 - 0.045 mm (0.0011 - 0.0018 in)

Limit : 0.1 mm (0.004 in)

- If the clearance exceeds the limit, select proper connecting rod bearing according to connecting rod big end diameter and crankshaft pin journal diameter to obtain specified bearing oil clearance. Refer to [EM-92, "HOW TO SELECT CONNECTING ROD BEARING"](#).

**Method of Using Plastigage**

- Remove engine oil and dust on crankshaft pin and the surfaces of each bearing completely.

- Cut a plastigage slightly shorter than the bearing width, and place it in crankshaft axial direction, avoiding oil holes.
- Install connecting rod bearings to connecting rod and cap, and tighten connecting rod bolts to the specified torque. Refer to [EM-86, "ASSEMBLY"](#) for the tightening procedure.

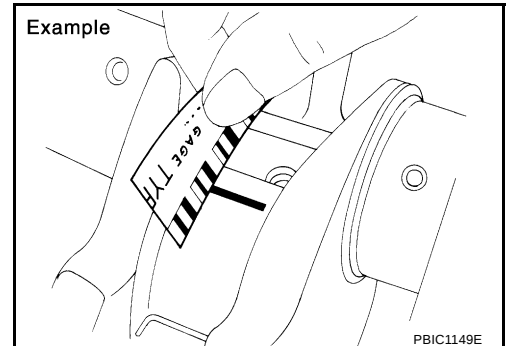
CAUTION:

Do not rotate crankshaft.

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

NOTE:

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



MAIN BEARING OIL CLEARANCE

Method by Calculation

- Install main bearings to cylinder block and lower cylinder block, and tighten lower cylinder block mounting bolts to the specified torque. Refer to [EM-86, "ASSEMBLY"](#) for the tightening procedure.
- Measure the inner diameter of main bearing with bore gauge.
(Bearing oil clearance) = (Main bearing inner diameter) – (Crankshaft main journal diameter)

Standard:

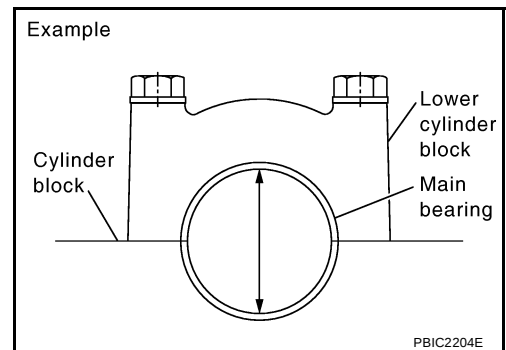
No. 1, 3 and 5 journals

: 0.012 - 0.022 mm (0.0005 - 0.0009 in)

No. 2 and 4 journals

: 0.018 - 0.028 mm (0.0007 - 0.0011 in)

Limit : 0.1 mm (0.004 in)



- If the clearance exceeds the limit, select proper main bearing according to main bearing housing inner diameter and crankshaft main journal diameter to obtain specified bearing oil clearance. Refer to [EM-95, "HOW TO SELECT MAIN BEARING"](#).

Method of Using Plastigage

- Remove engine oil and dust on crankshaft main journal and the surfaces of each bearing completely.
- Cut a plastigage slightly shorter than the bearing width, and place it in crankshaft axial direction, avoiding oil holes.
- Install main bearings to cylinder block and lower cylinder block, and tighten lower cylinder block mounting bolts to the specified torque. Refer to [EM-86, "ASSEMBLY"](#) for the tightening procedure.

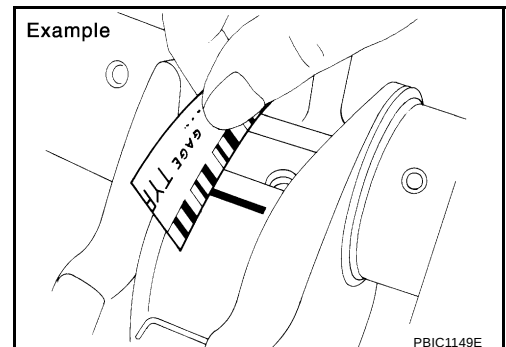
CAUTION:

Do not rotate crankshaft.

- Remove lower cylinder block and bearings, and using the scale on the plastigage bag, measure the plastigage width.

NOTE:

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

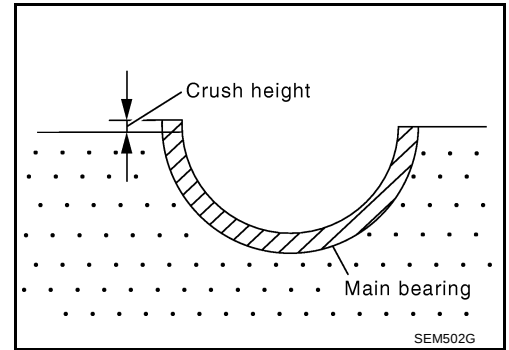


MAIN BEARING CRUSH HEIGHT

- When lower cylinder block is removed after being tightened to the specified torque with main bearings installed, the tip end of bearing must protrude. Refer to [EM-86, "ASSEMBLY"](#) for the tightening procedure.

Standard : There must be crush height.

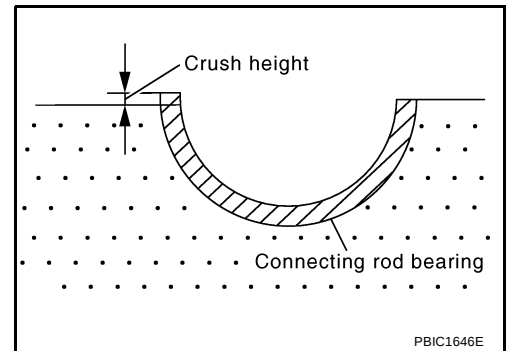
- If the standard is not met, replace main bearings.

**CONNECTING ROD BEARING CRUSH HEIGHT**

- 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-86, "ASSEMBLY"](#) for the tightening procedure.

Standard : There must be crush height.

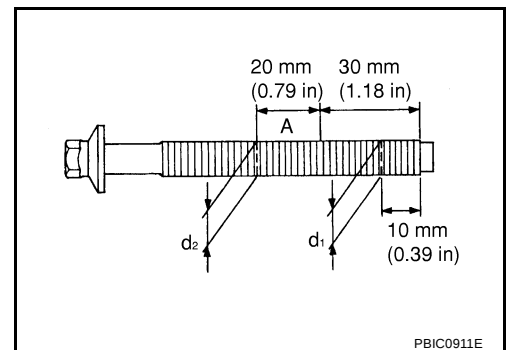
- If the standard is not met, replace connecting rod bearings.

**LOWER CYLINDER BLOCK MOUNTING BOLT OUTER DIAMETER**

- Perform only with M10 bolts.
- 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") : 0.13 mm (0.0051 in)

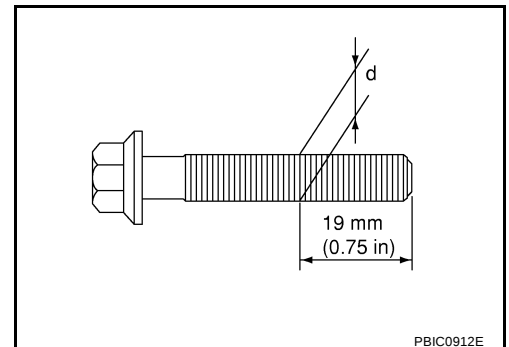
- If it exceeds the limit (a large difference in dimensions), replace lower cylinder block mounting bolt with a new one.

**CONNECTING ROD BOLT OUTER DIAMETER**

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

Limit : 7.75 mm (0.3051 in)

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



SERVICE DATA AND SPECIFICATIONS (SDS)

[QR]

SERVICE DATA AND SPECIFICATIONS (SDS)

PFP:00030

Standard and Limit GENERAL SPECIFICATIONS

BBS0059J

Cylinder arrangement		In-line 4
Displacement	cm ³ (cu in)	1,998 (121.92)
Bore and stroke	mm (in)	89.0 × 80.3 (3.504 × 3.161)
Valve arrangement		DOHC
Firing order		1-3-4-2
Number of piston rings	Compression	2
	Oil	1
Compression ratio		9.9
Compression pressure kPa (bar, kg/cm ² , psi) / 250 rpm	Standard	1,190 (11.9, 12.1, 173)
	Minimum	990 (9.9, 10.1, 144)
	Differential limit between cylinders	100 (1.0, 1.0, 14)

DRIVE BELT

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

EXHAUST MANIFOLD

Unit: mm (in)

Items	Limit
Exhaust manifold and three way catalyst assembly surface distortion	0.3 (0.012)

SPARK PLUG

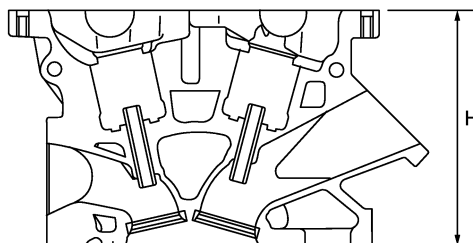
Unit: mm (in)

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

CYLINDER HEAD

Unit: mm (in)

Items	Limit
Head surface distortion	0.1 (0.004)

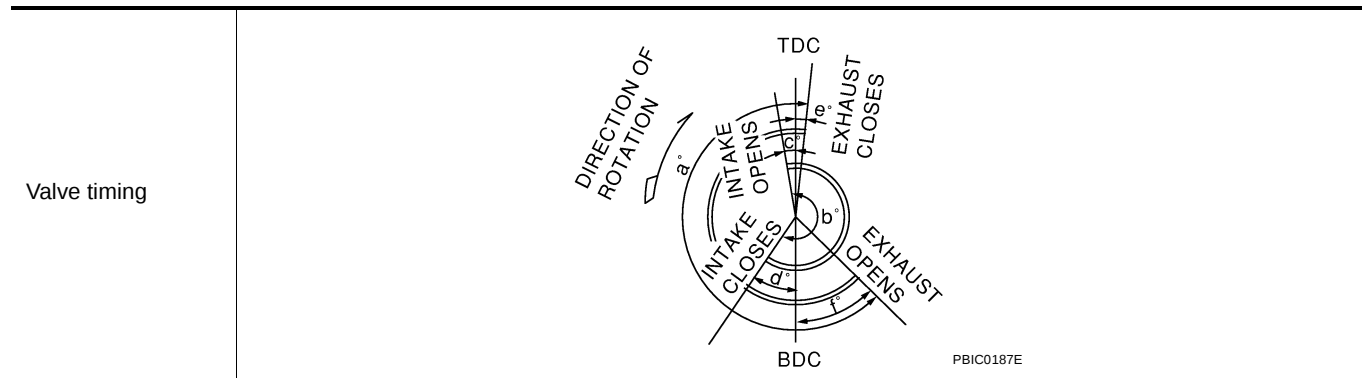


Nominal cylinder head height:
H = 129.4 mm (5.09 in)

PBIC0283E

VALVE

Valve Timing



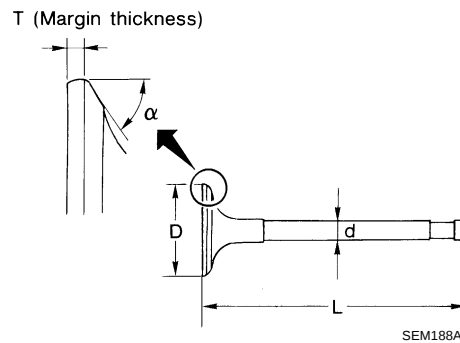
Unit: degree

a	b	c	d	e	f
212	236	-4 (31)	60 (25)	3	29

(): Valve timing control "ON"

Valve Dimensions

Unit: mm (in)



Valve head diameter "D"	Intake	35.5 - 35.8 (1.398 - 1.409)
	Exhaust	30.5 - 30.8 (1.201 - 1.213)
Valve length "L"	Intake	97.16 (3.8252)
	Exhaust	98.82 (3.8905)
Valve stem diameter "d"	Intake	5.965 - 5.980 (0.2348 - 0.2354)
	Exhaust	5.955 - 5.970 (0.2344 - 0.2350)
Valve seat angle "α"	Intake	45°15' - 45°45'
	Exhaust	
Valve margin "T"	Intake	1.1 (0.043)
	Exhaust	1.3 (0.051)

Valve Clearance

Unit: mm (in)

Items	Cold	Hot* (reference data)
Intake	0.24 - 0.32 (0.009 - 0.013)	0.304 - 0.416 (0.012 - 0.016)
Exhaust	0.26 - 0.34 (0.010 - 0.013)	0.308 - 0.432 (0.012 - 0.017)

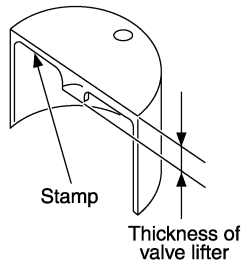
*: Approximately 80°C (176°F)

SERVICE DATA AND SPECIFICATIONS (SDS)

[QR]

Available Valve Lifter

Thickness mm (in)	Identification mark
-------------------	---------------------



KBIA0119E

6.96 (0.2740)	696
6.98 (0.2748)	698
7.00 (0.2756)	700
7.02 (0.2764)	702
7.04 (0.2772)	704
7.06 (0.2780)	706
7.08 (0.2787)	708
7.10 (0.2795)	710
7.12 (0.2803)	712
7.14 (0.2811)	714
7.16 (0.2819)	716
7.18 (0.2827)	718
7.20 (0.2835)	720
7.22 (0.2843)	722
7.24 (0.2850)	724
7.26 (0.2858)	726
7.28 (0.2866)	728
7.30 (0.2874)	730
7.32 (0.2882)	732
7.34 (0.2890)	734
7.36 (0.2898)	736
7.38 (0.2906)	738
7.40 (0.2913)	740
7.42 (0.2921)	742
7.44 (0.2929)	744
7.46 (0.2937)	746

Valve Spring

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

SERVICE DATA AND SPECIFICATIONS (SDS)

[QR]

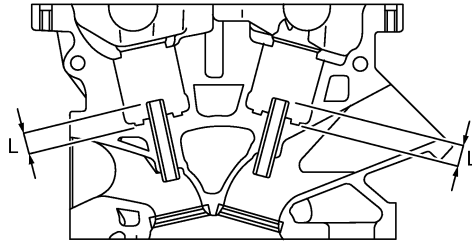
Valve Lifter

Unit: mm (in)

Items	Standard
Valve lifter outer diameter	33.965 - 33.980 (1.3372 - 1.3378)
Valve lifter hole diameter	34.000 - 34.021 (1.3386 - 1.3394)
Valve lifter clearance	0.020 - 0.056 (0.0008 - 0.0022)

Valve Guide

Unit: mm (in)



PBIC0184E

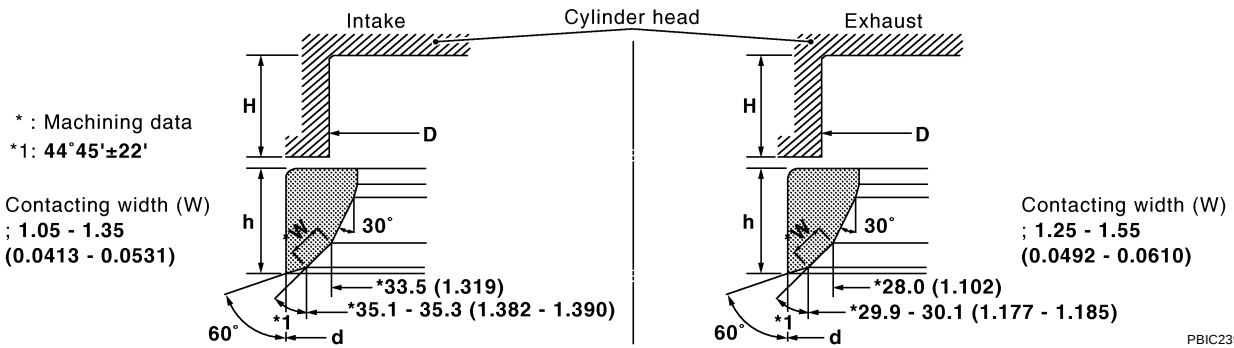
Items		Standard part	Service part
Valve guide	Outer diameter	10.023 - 10.034 (0.3946 - 0.3950)	10.223 - 10.234 (0.4025 - 0.4029)
	Inner diameter (Finished size)	6.000 - 6.018 (0.2362 - 0.2369)	
Cylinder head valve guide hole diameter		9.975 - 9.996 (0.3927 - 0.3935)	10.175 - 10.196 (0.4006 - 0.4014)
Interference fit of valve guide		0.027 - 0.059 (0.0011 - 0.0023)	
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"	Intake	10.1 - 10.3 (0.398 - 0.406)	
	Exhaust	10.0 - 10.4 (0.394 - 0.409)	

SERVICE DATA AND SPECIFICATIONS (SDS)

[QR]

Valve Seat

Unit: mm (in)



Items		Standard	Overize (Service) [0.5 (0.020)]
Cylinder head seat recess diameter "D"	Intake	36.500 - 36.516 (1.4370 - 1.4376)	37.000 - 37.016 (1.4567 - 1.4573)
	Exhaust	31.500 - 31.516 (1.2402 - 1.2408)	32.000 - 32.016(1.2598 - 1.2605)
Valve seat outer diameter "d"	Intake	36.597 - 36.613 (1.4408 - 1.4415)	37.097 - 37.113 (1.4605 - 1.4611)
	Exhaust	31.600 - 31.616 (1.2441 - 1.2447)	32.100 - 32.116 (1.2638 - 1.2644)
Valve seat interference fit	Intake	0.081 - 0.113 (0.0032 - 0.0044)	
	Exhaust	0.084 - 0.116 (0.0033 - 0.0046)	
Items		Standard	Service
Height "h"	Intake	5.9 - 6.0 (0.232 - 0.236)	5.0 - 5.1 (0.197 - 0.201)
	Exhaust	5.9 - 6.0 (0.232 - 0.236)	4.91 - 5.01 (0.1933 - 0.1972)
Depth "H"		6.0 (0.236)	

[QR]

Unit: mm (in)

A

EM

C

D

E

F

G

H

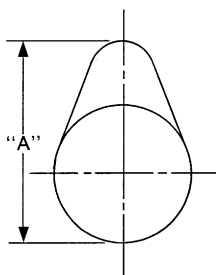
1

J

K

L

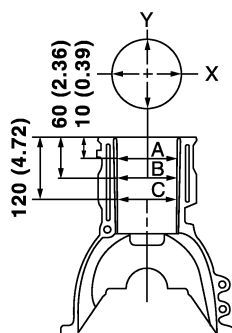
M



SEM671

*2 : Total indicator reading

Unit: mm (in)



PBIC0281E

K

L

M

SERVICE DATA AND SPECIFICATIONS (SDS)

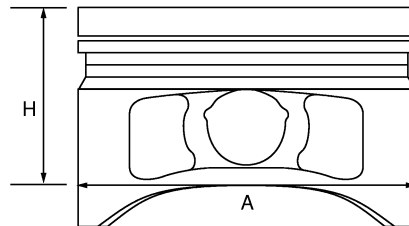
[QR]

Main bearing housing inner diameter grade	Grade No. A	58.944 - 58.945 (2.3206 - 2.3207)
	Grade No. B	58.945 - 58.946 (2.3207 - 2.3207)
	Grade No. C	58.946 - 58.947 (2.3207 - 2.3207)
	Grade No. D	58.947 - 58.948 (2.3207 - 2.3208)
	Grade No. E	58.948 - 58.949 (2.3208 - 2.3208)
	Grade No. F	58.949 - 58.950 (2.3208 - 2.3209)
	Grade No. G	58.950 - 58.951 (2.3209 - 2.3209)
	Grade No. H	58.951 - 58.952 (2.3209 - 2.3209)
	Grade No. J	58.952 - 58.953 (2.3209 - 2.3210)
	Grade No. K	58.953 - 58.954 (2.3210 - 2.3210)
	Grade No. L	58.954 - 58.955 (2.3210 - 2.3211)
	Grade No. M	58.955 - 58.956 (2.3211 - 2.3211)
	Grade No. N	58.956 - 58.957 (2.3211 - 2.3211)
	Grade No. P	58.957 - 58.958 (2.3211 - 2.3212)
	Grade No. R	58.958 - 58.959 (2.3212 - 2.3212)
	Grade No. S	58.959 - 58.960 (2.3212 - 2.3213)
	Grade No. T	58.960 - 58.961 (2.3213 - 2.3213)
	Grade No. U	58.961 - 58.962 (2.3213 - 2.3213)
	Grade No. V	58.962 - 58.963 (2.3213 - 2.3214)
	Grade No. W	58.963 - 58.964 (2.3214 - 2.3214)
	Grade No. X	58.964 - 58.965 (2.3214 - 2.3215)
	Grade No. Y	58.965 - 58.966 (2.3215 - 2.3215)
	Grade No. 4	58.966 - 58.967 (2.3215 - 2.3215)
	Grade No. 7	58.967 - 58.968 (2.3215 - 2.3216)
Difference in inner diameter between cylinders	Standard	Less than 0.03 (0.0012)

PISTON, PISTON RING AND PISTON PIN

Available Piston

Unit: mm (in)



PBIC0188E

Piston skirt diameter “A”	Standard	Grade No. 2	88.990 - 89.000 (3.5035 - 3.5039)
		Grade No. 3	89.000 - 89.010 (3.5039 - 3.5043)
		Oversize (Service) [0.2 (0.008)]	89.180 - 89.210 (3.5110 - 3.5122)
Piston height “H” dimension			42.0 (1.654)
Piston pin hole diameter	Grade No. 0		19.993 - 19.999 (0.7871 - 0.7874)
	Grade No. 1		19.999 - 20.005 (0.7874 - 0.7876)
Piston to cylinder bore clearance	Standard		0.010 - 0.030 (0.0004 - 0.0012)
	Limit		0.08 (0.0031)

Piston Ring

Unit: mm (in)

Items		Standard	Limit
Side clearance	Top	0.045 - 0.080 (0.0018 - 0.0031)	0.11 (0.0043)
	2nd	0.030 - 0.070 (0.0012 - 0.0028)	0.10 (0.0040)
	Oil ring	0.065 - 0.135 (0.0026 - 0.0053)	—

SERVICE DATA AND SPECIFICATIONS (SDS)

[QR]

Items		Standard	Limit
End gap	Top	0.21- 0.31 (0.0083 - 0.0122)	0.54 (0.0213)
	2nd	0.32 - 0.47 (0.0126 - 0.0185)	0.67 (0.0264)
	Oil (rail ring)	0.20 - 0.60 (0.0080 - 0.0240)	0.95 (0.0374)

Piston Pin

Unit: mm (in)

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

CONNECTING ROD

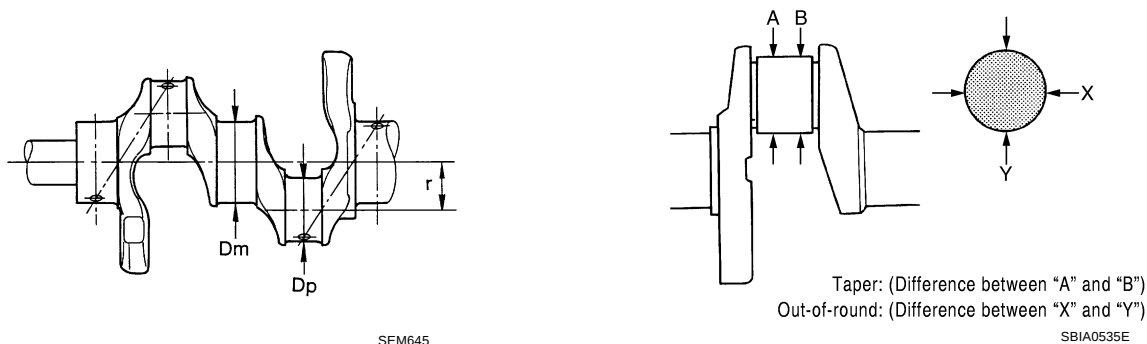
Unit: mm (in)

Center distance		152.85 - 152.95 (6.018 - 6.022)
Bend [per 100 (3.94)]	Limit	0.15 (0.0059)
Torsion [per 100 (3.94)]	Limit	0.30 (0.0120)
Connecting rod bushing inner diameter*	Grade No. 0	20.000 - 20.006 (0.7874 - 0.7876)
	Grade No. 1	20.006 - 20.012 (0.7876 - 0.7879)
Side clearance	Standard	0.20 - 0.35 (0.0079 - 0.0138)
	Limit	0.5 (0.020)
Connecting rod big end diameter	Grade No. 0	48.000 - 48.001 (1.8898 - 1.8898)
	Grade No. 1	48.001 - 48.002 (1.8898 - 1.8898)
	Grade No. 2	48.002 - 48.003 (1.8898 - 1.8899)
	Grade No. 3	48.003 - 48.004 (1.8899 - 1.8899)
	Grade No. 4	48.004 - 48.005 (1.8899 - 1.8900)
	Grade No. 5	48.005 - 48.006 (1.8900 - 1.8900)
	Grade No. 6	48.006 - 48.007 (1.8900 - 1.8900)
	Grade No. 7	48.007 - 48.008 (1.8900 - 1.8901)
	Grade No. 8	48.008 - 48.009 (1.8901 - 1.8901)
	Grade No. 9	48.009 - 48.010 (1.8901 - 1.8902)
	Grade No. A	48.010 - 48.011 (1.8902 - 1.8902)
	Grade No. B	48.011 - 48.012 (1.8902 - 1.8902)
	Grade No. C	48.012 - 48.013 (1.8902 - 1.8903)

*: After installing in connecting rod

CRANKSHAFT

Unit: mm (in)



Center distance "r"		40.11 - 40.19 (1.5791 - 1.5823)
Out-of-round (Difference between "X" and "Y")	Limit	0.005 (0.0002)
Taper (Difference between "A" and "B")	Limit	0.005 (0.0002)
Runout [TIR*]	Limit	0.03 (0.0012)

SERVICE DATA AND SPECIFICATIONS (SDS)

[QR]

Crankshaft end play	Standard	0.10 - 0.26 (0.004- 0.0102)
	Limit	0.3 (0.012)
Pin journal diameter grade. "DP"	Grade No. A	44.974 - 44.973 (1.7706 - 1.7706)
	Grade No. B	44.973 - 44.972 (1.7706 - 1.7705)
	Grade No. C	44.972 - 44.971 (1.7705 - 1.7705)
	Grade No. D	44.971 - 44.970 (1.7705 - 1.7705)
	Grade No. E	44.970 - 44.969 (1.7705 - 1.7704)
	Grade No. F	44.969 - 44.968 (1.7704 - 1.7704)
	Grade No. G	44.968 - 44.967 (1.7704 - 1.7704)
	Grade No. H	44.967 - 44.966 (1.7704 - 1.7703)
	Grade No. J	44.966 - 44.965 (1.7703 - 1.7703)
	Grade No. K	44.965 - 44.964 (1.7703 - 1.7702)
	Grade No. L	44.964 - 44.963 (1.7702 - 1.7702)
	Grade No. M	44.963 - 44.962 (1.7702 - 1.7702)
	Grade No. N	44.962 - 44.961 (1.7702 - 1.7701)
	Grade No. P	44.961 - 44.960 (1.7701 - 1.7701)
	Grade No. R	44.960 - 44.959 (1.7701 - 1.7700)
	Grade No. S	44.959 - 44.958 (1.7700 - 1.7700)
	Grade No. T	44.958 - 44.957 (1.7700 - 1.7700)
	Grade No. U	44.957 - 44.956 (1.7700 - 1.7699)
Main journal diameter grade. "Dm"	Grade No. A	54.979 - 54.978 (2.1645 - 2.1645)
	Grade No. B	54.978 - 54.977 (2.1645 - 2.1644)
	Grade No. C	54.977 - 54.976 (2.1644 - 2.1644)
	Grade No. D	54.976 - 54.975 (2.1644 - 2.1644)
	Grade No. E	54.975 - 54.974 (2.1644 - 2.1643)
	Grade No. F	54.974 - 54.973 (2.1643 - 2.1643)
	Grade No. G	54.973 - 54.972 (2.1643 - 2.1642)
	Grade No. H	54.972 - 54.971 (2.1642 - 2.1642)
	Grade No. J	54.971 - 54.970 (2.1642 - 2.1642)
	Grade No. K	54.970 - 54.969 (2.1642 - 2.1641)
	Grade No. L	54.969 - 54.968 (2.1641 - 2.1641)
	Grade No. M	54.968 - 54.967 (2.1641 - 2.1641)
	Grade No. N	54.967 - 54.966 (2.1641 - 2.1640)
	Grade No. P	54.966 - 54.965 (2.1640 - 2.1640)
	Grade No. R	54.965 - 54.964 (2.1640 - 2.1639)
	Grade No. S	54.964 - 54.963 (2.1639 - 2.1639)
	Grade No. T	54.963 - 54.962 (2.1639 - 2.1639)
	Grade No. U	54.962 - 54.961 (2.1639 - 2.1638)
	Grade No. V	54.961 - 54.960 (2.1638 - 2.1638)
	Grade No. W	54.960 - 54.959 (2.1638 - 2.1637)
	Grade No. X	54.959 - 54.958 (2.1637 - 2.1637)
	Grade No. Y	54.958 - 54.957 (2.1637 - 2.1637)
	Grade No. 4	54.957 - 54.956 (2.1637 - 2.1636)
	Grade No. 7	54.956 - 54.955 (2.1636 - 2.1636)

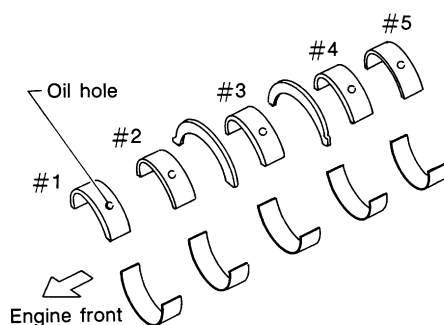
*: Total indicator reading

SERVICE DATA AND SPECIFICATIONS (SDS)

[QR]

MAIN BEARING

Unit: mm (in)



SEM685D

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

Undersize

Unit: mm (in)

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

Bearing Oil Clearance

Unit: mm (in)

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

SERVICE DATA AND SPECIFICATIONS (SDS)

[QR]

CONNECTING ROD BEARING

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

Undersize

Unit: mm (in)

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

Bearing Oil Clearance

Unit: mm (in)

Connecting rod bearing oil clearance	Standard	0.028 - 0.045 (0.0011 - 0.0018)
	Limit	0.1 (0.004)

PRECAUTIONS

Precautions Necessary for Steering Wheel Rotation After Battery Disconnect

BBS007TP

NOTE:

- This Procedure is applied only to models with Intelligent Key system and NATS (NISSAN ANTI-THEFT SYSTEM).
- Remove and install all control units after disconnecting both battery cables with the ignition knob in the "LOCK" position.
- Always use CONSULT-II to perform self-diagnosis as a part of each function inspection after finishing work. If DTC is detected, perform trouble diagnosis according to self-diagnostic results.

For models equipped with the Intelligent Key system and NATS, an electrically controlled steering lock mechanism is adopted on the key cylinder.

For this reason, if the battery is disconnected or if the battery is discharged, the steering wheel will lock and steering wheel rotation will become impossible.

If steering wheel rotation is required when battery power is interrupted, follow the procedure below before starting the repair operation.

OPERATION PROCEDURE

1. Connect both battery cables.

NOTE:

Supply power using jumper cables if battery is discharged.

2. Use the Intelligent Key or mechanical key to turn the ignition switch to the "ACC" position. At this time, the steering lock will be released.
3. Disconnect both battery cables. The steering lock will remain released and the steering wheel can be rotated.
4. Perform the necessary repair operation.
5. When the repair work is completed, return the ignition switch to the "LOCK" position before connecting the battery cables. (At this time, the steering lock mechanism will engage.)
6. Perform a self-diagnosis check of all control units using CONSULT-II.

Precautions for Drain Engine Coolant

BBS007TQ

Drain engine coolant when engine is cooled.

Precautions for Disconnecting Fuel Piping

BBS007TR

- 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

BBS007TS

- When instructed to use special service tools, 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 bolts and nuts, as a basic rule, start with the one furthest outside, then the one diagonally opposite, and so on. If the order of loosening is specified, do exactly as specified.

Precautions for Inspection, Repair and Replacement

BBS007TT

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

Precautions for Assembly and Installation

BBS007TU

- Use torque wrench to tighten nuts and bolts to specification.

PRECAUTIONS

[VQ]

- When tightening bolts and nuts, 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

BBS007TV

- Use angle wrench [SST: KV10112100] for the final tightening of the following engine parts:
 - Cylinder head bolts
 - Main bearing cap bolts
 - Connecting rod cap nuts (VQ23DE)
 - Connecting rod cap bolts (VQ35DE)
 - Crankshaft pulley bolt
- Do not use a torque value for final tightening.
- The torque value for these parts are for a preliminary step.
- Ensure thread and seat surfaces are clean and coated with engine oil.

Precautions for Liquid Gasket

BBS007TW

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.

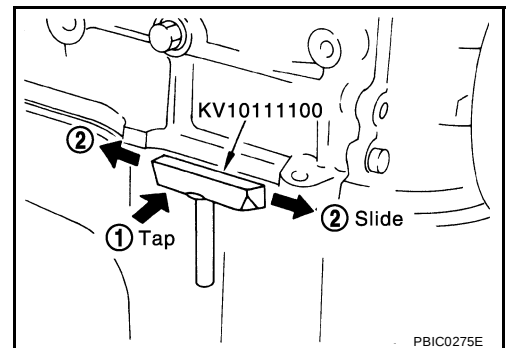
CAUTION:

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.

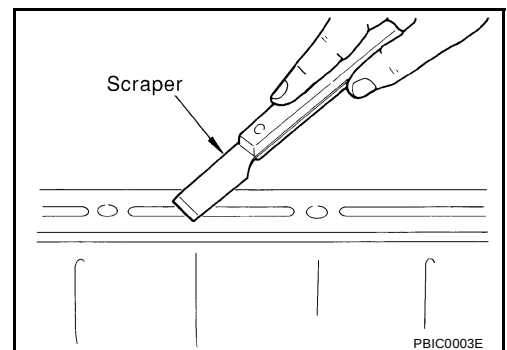
CAUTION:

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



LIQUID GASKET APPLICATION PROCEDURE

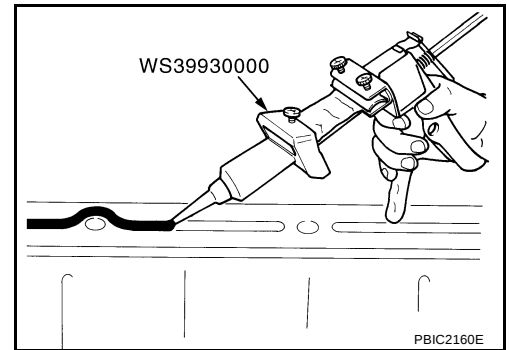
1. Using scraper, remove old liquid gasket adhering to the gasket application surface and the mating surface.
 - Remove liquid gasket completely from the groove of the gasket application surface, mounting bolts, and bolt holes.
2. Wipe the liquid gasket application surface and the mating surface with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



PRECAUTIONS

[VQ]

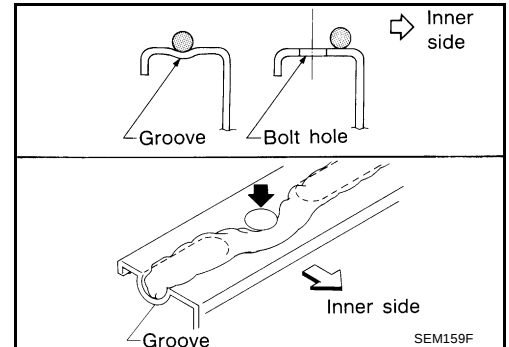
3. Attach liquid gasket tube to tube presser (SST).
Use Genuine Liquid Gasket or equivalent.
4. Apply liquid gasket without breaks to the specified location with the specified dimensions.
 - If there is a groove for the liquid gasket application, apply liquid gasket to the groove.



- As for the 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.

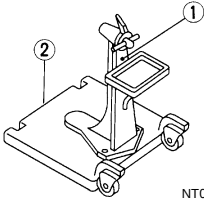
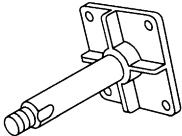
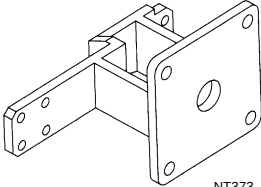
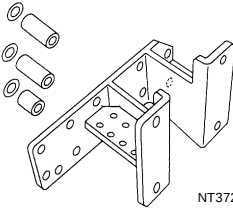
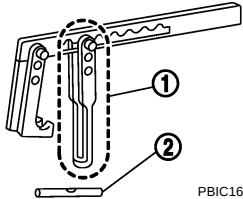
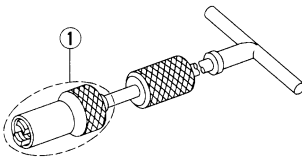
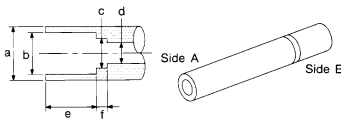
CAUTION:

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



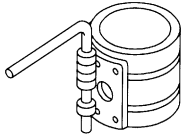
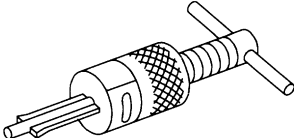
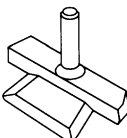
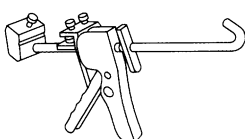
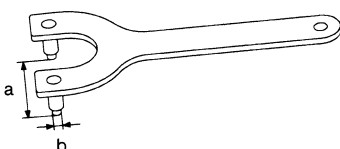
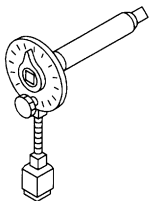
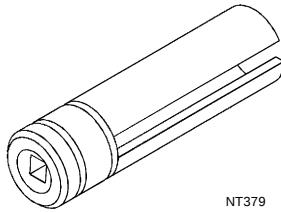
PREPARATION

Special Service Tools

Tool number Tool name		Description
ST0501S000 Engine stand assembly 1. ST05011000 Engine stand 2. ST05012000 Base	 NT042	Disassembling and assembling engine
KV10106500 Engine stand shaft	 NT028	
KV10117000 Engine sub-attachment	 NT373	KV10117000 has been replaced with KV10117001 (KV10117000 is no longer in production, but it is usable).
KV10117001 Engine sub-attachment	 NT372	Installing on cylinder block
KV10116200 Valve spring compressor 1. KV10115900 Attachment 2. KV10109220 Adapter	 PBIC1650E	Disassembling and assembling valve mechanism Part (1) is a component of KV10116200, but Part (2) is not so.
KV10107902 Valve oil seal puller 1. KV10116100 Valve oil seal puller adapter	 S-NT605	Removing valve oil seal
KV10115600 Valve oil seal drift	 S-NT603	Installing valve oil seal Use side A. a: 20 (0.79) dia. b: 13 (0.51) dia. c: 10.3 (0.406) dia. d: 8 (0.31) dia. e: 10.7 (0.421) f: 5 (0.2) Unit: mm (in)

PREPARATION

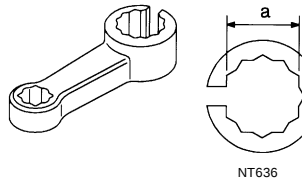
[VQ]

Tool number Tool name	Description	
EM03470000 Piston ring compressor	Installing piston assembly into cylinder bore	A
 NT044		EM
ST16610001 Pilot bushing puller	Removing pilot converter	C
 NT045		D
KV10111100 Seal cutter	Removing oil pan (lower and upper), front and rear timing chain case, etc.	E
 NT046		F
WS39930000 Tube presser	Pressing the tube of liquid gasket	G
 NT052		H
KV10109300 Pulley holder	Removing and installing crankshaft pulley a: 68 mm (2.68 in) b: 8 mm (0.31 in) dia.	I
 NT628		J
KV10112100 Angle wrench	Tightening bolts for bearing cap, cylinder head, etc. in angle	K
 NT014		L
KV10117100 Heated oxygen sensor wrench	Loosening or tightening heated oxygen sensor 1 For 22 mm (0.87 in) width hexagon nut	M
 NT379		

PREPARATION

[VQ]

Tool number Tool name	Description
KV10114400 Heated oxygen sensor wrench	Loosening or tightening heated oxygen sensor 2 a: 22 mm (0.87 in)
Quick connector release	Removing fuel tube quick connectors in engine room (Available in SEC. 164 of PARTS CATALOG: Part No. 16441 6N210)



NT636

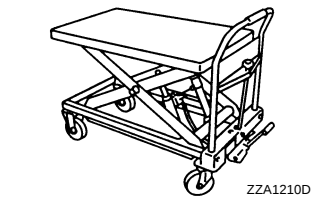


PBIC0198E

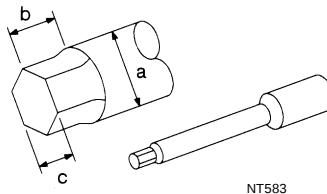
Commercial Service Tools

BBS004VJ

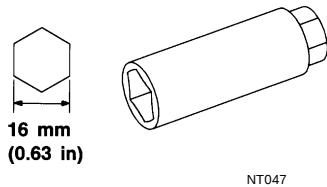
Tool number Tool name	Description
Manual lift table caddy	Removing and installing engine
Cylinder head bolt wrench	Loosening and tightening cylinder head bolt, and used with angle wrench [SST: KV10112100] a: 13 (0.51) dia. b: 12 (0.47) c: 10 (0.39) Unit: mm (in)
Spark plug wrench	Removing and installing spark plug
Valve seat cutter set	Finishing valve seat dimensions
Piston ring expander	Removing and installing piston ring



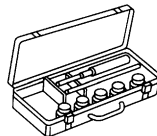
ZZA1210D



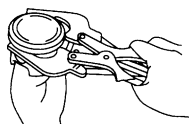
NT583



NT047



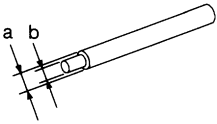
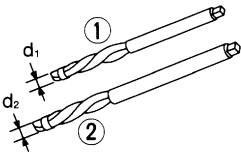
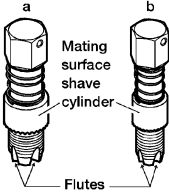
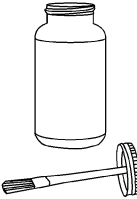
NT048



NT030

PREPARATION

[VQ]

Tool number Tool name	Description	
Valve guide drift	 NT015	Removing and installing valve guide Intake and Exhaust: a: 9.5 mm (0.374 in) dia. b: 5.5 mm (0.217 in) dia.
Valve guide reamer	 NT016	(1): Reaming valve guide inner hole (2): Reaming hole for oversize valve guide Intake and Exhaust: d1 : 6.0 mm (0.236 in) dia. d2 : 10.2 mm (0.402 in) dia.
Oxygen sensor thread cleaner	 AEM488	Reconditioning the exhaust system threads before installing a new heated oxygen sensor (Use with anti-seize lubricant shown below.) a = 18 mm (0.71 in) dia. for zirconia heated oxygen sensor b = 12 mm (0.47 in) dia. for titania heated oxygen sensor
Anti-seize lubricant (Permatex 133AR or equivalent meeting MIL specification MIL-A-907)	 AEM489	Lubricating oxygen sensor thread cleaning tool when reconditioning exhaust system threads

A

EM

C

D

E

F

G

H

I

J

K

L

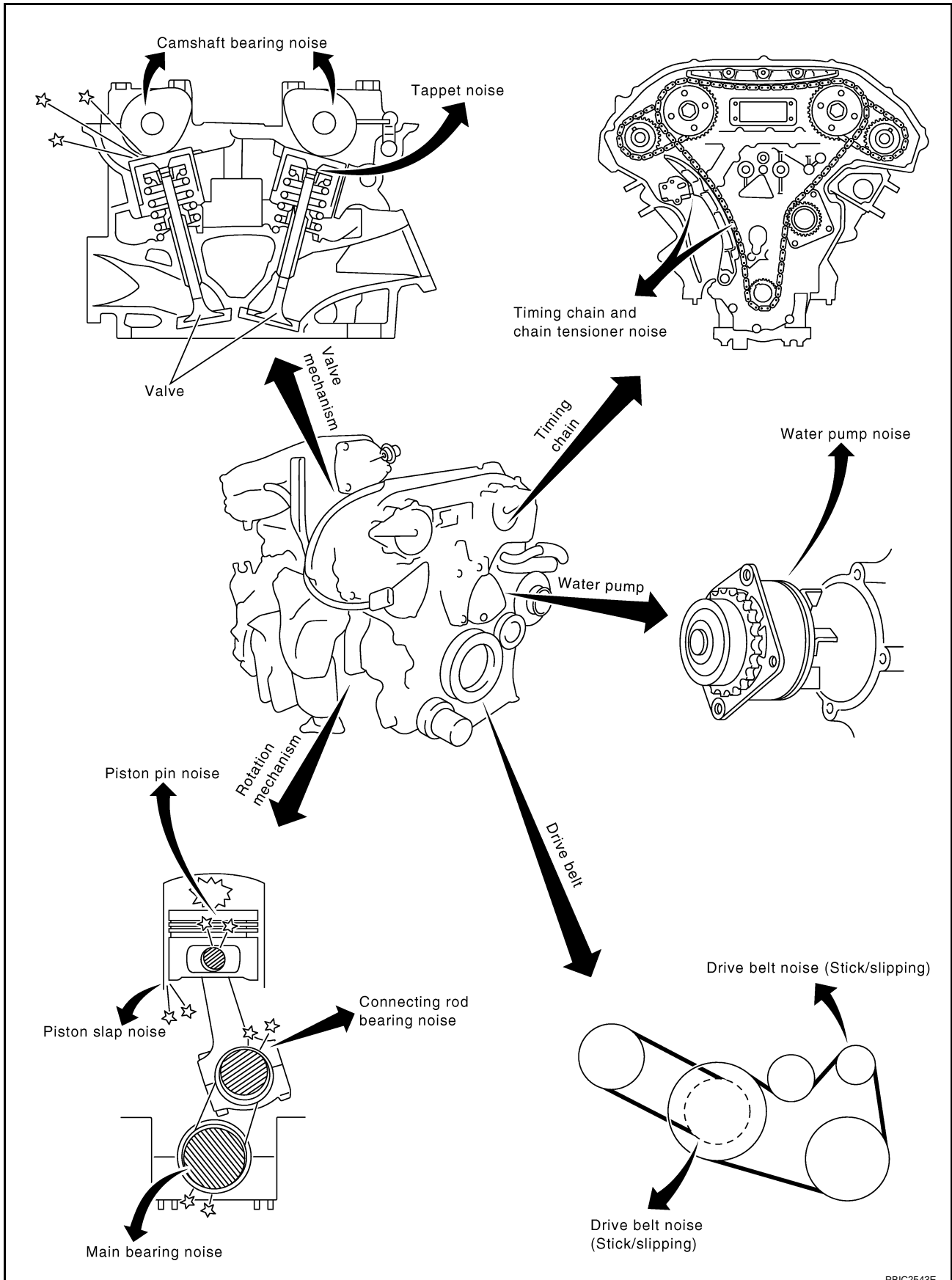
M

NOISE, VIBRATION AND HARSHNESS (NVH) TROUBLESHOOTING

PFP:00003

NVH Troubleshooting — Engine Noise

BBS004VK



PBIC2543E

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

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

If necessary, repair or replace these parts.

Location of noise	Type of noise	Operating condition of engine						Source of noise	Check item	Reference page
		Before warm-up	After warm-up	When starting	When idling	When racing	While driving			
Top of engine Rocker cover Cylinder head	Ticking or clicking	C	A	—	A	B	—	Tappet noise	Valve clearance	EM-202
	Rattle	C	A	—	A	B	C	Camshaft bearing noise	Camshaft runout Camshaft journal oil clearance	EM-194 EM-195
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	EM-245 EM-247
	Slap or rap	A	—	—	B	B	A	Piston slap noise	Piston to cylinder bore clearance Piston ring side clearance Piston ring end gap Connecting rod bend and torsion	EM-249 EM-246 EM-246 EM-247
	Knock	A	B	C	B	B	B	Connecting rod bearing noise	Connecting rod bushing oil clearance Connecting rod bearing oil clearance	EM-247 EM-253
	Knock	A	B	—	A	B	C	Main bearing noise	Main bearing oil clearance Crankshaft runout	EM-252 EM-251
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	EM-180 EM-173
Front of engine	Squeaking or fizzing	A	B	—	B	—	C	Drive belts (Sticking or slipping)	Drive belts deflection	EM-128
	Creaking	A	B	A	B	A	B	Drive belts (Slipping)	Idler pulley bearing operation	
	Squall Creak	A	B	—	B	A	B	Water pump noise	Water pump operation	CO-46 , "WATER PUMP"

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

DRIVE BELTS

Checking Drive Belts

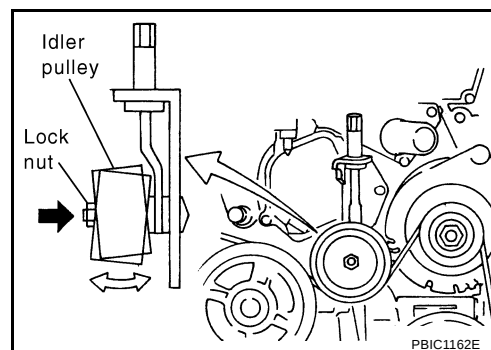
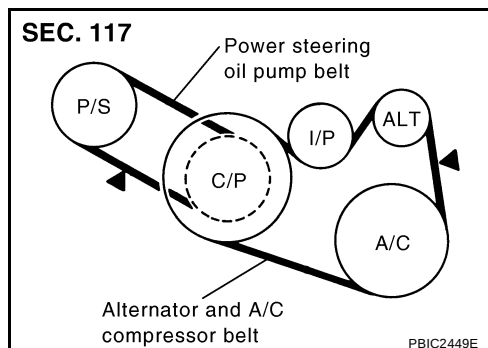
WARNING:

Be sure to perform the following when engine is stopped.

1. Inspect belts for cracks, fraying, wear and oil. If necessary, replace.
2. Inspect drive belt deflection at a point on the belt midway between pulleys.
 - Inspection should be done only when engine is cold, or over 30 minutes after engine is stopped.
 - When measuring deflection, apply 98 N (10 kg, 22 lb) at the ▼ marked point.
 - Adjust if belt deflection exceeds the limit.

CAUTION:

- When checking belt deflection immediately after installation, first adjust it to the specified value. Then, after turning crankshaft two turns or more, re-adjust to the specified value to avoid variation in deflection between pulleys.
- Release the tension by loosening lock nut and turning adjusting bolt when adjusting the belt. Tighten once the lock nut at 4.9 N·m (0.50 Kg-m, 43 in-lb). Then, adjust the belt tension by loosening lock nut between 45° and 90°.



Belt Deflection

	Deflection adjustment		Unit: mm (in)
	Used belt		New belt
	Limit	After adjustment	
Alternator and A/C compressor belt	7 (0.28)	4.2 - 4.6 (0.17 - 0.18)	3.7 - 4.1 (0.15 - 0.16)
Power steering oil pump belt	11 (0.43)	7.3 - 8.0 (0.29 - 0.30)	6.5 - 7.2 (0.26 - 0.28)
Applied pushing force	98 N (10 Kg, 22 lb)		

Tension Adjustment

BBS004VN

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

CAUTION:

- When belt is replaced with a new one, adjust it to value for “New belt” to accommodate for insufficient adaptability with pulley grooves.
- When deflection of belt being used exceeds “Limit”, adjust it to value for “After adjustment”.
- When checking belt deflection immediately after installation, first adjust it to the specified value. Then, after turning 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.

- Release the tension by loosening lock nut and turning adjusting nut when adjusting the belt. Tighten once the lock nut at 4.9 N·m (0.50 Kg-m, 43 in-lb). Then, adjust the belt tension by loosening lock nut between 45° and 90°.
- 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).
3. Release the belt tension on idler pulley by turning adjusting nut (B).
4. Tighten lock nut (A).

