ENGINE MECHANICAL

SECTION EM

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

NEEM0084

The Supplemental Restraint System “AIR BAG” and “SEAT BELT PRE-TENSIONER”, used along with a seat belt, help to reduce the risk or severity of injury to the driver and front passenger in a frontal collision. The Supplemental Restraint System consists of air bag modules (located in the center of the steering wheel and in the instrument panel on the passenger side), seat belt pre-tensioners, a diagnosis sensor unit, a crash zone sensor (4WD models), warning lamp, wiring harness, and spiral cable.
The vehicle (except crew cab model) is equipped with a passenger air bag deactivation switch. Because no rear seat exists where a rear-facing child restraint can be placed, the switch is designed to turn off the passenger air bag so that a rear-facing child restraint can be used in the front passenger seat. The switch is located in the center of the instrument panel, near the ashtray. When the switch is turned to the ON position, the passenger air bag is enabled and could inflate in a frontal collision. When the switch is turned to the OFF position, the passenger air bag is disabled and will not inflate in a frontal collision. A passenger air bag OFF indicator on the instrument panel lights up when the passenger air bag is switched OFF. The driver air bag always remains enabled and is not affected by the passenger air bag deactivation switch.
Information necessary to service the system safely is included in the **RS section** of this Service Manual.

WARNING:

- **To avoid rendering the SRS inoperative, which could increase the risk of personal injury or death in the event of a collision which would result in air bag inflation, all maintenance should be performed by an authorized NISSAN dealer.**
- **Improper maintenance, including incorrect removal and installation of the SRS, can lead to personal injury caused by unintentional activation of the system. For removal of Spiral Cable and Air Bag Module, see the RS section.**
- **Do not use electrical test equipment on any circuit related to the SRS unless instructed to in this Service Manual. Spiral cable and wiring harnesses (except “SEAT BELT PRE-TENSIONER”) are covered with yellow insulation either just before the harness connectors or on the complete harness, for easy identification.**
- **The vehicle (except crew cab model) is equipped with a passenger air bag deactivation switch which can be operated by the customer. When the passenger air bag is switched OFF, the passenger air bag is disabled and will not inflate in a frontal collision. When the passenger air bag is switched ON, the passenger air bag is enabled and could inflate in a frontal collision. After SRS maintenance or repair, make sure the passenger air bag deactivation switch is in the same position (ON or OFF) as when the vehicle arrived for service.**

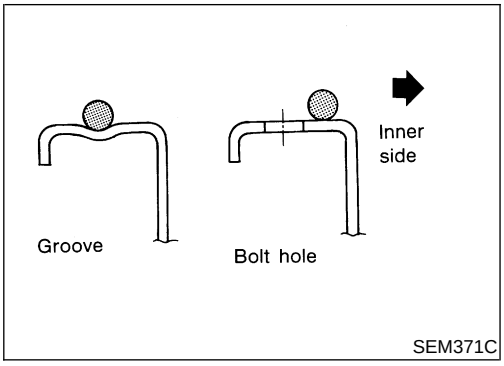
Parts Requiring Angular Tightening

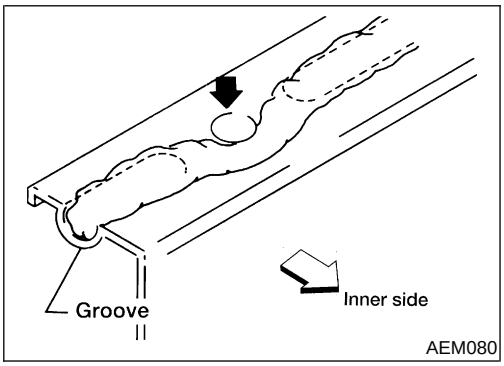
NEEM0001

- Use an angle wrench for the final tightening of the following engine parts:

a) Cylinder head bolts
b) Connecting rod cap nuts

- 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.





Liquid Gasket Application Procedure

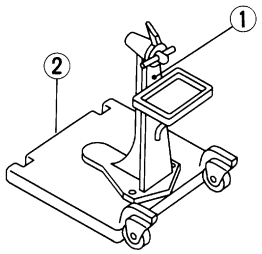
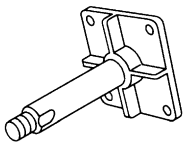
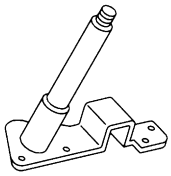
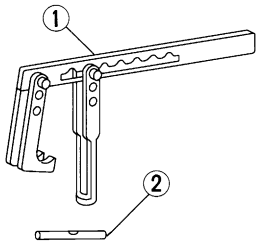
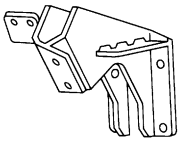
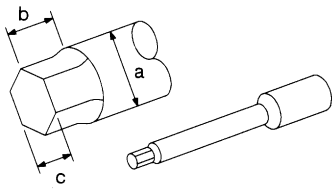
NEEM0002

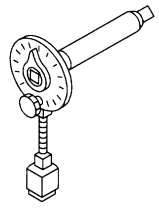
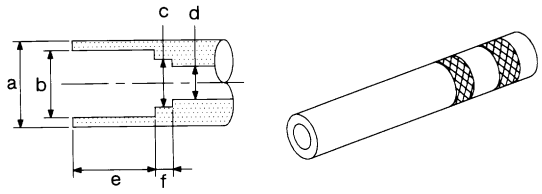
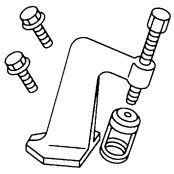
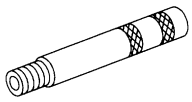
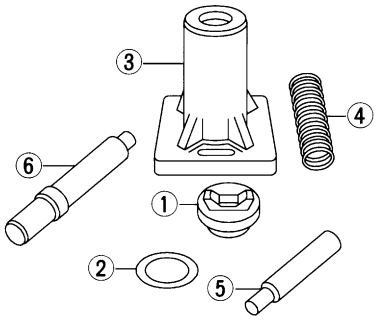
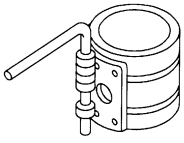
1) Use a scraper to remove all traces of old liquid gasket from mating surfaces and grooves. Also completely clean any oil stains from these portions.
2) Apply a continuous bead of liquid gasket to mating surfaces. (Use Genuine RTV silicone sealant Part No. 999MP-A7007 or equivalent.)
   - Be sure liquid gasket is 3.5 to 4.5 mm (0.138 to 0.177 in) dia. (for oil pan).
   - Be sure liquid gasket is 2.0 to 3.0 mm (0.079 to 0.118 in) dia. (in areas except oil pan).
3) Apply liquid gasket to inner surface around hole perimeter area (unless otherwise specified).
4) Assembly should be done within 5 minutes after coating.
5) Wait at least 30 minutes before refilling engine oil and engine coolant.

Special Service Tools

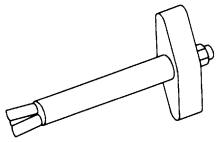
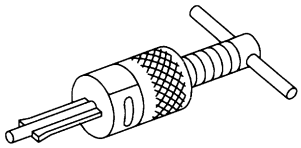
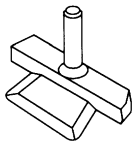
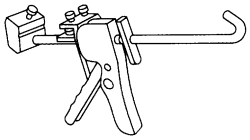
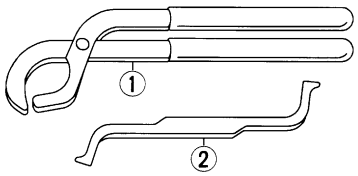
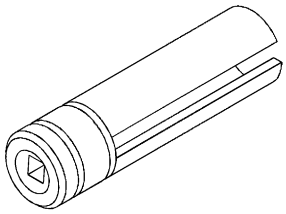
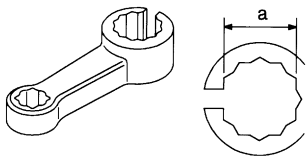
NEEM0003

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

Tool number (Kent-Moore No.) Tool name	Description	
ST0501S000 (—) Engine stand assembly **1** ST05011000 (—) Engine stand **2** ST05012000 (—) Base	 NT042	Disassembling and assembling
KV10106500 (—) Engine stand shaft	 NT028	
KV10105001 (—) Engine attachment	 NT031	
KV101092S0 (J26336-B) Valve spring compressor **1** KV10109210 (—) Compressor **2** KV100109220 (—) Adapter	 NT021	Disassembling and assembling valve components
KV10110001 (—) Engine sub-attachment	 NT032	
ST10120000 (J24239-01) Cylinder head bolt wrench	 NT583	Loosening and tightening cylinder head bolt **a: 13 mm (0.51 in) dia.** **b: 12 mm (0.47 in)** **c: 10 mm (0.39 in)**

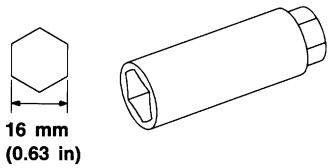
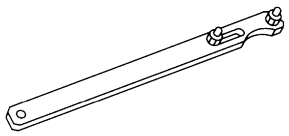
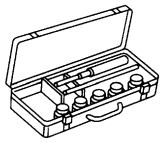
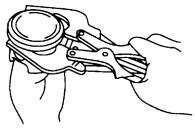
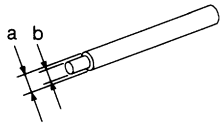
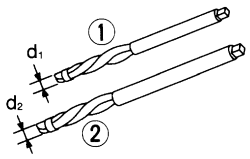
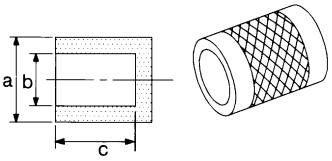
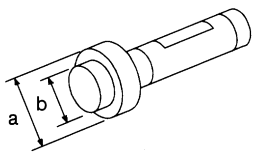
Tool number (Kent-Moore No.) Tool name	Description
KV10112100 (BT8653-A) Angle wrench	 NT014 Tightening bearing cap, cylinder head bolts, etc.
KV10116300 (J-38955) Valve oil seal drift	 NT602 Installing valve oil seal **a: 25 (0.98) dia.** **b: 14.4 (0.567) dia.** **c: 11.8 (0.465) dia.** **d: 10 (0.39) dia.** **e: 11 (0.43)** **f: 9 (0.35)**
KV10110600 (J33986) Valve spring compressor	 NT033 Disassembling and assembling valve components
KV10107501 (—) Valve oil seal drift	 NT025 Installing valve oil seal
KV10110300 (—) Piston pin press stand assembly **1** KV10110310 (—) Cap **2** KV10110330 (—) Spacer **3** ST13030020 (—) Press stand **4** ST13030030 (—) Spring **5** KV10110340 (—) Drift **6** KV10110320 (—) Center shaft	 NT036 Disassembling and assembling piston with connecting rod
EM03470000 (J8037) Piston ring compressor	 NT044 Installing piston assembly into cylinder bore

Special Service Tools (Cont'd)

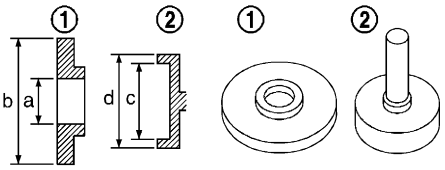
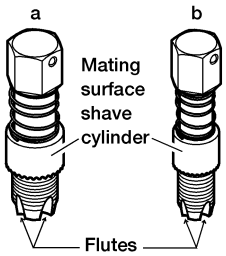
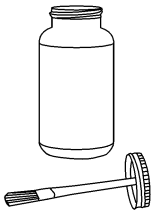
Tool number (Kent-Moore No.) Tool name	Description	
(J36467) Valve oil seal remover	 NT034	Removing valve oil seal
ST16610001 (J23907) Pilot bushing puller	 NT045	Removing crankshaft pilot bushing
KV10111100 (J37228) Seal cutter	 NT046	Removing oil pan
WS39930000 (—) Tube presser	 NT052	Pressing the tube of liquid gasket
KV101151S0 (J38972) Lifter stopper set **1** KV10115110 (J38972-1) Camshaft pliers **2** KV10115120 (J38972-2) Lifter stopper	 NT041	Changing valve lifter shims
KV10117100 (J3647-A) Heated oxygen sensor wrench	 NT379	Loosening or tightening heated oxygen sensor **For 22 mm (0.87 in) hexagon nut**
KV10114400 (J38365) Heated oxygen sensor wrench	 NT636	Loosening or tightening rear heated oxygen sensor (For right bank) **a: 22 mm (0.87 in)**

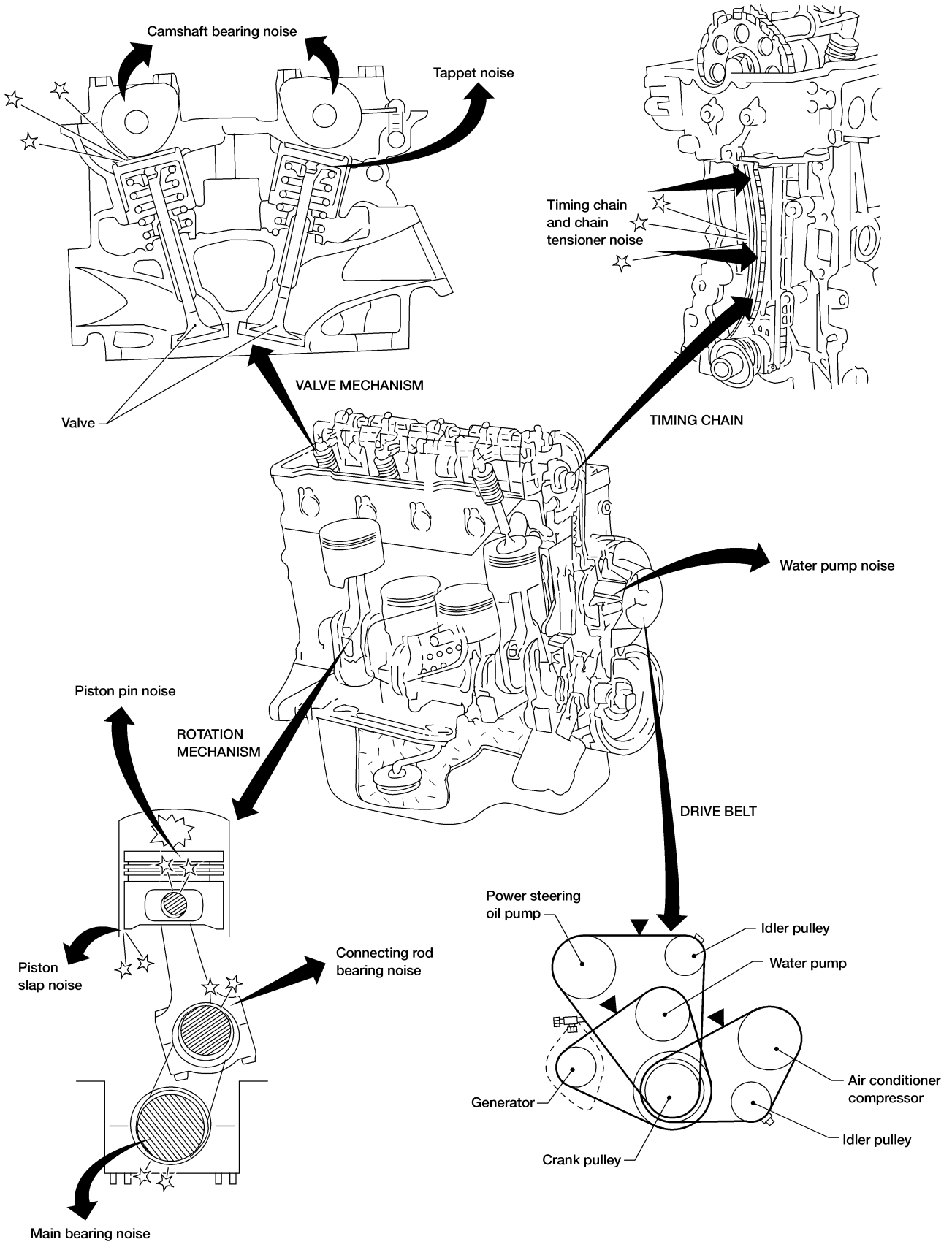
Commercial Service Tools

NEEM0004

Tool name (Kent Moore No.)	Description	
Spark plug wrench	 NT047	Removing and installing spark plug
Pulley holder	 NT035	Holding camshaft pulley while tightening or loosening camshaft bolt
Valve seat cutter set	 NT048	Finishing valve seat dimensions
Piston ring expander	 NT030	Removing and installing piston ring
Valve guide drift	 NT015	Removing and installing valve guide **Intake & Exhaust:** **a = 10.5 mm (0.413 in) dia.** **b = 6.6 mm (0.260 in) dia.**
Valve guide reamer	 NT016	Reaming valve guide 1 or hole for oversize valve guide 2 **Intake:** **d_1 = 7.0 mm (0.276 in) dia.** **d_2 = 11.2 mm (0.441 in) dia.** **Exhaust:** **d_1 = 8.0 mm (0.315 in) dia.** **d_2 = 12.2 mm (0.480 in) dia.**
Camshaft oil seal drift	 NT613	Installing camshaft oil seal **a: 60 mm (2.36 in) dia.** **b: 44.5 mm (1.752 in) dia.** **c: 75 mm (2.95 in)**
Front oil seal drift	 NT049	Installing front oil seal **a: 52 mm (2.05 in) dia.** **b: 44 mm (1.73 in) dia.**

Commercial Service Tools (Cont'd)

Tool name (Kent Moore No.)	Description	
Rear oil seal drift	 NT719	Installing rear oil seal **a: 46 mm (1.81 in)** **b: 110 mm (4.33 in)** **c: 84 mm (3.31 in)** **d: 96 mm (3.78 in)**
a: (J-43897-18) b: (J-43897-12) Thread repair tool for oxygen sensor	 AEM488	**a: 18 mm (0.71 in)** **b: 12 mm (0.47 in)**
Anti-seize thread compound	 AEM489	For preventing corrosion, seizing, and galling on high temperature applications.


Camshaft bearing noise
Tappet noise
Timing chain
and chain
tensioner noise
VALVE MECHANISM
Valve
TIMING CHAIN
Water pump noise
Piston pin noise
ROTATION
MECHANISM
DRIVE BELT
Power steering
oil pump
Idler pulley
Water pump
Piston
slap noise
Connecting rod
bearing noise
Air conditioner
compressor
Generator
Idler pulley
Crank pulley
Main bearing noise

AEM466

NVH Troubleshooting Chart — Engine Noise

NEEM0085S01

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 the engine.
4. Check the 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 start-ing	When idling	When rev-ving	While driving			
Top of engine Rocker cover Cylinder head	Ticking or clicking	C	A	—	A	B	—	Tappet noise	Valve clearance	EM-40
	Rattle	C	A	—	A	B	C	Camshaft bearing noise	Camshaft journal clear-ance Camshaft runout	EM-34
Crankshaft pulley Cylinder block (upper side of engine) Oil pan	Slap or knock	—	A	—	B	B	—	Piston pin noise	Piston and piston pin clearance Connecting rod bushing clearance	EM-47, 53
	Slap or rap	A	—	—	B	B	A	Piston slap noise	Piston ring side clearance Piston ring end gap Connecting rod bend and torsion Piston-to-bore clearance	EM-49, 48
	Knock	A	B	C	B	B	B	Connecting rod-bearing noise	Connecting rod bearing clearance (Big end) Connecting rod bushing clearance (Small end)	EM-52, 53
	Knock	A	B	—	A	B	C	Main bear-ing noise	Crankshaft runout Main bearing oil clear-ance	EM-50
Front of engine Timing chain cover	Tapping or ticking	A	A	—	B	B	B	Timing chain and chain ten-sioner noise	Timing chain cracks and wear	EM-24
Front of engine	Squeak-ing or fizzing	A	B	—	B	—	C	Other drive belts (Stick-ing or slip-ping)	Drive belt deflection	*1
	Creaking	A	B	A	B	A	B	Other drive belts (Slip-ping)	Idler pulley bearing operation	
	Squall creak	A	B	—	B	A	B	Water pump noise	Water pump operation	*2

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

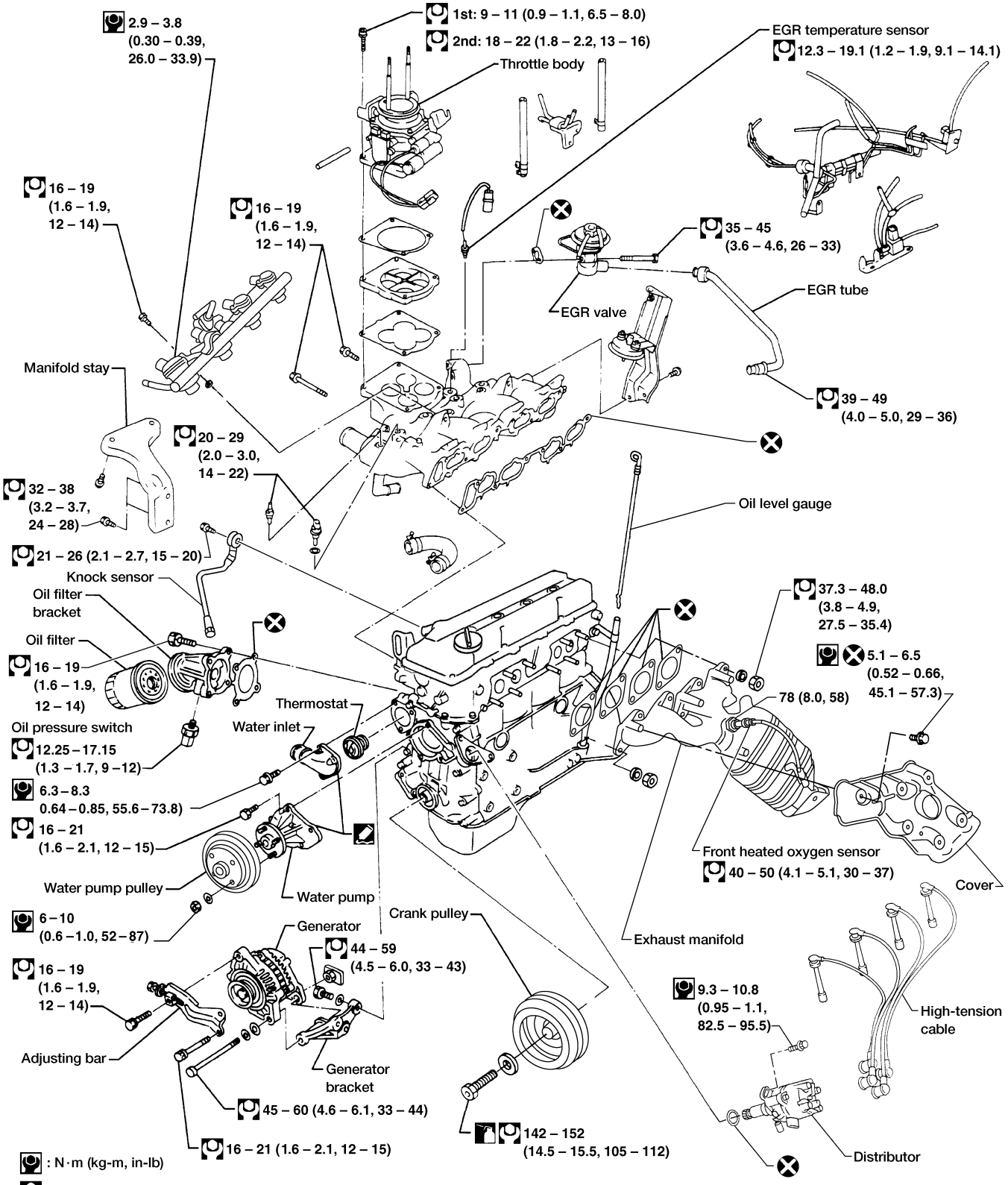
*1: “Checking Drive Belts”, “ENGINE MAINTENANCE”, ***MA-17***.

*2: “Water Pump Inspection”, “ENGINE COOLING SYSTEM”, ***LC-30***.