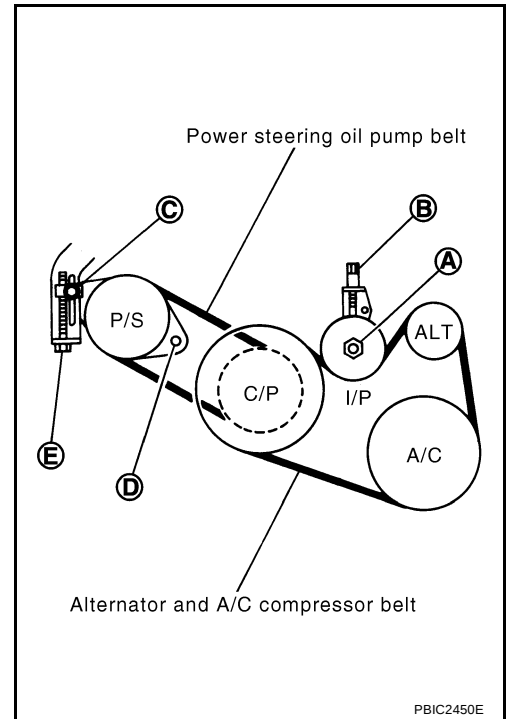
 : 4.9 N·m (0.50 kg-m, 43 in-lb)

5. Loosen lock nut (A) between 45° and 90°.
6. Adjust tension by turning adjusting nut (B).
 - For specified belt tension, refer to [EM-128, "Checking Drive Belts"](#).
7. Tighten lock nut (A).

 : 34.8 N·m (3.5 kg-m, 26 ft-lb)

8. 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-128, "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-128, "Tension Adjustment"](#). Remove alternator and A/C compressor belt and then power steering oil pump belt.

CAUTION:

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

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.
2. Adjust belt tension. Refer to [EM-128, "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-128, "Checking Drive Belts"](#) .

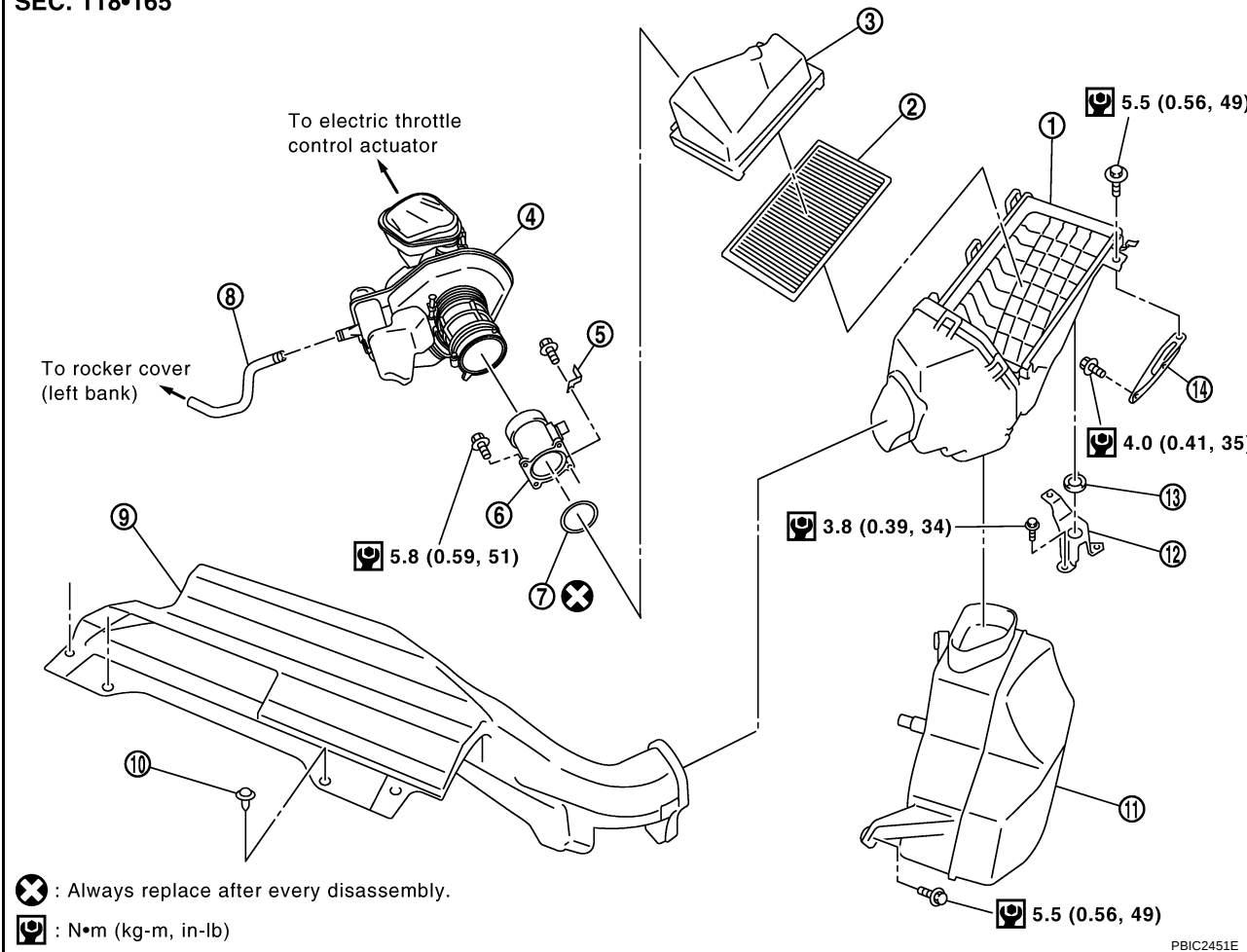
AIR CLEANER AND AIR DUCT

PFP:16500

Removal and Installation

BBS004VP

SEC. 118•165



PBIC2451E

- | | | |
|-----------------------------|-----------------------|-----------------------------|
| 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. Air duct (inlet) |
| 10. Clip | 11. Resonator | 12. Bracket |
| 13. Grommet | | |
| 14. Bracket | | |

REMOVAL

1. Remove air duct (inlet).
2. Disconnect harness connector from mass air flow sensor.
3. Disconnect PCV hose.
4. 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.
5. 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.
6. Remove resonator, removing left side fender protector (front), as necessary. Refer to [EI-23, "FENDER PROTECTOR"](#).

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.

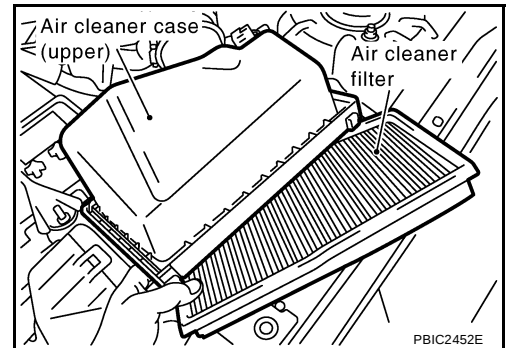
- Align marks. Attach each joint. Screw clamps firmly.

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.

BBS004VQ



INSTALLATION

Installation is the reverse order of removal.

INTAKE MANIFOLD COLLECTOR

PF14003

Removal and Installation

BBS004VR

A

EM

C

D

E

F

G

H

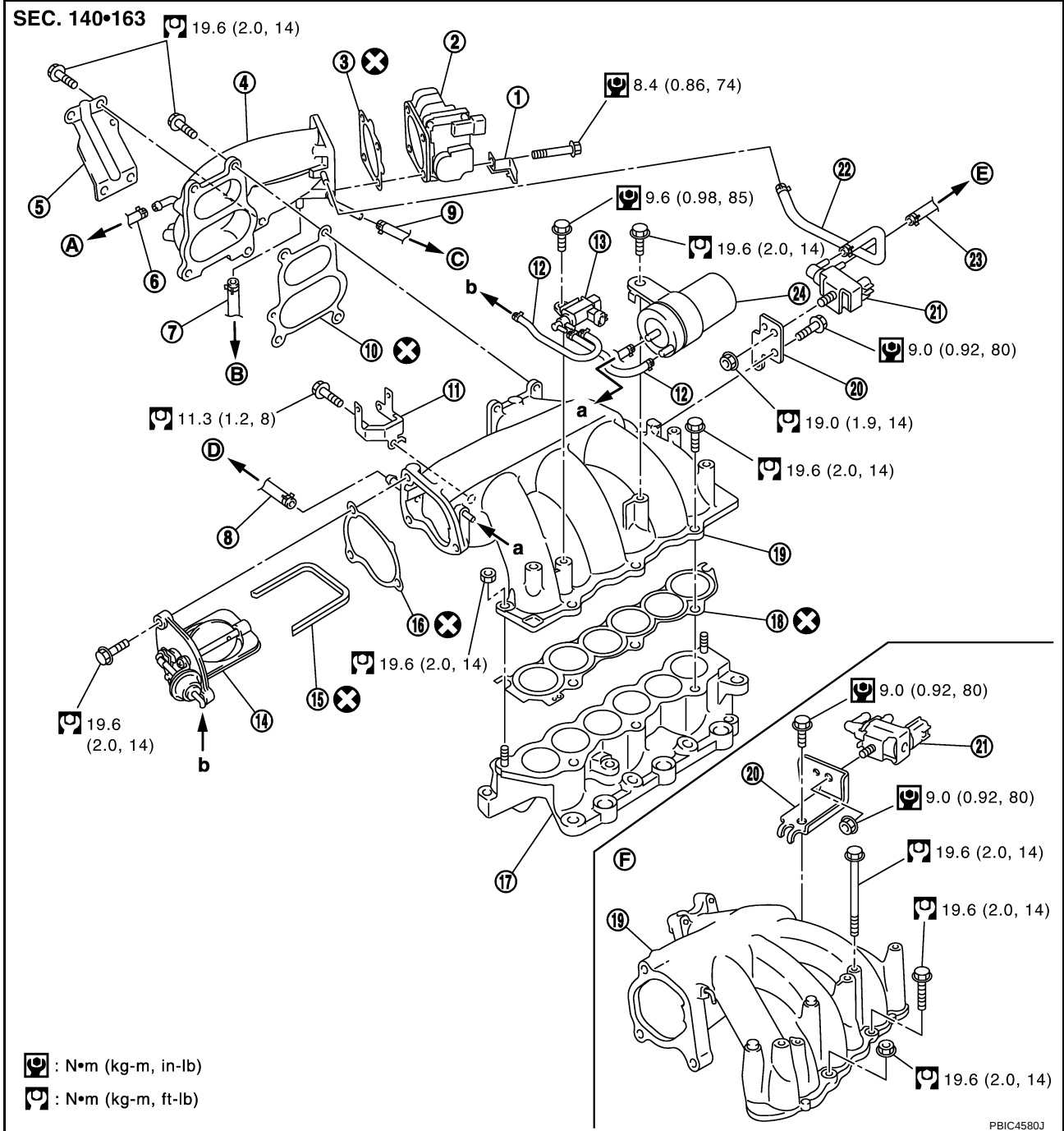
I

J

K

L

M



- | | | |
|---------------------------------------|---------------------------------------|---|
| 1. Bracket | 2. Electric throttle control actuator | 3. Gasket |
| 4. Intake manifold collector (upper) | 5. Intake manifold collector support | 6. PCV hose |
| 7. Water hose | 8. Vacuum hose | 9. Water hose |
| 10. Gasket | 11. Harness bracket | 12. Vacuum hose |
| 13. VIAS control solenoid valve | 14. Power valve | 15. Gasket |
| 16. Gasket | 17. Intake manifold | 18. Gasket |
| 19. Intake manifold collector (lower) | 20. Bracket | 21. EVAP canister purge volume control solenoid valve |
| 22. Vacuum hose | 23. EVAP hose | 24. Vacuum tank |
| A. To rocker cover (right bank) | B. To water outlet | C. To heater pipe |
| D. To brake booster | E. To vacuum pipe (EVAP canister) | F. VQ23DE |

- Refer to [GI-10, "Components"](#) for symbol marks in the figure.

NOTE:

The figure illustrates VQ35DE as an example. Each part form of VQ23DE is different from VQ35DE for difference of port diameter and so forth. Only portions which structures (components) differ are illustrated.

REMOVAL

WARNING:

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

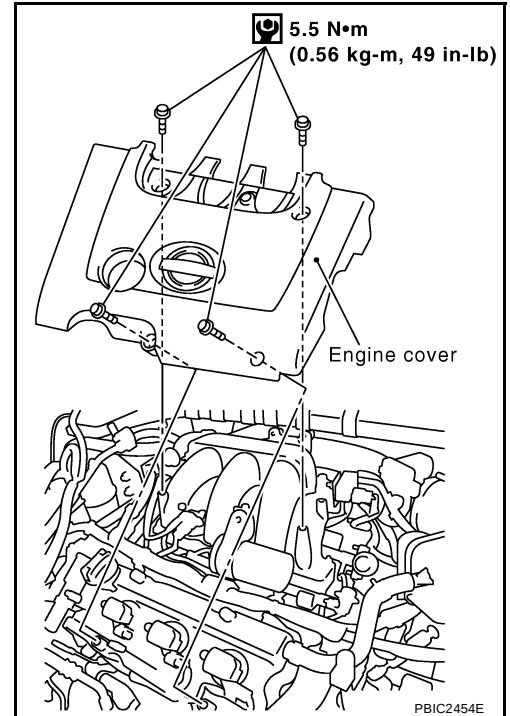
NOTE:

Show VQ35DE as an example unless the figure includes specification.

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-131, "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-34, "Changing Engine Coolant"](#).

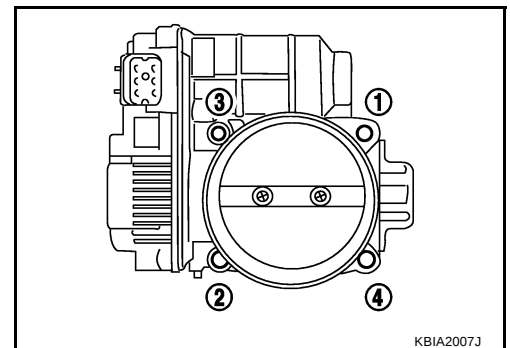
CAUTION:

Perform this step when engine is cold.

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

CAUTION:

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

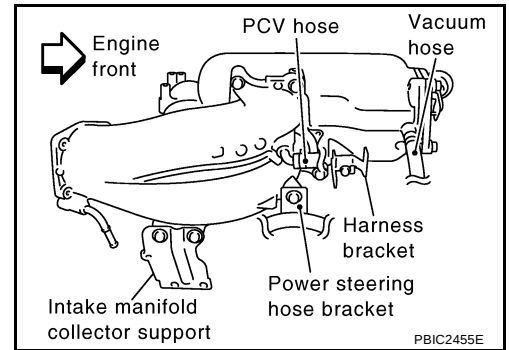


5. Disconnect water hoses from intake manifold collector (upper).
 - When engine coolant is not drained from radiator, attach plug to water hoses to prevent engine coolant leakage.

INTAKE MANIFOLD COLLECTOR

[VQ]

6. Remove the following:
 - Vacuum hose
 - PCV hose
 - Power steering hose bracket
 - Intake manifold collector support
 - Harness bracket



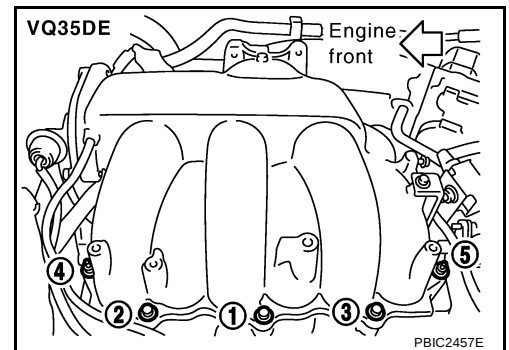
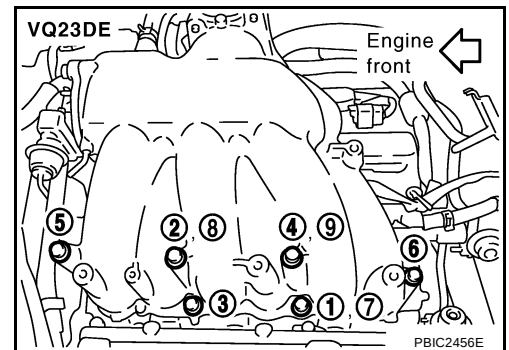
7. Disconnect vacuum hose, EVAP hose and harness connector from EVAP canister purge volume control solenoid valve.
8. Remove EVAP canister purge volume control solenoid valve.
9. Remove VIAS control solenoid valve and vacuum tank.
 - Add mating marks as necessary for easier installation.
10. Loosen mounting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

CAUTION:

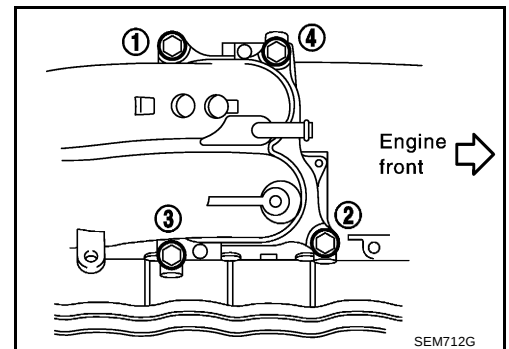
Cover engine openings to avoid entry of foreign materials.

NOTE:

Disregard the numerical order No. 7 to 9 in removal. (VQ23DE)



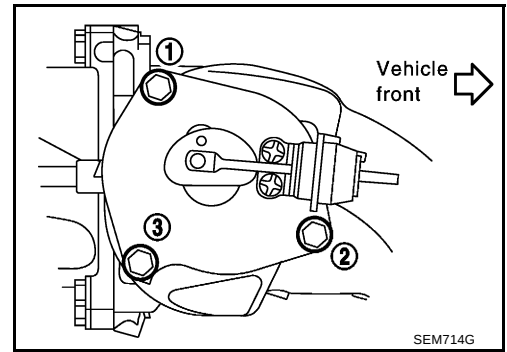
11. Loosen mounting bolts in the reverse order as shown in the figure to remove intake manifold collector (upper) from intake manifold collector (lower).



INTAKE MANIFOLD COLLECTOR

[VQ]

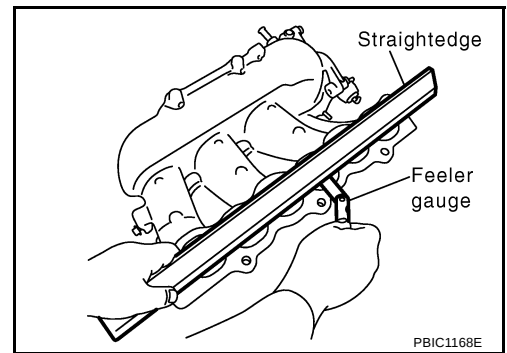
- Loosen mounting bolts in the reverse order as shown in the figure to remove power valve from intake manifold collector (lower).



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

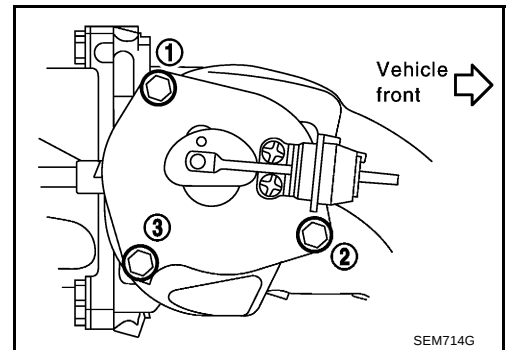
Note the following, and install in the reverse order of removal.

NOTE:

Show VQ35DE as an example unless the figure includes specification.

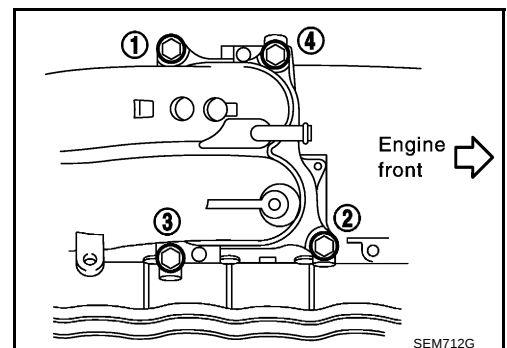
Power Valve

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.

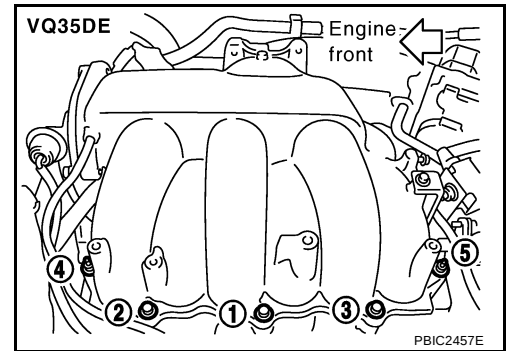
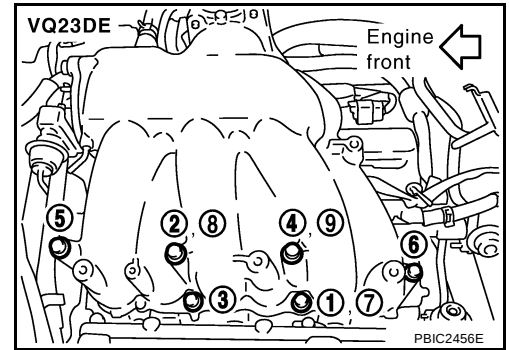


Intake Manifold Collector (Lower)

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

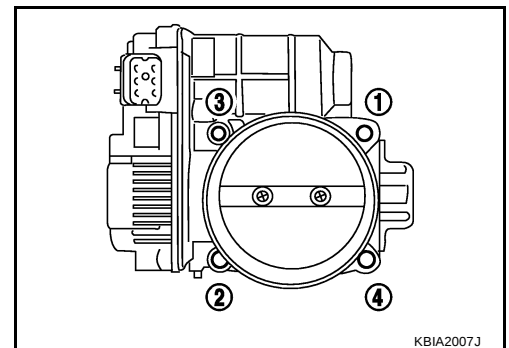
NOTE:

Tighten mounting bolts No. 1, 2 and 4 in two steps. The numerical order of No. 7, 8 and 9 shows second step. (VQ23DE)



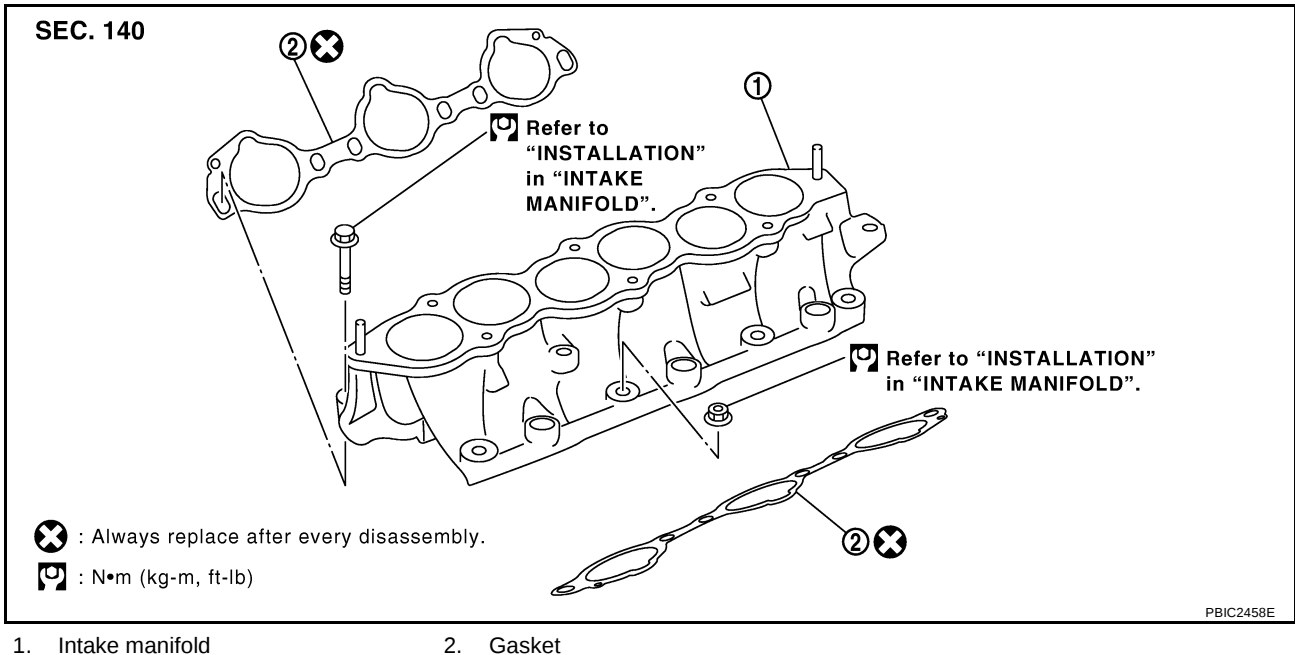
Electric Throttle Control Actuator

- Install gasket with positioning no-protrusion surface upward or downward. (VQ35DE)
- 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-389, "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-389, "Idle Air Volume Learning"](#).



INTAKE MANIFOLD

Removal and Installation

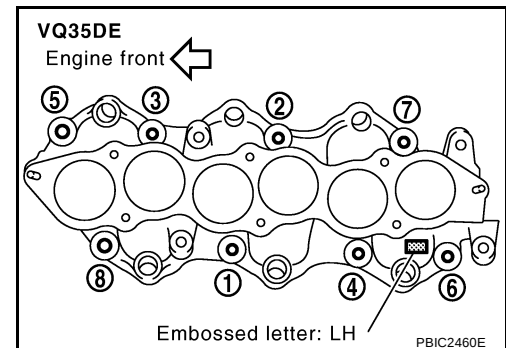
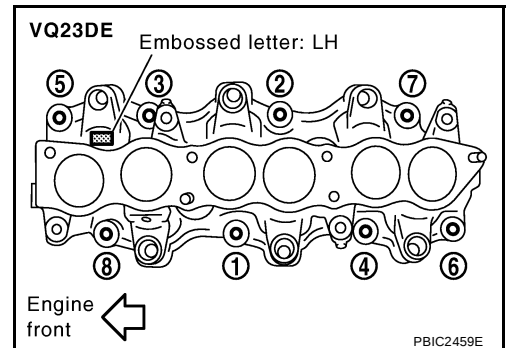


NOTE:

Figure is shown as an example VQ35DE. VQ23DE has a different port shape, bolt hole for intake manifold collector (lower) installation and stud bolt position.

REMOVAL

1. Release fuel pressure. Refer to [EC-392, "FUEL PRESSURE RELEASE"](#).
2. Remove intake manifold collectors (upper and lower). Refer to [EM-133, "INTAKE MANIFOLD COLLECTOR"](#).
3. Remove fuel tube and fuel injector assembly. Refer to [EM-155, "FUEL INJECTOR AND FUEL TUBE"](#).
4. Loosen mounting nuts and bolts in the reverse order as shown in the figure to remove intake manifold.



5. Remove gaskets.

CAUTION:

Cover engine openings to avoid entry of foreign materials.

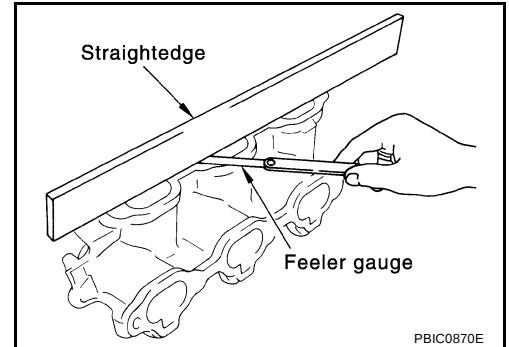
INSPECTION AFTER REMOVAL

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.



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.

 : **10.8 N·m (1.1 kg-m, 8 ft-lb)**

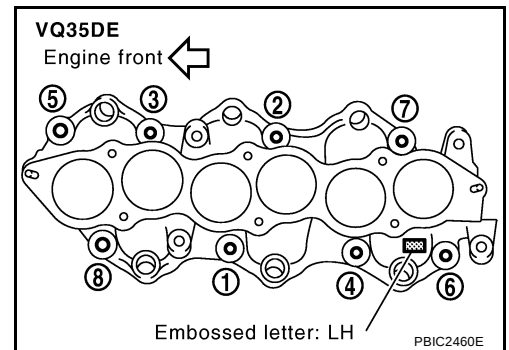
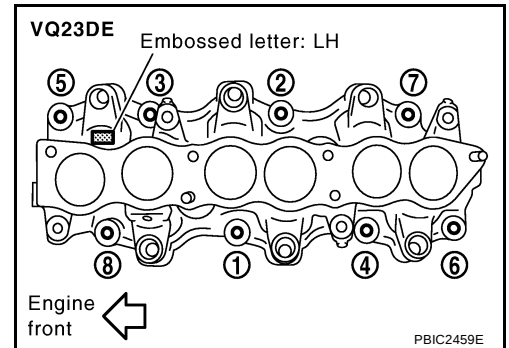
- Position the direction of embossed letter at the edge as shown in the figure, and install intake manifold.
- Tighten all mounting nuts and bolts to the specified torque in two or more steps in numerical order shown in the figure.

 **1st step**

: **7.4 N·m (0.75 kg-m, 5 ft-lb)**

 **2nd step and after**

: **29.0 N·m (3.0 kg-m, 21 ft-lb)**



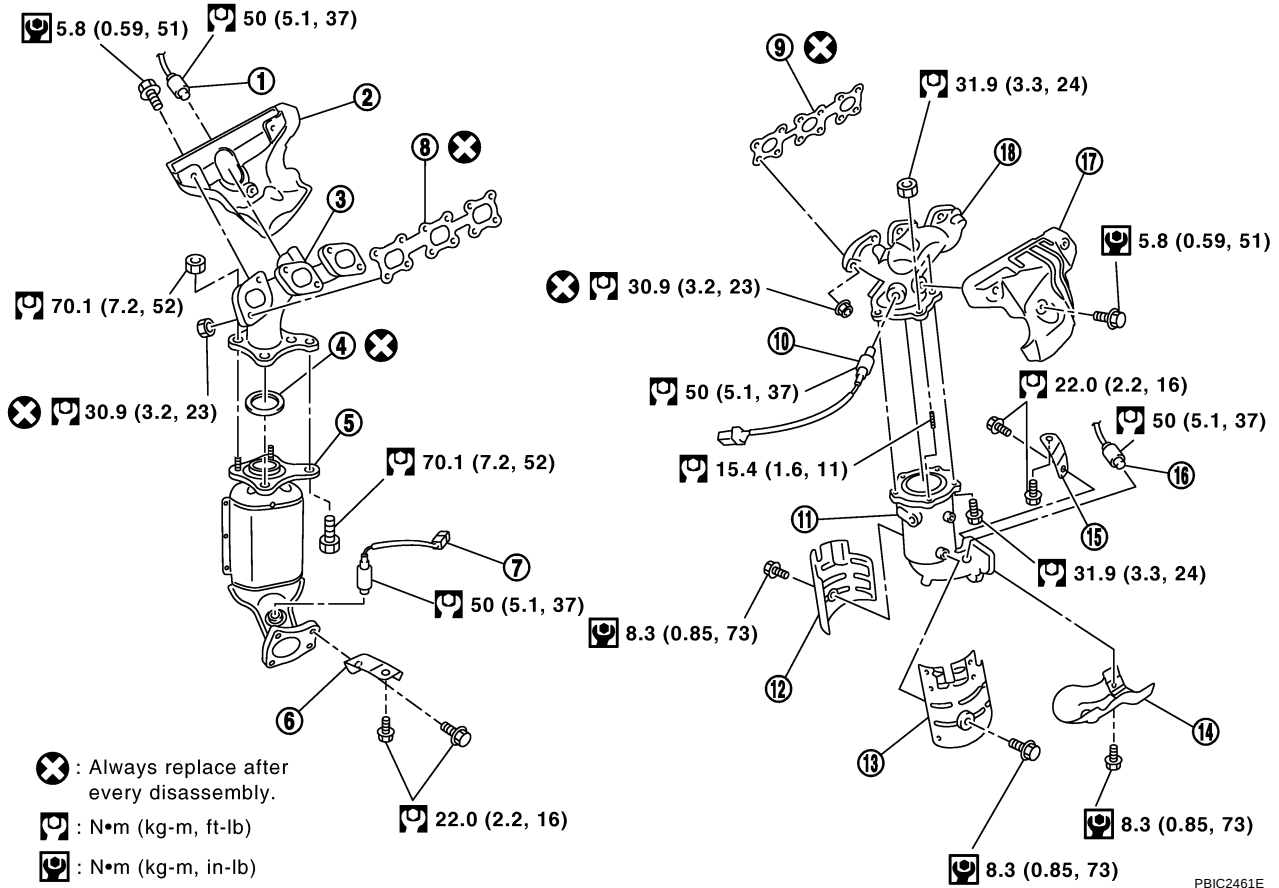
EXHAUST MANIFOLD AND THREE WAY CATALYST

PFP:14004

Removal and Installation

BBS004VT

SEC. 140•208•226



PBIC2461E

- | | | |
|-------------------------------------|--|--|
| 1. Heated oxygen 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. Heated oxygen 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.

1. Drain engine coolant. Refer to [CO-34, "Changing Engine Coolant"](#).

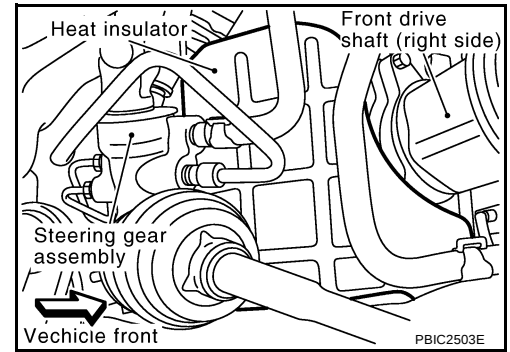
CAUTION:

- Perform this step when engine is cold.
 - Do not spill engine coolant on drive belts.
2. Remove the following:
 - Engine cover; Refer to [EM-133, "INTAKE MANIFOLD COLLECTOR"](#).
 - Air duct (inlet), air cleaner cases (upper and lower) with mass air flow sensor and air duct assembly; Refer to [EM-131, "AIR CLEANER AND AIR DUCT"](#).
 - Undercover
 - Radiator and radiator cooling fan assembly; Refer to [CO-37, "RADIATOR"](#).

EXHAUST MANIFOLD AND THREE WAY CATALYST

[VQ]

3. Remove exhaust front tube mounting bracket and then remove exhaust front tube. Refer to [EX-2](#), "EXHAUST SYSTEM".
4. Remove heat insulator.



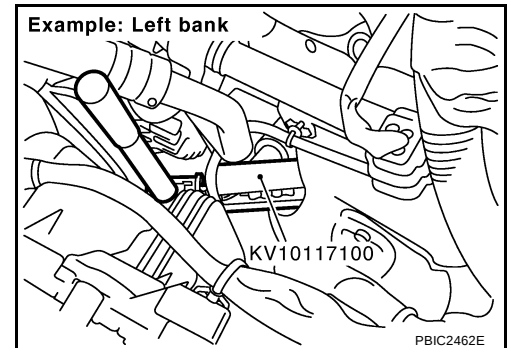
5. Disconnect harness connector and remove heated oxygen sensor 1 on both banks with heated oxygen sensor wrench (SST).
 - Put marks to identify installation positions of each heated oxygen sensor 1.

CAUTION:

- Be careful not to damage heated oxygen sensor 1.
- Discard any heated oxygen sensor 1 which has been dropped onto a hard surface such as a concrete floor; replace with a new sensor.

NOTE:

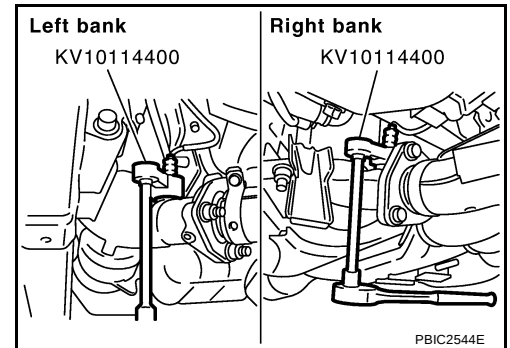
Figure is shown as an example of left bank.



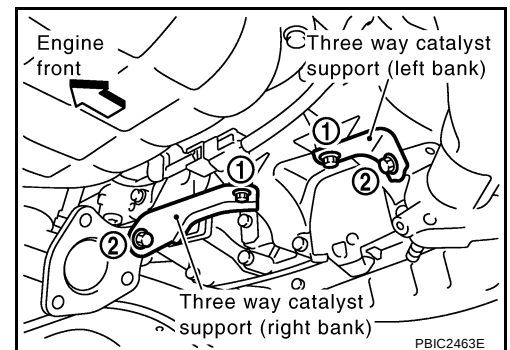
6. Disconnect harness connector and remove heated oxygen sensor 2 on both banks with heated oxygen sensor wrench (SST).
 - Put marks to identify installation positions of each heated oxygen sensor 2.

CAUTION:

- Be careful not to damage heated oxygen sensor 2.
- Discard any heated oxygen sensor 2 which has been dropped onto a hard surface such as a concrete floor; replace with a new sensor.



7. Remove exhaust manifold covers (right and left banks) and three way catalyst covers.
8. Remove mounting bolts in the reverse order as shown in the figure to remove three way catalyst supports (right and left banks).

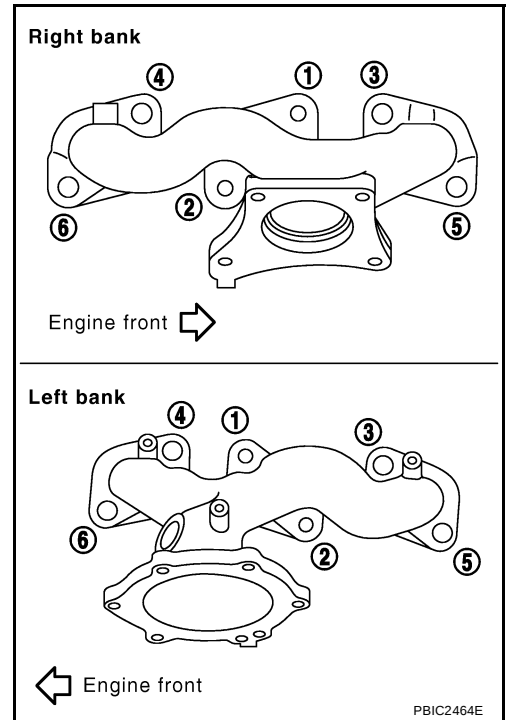


9. Remove three way catalysts (right and left banks) by loosening bolts first and then removing nuts.

CAUTION:

Handle carefully to avoid any shock to three way catalyst.

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



11. Remove gaskets.

CAUTION:

Cover engine openings to avoid entry of foreign materials.

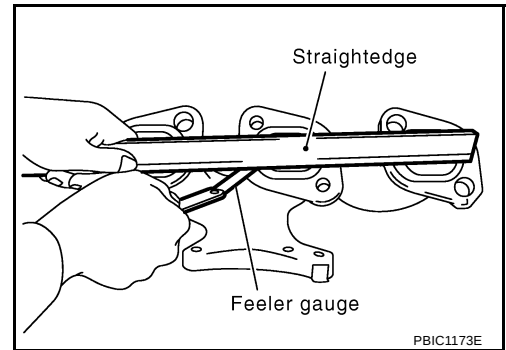
INSPECTION AFTER REMOVAL

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.

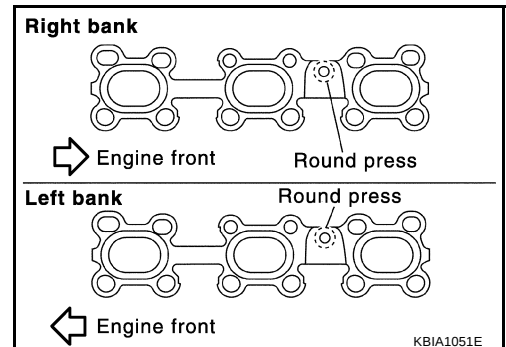


INSTALLATION

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

Exhaust Manifold Gasket

Install in the direction indicated in the figure.

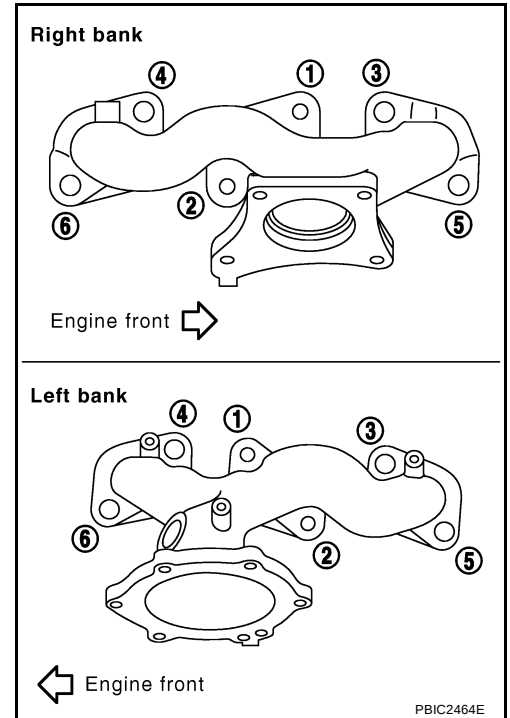


Exhaust Manifold

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

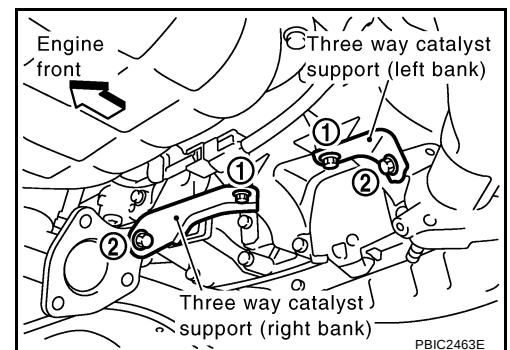
 : 15.4 N·m (1.6 kg-m, 11 ft-lb)

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



Three Way Catalyst Supports

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



Heated Oxygen Sensor

- Install heated oxygen sensors in the original position.
- Install referring the following if the installation positions cannot be identified.

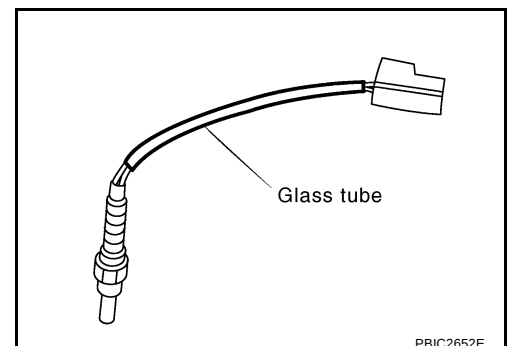
Glass tube color

Heated oxygen sensor 1 (bank 1)	: Green
Heated oxygen sensor 1 (bank 2)	: Black
Heated oxygen sensor 2*	: White

*: Heated oxygen sensor 2 are same parts both bank 1 and bank 2.

CAUTION:

- Before installing new heated oxygen sensor, clean exhaust system threads using heated oxygen sensor thread cleaner (commercial service tool) 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.

OIL PAN AND OIL STRAINER

PFP:11110

Removal and Installation

BBS004VU

A

EM

C

D

E

F

G

H

I

J

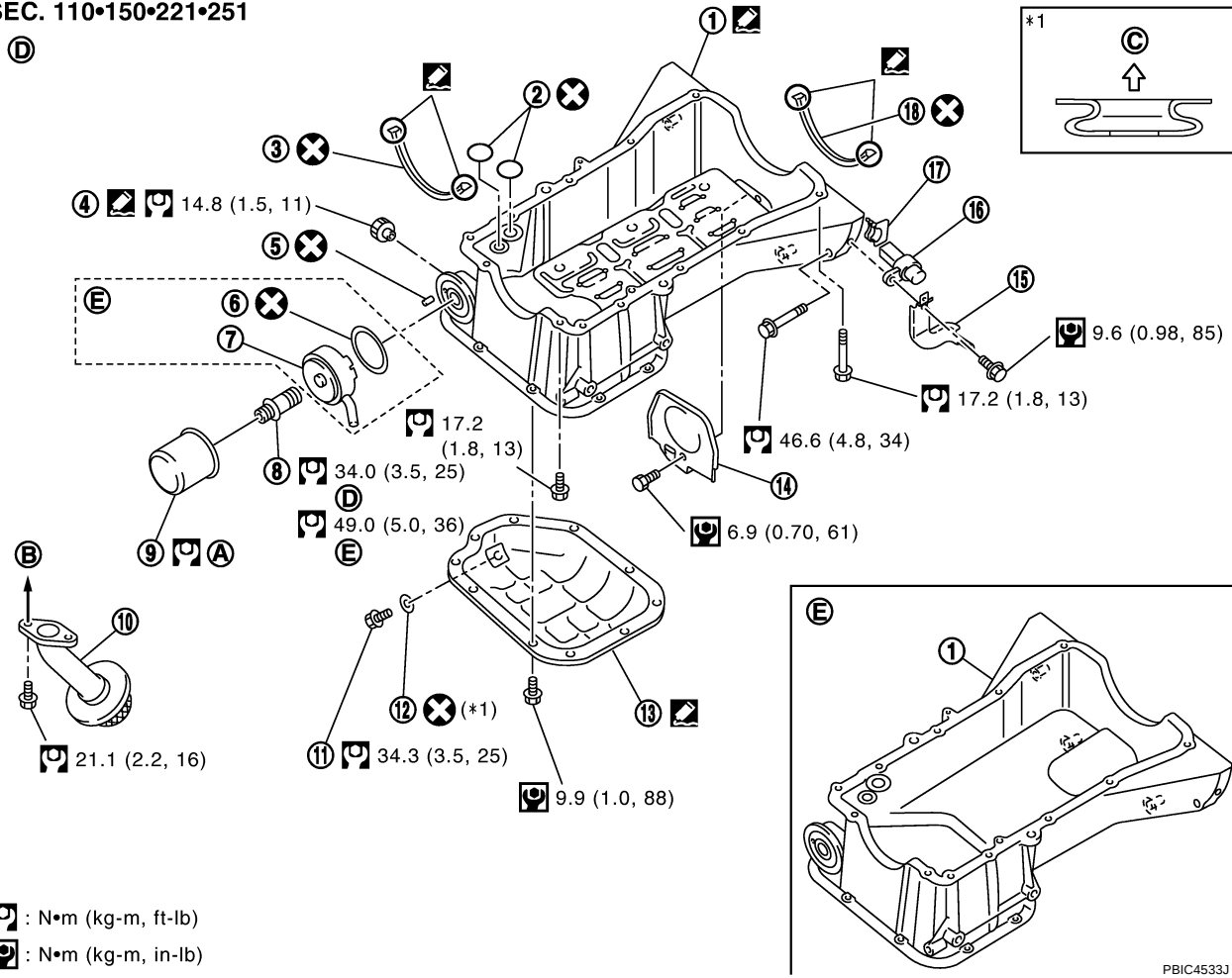
K

L

M

SEC. 110•150•221•251

D



- | | | |
|--------------------------------------|---|---------------------------|
| 1. Oil pan (upper) | 2. O-ring | 3. Oil pan gasket (front) |
| 4. Oil pressure switch | 5. Plug (VQ23DE)
Relief valve (VQ35DE) | 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 (rear) |
| A. Refer to LU-22 | B. To oil pump | C. Oil pan side |
| D. VQ23DE | E. VQ35DE | |

- Refer to [GI-10, "Components"](#) for symbol marks in the figure.

REMOVAL

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-21, "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-34, "Changing Engine Coolant"](#).

CAUTION:

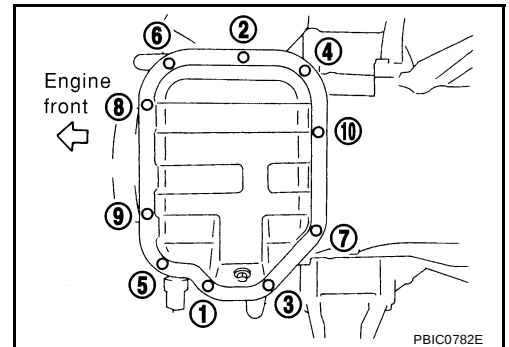
- Perform this step when engine is cold.
- Do not spill engine coolant on drive belts.

- Remove the following:
 - Engine cover; Refer to [EM-133, "INTAKE MANIFOLD COLLECTOR"](#) .
 - Splash guard (RH)
 - Exhaust front tube; Refer to [EX-2, "EXHAUST SYSTEM"](#) .
 - Drive belts; Refer to [EM-128, "DRIVE BELTS"](#) .
- Remove A/C compressor with piping connected, and temporarily secure it to aside. Refer to [ATC-133, "Components"](#) .
- Remove three way catalysts (right and left banks) from exhaust manifolds (right and left banks). Refer to [EM-140, "EXHAUST MANIFOLD AND THREE WAY CATALYST"](#) .
- Remove oil pressure switch. Refer to [LU-20, "OIL PRESSURE CHECK"](#) .
- 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.

- Remove oil filter. Refer to [LU-22, "OIL FILTER"](#) .
- Remove oil cooler and water pipes (VQ35DE). Refer to [LU-23, "OIL COOLER \(VQ35DE\)"](#) .
- Remove oil pan (lower) as follows:
 - Loosen mounting bolts in the reverse order as shown in the figure.

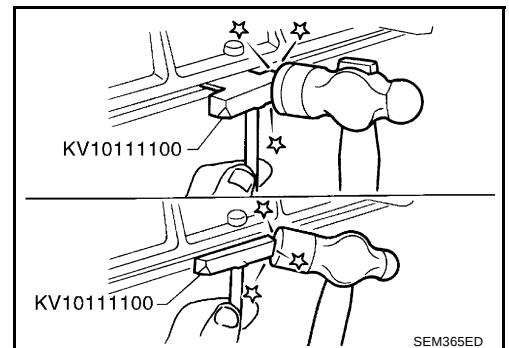


- Insert seal cutter (SST) between oil pan (lower) and oil pan (upper).

CAUTION:

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

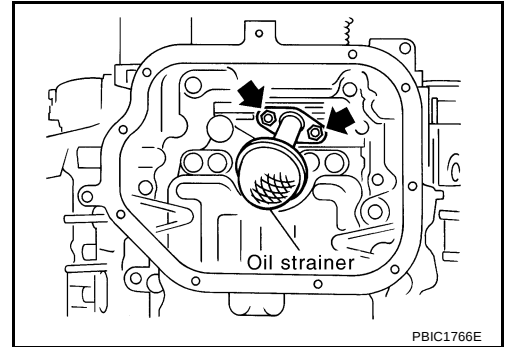
- Slide seal cutter by tapping on the side of the tool with hammer. Remove oil pan (lower).



OIL PAN AND OIL STRAINER

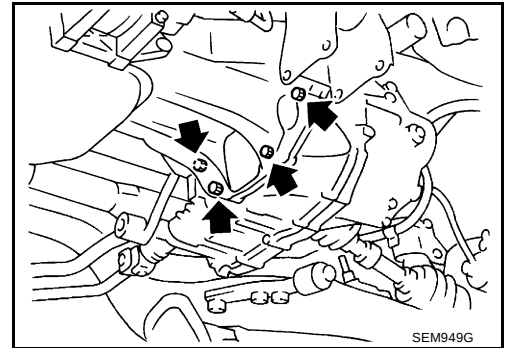
[VQ]

11. Remove oil strainer.

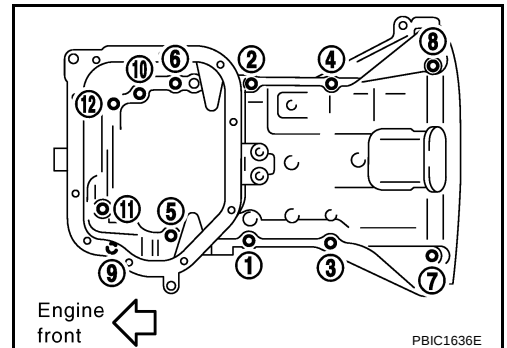


12. Remove oil pan (upper) as follows:

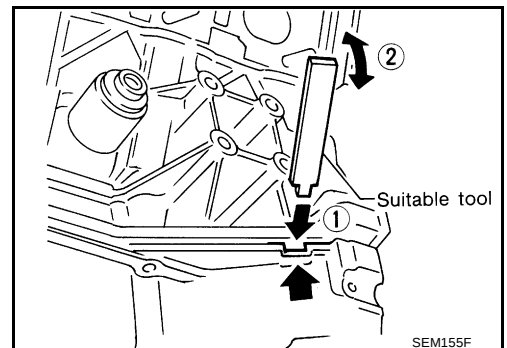
a. Remove transaxle joint bolts which pierce oil pan (upper).



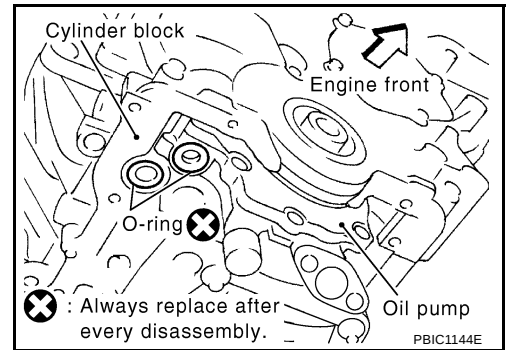
b. Loosen mounting bolts in the reverse order as shown in the figure.



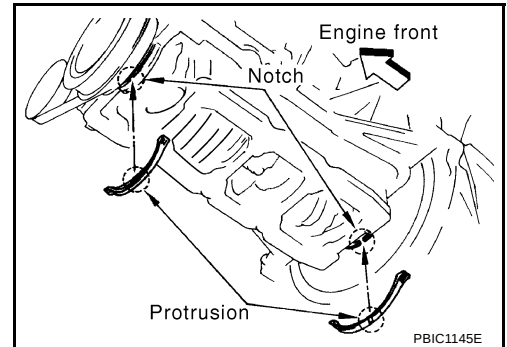
c. Insert suitable tool into the notch of oil pan (upper) as shown (1). Pry off oil pan (upper) by moving tool up and down as shown (2) to remove oil pan (upper).



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



14. Remove oil pan gasket.



INSPECTION AFTER REMOVAL

Oil Strainer

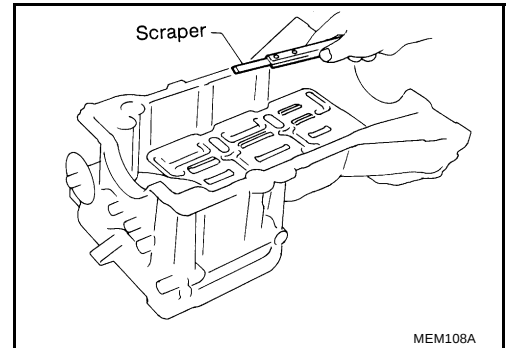
Clean oil strainer if any object attached.

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.

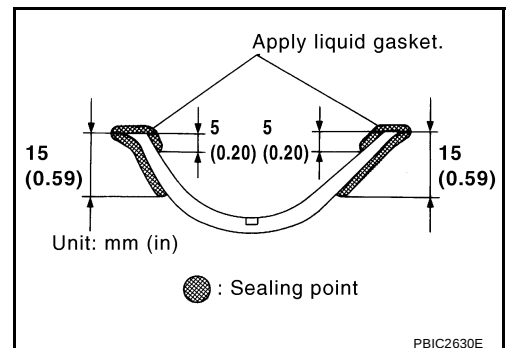
CAUTION:

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

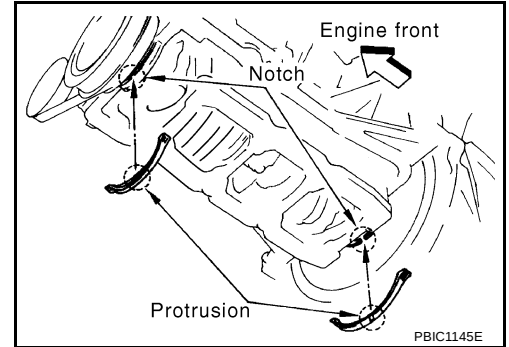


- b. Install oil pan gaskets.
 - Apply liquid gasket to new oil pan gaskets as shown in the figure.

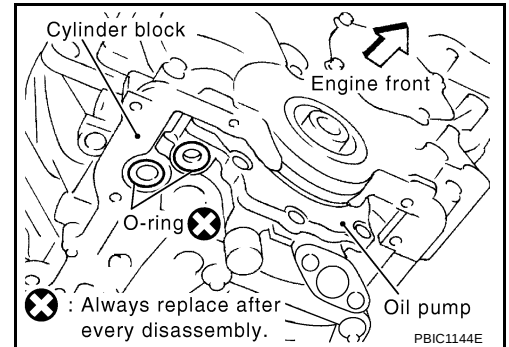
Use Genuine Liquid Gasket or equivalent.



- 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.

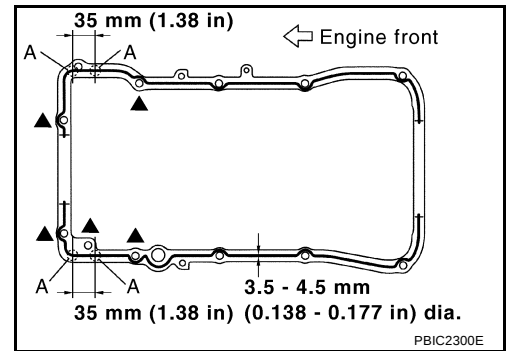


- d. Apply a continuous bead of liquid gasket with tube presser [SST: WS39930000] to cylinder block mating surface of oil pan (upper) to a limited portion as shown in the figure.

Use Genuine Liquid Gasket or equivalent.

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).

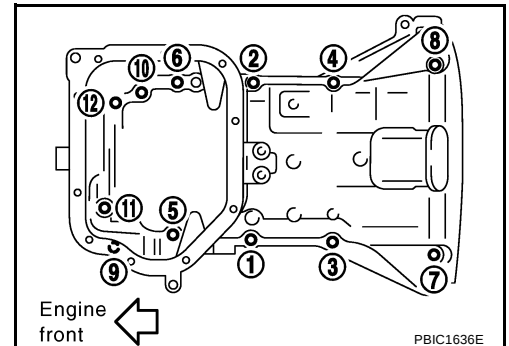
CAUTION:

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

- Tighten 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.
 2. Install oil strainer to oil pump.
 3. Install oil pan (lower) as follows:

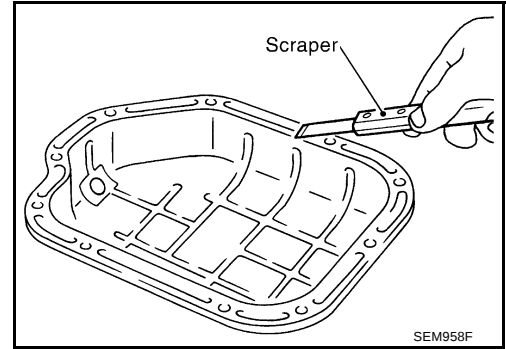
OIL PAN AND OIL STRAINER

[VQ]

- 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.

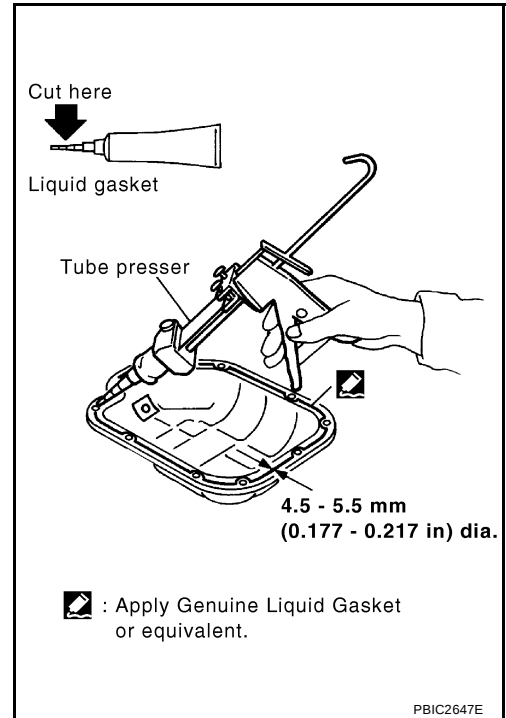


- b. Apply a continuous bead of liquid gasket with tube presser [SST: WS39930000] to oil pan (lower) as shown in the figure.

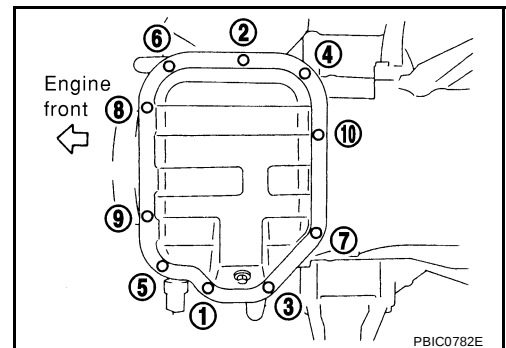
Use Genuine Liquid Gasket or equivalent.

CAUTION:

Attaching should be done within 5 minutes after coating.



- c. Install oil pan (lower).
- 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-145, "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

1. Check the engine oil level and adjust engine oil. Refer to [LU-19, "ENGINE OIL"](#).
2. Start engine, and make sure there is no leak of engine oil.

- 3. Stop engine and wait for 10 minutes.
- 4. Check the engine oil level again. Refer to [LU-19, "ENGINE OIL"](#) .

A

EM

C

D

E

F

G

H

I

J

K

L

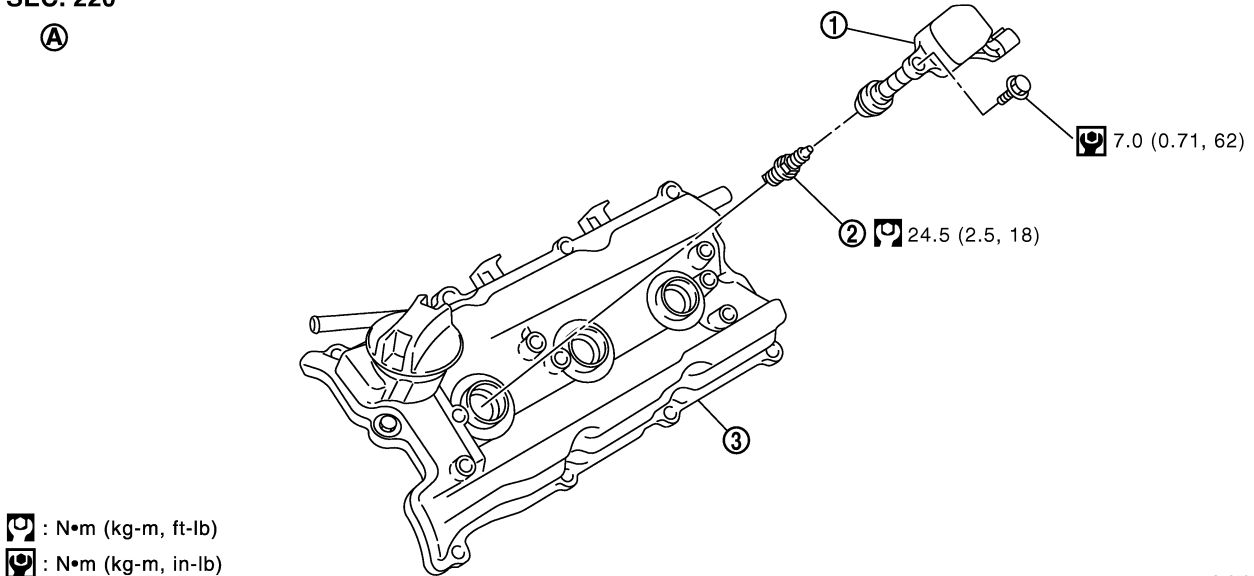
M

IGNITION COIL

Removal and Installation

SEC. 220

A



: N·m (kg-m, ft-lb)

: N·m (kg-m, in-lb)

PBIC4359E

1. Ignition coil

2. Spark plug

3. Rocker cover

A. Left bank

REMOVAL

1. Remove engine cover. Refer to [EM-133, "INTAKE MANIFOLD COLLECTOR"](#) .
2. Remove intake manifold collectors (upper and lower). (At the right bank side, remove ignition coil) Refer to [EM-133, "INTAKE MANIFOLD COLLECTOR"](#) .
3. Move aside harness, harness bracket, and hoses located above ignition coil.
4. Disconnect harness connector from ignition coil.
5. Remove ignition coil.

CAUTION:

Do not drop or shock it.

INSTALLATION

Installation is the reverse order of removal.

SPARK PLUG (PLATINUM-TIPPED TYPE)

PFP:22401

Removal and Installation

BBS004VW

A

EM

C

D

E

F

G

H

I

J

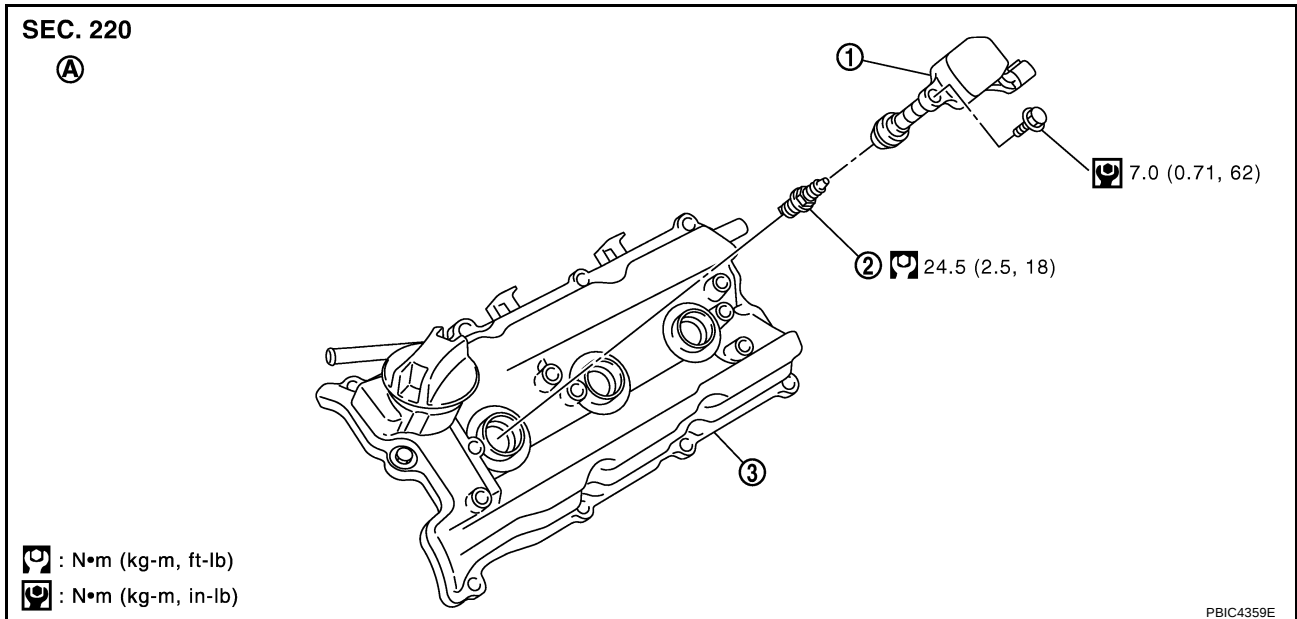
K

L

M

SEC. 220

A



PBIC4359E

1. Ignition coil

2. Spark plug

3. Rocker cover

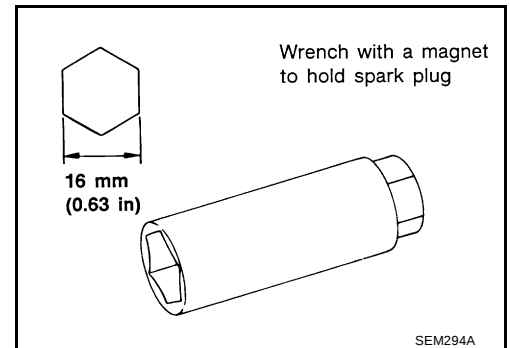
A. Left bank

REMOVAL

1. Remove engine cover. Refer to [EM-133, "INTAKE MANIFOLD COLLECTOR"](#).
2. Remove ignition coil. Refer to [EM-152, "IGNITION COIL"](#).
3. Remove spark plug using spark plug wrench (commercial service tool).

CAUTION:

Do not drop or shock it.



SEM294A

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)

[VQ]

CAUTION:

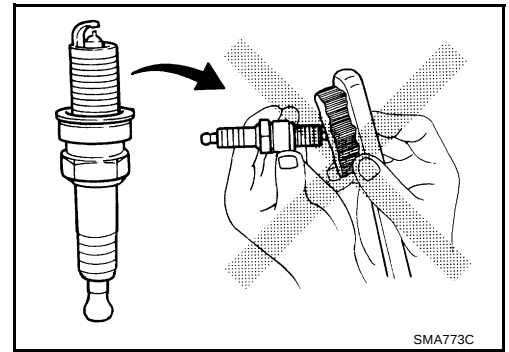
- Do not drop or shock spark plug.
- Do not use wire brush for cleaning.
- If plug tip is covered with carbon, spark plug cleaner may be used.

Cleaner air pressure:

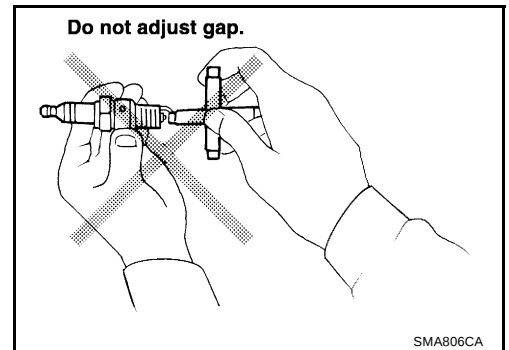
Less than 588 kPa (5.88 bar, 6 kg/cm² , 85 psi)

Cleaning time:

Less than 20 seconds



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



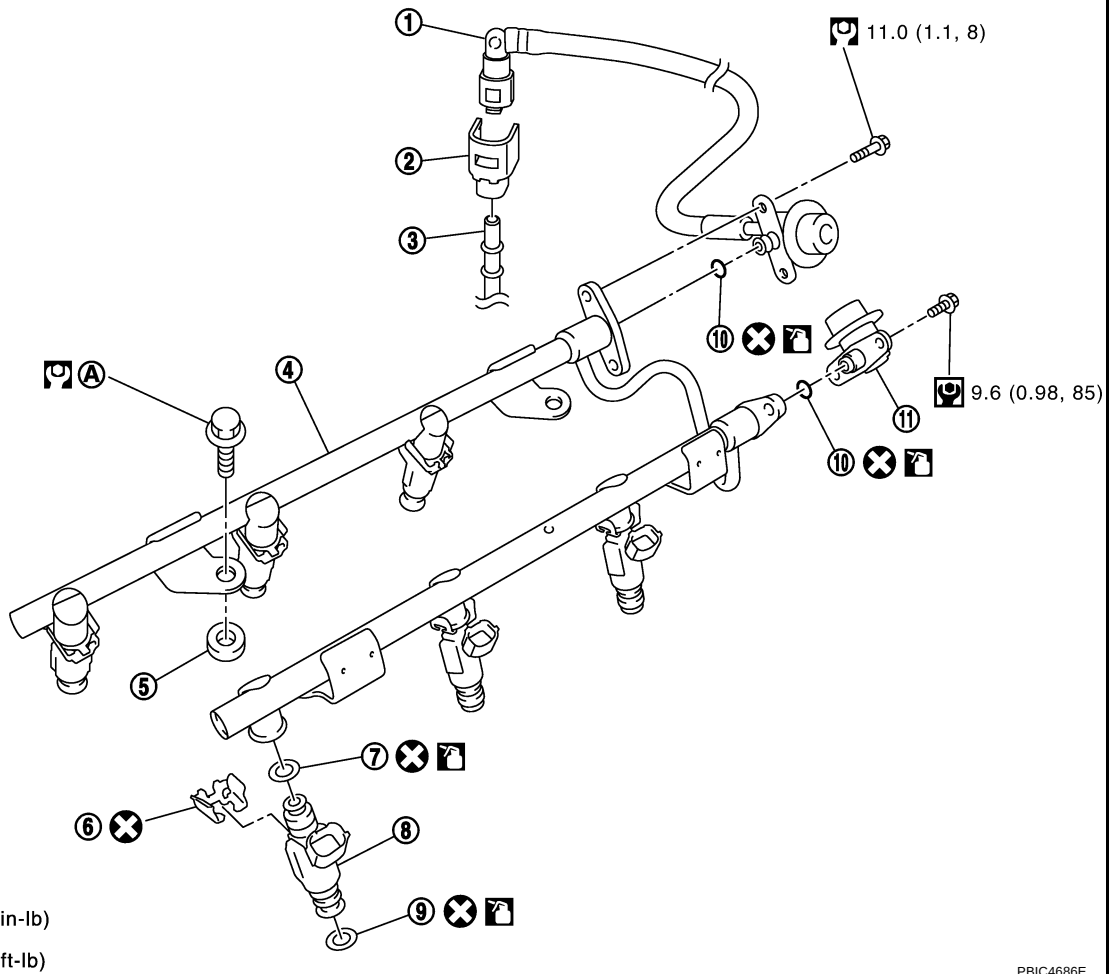
INSTALLATION

Installation is the reverse order of removal.

FUEL INJECTOR AND FUEL TUBE

Removal and Installation

SEC. 164



- | | | |
|--|------------------------|---|
| 1. Fuel feed hose (with damper) | 2. Quick connector cap | 3. Centralized under-floor piping |
| 4. Fuel tube | 5. Spacer | 6. Clip |
| 7. O-ring (black) (VQ23DE)
O-ring (blue) (VQ35DE) | 8. Fuel injector | 9. O-ring (green) (VQ23DE)
O-ring (brown) (VQ35DE) |
| 10. O-ring | 11. Fuel damper | |

A. Refer to [EM-157](#)

- Refer to GI-10, "Components" for symbol marks in the figure.

CAUTION:

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

REMOVAL

WARNING:

- Put a “CAUTION FLAMMABLE” sign in the workshop.
- Be sure to work in a well ventilated area and furnish workshop with a CO₂ fire extinguisher.
- Do not smoke while servicing fuel system. Keep open flames and sparks away from the work area.
- To avoid the danger of being scalded, do not drain engine coolant when engine is hot.

1. Remove engine cover. Refer to [EM-133, "INTAKE MANIFOLD COLLECTOR"](#) .
2. Release the fuel pressure. Refer to [EC-392, "FUEL PRESSURE RELEASE"](#) .
3. Drain engine coolant, or when water hoses are disconnected, attach plug to prevent engine coolant leakage. Refer to [CO-34, "Changing Engine Coolant"](#) and [EM-133, "INTAKE MANIFOLD COLLECTOR"](#) .

CAUTION:

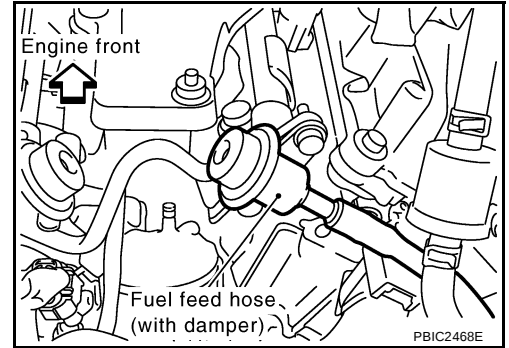
Perform this step when engine is cold.

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

4. Remove air duct (inlet), air cleaner case (upper) with mass air flow sensor and air duct assembly. Refer to [EM-131, "AIR CLEANER AND AIR DUCT"](#).
5. Remove intake manifold collectors (upper and lower). Refer to [EM-133, "INTAKE MANIFOLD COLLECTOR"](#).
6. 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.



7. 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), 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.

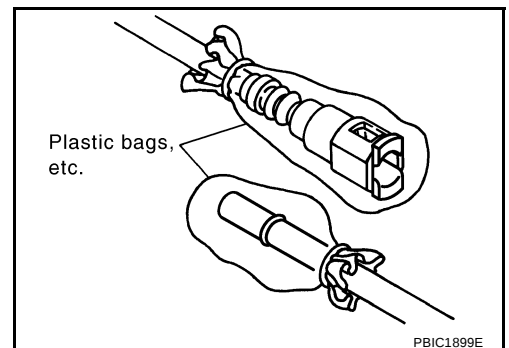
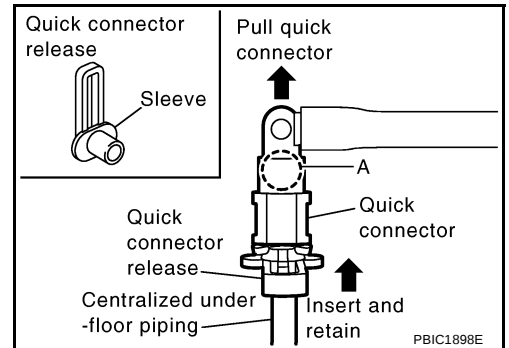
CAUTION:

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:

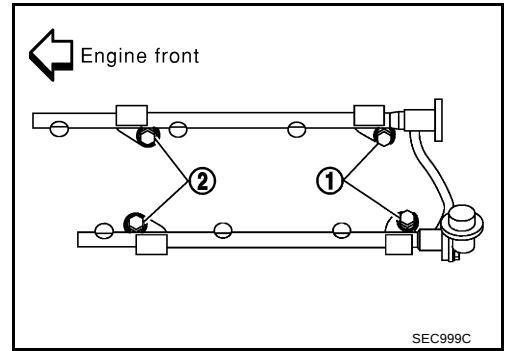
- Pull quick connector holding "A" position as shown in the figure.
- Do not pull with lateral force applied. O-ring inside quick connector may be damaged.
- Prepare container and cloth beforehand as fuel will leak out.
- Avoid fire and sparks.
- Keep parts away from heat source. Especially, be careful 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.



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

CAUTION:

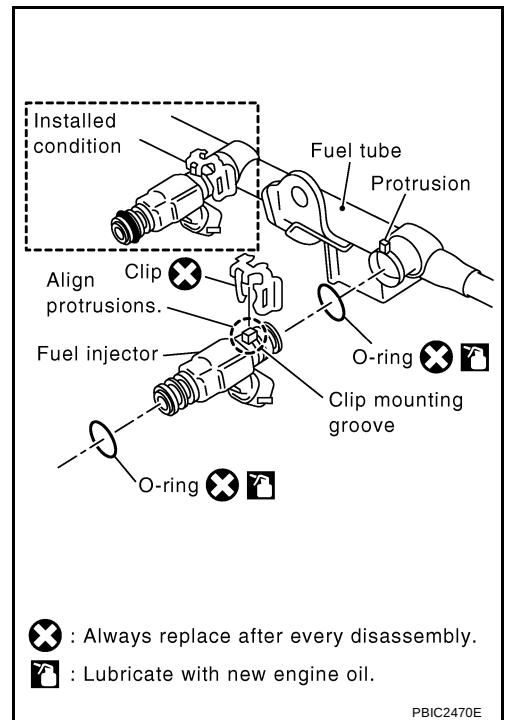
Do not tilt it, or remaining fuel in pipes may flow out from pipes.



10. Remove spacers on intake manifold.
11. 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.



12. Remove fuel damper from 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-rings are different. Be careful not to confuse them.

Fuel tube side

VQ23DE : Black

VQ35DE : Blue

Nozzle side

VQ23DE : Green

VQ35DE : Brown

- Handle O-ring with bare hands. Do not wear gloves.
- Lubricate O-ring with new engine oil.
- Do not clean O-ring with solvent.
- Make sure that O-ring and its mating part are free of foreign material.
- When installing O-ring, be careful not to scratch it with tool or fingernails. Also be careful not to twist or stretch O-ring. If O-ring was stretched while it was being attached, do not insert it quickly into fuel tube.
- Insert O-ring straight into fuel 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:

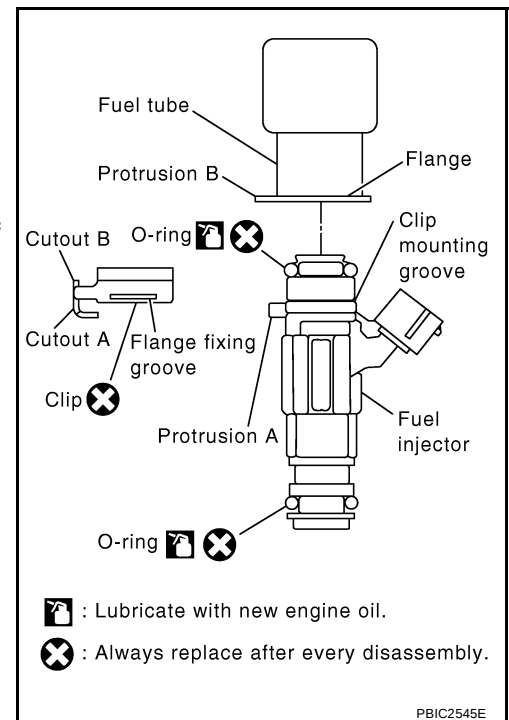
- Do not reuse clip. Replace it with new one.
- Be careful to keep clip from interfering with O-ring. If interference occurs, replace O-ring.

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.



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.

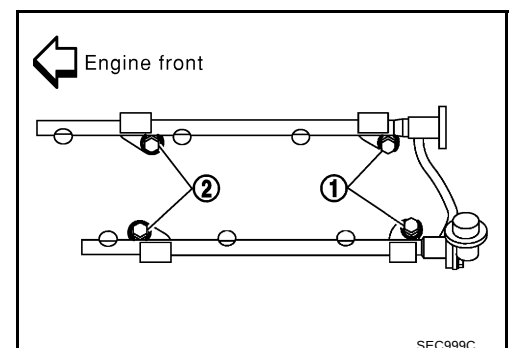
- Tighten mounting bolts in two steps in numerical order as shown in the figure.

1st step

: 10.1 N·m (1.0 kg-m, 7 ft-lb)

2nd step

: 23.6 N·m (2.4 kg-m, 17 ft-lb)



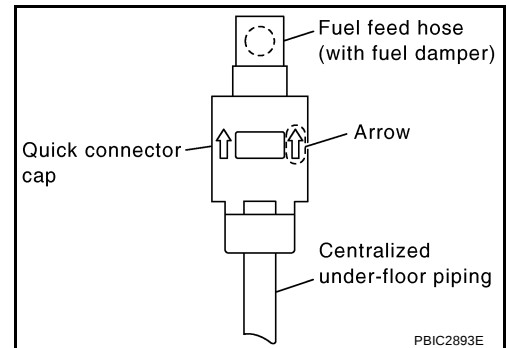
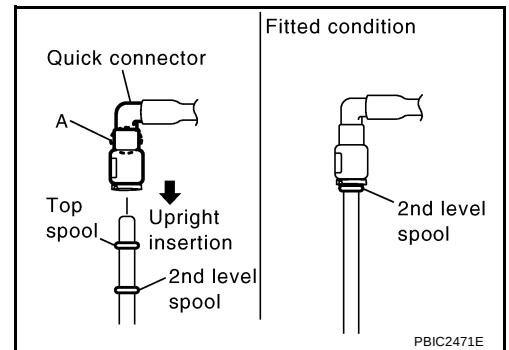
6. Connect fuel injector harness connector.
7. Install intake manifold collectors (upper and lower). Refer to [EM-133, "INTAKE MANIFOLD COLLECTOR"](#).
8. Connect fuel feed hose (with damper).
 - Handling procedure of O-ring is the same as that of fuel damper.
 - Insert fuel damper straight into fuel 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 as follows:
 - 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.



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

INSPECTION AFTER INSTALLATION

Check Fuel Leakage

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

NOTE:

Use mirrors for checking at points out of clear sight.

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

CAUTION:

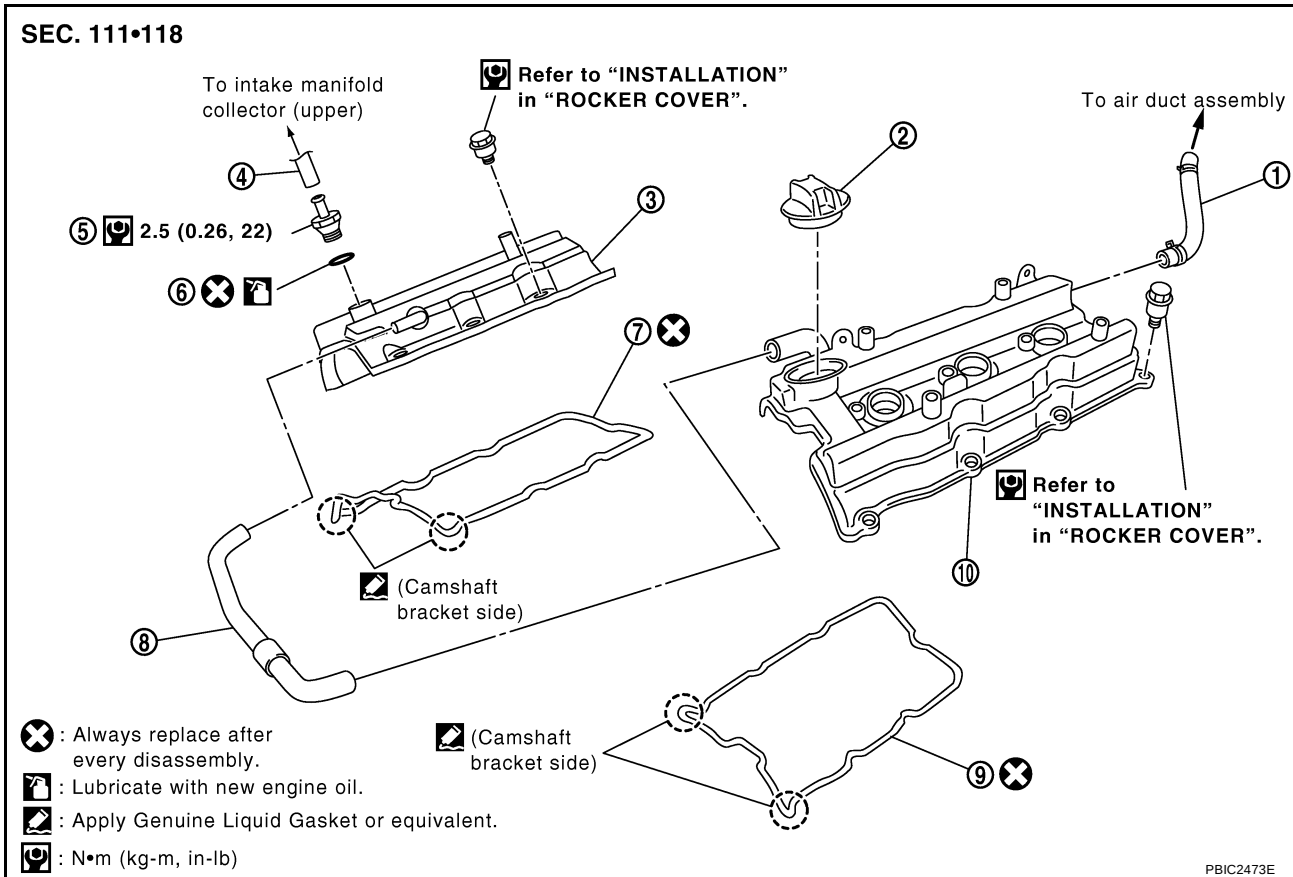
Do not touch engine immediately after stopped, as engine becomes extremely hot.

ROCKER COVER

PF13264

Removal and Installation

BBS004VY



PBIC2473E

- | | | |
|-------------------------------------|-------------------|------------------------------------|
| 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) | | |

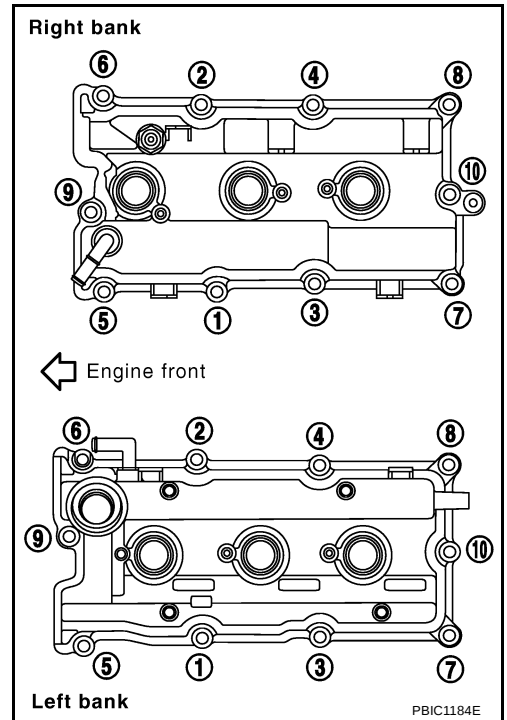
REMOVAL

1. Remove engine cover. Refer to [EM-133, "INTAKE MANIFOLD COLLECTOR"](#).
2. Remove intake manifold collectors (upper and lower). (At the right bank side remove) Refer to [EM-133, "INTAKE MANIFOLD COLLECTOR"](#).
3. Remove ignition coil. Refer to [EM-152, "IGNITION COIL"](#).
4. Remove PCV hoses from rocker covers.
5. Remove PCV valve and O-ring from rocker cover (right bank), if necessary.
6. Remove oil filler cap from rocker cover (left bank), if necessary.

ROCKER COVER

[VQ]

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



8. Remove rocker cover gaskets from rocker covers.
9. 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

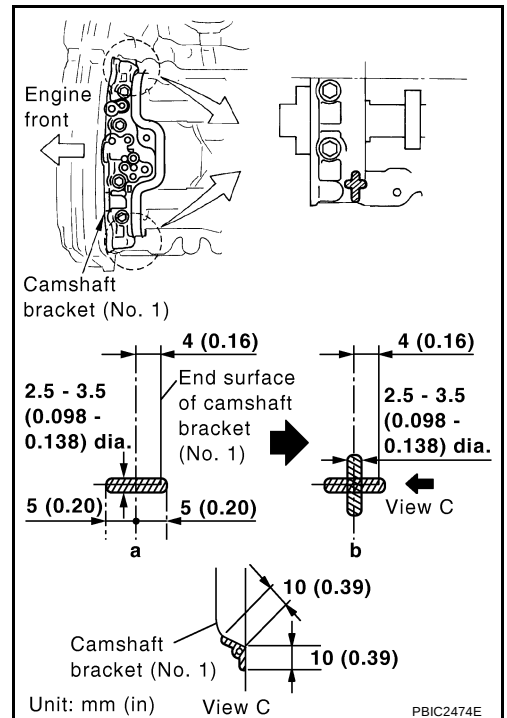
1. Apply liquid gasket with tube presser [SST: WS39930000] to joint part among rocker cover, cylinder head and camshaft bracket (No. 1) as follows:

Use Genuine Liquid Gasket or equivalent.

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

[VQ]

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



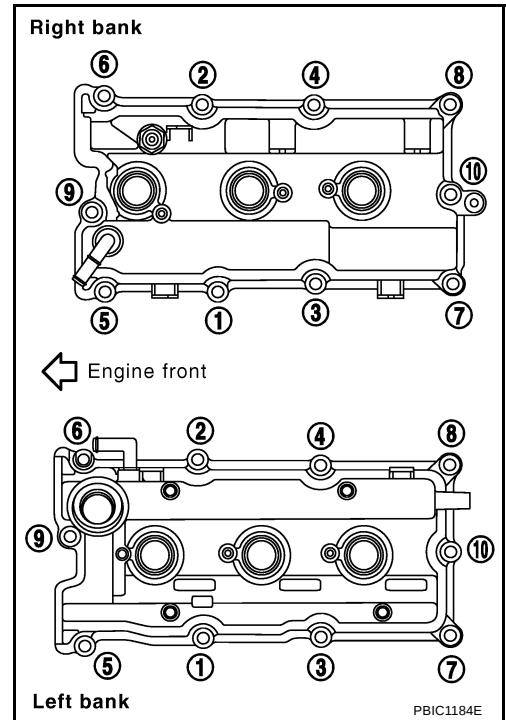
1st step

: 2.0 N·m (0.20 kg-m, 18 in-lb)



2nd step

: 8.3 N·m (0.85 kg-m, 73 in-lb)



5. Install oil filter 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

PFP:13599

Removal and Installation

BBS004VZ

NOTE:

- This section describes removal/installation procedure of front timing chain case and timing chain related parts without removing oil pan (upper) on vehicle.
- When oil pan (upper) 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 the reverse order of removal. Refer to [EM-173, "TIMING CHAIN"](#) .
- Refer to [EM-173, "TIMING CHAIN"](#) for component parts location.

REMOVAL

1. Remove engine cover. Refer to [EM-133, "INTAKE MANIFOLD COLLECTOR"](#) .
2. Remove air duct (inlet), air cleaner case (upper) with mass air flow sensor and air duct assembly. Refer to [EM-131, "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-21, "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-34, "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-133, "INTAKE MANIFOLD COLLECTOR"](#) .
 8. Remove drive belts. Refer to [EM-128, "DRIVE BELTS"](#) .
 9. Remove alternator. Refer to [SC-27, "CHARGING SYSTEM"](#) .
 10. Remove power steering oil pump from bracket with piping connected, and temporarily secure it to aside. Refer to [PS-29, "POWER STEERING OIL PUMP"](#) .
 11. Remove power steering oil pump bracket. Refer to [PS-29, "POWER STEERING OIL PUMP"](#) .
 12. Remove idler pulley and bracket. Refer to [EM-173, "TIMING CHAIN"](#) .
 13. Separate engine harnesses removing their brackets from front timing chain case.
 14. Remove rocker covers (right and left bank). Refer to [EM-160, "ROCKER COVER"](#) .

NOTE:

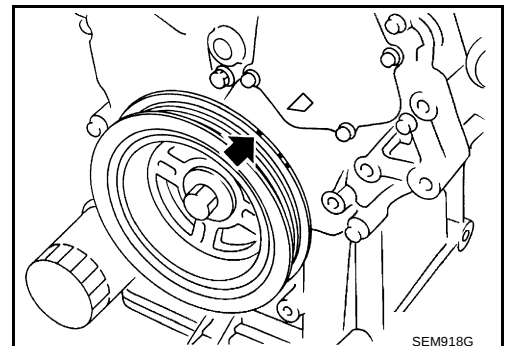
When only timing chain (primary) is removed, rocker cover does not need to be removed.

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.



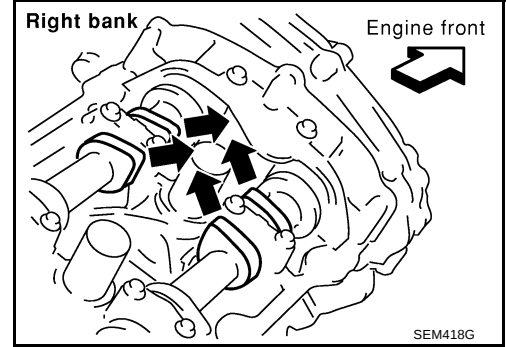
FRONT TIMING CHAIN CASE

[VQ]

- 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:

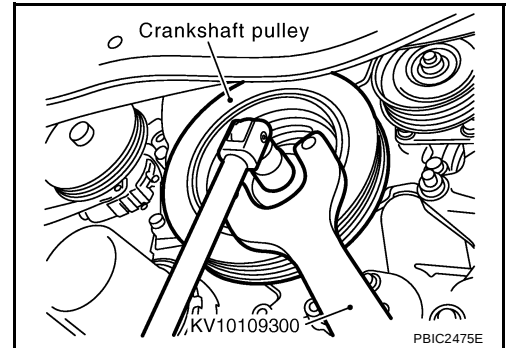
When only timing chain (primary) is removed, rocker cover does not need to be removed. To make sure that No. 1 cylinder is at its compression TDC, remove front timing chain case first. Then check mating marks on camshaft sprockets. Refer to [EM-181, "INSTALLATION"](#).



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:

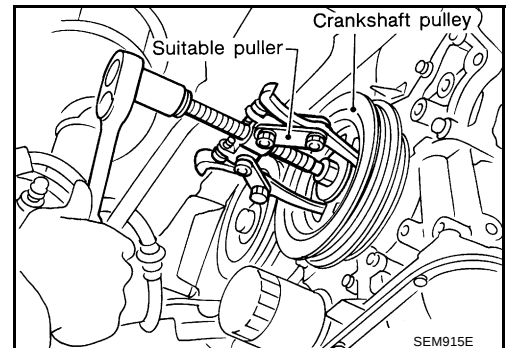
Do not remove crankshaft pulley bolt as it will be used as a supporting point for suitable puller.



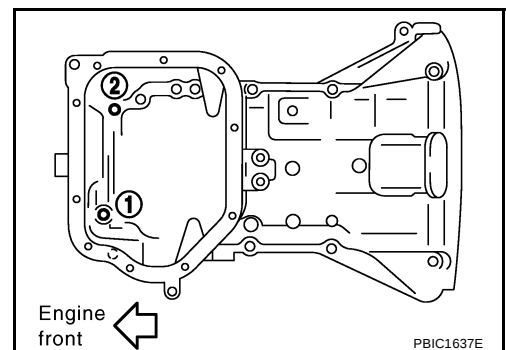
- c. Place suitable puller tab on holes of crankshaft pulley, and pull crankshaft pulley through.

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-145, "OIL PAN AND OIL STRAINER"](#).
18. Loosen two mounting bolts in front of oil pan (upper) in the 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.

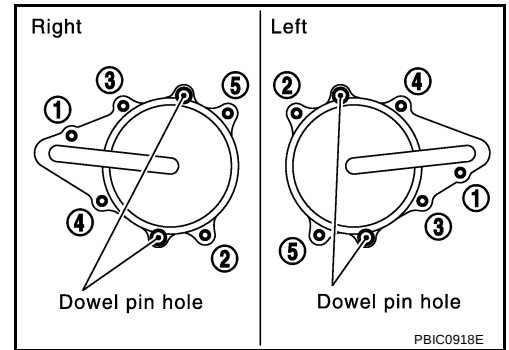
FRONT TIMING CHAIN CASE

[VQ]

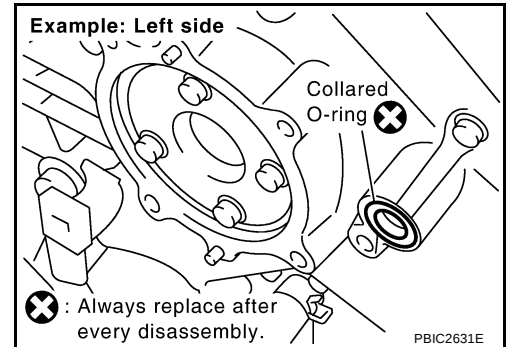
- Loosen mounting bolts in the reverse order as shown in the figure.
- Use seal cutter [SST: KV10111100] or equivalent tool to cut liquid gasket for removal.

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).

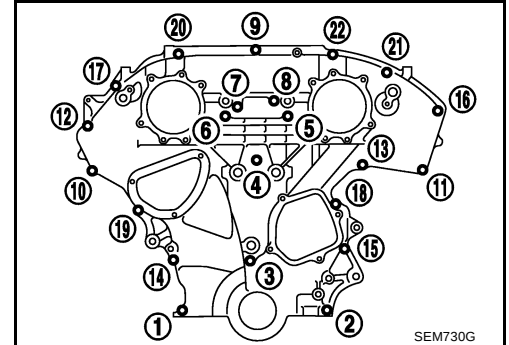


23. Remove engine mounting insulator (RH) and engine mounting bracket (RH). Refer to [EM-223, "ENGINE ASSEMBLY"](#).

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 the reverse order as shown in the figure.



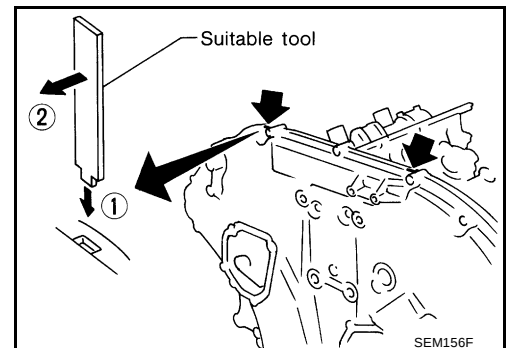
- b. Insert suitable tool into the notch at the top of front timing chain case as shown (1).

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

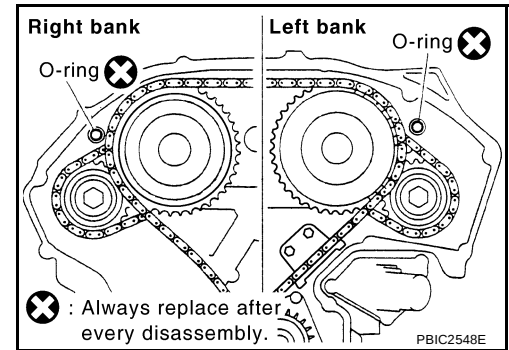
- Use seal cutter [SST: KV10111100] to cut liquid gasket for removal.

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 O-rings from rear timing chain case.



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

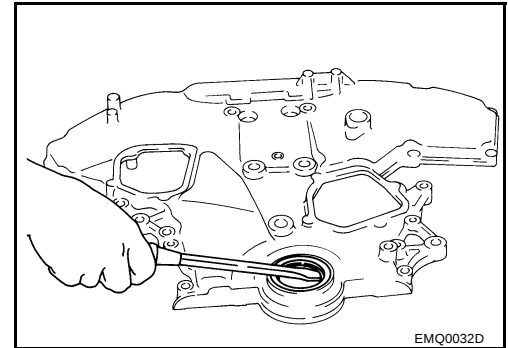
- Use seal cutter [SST: KV10111100] to cut liquid gasket for removal.

28. 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.

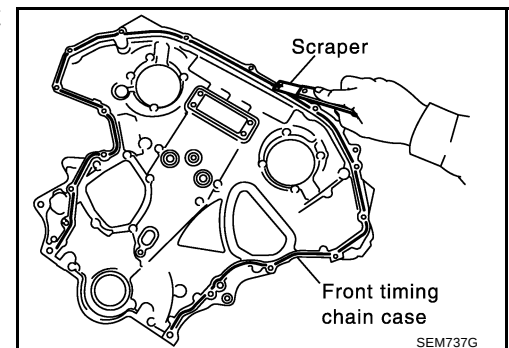


29. Remove timing chain and related parts. Refer to [EM-173, "TIMING CHAIN"](#).

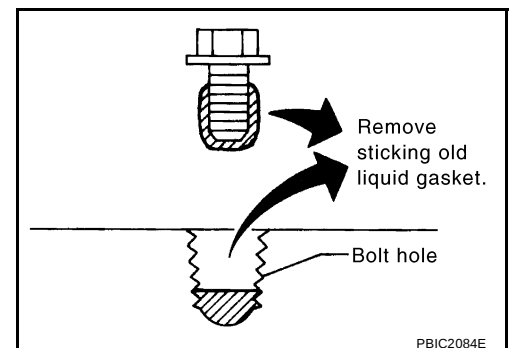
30. Use scraper to remove all traces of old liquid gasket from front and rear timing chain cases and oil pan (upper), and liquid gasket mating surfaces.

CAUTION:

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



- Remove old liquid gasket from bolt hole and thread.