Removal and Installation

NEEM0086

SEC. 120 • 140 • 147 • 150 • 163 • 164 • 210 • 220 • 221 • 230 • 231



: N·m (kg-m, in-lb)

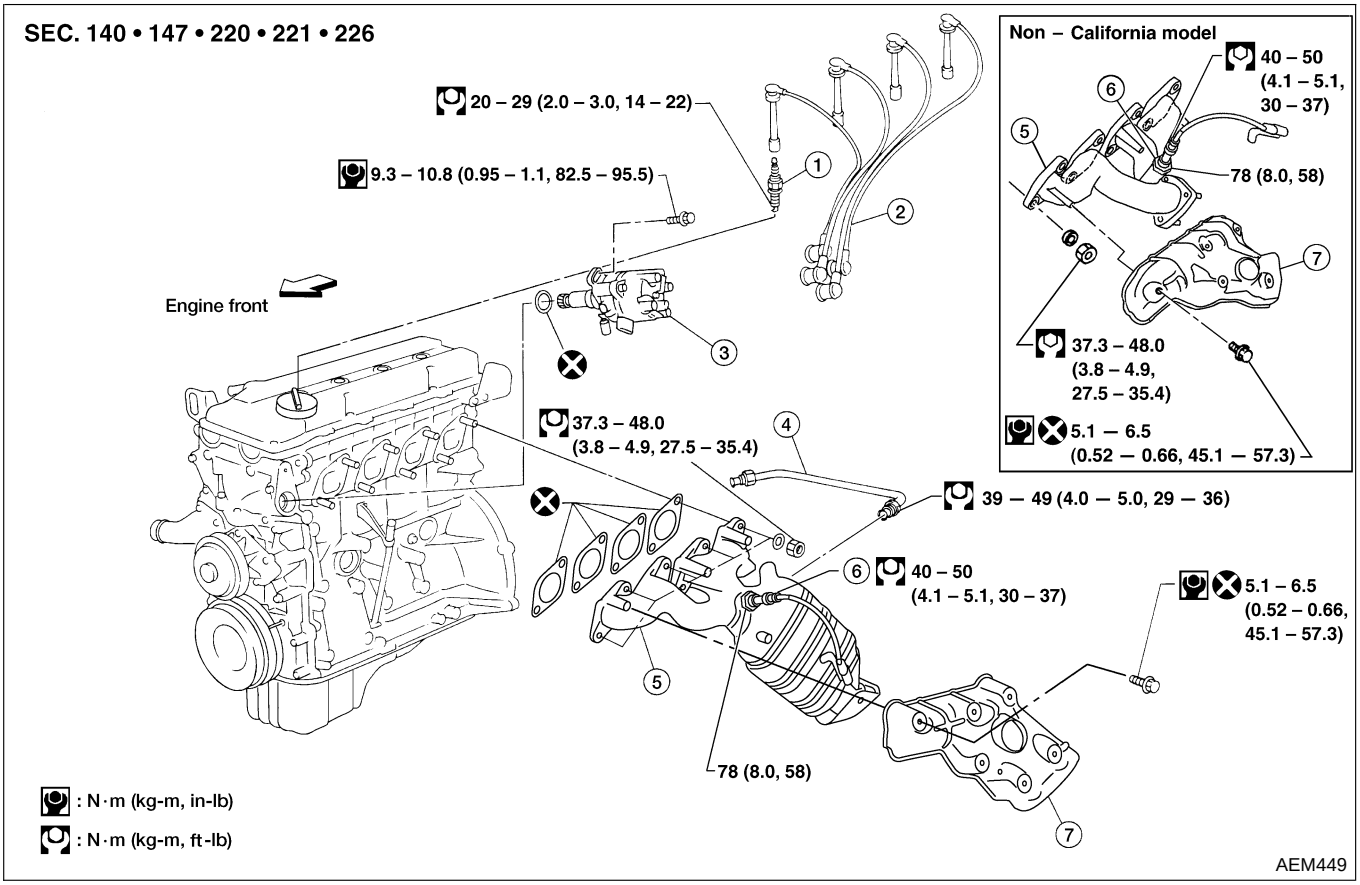
: N·m (kg-m, ft-lb)

: Apply liquid gasket. Use Genuine RTV Silicone Sealant, Part No. 999 MP - A7007, or equivalent.

: Lubricate with new engine oil.

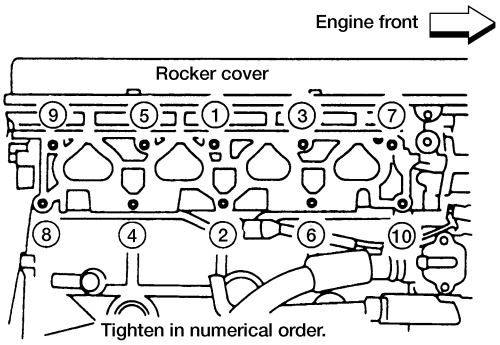
AEM465

Removal and Installation (Cont'd)



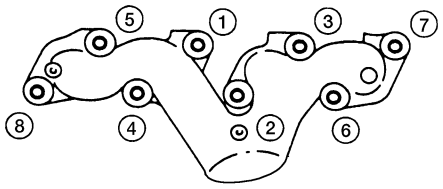
1. Spark plug
2. Ignition wire
3. Camshaft position sensor built into distributor
4. EGR tube
5. Exhaust manifold
6. Front heated oxygen sensor
7. Exhaust manifold cover

Intake manifold



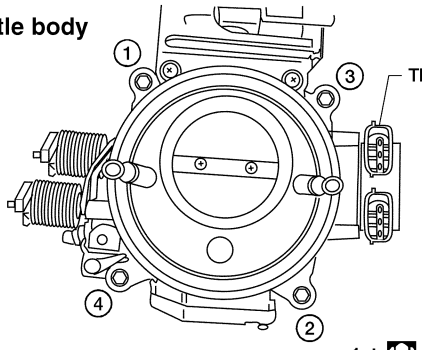
Tighten in numerical order.
Loosen in reverse order.
15.7 – 18.6 (1.6 – 1.9, 11.6 – 13.7)

Exhaust manifold



Tighten in numerical order.
Loosen in reverse order.
37.3 – 48.0 (3.8 – 4.9, 27.5 – 35.4)

Throttle body



Tighten in numerical order.
Loosen in reverse order.
1st: 9 – 11 (0.9 – 1.1, 6.5 – 8.0)
2nd: 18 – 22 (1.8 – 2.2, 13 – 16)

: N·m (kg-m, ft-lb)

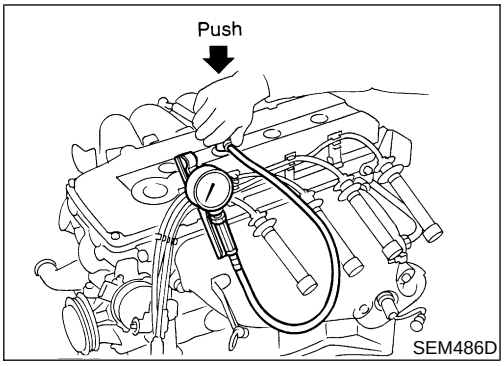
AEM467

MEASUREMENT OF COMPRESSION PRESSURE

1. Warm up engine.
2. Turn ignition switch OFF.
3. Release fuel pressure.
   Refer to “Fuel Pressure Release”, “BASIC SERVICE PROCEDURE”, ***EC-40*** or***EC-620***.
4. Remove all spark plugs.

- **Clean area around plug with compressed air before removing the spark plug.**

5. Disconnect camshaft position sensor harness connector at the distributor.
6. Remove fuel injector fuse **3** on FUSE BLOCK (J/B) behind the instrument lower panel driver’s side.



7. Attach a compression tester to No. 1 cylinder.
8. Depress accelerator pedal fully to keep throttle valve wide open.
9. Crank engine and record highest gauge indication.
10. Repeat the measurement on each cylinder as shown above.

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

Compression pressure: kPa (kg/cm^2, psi)/300 rpm

Standard

1,226 (12.5, 178)

Minimum

1,030 (10.5, 149)

Difference limit between cylinders

98 (1.0, 14)

11. If compression in one or more cylinders is low:

a. Pour a small amount of engine oil into cylinders through spark plug holes.

b. Retest compression.

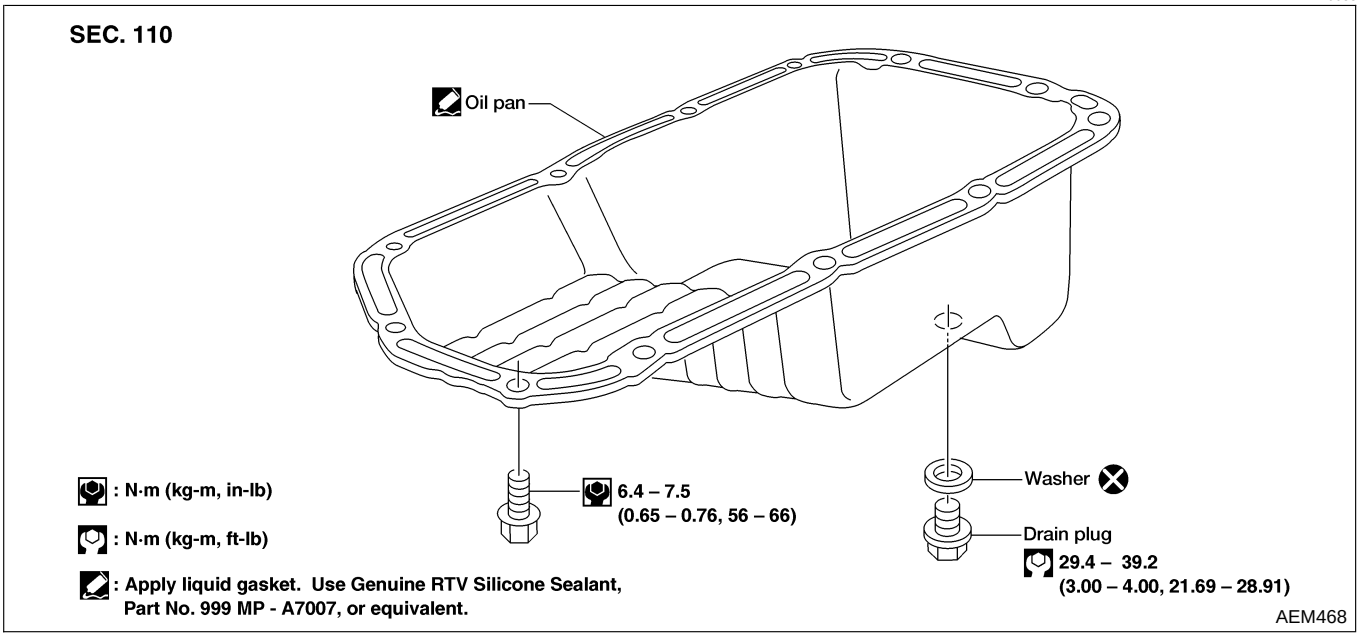
- **If adding oil improves cylinder compression, piston rings may be worn or damaged. If so, replace piston rings after checking piston.**
- **If pressure stays low, a valve may be sticking or seating improperly. Inspect and repair valve and valve seat. (Refer to SDS, EM-58 and EM-61.) If valve or valve seat is damaged excessively, replace it.**
- **If compression in any two cylinders adjacent cylinders is low, and if adding oil does not improve compression, there is leakage past the gasket surface. If so, replace cylinder head gasket.**

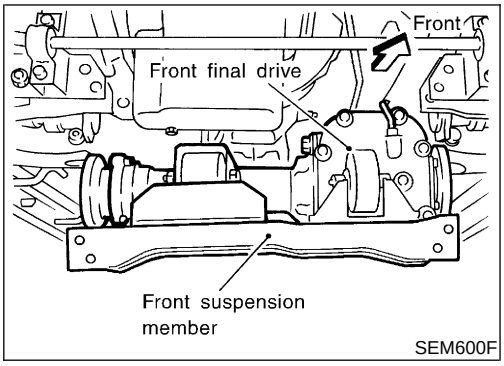
12. Reinstall spark plugs, fuel injector fuse, fuel pump fuse, and reconnect camshaft position sensor harness connector at the distributor.
13. Erase the DTC stored in the ECM.

CAUTION:
Always erase the DTC after checking compression.
Refer to "HOW TO ERASE EMISSION-RELATED DIAGNOSTIC INFORMATION", *EC-69* or *EC-651*.

Components

NEEM0088

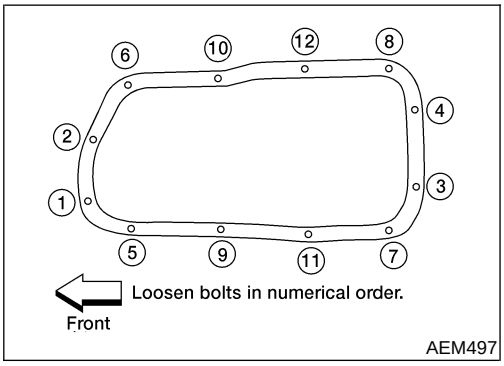




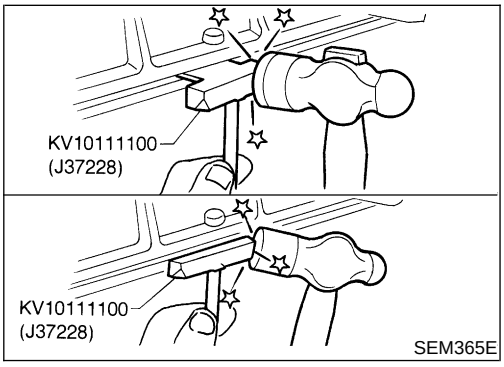
Removal

NEEM0089

1. Raise vehicle and support it with safety stands.
2. Remove engine under cover.
3. Drain engine oil.
4. Remove front final drive together with differential mounting member. Refer to “Removal and Installation”, “FRONT FINAL DRIVE”) — 4WD models only, ***PD-18*** or ***PD-44***.
5. Remove front suspension member.



6. Remove oil pan bolts.



7. Remove oil pan.

a. Insert Tool between cylinder block and oil pan.

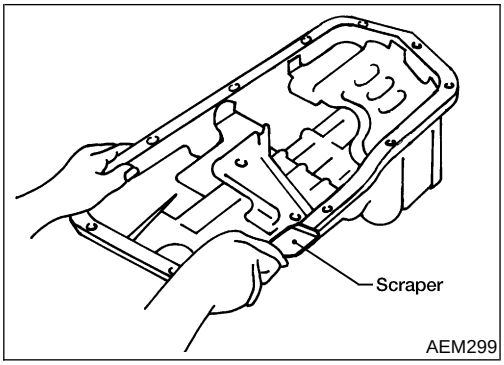
- **Be careful not to damage aluminum mating surface.**
- **Do not insert screwdriver, or oil pan flange will be damaged.**

b. Slide Tool by tapping on the side of the Tool with a hammer.

8. Pull out oil pan from front side.

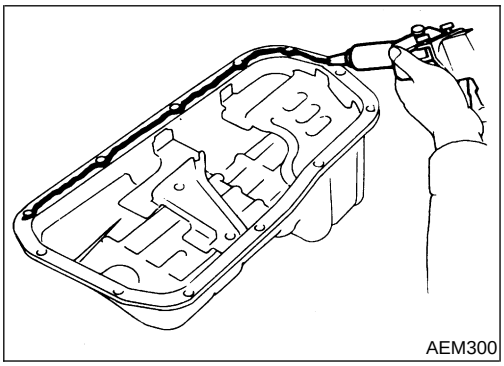
Installation

NEEM0090



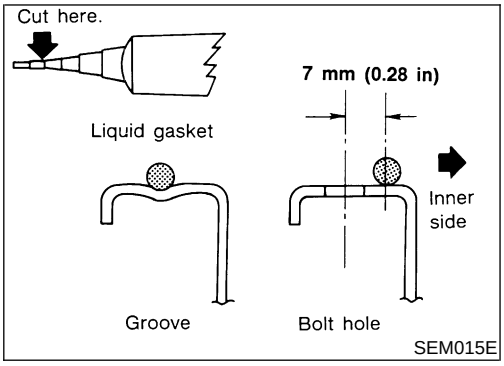
1. Use a scraper to remove old liquid gasket from mating surface of oil pan.

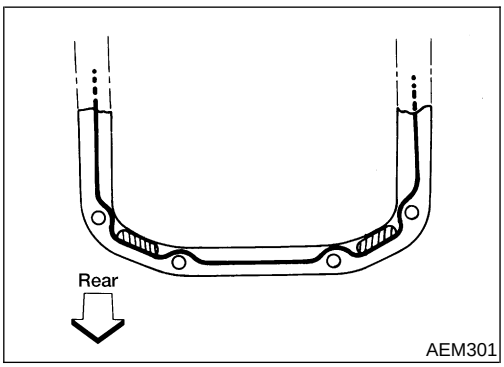
- **Also remove traces of liquid gasket from mating surface of cylinder block.**



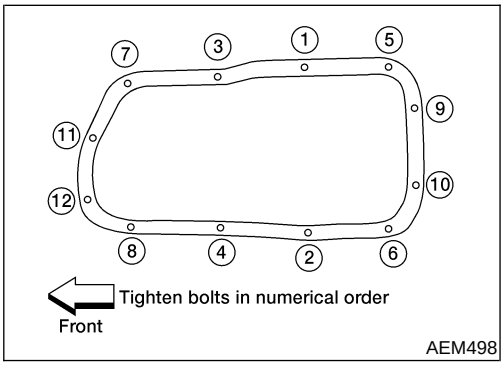
2. Apply a continuous bead of liquid gasket to mating surface of oil pan.

- **Use Genuine RTV Silicone Sealant, Part No. 999 MP-A7007 or equivalent.**
- **Apply to groove on mating surface.**
- **Allow 7 mm (0.28 in) clearance around bolt hole.**





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



3. Install oil pan.

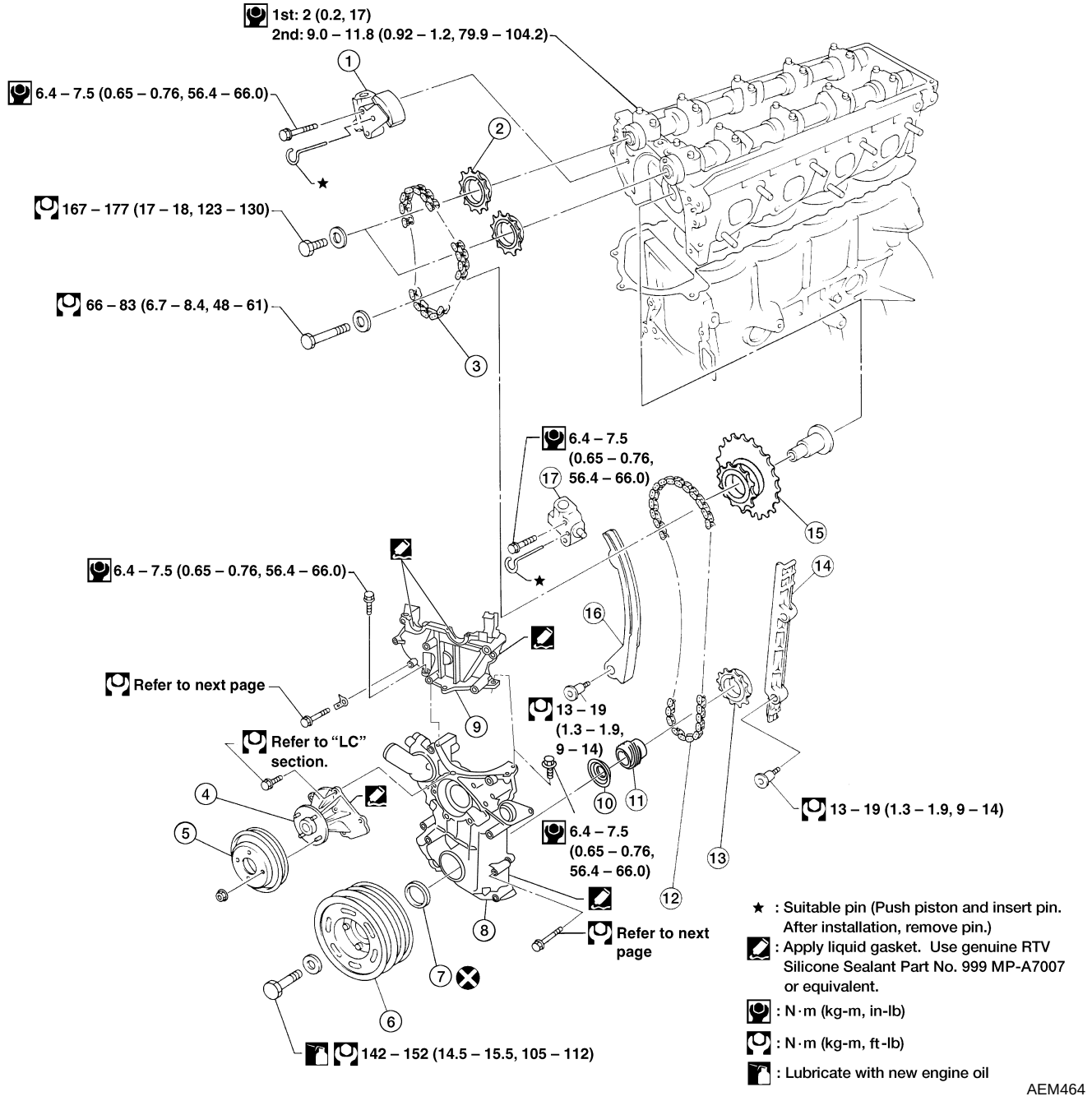
- **Tighten oil pan bolts in numerical order.**
  : 6.4 - 7.5 N·m (0.65 - 0.76 kg-m, 56 - 66 in-lb)
- **Wait at least 30 minutes before refilling engine oil.**