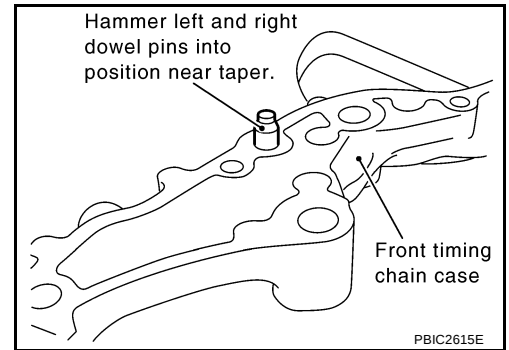
INSTALLATION

1. Install timing chain and related parts. Refer to [EM-173, "TIMING CHAIN"](#).

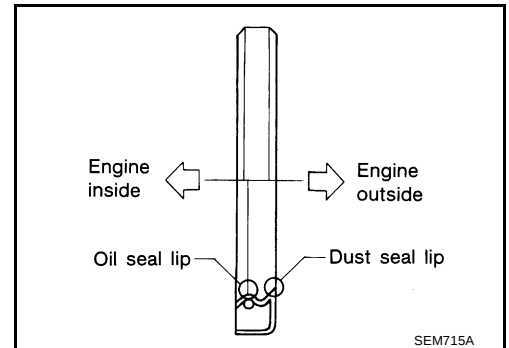
FRONT TIMING CHAIN CASE

[VQ]

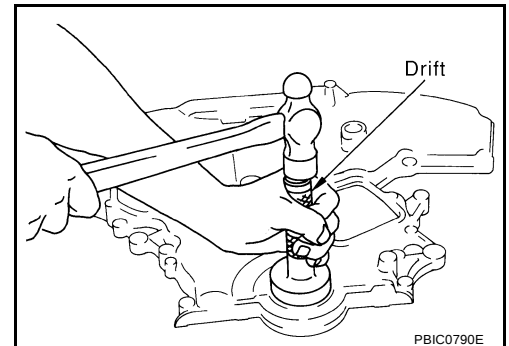
2. Hammer dowel pins (right and left) into front timing chain case up to a point close to taper in order to shorten protrusion length.



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.



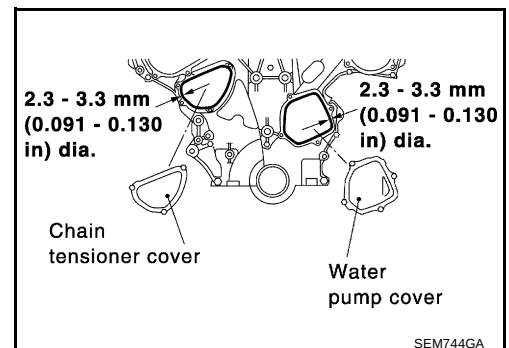
- Using suitable drift [outer diameter: 60 mm (2.36 in)], press-fit oil seal until it becomes flush with front timing chain case end face.
- Make sure the garter spring is in position and seal lip is not inverted.



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.

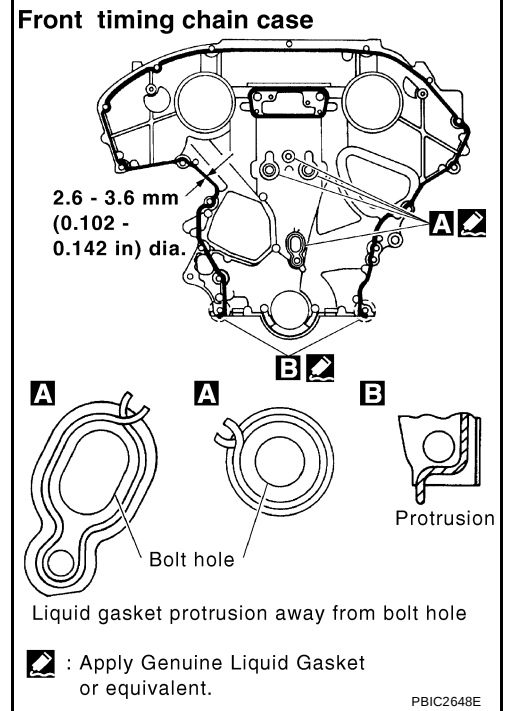
Use Genuine Liquid Gasket or equivalent.



5. Install front timing chain case as follows:

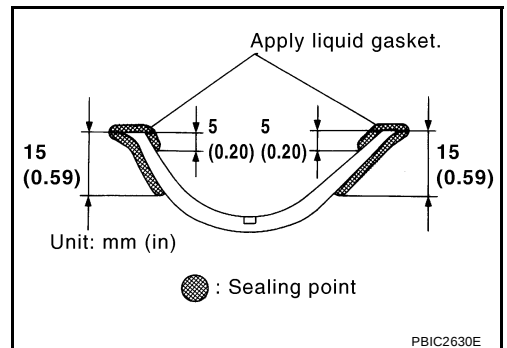
- a. Apply a continuous bead of liquid gasket with tube presser [SST: WS39930000] to front timing chain case back side as shown in the figure.

Use Genuine Liquid Gasket or equivalent.

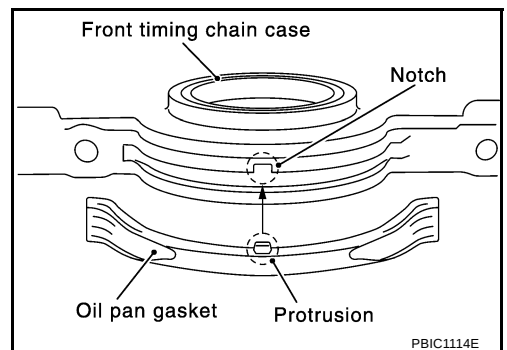


- b. Install new oil pan gasket.

- Apply liquid gasket to oil pan gasket as shown in the figure.
Use Genuine Liquid Gasket or equivalent.



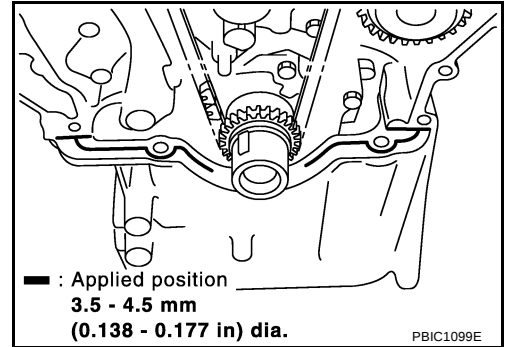
- Align notch of front timing chain case with protrusion of oil pan gasket.



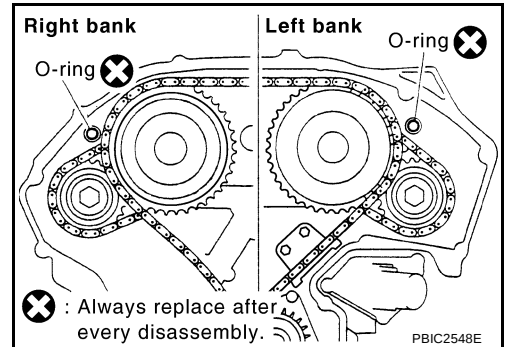
FRONT TIMING CHAIN CASE

[VQ]

- Apply liquid gasket with tube presser [SST: WS39930000] to top surface of oil pan (upper) as shown in the figure.
Use Genuine Liquid Gasket or equivalent.



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

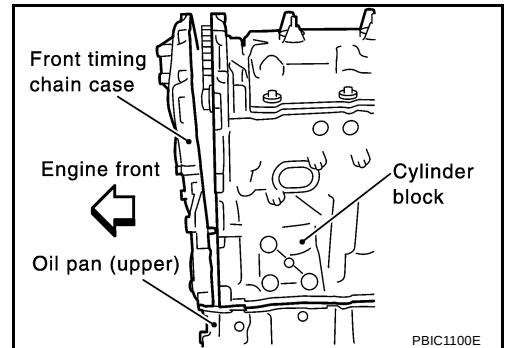


- d. Assemble front timing chain case as follows:

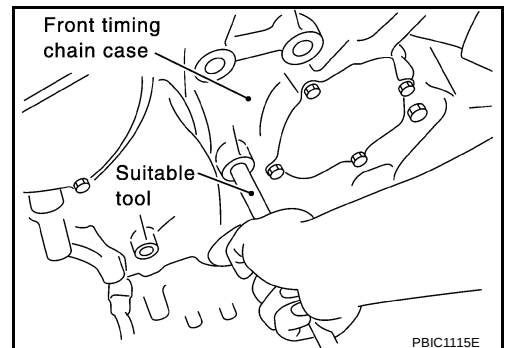
- i. Fit lower end of front timing chain case tightly onto top face of oil pan (upper). From the fitting point, make entire front timing chain case contact rear timing chain case completely.

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.



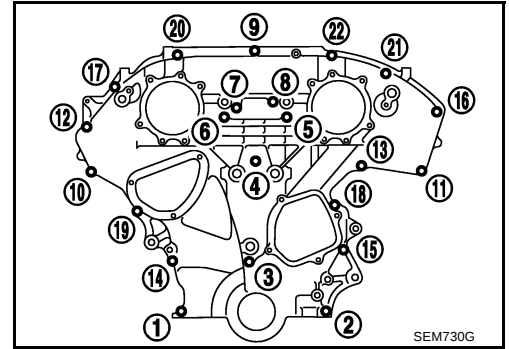
- e. Tighten mounting bolts to the specified torque in numerical order as shown in the figure.
- There are two types of mounting bolt. Refer to the following for locating bolts.

M8 bolts : 1, 2

 : 28.4 N·m (2.9 kg-m, 21 ft-lb)

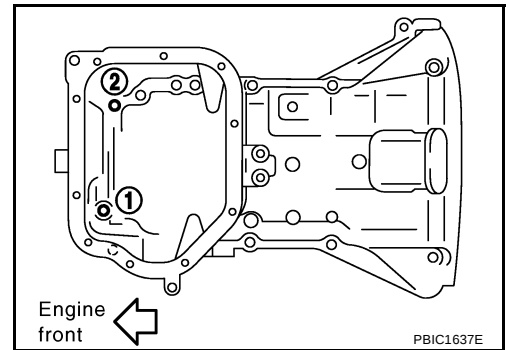
M6 bolts : Except the above

 : 12.7 N·m (1.3 kg-m, 9 ft-lb)

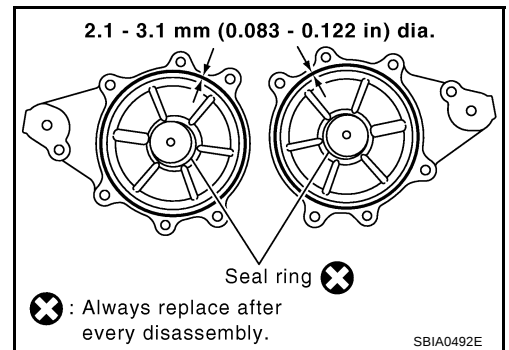


- f. After all bolts tightening, retighten them to the specified torque in numerical order as shown in the figure.
6. Install engine mounting bracket (RH) and engine mounting insulator (RH). Refer to [EM-223, "ENGINE ASSEMBLY"](#).
7. Remove jack which supports the oil pan (lower) bottom.
8. Remove oil pan (lower).
9. Install two mounting bolts in front of oil pan (upper) in numerical order as shown in the figure.

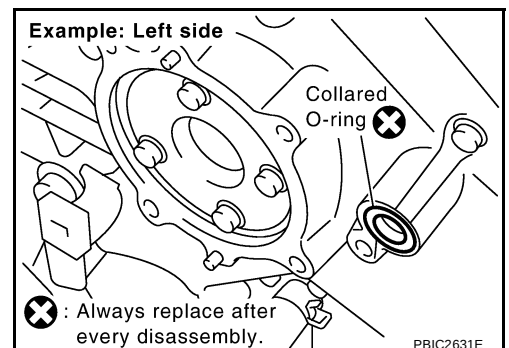
 : 17.2 N·m (1.8 kg-m, 13 ft-lb)



10. Install oil pan (lower). Refer to [EM-145, "OIL PAN AND OIL STRAINER"](#).
11. 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 Liquid Gasket or equivalent.**

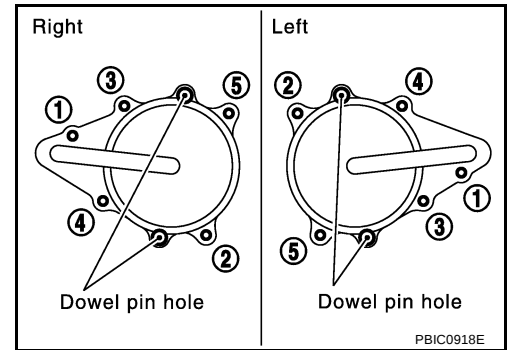


- c. Install new collared O-rings in front timing chain case oil holes (left and right sides).



- 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.

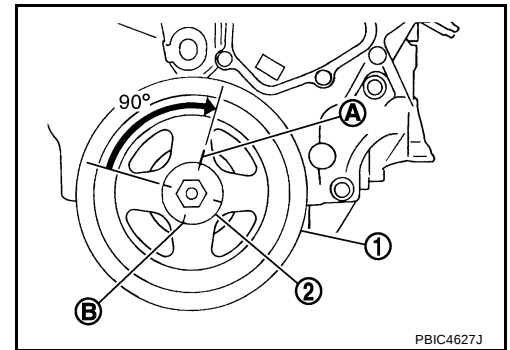
- e. Tighten mounting bolts in numerical order as shown in the figure.



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)

- d. Place a matching mark (A) on crank pulley (1) aligning with the matching (B) of crank pulley mounting bolt (2). Tighten the bolts 90 degrees (one marks).



- e. Rotate crankshaft pulley in normal direction (clockwise when viewed from engine front) to confirm it turns smoothly.
13. For the following operations, perform steps in the reverse order of removal.

INSPECTION AFTER INSTALLATION

Inspection for Leaks

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

- Before starting engine, check oil/fluid levels including engine coolant and engine oil. If less than required quantity, fill to the specified level. Refer to [MA-14. "RECOMMENDED FLUIDS AND LUBRICANTS"](#).
- Run engine to check for unusual noise and vibration.

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.

- Warm up engine thoroughly to make sure there is no leakage of exhaust gases, or any oil/fluids including engine oil and engine coolant.
- Bleed air from lines and hoses of applicable lines, such as in cooling system.
- After cooling down engine, again check oil/fluid levels including engine oil and engine coolant. Refill to the specified level, if necessary.

FRONT TIMING CHAIN CASE

[VQ]

Summary of the inspection items:

Item	Before starting engine	Engine running	After engine stopped
Engine coolant	Level	Leakage	Level
Engine oil	Level	Leakage	Level
Other oils and fluid*	Level	Leakage	Level

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

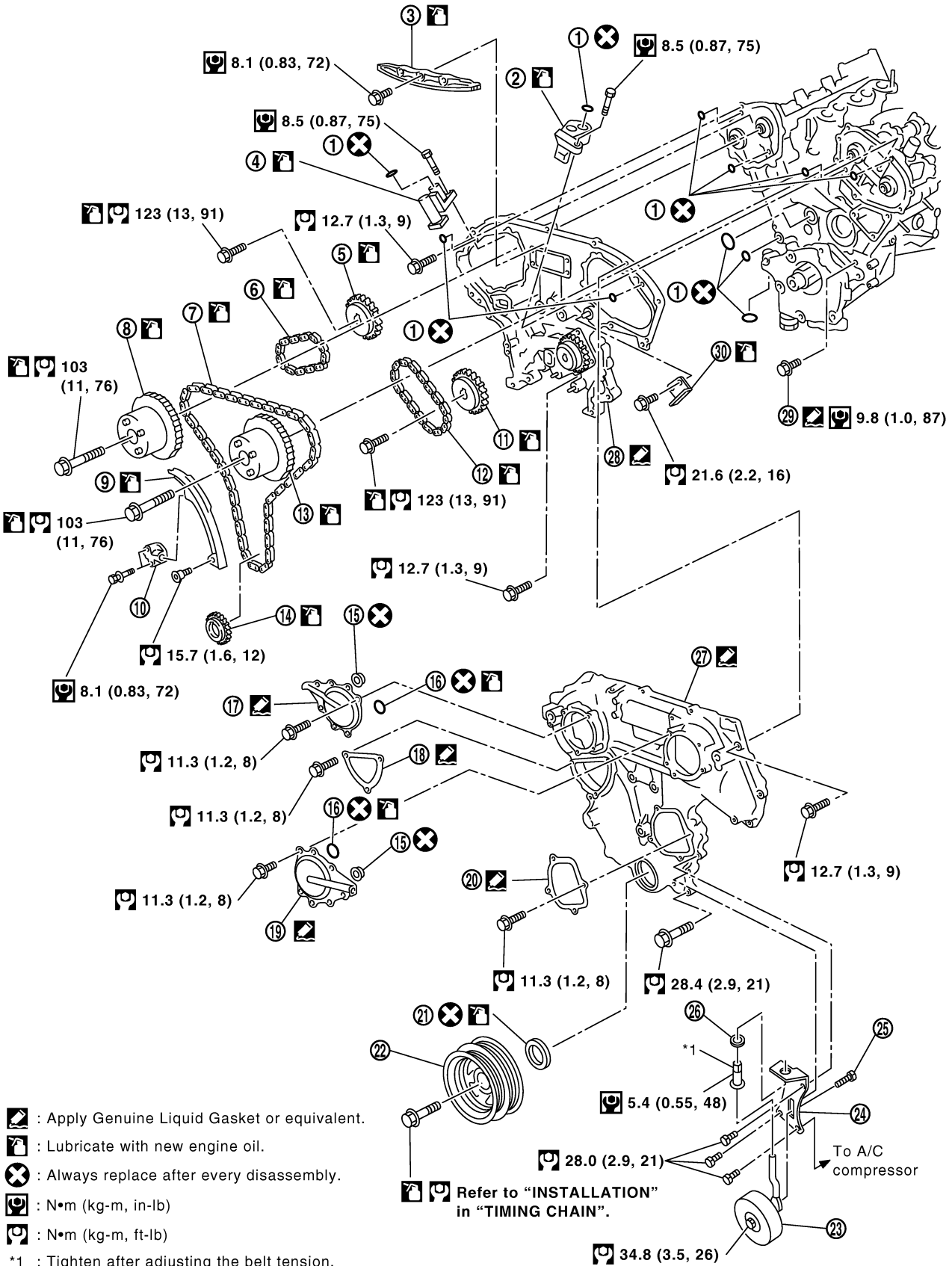
TIMING CHAIN

PFP:13028

Removal and Installation

BBS004W0

SEC. 120•130•150•210•275



PBIC2476E

- | | | |
|---------------------------------------|---------------------------------------|------------------------------|
| 1. O-ring | 2. Timing chain tensioner (secondary) | 3. Internal chain guide |
| 4. Timing chain tensioner (secondary) | 5. Camshaft sprocket (EXH) | 6. Timing chain (secondary) |
| 7. Timing chain (primary) | 8. Camshaft sprocket (INT) | 9. Slack guide |
| 10. Timing chain tensioner (primary) | 11. Camshaft sprocket (EXH) | 12. Timing chain (secondary) |
| 13. Camshaft sprocket (INT) | 14. Crankshaft sprocket | 15. Collared O-ring |
| 16. Seal ring | 17. Intake valve timing control cover | 18. Chain tensioner cover |
| 19. Intake valve timing control cover | 20. Water pump cover | 21. Front oil seal |
| 22. Crankshaft pulley | 23. Idler pulley | 24. Idler pulley bracket |
| 25. Center shaft | 26. Washer | 27. Front timing chain case |
| 28. Rear timing chain case | 29. Water drain plug (front) | 30. Tension guide |

NOTE:

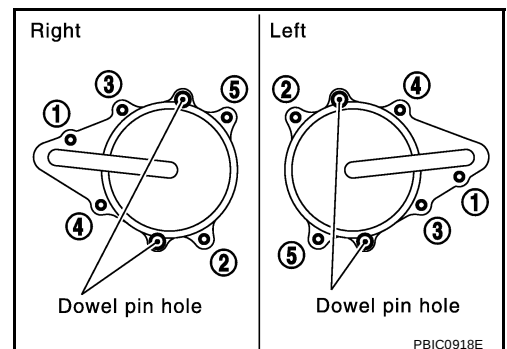
- This section describes procedures for removal/installation front timing chain case and timing chain related parts, and rear timing chain case, when oil pan (upper) needs to be removed/installed for engine overhaul, etc.
- To removal/installation front timing chain case, timing chain, and timing chain related parts without removing oil pan (upper), refer to [EM-163, "FRONT TIMING CHAIN CASE"](#).

REMOVAL

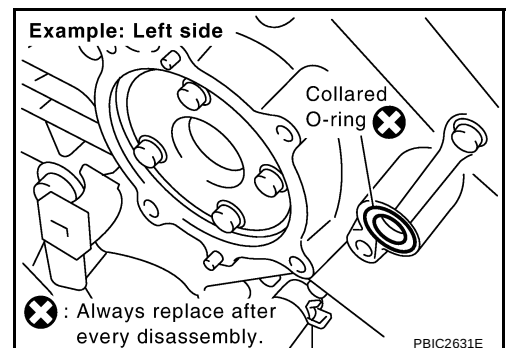
1. Remove engine assembly from vehicle, and separate front suspension member and transaxle from engine. Refer to [EM-223, "ENGINE ASSEMBLY"](#).
2. Install engine sub-attachment with engine stand shaft [SST: KV10117001 and KV10106500] to right side of cylinder block, then lift engine, and mount it onto engine stand [SST: ST0501S000]. Refer to [EM-228, "CYLINDER BLOCK"](#).
3. Drain engine oil. Refer to [LU-21, "Changing Engine Oil"](#).
4. Drain engine coolant from inside engine. Refer to [EM-229, "DISASSEMBLY"](#).
5. Remove intake manifold collectors (upper and lower). Refer to [EM-133, "INTAKE MANIFOLD COLLECTOR"](#).
6. Remove rocker covers (right and left banks). Refer to [EM-160, "ROCKER COVER"](#).
7. Remove oil pans (lower and upper) and oil strainer. Refer to [EM-145, "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 the reverse order as shown in the figure.
 - Use seal cutter [SST: KV10111100] 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.

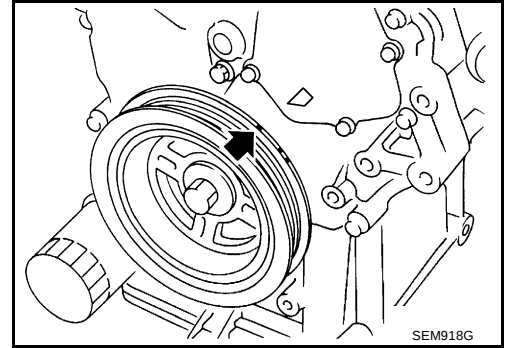


11. Remove collared O-ring from front timing chain case oil hole (left and right sides).



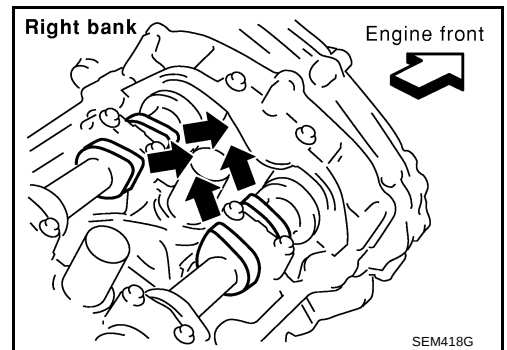
12. Obtain No. 1 cylinder at TDC of its compression stroke as follows:

- 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.

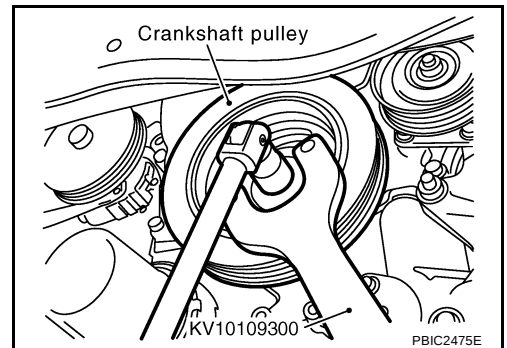


13. Remove crankshaft pulley as follows:

- 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:

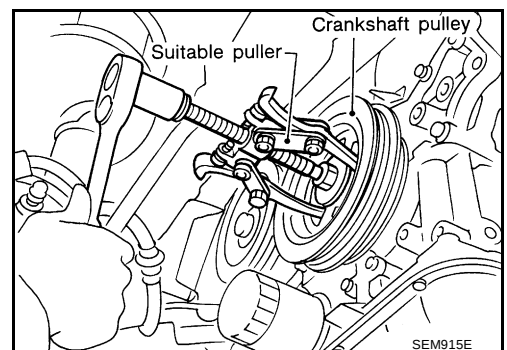
Do not remove crankshaft pulley bolt as it will be used as a supporting point for suitable puller.



- 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.

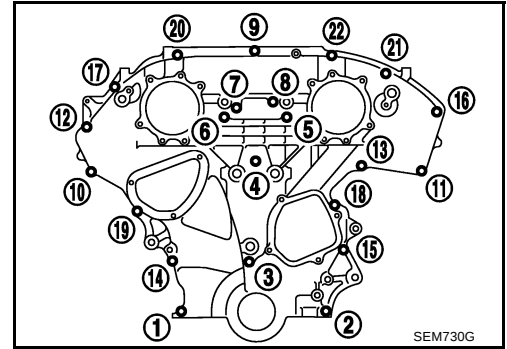


14. Remove front timing chain case as follows:

TIMING CHAIN

[VQ]

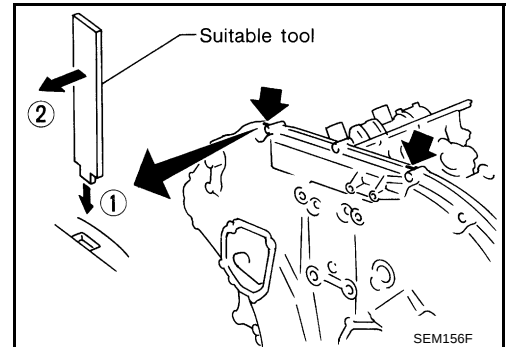
- a. Loosen mounting bolts in the reverse order as shown in the figure.



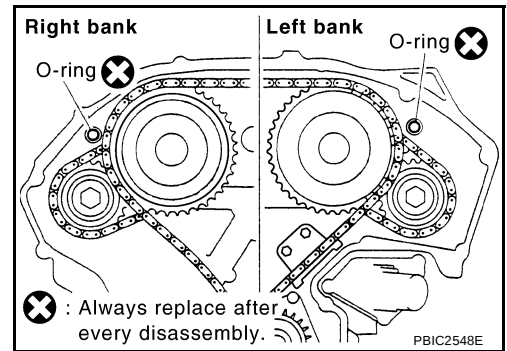
- b. Insert suitable tool into the notch at the top of front timing chain case as shown (1).
- c. Pry off case by moving tool as shown (2).
- Use seal cutter [SST: KV10111100] to cut liquid gasket for removal.

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.



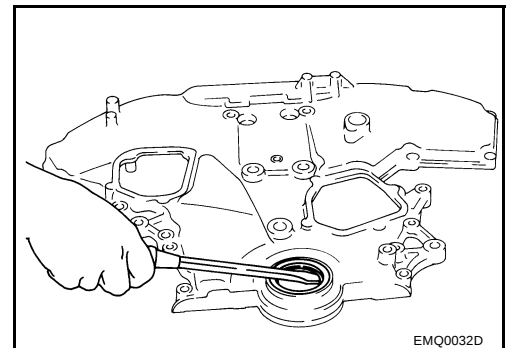
15. Remove O-rings from rear timing chain case.



16. Remove water pump cover and chain tensioner cover from front timing chain case.
- Use seal cutter [SST: KV10111100] 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

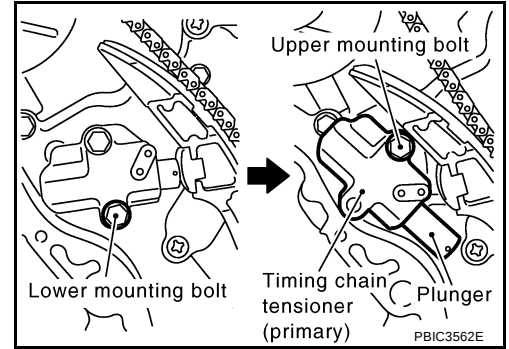
[VQ]

- a. Remove lower mounting bolt.
- b. Loosen upper mounting bolt slowly, and then turn timing chain tensioner (primary) on the mounting bolt so that plunger is fully expanded.

NOTE:

Even if plunger is fully expanded, it is not dropped from the body of timing chain tensioner (primary).

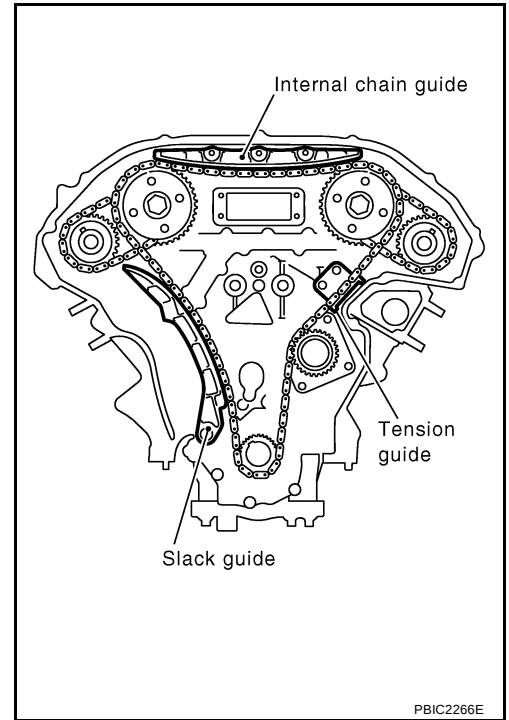
- c. Remove upper mounting bolt, and then remove timing chain tensioner (primary).



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:

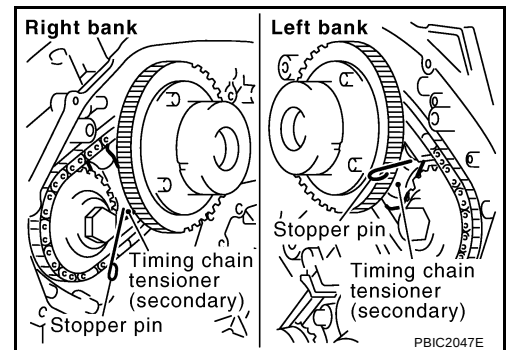
After removing timing chain (primary), do not turn crankshaft and camshaft separately, or valves will strike the piston heads.

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

- 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-192, "CAMSHAFT"](#). [Removing camshaft bracket (No. 1) is required.]



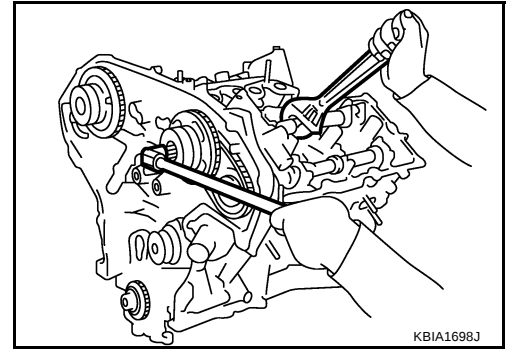
TIMING CHAIN

[VQ]

- 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.

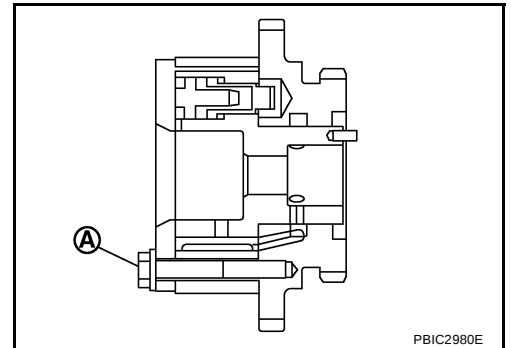
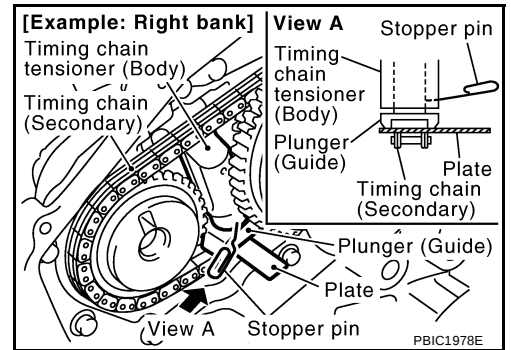
NOTE:

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

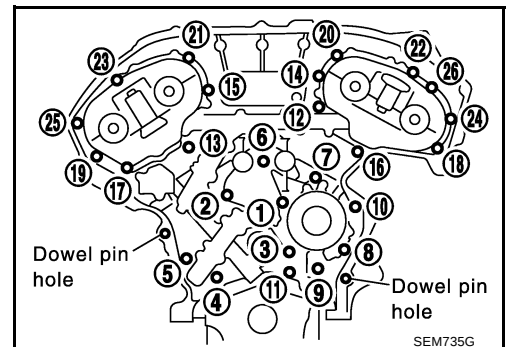
- When handling camshaft sprocket (INT), be careful of the following caution:

CAUTION:

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

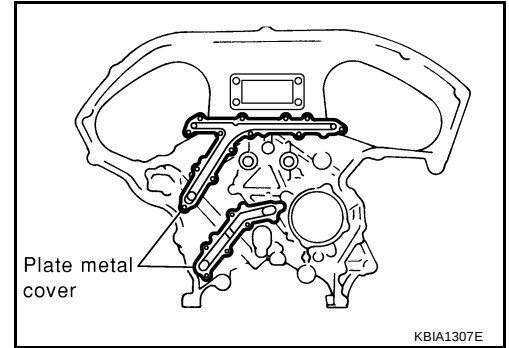


22. Remove water pump. Refer to [CO-46, "WATER PUMP"](#).
23. Remove rear timing chain case as follows:
- Loosen and remove mounting bolts in the reverse order as shown in the figure.
 - Cut liquid gasket using seal cutter [SST: KV10111100] and remove rear timing chain case.

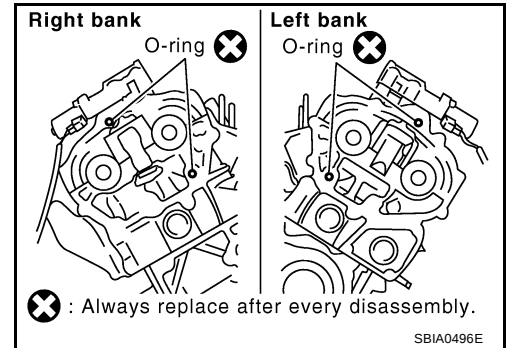


CAUTION:

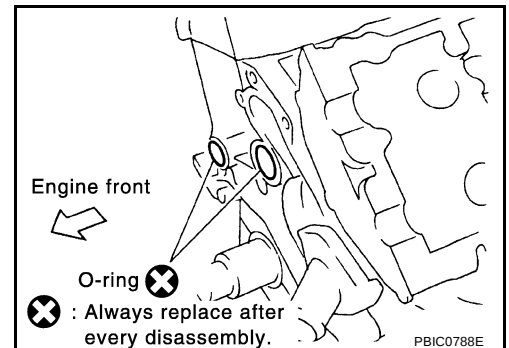
- Do not remove plate metal cover of oil passage.
- After removal, handle rear timing chain case carefully so it does not tilt, cant, or warp under a load.



24. Remove O-rings from cylinder head.



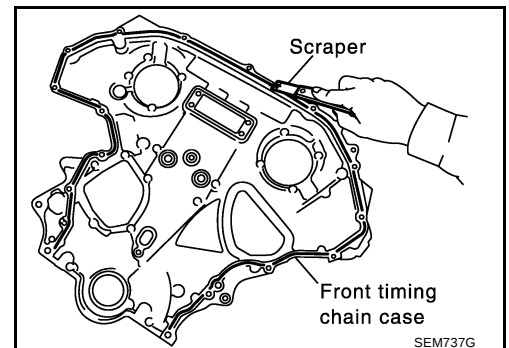
25. Remove O-rings from cylinder block.



26. Remove timing chain tensioners (secondary) from cylinder head as follows, if necessary.

- Remove camshaft brackets (No. 1). Refer to [EM-192, "REMOVAL"](#).
- Remove timing chain tensioners (secondary) with stopper pin attached.

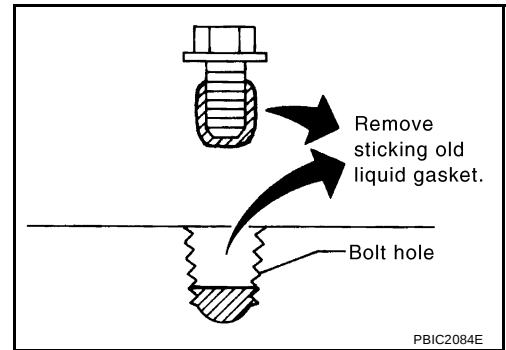
27. Use scraper to remove all traces of old liquid gasket from front and rear timing chain cases, and opposite mating surfaces.



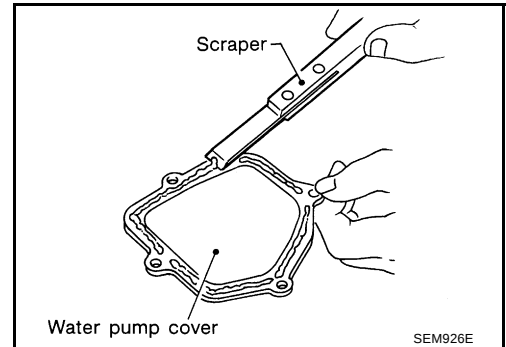
TIMING CHAIN

[VQ]

- Remove old liquid gasket from bolt hole and thread.



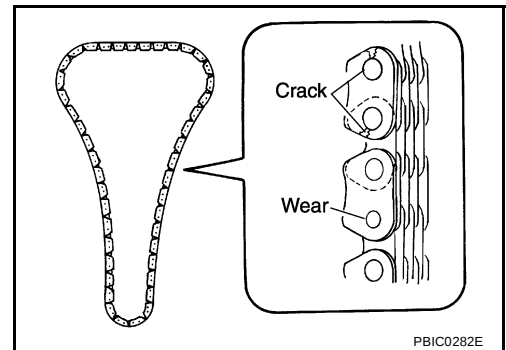
28. Use scraper to remove all traces of old liquid gasket from water pump cover, chain tensioner cover and intake valve timing control covers.



INSPECTION AFTER REMOVAL

Timing Chain

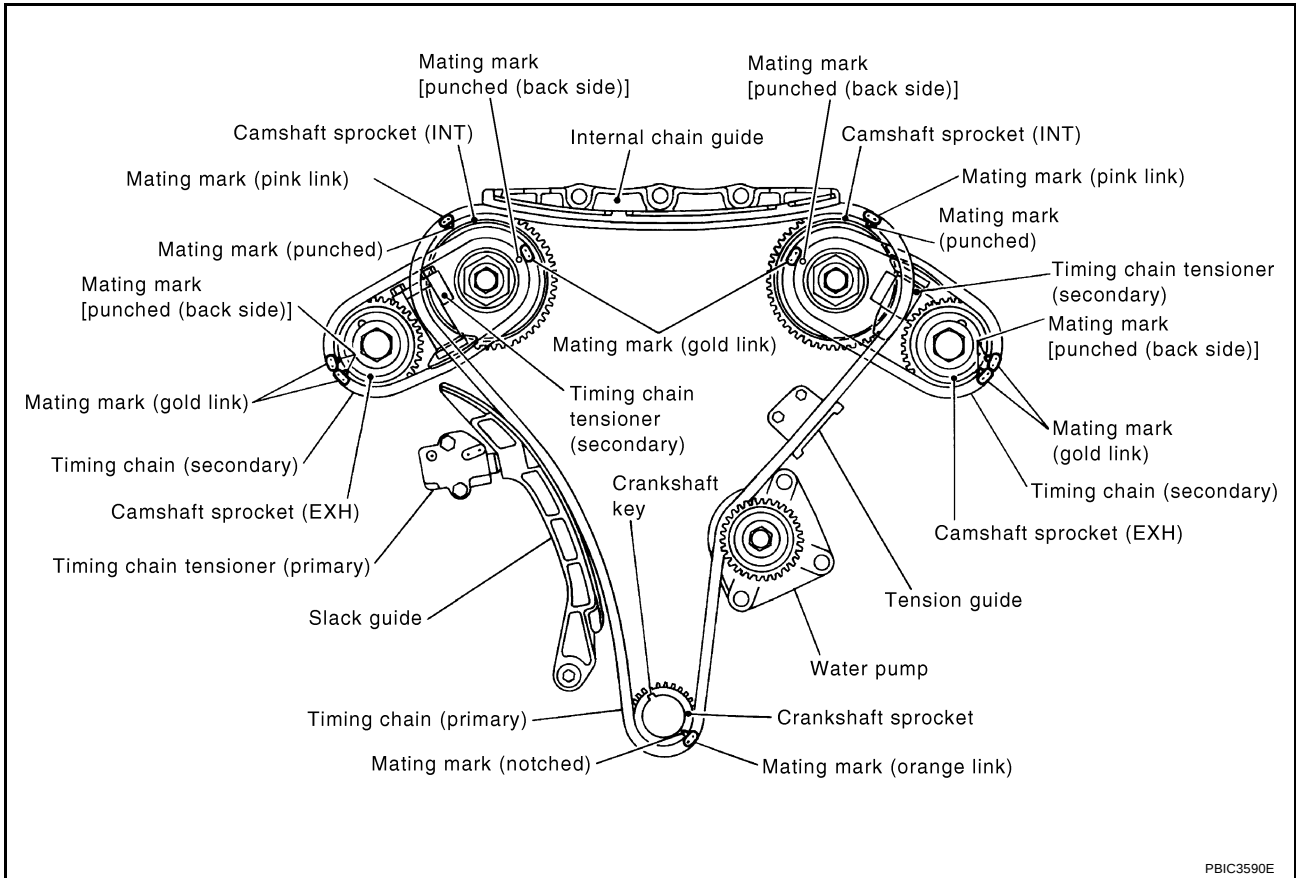
Check for cracks and any excessive wear at link plates and roller links of timing chain. Replace timing chain as necessary.



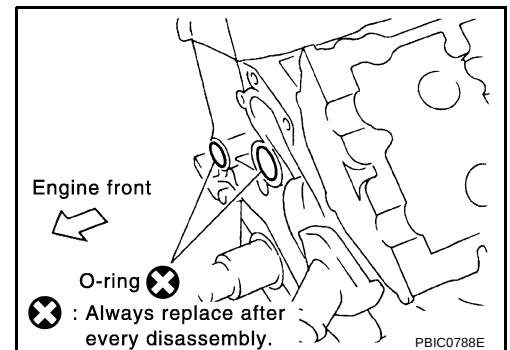
INSTALLATION

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.



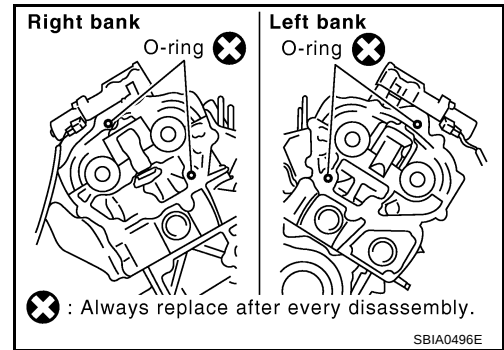
1. Install timing chain tensioners (secondary) to cylinder head as follows if removed. Refer to [EM-197, "INSTALLATION"](#).
 - a. Install timing chain tensioners (secondary) with stopper pin attached and new O-ring.
 - b. Install camshaft brackets (No. 1). Refer to [EM-197, "INSTALLATION"](#).
2. Install rear timing chain case as follows:
 - a. Install new O-rings onto cylinder block.



TIMING CHAIN

[VQ]

- b. Install new O-rings to cylinder head.



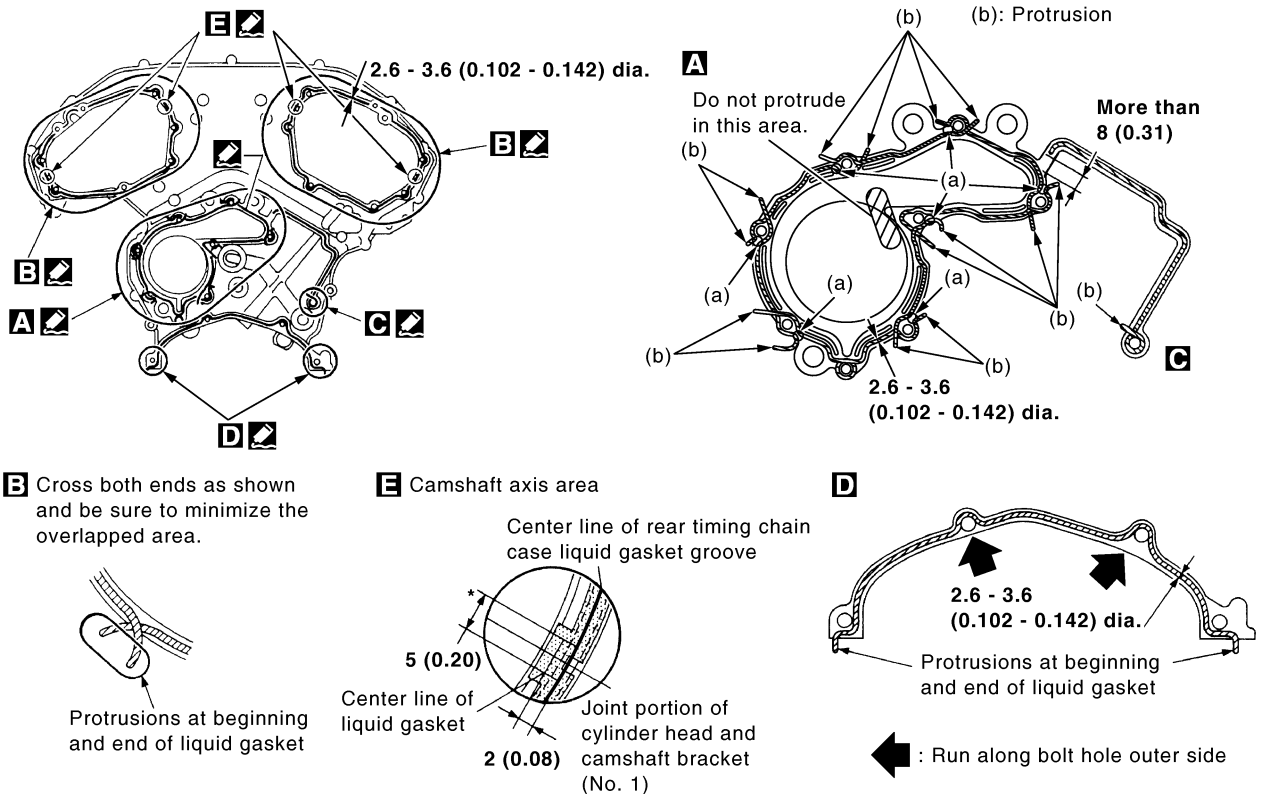
- c. Apply liquid gasket with tube presser [SST: WS39930000] to rear timing chain case back side as shown in the figure.

Use Genuine Liquid Gasket or equivalent.

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.

Rear timing chain case: Back side



*: Apply liquid gasket to the chamfered surface between camshaft bracket (No. 1) and cylinder head.

: Apply Genuine Liquid Gasket or equivalent.

Unit: mm (in)

PBIC2616E

- 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

[VQ]

- 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

 : 12.7 N·m (1.3 kg-m, 9 ft-lb)

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

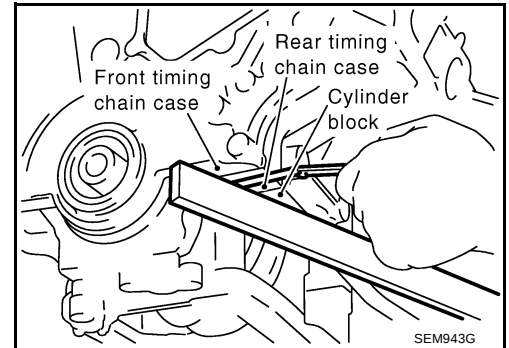
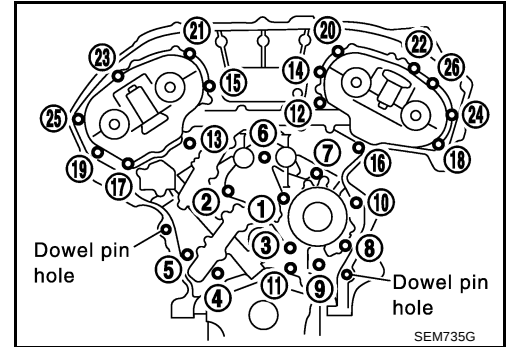
- If liquid gasket protrudes, wipe it off immediately.

- g. After installing rear timing chain case, check 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 standard, repeat the installation procedure.



3. Install water pump with new O-rings. Refer to [CO-46, "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)

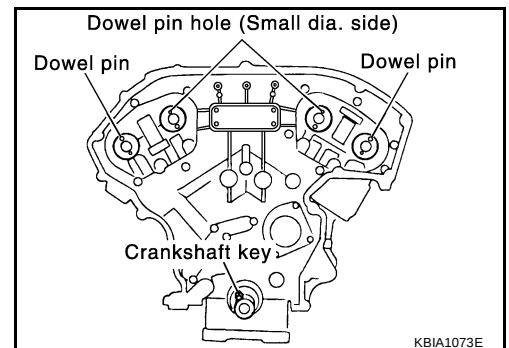
NOTE:

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:

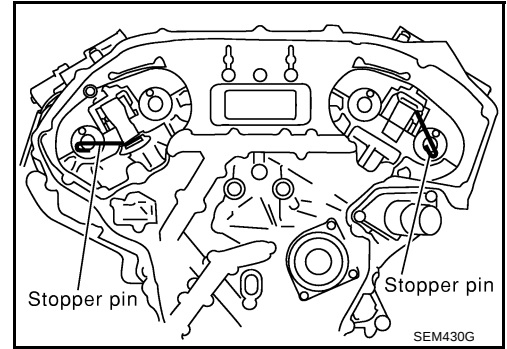
Hole on small dia. side must be used for intake side dowel pin hole. Do not misidentify (ignore big dia. side).

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.

- a. Push plunger of 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.

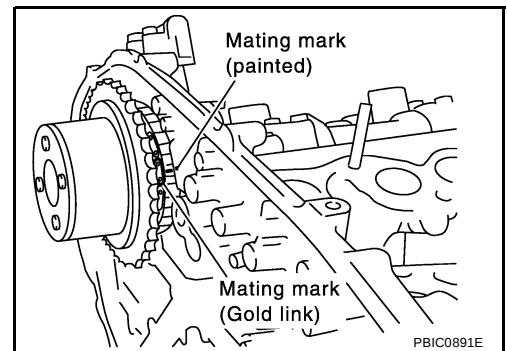
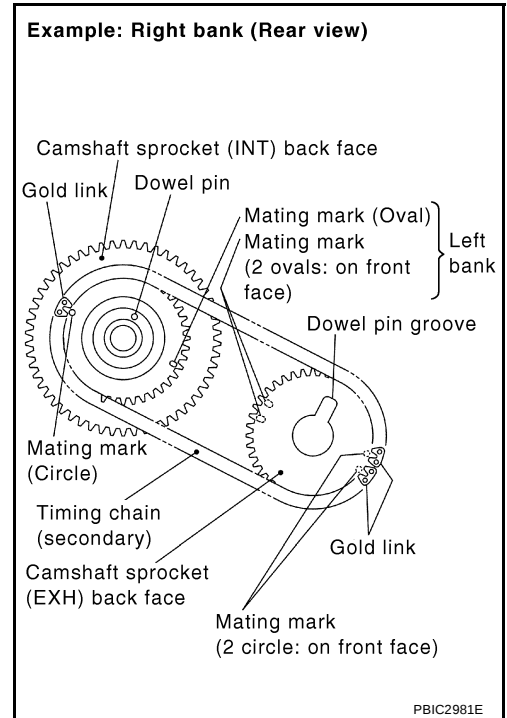
NOTE:

- 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.

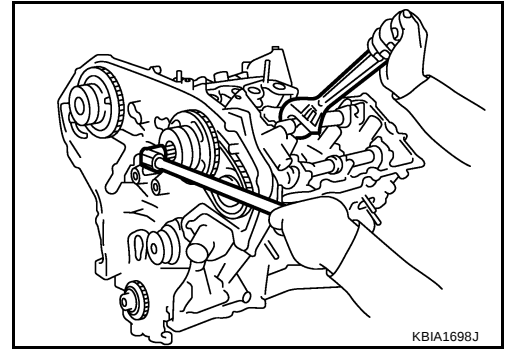
- Align dowel pin and pin hole on camshafts with the groove and dowel pin on sprockets, and install them.
- On the intake side, align pin hole on the small diameter side of the camshaft front end with dowel pin on the back side of camshaft sprocket, and install them.
- On the exhaust side, align dowel 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.



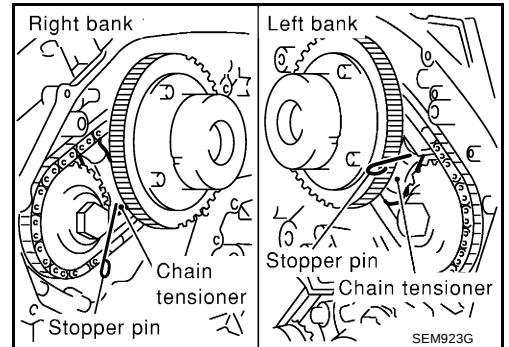
TIMING CHAIN

[VQ]

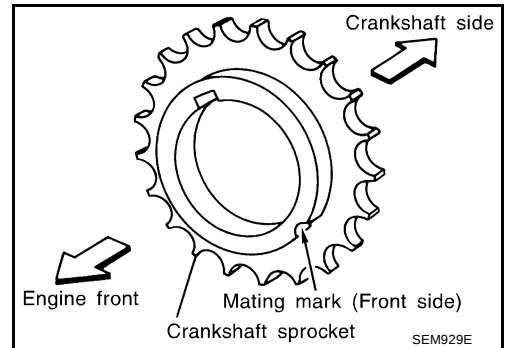
- c. After confirming the mating marks are aligned, tighten camshaft sprocket mounting bolts.
 - Secure camshaft using wrench at the hexagonal portion to tighten mounting bolts.



- 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.

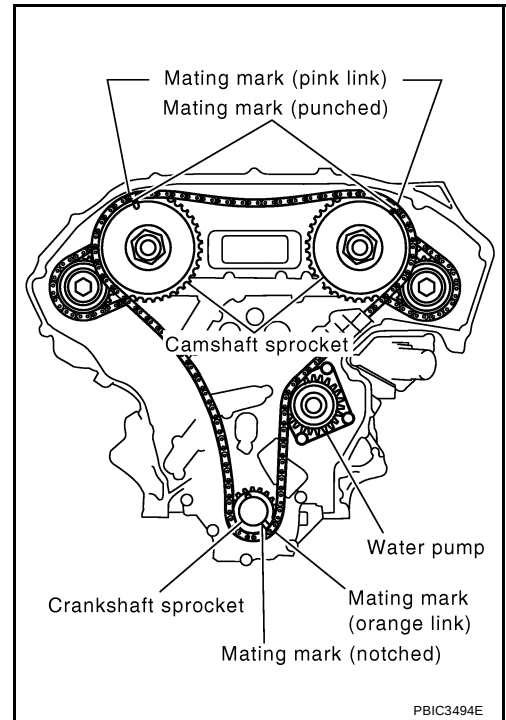


- b. Install timing chain (primary).

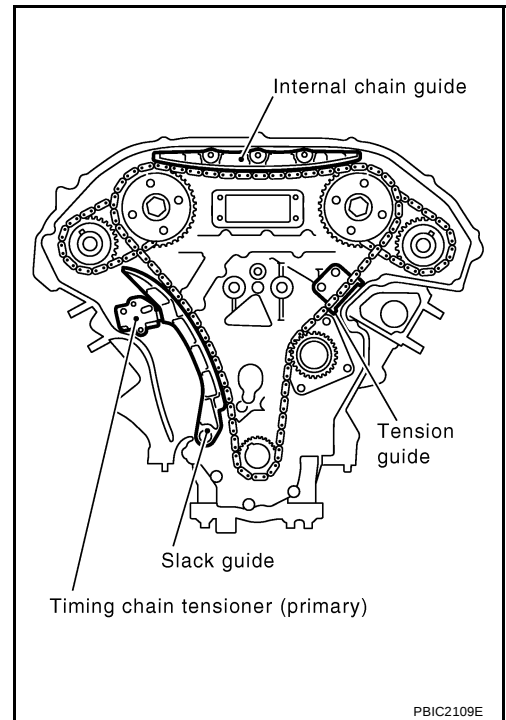
TIMING CHAIN

[VQ]

- Install timing chain (primary) so the mating mark (punched) on camshaft sprocket (INT) is aligned with the pink 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).

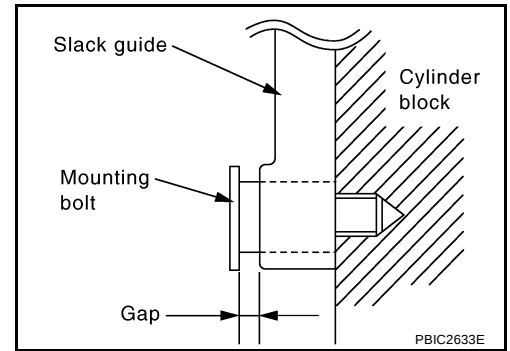


8. Install internal chain guide, slack guide and timing chain tensioner (primary).



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.



9. Install the timing chain tensioner (primary) with the following procedure:

- a. Pull plunger stopper tab up (or turn lever downward) so as to remove plunger stopper tab from the ratchet of plunger.

NOTE:

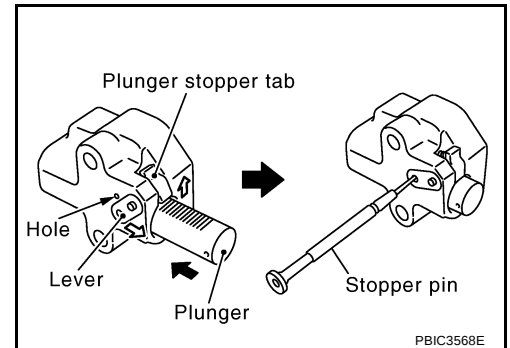
Plunger stopper tab and lever are synchronized.

- b. Push plunger into the inside of tensioner body.
- c. Hold plunger in the fully compressed position by engaging plunger stopper tab with the tip of ratchet.
- d. To secure lever, insert stopper pin through hole of lever into tensioner body hole.

- The lever parts and the tab are synchronized. Therefore, the plunger will be secured under this condition.

NOTE:

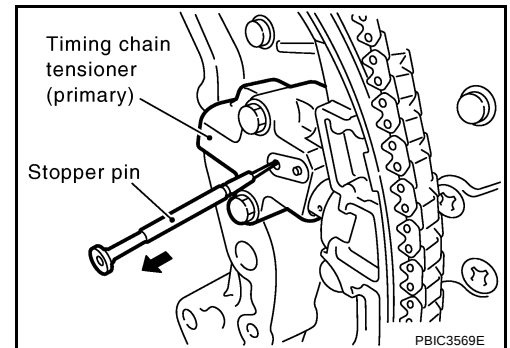
Figure shows the example of 1.2 mm (0.047 in) diameter thin screwdriver being used as the stopper pin.



- e. Install timing chain tensioner (primary).

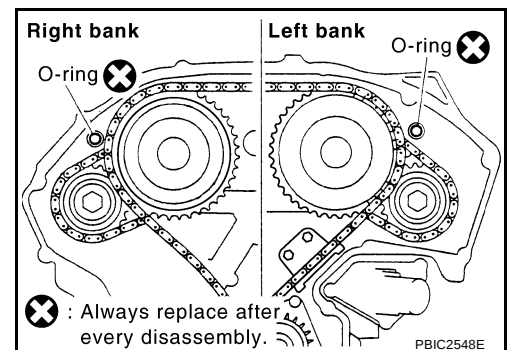
- Remove any dirt and foreign materials completely from the back and the mounting surfaces of timing chain tensioner (primary).

- f. Pull out stopper pin after installing, and then release plunger.



10. Make sure again that the mating marks on each sprocket and each timing chain have not slipped out of alignment.

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



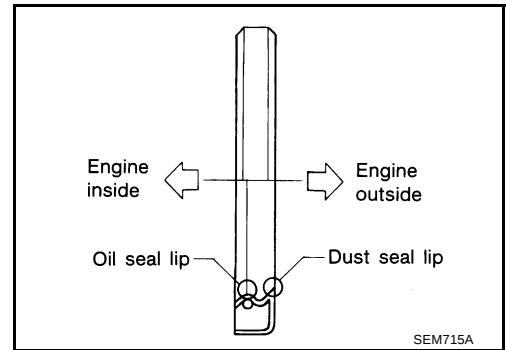
12. Install new front oil seal on front timing chain case.

- Apply new engine oil to both oil seal lip and dust seal lip.

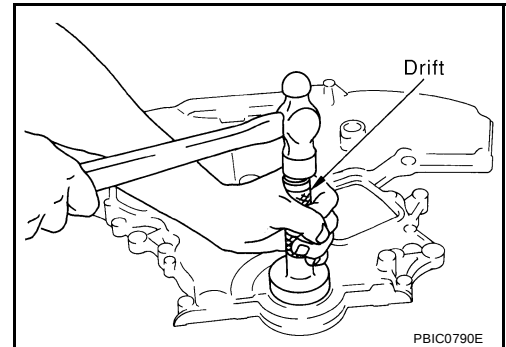
TIMING CHAIN

[VQ]

- Install it so that each seal lip is oriented as shown in the figure.



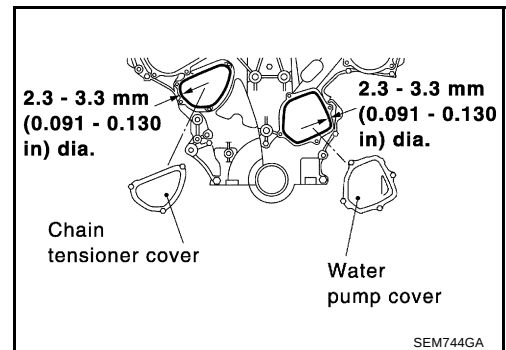
- Using suitable drift [outer diameter: 60 mm (2.36 in)], press-fit oil seal until it becomes flush with front timing chain case end face.
- Make sure the garter spring is in position and seal lip is not inverted.



13. 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 Liquid Gasket or equivalent.



14. Install front timing chain case as follows:

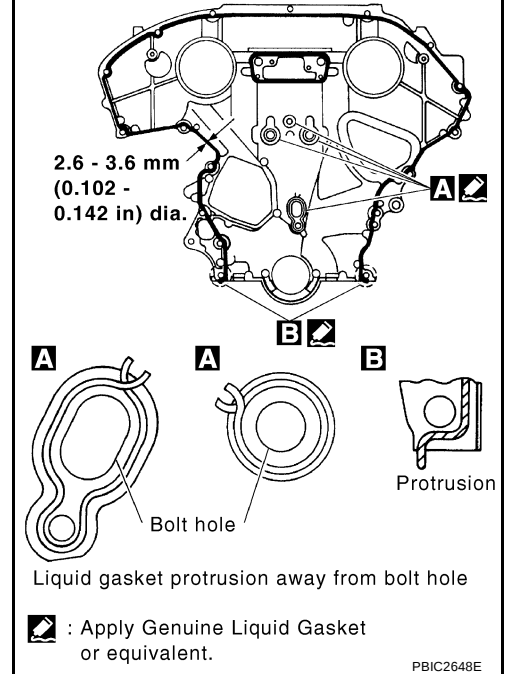
TIMING CHAIN

[VQ]

- 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 Liquid Gasket or equivalent.

Front timing chain case



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

: 28.4 N·m (2.9 kg-m, 21 ft-lb)

M6 bolts : Except the above

: 12.7 N·m (1.3 kg-m, 9 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).

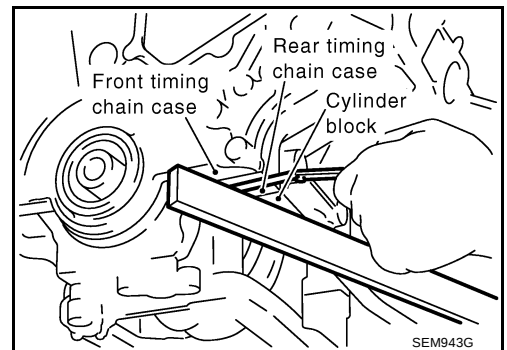
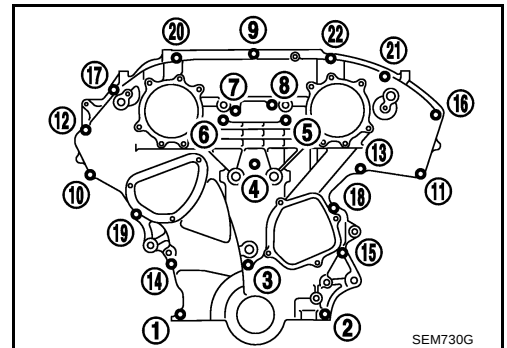
- e. After installing front timing chain case, check the surface height difference between the following parts on the oil pan (upper) mounting surface.

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 standard, repeat the installation procedure.



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

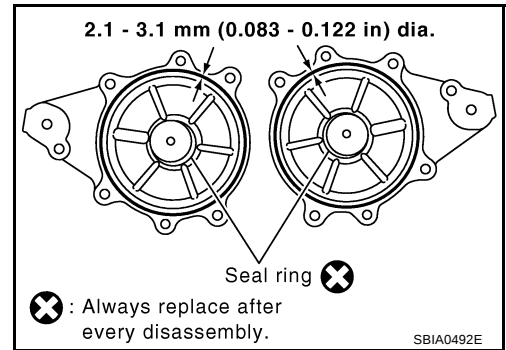
- a. Install new seal rings in shaft grooves.

TIMING CHAIN

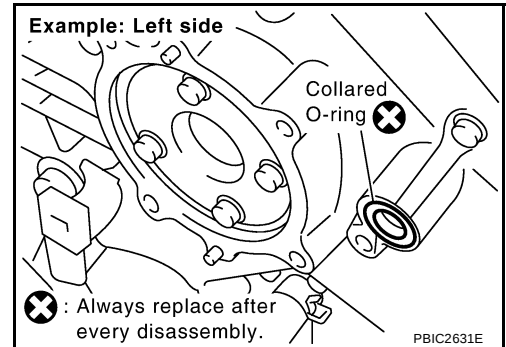
[VQ]

- b. Apply a continuous bead of liquid gasket with tube presser [SST: WS39930000] to intake valve timing control covers as shown in the figure.

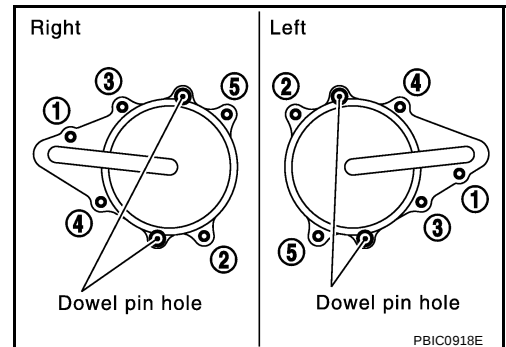
Use Genuine Liquid Gasket or equivalent.



- c. Install new collared O-ring in front timing chain case oil hole (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.
- e. Tighten mounting bolts in numerical order as shown in the figure.

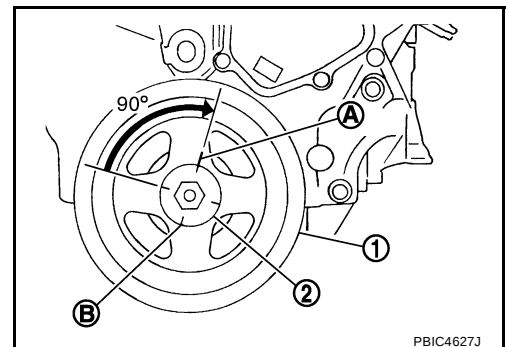


16. Install crankshaft pulley as follows:

- 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)

- d. Place a matching mark (A) on crank pulley (1) aligning with the matching (B) of crank pulley mounting bolt (2). Tighten the bolts 90 degrees (one marks).



- e. Rotate crankshaft pulley in normal direction (clockwise when viewed from engine front) to confirm it turns smoothly.
17. For the following operations, perform steps in the reverse order of removal.

INSPECTION AFTER INSTALLATION

Inspection for Leaks

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

- Before starting engine, check oil/fluid levels including engine coolant and engine oil. If less than required quantity, fill to the specified level. Refer to [MA-14, "RECOMMENDED FLUIDS AND LUBRICANTS"](#).
- Use procedure below to check for fuel leakage.
 - Turn ignition switch "ON" (with engine stopped). With fuel pressure applied to fuel piping, check for fuel leakage at connection points.
 - Start engine. With engine speed increased, check again for fuel leakage at connection points.
- Run engine to check for unusual noise and vibration.

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.

- Warm up engine thoroughly to make sure there is no leakage of fuel, exhaust gases, or any oil/fluids including engine oil and engine coolant.
- Bleed air from lines and hoses of applicable lines, such as in cooling system.
- After cooling down engine, again check oil/fluid levels including engine oil and engine coolant. Refill to the specified level, if necessary.

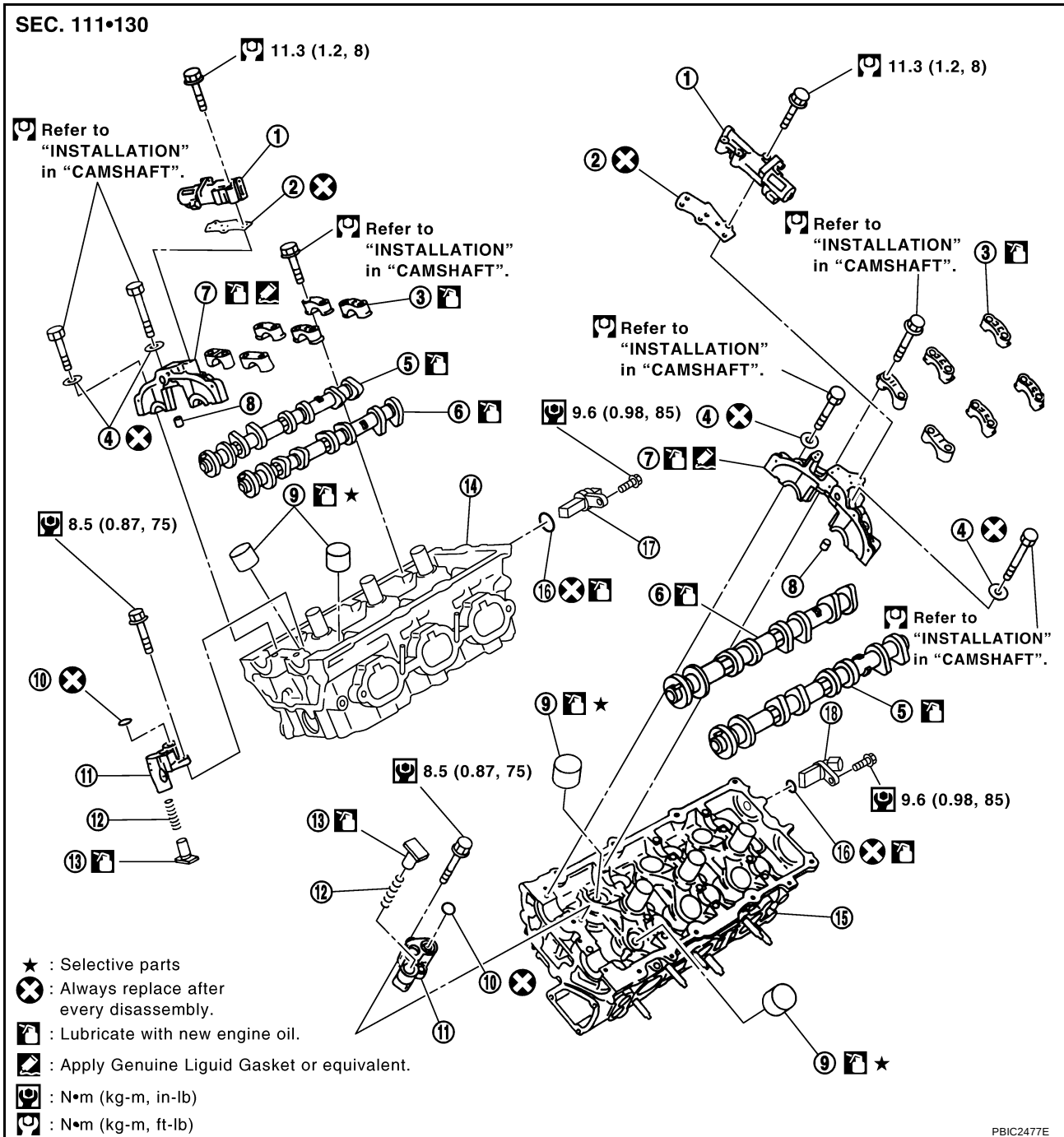
Summary of the inspection items:

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

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

CAMSHAFT

Removal and Installation



PBIC2477E

- | | | |
|---|---|--|
| 1. Intake valve timing control solenoid valve | 2. Gasket | 3. Camshaft bracket (No. 2 to 4) |
| 4. Seal washer | 5. Camshaft (EXH) | 6. Camshaft (INT) |
| 7. Camshaft bracket (No. 1) | 8. Dowel pin | 9. Valve lifter |
| 10. O-ring | 11. Timing chain tensioner (secondary) | 12. Spring |
| 13. Plunger | 14. Cylinder head (right bank) | 15. Cylinder head (left bank) |
| 16. O-ring | 17. Camshaft position sensor (PHASE) (right bank) | 18. Camshaft position sensor (PHASE) (left bank) |

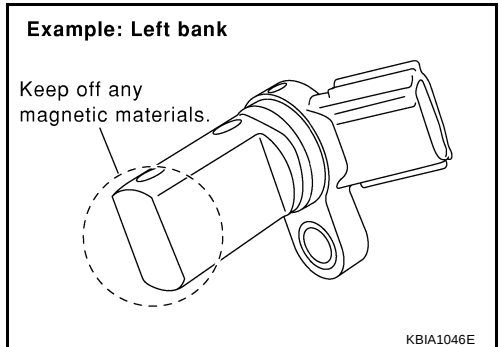
REMOVAL

1. Remove engine assembly from vehicle, and separate front suspension member and transaxle from engine. Refer to [EM-223, "ENGINE ASSEMBLY"](#).

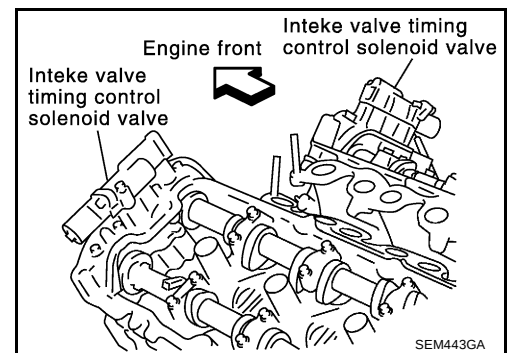
2. Install engine sub-attachment with engine stand shaft [SST: KV10117001 and KV10106500] to right side of cylinder block, then lift engine, and mount it onto engine stand [SST: ST0501S000]. Refer to [EM-228](#), "CYLINDER BLOCK" .
3. Remove front timing chain case, camshaft sprocket, timing chain and rear timing chain case. Refer to [EM-173](#), "TIMING CHAIN" .
4. Remove camshaft position sensors (PHASE) (right and left banks) from cylinder head back side.

CAUTION:

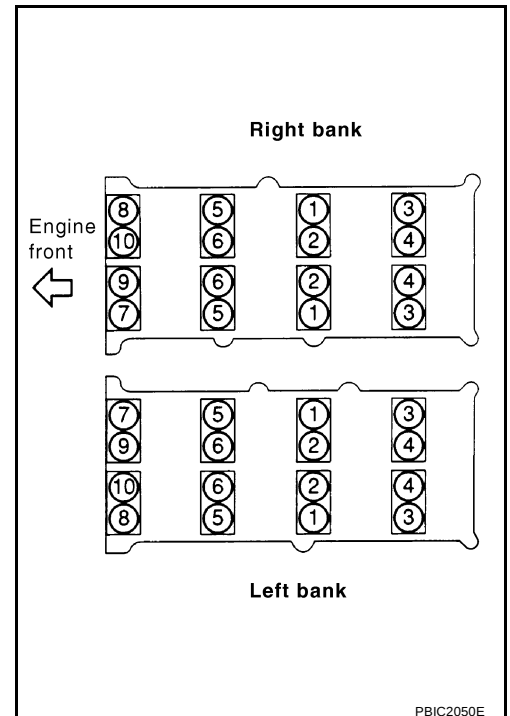
- Handle carefully to avoid dropping and shocks.
- Do not disassemble.
- Do not allow metal powder to adhere to magnetic part at sensor tip.
- Do not place sensors in a location where they are exposed to magnetism.



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 the reverse order as shown in the figure.

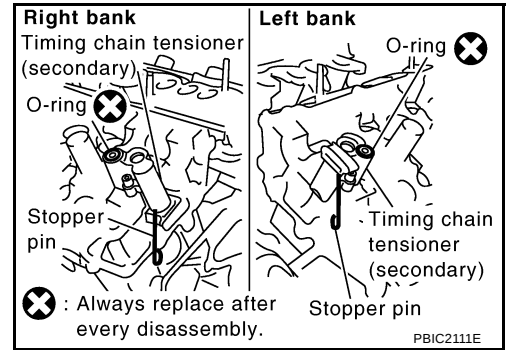


7. Remove camshafts.
8. Remove valve lifters.

- Identify installation positions, and store them without mixing them up.
- Remove chain tensioners (secondary) from both cylinder heads (right and left banks).
 - Remove timing chain tensioner (secondary) with its stopper pin attached.

NOTE:

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



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 camshaft runout on dial indicator. (Total indicator reading)

Standard : 0.02 mm (0.0010 in)

Limit : 0.05 mm (0.0020 in)

- If it exceeds the limit, replace camshaft.

Camshaft Cam Height

- Measure camshaft cam height with micrometer.

Standard cam height

Intake

VQ23DE : 44.265 - 44.455 mm (1.7427 - 1.7502 in)

VQ35DE : 44.865 - 45.055 mm (1.7663 - 1.7738 in)

Exhaust

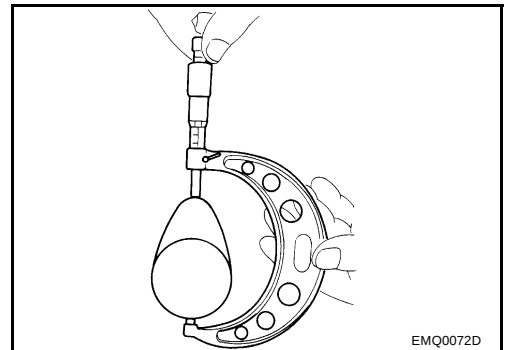
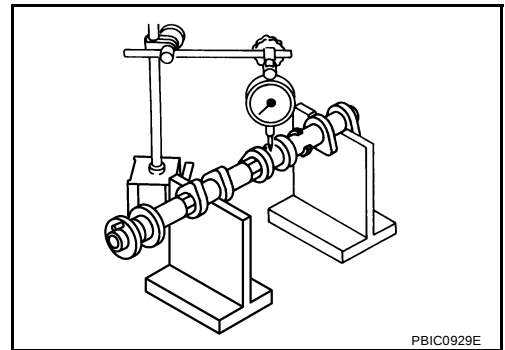
VQ23DE : 43.405 - 43.595 mm (1.7089 - 1.7163 in)

VQ35DE : 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

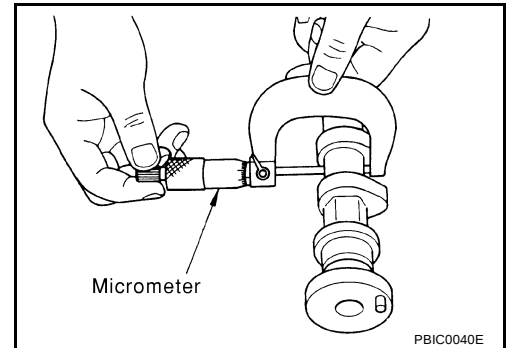
CAMSHAFT JOURNAL DIAMETER

- Measure 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)



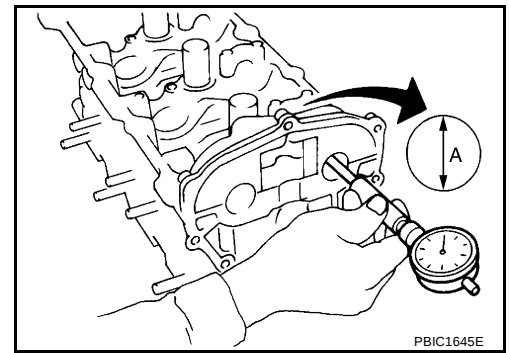
CAMSHAFT BRACKET INNER DIAMETER

- Tighten camshaft bracket bolt with the specified torque. Refer to [EM-197, "INSTALLATION"](#) for the tightening procedure.
- Measure 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 it exceeds the limit, replace either or both camshaft and cylinder head.

NOTE:

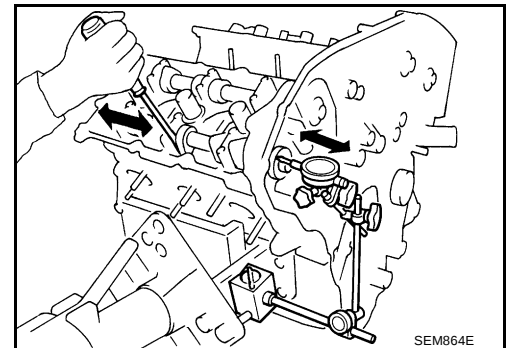
Camshaft bracket cannot be replaced as a single part, because it is machined together with cylinder head. Replace whole cylinder head assembly.

Camshaft End Play

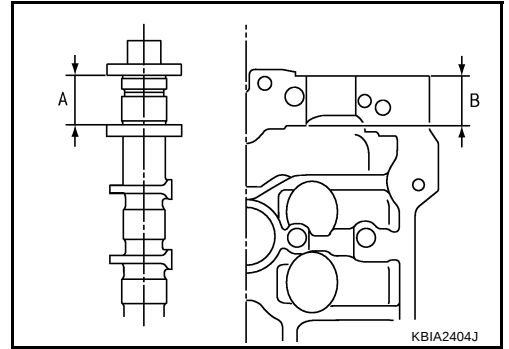
- Install dial indicator in thrust direction on front end of camshaft. Measure the end play of dial indicator when camshaft is moved forward/backward (in direction to axis).

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.

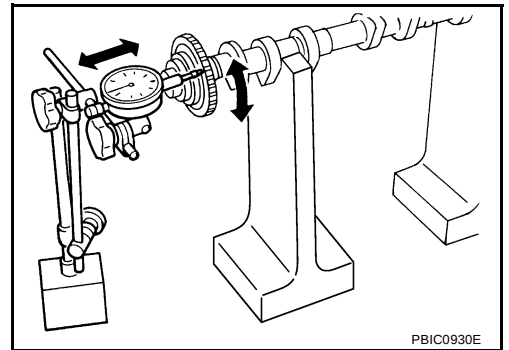
CAUTION:

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

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

Limit : 0.15 mm (0.0059 in)

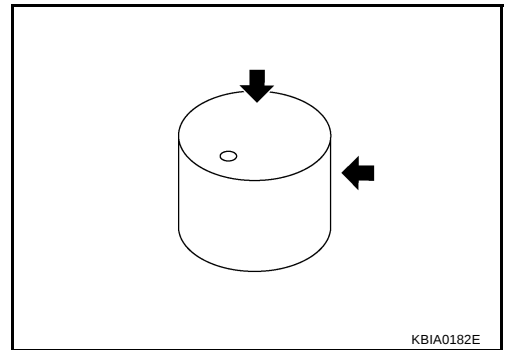
- If it exceeds the limit, replace camshaft sprocket.



Valve Lifter

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

- If anything above is found, replace valve lifter. Refer to [EM-202, "Valve Clearance"](#).



Valve Lifter Clearance

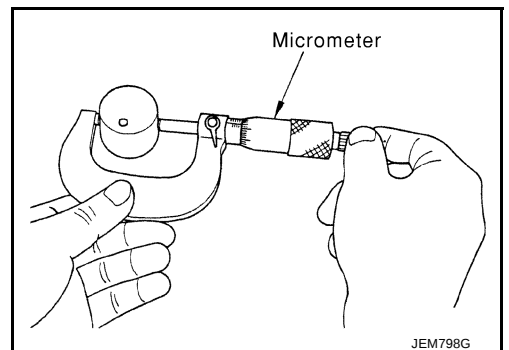
VALVE LIFTER OUTER DIAMETER

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

Standard

VQ23DE : 29.977 - 29.987 mm (1.1802 - 1.1806 in)

VQ35DE : 33.977 - 33.987 mm (1.3377 - 1.3381 in)



VALVE LIFTER HOLE DIAMETER

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

Standard

Intake

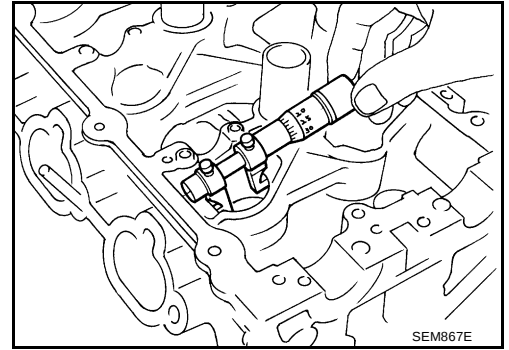
VQ23DE : 30.015 - 30.031 mm (1.1817 - 1.1823 in)

VQ35DE : 34.000 - 34.016 mm (1.3386 - 1.3392 in)

Exhaust

VQ23DE : 30.003 - 30.019 mm (1.1812 - 1.1818 in)

VQ35DE : 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

VQ23DE : 0.028 - 0.054 mm (0.0011 - 0.0021 in)

VQ35DE : 0.013 - 0.039 mm (0.0005 - 0.0015 in)

Exhaust

VQ23DE : 0.016 - 0.042 mm (0.0006 - 0.0017 in)

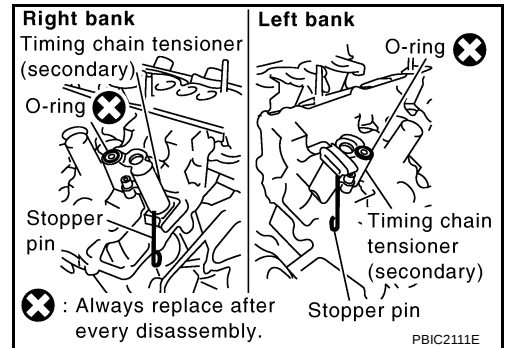
VQ35DE : 0.013 - 0.039 mm (0.0005 - 0.0015 in)

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

INSTALLATION

- Install timing chain tensioners (secondary) on both cylinder heads (right and left banks).

- Install timing chain tensioner (secondary) with its stopper pin attached.
- Install timing chain tensioner (secondary) with sliding part facing downward on cylinder head (right bank), and with sliding part facing upward on cylinder head (left bank).
- Install new O-ring as shown in the figure.

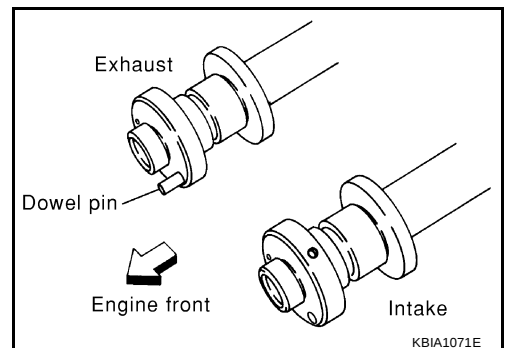


- Install valve lifters.

- Install them in the original position.

- Install camshafts.

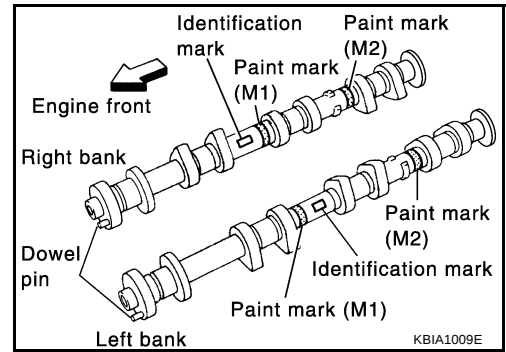
- Install camshaft with dowel pin attached to its front end face on the exhaust side.



CAMSHAFT

[VQ]

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



VQ23DE

Bank	INT/EXH	Dowel pin	Paint marks		Identification mark
			M1	M2	
RH	INT	No	White	No	RE
	EXH	Yes	No	Blue	RE
LH	INT	No	White	No	LH
	EXH	Yes	No	Blue	LH

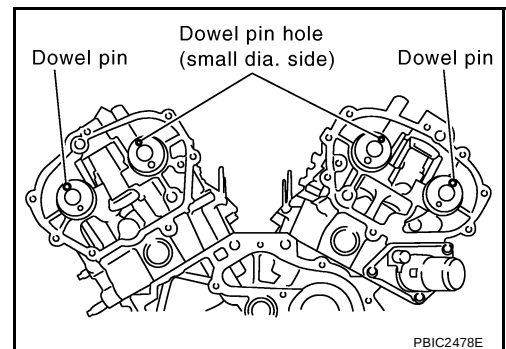
VQ35DE

Bank	INT/EXH	Dowel pin	Paint marks		Identification 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 camshafts so that dowel pin hole and dowel pin on front end face are positioned as shown in the figure. (No. 1 cylinder TDC on its compression stroke)

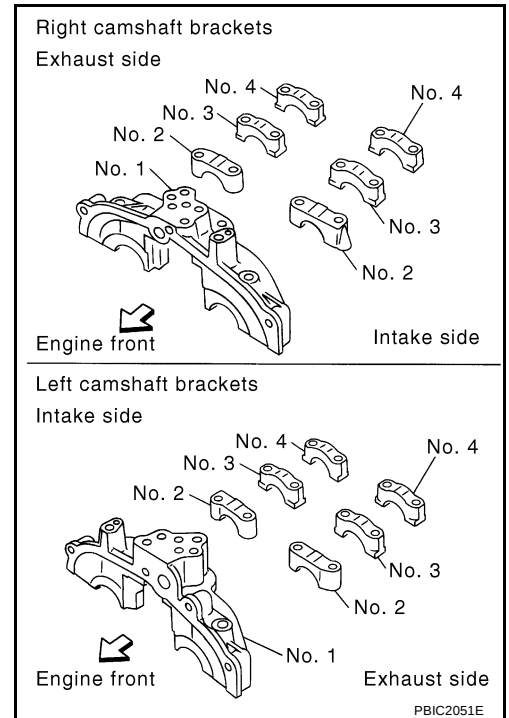
NOTE:

- 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.



4. Install camshaft brackets.

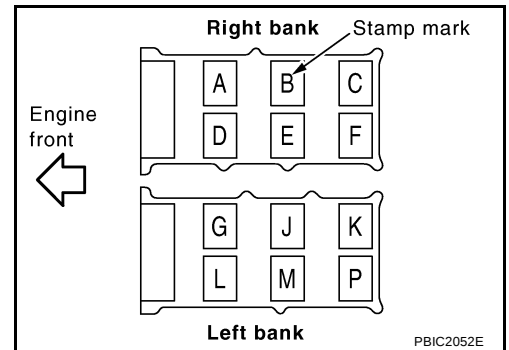
- Remove foreign material completely from camshaft bracket backside and from cylinder head installation face.
- Install camshaft bracket in original position and direction as shown in the figure.



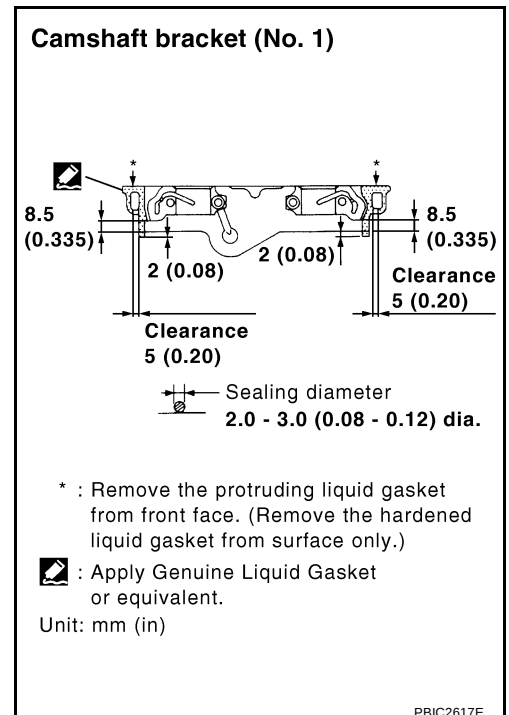
- Install camshaft brackets (No. 2 to 4) aligning the stamp marks as shown in the figure.

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 Liquid Gasket or equivalent.



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.

 : 1.96 N·m (0.20 kg-m, 1 ft-lb)

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

 : 1.96 N·m (0.20 kg-m, 1 ft-lb)

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

 : 5.88 N·m (0.60 kg-m, 4 ft-lb)

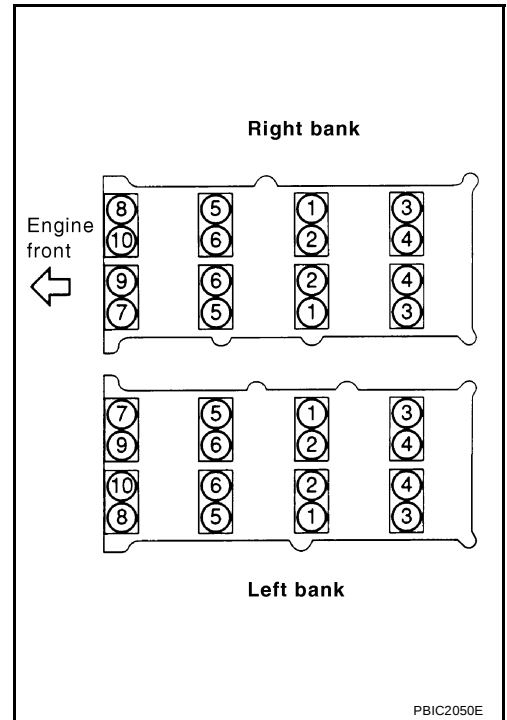
- d. Tighten No. 1 to 10 in numerical order as shown.

 : 10.4 N·m (1.1 kg-m, 8 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.

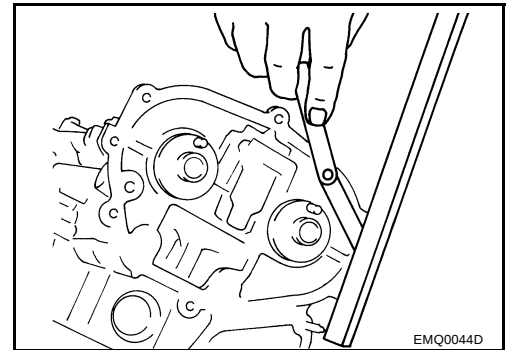
- Mating surface of rocker cover
- Mating surface of rear timing chain case



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

Standard : -0.14 to 0.14 mm (-0.006 to 0.006 in)

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



7. Check and adjust the valve clearance. Refer to [EM-202, "Valve Clearance"](#).
8. Install in the reverse order of removal after this step.

INSPECTION AFTER INSTALLATION

Inspection of Camshaft Sprocket (INT) Oil Groove

CAUTION:

- Perform this inspection only when DTC P0011 or P0021 are detected in self-diagnostic results of CONSULT-II and it is directed according to inspection procedure of EC section. Refer to [EC-427, "SELF-DIAG RESULTS MODE"](#) .

- Check when engine ins cold so as to prevent burns from any splashing engine oil.

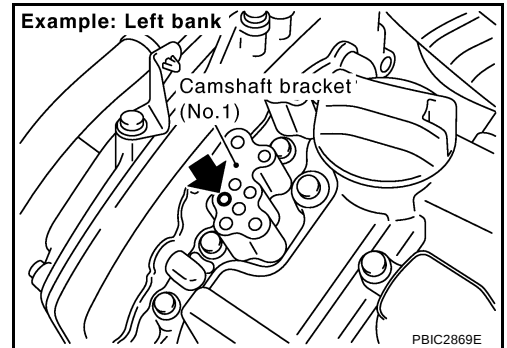
1. Check the engine oil level. Refer to [LU-19, "ENGINE OIL"](#) .
2. Perform the following procedure so as to prevent the engine from being unintentionally started while checking.
 - a. Release fuel pressure. Refer to [EC-392, "FUEL PRESSURE RELEASE"](#) .
 - b. Disconnect ignition coil and injector harness connectors.
3. Remove intake manifold control solenoid valve. Refer to [EM-192, "CAMSHAFT"](#) .
4. Crank the engine, and then make sure that engine oil comes out from camshaft bracket (No. 1) oil hole. End crank after checking.

WARNING:

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

CAUTION:

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



- Clean oil groove between oil strainer and intake valve timing control solenoid valve if engine oil does not come out from camshaft bracket (No. 1) oil hole. Refer to [LU-17, "LUBRICATION SYSTEM"](#) .
5. Remove components between intake valve timing control solenoid valve and camshaft sprocket (INT), and then check each oil groove for clogging.
 - Clean oil groove if necessary. Refer to [LU-17, "LUBRICATION SYSTEM"](#) .
 6. After inspection, install removed parts.

Inspection for Leaks

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

- Before starting engine, check oil/fluid levels including engine coolant and engine oil. If less than required quantity, fill to the specified level. Refer to [MA-14, "RECOMMENDED FLUIDS AND LUBRICANTS"](#) .
- Use procedure below to check for fuel leakage.
 - Turn ignition switch "ON" (with engine stopped). With fuel pressure applied to fuel piping, check for fuel leakage at connection points.
 - Start engine. With engine speed increased, check again for fuel leakage at connection points.
- Run engine to check for unusual noise and vibration.

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.

- Warm up engine thoroughly to make sure there is no leakage of fuel, exhaust gases, or any oil/fluids including engine oil and engine coolant.
- Bleed air from lines and hoses of applicable lines, such as in cooling system.
- After cooling down engine, again check oil/fluid levels including engine oil and engine coolant. Refill to the specified level, if necessary.

Summary of the inspection items:

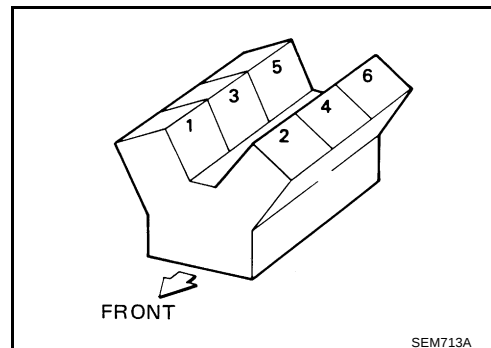
Item	Before starting engine	Engine running	After engine stopped
Engine coolant	Level	Leakage	Level
Engine oil	Level	Leakage	Level
Other oils and fluid*	Level	Leakage	Level
Fuel	Leakage	Leakage	Leakage
Exhaust gases	—	Leakage	—

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

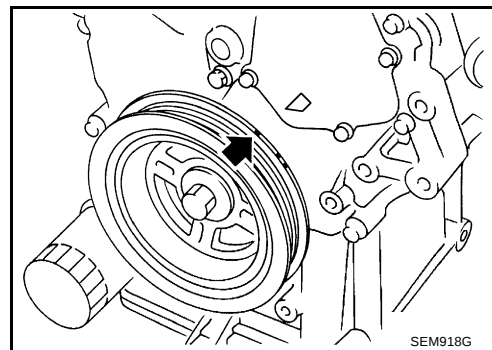
Valve Clearance INSPECTION

BBS004W2

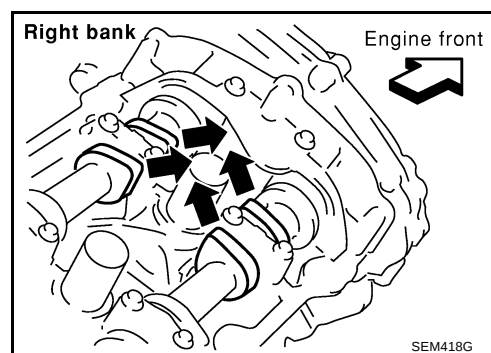
In cases of removing/installing or replacing camshaft and valve-related parts, or of unusual engine conditions due to changes in valve clearance (found malfunctions during starting, idling or causing noise), perform inspection as follows:



1. Remove rocker covers (right and left banks). Refer to [EM-160, "ROCKER COVER"](#).
2. Remove splash guard (RH).
3. 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.



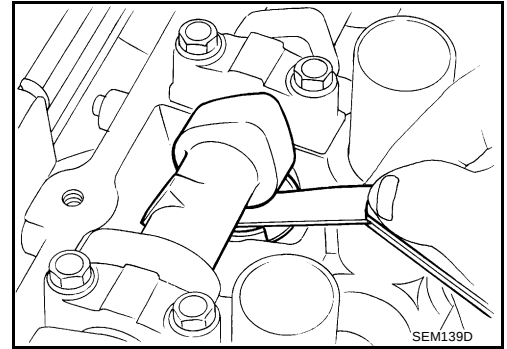
- Make sure that intake and exhaust cam noses on No. 1 cylinder (engine front side of right bank) are located as shown in the figure.
- If not, rotate crankshaft one revolution (360 degrees) and align as shown in the figure.



CAMSHAFT

[VQ]

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



Valve clearance:

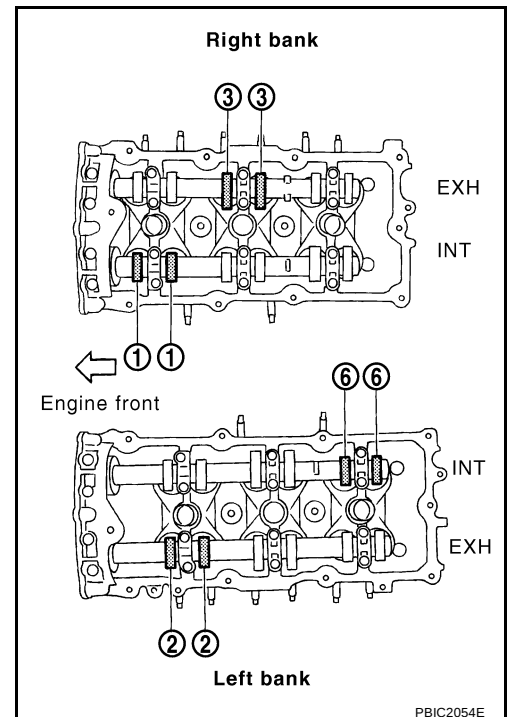
Unit: mm (in)

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

*: Approximately 80°C (176°F)

- 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

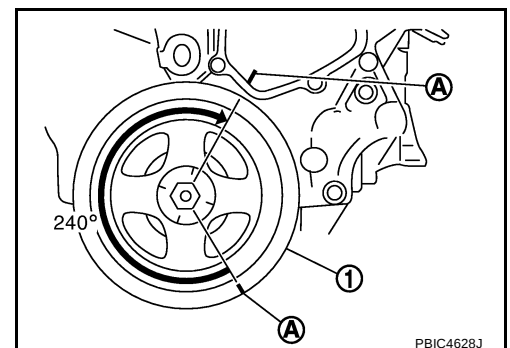
Measuring position (right bank)		No. 1 CYL.	No. 3 CYL.	No. 5 CYL.
No. 1 cylinder at compression TDC	EXH		x	
	INT	x		
Measuring position (left bank)		No. 2 CYL.	No. 4 CYL.	No. 6 CYL.
No. 1 cylinder at compression TDC	INT			x
	EXH	x		



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

NOTE:

- To align cylinder No.3 with the compression top dead center, place matching marks (A) on the crank pulley (1) side and on the cylinder block side at a point 240°counterclockwise from the compression top dead center using the hex head of the crank pulley mounting bolt as guide.