4. Install parts in reverse order of removal.

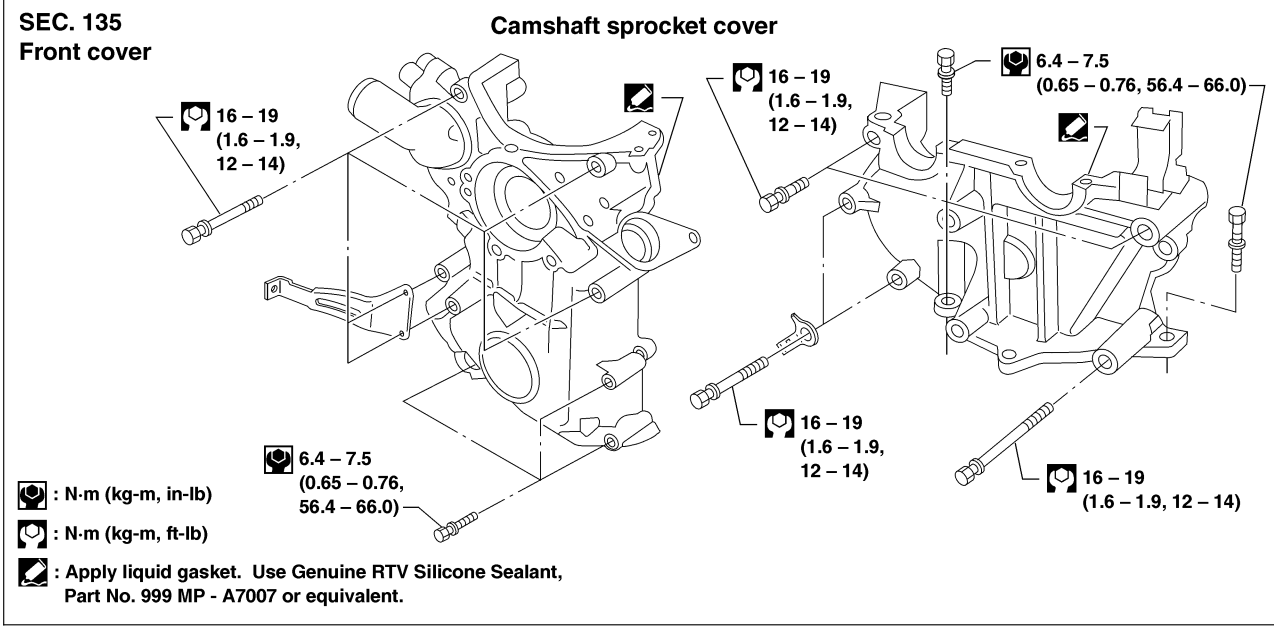
Components

NEEM0091

SEC. 120 • 130 • 135 • 210

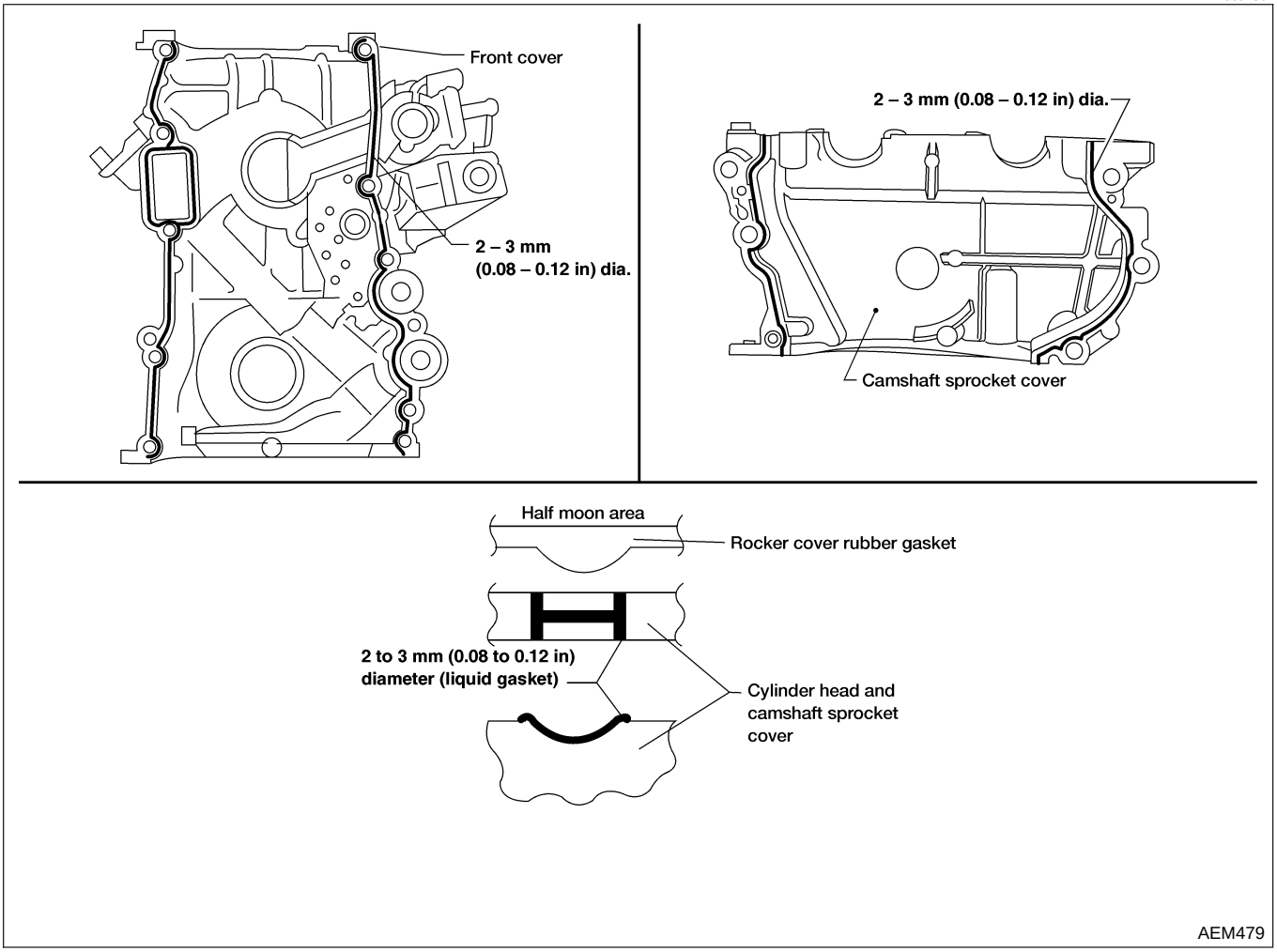


1. Upper timing chain tensioner
2. Cam sprocket
3. Upper timing chain
4. Water pump
5. Water pump pulley
6. Crankshaft pulley
7. Front oil seal
8. Front cover
9. Camshaft sprocket cover
10. Oil slinger
11. Oil pump drive gear
12. Lower timing chain
13. Crankshaft sprocket
14. Chain guide
15. Idler sprocket
16. Chain tension arm
17. Lower timing chain tensioner



LIQUID GASKET APPLICATION PLACES

NEEM0091S01



Removal

NEEM0092

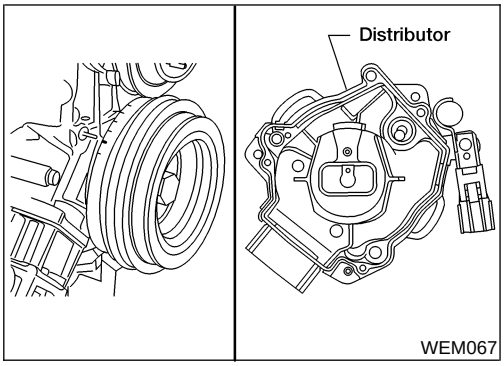
CAUTION:

- **After removing timing chain, do not turn crankshaft and camshaft separately, or valves will strike piston heads.**
- **When installing chain tensioners or other sliding parts, lubricate contacting surfaces with new engine oil.**
- **Apply new engine oil to bolt threads and seat surfaces when installing camshaft sprockets and crankshaft pulley.**
- **Do not spill engine coolant on drive belts.**

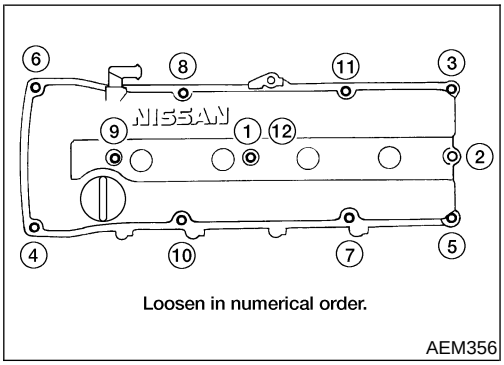
UPPER TIMING CHAIN

NEEM0092S01

1. Remove the air cleaner assembly.
2. Remove the spark plug wires.

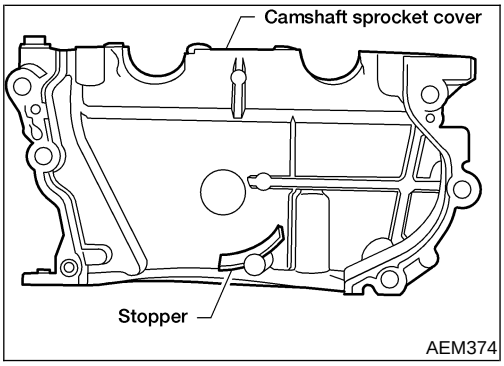


3. Set No.1 piston at TDC on its compression stroke.
4. Remove vacuum hoses, electrical harness connectors, and harness clamps.
5. Remove the power steering belt.
6. Remove the power steering pump and position it to one side. Remove the idler pulley and bracket as well.

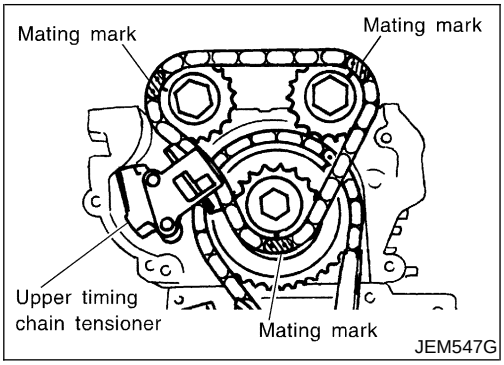


7. Remove the rocker cover.

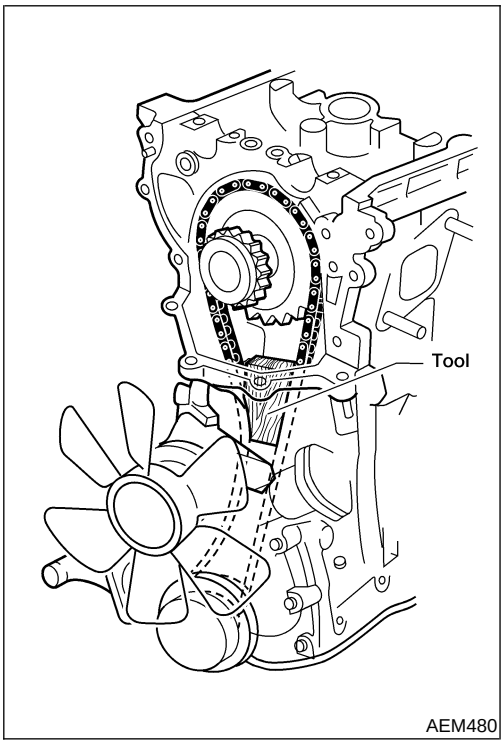
- **Remove in numerical order as shown.**



8. Remove the camshaft sprocket cover.



9. Wipe off the links of the timing chain next to the timing marks on the sprockets. Put paint marks on the timing chain, matching them with the timing marks on the cam sprockets and idler sprocket.
10. Remove cam sprocket bolts, cam sprockets and upper timing chain.



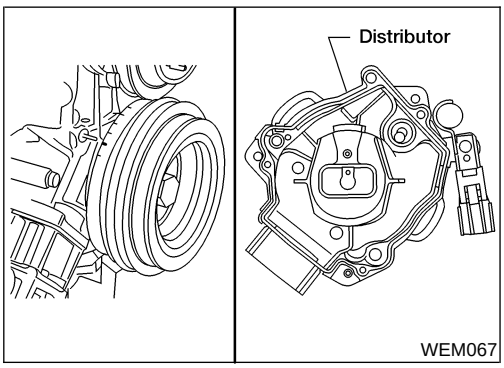
IDLER SPROCKET

NEEM0092S02

1. Remove upper timing chain.
   Refer to "UPPER TIMING CHAIN", "Removal" EM-22.
2. Support lower timing chain by using a suitable tool to prevent chain tensioner spring from coming out.

NOTE:
This step is only to be applied when the lower cover is not being removed.

3. Remove the idler sprocket.



LOWER TIMING CHAIN

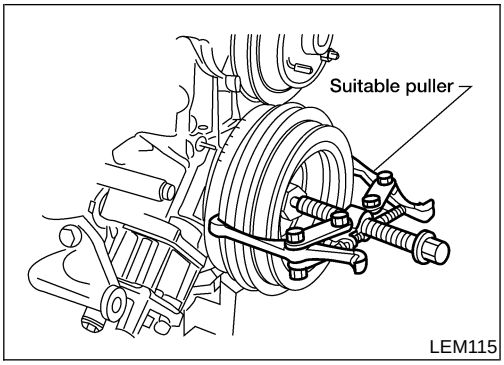
NEEM0092S03

1. Drain coolant by removing the cylinder block drain plug and opening the radiator drain cock. Refer to MA section of the Service Manual.
2. Drain engine oil from drain plug of oil pan.
3. Remove the following parts.

- Alternator drive belt.
- A/C compressor drive belt.
- Cooling fan with coupling.
- Radiator shroud.

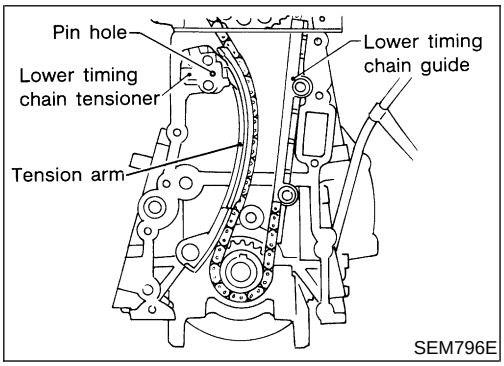
4. Remove A/C compressor and position it to the side. Remove the idler pulley and bracket as well.
5. Set No. 1 piston to TDC on its compression stroke.
6. Remove the distributor.

Removal (Cont'd)



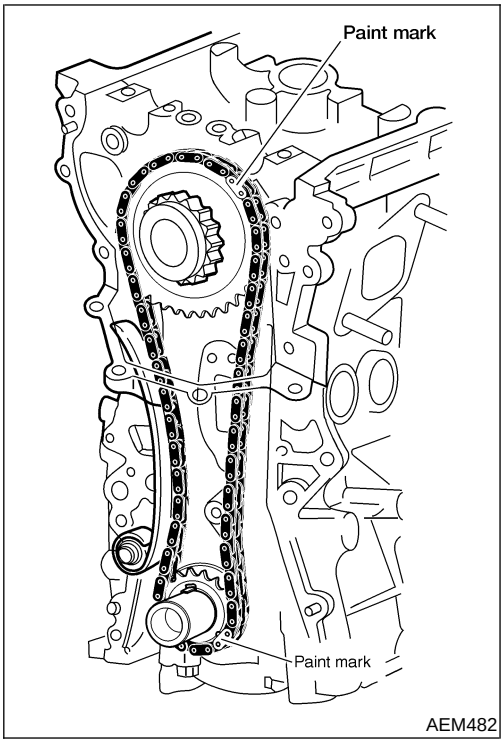
7. Remove the crankshaft pulley with suitable puller.
8. Remove oil pan.
   Refer to "Removal" in "OIL PAN" (EM-18).
9. Remove the oil pump and distributor drive shaft, then the oil pickup strainer.
10. Remove the front cover.

CAUTION:
Be careful not to tear or damage the cylinder head gasket.



11. Remove the following parts.
- Lower timing chain tensioner (Push piston and insert a suitable pin into pin hole.)
- Chain tension arm
- Lower timing chain guide

12. Remove the upper timing chain and idler sprocket. **Refer to "UPPER TIMING CHAIN" in "Removal"(EM-22) and "IDLER SPROCKET" (EM-23).**

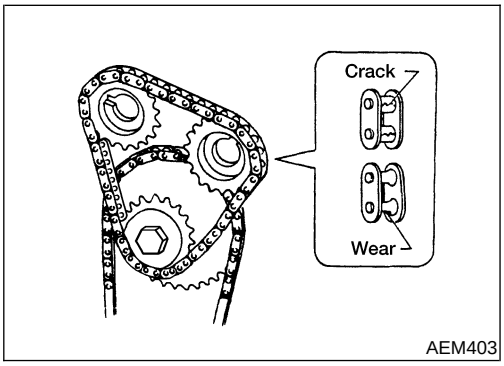


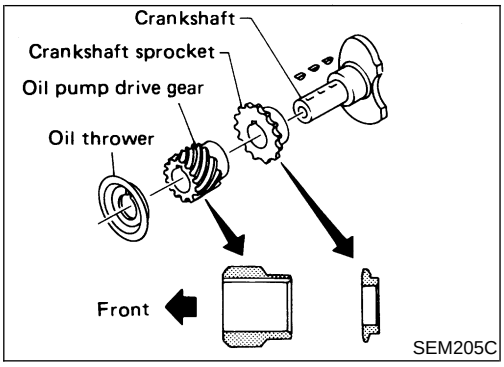
13. Wipe off the links of the timing chain next to the timing marks on the sprockets. Put paint marks on the timing chain, matching them with the timing marks on the crankshaft sprocket and idler sprocket.
14. Remove the lower timing chain and sprocket.

Inspection

NEEM0093

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





SEM205C

Installation

NEEM0094

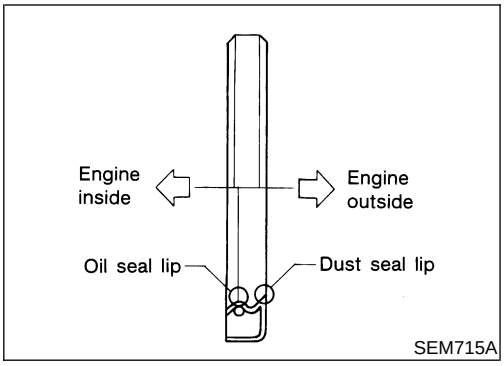
LOWER TIMING CHAIN

NEEM0094S01

1. Install crankshaft sprocket.
- **Make sure that mating marks of crankshaft sprocket face front of engine.**
2. Install the idler sprocket and lower timing chain using the mating marks and the paint marks made during the removal process.

CAUTION:
Be careful not to tear or damage the cylinder head gasket.

3. Install chain guide and chain tension arm.
4. Install lower chain tensioner and remove the pin securing the piston into the tensioner body.



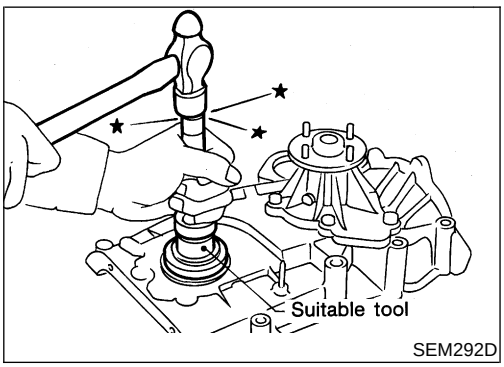
SEM715A

5. Front cover installation:
- Using a scraper or other suitable tool remove all traces of liquid gasket from the cylinder block and front cover mating surfaces.
- Install new crankshaft seal in front cover.
- **Apply a continuous bead of liquid gasket to front cover (Refer to EM-21).**

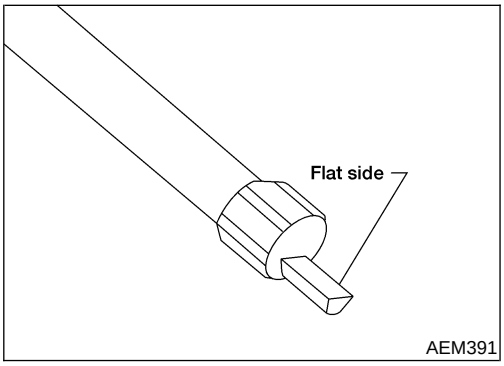
NOTE:
Use Genuine Nissan RTV Silicone Sealant P/N 999MP-A7007 or equivalent.

- **Be sure to install new front oil seal. Refer to EM-28.**
- Also place RTV sealant on the head gasket surface.
- Install the front cover to the engine.

6. Install oil strainer and oil pan. Refer to “Installation” in “OIL PAN”, EM-19.



SEM292D



AEM391

7. Install the oil pump and distributor drive shaft.

NOTE:
Make sure the flat side of the distributor drive shaft is facing the engine. Failure to do so will result in the distributor being out of time.

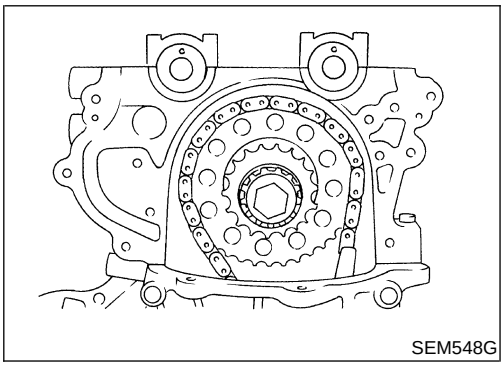
8. Install the following parts:
- Crankshaft pulley.
- A/C compressor and idler pulley bracket.
- Radiator shroud and cooling fan with coupling.
- A/C compressor, alternator and power steering pump drive belts.

- Air duct.

IDLER SPROCKET

NEEM0094S02

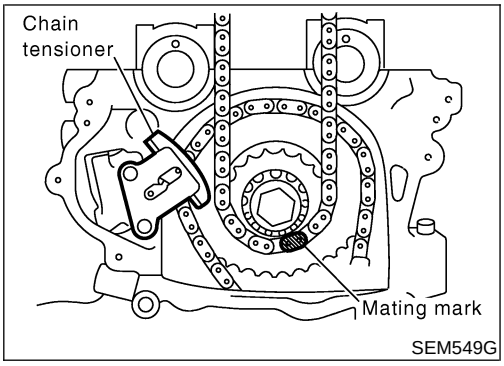
1. Install lower timing chain.
   Refer to "LOWER TIMING CHAIN", "Installation".
2. Install idler sprocket and bolt.


SEM548G

UPPER TIMING CHAIN

NEEM0094S03

1. Install lower timing chain and idler sprocket.
   Refer to "LOWER TIMING CHAIN" (EM-25) and "IDLER SPROCKET" (EM-26) in "Installation".



SEM549G

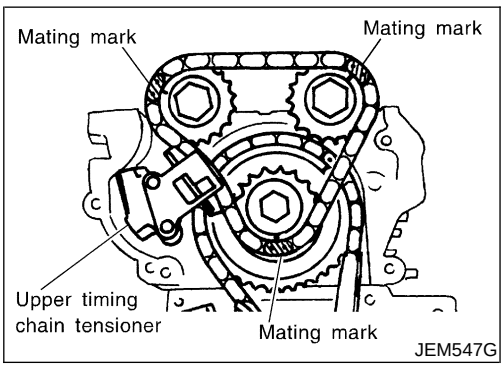
2. Install upper timing chain and sprockets, referring to the painted marks made during removal.
3. Install chain tensioner. Remove the pin holding the tensioner piston in the bore of the tensioner.
4. Install camshaft sprocket cover:

- Use a scraper to remove all traces of liquid gasket from mating surfaces of the engine block and camshaft sprocket cover.
- Apply a continuous bead of RTV sealant to the cover. Refer to EM-21.
- Also place RTV sealant on the head gasket surface.

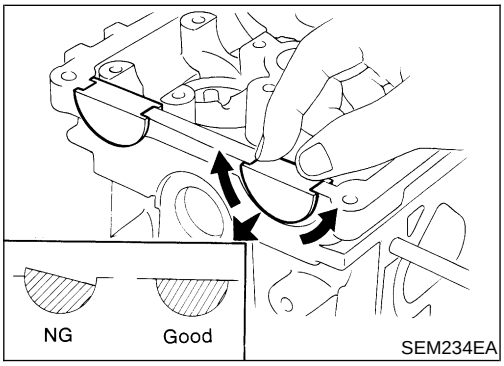
NOTE:
Use Nissan Genuine RTV Silicone Sealant, Part No. 999 MP-A7007 or equivalent.

CAUTION:

- **Be careful not to tear or damage the cylinder head gasket.**
- **Be careful upper timing chain does not slip or jump when installing camshaft sprocket cover.**



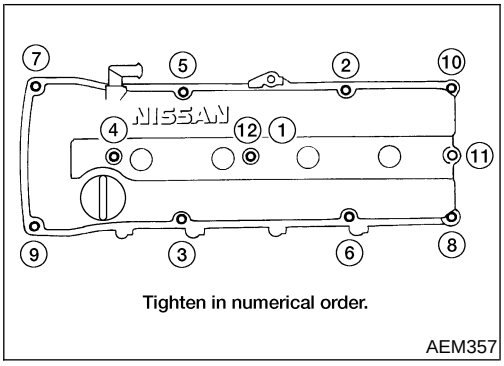
JEM547G



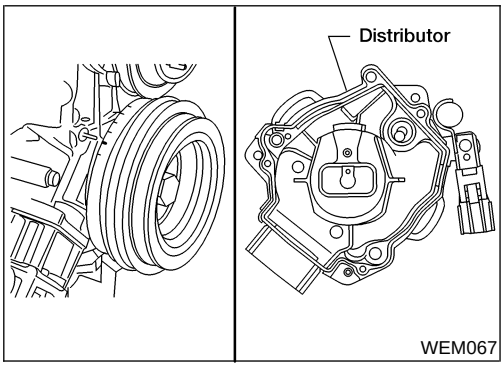
SEM234EA

5. Install rubber plugs into cylinder head after applying RTV sealant. Refer to EM-21.

- Rubber plugs should be installed flush with the cylinder head surface.



6. Install rocker cover. Tighten bolts in numerical order.
   : 8 - 11 N·m (0.8 - 1.1 kg-m, 69 - 95 in-lb).



7. Install distributor, aligning as shown.
8. Install vacuum hoses, electrical harnesses, connectors, and harness clamps.

Replacement

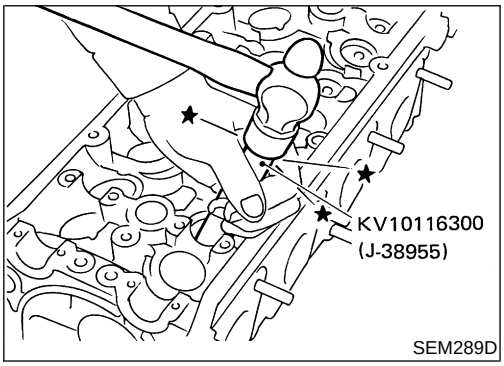
NEEM0095

VALVE OIL SEAL

NEEM0095S01

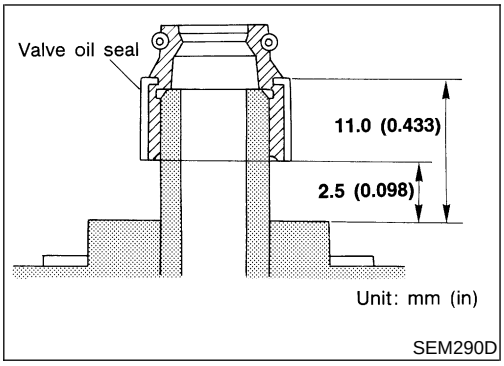
1. Remove rocker cover.
2. Remove camshaft. Refer to “TIMING CHAIN” (EM-20).
3. Remove valve spring and valve oil seal with Tool or a suitable tool.

Piston concerned should be set at TDC to prevent valve from falling.



SEM289D

4. Apply engine oil to new valve oil seal and install it with Tool.

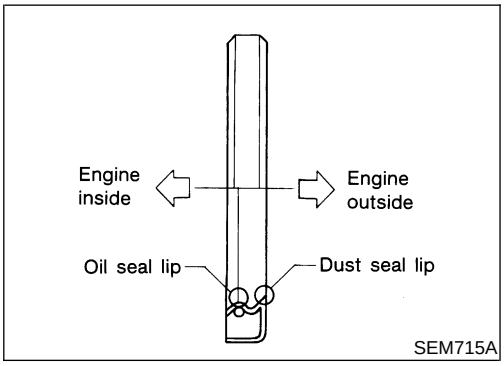


SEM290D

OIL SEAL INSTALLING DIRECTION

NEEM0095S02

- Install new oil seal in the direction shown.



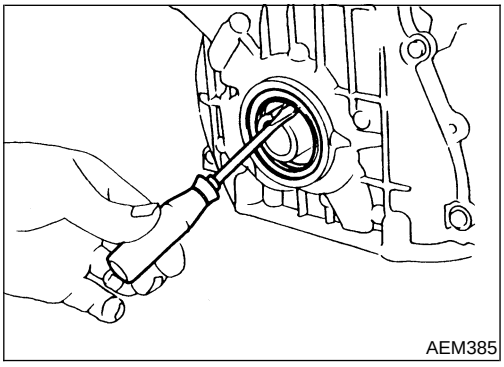
SEM715A

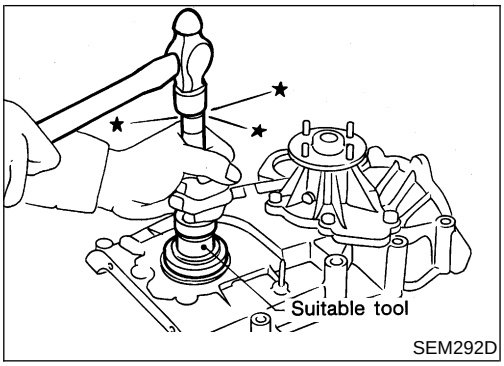
FRONT OIL SEAL

NEEM0095S03

1. Remove radiator shroud and crankshaft pulley.
2. Remove front oil seal

- **Be careful not to scratch front cover.**


AEM385



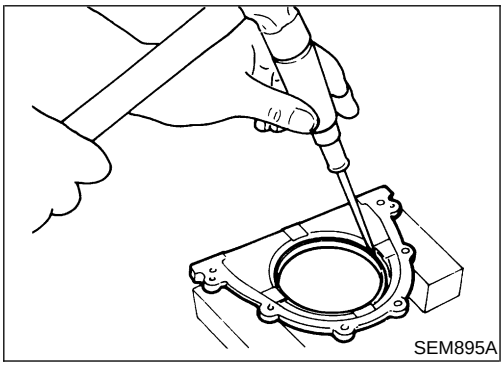
3. Apply engine oil to new oil seal and install it using a suitable tool.

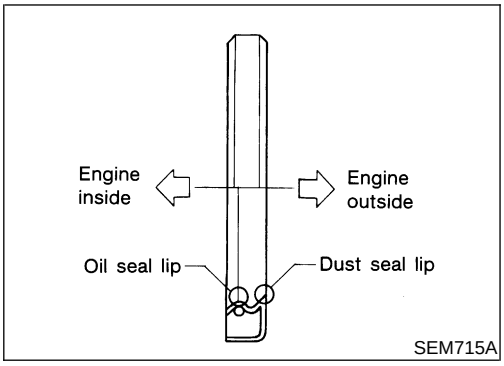
REAR OIL SEAL

NEEM0095S04

1. Remove flywheel or drive plate.
2. Remove rear oil seal retainer.
3. Remove rear oil seal from retainer.

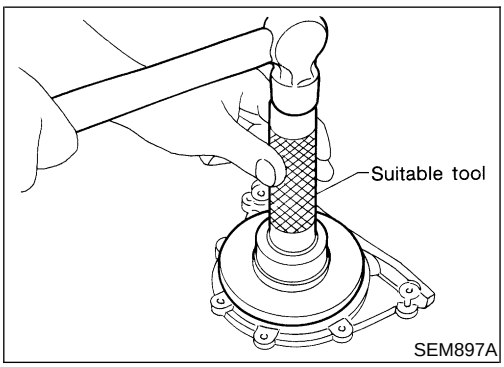
- **Be careful not to scratch rear oil seal retainer.**

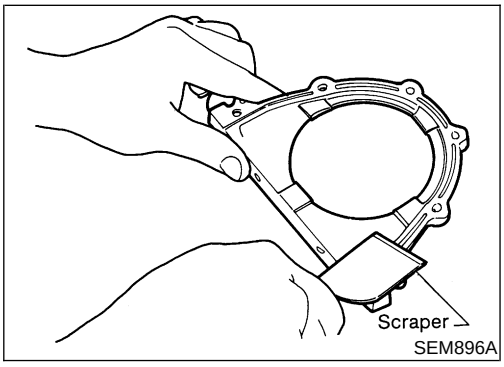




4. Apply engine oil to new oil seal and install it using suitable tool.

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



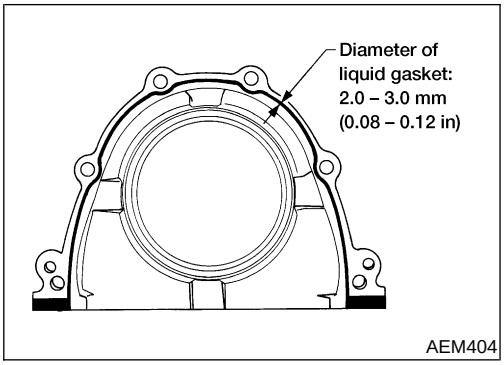


5. Install rear oil seal retainer.

a. Before installing rear oil seal retainer, remove all traces of liquid gasket from mating surface using a scraper.

- **Also remove traces of liquid gasket from mating surface of cylinder block.**

Replacement (Cont'd)



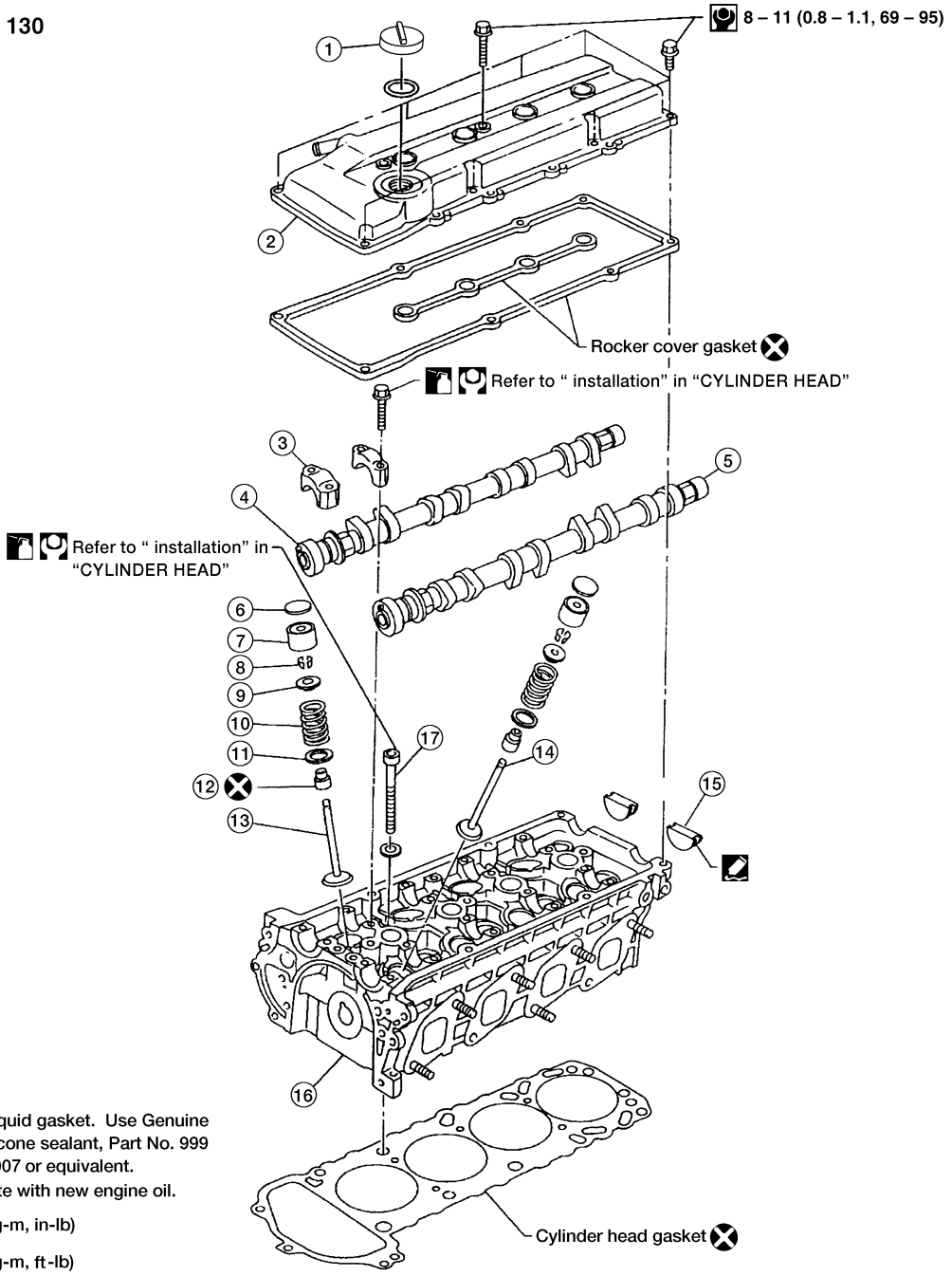
b. Apply a continuous bead of liquid gasket to mating surface of rear oil seal retainer.

- **Use Genuine RTV Silicone Sealant, Part No. 999 MP-A7007 or equivalent.**
- **Apply around inner side of bolt holes.**

Components

NEEM0096

SEC. 111 • 130



AEM463

1. Oil filler cap
2. Rocker cover
3. Camshaft bracket
4. Intake camshaft
5. Exhaust camshaft
6. Shim
7. Valve lifter
8. Valve cotter
9. Spring retainer
10. Valve spring
11. Spring seat
12. Valve oil seal
13. Intake valve
14. Exhaust valve
15. Rubber plug
16. Cylinder head
17. Cylinder head bolt

Removal

NEEM0097

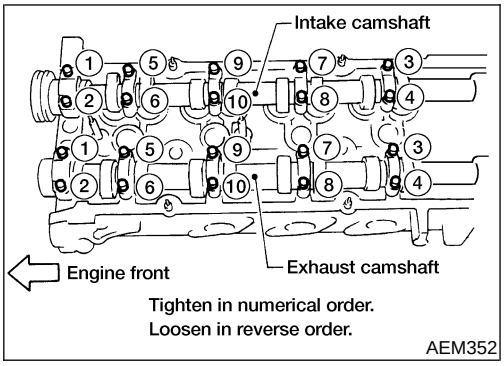
CAUTION:

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

- **Before removing camshaft and idler sprockets, apply paint marks to them for retiming.**

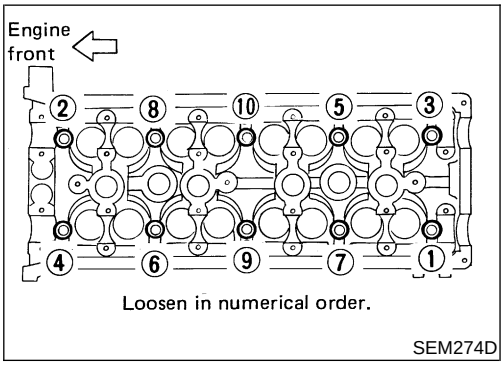
1) Remove upper timing chain and idler sprocket.

- **Refer to "UPPER TIMING CHAIN" EM-22 and "IDLER SPROCKET" EM-23 in "Removal", "TIMING CHAIN".**
- **For retiming during cylinder head removal/installation, apply paint marks to camshaft sprockets, upper timing chain, lower timing chain, and idler sprocket.**



2) Remove camshaft brackets and camshafts.

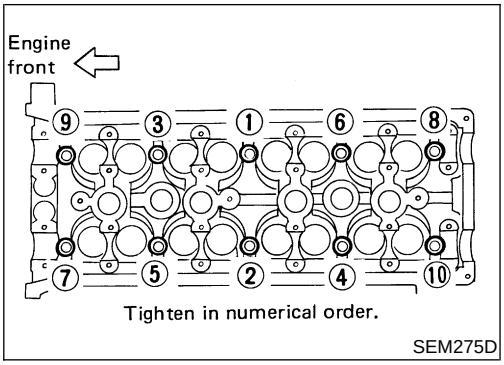
- **Mark these parts' original positions for reassembly.**

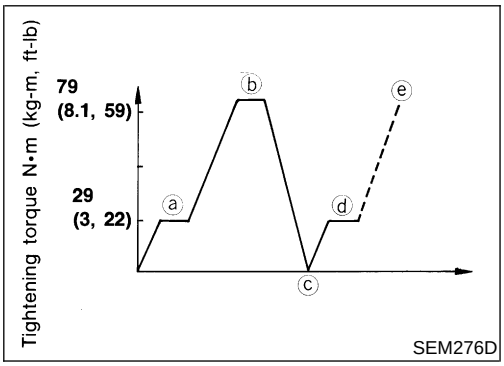


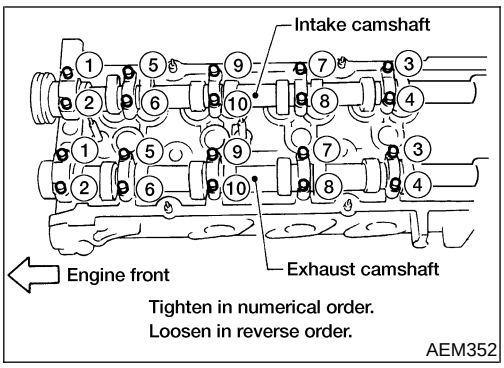
3) Remove cylinder head bolts in numerical order.

- **Removing bolts in incorrect order could result in a warped or cracked cylinder head.**
- **Loosen cylinder head bolts in two or three steps.**

4) Remove cylinder head and cylinder head gasket.







Installation

NEEM0098

1) Tighten cylinder head bolts in numerical order using the following procedure:

a) Tighten all bolts to 29 N·m (3.0 kg-m, 22 ft-lb).

b) Tighten all bolts to 79 N·m (8.1 kg-m, 59 ft-lb).

c) Loosen all bolts completely.

d) Tighten all bolts to 25 to 34 N·m (2.5 to 3.5 kg-m, 18 to 25 ft-lb).

e) Turn all bolts 86 to 91 degrees clockwise. If angle wrench is not available, mark all cylinder head bolts on the side facing engine front. Then turn each cylinder head bolts 86 to 91 degrees clockwise.

2) Install camshafts and camshaft brackets in the order shown using the following procedure:

a) Set camshafts and camshaft brackets.

- Dowel pins of both intake and exhaust camshafts should be at 12 o'clock positions when installing the camshafts.

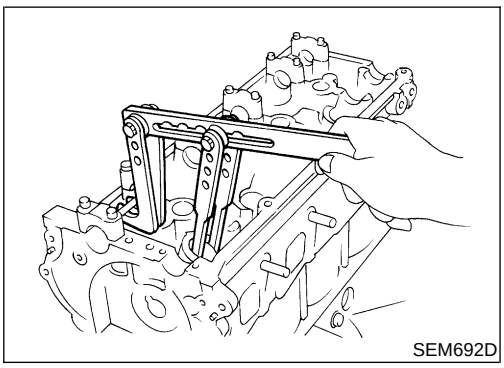
b) Tighten all bolts to 2 N·m (0.2 kg-m, 17 in-lb).

c) Tighten all bolts to 9.0 to 11.8 N·m (0.92 to 1.2 kg-m, 79.9 to 104.2 in-lb).

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

3) Install upper timing chain and idler sprocket.

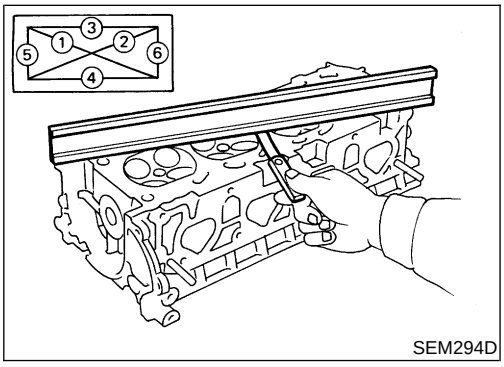
- **Refer to "UPPER TIMING CHAIN" EM-26 and "IDLER SPROCKET" EM-26 in "Installation", "TIMING CHAIN".**



Disassembly

NEEM0099

1. Remove intake manifold and exhaust manifold. Refer to "OUTER COMPONENT PARTS" (EM-13).
2. Remove valve components.
3. Remove valve oil seal with a suitable tool.



Inspection

NEEM0100

CYLINDER HEAD DISTORTION

NEEM0100S01

Clean surface of cylinder head.
Use a reliable straightedge and feeler gauge to check the flatness of cylinder head surface.
Check along six positions shown in the figure.

Head surface flatness:

Standard Less than 0.03 mm (0.0012 in)

Limit 0.1 mm (0.004 in)

If beyond the specified limit, replace it or resurface it.

Resurfacing limit:

The limit of cylinder head resurfacing is determined by the cylinder block resurfacing.

Amount of cylinder head resurfacing is "A".

Amount of cylinder block resurfacing is "B".

The maximum limit:

A + B = 0.2 mm (0.008 in)

After resurfacing cylinder head, check that camshaft rotates freely by hand. If resistance is felt, cylinder head must be replaced.

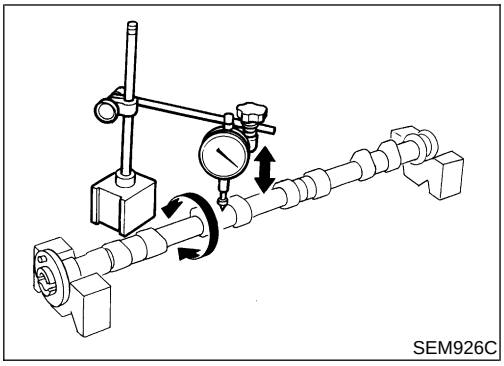
Nominal cylinder head height:

126.3 - 126.5 mm (4.972 - 4.980 in)

CAMSHAFT VISUAL CHECK

NEEM0100S02

Check camshaft for scratches, seizure and wear.


SEM926C

CAMSHAFT RUNOUT

NEEM0100S03

1. Measure camshaft runout at the center journal.

Runout (Total indicator reading):

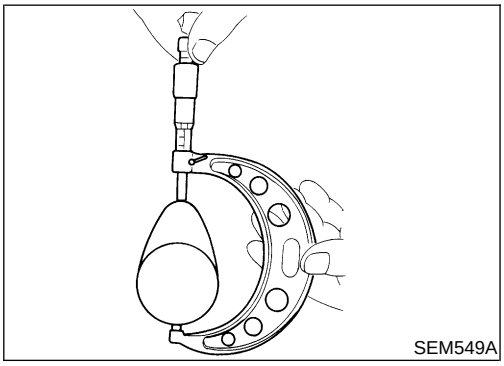
Standard:

Less than 0.02 mm (0.0008 in)

Limit:

0.04 mm (0.0016 in)

2. If it exceeds the limit, replace camshaft.


SEM549A

CAMSHAFT CAM HEIGHT

NEEM0100S04

1. Measure camshaft cam height.

Standard cam height:

Intake 42.505 - 42.695 mm (1.673 - 1.681 in)

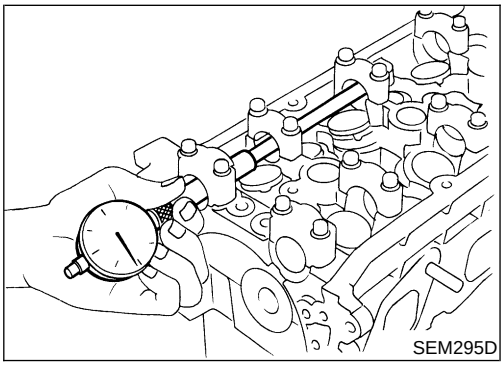
Exhaust 40.905 - 41.095 mm (1.610 - 1.618 in)

Cam height wear limit:

Intake & Exhaust

0.2 mm (0.008 in)

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


SEM295D

CAMSHAFT JOURNAL CLEARANCE

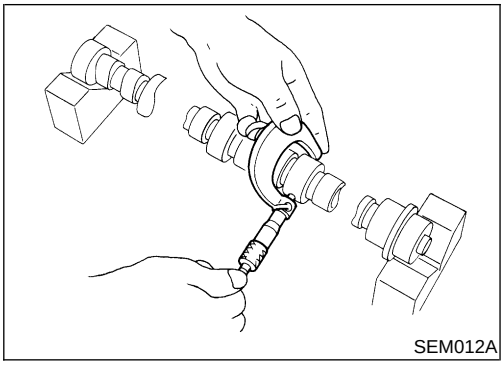
NEEM0100S05

1. Install camshaft bracket and tighten bolts to the specified torque.
2. Measure inner diameter of camshaft bearing.

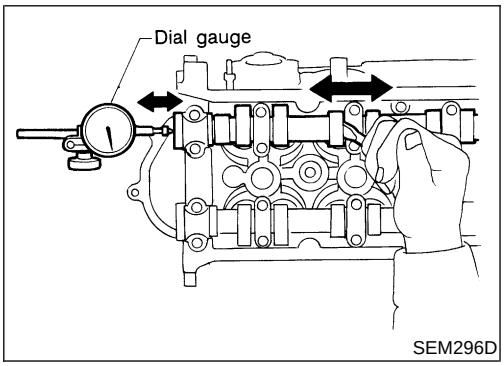
Standard inner diameter:

#1 to #5 journals

28.000 - 28.025 mm (1.1024 - 1.1033 in)


SEM012A

3. Measure outer diameter of camshaft journal.
   Standard outer diameter:
   #1 to #5 journals
   27.935 - 27.955 mm (1.0998 - 1.1006 in)
4. If clearance exceeds the limit, replace camshaft and/or cylinder head.
   Camshaft journal clearance:
   Standard 0.045 - 0.090 mm (0.0018 - 0.0035 in)
   Limit 0.12 mm (0.0047 in)

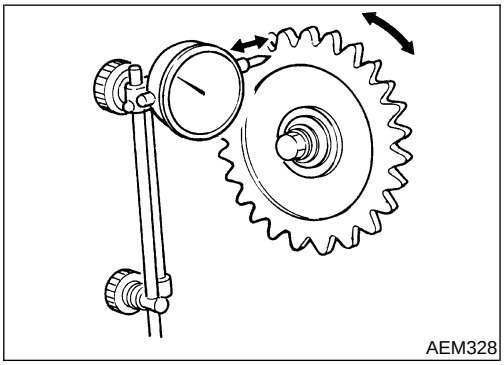


SEM296D

CAMSHAFT END PLAY

NEEM0100S06

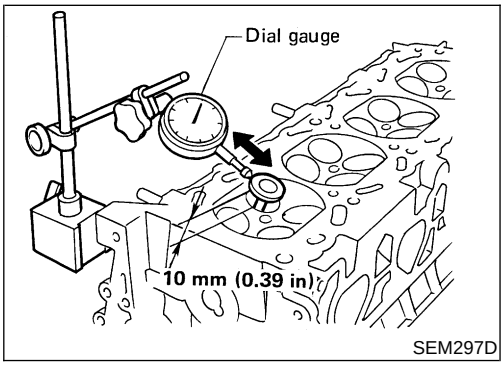
1. Install camshaft in cylinder head.
2. Measure camshaft end play.
   Camshaft end play:
   Standard
   0.070 - 0.148 mm (0.0028 - 0.0058 in)
   Limit
   0.2 mm (0.008 in)
3. If end play exceeds the limit, replace camshaft and remeasure camshaft end play.
4. If end play still exceeds the limit after replacing camshaft, replace cylinder head.