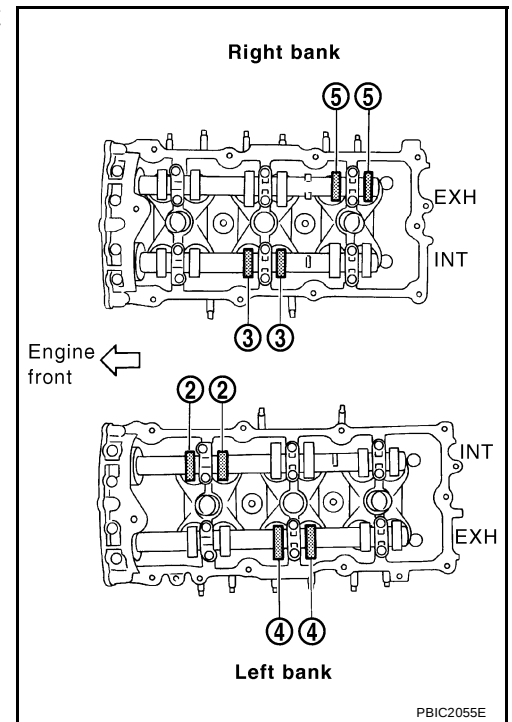


CAMSHAFT

[VQ]

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

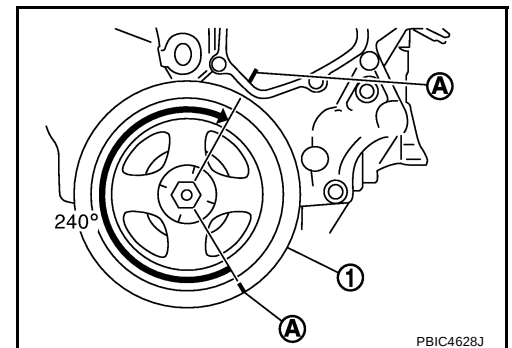
Measuring position (right bank)		No. 1 CYL.	No. 3 CYL.	No. 5 CYL.
No. 3 cylinder at compression TDC	EXH			x
	INT		x	
Measuring position (left bank)		No. 2 CYL.	No. 4 CYL.	No. 6 CYL.
No. 3 cylinder at compression TDC	INT	x		
	EXH		x	



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

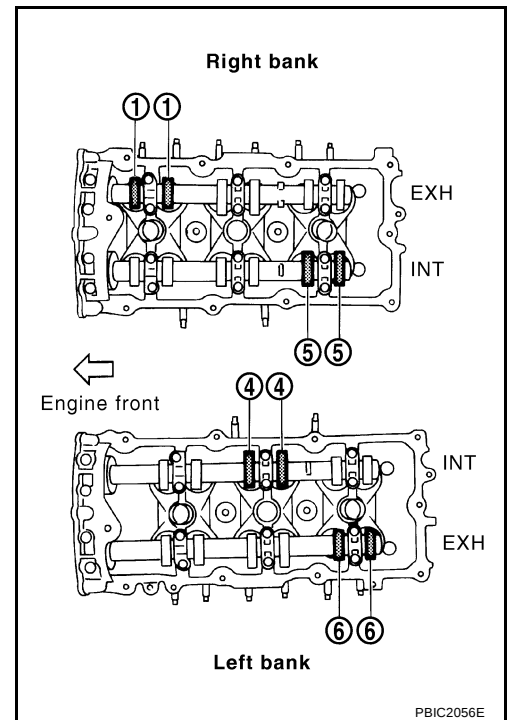
NOTE:

- To align cylinder No.5 with the compression top dead center, place matching marks (A) on the crank pulley (1) side and on the cylinder block side at a point 240°counterclockwise from the compression top dead center using the hex head of the crank pulley mounting bolt as aguide.



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

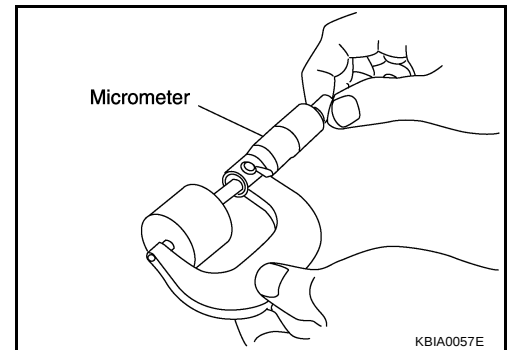
Measuring position (right bank)		No. 1 CYL.	No. 3 CYL.	No. 5 CYL.
No. 5 cylinder at compression TDC	EXH	x		
	INT			x
Measuring position (left bank)		No. 2 CYL.	No. 4 CYL.	No. 6 CYL.
No. 5 cylinder at compression TDC	INT		x	
	EXH			x



4. For the measured value are out of the standard, perform adjustment. Refer to [EM-205, "ADJUSTMENT"](#).

ADJUSTMENT

- Perform adjustment depending on selected head thickness of valve lifter.
1. Remove camshaft. Refer to [EM-192, "REMOVAL"](#).
 2. Remove valve lifters at the locations that are out of the standard.
 3. Measure the center thickness of 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

t₁ = Removed valve lifter thickness

C₁ = Measured valve clearance

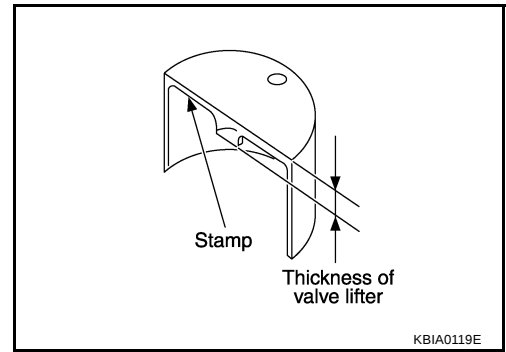
C₂ = Standard valve clearance:

Intake : 0.30 mm (0.012 in)*

Exhaust : 0.33 mm (0.013 in)*

*: Approximately 20°C (68°F)

- Thickness of new valve lifter can be identified by stamp marks on the reverse side (inside the cylinder).

**VQ23DE**

Stamp mark		Thickness
INT	EXH	
666U		6.66 mm
668U		6.68 mm
.		.
.		.
718U		7.18 mm

Available thickness of valve lifter: 27 sizes with range 6.66 to 7.18 mm (0.2622 to 0.2827 in) in steps of 0.02 mm (0.0008 in) (when manufactured at factory). Refer to [EM-258, "Available Valve Lifter"](#) .

VQ35DE

Stamp mark		Thickness
INT	EXH	
788U	788R	7.88 mm
790U	790R	7.90 mm
.	.	.
.	.	.
840U	840R	8.40 mm

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). Refer to [EM-258, "Available Valve Lifter"](#) .

CAUTION:

Install identification letter at the end, "U" and "R", at each of proper positions. (Be careful of mis-installation between intake and exhaust)

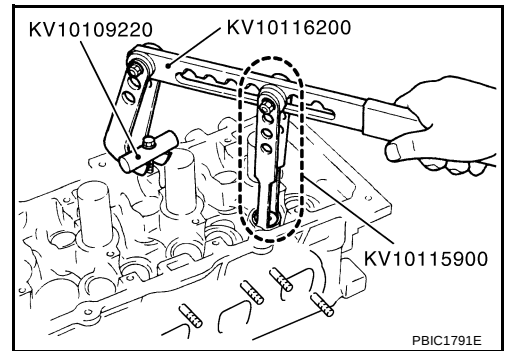
5. Install selected valve lifter.
6. Install camshaft. Refer to [EM-197, "INSTALLATION"](#) .
7. Manually rotate crankshaft pulley a few rotations.
8. Make sure that the valve clearances for cold engine are within the specifications by referring to the specified values. Refer to [EM-202, "INSPECTION"](#) .
9. Install all removed parts in the reverse order of removal. Refer to [EM-197, "INSTALLATION"](#) .
10. Warm up the engine, and check for unusual noise and vibration.

OIL SEAL

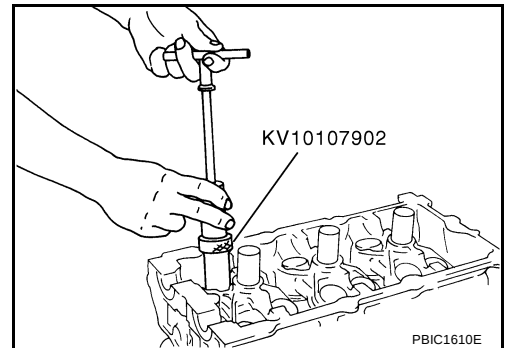
Removal and Installation of Valve Oil Seal

REMOVAL

1. Remove engine assembly from vehicle, and separate front suspension member and transaxle from engine. Refer to [EM-223, "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-228, "CYLINDER BLOCK"](#).
 3. Remove camshaft relating to valve oil seal to be removed. Refer to [EM-192, "CAMSHAFT"](#).
 4. Remove valve lifters. Refer to [EM-192, "CAMSHAFT"](#).
 5. Rotate 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).



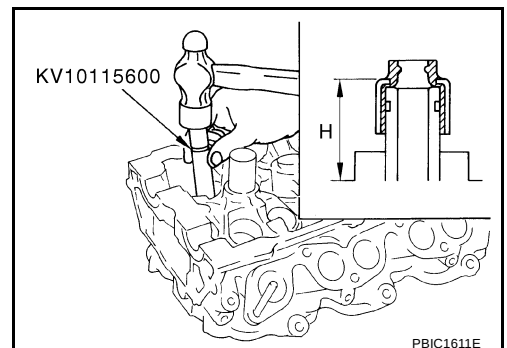
INSTALLATION

1. Apply 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 the 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.

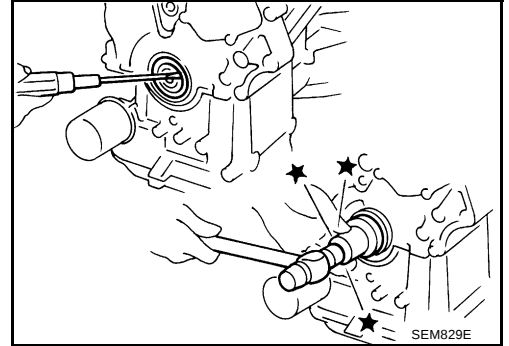
Removal and Installation of Front Oil Seal

REMOVAL

- Remove the following:
 - Right side front road wheel and tire.
 - Splash guard (RH)
 - Drive belts; Refer to [EM-128, "DRIVE BELTS"](#).
 - Crankshaft pulley; Refer to [EM-173, "TIMING CHAIN"](#).
- Remove front oil seal using suitable tool.

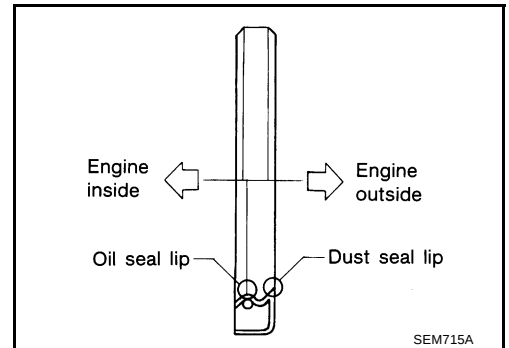
CAUTION:

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



INSTALLATION

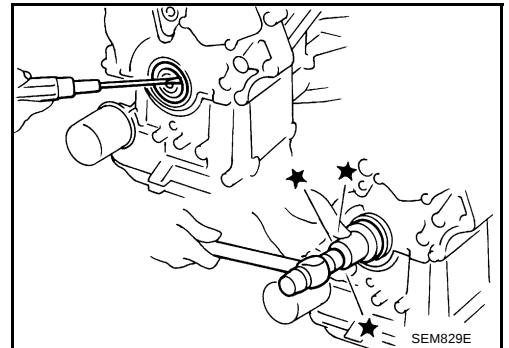
- Apply engine oil to both oil seal lip and dust seal lip.
 - Install front oil seal.
- Install front oil seal so that each seal lip is oriented as shown in the figure.



- 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.



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

Removal and Installation of Rear Oil Seal

REMOVAL

- Remove engine assembly from vehicle, and separate front suspension member and transaxle from engine. Refer to [EM-223, "ENGINE ASSEMBLY"](#).
- 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-228, "CYLINDER BLOCK"](#).
- Remove drive plate. Refer to [EM-228, "CYLINDER BLOCK"](#).
- Remove oil pan (upper). Refer to [EM-145, "OIL PAN AND OIL STRAINER"](#).

OIL SEAL

[VQ]

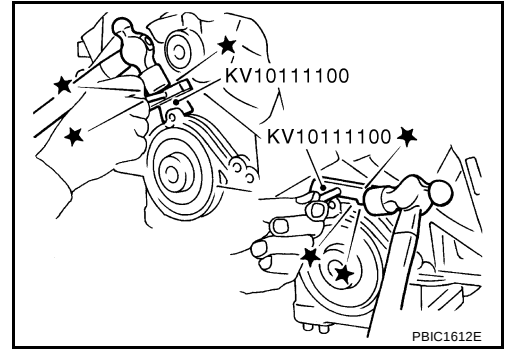
5. Use seal cutter (SST) to cut away liquid gasket and remove rear oil seal retainer.

CAUTION:

Be careful not to damage mating surfaces.

NOTE:

Regard both rear oil seal and retainer as an assembly.

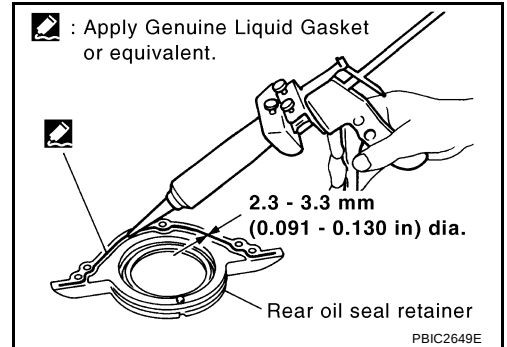


INSTALLATION

1. Remove old liquid gasket on mating surface of cylinder block and oil pan (upper) 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 new rear oil seal retainer as shown in the figure.

Use Genuine Liquid Gasket or equivalent.

- Assembly should be done within 5 minutes after coating.



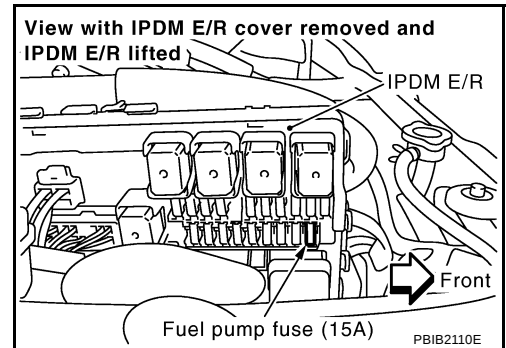
4. Install rear oil seal retainer to cylinder block. Refer to [EM-228, "CYLINDER BLOCK"](#).
5. Install in the reverse order of removal after this step.

CYLINDER HEAD

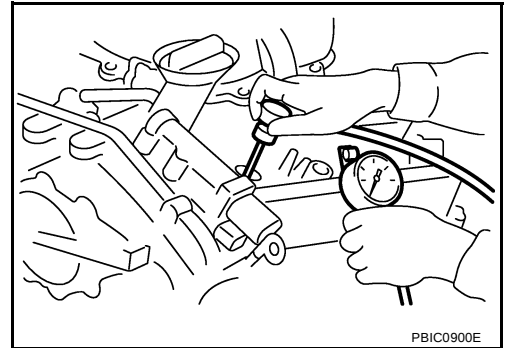
On-Vehicle Service

CHECKING COMPRESSION PRESSURE

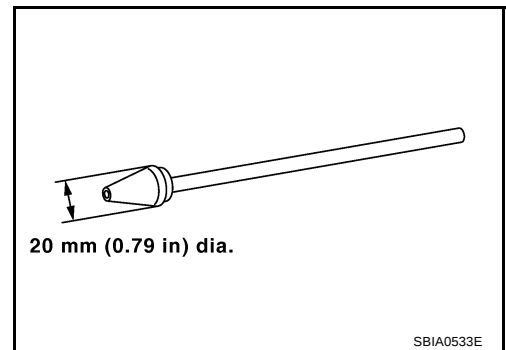
1. Warm up engine thoroughly. Then, stop it.
2. Release fuel pressure. Refer to [EC-392, "FUEL PRESSURE RELEASE"](#).
3. Disconnect fuel pump fuse to avoid fuel injection during measurement.



4. Remove engine cover. Refer to [EM-133, "INTAKE MANIFOLD COLLECTOR"](#).
5. Remove ignition coil and spark plug from each cylinder. Refer to [EM-152, "IGNITION COIL"](#) and [EM-153, "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 (bar, kg/cm², psi) /rpm

	VQ23DE	VQ35DE
Standard	1,050 (10.5, 10.7, 152) / 300	1,270 (12.70, 13.0, 184) / 300
Minimum	750 (7.5, 7.7, 109) / 300	980 (9.8, 10.0, 142) / 300
Differential limit between cylinders	100 (1.0, 1.0, 15) / 300	100 (1.0, 1.0, 15) / 300

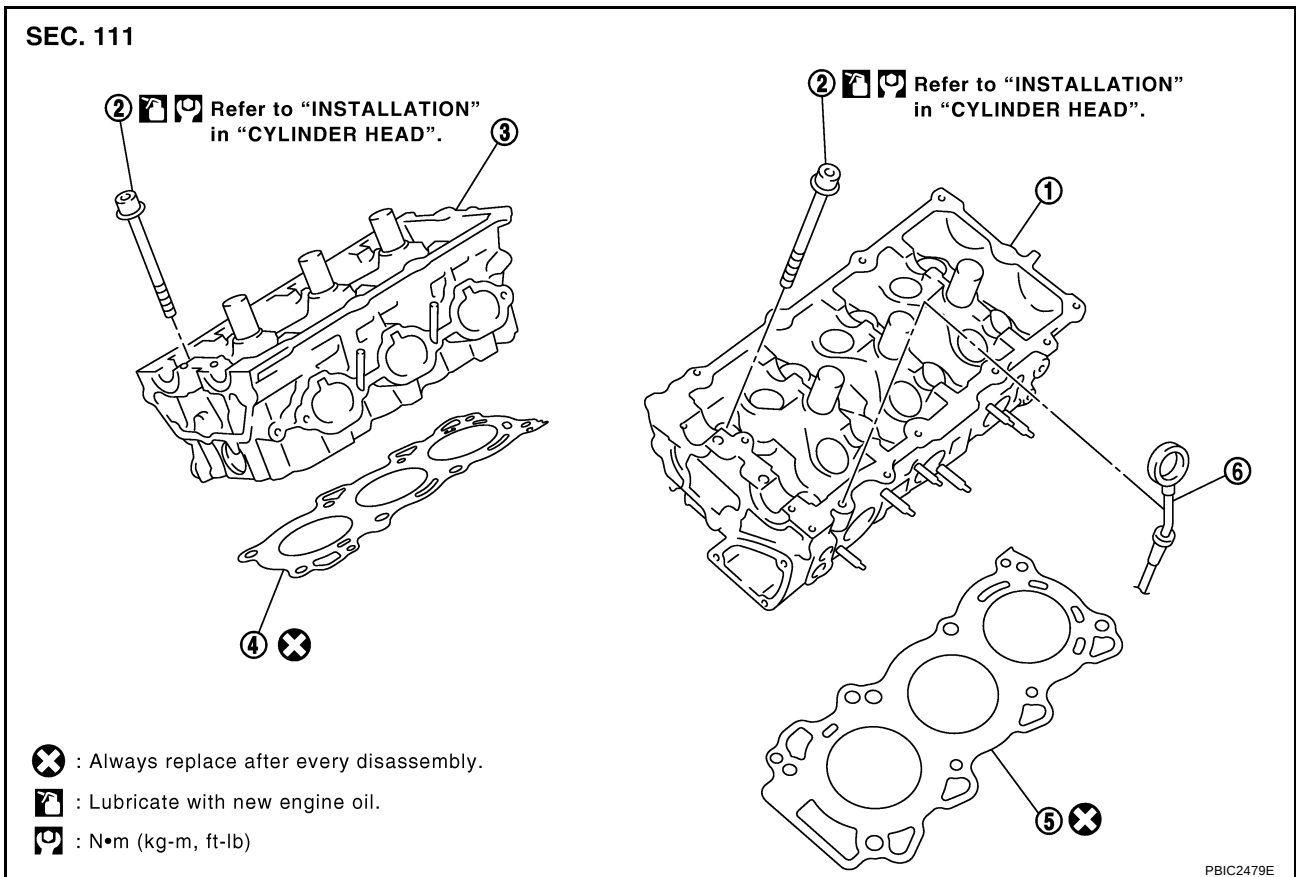
CAUTION:

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

- If the engine speed is out of specified range, check battery liquid for proper gravity. Check engine speed again with normal battery gravity.
 - If compression pressure is below minimum value, check valve clearances and parts associated with combustion chamber (valve, valve seat, piston, piston ring, cylinder bore, cylinder head, cylinder head gasket). After the checking, measure compression pressure again.
 - If some cylinders have low compression pressure, pour small amount of engine oil into the spark plug hole of the cylinder to re-check it for compression.
 - If the added engine oil improves the compression, piston rings may be worn out or damaged. Check the piston rings and replace if necessary.
 - If the compression pressure remains at low level despite the addition of engine oil, 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 gasket is leaking. In such a case, replace cylinder head gasket.
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-394, "TROUBLE DIAGNOSIS"](#).

Removal and Installation

BBS004W7

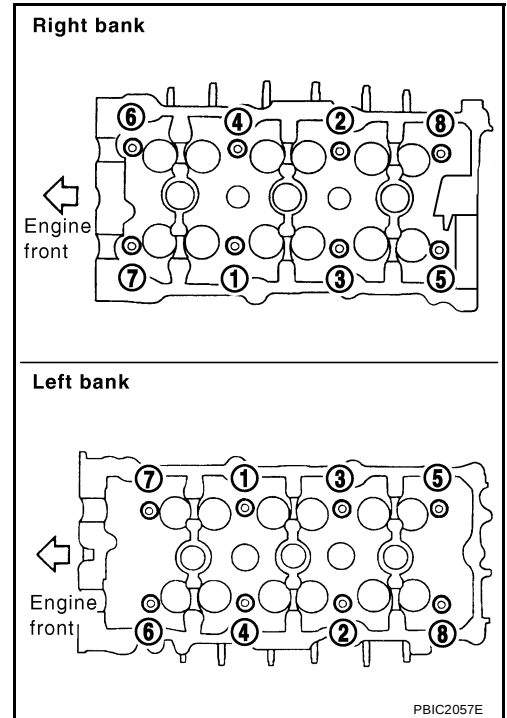


- | | | |
|--------------------------------------|-------------------------------------|-------------------------------|
| 1. Cylinder head (left bank) | 2. Cylinder head bolt | 3. Cylinder head (right bank) |
| 4. Cylinder head gasket (right bank) | 5. Cylinder head gasket (left bank) | 6. Oil level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

REMOVAL

1. Remove engine assembly from vehicle, and separate front suspension member and transaxle from engine. Refer to [EM-223, "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-228, "CYLINDER BLOCK"](#).

3. Remove camshaft. Refer to [EM-192, "CAMSHAFT"](#) .
4. Remove engine slingers.
5. Remove the following:
 - Fuel tube and fuel injector assembly; Refer to [EM-155, "FUEL INJECTOR AND FUEL TUBE"](#) .
 - Intake manifold; Refer to [EM-138, "INTAKE MANIFOLD"](#) .
 - Exhaust manifold; Refer to [EM-140, "EXHAUST MANIFOLD AND THREE WAY CATALYST"](#) .
 - Water inlet and thermostat assembly; Refer to [CO-50, "WATER INLET AND THERMOSTAT ASSEMBLY"](#) .
 - Water outlet, water bypass pipe, heater pipe and water connector; Refer to [CO-52, "WATER OUTLET AND WATER PIPING"](#) .
6. Remove cylinder head bolts in the reverse order as shown in the figure with cylinder head bolt wrench (commercial service tool) to remove cylinder heads (right and left banks).

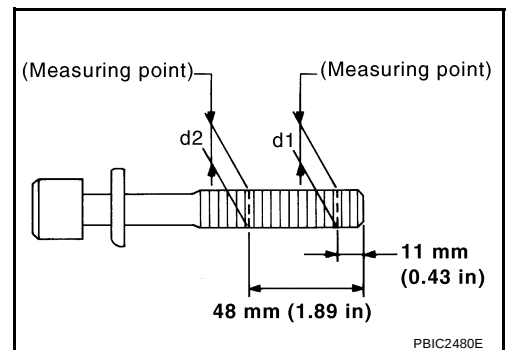


7. Remove cylinder head gaskets.

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 Distortion

NOTE:

When performing this inspection, cylinder block distortion should be also checking. Refer to [EM-248, "CYLINDER BLOCK DISTORTION"](#).

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

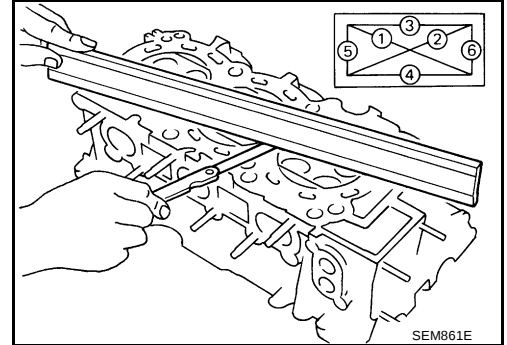
CAUTION:

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.

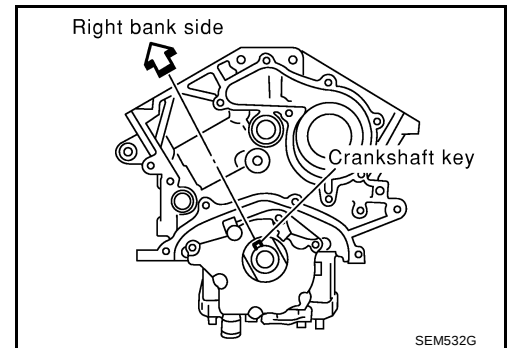
Limit : 0.1 mm (0.004 in)

- 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.

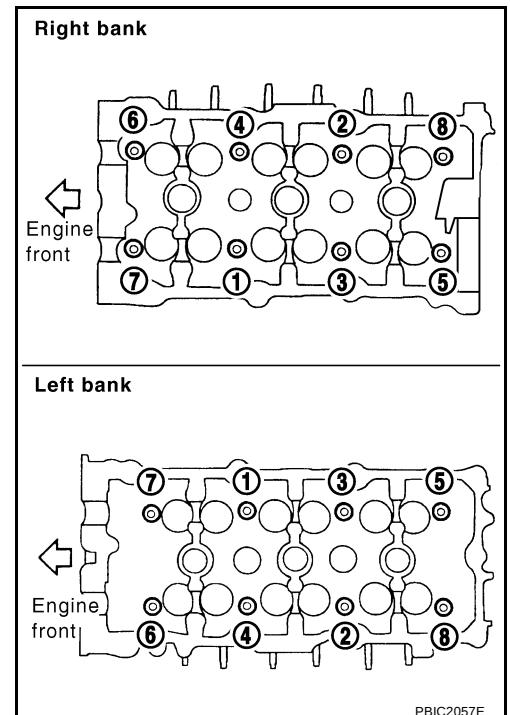
: 0 N·m (0 kg-m, 0 ft-lb)

CAUTION:

In step "c", loosen bolts in the 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

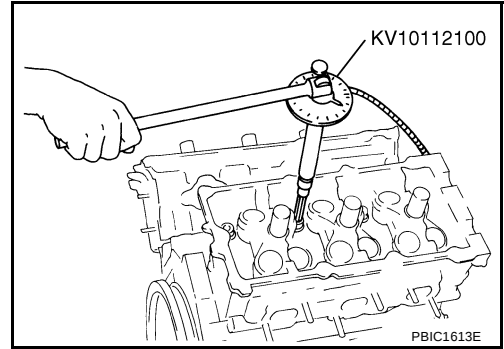
[VQ]

- 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.

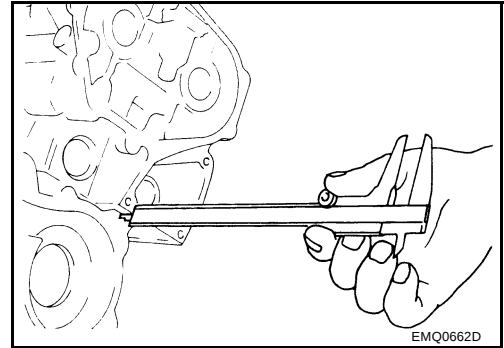
- Check tightening angle indicated on angle wrench (SST) indicator plate.
- f. Turn all cylinder head bolts 90 degrees clockwise again. (Angle tightening)



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.

INSPECTION AFTER INSTALLATION**Inspection for Leaks**

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

- Before starting engine, check oil/fluid levels including engine coolant and engine oil. If less than required quantity, fill to the specified level. Refer to [MA-14, "RECOMMENDED FLUIDS AND LUBRICANTS"](#).
- Use procedure below to check for fuel leakage.
 - Turn ignition switch "ON" (with engine stopped). With fuel pressure applied to fuel piping, check for fuel leakage at connection points.
 - Start engine. With engine speed increased, check again for fuel leakage at connection points.
- Run engine to check for unusual noise and vibration.
- Warm up engine thoroughly to make sure there is no leakage of fuel, exhaust gases, or any oil/fluids including engine oil and engine coolant.
- Bleed air from lines and hoses of applicable lines, such as in cooling system.
- After cooling down engine, again check oil/fluid levels including engine oil and engine coolant. Refill to the specified level, if necessary.

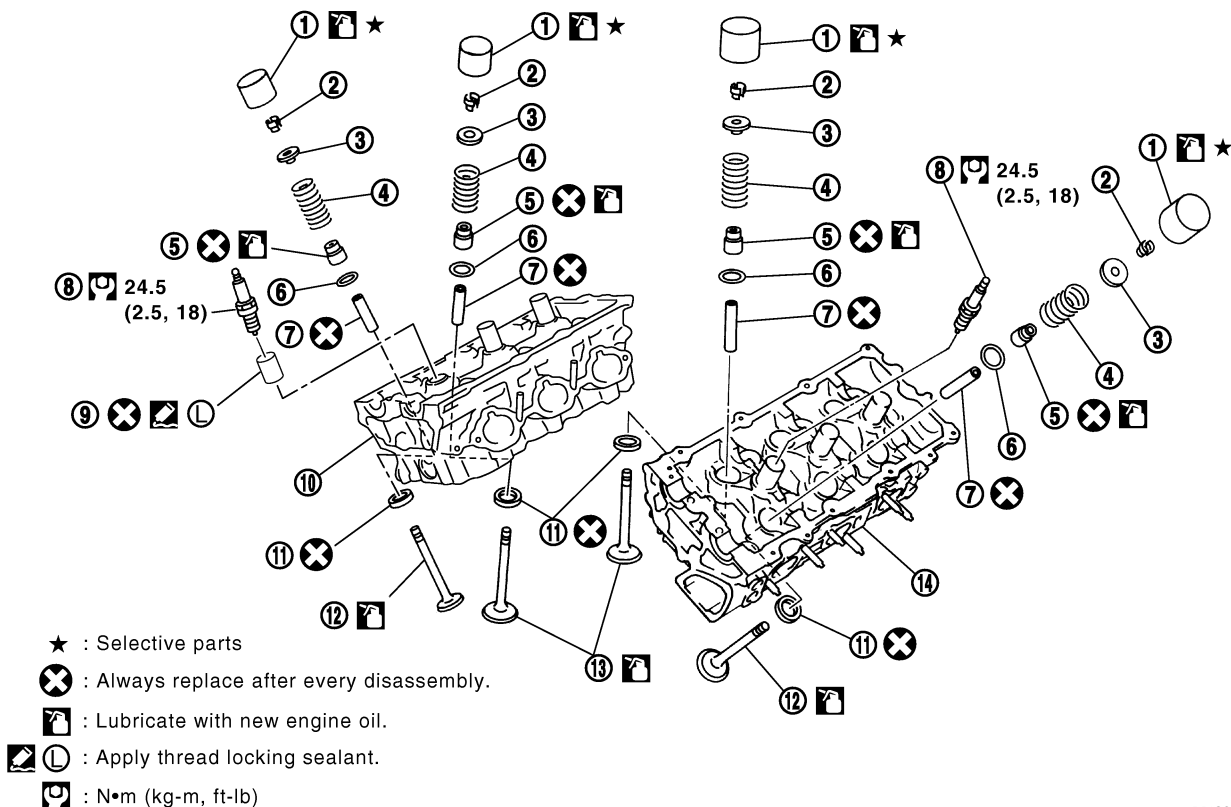
Summary of the inspection items:

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

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

Disassembly and Assembly

BBS004W8

SEC. 111•130•220

PBIC2481E

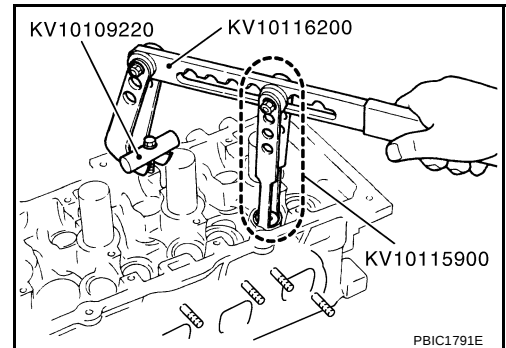
- | | | |
|--------------------------------|-------------------------------|--------------------------|
| 1. Valve lifter | 2. Valve collet | 3. Valve spring retainer |
| 4. Valve spring | 5. Valve oil seal | 6. Valve spring seat |
| 7. Valve guide | 8. Spark plug | 9. Spark plug tube |
| 10. Cylinder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

DISASSEMBLY

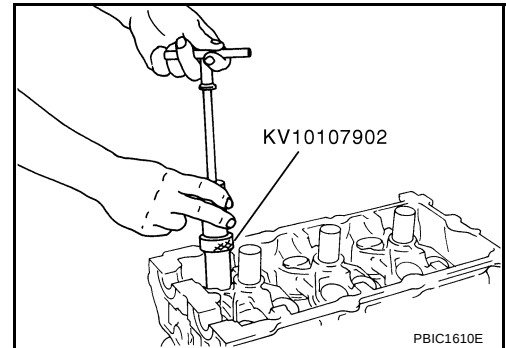
- Remove spark plug with spark plug wrench (commercial service tool).
- Remove valve lifter.
 - Identify installation positions, and store them without mixing them up.
- Remove valve collet.
 - Compress valve spring with valve spring compressor, attachment and adapter (SST). Remove valve collet with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

CAUTION:

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



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



- If valve seat must be replaced, refer to [EM-220, "VALVE SEAT REPLACEMENT"](#).
- If valve guide must be replaced, refer to [EM-219, "VALVE GUIDE REPLACEMENT"](#).
- 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

- When valve guide is removed, install it. Refer to [EM-219, "VALVE GUIDE REPLACEMENT"](#).
- When valve seat is removed, install it. Refer to [EM-220, "VALVE SEAT REPLACEMENT"](#).

CYLINDER HEAD

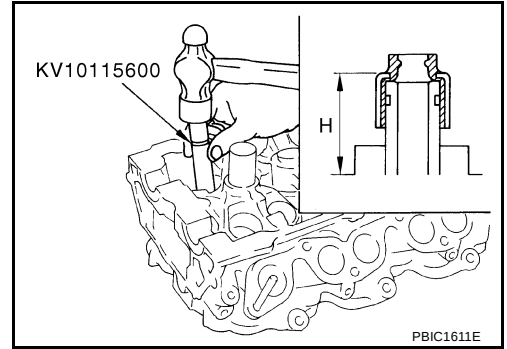
[VQ]

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)



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. (VQ23DE)

Paint mark collar

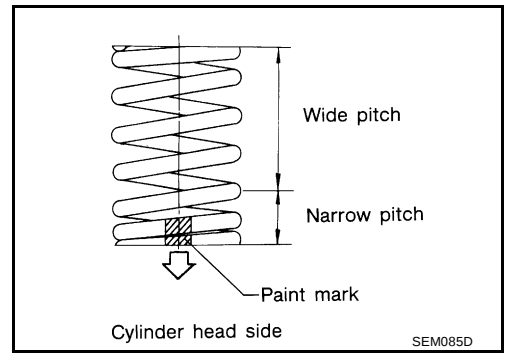
VQ23DE

Intake : White

Exhaust : Purple or orange*

VQ35DE

Intake, Exhaust : Blue



***: Exhaust side valve spring for VQ23DE has a parallel setting.**

7. Install valve spring retainer.

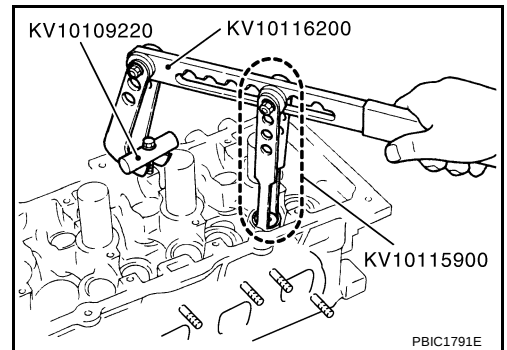
8. Install valve collet.

- 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 Thread Locking Sealant or equivalent.

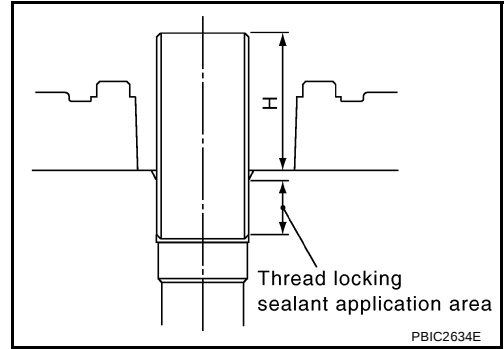
- c. Using drift, press-fit spark plug tube so that its height "H" is as specified in the figure.

Standard press-fit height "H" :

: 38.1 - 39.1 mm (1.500 - 1.539 in)

CAUTION:

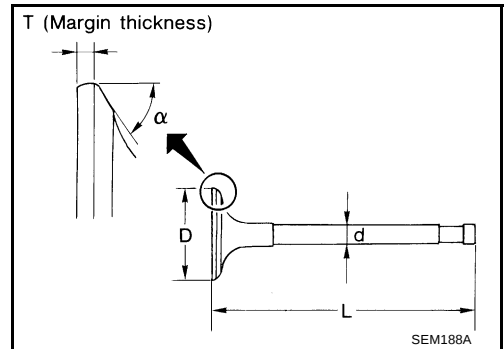
- When press-fitting, take care not to deform spark plug tube.
 - After press-fitting, wipe off liquid gasket protruding onto cylinder-head upper face.
11. Install spark plug with spark plug wrench (commercial service tool).



BBS004W9

Inspection After Disassembly VALVE DIMENSIONS

- Check dimensions of each valve. For dimensions, refer to [EM-260, "Valve Dimensions"](#).
- If dimensions are out of the standard, replace valve.



VALVE GUIDE CLEARANCE

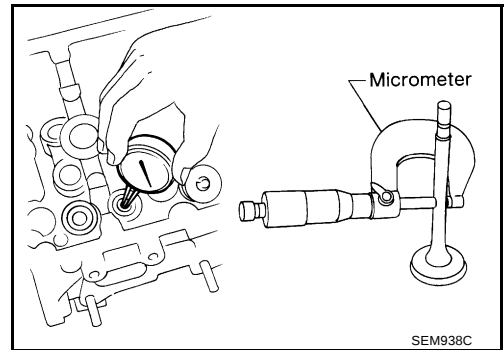
Valve Stem Diameter

Measure 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 inner diameter of valve guide with bore gauge.

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)

CYLINDER HEAD

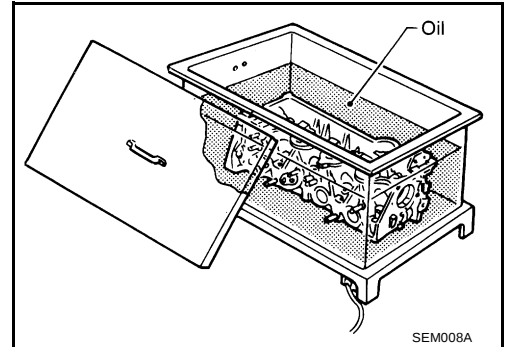
[VQ]

- If it exceeds the limit, replace valve and/or valve guide. When valve guide must be replaced, refer to [EM-219, "VALVE GUIDE REPLACEMENT"](#).

VALVE GUIDE REPLACEMENT

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

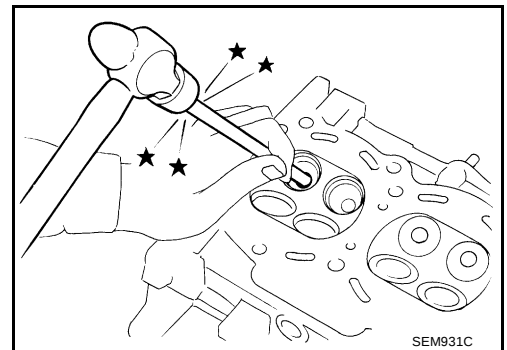
1. To remove valve guide, heat cylinder head to 110 to 130°C (230 to 266°F) by soaking in heated oil.



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

CAUTION:

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

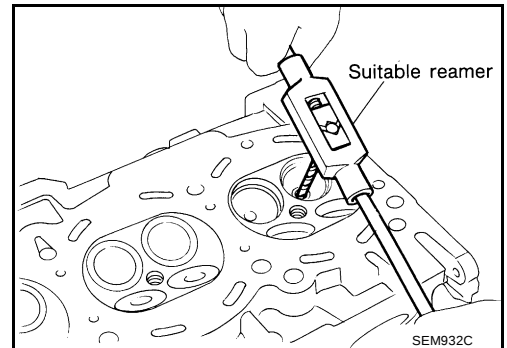


3. Using valve guide reamer (commercial service tool), ream cylinder head valve guide hole.

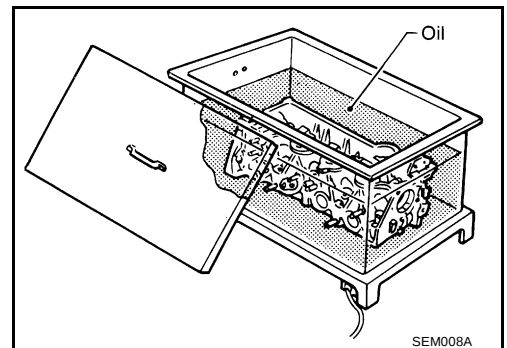
Valve guide hole diameter (for service parts):

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.



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

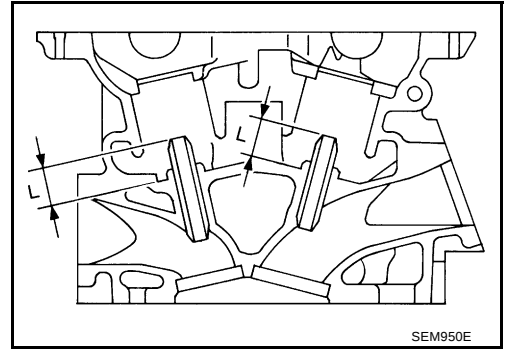
Projection "L"

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.

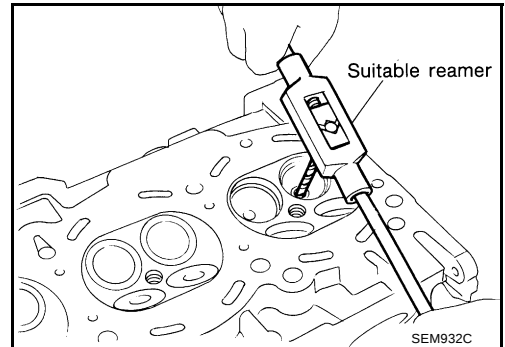


- Using valve guide reamer (commercial service tool), apply reamer finish to valve guide.

Standard:

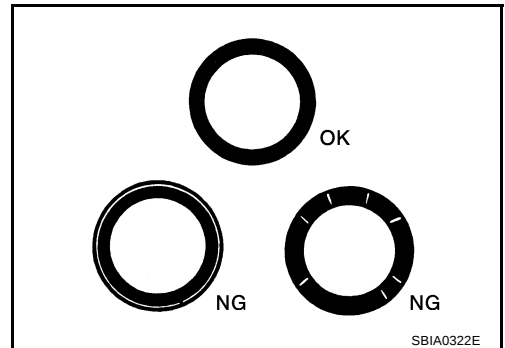
Intake and exhaust

: 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-220, "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-262, "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

VQ23DE : 35.500 - 35.516 mm (1.3976 - 1.3983 in)

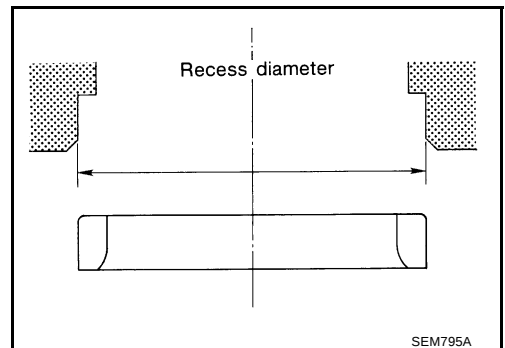
VQ35DE : 38.500 - 38.516 mm (1.5157 - 1.5164 in)

Exhaust

VQ23DE : 30.500 - 30.516 mm (1.2008 - 1.2014 in)

VQ35DE : 32.700 - 32.716 mm (1.2874 - 1.2880 in)

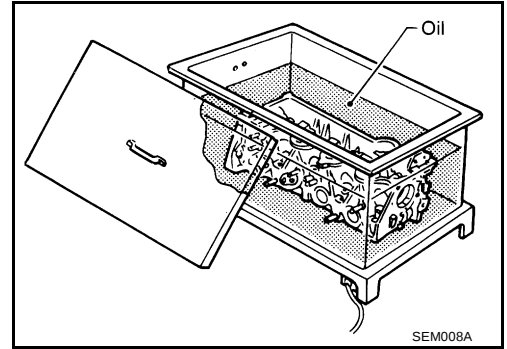
- Be sure to ream in circles concentric to valve guide center. This will enable valve to fit correctly.



CYLINDER HEAD

[VQ]

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



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

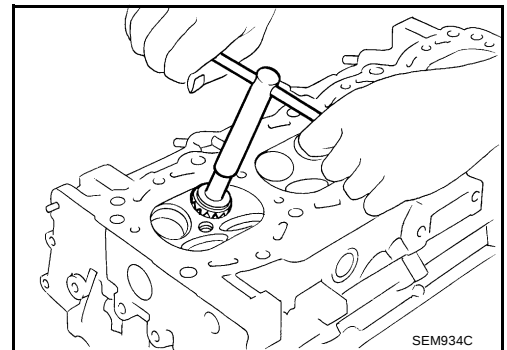
CAUTION:

- Avoid directly touching cold valve seats.
- Cylinder head contains heat. When working, wear protective equipment to avoid getting burned.

- Using valve seat cutter set (commercial service tool) or valve seat grinder, finish seat to the specified dimensions. Refer to [EM-262, "Valve Seat"](#).

CAUTION:

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



- Using compound, grind to adjust valve fitting.
- Check again for normal contact. Refer to [EM-220, "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

Intake

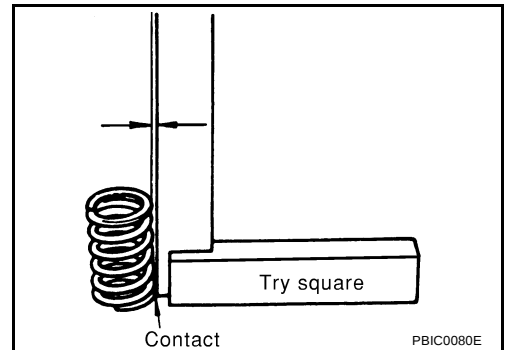
VQ23DE : 2.1 mm (0.083 in)

VQ35DE : 2.1 mm (0.083 in)

Exhaust

VQ23DE : 2.3 mm (0.091 in)

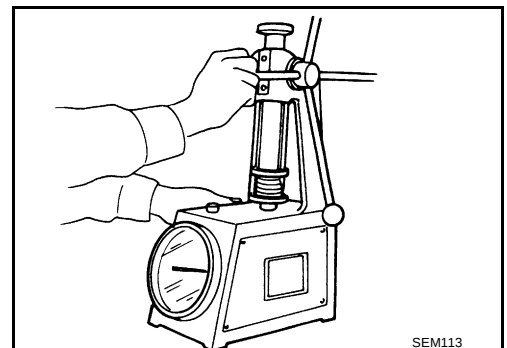
VQ35DE : 2.1 mm (0.083 in)



- If it exceeds the limit, replace valve spring.

VALVE SPRING DIMENSIONS AND VALVE SPRING PRESSURE LOAD

- Check valve spring each load at specified spring height.



CYLINDER HEAD

[VQ]

Standard:

Engine	VQ23DE			VQ35DE	
Position	Intake	Exhaust*		Intake	Exhaust
Free height	47.15 mm (1.8563 in)	52.28 mm (2.0583 in)	52.31 mm (2.0594 in)	47.07 mm (1.8531 in)	
Installation height	37.00 mm (1.4567 in)	37.00 mm (1.4567 in)	37.00 mm (1.4567 in)	37.00 mm (1.4567 in)	
Installation load	166 - 188 N (16.9 - 19.2 kg, 37 - 42 lb)	153 - 173 N (15.6 - 17.6 kg, 34 - 39 lb)	153 - 173 N (15.6 - 17.6 kg, 34 - 39 lb)	166 - 188 N (16.9 - 19.2 kg, 37 - 42 lb)	
Height during valve open	27.20 mm (1.0709 in)	29.25 mm (1.1516 in)	29.25 mm (1.1516 in)	27.20 mm (1.0709 in)	
Load with valve open	373 - 421 N (38.0 - 42.9 kg, 84 - 95 lb)	276 - 312 N (28.1 - 31.8 kg, 62 - 70 lb)	276 - 312 N (28.1 - 31.8 kg, 62 - 70 lb)	373 - 421 N (38.0 - 42.9 kg, 84 - 95 lb)	

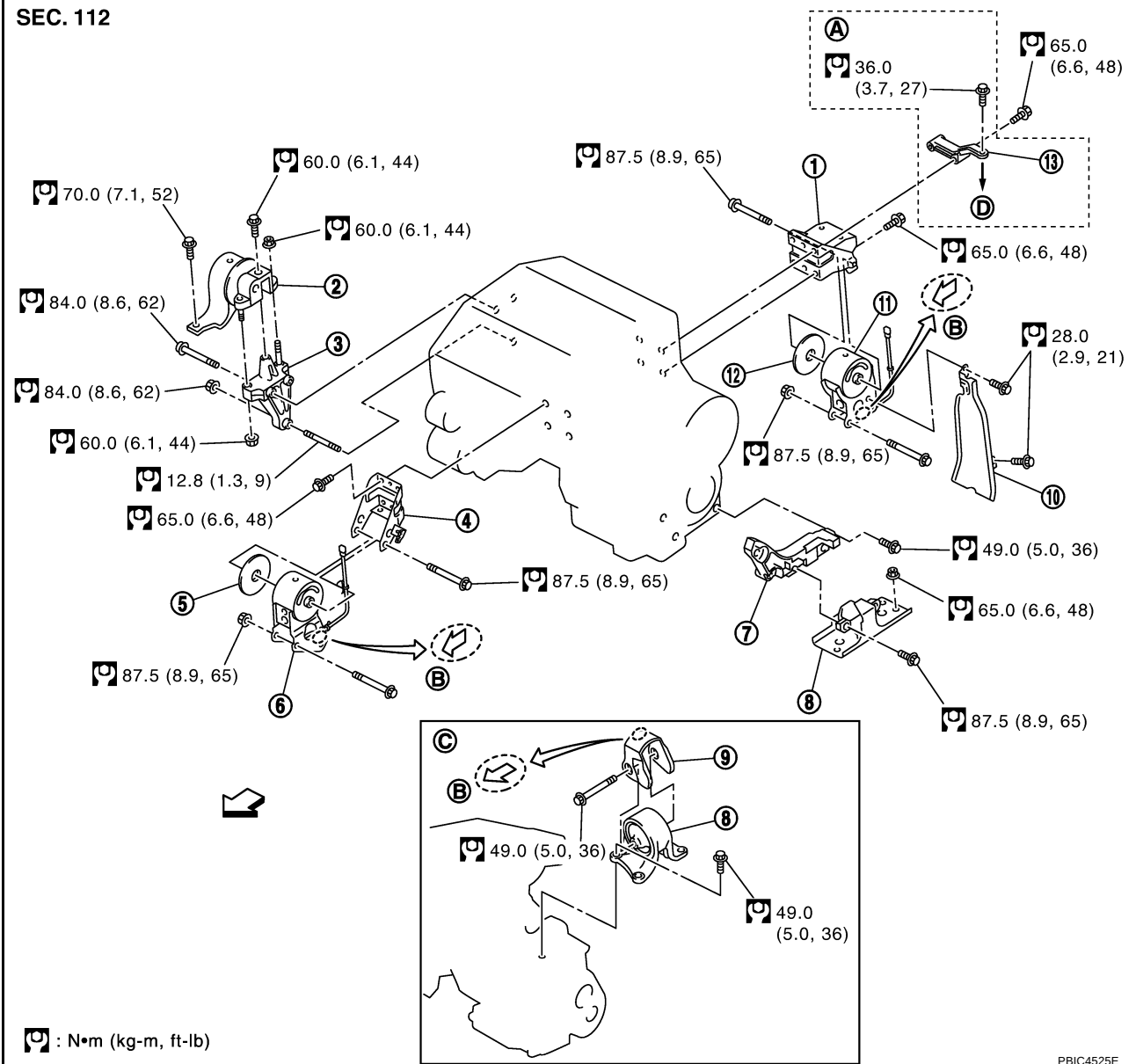
*: Exhaust side valve spring for VQ23DE has a parallel setting.