AEM328

CAMSHAFT SPROCKET RUNOUT

NEEM0100S07

1. Install sprocket on camshaft.
2. Measure camshaft sprocket runout.
   Runout (Total indicator reading):
   Limit 0.15 mm (0.0059 in)
3. If it exceeds the limit, replace camshaft sprocket.

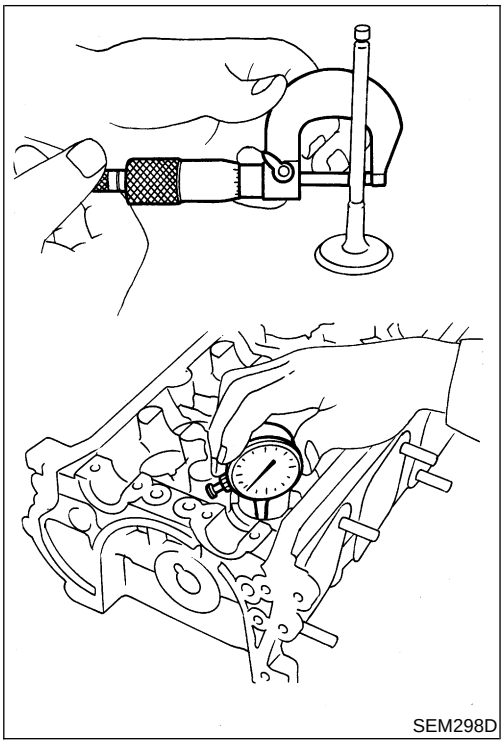


SEM297D

VALVE GUIDE CLEARANCE

NEEM0100S08

1. Measure valve deflection as shown in figure. (Valve and valve guide mostly wear in this direction.)
   Valve deflection limit (Dial gauge reading):
   Intake & Exhaust
   0.2 mm (0.008 in)


SEM298D

2. If it exceeds the limit, check valve to valve guide clearance.

a. Measure valve stem diameter and valve guide inner diameter.

b. Check that clearance is within specification.
Valve to valve guide clearance = Valve guide inner diameter - Valve stem diameter:

Unit: mm (in)

	Standard	Limit
Intake	0.020 - 0.053 (0.0008 - 0.0021)	0.08 (0.0031)
Exhaust	0.040 - 0.073 (0.0016 - 0.0029)	0.1 (0.004)

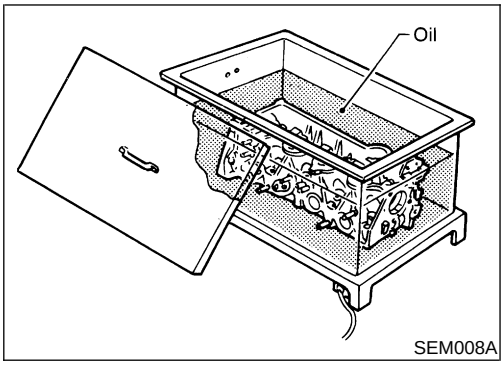
c. If it exceeds the limit, replace valve and remeasure clearance.

- If clearance still exceeds the limit after replacing valve, replace the valve guide.

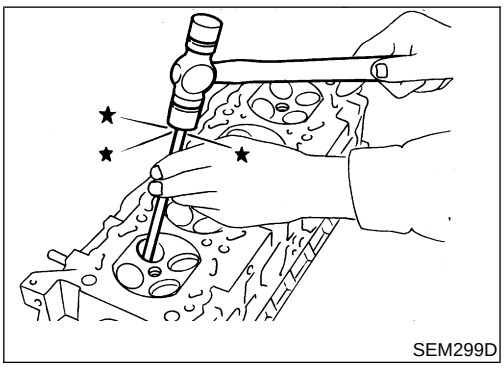
VALVE GUIDE REPLACEMENT

NEEM0100S09

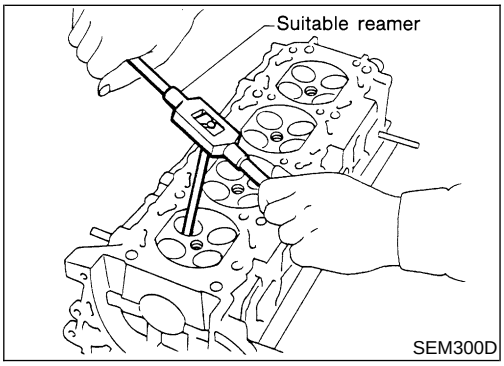
1. To remove valve guide, heat cylinder head to 120 to 140°C (248 to 284°F) by soaking in heated oil.



SEM008A

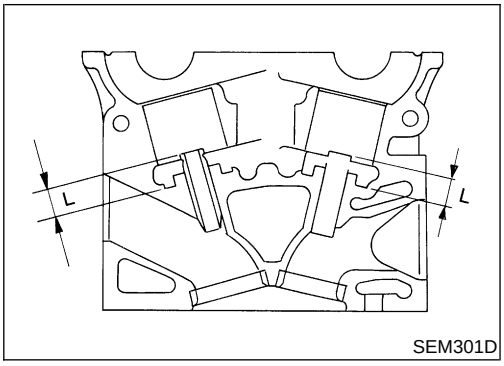

SEM299D

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



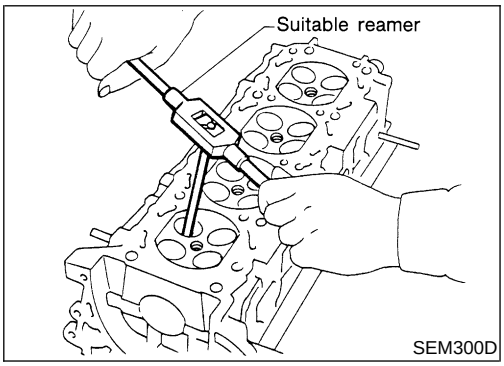
SEM300D

3. Ream cylinder head valve guide hole.
Valve guide hole diameter
(for service parts):
Intake & Exhaust
11.175 - 11.196 mm (0.4400 - 0.4408 in)



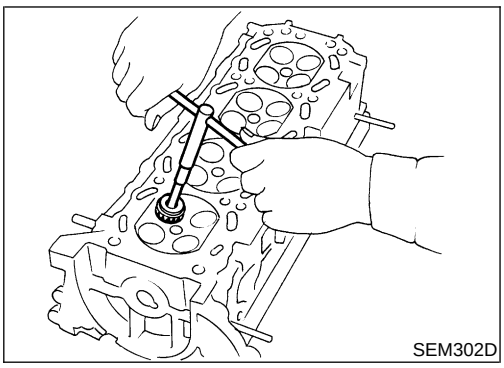
SEM301D

4. Heat cylinder head to 120 to 140°C (248 to 284°F) and press service valve guide onto cylinder head.
   Projection "L":
   13.3 - 13.9 mm (0.524 - 0.547 in)



SEM300D

5. Ream valve guide.
   Finished size:
   Intake & Exhaust
   7.000 - 7.018 mm (0.2756 - 0.2763 in)

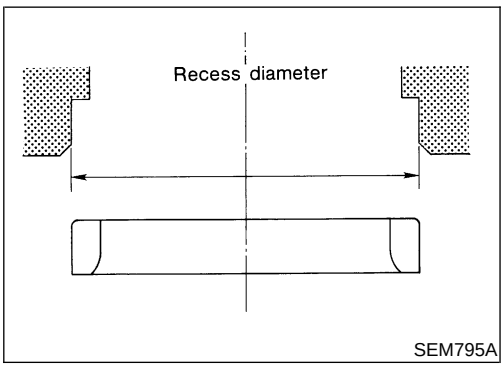

SEM302D

VALVE SEATS

NEEM0100S10

Check valve seats for pitting at contact surface. Resurface or replace if excessively worn.

- **Before repairing valve seats, check valve and valve guide for wear. If they have worn, replace them. Then correct valve seat.**
- **Use both hands to cut uniformly.**



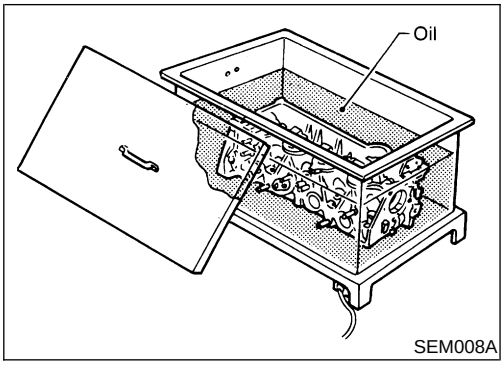
SEM795A

REPLACING VALVE SEAT FOR SERVICE PARTS

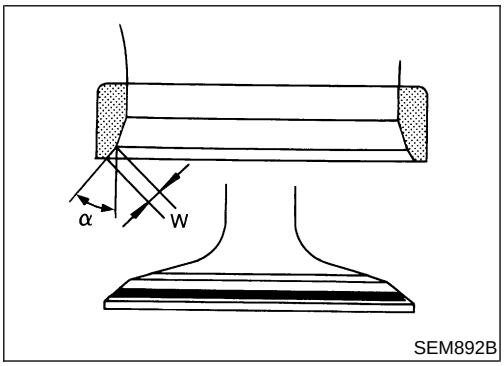
NEEM0100S11

1. Bore out old seat until it collapses. Boring should not continue beyond the bottom face of the seat recess in cylinder head. Set the machine depth stop to ensure this.
2. Ream cylinder head recess.
   Reaming bore for service valve seat
   Oversize [0.5 mm (0.020 in)]:
   Intake 38.000 - 38.016 mm (1.4961 - 1.4967 in)
   Exhaust 32.700 - 32.716 mm (1.2874 - 1.2880 in)

Use the valve guide center for reaming to ensure valve seat will have the correct fit.

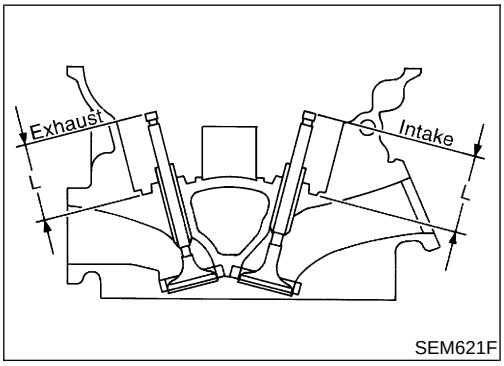


3. Heat cylinder head to 120 to 140°C (248 to 284°F).
4. Press fit valve seat until it seats on the bottom.



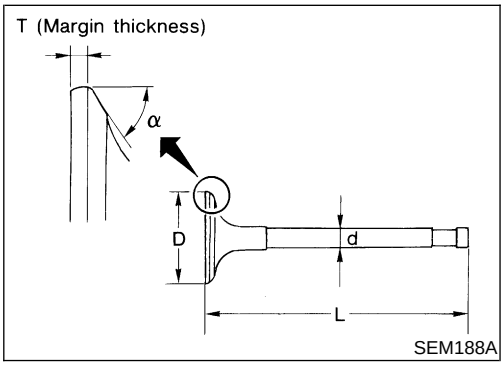
5. Cut or grind valve seat using suitable tool to the specified dimensions as shown in SDS.
6. After cutting, lap valve seat with abrasive compound.
7. Check valve seating condition.

Seat face angle "α":
45°15′ - 45°45′ deg.
Contacting width "W":
Intake
1.48 - 1.63 mm (0.0583 - 0.0642 in)
Exhaust
1.8 - 2.0 mm (0.071 - 0.079 in)



8. Use a depth gauge to measure the distance between the mounting surface of the cylinder head spring seat and the valve stem end. If the distance is shorter than specified, repeat step 5 above to adjust it. If it is longer, replace the valve seat with a new one.

Valve seat resurface limit "L":
Intake 42.02 - 42.52 mm (1.6543 - 1.6740 in)
Exhaust 42.03 - 42.53 mm (1.6547 - 1.6744 in)

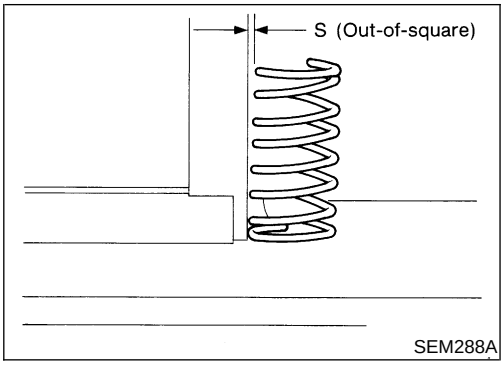


VALVE DIMENSIONS

NEEM0100S12

Check dimensions of each valve. For dimensions, refer to SDS (EM-58). When valve head has been worn down to 0.5 mm (0.020 in) in margin thickness, replace valve.

Grinding allowance for valve stem tip is 0.2 mm (0.008 in) or less.



SEM288A

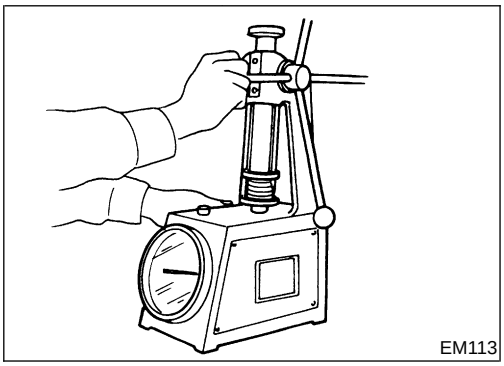
VALVE SPRING

NEEM0100S13

Squareness

NEEM0100S1301

1. Measure dimension "S".
   Out-of-square "S":
   Less than 2.2 mm (0.087 in)
2. If it exceeds the limit, replace spring.


EM113

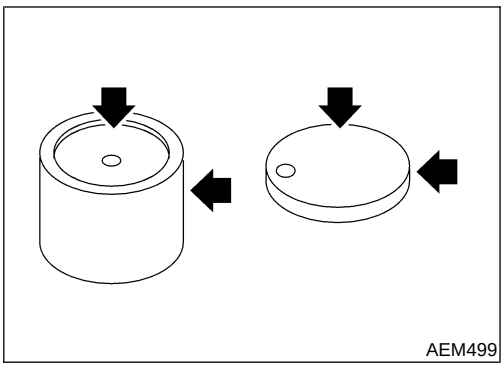
Pressure

NEEM0100S1302

Check valve spring pressure at specified spring height.

Pressure: N (kg, lb) at height mm (in)
Standard
418.0 (42.6, 93.9) at 29.17 (1.1484)
Limit
393.0 (40.1, 88.4) at 29.17 (1.1484)

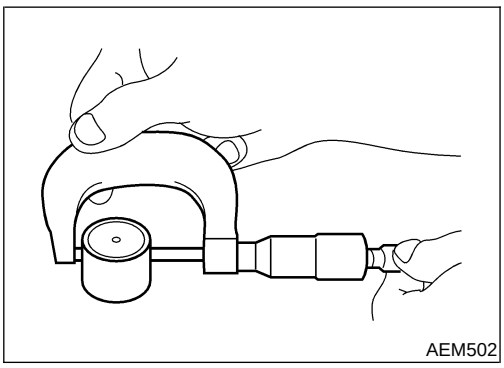
If it exceeds the limit, replace spring.


AEM499

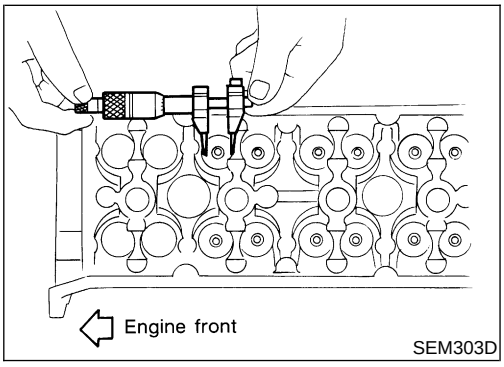
VALVE LIFTER AND VALVE SHIM

NEEM0100S14

1. Visually check contact and sliding surfaces for wear and scratches.


AEM502

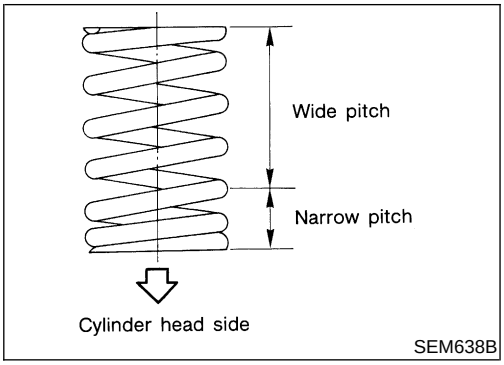
2. Check diameter of valve lifter and valve lifter guide bore.
   Valve lifter outer diameter:
   33.960 - 33.975 mm (1.3370 - 1.3376 in)



SEM303D

Lifter guide bore diameter:
34.000 - 34.021 mm (1.3386 - 1.3394 in)
Valve lifter to valve lifter guide clearance:
0.025 - 0.061 mm (0.0010 - 0.0024 in)

If it exceeds the standard diameter or clearance, replace valve lifter or cylinder head.



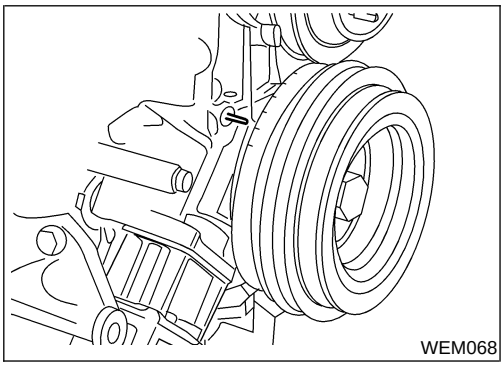
SEM638B

Assembly

NEEM0101

1. Install valve component parts.

- **Always use new valve oil seal. Refer to "OIL SEAL REPLACEMENT" (EM-28).**
- **Before installing valve oil seal, install valve spring seat.**
- **Install outer valve spring (uneven pitch type) with its narrow pitch side toward cylinder head side.**
- **After installing valve component parts, tap valve stem tip with plastic hammer to assure a proper fit.**


WEM068

Valve Clearance

NEEM0102

CHECKING

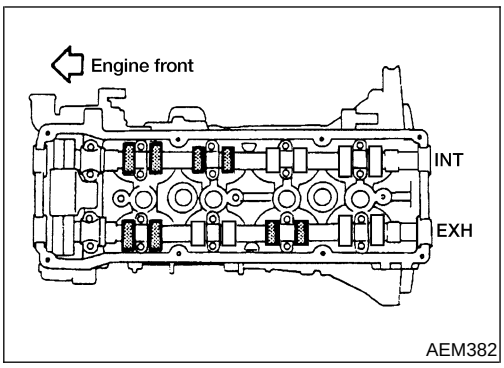
NEEM0102S01

Check valve clearance while engine is warm but not running.

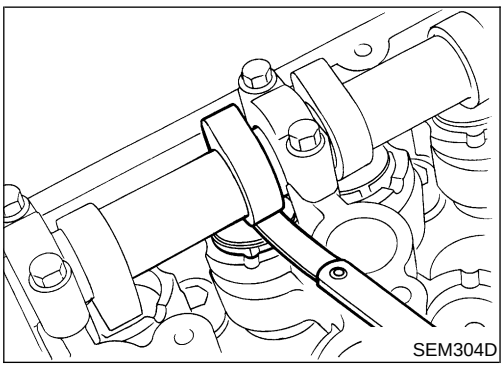
1. Remove rocker cover and all spark plugs.
2. Set No. 1 cylinder at TDC on its compression stroke.

- Align pointer with TDC mark on crankshaft pulley.
- Check that valve lifters on No. 1 cylinder are loose and valve lifters on No. 4 are tight.
  If not, turn crankshaft one revolution (360°) and align as above.

3. Check only those valves shown in the figure.



AEM382


SEM304D

4. Using a feeler gauge, measure clearance between valve lifter and camshaft.

- Record any valve clearance measurements which are out of specification. They will be used later to determine the required replacement adjusting shim.

Valve clearance (Hot):

Intake

0.31 - 0.39 mm (0.012 - 0.015 in)

Exhaust

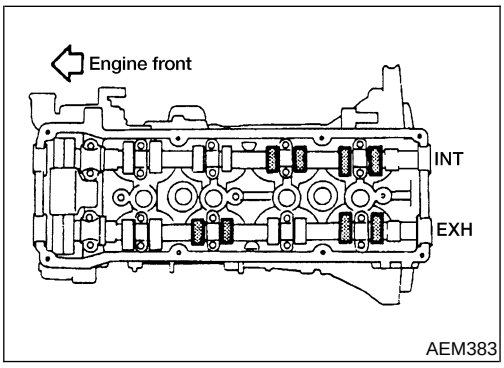
0.33 - 0.41 mm (0.013 - 0.016 in)

5. Turn crankshaft one revolution (360°) and align mark on crankshaft pulley with pointer.
6. Check those valves shown in the figure.

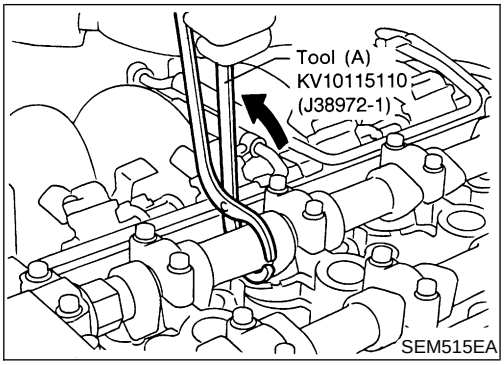
- Use the same procedure as mentioned in step 4.

7. If all valve clearances are within specification, install the following parts.

- Rocker cover
- All spark plugs



AEM383



ADJUSTING

NEEM0102S02

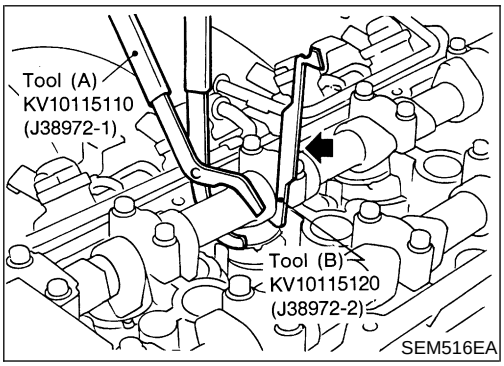
Adjust valve clearance while engine is cold.

1. Turn crankshaft to position cam lobe on camshaft of valve that must be adjusted upward.
2. Place Tool (A) around camshaft as shown in figure.
3. Rotate Tool (A) so that lifter is pushed down.

Before placing Tool (A), rotate notch toward center of cylinder head (See figure.), to simplify shim removal later.

CAUTION:

Be careful not to damage cam surface with Tool (A).

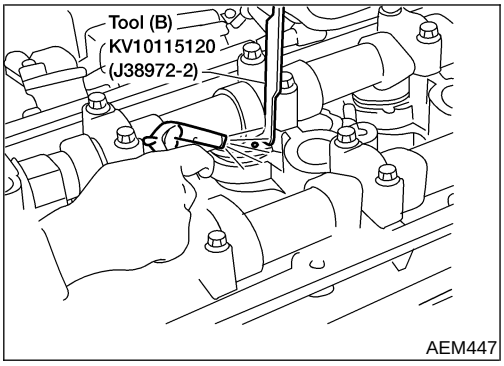


4. Place Tool (B) between camshaft and the edge of the valve lifter to retain valve lifter.

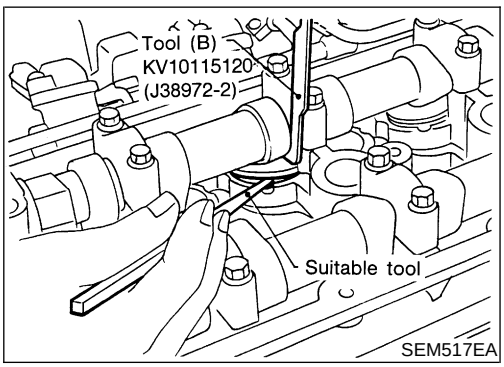
CAUTION:

- **Tool (B) must be placed as close to camshaft bracket as possible.**
- **Be careful not to damage cam surface with Tool (B).**

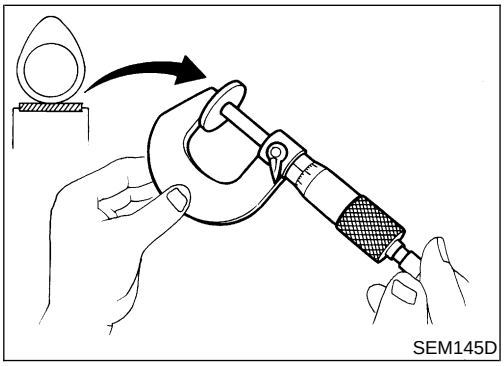
5. Remove Tool (A).



6. Rotate adjusting shim until hole is visible. Blow air into the hole to separate adjusting shim from valve lifter.



7. Remove adjusting shim using a small screwdriver and a magnetic finger.



8. Determine replacement adjusting shim size as follows.

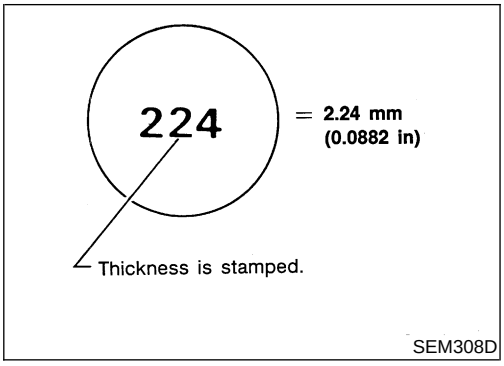
a. Using a micrometer determine thickness of removed shim.

b. Calculate thickness of new adjusting shim so valve clearance comes within specified values.

R = Thickness of removed shim
N = Thickness of new shim
M = Measured valve clearance

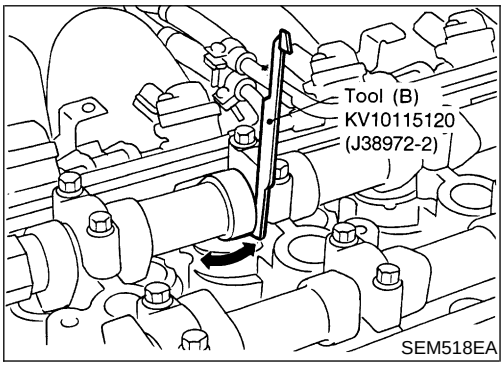
Intake & Exhaust:

N = R + [M − 0.37 mm (0.0146 in)]



Shims are available in thicknesses from 1.96 mm (0.0772 in) to 2.68 mm (0.1055 in), in steps of 0.02 mm (0.0008 in).

c. Select new shim with thickness as close as possible to calculated value.
Refer to SDS, EM-60.

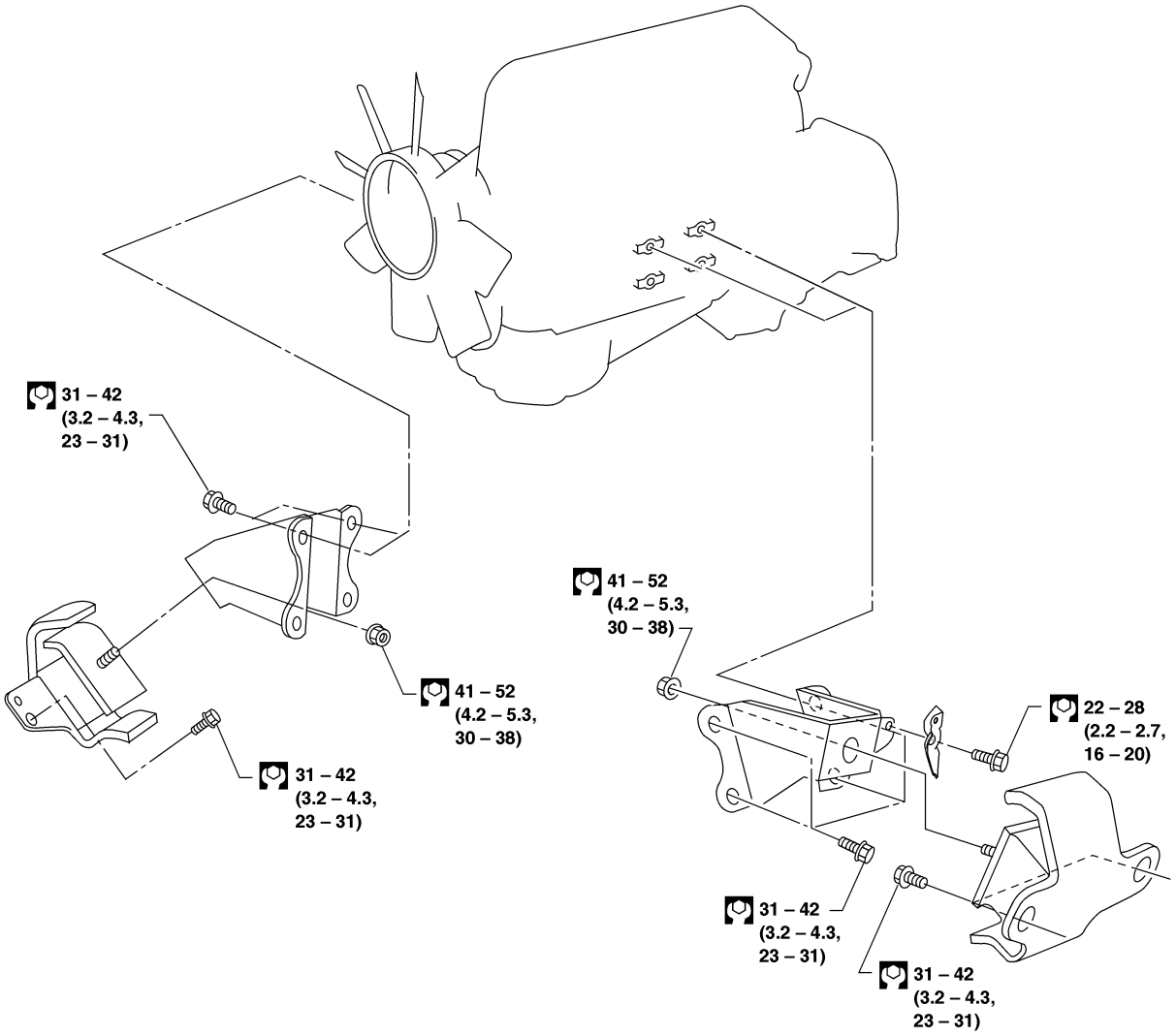


9. Install new shim using a suitable tool.
- **Install with the surface on which the thickness is stamped facing down.**
10. Place Tool (A) as mentioned in steps 2 and 3.
11. Remove Tool (B).
12. Remove Tool (A).
13. Recheck valve clearance.
Refer to "CHECKING" (EM-40).

Removal and Installation

NEEM0103

SEC. 112



: N·m (kg-m, ft-lb)

AEM462

WARNING:

- **Position vehicle on a flat and solid surface.**
- **Place chocks at front and back of rear wheels.**
- **Do not remove engine until exhaust system has completely cooled off.**
  Otherwise, you may burn yourself and/or fire may break out in fuel line.
- **Before disconnecting fuel hose, release fuel pressure. Refer to *EC-40*, ("Fuel Pressure Release", "BASIC SERVICE PROCEDURE").**
- **Be sure to hoist engine and transmission in a safe manner.**
- **For engines not equipped with engine slingers, attach proper slingers and bolts described in PARTS CATALOG.**

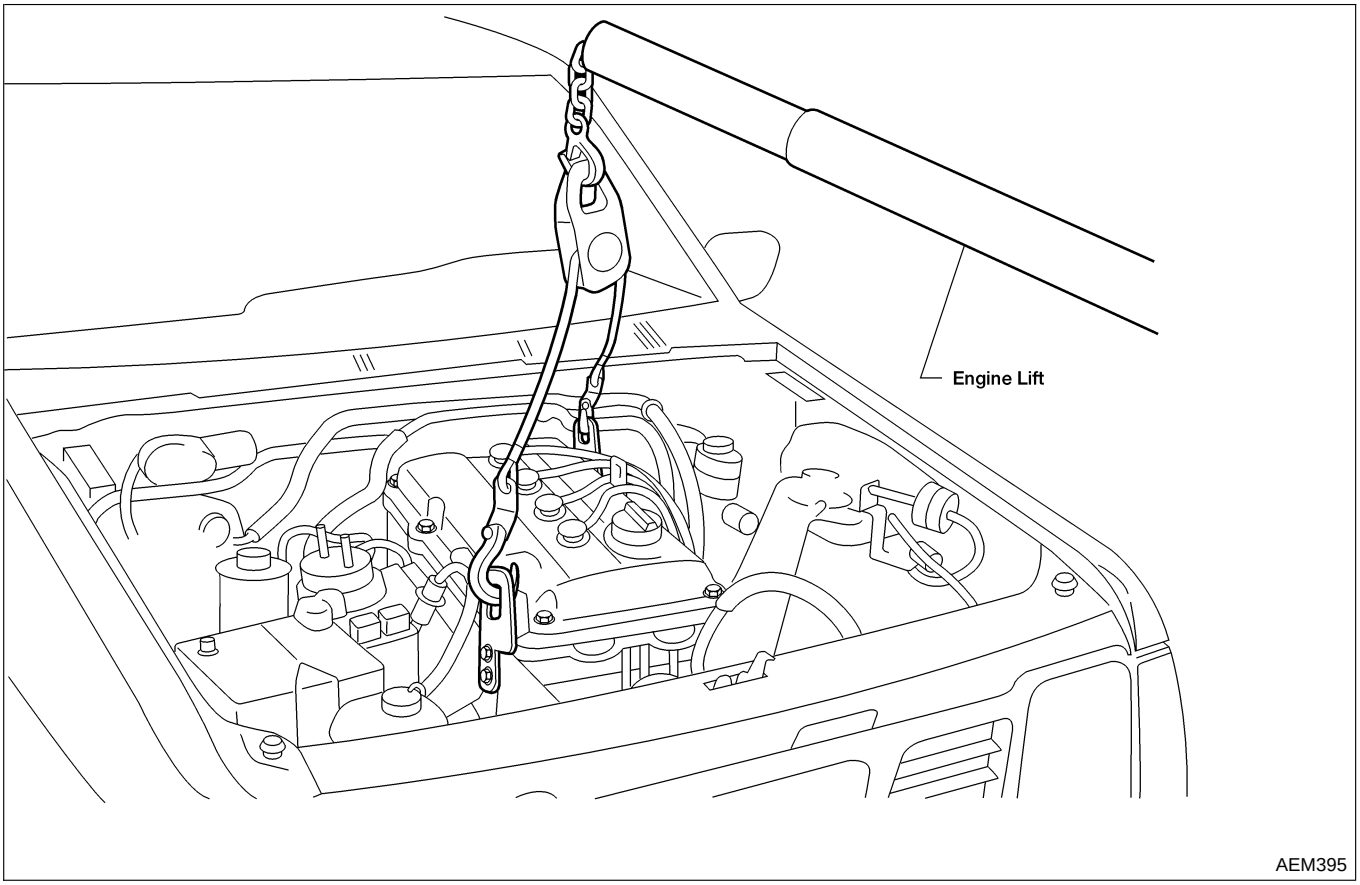
CAUTION:

- **When lifting engine, be sure to clear surrounding parts. Take special care near accelerator wire casing, brake lines and brake master cylinder.**
- **In hoisting the engine, always use engine slingers in a safe manner.**
- **Before separating engine and transmission, remove the crankshaft position sensor (OBD) from the assembly.**
- **Always take extra care not to damage edge of crankshaft position sensor (OBD) or ring gear teeth.**

REMOVAL

NEEM0103S01

1. Drain coolant from engine block and radiator. Refer to ***MA-18***, ("Changing Engine Coolant", "ENGINE MAINTENANCE").
2. Release fuel pressure. Refer to ***EC-40***, ("Fuel Pressure Release", "BASIC SERVICE PROCEDURE").
3. Remove negative battery cable.
4. Remove hood. Refer to ***BT-12***.
5. Remove air cleaner.
6. Remove power steering drive belt, generator drive belt and A/C compressor drive belt.
7. Remove radiator. Refer to ***LC-14***, ("Radiator", "ENGINE COOLING SYSTEM").
8. Remove exhaust manifold heat shield.
9. Disconnect exhaust system from #1 catalytic converter.
10. Remove A/C compressor from bracket. Refer to ***HA-77***, ("Compressor Mounting", "SERVICE PROCEDURES").
11. Disconnect accelerator wire, vacuum hoses, electrical connectors, heater hoses and vacuum booster hose.
12. Remove four power steering pump bolts.
13. Remove transmission Refer to ***MT-10*** or ***AT-62***, ("Removal", "REMOVAL AND INSTALLATION").
14. Remove LH and RH engine mounts.
15. Remove engine.



INSTALLATION

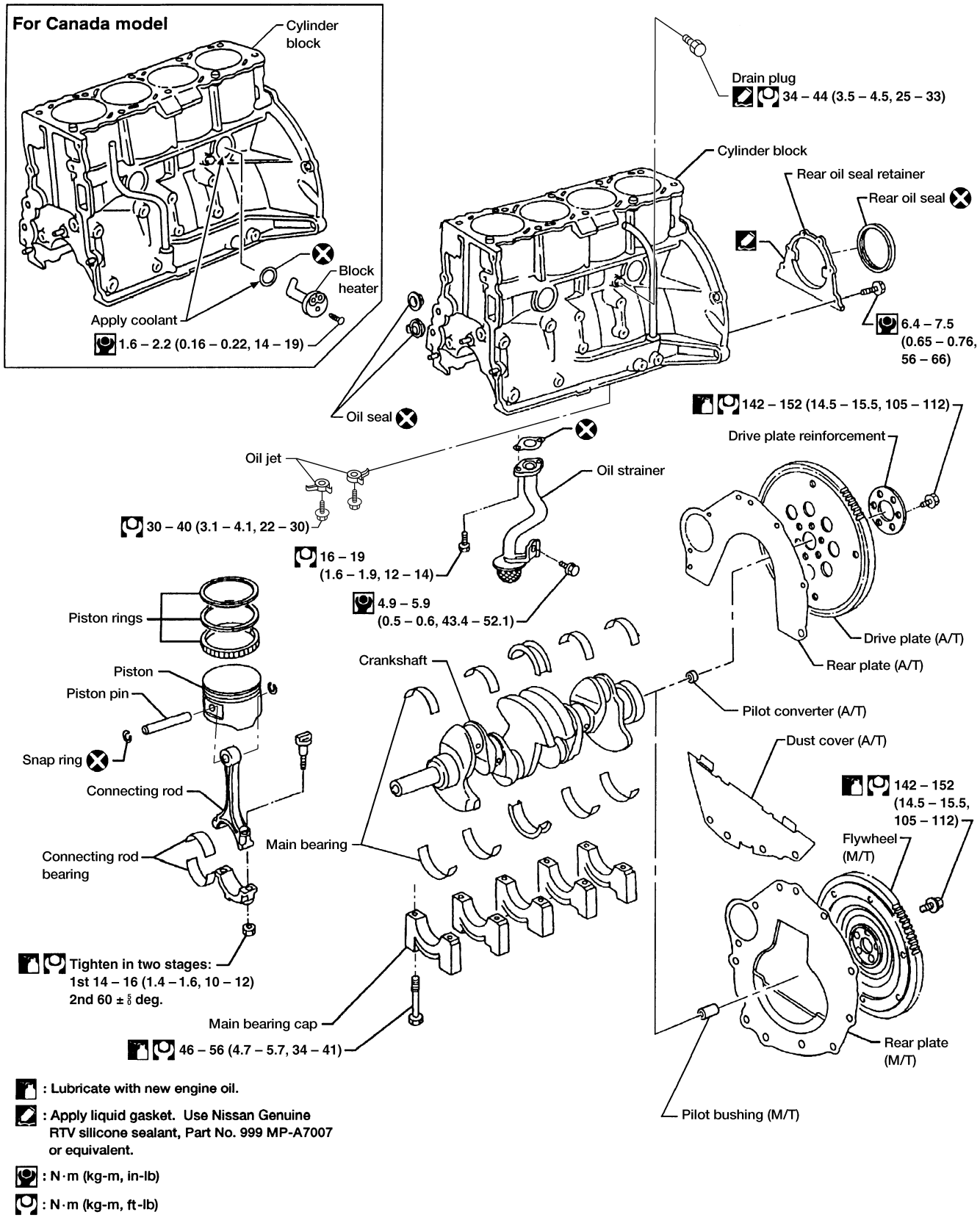
NEEM0103S02

- Install in reverse order of removal.

Components

NEEM0104

SEC. 110 • 120 • 135 • 150 • 210



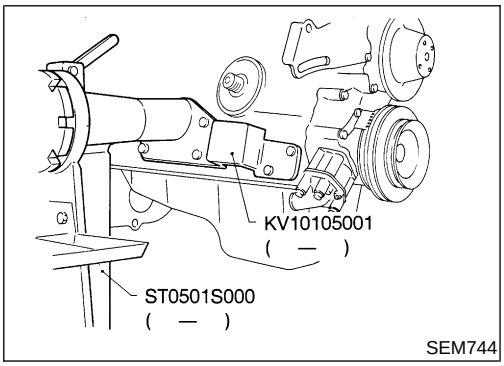
AEM461

Removal and Installation

NEEM0105

CAUTION:

- **When installing sliding parts (bearings, pistons, etc.), lubricate contacting surfaces with new engine oil.**
- **Place removed parts such as bearings and bearing caps in their proper order and direction.**
- **When installing connecting rod nuts and main bearing cap bolts, apply new engine oil to threads and seating surfaces.**
- **Do not allow any magnetic materials to contact the ring gear teeth of flywheel or drive plate.**



SEM744

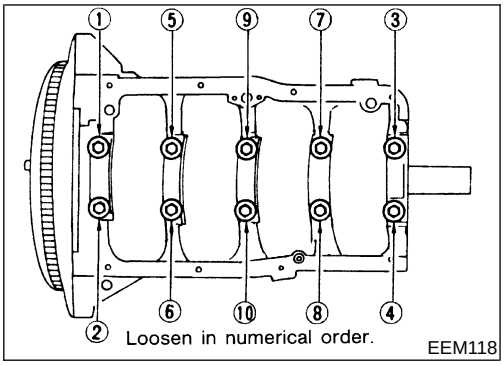
Disassembly

NEEM0106

PISTON AND CRANKSHAFT

NEEM0106S01

1. Place engine on a work stand.
2. Drain coolant and oil.
3. Remove oil pan.
4. Remove timing chain. Refer to “Removal” in “TIMING CHAIN” (EM-22).
5. Remove water pump.
6. Remove cylinder head.
7. Remove pistons with connecting rods.



EEM118

8. Remove bearing caps and crankshaft.

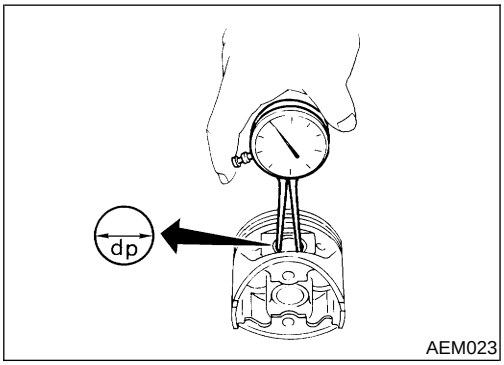
- **Before removing bearing caps, measure crankshaft end play. Refer to EM-55.**
- **Bolts should be loosened in two or three steps.**

Inspection

NEEM0107

PISTON AND PISTON PIN CLEARANCE

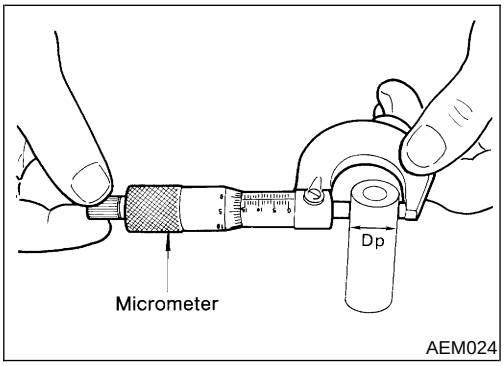
NEEM0107S01



AEM023

1. Measure inner diameter of piston pin hole “dp”.

Standard diameter “dp”:
20.993 - 21.005 mm (0.8265 - 0.8270 in)



AEM024

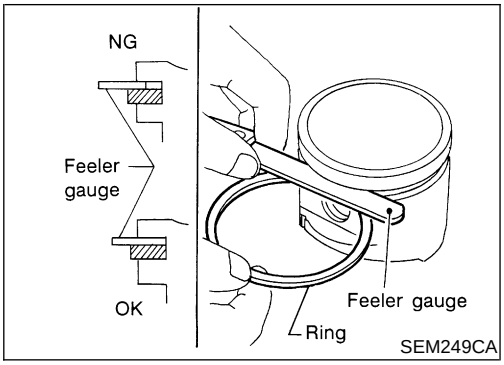
2. Measure outer diameter of piston pin “Dp”.

Standard diameter “Dp”:
20.989 - 21.001 mm (0.8263 - 0.8268 in)

3. Calculate piston pin clearance.

dp − Dp = −0.002 - 0.01 mm (−0.0001 - 0.0004 in)

If it exceeds the above value, replace piston assembly with pin.



PISTON RING SIDE CLEARANCE

NEEM0107S02

Side clearance:

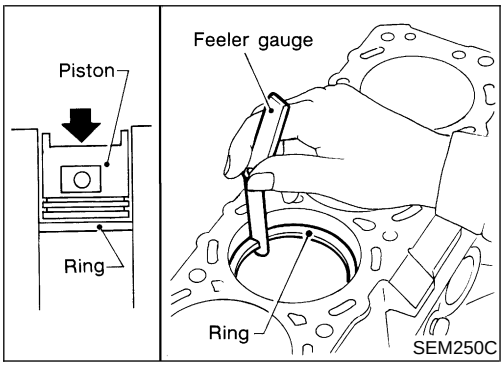
Top ring 0.04 - 0.08 mm (0.0016 - 0.0031 in)

2nd ring 0.03 - 0.07 mm (0.0012 - 0.0028 in)

Max. limit of side clearance:

0.1 mm (0.004 in)

If out of specification, replace piston ring.
If clearance exceeds maximum limit with new ring, replace piston.



PISTON RING END GAP

NEEM0107S03

End gap:

Top ring

0.28 - 0.52 mm (0.0110 - 0.0205 in)

2nd ring

0.45 - 0.69 mm (0.0177 - 0.0272 in)

(R or T is punched on the ring.)

0.55 - 0.70 mm (0.0217 - 0.0276 in)

(N is punched on the ring.)

Oil ring

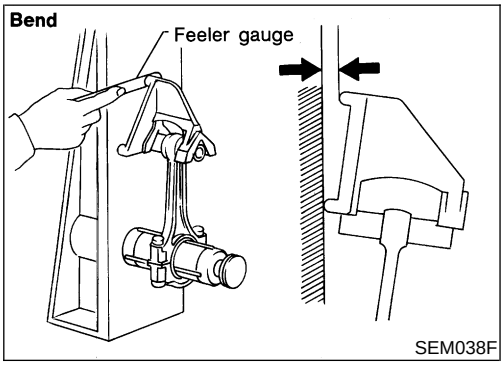
0.20 - 0.69 mm (0.0079 - 0.0272 in)

Max. limit of ring gap:

Refer to SDS, EM-64.

If out of specification, replace piston ring. If gap exceeds maximum limit with a new ring, rebore cylinder and use oversized piston and piston rings. Refer to SDS, EM-64.

- When replacing the piston, check cylinder block surface for scratches or seizure. If scratches or seizure are found, hone or replace the cylinder block.