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

ENGINE ASSEMBLY

Removal and Installation

SEC. 112



- Refer to [GI-10, "Components"](#) for symbol marks in the figure.

WARNING:

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

CAUTION:

- Always be careful to work safely, avoid forceful or uninstructed operations.

- Do not start working until exhaust system and engine coolant are cool enough.
- If items or work required are not covered by the engine section, refer to the applicable sections.
- Always use the support point specified for lifting.
- Use either 2-pole lift type or separate type lift as best you can. If board-on type is used for unavoidable reasons, support at the rear axle jacking point with transmission jack or similar tool before starting work, in preparation for the backward shift of center of gravity.
- For supporting points for lifting and jacking point at rear axle, refer to [GI-37, "Garage Jack and Safety Stand and 2-Pole Lift"](#) .

REMOVAL

Outline

At first, remove engine and transaxle assembly with front suspension member from vehicle downward. Separate front suspension member, and then separate engine from transaxle.

Preparation

1. Release fuel pressure. Refer to [EC-392, "FUEL PRESSURE RELEASE"](#) .
2. Drain engine coolant from radiator. Refer to [CO-34, "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-133, "INTAKE MANIFOLD COLLECTOR"](#) .
 - Hood assembly; Refer to [BL-13, "HOOD"](#) .
 - Front road wheels 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-131, "AIR CLEANER AND AIR DUCT"](#) .
 - Battery, battery tray and battery tray bracket; Refer to [SC-4, "BATTERY"](#) .
 - Drive belts; Refer to [EM-128, "DRIVE BELTS"](#) .
 - Radiator, reservoir of radiator; Refer to [CO-37, "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-52, "WATER OUTLET AND WATER PIPING"](#) .
 - Install plug to avoid leakage of engine coolant.
2. Remove EVAP hose. Refer to [EM-133, "INTAKE MANIFOLD COLLECTOR"](#) .
3. Disconnect fuel feed hose (with fuel damper) quick connector at centralized under-floor piping side. Refer to [EM-155, "FUEL INJECTOR AND FUEL TUBE"](#) .
 - Install plug to avoid leakage of fuel.
4. Disconnect shift control cable at transaxle side. Refer to [AT-213, "SHIFT CONTROL SYSTEM"](#) .
5. Disconnect brake booster vacuum hose at engine side. Refer to [EM-133, "INTAKE MANIFOLD COLLECTOR"](#) .
6. Remove IPDM E/R mounting bolt and IPDM E/R bracket mounting bolts, and move it to aside. Refer to [PG-17, "IPDM E/R \(INTELLIGENT POWER DISTRIBUTION MODULE ENGINE ROOM\)"](#) .
7. Remove alternator. Refer to [SC-27, "CHARGING SYSTEM"](#) .
8. Remove A/C compressor with piping connected, and temporarily secure it to aside. Refer to [ATC-133, "Components"](#) .
9. Disconnect suction hoses of power steering oil pump at reservoir tank side.
 - Install plug to avoid leakage of power steering fluid.

Vehicle Underbody

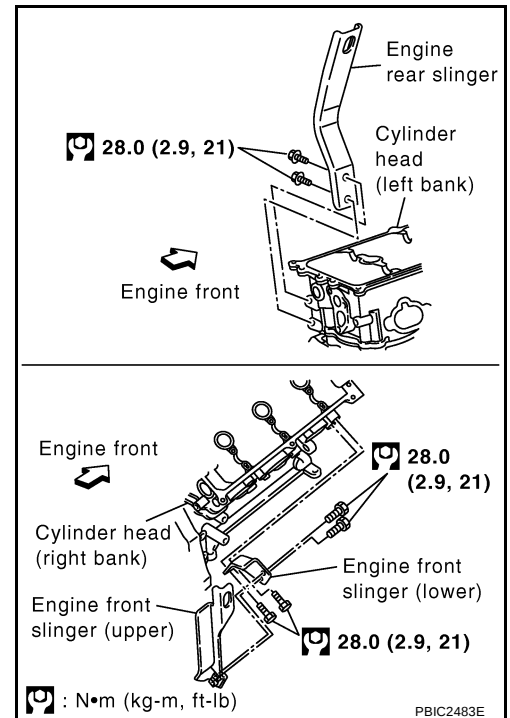
1. Remove front drive shafts (right and left sides). Refer to [FAX-8, "FRONT DRIVE SHAFT"](#) .
2. Remove front exhaust tube. Refer to [EX-2, "EXHAUST SYSTEM"](#) .
3. Disconnect steering lower joint at power steering gear assembly side, and release steering lower shaft. Refer to [PS-17, "POWER STEERING GEAR AND LINKAGE"](#) .
4. Disconnect front stabilizer connecting rod. Refer to [FSU-16, "STABILIZER BAR"](#) .
5. Disconnect power steering piping at a point between vehicle and engine. Refer to [PS-39, "HYDRAULIC LINE"](#) .
 - Install plug to avoid leakage of power steering fluid.
6. 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.

Removal Work

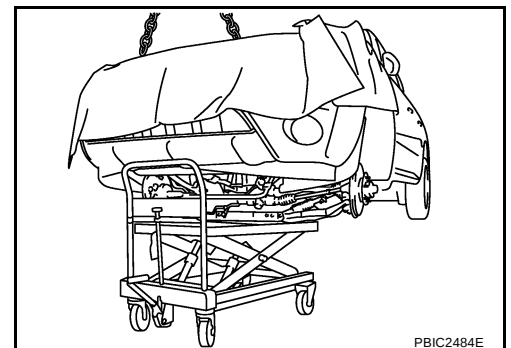
1. Install engine slingers into front of cylinder head (right bank) and rear of cylinder head (left bank).



2. Lift with hoist and secure engine in position.
3. Use manual lift table caddy (commercial service tool) or equivalently rigid tool such as transmission jack. Securely support bottom of front suspension member, and simultaneously adjust hoist tension.

CAUTION:

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



4. Separate engine mounting insulator (RH) and engine mounting bracket (RH).
5. Remove engine mounting (LH) through-bolt. (VQ23DE)

6. Remove front suspension member mounting nuts and bolts. Refer to [FSU-5, "FRONT SUSPENSION ASSEMBLY"](#).
7. Carefully lower engine, transaxle and front suspension member assembly. When performing work, observe the following caution.

CAUTION:

- Confirm there is no interference with vehicle.
- Make sure that 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. Remove power steering oil pump, power steering piping and power steering bracket from engine and transaxle assembly. Refer to [PS-39, "HYDRAULIC LINE"](#).
2. Remove starter motor. Refer to [SC-14, "STARTING SYSTEM"](#).
3. Disconnect harness connector of engine mounting insulators (front and rear).
4. Remove engine mounting (front) and engine mounting (rear) through-bolts.
5. Lift with hoist and separate engine and transaxle assembly from front suspension member.

CAUTION:

Before and during this lifting, always make sure that any harnesses are not connected.

6. Remove each engine mounting insulator and each engine mounting bracket from engine, transaxle and front suspension member.
7. Separate engine and transaxle. Refer to [AT-241, "TRANSAXLE ASSEMBLY"](#) (A/T), [CVT-193, "TRANSAXLE ASSEMBLY"](#) (CVT).

INSTALLATION

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

- Do not allow engine mounting insulator to be damaged and careful no engine oil gets on it.
- For a path with a specified installation orientation, refer to component figure in [EM-223, "Removal and Installation"](#).
- Make sure all engine mounting insulators are seated properly, then tighten nuts and bolts.

INSPECTION AFTER INSTALLATION

Inspection for Leaks

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

- Before starting engine, check oil/fluid levels including engine coolant and engine oil. If less than required quantity, fill to the specified level. Refer to [MA-14, "RECOMMENDED FLUIDS AND LUBRICANTS"](#).
- Use procedure below to check for fuel leakage.
 - Turn ignition switch "ON" (with engine stopped). With fuel pressure applied to fuel piping, check for fuel leakage at connection points.
 - Start engine. With engine speed increased, check again for fuel leakage at connection points.
- Run engine to check for unusual noise and vibration.
- Warm up engine thoroughly to make sure there is no leakage of fuel, exhaust gases, or any oil/fluids including engine oil and engine coolant.
- Bleed air from lines and hoses of applicable lines, such as in cooling system.
- After cooling down engine, again check oil/fluid levels including engine oil and engine coolant. Refill to the specified level, if necessary.

ENGINE ASSEMBLY

[VQ]

Summary of the inspection items:

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

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

A

EM

C

D

E

F

G

H

I

J

K

L

M

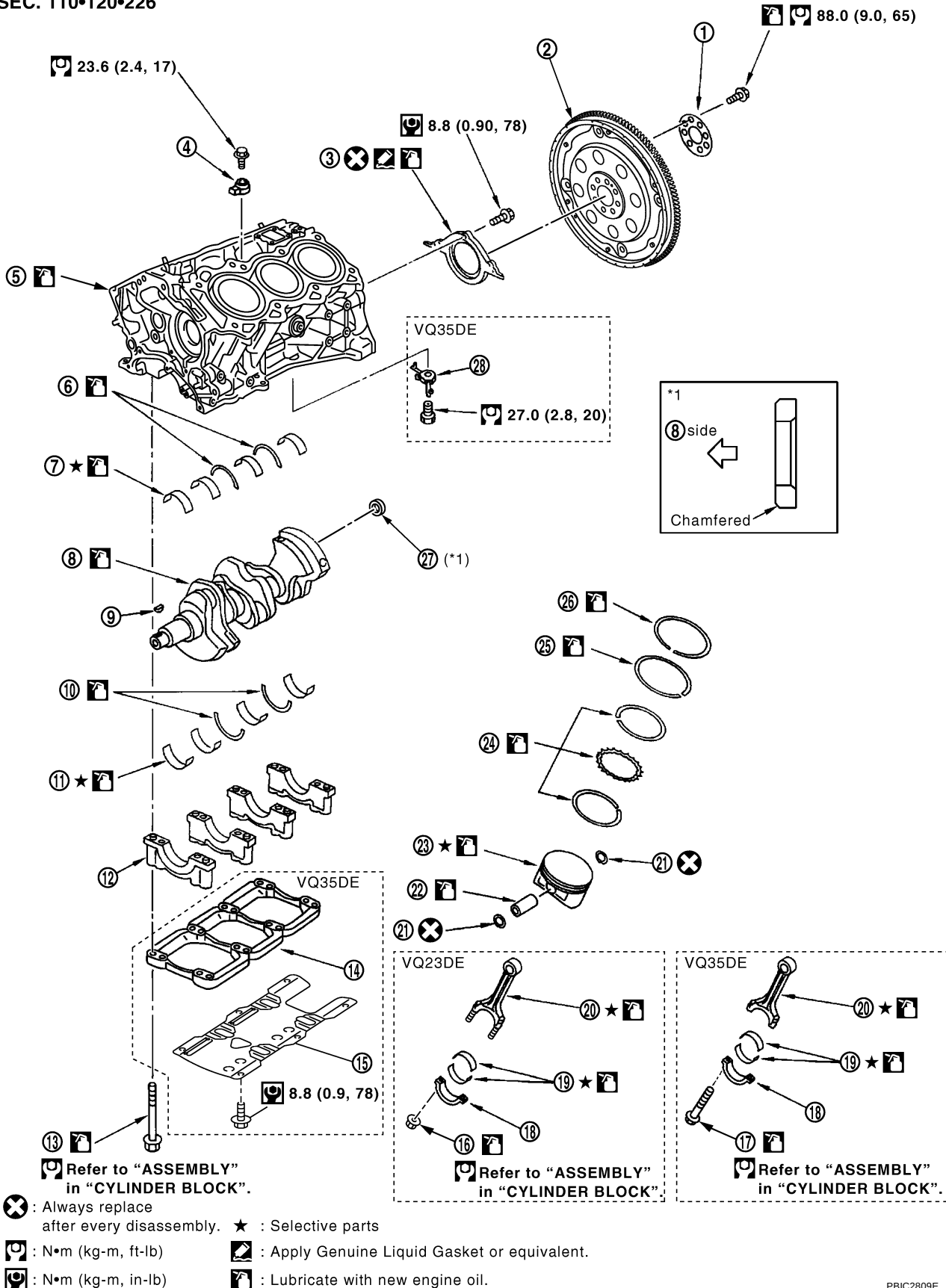
CYLINDER BLOCK

PFP:11010

Disassembly and Assembly

BBS004WB

SEC. 110•120•226



PBIC2809E

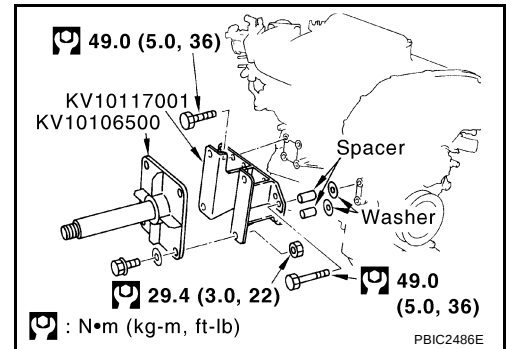
- | | | |
|----------------------------|--------------------------|--------------------------------|
| 1. Reinforcement plate | 2. Drive plate | 3. Rear oil seal retainer |
| 4. Knock sensor | 5. Cylinder block | 6. Thrust bearing (upper) |
| 7. Main bearing (upper) | 8. Crankshaft | 9. Key |
| 10. Thrust bearing (lower) | 11. Main bearing (lower) | 12. Main bearing cap |
| 13. Main bearing cap bolt | 14. Main bearing beam | 15. Baffle plate |
| 16. Connecting rod nut | 17. Connecting rod bolt | 18. Connecting rod bearing cap |
| 19. Connecting rod bearing | 20. Connecting rod | 21. Snap ring |
| 22. Piston pin | 23. Piston | 24. Oil ring |
| 25. Second ring | 26. Top ring | 27. Pilot converter |
| 28. Oil jet | | |

DISASSEMBLY

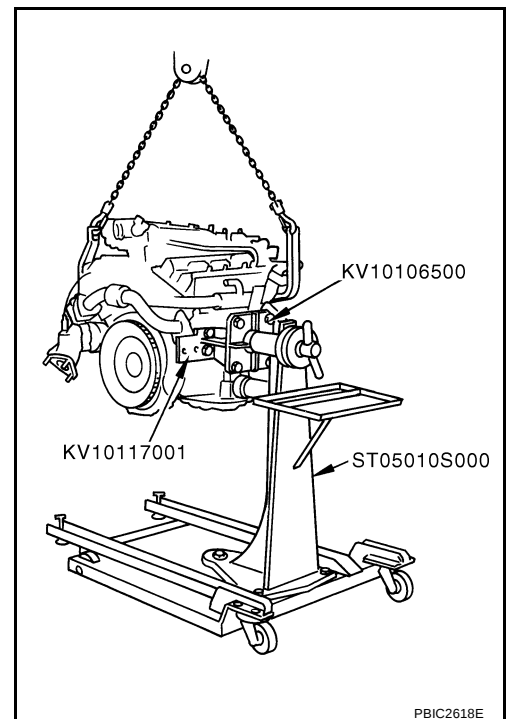
NOTE:

Show VQ35DE (with main bearing beam, connecting rod bearing cap is tighten by bolts) as an example unless the figure includes specification.

1. Remove engine assembly from vehicle, and separate front suspension member and transaxle from engine. Refer to [EM-223, "ENGINE ASSEMBLY"](#).
2. Remove exhaust manifolds (right and left banks). Refer to [EM-140, "EXHAUST MANIFOLD AND THREE WAY CATALYST"](#).
3. Install engine sub-attachment with engine stand shaft (SST) to right side of cylinder block.
 - Use spacer to engine front side.



4. Lift engine, and mount it onto engine stand (SST).



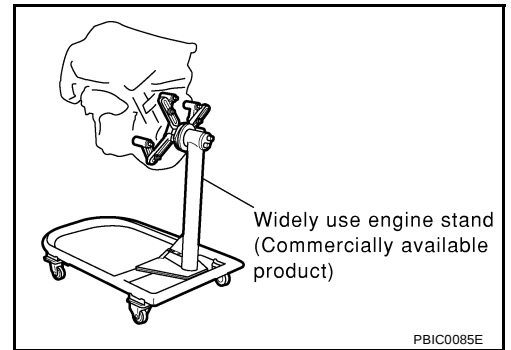
- A widely use engine stand can be used.

CAUTION:

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

NOTE:

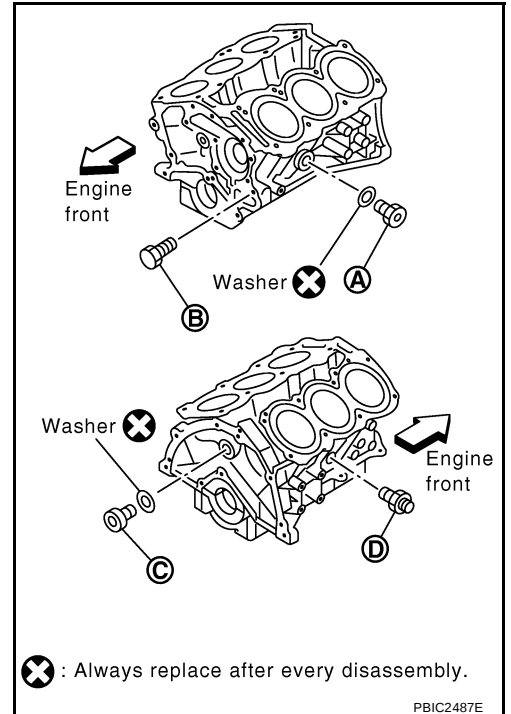
This example is engine stand for holding at transaxle mounting side with drive plate removed.



5. Drain engine oil. Refer to [LU-21, "Changing Engine Oil"](#).
6. Drain engine coolant by removing water drain plugs from cylinder block both sides at "A" and "D" and cylinder block front side at "B" as shown in the figure.

NOTE:

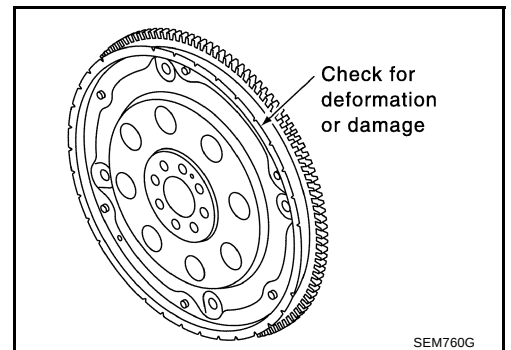
Water drain plug at the right bank side for VQ35DE is also used as a connector of water pipe for oil cooler. Refer to [LU-23, "OIL COOLER \(VQ35DE\)"](#).



7. 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.
- 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.

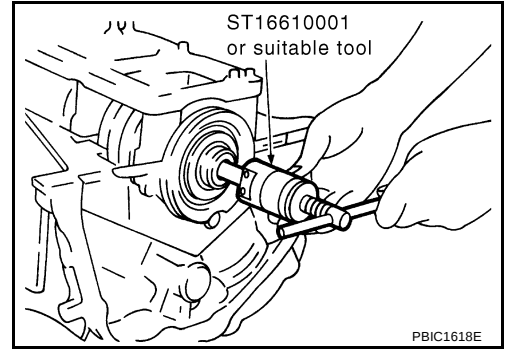


8. Remove cylinder head. Refer to [EM-210, "CYLINDER HEAD"](#).
9. Remove knock sensor.

CAUTION:

Carefully handle sensor avoiding shocks.

10. Remove pilot converter using pilot bushing puller (SST) or suitable tool as necessary.



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

CAUTION:

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

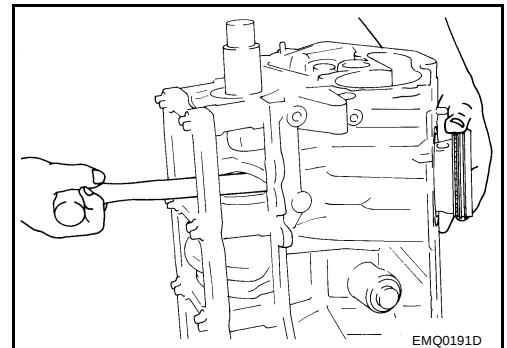
NOTE:

Regard both rear oil seal and retainer as an assembly.

12. Remove piston and connecting rod assembly as follows:
 - Before removing piston and connecting rod assembly, check the connecting rod side clearance. Refer to [EM-245, "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.



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

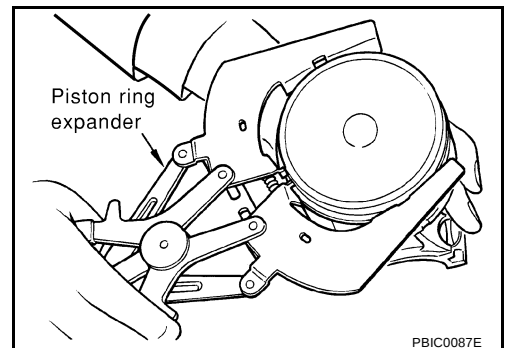
CAUTION:

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

14. Remove piston rings from piston.
 - Before removing piston rings, check the piston ring side clearance. Refer to [EM-246, "PISTON RING SIDE CLEARANCE"](#).
 - Use piston ring expander (commercial service tool).

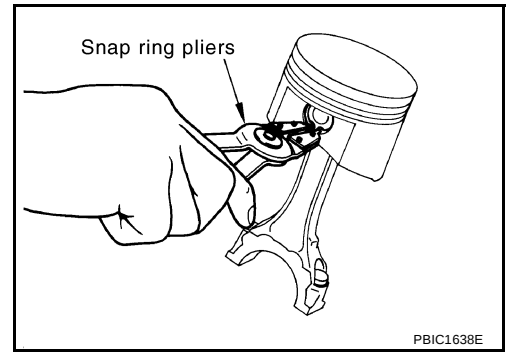
CAUTION:

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

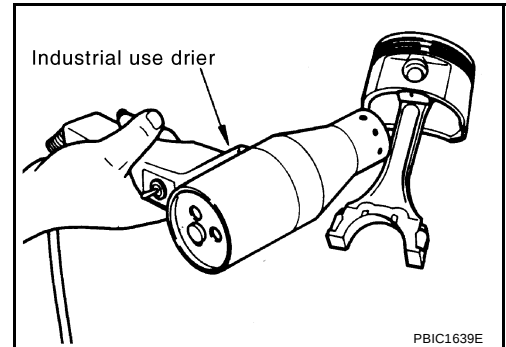


15. Remove piston from connecting rod as follows:

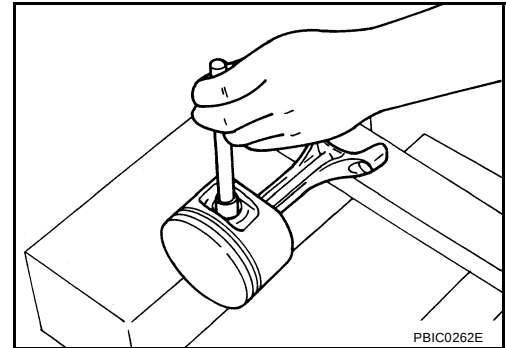
- a. Using snap ring pliers, remove snap ring.



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



- c. Push out piston pin with stick of outer diameter approximately 20 mm (0.79 in).

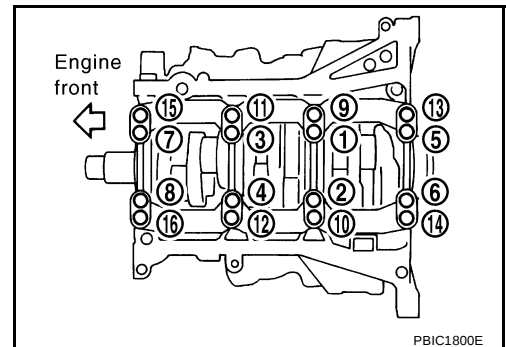


16. Remove main bearing cap bolts.

NOTE:

Use TORX socket (size E14).

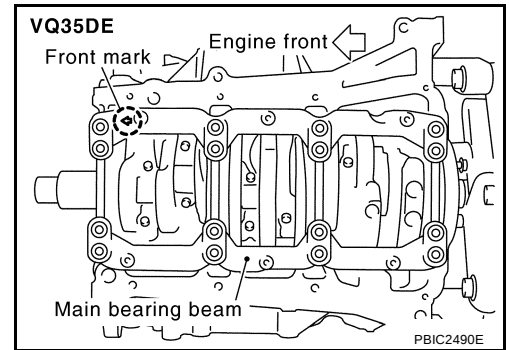
- Before loosening main bearing cap bolts, measure crankshaft end play. Refer to [EM-245, "CRANK-SHAFT END PLAY"](#).
- Loosen bolts in reverse order as shown in the figure in several different steps.



CYLINDER BLOCK

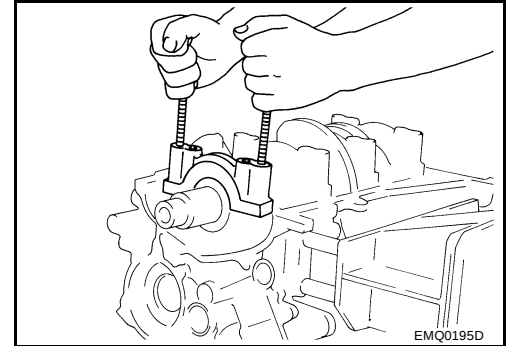
[VQ]

17. Remove main bearing beam. (VQ35DE)



18. Remove main bearing caps.

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



19. Remove crankshaft.

20. Remove main bearings and thrust bearings from cylinder block and main bearing caps.

CAUTION:

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

21. Remove oil jet. (VQ35DE)

ASSEMBLY

NOTE:

Show VQ35DE (with main bearing beam, connecting rod bearing cap is tighten by bolts) as an example unless the figure includes specification.

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.

CYLINDER BLOCK

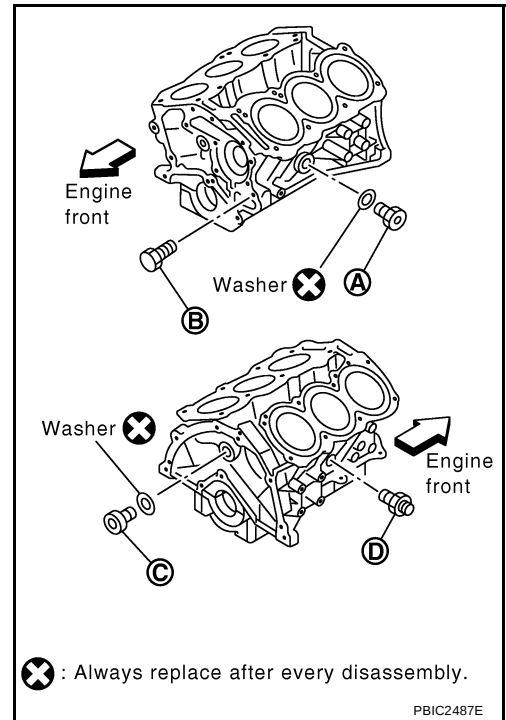
[VQ]

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

NOTE:

Water drain plug at the right bank side for VQ35DE is also used as a connector of water pipe for oil cooler. Refer to [LU-23, "OIL COOLER \(VQ35DE\)"](#).

- Apply sealant to the thread of water drain plug "A".
Use Anaerobic Liquid Gasket or equivalent.
- Apply sealant to the thread of water drain plugs "B" and "D".
Use Genuine Liquid Gasket or equivalent.
- Apply sealant to the thread of plug "C".
Use Thread Locking Sealant or equivalent.
- Replace washers with new one.

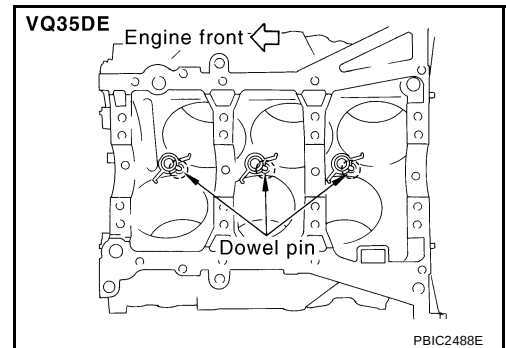


- Tighten each plug as specified below.

Part	Washer	Tightening torque	
		VQ23DE	VQ35DE
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	19.6 N·m (2.0 kg-m, 14 ft-lb)	39.2 N·m (4.0 kg-m, 29 ft-lb)

3. Install oil jet. (VQ35DE)

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



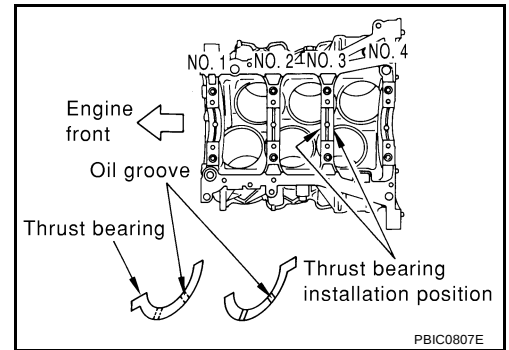
4. Install main bearings and thrust bearings as follows:

- a. Remove dust, dirt, and engine oil on bearing mating surfaces of cylinder block and main bearing caps.

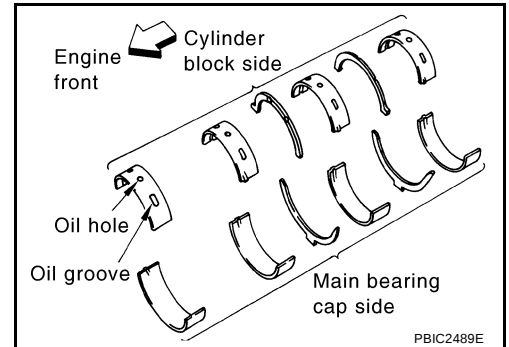
CYLINDER BLOCK

[VQ]

- b. 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 protrusion on one end on cylinder block, and thrust bearing with a protrusion at center on main bearing cap. Align each protrusion with mating notch.



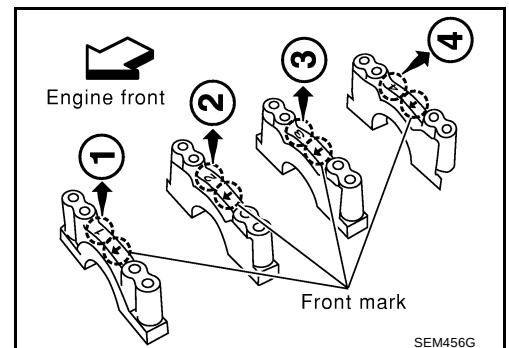
- c. Install main bearings paying attention to the direction.
- Main bearing with oil hole and groove goes on cylinder block. The one without them goes on main bearing cap.
 - Before installing main bearings, apply engine oil to the bearing surface (inside). Do not apply engine oil to the back surface, 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.



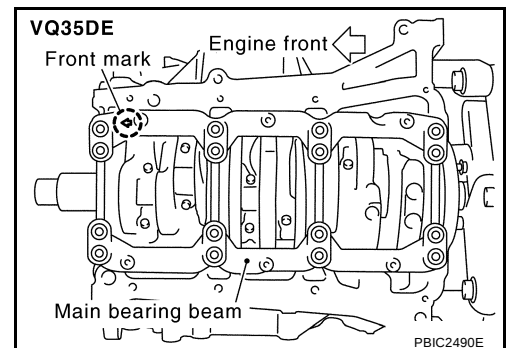
5. Install crankshaft to cylinder block.
- While turning crankshaft by hand, check that it turns smoothly.
6. Install main bearing caps.
- Main bearing caps are identified by identification mark cast on them. For installation, face front mark to front side.

NOTE:

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



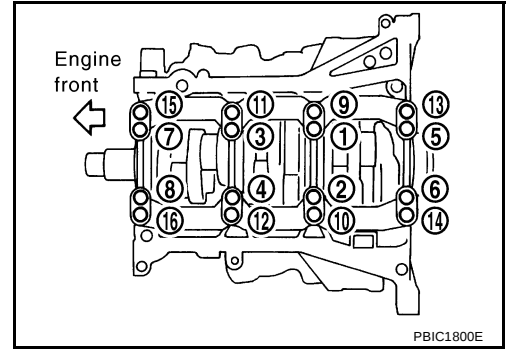
7. Install main bearing beam. (VQ35DE)
- Install main bearing beam with front mark facing downward (oil pan side).
 - Install main bearing beam with front mark facing front of engine.



8. Inspect outer diameter of main bearing cap bolts. Refer to [EM-253, "MAIN BEARING CAP BOLT OUTER DIAMETER"](#).

9. Tighten 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)

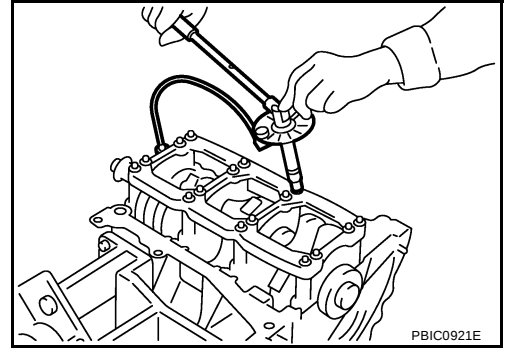


- c. Turn all main bearing cap bolts 90 degrees clockwise. (Angle tightening)

CAUTION:

Use angle wrench [SST: KV10112100] to check tightening angle. Do not make judgment by visual inspection.

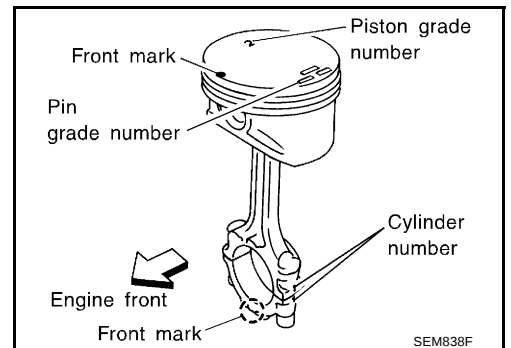
- After installing main bearing cap bolts, make sure that crankshaft can be rotated smoothly by hand.
- Check crankshaft end play. Refer to [EM-245, "CRANKSHAFT END PLAY"](#).



10. Inspect outer diameter of connecting rod bolts. Refer to [EM-253, "CONNECTING ROD BOLT OUTER DIAMETER"](#).

11. Install piston to connecting rod as follows:

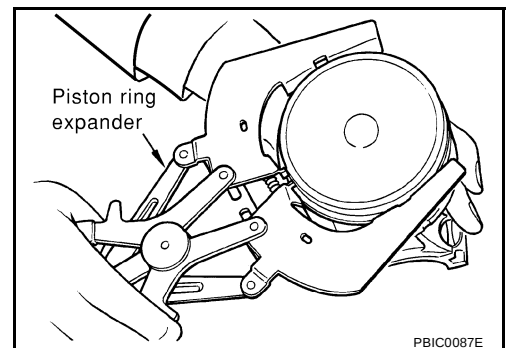
- a. Using snap ring pliers, install new snap ring to the groove of piston rear side.
 - Insert it fully into groove to install.
- b. Install piston to connecting rod.
 - Using industrial use drier or similar tool, heat piston until piston pin can be pushed in by hand without excess force [approx. 60 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 head 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.



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 expanding them excessively.



CYLINDER BLOCK

[VQ]

- Position each ring with the gap as shown in the figure referring to the piston front mark.
- Install top ring and second ring with the stamped surface facing upward. (VQ23DE)

Stamped mark:

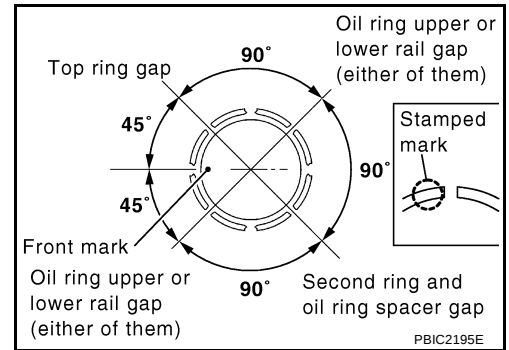
Top ring : R

Second ring : R2

- Install second ring with the stamped surface facing upward. (VQ35DE)

Stamped mark:

Second ring : R

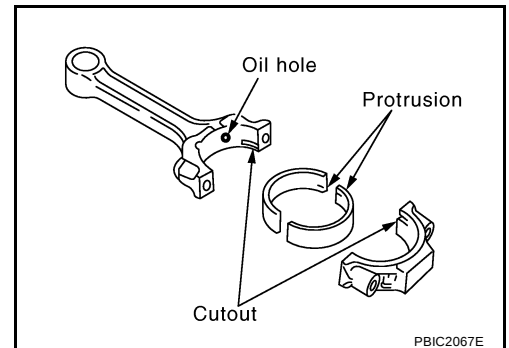


NOTE:

If there is no stamped mark on piston ring, no specific orientation is required for installation.

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.

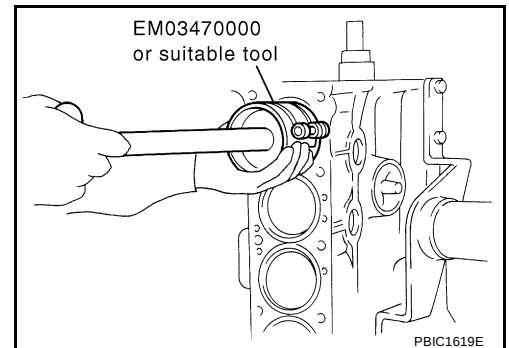


14. Install piston and connecting rod assembly to crankshaft.

- 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 head is facing front of engine.
- Using piston ring compressor (SST) or suitable tool, install piston with the front mark on the piston head facing the front of engine.

CAUTION:

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

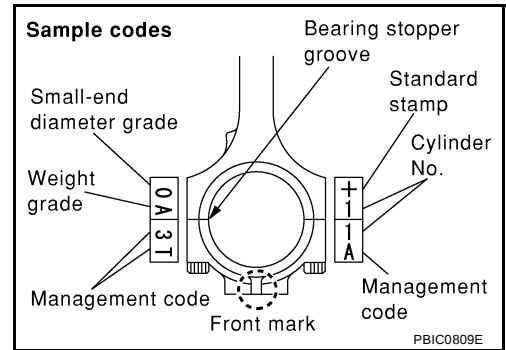


15. Install connecting rod bearing caps.

CYLINDER BLOCK

[VQ]

- 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 nuts (VQ23DE) or connecting rod bolts (VQ35DE) as follows:

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

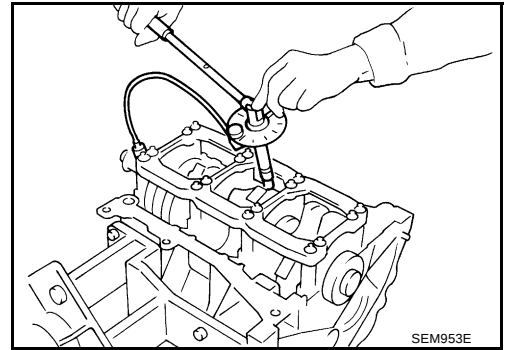
: 19.6 N·m (2.0 kg-m, 14 ft-lb)

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

CAUTION:

Use angle wrench [SST: KV10112100] to check tightening angle. Do not make judgment by visual inspection.

- After tightening connecting rod nuts or bolts, make sure that crankshaft rotates smoothly.



17. Install rear oil seal retainer to cylinder block.

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

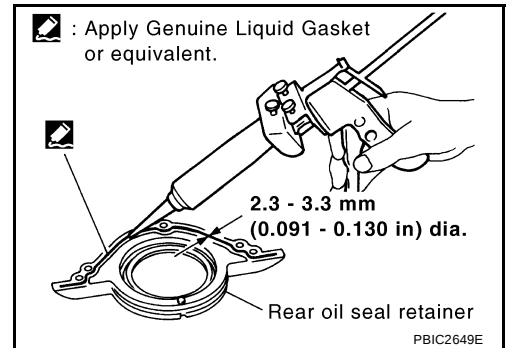
Use Genuine Liquid Gasket or equivalent.

CAUTION:

Replace with a new part.

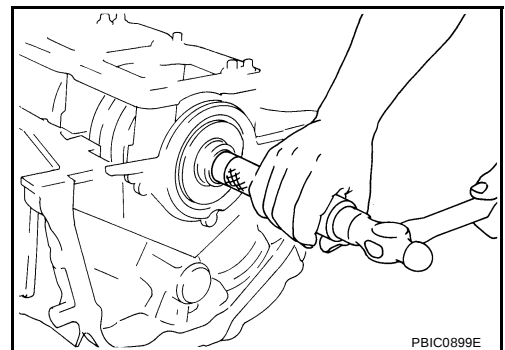
NOTE:

Regard both rear oil seal and retainer as an assembly.



18. Install pilot converter.

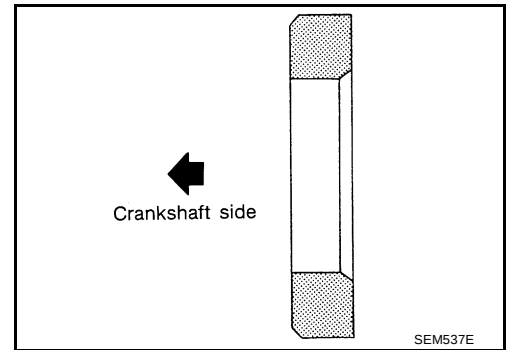
- With drift [outer diameter: approx. 33 mm (1.30 in)], press-fit as far as it will go.



CYLINDER BLOCK

[VQ]

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



19. Install knock sensor.

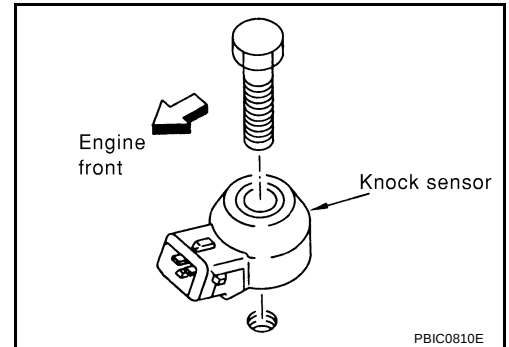
- Install knock sensor so that connector faces front of engine.
- After installing knock sensor, connect harness connector, and lay it out to rear of engine.

CAUTION:

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

NOTE:

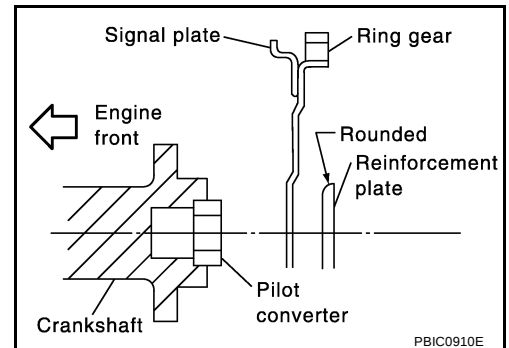
- Make sure that there is no foreign material on the cylinder block mating surface and the back surface of knock sensor.
- Make sure that knock sensor does not interfere with other parts.



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.
- Fix crankshaft pulley with pulley holder [SST: KV10109300].
- Tighten mounting bolts crosswise over several times.



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*	—	—	—

CYLINDER BLOCK

[VQ]

*: 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.

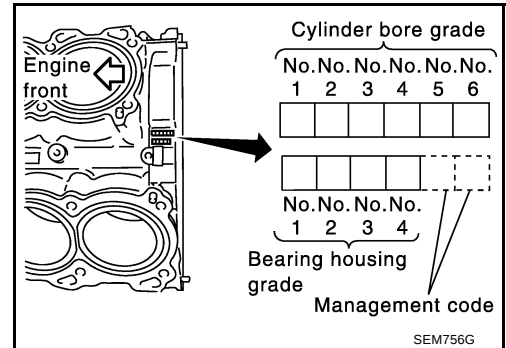
HOW TO SELECT PISTON

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.

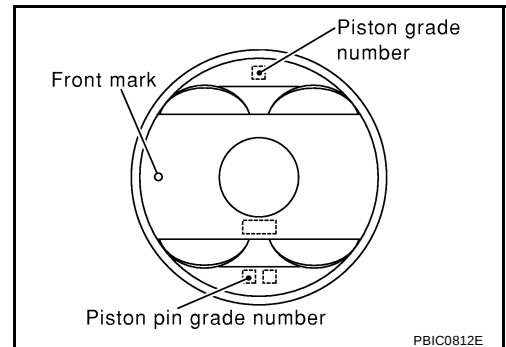
NOTE:

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-249, "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.

Piston Selection Table

VQ23DE

Unit: mm (in)

Grade	1	2 (or no mark)	3
Cylinder bore inner diameter	85.000 - 85.010 (3.3465 - 3.3468)	85.010 - 85.020 (3.3468 - 3.3472)	85.020 - 85.030 (3.3472 - 3.3476)
Piston skirt diameter	84.980 - 84.990 (3.3457 - 3.3461)	84.990 - 85.000 (3.3461 - 3.3465)	85.000 - 85.010 (3.3465 - 3.3468)

VQ35DE

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.

CYLINDER BLOCK

[VQ]

- 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.

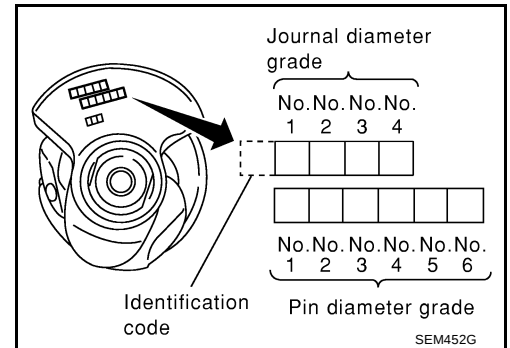
HOW TO SELECT CONNECTING ROD BEARING

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-247, "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-251, "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

VQ23DE

Unit: mm (in)

Connecting rod big end diameter	48.000 - 48.013 (1.8898 - 1.8903)
---------------------------------	-----------------------------------

Unit: mm (in)

Crankshaft		Connecting rod bearing		
Crankshaft pin journal diameter	Grade (Mark)	Dimension (Bearing thickness range)	Bearing grade No.	Color
44.968 - 44.974 (1.7704 - 1.7706)	0	1.500 - 1.503 (0.0591 - 0.0592)	STD 0	Black
44.962 - 44.968 (1.7702 - 1.7704)	1	1.503 - 1.506 (0.0592 - 0.0593)	STD 1	Brown
44.956 - 44.962 (1.7699 - 1.7702)	2	1.506 - 1.509 (0.0593 - 0.0594)	STD 2	Green

VQ35DE

Unit: mm (in)

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

Unit: mm (in)

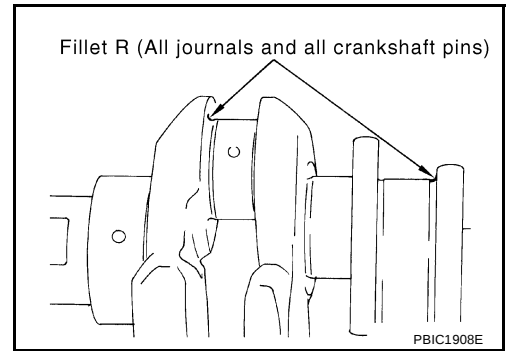
Crankshaft		Connecting rod bearing		
Crankshaft pin journal diameter	Grade (Mark)	Dimension (Bearing thickness range)	Bearing grade No.	Color
51.968 - 51.974 (2.0460 - 2.0462)	0	1.500 - 1.503 (0.0591 - 0.0592)	STD 0	Black
51.962 - 51.968 (2.0457 - 2.0460)	1	1.503 - 1.506 (0.0592 - 0.0593)	STD 1	Brown
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.

CAUTION:

In grinding crankshaft pin 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)	1.626 - 1.634 (0.0640 - 0.0643)

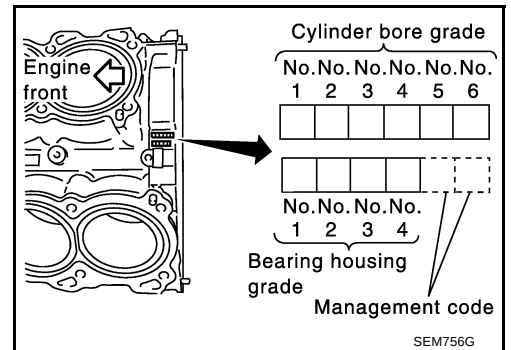
NOTE:

Both VQ23DE and VQ35DE thickness of undersize bearing is the same.