CONNECTING ROD BEND AND TORSION

NEEM0107S04

Bend:

Limit 0.15 mm (0.0059 in)

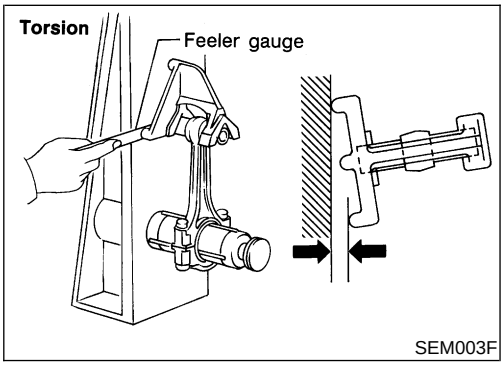
per 100 mm (3.94 in) length

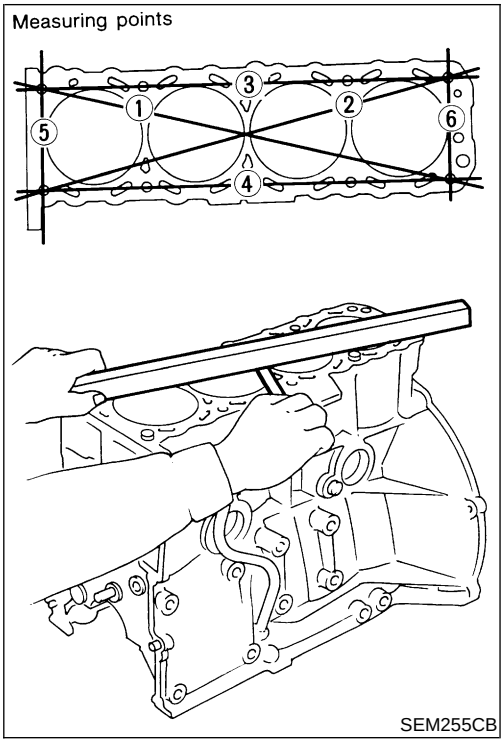
Torsion:

Limit 0.30 mm (0.0118 in)

per 100 mm (3.94 in) length

If it exceeds the limit, replace connecting rod assembly.





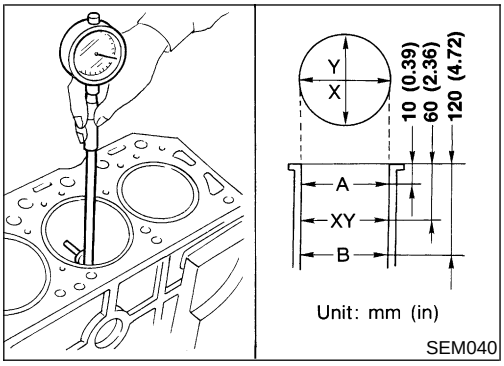
CYLINDER BLOCK DISTORTION AND WEAR

NEEM0107S05

1. Clean upper face of cylinder block.
   Use a reliable straightedge and feeler gauge to check the flatness of cylinder block surface. Check along six positions shown in figure.
   Limit:
   0.1 mm (0.004 in)
2. If out of specification, resurface it.
   The limit for cylinder block resurfacing is determined by cylinder head resurfacing.

Amount of cylinder head resurfacing is "A"
Amount of cylinder block resurfacing is "B"
The maximum limit is as follows:
A + B = 0.2 mm (0.008 in)
Nominal cylinder block height from crankshaft center:
246.95 - 247.05 mm (9.7224 - 9.7264 in)

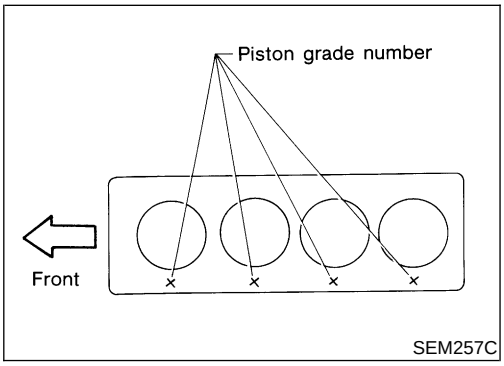
3. If necessary, replace cylinder block.



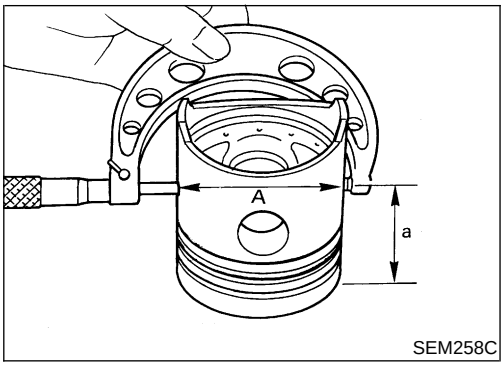
PISTON-TO-BORE CLEARANCE

NEEM0107S06

1. Using a bore gauge, measure cylinder bore for wear, out-of-round and taper.
   Standard inner diameter:
   Refer to SDS, EM-62.
   Wear limit: 0.2 mm (0.008 in)
   Out-of-round (X − Y) standard: 0.015 mm (0.0006 in)
   Taper (A − B) standard: 0.010 mm (0.0004 in)
   If it exceeds the limit, rebore all cylinders. Replace cylinder block if necessary.
2. Check for scratches and seizure. If seizure is found, hone it.



- **If cylinder block and piston are replaced, match piston grade with grade number on cylinder block upper surface.**



3. Measure piston skirt diameter.
   Piston diameter "A":
   Refer to SDS, EM-64.
   Measuring point "a" (Distance from the top):
   Approximately 48 mm (1.89 in)
4. Check that piston-to-bore clearance is within specification.
   Piston-to-bore clearance "B":
   0.020 - 0.040 mm (0.0008 - 0.0016 in)
5. Determine piston oversize according to amount of cylinder wear.

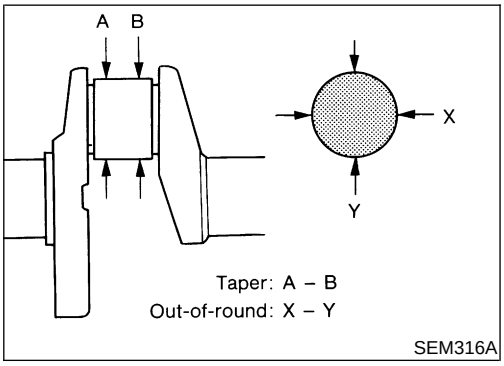
Oversize pistons are available for service. Refer to SDS, EM-64.

6. Cylinder bore size is determined by adding piston-to-bore clearance to piston diameter "A".
   Rebored size calculation:
   D = A + B − C
   where,
   D: Bored diameter
   A: Piston diameter as measured
   B: Piston-to-bore clearance
   C: Honing allowance 0.02 mm (0.0008 in)
7. Install main bearing caps and tighten bolts to the specified torque. This will prevent distortion of cylinder bores.
8. Cut cylinder bores.

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

9. Hone cylinders to obtain specified piston-to-bore clearance.
10. Measure finished cylinder bore for out-of-round and taper.

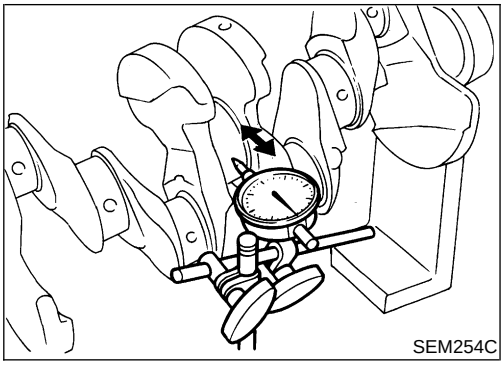
- **Measurement should be done after cylinder bore cools down.**



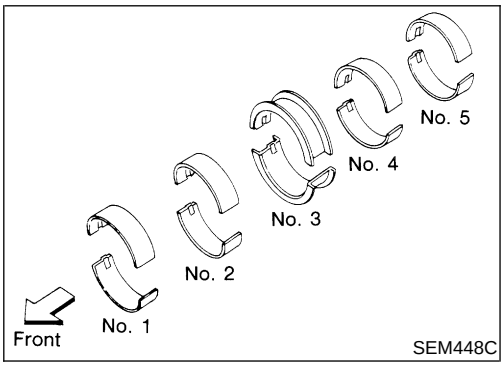
CRANKSHAFT

NEEM0107S07

1. Check crankshaft main and pin journals for score, wear or cracks.
2. With a micrometer, measure journals for taper and out-of-round.
   Out-of-round (X − Y):
   Main journal Less than 0.01 mm (0.0004 in)
   Crank pin Less than 0.005 mm (0.0002 in)
   Taper (A − B):
   Main journal Less than 0.01 mm (0.0004 in)
   Crank pin Less than 0.005 mm (0.0002 in)


SEM254C

3. Measure crankshaft runout.
   Runout (Total indicator reading):
   Less than 0.10 mm (0.0039 in)



SEM448C

BEARING CLEARANCE

NEEM0107S08

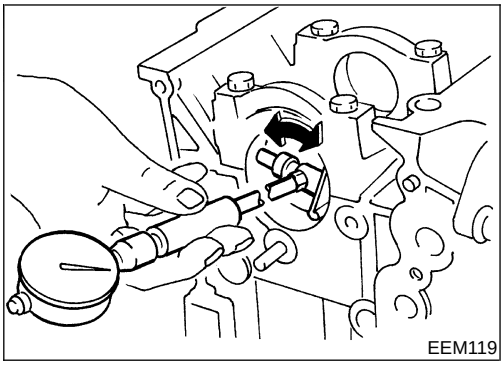
- Use Method A or Method B. Method A is preferred because it is more accurate.

Method A (Using bore gauge and micrometer)

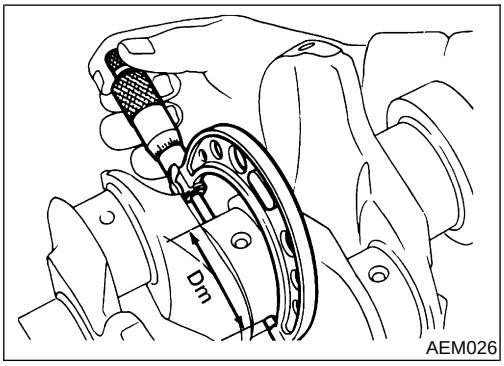
Main bearing

NEEM0107S0801

1. Set main bearings in their proper positions on cylinder block and main bearing cap.

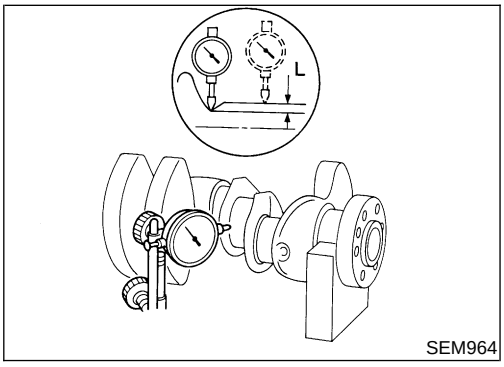

EEM119

2. Install main bearing cap to cylinder block.
- **Tighten all bolts in correct order in two or three stages. Refer to EM-46 and EM-55.**
3. Measure inner diameter "A" of each main bearing.



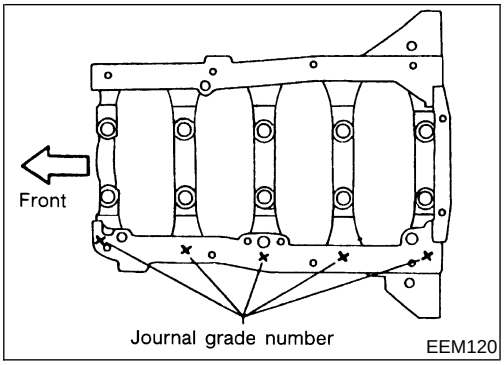
AEM026

4. Measure outer diameter "Dm" of each crankshaft main journal.
5. Calculate main bearing clearance.
   Main bearing clearance = A − Dm
   Standard:
   0.020 - 0.047 mm (0.0008 - 0.0019 in)
   Limit:
   0.1 mm (0.004 in)
6. If it exceeds the limit, replace bearing.
7. If clearance cannot be adjusted within the standard of any bearing, grind crankshaft journal and use undersized bearing.



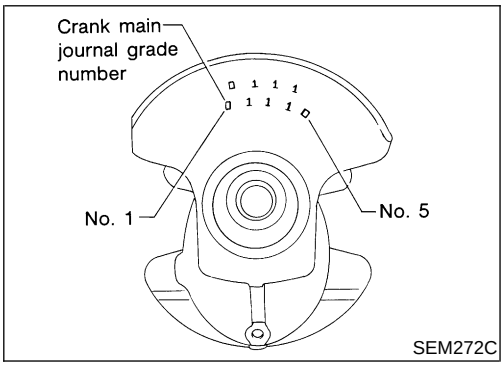
SEM964

a. **When grinding crankshaft journal, confirm that "L" dimension in fillet roll is more than the specified limit.**
   "L": 0.1 mm (0.004 in)
b. **Refer to SDS EM-65 & EM-66 for grinding crankshaft and available service parts.**



8. If crankshaft is reused, measure main bearing clearance and select thickness of main bearing.
   If crankshaft or cylinder block is replaced, select thickness of main bearings as follows:

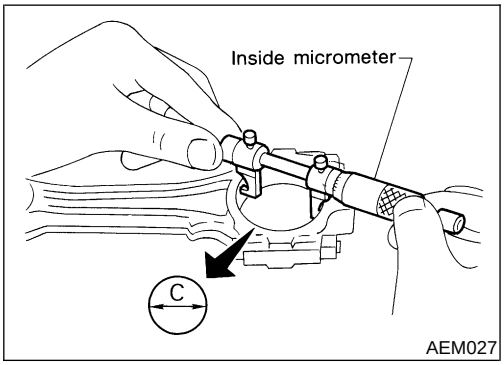
a. Grade number of each cylinder block main journal is punched on the respective cylinder block. These numbers are punched in either Arabic or Roman numerals.



b. Grade number of each crankshaft main journal is punched on crankshaft. These numbers are punched in either Arabic or Roman numerals.

c. Select main bearing with suitable thickness according to the following example or table.
   For example:
   Main journal grade number: 1
   Crankshaft journal grade number: 2
   Main bearing grade number = 1 + 2 = 3 (Yellow)
   Main bearing grade number and identification color:

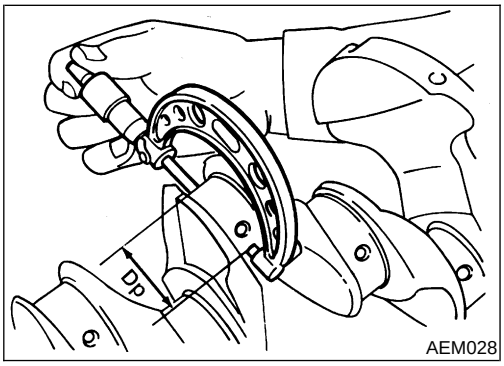
		Main journal grade number		
		0	1	2
Crankshaft journal grade number	0	0 (Black)	1 (Brown)	2 (Green)
	1 or I	1 (Brown)	2 (Green)	3 (Yellow)
	2 or II	2 (Green)	3 (Yellow)	4 (Blue)



Connecting Rod Bearing (Big end)

NEEM0107S0802

1. Install connecting rod bearing to connecting rod and cap.
2. Install connecting rod cap to connecting rod.
- **Tighten bolts to the specified torque.**
3. Measure inner diameter "C" of each bearing.



4. Measure outer diameter "Dp" of each crankshaft pin journal.
5. Calculate connecting rod bearing clearance.

Connecting rod bearing clearance = C − Dp:

Standard

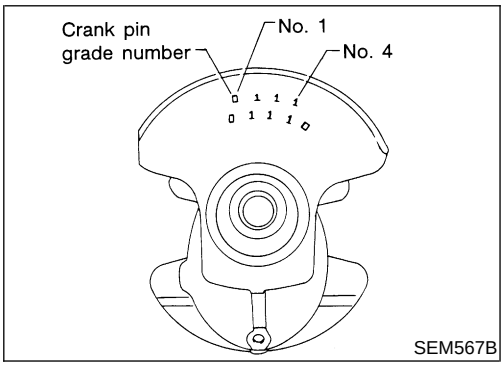
0.010 - 0.035 mm (0.0004 - 0.0014 in)

Limit

0.09 mm (0.0035 in)

6. If it exceeds the limit, replace bearing.
7. If clearance cannot be adjusted within the standard of any bearing, grind crankshaft journal and use undersized bearing.

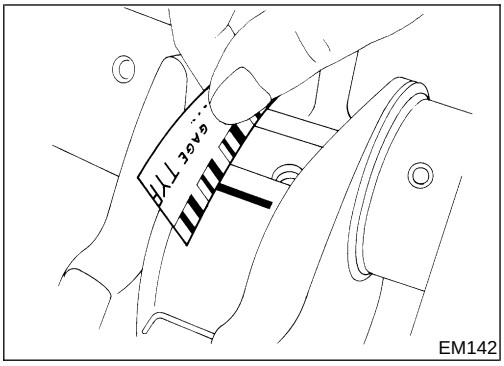
Refer to step 5 of "BEARING CLEARANCE", EM-51.



8. If crankshaft is replaced, select connecting rod bearing according to the following table.

Connecting rod bearing grade number:
These numbers are punched in either Arabic or Roman numerals.

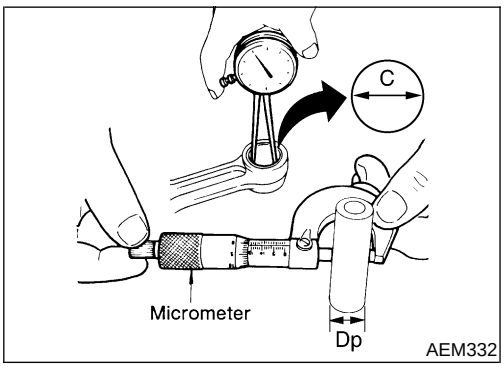
Crank pin grade number	Connecting rod bearing grade number
0	0
1 or I	1
2 or II	2



Method B (Using plastigage)

CAUTION:

- **Do not turn crankshaft or connecting rod while plastigage is being inserted.**
- **When bearing clearance exceeds the specified limit, ensure that the proper bearing has been installed. Then if excessive bearing clearance exists, use a thicker main bearing or undersized bearing so that the specified bearing clearance is obtained.**



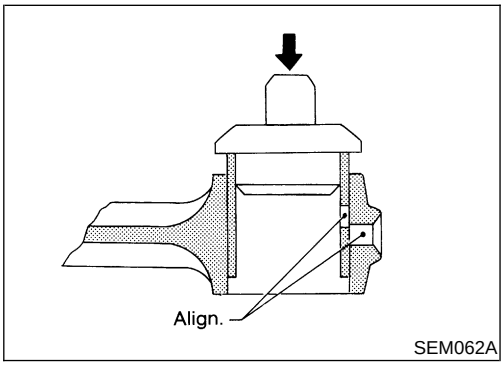
CONNECTING ROD BUSHING CLEARANCE (SMALL END)

NEEM0107S09

1. Measure inner diameter "C" of bushing.
2. Measure outer diameter "Dp" of piston pin.
3. Calculate connecting rod bushing clearance.

C − Dp =
0.005 - 0.017 mm (0.0002 - 0.0007 in) (Standard)
0.023 mm (0.0009 in) (Limit)

If out of specification, replace connecting rod assembly and/or piston set with pin.



REPLACEMENT OF CONNECTING ROD BUSHING (SMALL END)

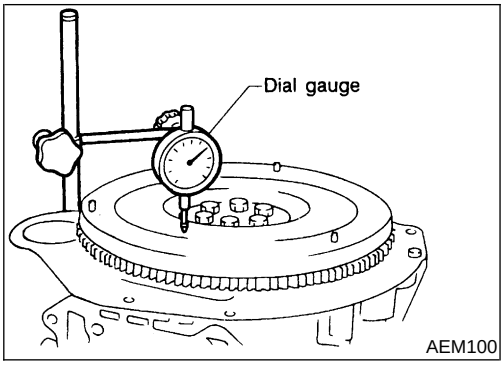
NEEM0107S10

1. Drive in small end bushing until it is flush with end surface of rod.

Be sure to align the oil holes.

2. Ream the bushing until clearance with piston pin is within specification.

Clearance between connecting rod bushing and piston pin:
0.005 - 0.017 mm (0.0002 - 0.0007 in)



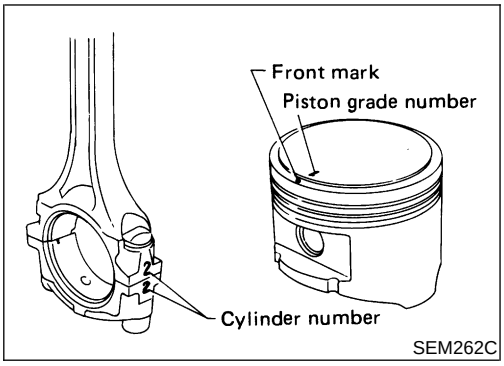
FLYWHEEL/DRIVE PLATE RUNOUT

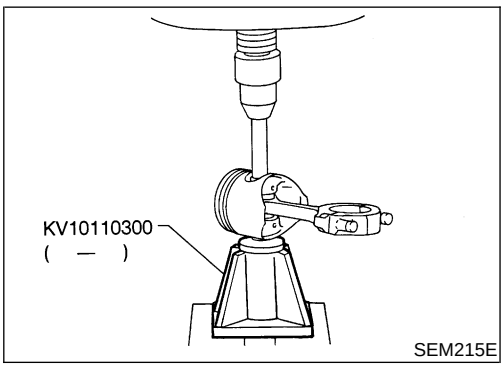
NEEM0107S11

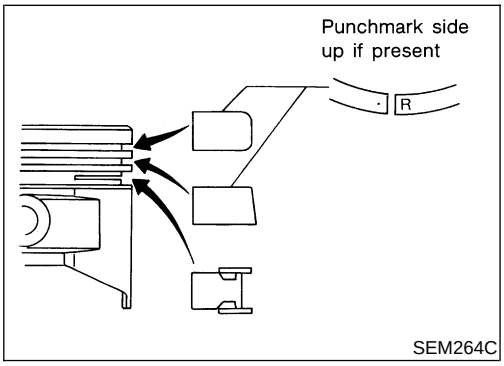
Runout (Total indicator reading):
Flywheel (M/T model)
Less than 0.15 mm (0.006 in)
Drive plate (A/T model)
Less than 0.15 mm (0.006 in)

CAUTION:

- **Be careful not to damage the ring gear teeth.**
- **Check the drive plate for deformation and cracks.**
- **Do not allow any magnetic materials to contact the ring gear teeth.**
- **Do not resurface the flywheel. Replace as necessary.**







Assembly

NEEM0108

PISTON

NEEM0108S01

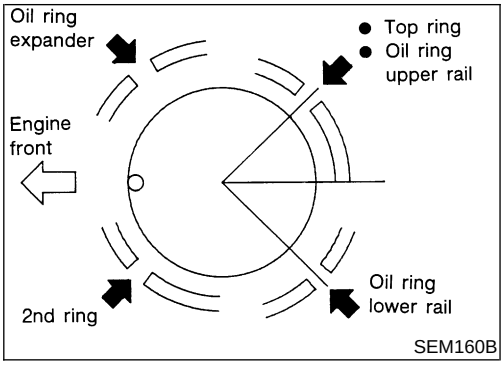
1. Heat piston to 60 to 70°C (140 to 158°F) and assemble piston, piston pin and connecting rod.

- **Align the direction of piston and connecting rod.**
- **Numbers stamped on connecting rod and cap correspond to each cylinder.**
- **After assembly, make sure connecting rod swings smoothly.**

2. Set piston rings as shown.

CAUTION:

- **When piston rings are not replaced, make sure that piston rings are mounted in their original positions.**
- **When piston rings are being replaced and no punchmark is present, piston rings can be mounted with either side up.**



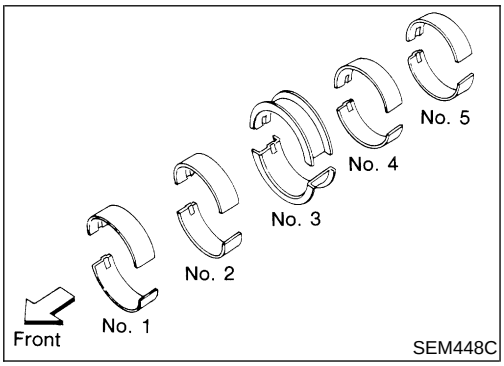
3. Align piston rings so that end gaps are positioned as shown.