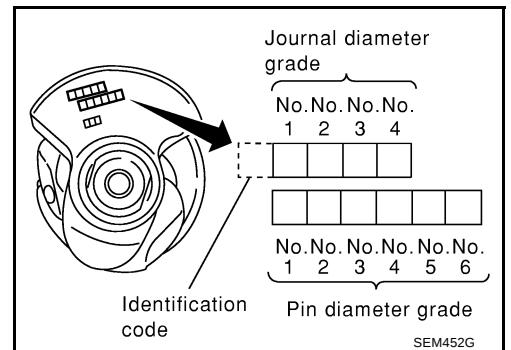
HOW TO SELECT MAIN BEARING

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-249, "MAIN BEARING HOUSING INNER DIAMETER"](#) and [EM-250, "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

[VQ]

Main Bearing Selection Table

Cylinder block main bearing housing inner diameter Unit: mm (in) Crankshaft main journal diameter Unit: mm (in)		Mark	Hole diameter																											
		A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	S	T	U	V	W	X	Y	4	7					
			63.993 - 63.994 (2.5194 - 2.5194)	63.994 - 63.995 (2.5194 - 2.5195)	63.995 - 63.996 (2.5195 - 2.5195)	63.996 - 63.997 (2.5195 - 2.5196)	63.997 - 63.998 (2.5196 - 2.5196)	63.998 - 63.999 (2.5196 - 2.5196)	63.999 - 64.000 (2.5196 - 2.5197)	64.000 - 64.001 (2.5197 - 2.5197)	64.001 - 64.002 (2.5197 - 2.5198)	64.002 - 64.003 (2.5198 - 2.5198)	64.003 - 64.004 (2.5198 - 2.5198)	64.004 - 64.005 (2.5198 - 2.5199)	64.005 - 64.006 (2.5199 - 2.5199)	64.006 - 64.007 (2.5199 - 2.5200)	64.007 - 64.008 (2.5200 - 2.5200)	64.008 - 64.009 (2.5200 - 2.5200)	64.009 - 64.010 (2.5200 - 2.5201)	64.010 - 64.011 (2.5201 - 2.5201)	64.011 - 64.012 (2.5201 - 2.5202)	64.012 - 64.013 (2.5202 - 2.5202)	64.013 - 64.014 (2.5202 - 2.5202)	64.014 - 64.015 (2.5202 - 2.5203)	64.015 - 64.016 (2.5203 - 2.5203)	64.016 - 64.017 (2.5203 - 2.5203)				
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				
B	59.974 - 59.973 (2.3612 - 2.3611)		0	0	01	01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4				
C	59.973 - 59.972 (2.3611 - 2.3611)		0	01	01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4				
D	59.972 - 59.971 (2.3611 - 2.3611)		01	01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4				
E	59.971 - 59.970 (2.3611 - 2.3610)		01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45				
F	59.970 - 59.969 (2.3610 - 2.3610)		01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45				
G	59.969 - 59.968 (2.3610 - 2.3609)		1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	45				
H	59.968 - 59.967 (2.3609 - 2.3609)		1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5					
J	59.967 - 59.966 (2.3609 - 2.3609)		1	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5					
K	59.966 - 59.965 (2.3909 - 2.3608)		12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5				
L	59.965 - 59.964 (2.3608 - 2.3608)		12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56				
M	59.964 - 59.963 (2.3608 - 2.3607)		12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	5	56				
N	59.963 - 59.962 (2.3607 - 2.3607)		2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	5	56	56				
P	59.962 - 59.961 (2.3607 - 2.3607)		2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	5	56	56	56				
R	59.961 - 59.960 (2.3607 - 2.3606)		2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	5	56	56	56	6				
S	59.960 - 59.959 (2.3606 - 2.3606)		23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	5	56	56	56	6	6				
T	59.959 - 59.958 (2.3606 - 2.3605)		23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	5	56	56	56	6	6	6				
U	59.958 - 59.957 (2.3605 - 2.3605)		23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	5	56	56	56	6	6	6	67				
V	59.957 - 59.956 (2.3605 - 2.3605)		3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	5	56	56	56	6	6	6	67	67				
W	59.956 - 59.955 (2.3605 - 2.3604)		3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7				
X	59.955 - 59.954 (2.3604 - 2.3604)		3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7				
Y	59.954 - 59.953 (2.3604 - 2.3603)		34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7				
4	59.953 - 59.952 (2.3603 - 2.3603)		34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	7				
7	59.952 - 59.951 (2.3603 - 2.3603)		34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	7	7				

PBIC1981E

CYLINDER BLOCK

[VQ]

Main Bearing Grade Table (All Journals)

Unit: mm (in)

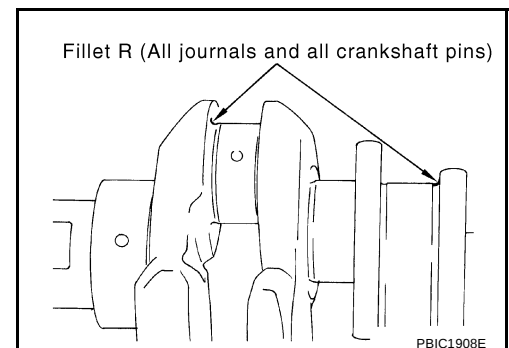
Grade number		Thickness	Width	Identification color	Remarks
0		2.000 - 2.003 (0.0787 - 0.0789)	19.9 - 20.1 (0.783 - 0.791)	Black	Grade and color are the same for upper and lower bearings.
1		2.003 - 2.006 (0.0789 - 0.0790)		Brown	
2		2.006 - 2.009 (0.0790 - 0.0791)		Green	
3		2.009 - 2.012 (0.0791 - 0.0792)		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	UPR	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)

NOTE:

Both VQ23DE and VQ35DE thickness of undersize bearing is the same.

Inspection After Disassembly

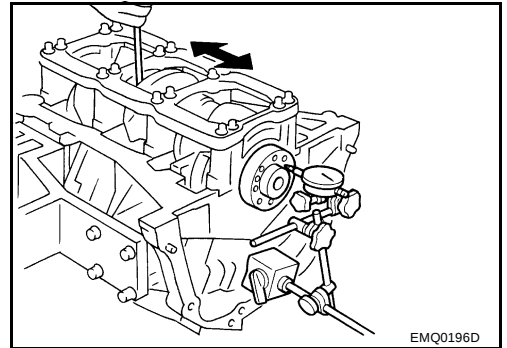
CRANKSHAFT END PLAY

- 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 (0.012 in)

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



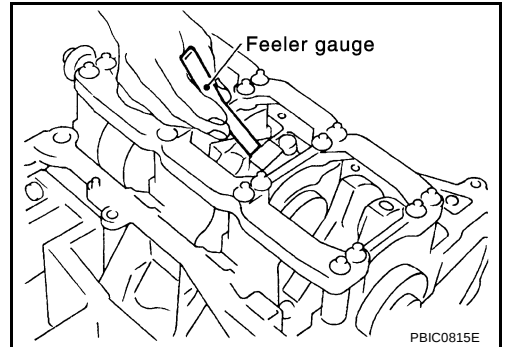
CONNECTING ROD SIDE CLEARANCE

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

Standard : 0.20 - 0.35 mm (0.008 - 0.0138 in)

Limit : 0.40 mm (0.016 in)

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

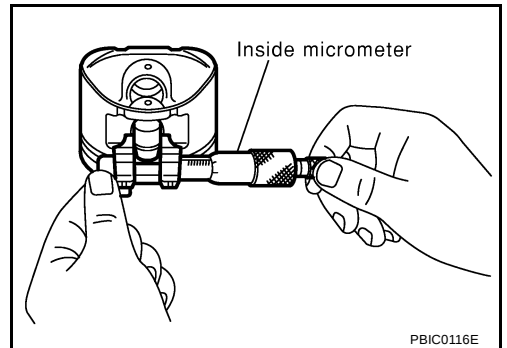


PISTON TO PISTON PIN OIL CLEARANCE

Piston Pin Hole Diameter

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

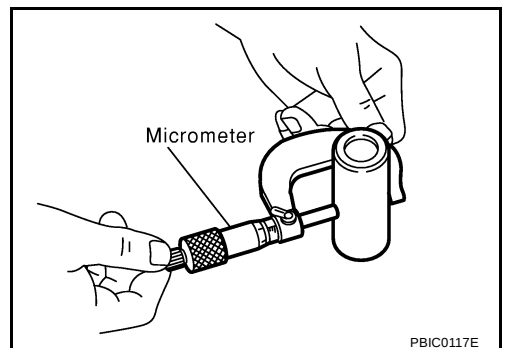
Standard : 21.993 - 22.005 mm (0.8659 - 0.8663 in)



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 the calculated value is out of the standard, replace piston and piston pin assembly.

- When replacing piston and piston pin assembly, refer to [EM-240, "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:

VQ23DE

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	: 0.045 - 0.125 mm (0.0018 - 0.0049 in)

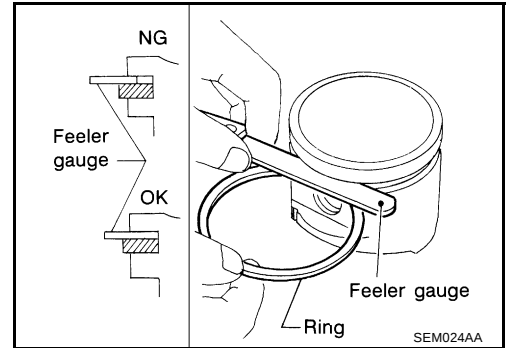
VQ35DE

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 (0.004 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 cylinder bore inner diameter is within the specification. Refer to [EM-249, "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:

VQ23DE

Top ring	: 0.20 - 0.30 mm (0.008 - 0.012 in)
2nd ring	: 0.31 - 0.46 mm (0.0122 - 0.0181 in)
Oil ring	: 0.20 - 0.60 mm (0.008 - 0.0236 in)

VQ35DE

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 (0.008 - 0.02 in)

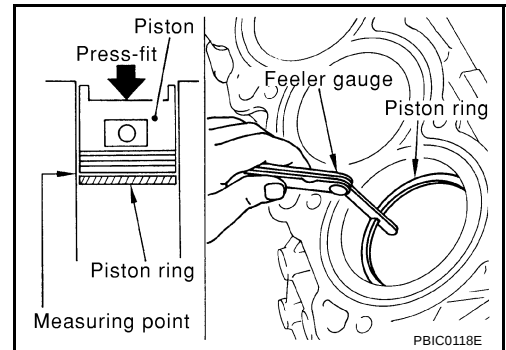
Limit:

VQ23DE

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

VQ35DE

Top ring	: 0.47 mm (0.0185 in)
2nd ring	: 0.59 mm (0.0232 in)
Oil ring	: 0.76 mm (0.0299 in)



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

CONNECTING ROD BEND AND TORSION

- Check with connecting rod aligner.

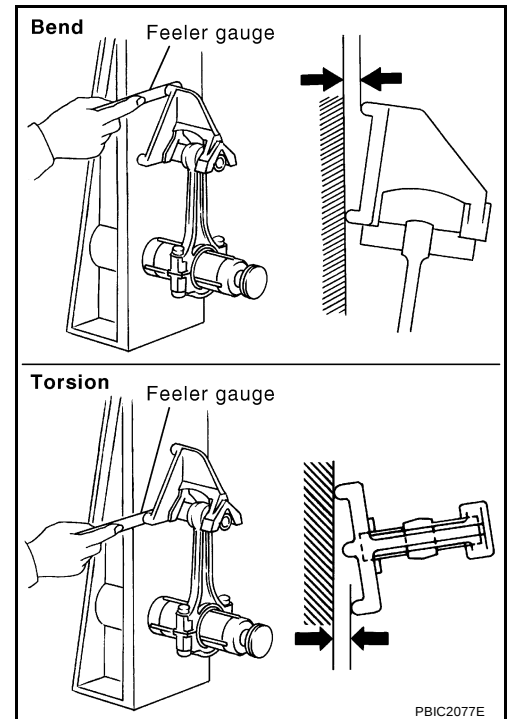
Bend:

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

Torsion:

Limit: 0.30 mm (0.012 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 nuts (VQ23DE) or connecting rod bolts (VQ35DE) to the specified torque. Refer to [EM-233, "ASSEMBLY"](#) for the tightening procedure.
- Measure the inner diameter of connecting rod big end with inside micrometer.

Standard

VQ23DE : 48.000 - 48.013 mm (1.8898 - 1.8903 in)

VQ35DE : 55.000 - 55.013 mm (2.1654 - 2.1659 in)

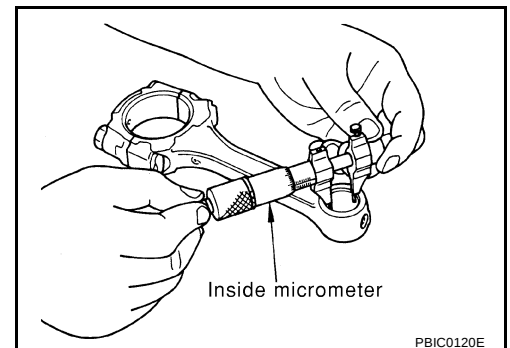
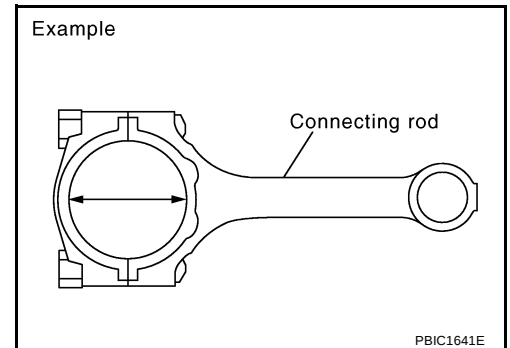
- If out of the standard, replace connecting rod assembly.

CONNECTING ROD BUSHING OIL CLEARANCE

Connecting Rod Bushing Inner Diameter

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

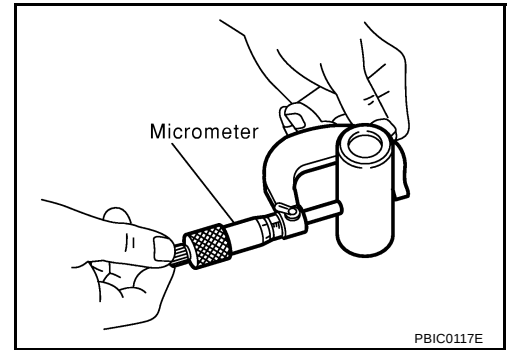
Standard : 22.000 - 22.012 mm (0.8661 - 0.8666 in)



Piston Pin Outer Diameter

Measure the outer diameter of piston pin with micrometer.

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



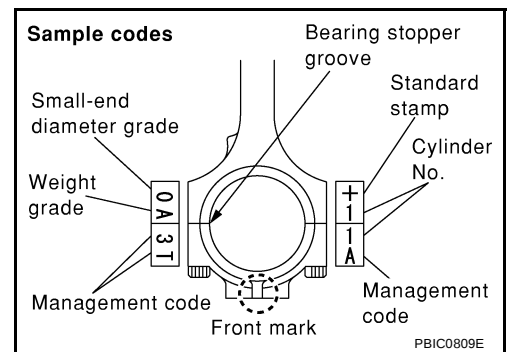
Connecting Rod Bushing Oil Clearance

(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-240, "HOW TO SELECT PISTON"](#) .
- If replacing connecting rod assembly, refer to [EM-251, "CONNECTING ROD BEARING OIL CLEARANCE"](#) to select the connecting rod bearing.

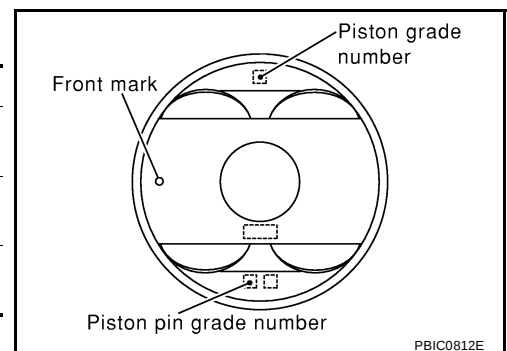


Factory installed parts grading:

- 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.

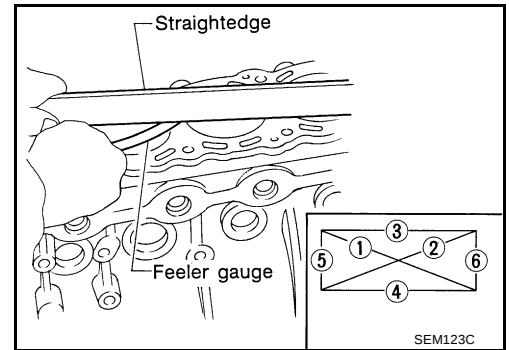
CYLINDER BLOCK

[VQ]

- 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

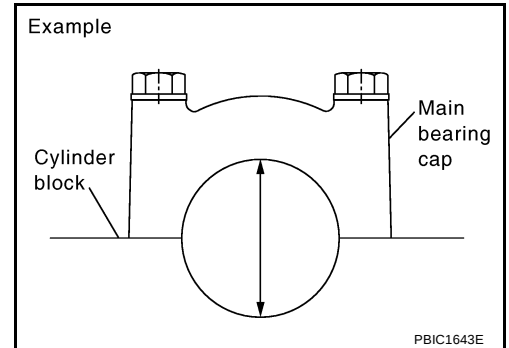
- Install main bearing caps and main bearing beam (VQ35DE) without installing main bearings, and tighten main bearing cap bolts to the specified torque. Refer to [EM-233, "ASSEMBLY"](#) for the tightening procedure.
- Measure the inner diameter of main bearing housing with bore gauge.

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") ("X" is in longitudinal direction of engine)

Standard inner diameter:

VQ23DE : 85.000 - 85.030 mm (3.3465 - 3.3476 in)

VQ35DE : 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")

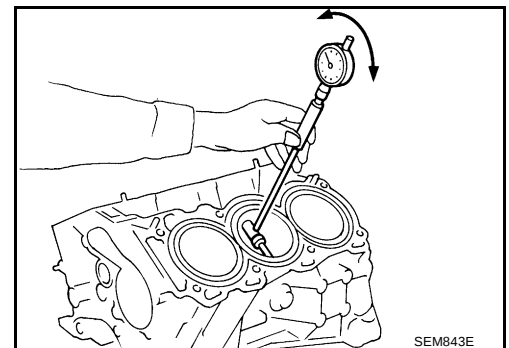
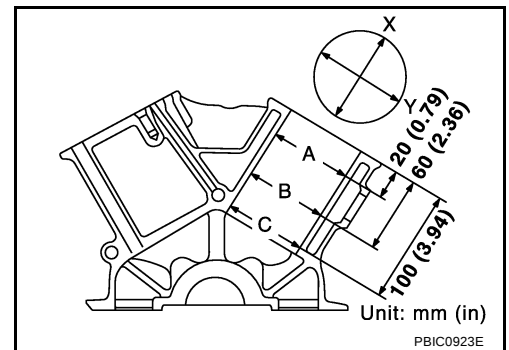
: 0.01 mm (0.0004 in)

- 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 an oversize piston, use over size pistons for all cylinders with oversize piston rings.

Oversize (OS) : 0.2 mm (0.008 in)



Piston Skirt Diameter

Measure outer diameter of piston skirt with micrometer.

Measure point

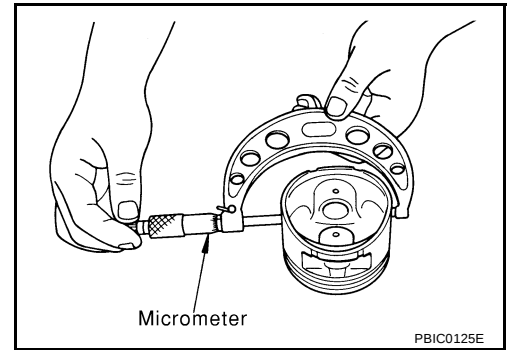
VQ23DE : Distance from the top 45.4 mm (1.787 in)

VQ35DE : Distance from the top 41.0 mm (1.614 in)

Standard

VQ23DE : 84.980 - 85.010 mm (3.3457 - 3.3468 in)

VQ35DE : 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 calculated value exceeds the limit, replace piston and piston pin assembly. Refer to [EM-240, "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 (VQ35DE), and tighten to the specified torque. Otherwise, cylinder bores may be distorted in final assembly. Refer to [EM-233, "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 the taper.

NOTE:

Measurement should be done after cylinder bore cools down.

CRANKSHAFT MAIN JOURNAL DIAMETER

- Measure 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-252, "MAIN BEARING OIL CLEARANCE"](#).

CRANKSHAFT PIN JOURNAL DIAMETER

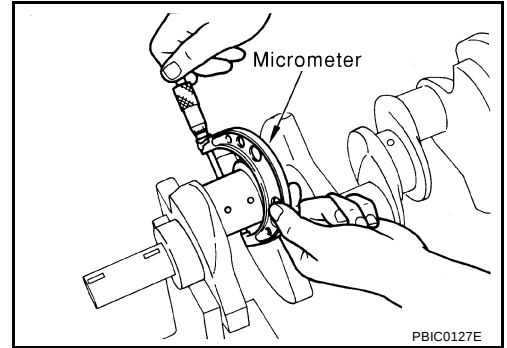
- Measure outer diameter of crankshaft pin journal with micrometer.

Standard

VQ23DE : 44.956 - 44.974 mm (1.7699 - 1.7706 in) dia.

VQ35DE : 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-251](#), "[CONNECTING ROD BEARING OIL CLEARANCE](#)".



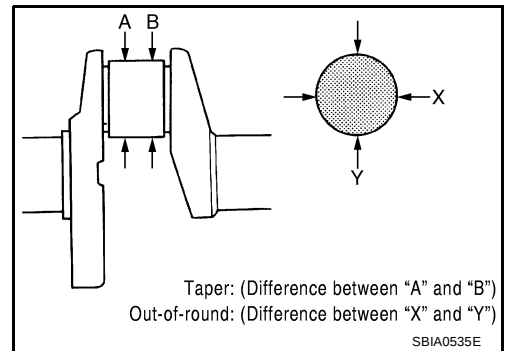
CRANKSHAFT OUT-OF-ROUND AND TAPER

- 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 main bearing and/or connecting rod bearing. Refer to [EM-252](#), "[MAIN BEARING OIL CLEARANCE](#)" and/or [EM-251](#), "[CONNECTING ROD BEARING OIL CLEARANCE](#)".

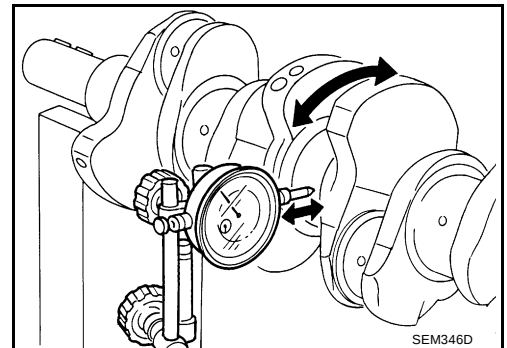
CRANKSHAFT RUNOUT

- 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 : 0.1 mm (0.004 in)

- If it exceeds the limit, replace crankshaft.

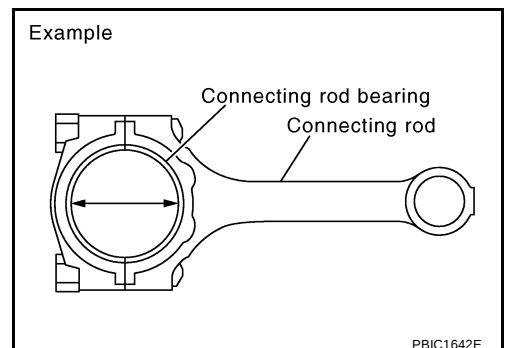


CONNECTING ROD BEARING OIL CLEARANCE

Method by Calculation

- Install connecting rod bearings to connecting rod and connecting rod bearing cap, and tighten connecting rod nuts (VQ23DE) or connecting rod bolts (VQ35DE) to the specified torque. Refer to [EM-233](#), "[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)

- If 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-241, "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 connecting rod bearing cap, and tighten connecting rod nuts (VQ23DE) or connecting rod bolts (VQ35DE) to the specified torque. Refer to [EM-233, "ASSEMBLY"](#) for the tightening procedure.

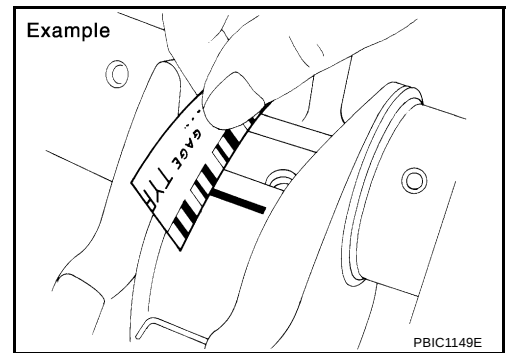
CAUTION:

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".



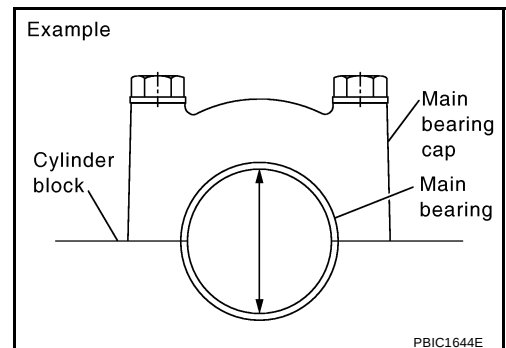
MAIN BEARING OIL CLEARANCE

Method by Calculation

- Install main bearings to cylinder block and main bearing caps, and tighten main bearing cap bolts with main bearing beam (VQ35DE) to the specified torque. Refer to [EM-233, "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 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-242, "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 (VQ35DE) to the specified torque. Refer to [EM-233, "ASSEMBLY"](#) for the tightening procedure.

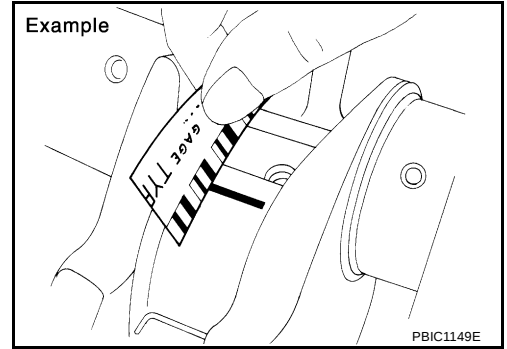
CAUTION:

Do not rotate crankshaft.

- Remove main bearing caps and bearings, and using scale on plastigage bag, measure the plastigage width.

NOTE:

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

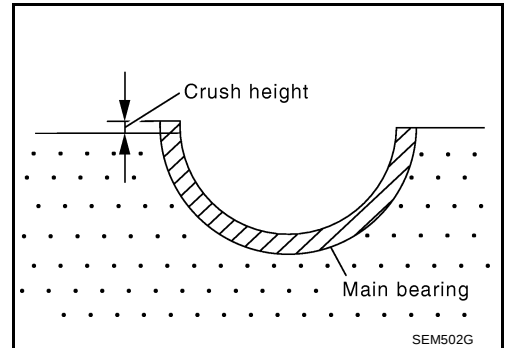


CRUSH HEIGHT OF MAIN BEARING

- When main bearing cap is removed after being tightened to the specified torque with main bearings installed, the tip end of bearing must protrude. Refer to [EM-233, "ASSEMBLY"](#) for the tightening procedure.

Standard : There must be crush height.

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

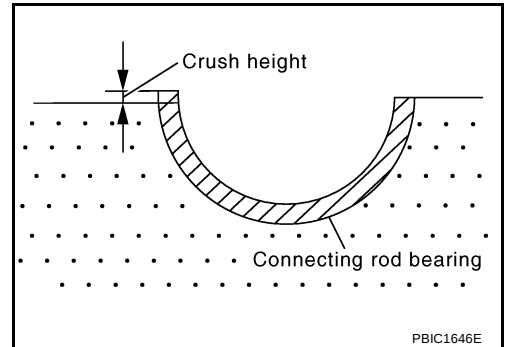


CRUSH HEIGHT OF CONNECTING ROD BEARING

- 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-233, "ASSEMBLY"](#) for the tightening procedure.

Standard : There must be crush height.

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

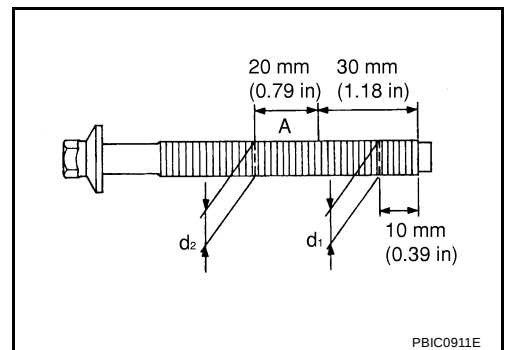


MAIN BEARING CAP BOLT OUTER DIAMETER

- Measure 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.



CONNECTING ROD BOLT OUTER DIAMETER

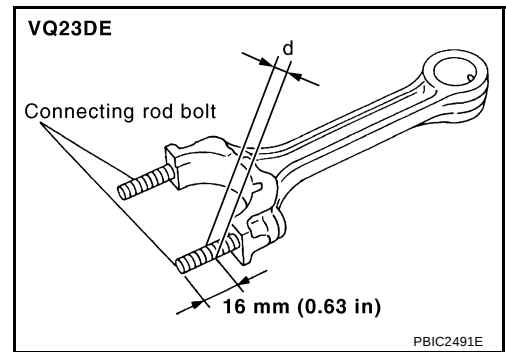
VQ23DE

- Install nut to connecting rod bolt, and make sure if the nut can smoothly tighten until the end of screw thread by hands.

CYLINDER BLOCK

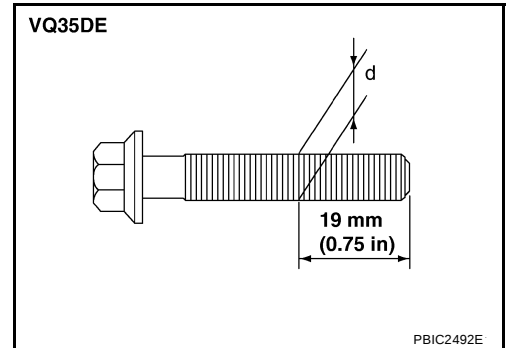
[VQ]

- Measure outer diameter “d” at position as shown in the figure.
- If 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, replace connecting rod bolt and nut with new one.



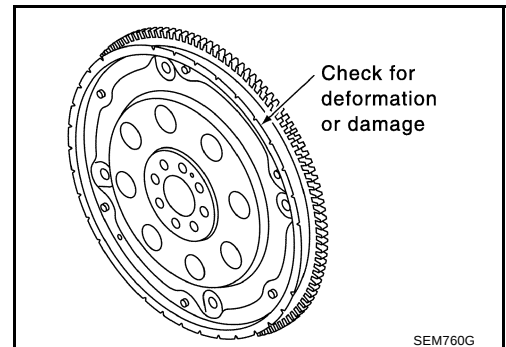
VQ35DE

- Measure outer diameter “d” at position as shown in the figure.
- If 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.

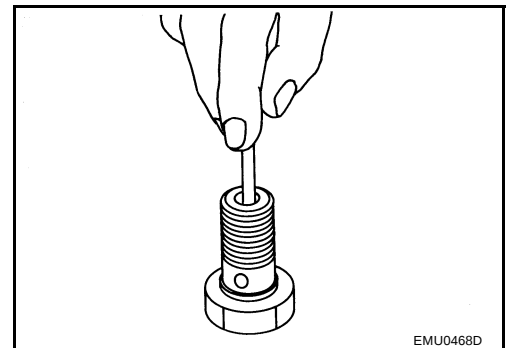


OIL JET (VQ35DE)

- 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 (VQ35DE)

- 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)

[VQ]

SERVICE DATA AND SPECIFICATIONS (SDS)

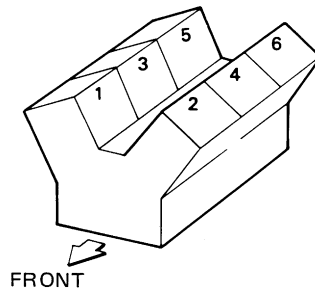
PFP:00100

Standard and Limit

BBS004WE

GENERAL SPECIFICATIONS

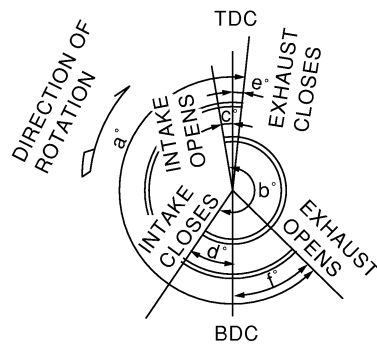
Engine		VQ23DE	VQ35DE
Cylinder arrangement		V-6	
Displacement cm^3 (cu in)		2,349 (143.34)	3,498 (213.45)
Bore and stroke mm (in)		85.0 $\times$ 69.0 (3.346 $\times$ 2.717)	95.5 $\times$ 81.4 (3.760 $\times$ 3.205)
Valve arrangement		DOHC	
Firing order		1-2-3-4-5-6	
Number of piston rings	Compression	2	
	Oil	1	
Number of main bearings		4	
Compression ratio		9.8	10.3
Compression pressure kPa (bar, kg/cm^2 , psi) / 300 rpm	Standard	1,050 (10.5, 10.7, 152)	1,270 (12.7, 13.0, 184)
	Minimum	750 (7.5, 7.7, 109)	980 (9.8, 10.0, 142)
	Differential limit between cylinders	100 (1.0, 1.0, 15)	100 (1.0, 1.0, 15)
Cylinder number			



SEM713A

VALVE TIMING

Valve timing
(Intake valve timing control - "OFF")



PBIC0187E

Unit: degree

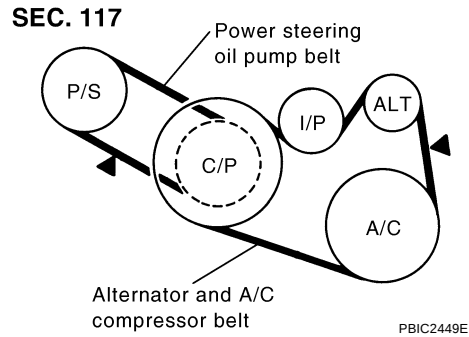
	a	b	c	d	e	f
VQ23DE	232	230	-7	57	6	46
VQ35DE	240	238	-6	64	8	52

SERVICE DATA AND SPECIFICATIONS (SDS)

[VQ]

DRIVE BELT

	Deflection adjustment		Unit: mm (in)
	Used belt		New belt
	Limit	After adjustment	
Alternator and A/C compressor belt	7 (0.28)	4.2 - 4.6 (0.17 - 0.18)	3.7 - 4.1 (0.15 - 0.16)
Power steering oil pump belt	11 (0.43)	7.3 - 8.0 (0.29 - 0.30)	6.5 - 7.2 (0.26 - 0.28)
Applied pushing force	98 N (10 kg, 22 lb)		



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

Unit: mm (in)

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

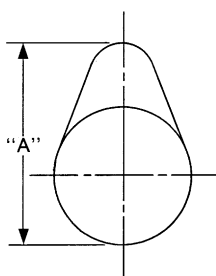
SERVICE DATA AND SPECIFICATIONS (SDS)

[VQ]

CAMSHAFT AND CAMSHAFT BEARING

Unit: mm (in)

Items		Standard		Limit
		VQ23DE	VQ35DE	
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	44.265 - 44.455 (1.7427 - 1.7502)	44.865 - 45.055 (1.7663 - 1.7738)	0.2 (0.008)* ¹
	Exhaust	43.405 - 43.595 (1.7089 - 1.7163)	44.865 - 45.055 (1.7663 - 1.7738)	
Camshaft runout [TIR* ²]		Less than 0.02 (0.0010)		0.05 (0.0020)
Camshaft sprocket runout [TIR* ²]		—		0.15 (0.0059)



SEM671

*¹ : Cam wear limit

*² : Total indicator reading

Valve Lifter

Unit: mm (in)

Items		Standard	
		VQ23DE	VQ35DE
Valve lifter outer diameter		29.977 - 29.987 (1.1802 - 1.1806)	33.977 - 33.987 (1.3377 - 1.3381)
Valve lifter hole diameter	Intake	30.015 - 30.031 (1.1817 - 1.1823)	34.000 - 34.016 (1.3386 - 1.3392)
	Exhaust	30.003 - 30.019 (1.1812 - 1.1818)	
Valve lifter clearance	Intake	0.028 - 0.054 (0.0011 - 0.0021)	0.013 - 0.039 (0.0005 - 0.0015)
	Exhaust	0.016 - 0.042 (0.0006 - 0.0017)	

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)

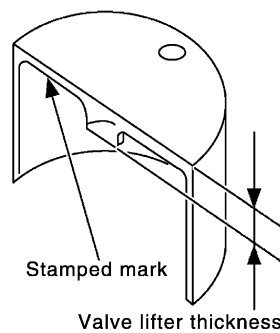
SERVICE DATA AND SPECIFICATIONS (SDS)

[VQ]

Available Valve Lifter VQ23DE

Unit: mm (in)

Identification (stamped) mark		Thickness
Intake	Exhaust	
666U		6.66 (0.2622)
668U		6.68 (0.2630)
670U		6.70 (0.2638)
672U		6.72 (0.2646)
674U		6.74 (0.2654)
676U		6.76 (0.2661)
678U		6.78 (0.2669)
680U		6.80 (0.2677)
682U		6.82 (0.2685)
684U		6.84 (0.2693)
686U		6.86 (0.2701)
688U		6.88 (0.2709)
690U		6.90 (0.2717)
692U		6.92 (0.2724)
694U		6.94 (0.2732)
696U		6.96 (0.2740)
698U		6.98 (0.2748)
700U		7.00 (0.2756)
702U		7.02 (0.2764)
704U		7.04 (0.2772)
706U		7.06 (0.2780)
708U		7.08 (0.2787)
710U		7.10 (0.2795)
712U		7.12 (0.2803)
714U		7.14 (0.2811)
716U		7.16 (0.2819)
718U		7.18 (0.2827)



SEM758G

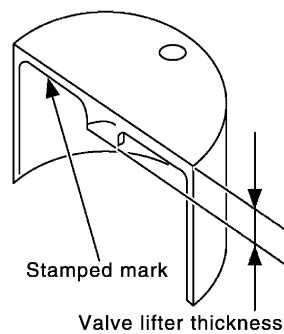
VQ35DE

Unit: mm (in)

SERVICE DATA AND SPECIFICATIONS (SDS)

[VQ]

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



SEM758G

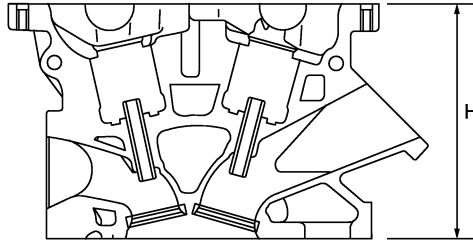
SERVICE DATA AND SPECIFICATIONS (SDS)

[VQ]

CYLINDER HEAD

Unit: mm (in)

Items	Standard	Limit
Head surface distortion	0.03 (0.0012)	0.1 (0.004)
Normal cylinder head height "H"	126.3 - 126.5 (4.972 - 4.980)	—

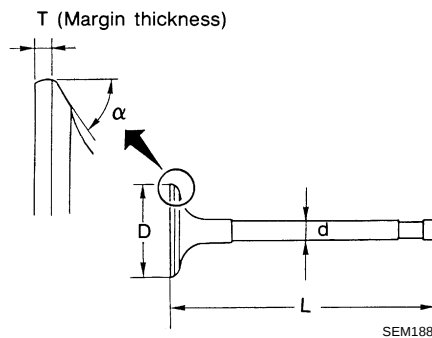


PBIC0924E

Valve Dimensions

Unit: mm (in)

Engine		VQ23DE	VQ35DE
Valve head diameter "D"	Intake	34.0 - 34.3 (1.339 - 1.350)	37.0 - 37.3 (1.457 - 1.469)
	Exhaust	29.0 - 29.3 (1.142 - 1.154)	31.2 - 31.5 (1.228 - 1.240)
Valve length "L"	Intake	99.28 (3.909)	96.46 (37.99)
	Exhaust	96.81 (38.11)	93.99 (37.00)
Valve stem diameter "d"	Intake	5.965 - 5.980 (0.2348 - 0.2354)	
	Exhaust	5.955 - 5.970 (0.2344 - 0.2350)	
Valve seat angle "α"	Intake	45°15' - 45°45'	
	Exhaust		
Valve margin "T"	Intake	1.1 (0.043)	
	Exhaust	1.3 (0.051)	
Valve margin "T" wear limit		0.5 (0.020)	
Valve stem end surface grinding limit		0.2 (0.008)	

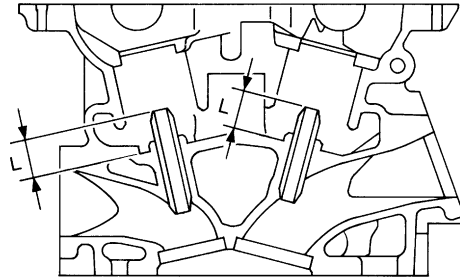


SERVICE DATA AND SPECIFICATIONS (SDS)

[VQ]

Valve Guide

Unit: mm (in)



SEM950E

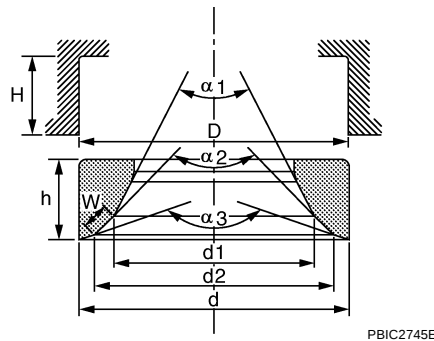
Items		Standard	Oversize (Service) [0.2 (0.008)]
Valve guide	Outer diameter	10.023 - 10.034 (0.3946 - 0.3950)	10.223 - 10.234 (0.4025 - 0.4029)
	Inner diameter (Finished size)	6.000 - 6.018 (0.2362 - 0.2369)	
Cylinder head valve guide hole diameter		9.975 - 9.996 (0.3927 - 0.3935)	10.175 - 10.196 (0.4006 - 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)	0.10 (0.004)
Projection length "L"		12.6 - 12.8 (0.496 - 0.504)	

SERVICE DATA AND SPECIFICATIONS (SDS)

[VQ]

Valve Seat

Unit: mm (in)



Items		Standard		Oversize (Service) [0.5 (0.020)]	
		VQ23DE	VQ35DE	VQ23DE	VQ35DE
Cylinder head seat recess diameter “D”	Intake	35.000 - 35.016 (1.3780 - 1.3786)	38.000 - 38.016 (1.4961 - 1.4967)	35.500 - 35.516 (1.3976 - 1.3983)	38.500 - 38.516 (1.5157 - 1.5164)
	Exhaust	30.000 - 30.016 (1.1811 - 1.1817)	32.200 - 32.216 (1.2677 - 1.2683)	30.500 - 30.516 (1.2008 - 1.2014)	32.700 - 32.716 (1.2874 - 1.2880)
Valve seat outer diameter “d”	Intake	35.080 - 35.096 (1.3811 - 1.3817)	38.097 - 38.113 (1.4999 - 1.5005)	35.580 - 35.596 (1.4008 - 1.014)	38.597 - 38.613 (1.5196 - 1.5202)
	Exhaust	30.080 - 30.096 (1.1842 - 1.1849)	32.280 - 32.296 (1.2709 - 1.2715)	30.580 - 30.596 (1.2039 - 1.2046)	32.780 - 32.796 (1.2905 - 1.2912)
Valve seat interference fit	Intake	0.064 - 0.096 (0.0025 - 0.0038)	0.081 - 0.113 (0.0032 - 0.0044)	0.064 - 0.096 (0.0025 - 0.0038)	0.081 - 0.113 (0.0032 - 0.0044)
	Exhaust	0.064 - 0.096 (0.0025 - 0.0038)			
Items		Standard			
		VQ23DE		VQ35DE	
Diameter” d1 ”*1	Intake	32 (1.26)		35 (1.38)	
	Exhaust	26.5 (1.043)		28.7 (1.130)	
Diameter” d2 ”*2	Intake	33.3 – 33.8 (1.311 – 1.331)		36.3 – 36.8 (1.429 – 1.449)	
	Exhaust	28.1 – 28.6 (1.106 – 1.126)		30.3 – 30.8 (1.193 – 1.213)	
Angle” α1 ”	Intake	60°			
	Exhaust	60°			
Angle” α2 ”	Intake	88°45’ – 90°15’			
	Exhaust	88°45’ – 90°15’			
Angle” α3 ”	Intake	120°			
	Exhaust	120°			
Contacting width” W ”*3	Intake	1.0 – 1.4 (0.039 – 0.055)			
	Exhaust	1.2 – 1.6 (0.047 – 0.063)			
Items		Standard		Service	
		VQ23DE	VQ35DE	VQ23DE	VQ35DE
Height “h”	Intake	6.2 - 6.3 (0.244 - 0.248)	5.9 - 6.0 (0.232 - 0.236)	5.4 - 5.5 (0.213 - 0.217)	5.05 - 5.15 (0.1988 - 0.2028)
	Exhaust	5.9 - 6.0 (0.232 - 0.246)	5.9 - 6.0 (0.232 - 0.236)	4.95 - 5.05 (0.1949 - 0.1988)	4.95 - 5.05 (0.1949 - 0.1988)
Depth “H”	Intake	6.35 (0.2500)	6.0 (0.246)	6.35 (0.2500)	6.0 (0.246)
	Exhaust	6.0 (0.246)			

※1 : Diameter made by intersection point of conic angles "α1" and "α2"

※2: Diameter made by intersection point of coind angles "α1" and "α2"

SERVICE DATA AND SPECIFICATIONS (SDS)

[VQ]

*³ Machining data

Valve Spring

Engine	VQ23DE			VQ35DE	
Position	Intake	Exhaust*		Intake	Exhaust
Free height	47.15 mm (1.8563 in)	52.28 mm (2.0583 in)	52.31 mm (2.0594 in)	47.07 mm (1.8531 in)	
Installation height	37.00 mm (1.4567 in)	37.00 mm (1.4567 in)	37.00 mm (1.4567 in)	37.00 mm (1.4567 in)	
Installation load	166 - 188 N (16.9 - 19.2 kg, 37 - 42 lb)	153 - 173 N (15.6 - 17.6 kg, 34 - 39 lb)	153 - 173 N (15.6 - 17.6 kg, 34 - 39 lb)	166 - 188 N (16.9 - 19.2 kg, 37 - 42 lb)	
Height during valve open	27.20 mm (1.0709 in)	29.25 mm (1.1516 in)	29.25 mm (1.1516 in)	27.20 mm (1.0709 in)	
Load with valve open	373 - 421 N (38.0 - 42.9 kg, 84 - 95 lb)	276 - 312 N (28.1 - 31.8 kg, 62 - 70 lb)	276 - 312 N (28.1 - 31.8 kg, 62 - 70 lb)	373 - 421 N (38.0 - 42.9 kg, 84 - 95 lb)	
Squareness	2.1 mm (0.083 in)	2.3 mm (0.091 in)	2.3 mm (0.091 in)	2.1 mm (0.083 in)	

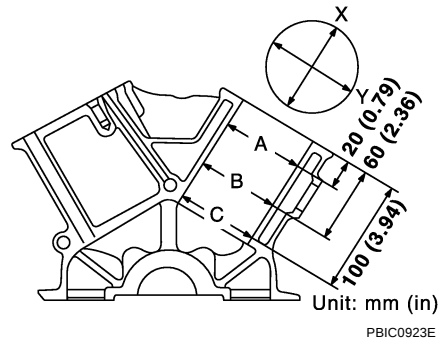
*: Exhaust side valve spring for VQ23DE has a parallel setting.

SERVICE DATA AND SPECIFICATIONS (SDS)

[VQ]

CYLINDER BLOCK

Unit: mm (in)



Engine				VQ23DE		VQ35DE	
Surface distortion			Standard		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	85.000 - 85.010 (3.3465 - 3.3468)		95.500 - 95.510 (3.7598 - 3.7602)	
			Grade No. 2	85.010 - 85.020 (3.3468 - 3.3472)		95.510 - 95.520 (3.7602 - 3.7606)	
			Grade No. 3	85.020 - 85.030 (3.3472 - 3.3476)		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)		

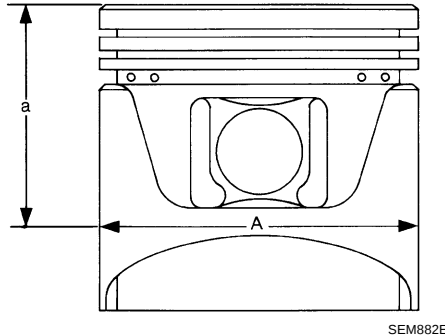
SERVICE DATA AND SPECIFICATIONS (SDS)

[VQ]

PISTON, PISTON RING AND PISTON PIN

Available Piston

Unit: mm (in)



Items		Standard		Oversize (Service) [0.2 (0.008)]	
		VQ23DE	VQ35DE	VQ23DE	VQ35DE
Piston skirt diameter "A"	Grade No. 1	84.980 - 84.990 (3.3457 - 3.3461)	95.480 - 95.490 (3.7590 - 3.7594)	—	
	Grade No. 2	84.990 - 85.000 (3.3461 - 3.3465)	95.490 - 95.500 (3.7594 - 3.7598)	—	
	Grade No. 3	85.000 - 85.010 (3.3465 - 3.3468)	95.500 - 95.510 (3.7598 - 3.7602)	—	
	Service	—		85.180 - 85.210 (3.3535 - 3.3547)	95.680 - 95.710 (3.7669 - 3.7681)
Items		Standard		Limit	
		VQ23DE	VQ35DE	VQ23DE	VQ35DE
"a" dimension		45.4 (1.787)	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	
		VQ23DE	VQ35DE	VQ23DE	VQ35DE
Side clearance	Top	0.045 - 0.080 (0.0018 - 0.0031)	0.045 - 0.080 (0.0018 - 0.0031)	0.11 (0.0043)	
	2nd	0.030 - 0.070 (0.0012 - 0.0028)	0.030 - 0.070 (0.0012 - 0.0028)	0.10 (0.004)	
	Oil ring	0.045 - 0.125 (0.0018 - 0.0049)	0.065 - 0.135 (0.0026 - 0.0053)	—	
End gap	Top	0.20 - 0.30 (0.0079 - 0.0118)	0.23 - 0.33 (0.0091 - 0.0130)	0.54 (0.0213)	0.47 (0.0185)
	2nd	0.31 - 0.46 (0.0122 - 0.0181)	0.33 - 0.48 (0.0130 - 0.0189)	0.67 (0.0264)	0.59 (0.0232)
	Oil (rail ring)	0.20 - 0.60 (0.0079 - 0.0236)	0.20 - 0.50 (0.0079 - 0.0197)	0.95 (0.0374)	0.76 (0.0299)

SERVICE DATA AND SPECIFICATIONS (SDS)

[VQ]

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)	0.03 (0.0012)

CONNECTING ROD

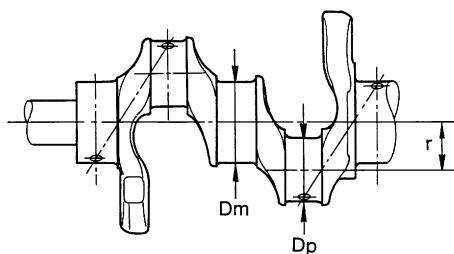
Unit: mm (in)

Items		Standard		Limit
		VQ23DE	VQ35DE	
Center distance		149.75 - 149.85 (5.896 - 5.900)	144.15 - 144.25 (5.6752 - 5.6791)	—
Bend [per 100 (3.94)]		—		0.15 (0.0059)
Torsion [per 100 (3.94)]		—		0.3 (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)		48.000 - 48.013 (1.8898 - 1.8903)	55.000 - 55.013 (2.1654 - 2.1659)	—
Side clearance		0.20 - 0.35 (0.008 - 0.0138)		0.4 (0.016)

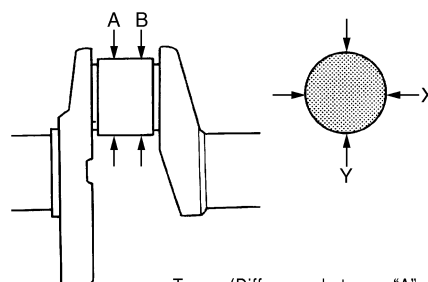
*: After installing in connecting rod

CRANKSHAFT

Unit: mm (in)



SEM645



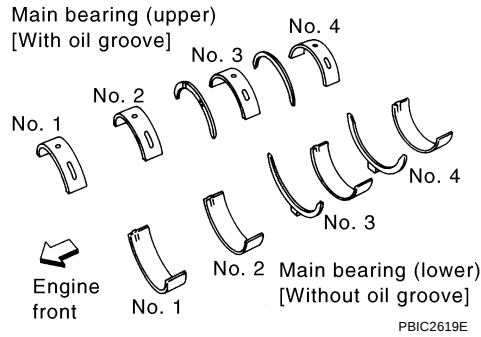
Taper: (Difference between "A" and "B")
Out-of-round: (Difference between "X" and "Y")

SBIA0535E

Engine			VQ23DE	VQ35DE
Main journal diameter “Dm”	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	44.968 - 44.974 (1.7704 - 1.7706)	51.968 - 51.974 (2.0460 - 2.0462)
		Grade No. 1	44.962 - 44.968 (1.7702 - 1.7704)	51.962 - 51.968 (2.0457 - 2.0460)
		Grade No. 2	44.956 - 44.962 (1.7699 - 1.7702)	51.956 - 51.962 (2.0455 - 2.0457)
Center distance “r”			34.46 - 34.54 (1.3567 - 1.3598)	40.66 - 40.74 (1.6008 - 1.6039)
Out-of-round (Difference between “X” and “Y”)	Limit	0.002 (0.0001)		
Taper (Difference between “A” and “B”)		0.002 (0.0001)		
Crankshaft runout [TIR*]	Standard	Less than 0.05 (0.002)		
	Limit	0.1 (0.004)		
Crankshaft end play	Standard	0.10 - 0.25 (0.004 - 0.0098)		
	Limit	0.3 (0.02)		

*: Total indicator reading

MAIN BEARING



Grade number	UPR/LWR	Thickness mm (in)	Width 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	
01	UPP	2.003 - 2.006 (0.0789 - 0.0790)		Brown	Grade is different for upper and lower bearings.
	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)

[VQ]

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)*	0.07 (0.0028)

*: Actual clearance