CRANKSHAFT

NEEM0108S02

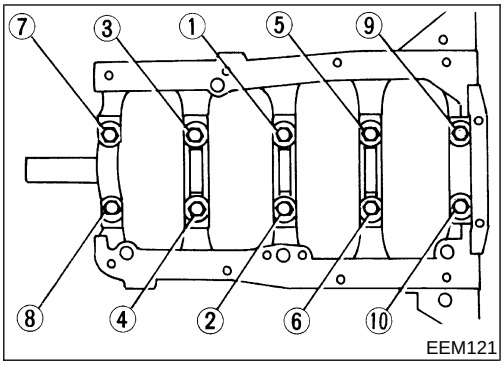
1. Set main bearings in their proper positions on cylinder block and main bearing caps.

- **Confirm that correct main bearings are used. Refer to EM-51.**
- **Apply new engine oil to bearing surfaces.**



2. Install crankshaft and main bearing caps and tighten bolts to the specified torque. Refer to EM-46.

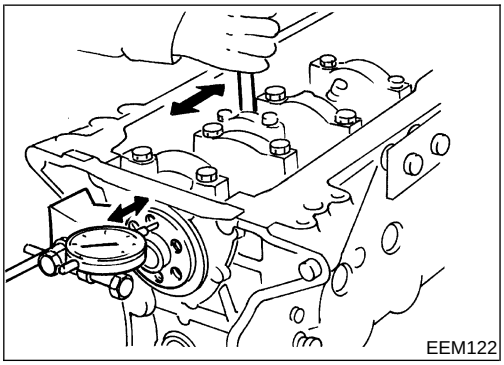
- **Apply new engine oil to the bolt threads and seat surface.**
- **Prior to tightening bearing cap bolts, place bearing cap in its proper position by shifting crankshaft in the axial direction.**
- **Tighten bearing cap bolts gradually in two or three stages. Start with center bearing and move outward as shown in figure.**
- **After securing bearing cap bolts, make sure crankshaft turns smoothly by hand.**



3. Measure crankshaft end play.

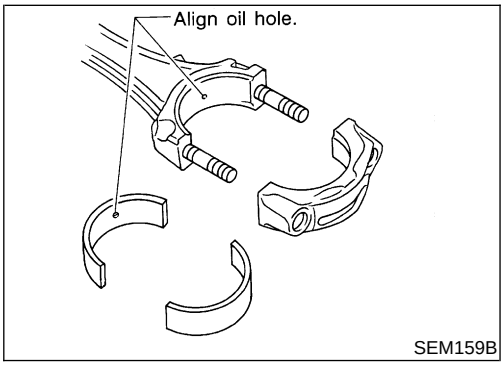
Crankshaft end play:
Standard
0.05 - 0.18 mm (0.0020 - 0.0071 in)
Limit
0.3 mm (0.012 in)

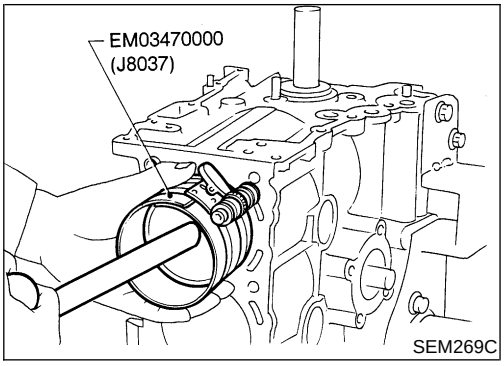
If beyond the limit, replace No. 3 bearing with a new one.



4. Install connecting rod bearings in connecting rods and connecting rod caps.

- **Confirm that correct bearings are used. Refer to EM-52.**
- **Install bearings so that oil hole in connecting rod aligns with oil hole of bearing.**
- **Apply new engine oil to bearing surfaces, bolt threads and seating surfaces.**

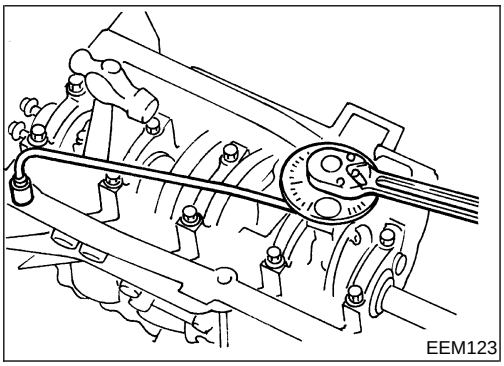




5. Install pistons with connecting rods.

a. Install them into corresponding cylinders with Tool.

- **Arrange so that front mark on piston head faces toward front of engine.**
- **Make sure connecting rod does not scratch cylinder wall.**
- **Make sure connecting rod bolts do not scratch crankshaft journals.**
- **Apply new engine oil to piston rings and sliding surface of piston.**



b. Install connecting rod bearing caps.
Tighten connecting rod bearing cap nuts using the following procedure.

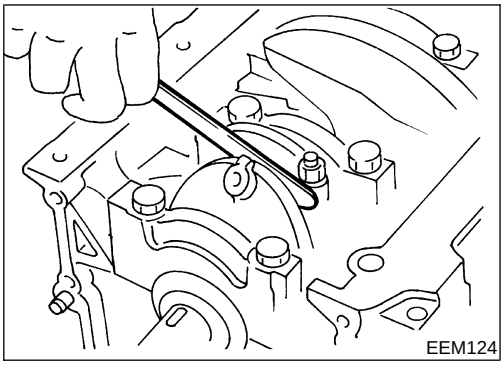
Connecting rod bearing nut:

(1) Tighten to 14 - 16 N·m

(1.4 - 1.6 kg-m, 10 - 12 ft-lb).

(2) Tighten bolts $60^{+5}/_{-0}$ degrees clockwise with an angle wrench.

If an angle wrench is not available, tighten them to 38 - 44 N·m (3.9 - 4.5 kg-m, 28 - 33 ft-lb).



6. Measure connecting rod side clearance.

Connecting rod side clearance:

Standard

0.2 - 0.4 mm (0.008 - 0.016 in)

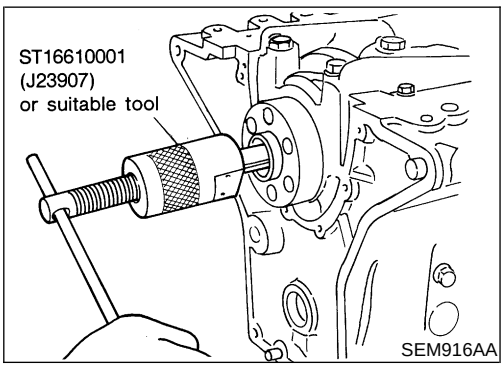
Limit

0.6 mm (0.024 in)

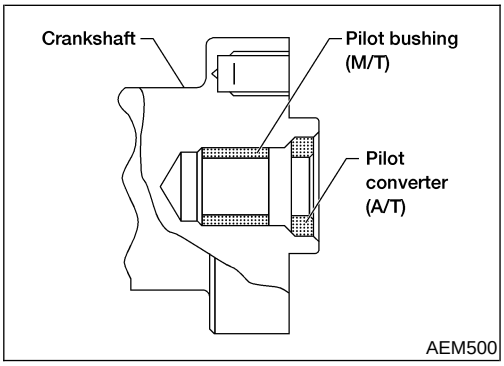
If beyond the limit, replace connecting rod and/or crankshaft.

REPLACING PILOT BUSHING

NEEM0108S03



1. Remove pilot bushing (M/T) or pilot convertor (A/T).



2. Install pilot bushing (M/T) or pilot convertor (A/T).

General Specifications

NEEM0109

Cylinder arrangement		In-line 4
Displacement		2,389 cm^3 (145.78 cu in)
Bore and stroke		89 x 96 mm (3.50 x 3.78 in)
Valve arrangement		DOHC
Firing order		1-3-4-2
Number of piston rings	Compression	2
	Oil	1
Number of main bearings		5
Compression ratio		9.2

COMPRESSION PRESSURE

NEEM0109S01

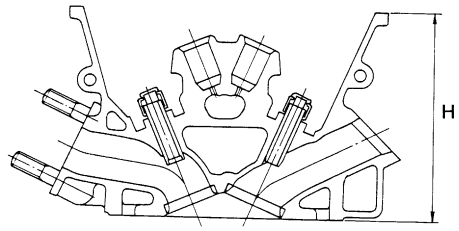
Unit: kPa (kg/cm^2, psi)/300 rpm

Standard	1,226 (12.5, 178)
Minimum	1,030 (10.5, 149)
Differential limit between cylinders	98 (1.0, 14)

Cylinder Head

NEEM0110

Unit: mm (in)



Nominal cylinder head height:
H = 126.3 - 126.5 (4.972 - 4.980)

SEM519E

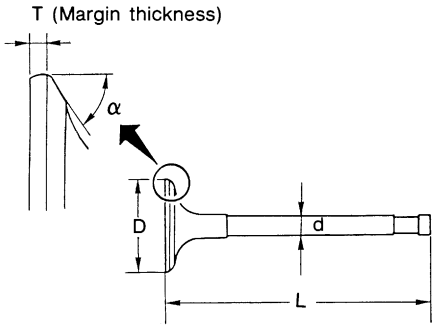
	Standard	Limit
Head surface distortion	Less than 0.03 (0.0012)	0.1 (0.004)

Valve

VALVE

NEEM0111

NEEM0111S01
Unit: mm (in)



SEM188

Valve head diameter “D”	Intake	36.5 - 36.7 (1.437 - 1.445)
	Exhaust	31.2 - 31.4 (1.228 - 1.236)
Valve length “L”	Intake	101.17 - 101.47 (3.9831 - 3.9949)
	Exhaust	98.67 - 98.97 (3.8846 - 3.8964)
Valve stem diameter “d”	Intake	6.965 - 6.980 (0.2742 - 0.2748)
	Exhaust	6.945 - 6.960 (0.2734 - 0.2740)
Valve seat angle “α”	Intake & Exhaust	45°15′ - 45°45′
Valve margin “T”	Intake	0.95 - 1.25 (0.0374 - 0.0492)
	Exhaust	1.15 - 1.45 (0.0453 - 0.0571)
Valve margin “T” limit		More than 0.5 (0.020)
Valve stem end surface grinding limit		Less than 0.2 (0.008)

VALVE SPRING

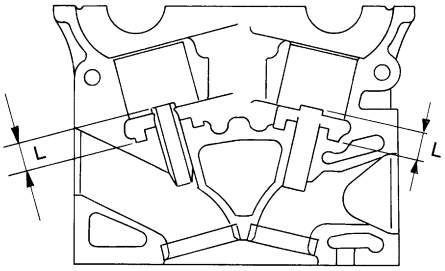
NEEM0111S02

Free height mm (in)		50.3 (1.9831)
Pressure N (kg, lb) at height mm (in)	Standard	418.0 (42.6, 93.9) at 29.17 (1.1484)
	Limit	393.0 (40.1, 88.4) at 29.17 (1.1484)
Out-of-square mm (in)		Less than 2.2 (0.087)

VALVE GUIDE

NEEM0111S03

Unit: mm (in)



SEM301D

		Standard	Service
Valve guide Outer diameter	Intake	11.023 - 11.034 (0.4340 - 0.4344)	11.223 - 11.234 (0.4418 - 0.4423)
	Exhaust	11.023 - 11.034 (0.4340 - 0.4344)	11.223 - 11.234 (0.4418 - 0.4423)
Valve guide Inner diameter (Finished size)	Intake	7.000 - 7.018 (0.2756 - 0.2763)	
	Exhaust	7.000 - 7.018 (0.2756 - 0.2763)	
Cylinder head valve guide hole diameter	Intake	10.975 - 10.996 (0.4321 - 0.4329)	11.175 - 11.196 (0.4400 - 0.4408)
	Exhaust	10.975 - 10.996 (0.4321 - 0.4329)	11.175 - 11.196 (0.4400 - 0.4408)
Interference fit of valve guide		0.027 - 0.059 (0.0011 - 0.0023)	
		Standard	Limit
Stem to guide clearance	Intake	0.020 - 0.053 (0.0008 - 0.0021)	0.08 (0.0031)
	Exhaust	0.040 - 0.073 (0.0016 - 0.0029)	0.1 (0.004)
Valve deflection limit		0.2 (0.008)	
Projection length "L"		13.3 - 13.9 (0.524 - 0.547)	

VALVE LIFTER

NEEM0111S04

Unit: mm (in)

Valve lifter outer diameter	33.960 - 33.975 (1.3370 - 1.3376)
Lifter guide inner diameter	34.000 - 34.021 (1.3386 - 1.3394)
Clearance between lifter and filter guide	0.025 - 0.061 (0.0010 - 0.0024)

VALVE CLEARANCE ADJUSTMENT

NEEM0111S05

Unit: mm (in)

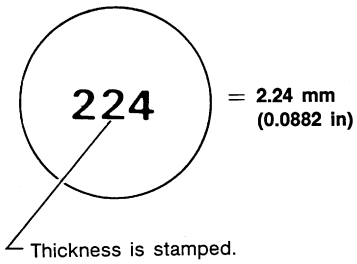
Valve clearance (Hot)	Intake	0.31 - 0.39 (0.012 - 0.015)
	Exhaust	0.33 - 0.41 (0.013 - 0.016)

Valve (Cont'd)

AVAILABLE SHIMS

NEEM0111S06

Thickness mm (in)	Identification mark	Thickness mm (in)	Identification mark
1.96 (0.0772)	196	1.98 (0.0780)	198
2.00 (0.0787)	200	2.02 (0.0795)	202
2.04 (0.0803)	204	2.06 (0.0811)	206
2.08 (0.819)	208	2.10 (0.0827)	210
2.12 (0.0835)	212	2.14 (0.0843)	214
2.16 (0.0850)	216	2.18 (0.0858)	218
2.20 (0.0866)	220	2.22 (0.0874)	222
2.24 (0.0882)	224	2.26 (0.0890)	226
2.28 (0.0898)	228	2.30 (0.0906)	230
2.32 (0.0913)	232	2.34 (0.0921)	234
2.36 (0.0929)	236	2.38 (0.0937)	238
2.40 (0.0945)	240	2.42 (0.0953)	242
2.44 (0.0961)	244	2.46 (0.0969)	246
2.48 (0.0976)	248	2.50 (0.0984)	250
2.52 (0.0992)	252	2.54 (0.1000)	254
2.56 (0.1008)	256	2.58 (0.1016)	258
2.60 (0.1024)	260	2.62 (0.1031)	262
2.64 (0.1039)	264	2.66 (0.1047)	266
2.68 (0.1055	268	—	—

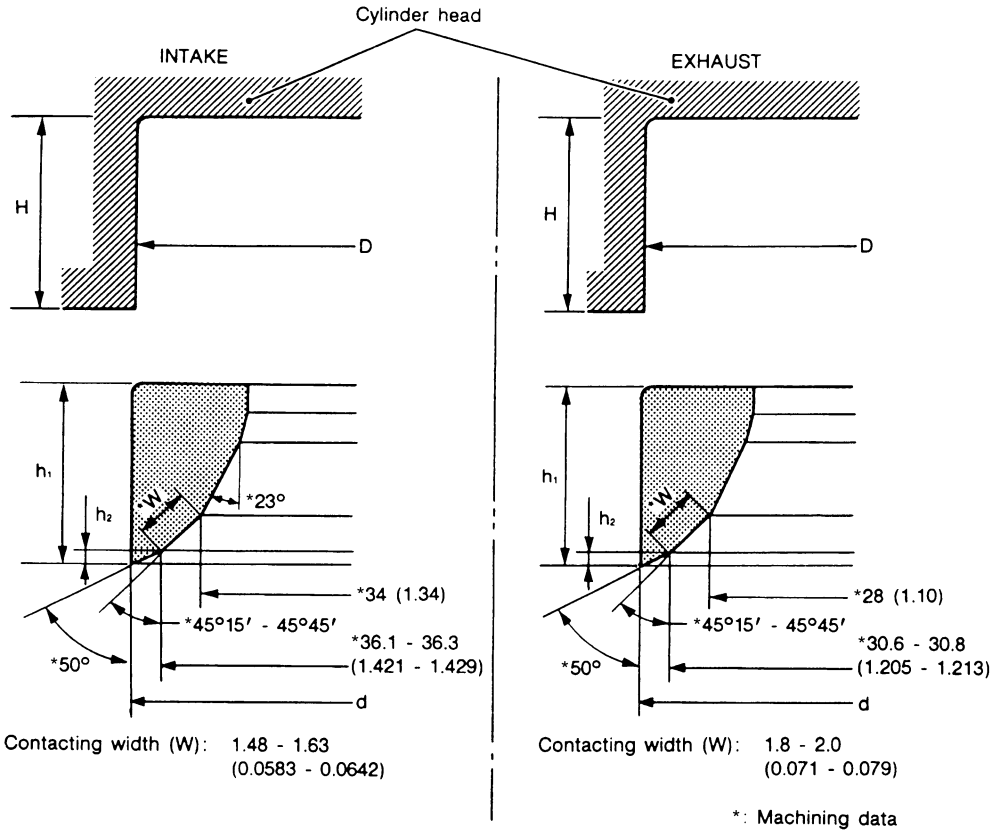


SEM308D

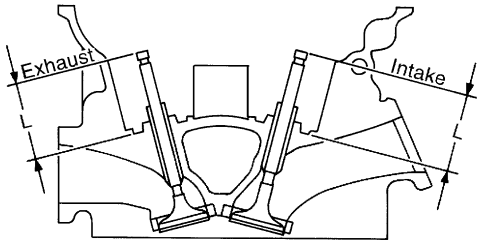
VALVE SEAT

NEEM0111S07

Unit: mm (in)



AEM456



SEM621F

		Standard	Service
Cylinder head seat recess diameter (D)	Intake	37.500 - 37.516 (1.4764 - 1.4770)	38.000 - 38.016 (1.4961 - 1.4967)
	Exhaust	32.200 - 32.216 (1.2677 - 1.2683)	32.700 - 32.716 (1.2874 - 1.2880)
Valve seat interference fit	Intake	0.064 - 0.096 (0.0025 - 0.0038)	
	Exhaust	0.064 - 0.096 (0.0025 - 0.0038)	
Valve seat outer diameter (d)	Intake	37.580 - 37.596 (1.4795 - 1.4802)	38.080 - 38.096 (1.4992 - 1.4998)
	Exhaust	32.280 - 32.296 (1.2709 - 1.2715)	32.780 - 32.796 (1.2905 - 1.2912)
Depth (H)	Intake	6.1 - 6.3 (0.240 - 0.248)	
	Exhaust	6.1 - 6.3 (0.240 - 0.248)	
Height (h_1)	Intake	5.8 - 6.0 (0.228 - 0.236) 5.9 - 6.0 (0.232 - 0.236)	5.3 - 5.5 (0.209 - 0.217)
	Exhaust	5.9 - 6.0 (0.232 - 0.236)	5.32 - 5.42 (0.209 - 0.213)

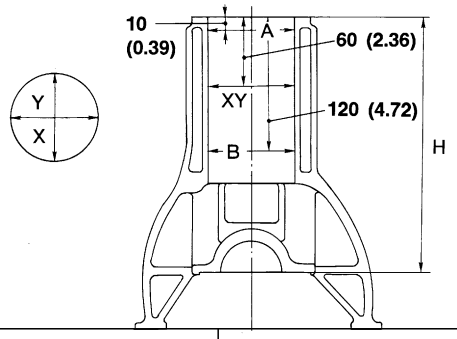
Valve (Cont'd)

Height (h_2)	Intake	0.24 - 0.64 (0.0094 - 0.0252) 0.34 - 0.64 (0.0134 - 0.0252)
	Exhaust	0.43 - 0.73 (0.0169 - 0.0287)
Depth (L)	Intake	42.02 - 42.52
	Exhaust	42.03 - 42.53

Cylinder Block

NEEM0112

Unit: mm (in)



SEM400E

			Standard	Limit
Distortion			—	0.1 (0.004)
Cylinder bore	Inner diameter	Grade 1	89.000 - 89.010 (3.5039 - 3.5043)	0.2 (0.008)*
		Grade 2	89.010 - 89.020 (3.5043 - 3.5047)	
		Grade 3	89.020 - 89.030 (3.5047 - 3.5051)	
	Out-of-round (X − Y)		Less than 0.015 (0.0006)	—
	Taper (A − B)		Less than 0.010 (0.0004)	—
Difference in inner diameter between cylinders			Less than 0.03 (0.0012)	0.2 (0.008)
Piston-to-cylinder clearance			0.020 - 0.040 (0.0008 - 0.0016)	—
Cylinder block height (From crankshaft center)			246.95 - 247.05 (9.7224 - 9.7264)	0.2 (0.008)**

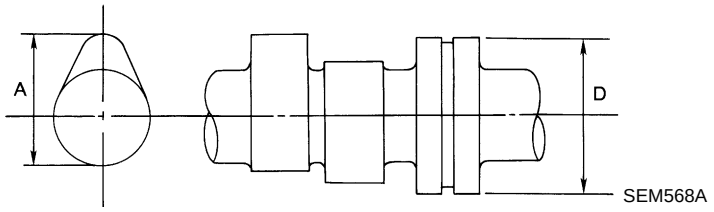
* Wear limit

** Total amount of cylinder head resurfacing and cylinder block resurfacing

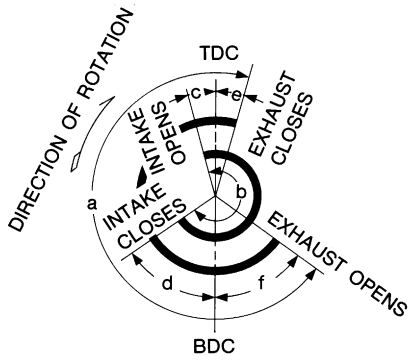
Camshaft and Camshaft Bearing

NEEM0113

Unit: mm (in)



SEM568A



EM120

		Standard	Limit
Cam height (A)	Intake	42.505 - 42.695 (1.673 - 1.681)	—
	Exhaust	40.905 - 41.095 (1.610 - 1.618)	—
Wear limit of cam height		—	0.2 (0.008)
Camshaft journal to bearing clearance		0.045 - 0.090 (0.0018 - 0.0035)	0.12 (0.0047)
Inner diameter of camshaft bearing	#1 to #5 journals	28.000 - 28.025 (1.1024 - 1.1033)	—
Outer diameter of camshaft journal (D)	#1 to #5 journals	27.935 - 27.955 (1.0998 - 1.1006)	—
Camshaft runout*		Less than 0.02 (0.0008)	0.04 (0.0016)
Camshaft end play		0.070 - 0.148 (0.0028 - 0.0058)	0.2 (0.008)
Valve timing (Degree on crankshaft)	a	216	—
	b	232	—
	c	−1	—
	d	53	—
	e	4	—
	f	32	—

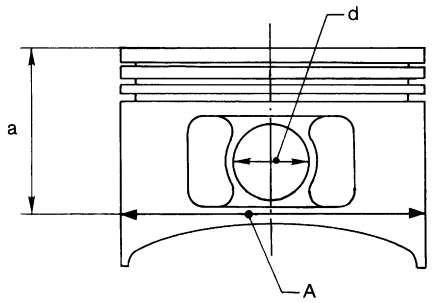
* Total indicator reading

Piston, Piston Ring and Piston pin

NEEM0114

PISTON

NEEM0114S01
Unit: mm (in)



SEM804E

Piston skirt diameter (A)	Standard	Grade No. 1	88.970 - 88.980 (3.5027 - 3.5031)
		Grade No. 2	88.980 - 88.990 (3.5031 - 3.5035)
		Grade No. 3	88.990 - 89.000 (3.5035 - 3.5039)
	Service (Oversize)	0.5 (0.020)	89.470 - 89.500 (3.5224 - 3.5236)
		1.0 (0.039)	89.970 - 90.000 (3.5421 - 3.5433)
Dimension (a)		Approximately 48 (1.89)	
Piston pin hole diameter (d)		20.993 - 21.005 (0.8265 - 0.8270)	
Piston-to-cylinder bore clearance		0.020 - 0.040 (0.0008 - 0.0016)	

PISTON PIN

NEEM0114S02
Unit: mm (in)

	Standard	Limit
Piston pin outer diameter	20.989 - 21.001 (0.8263 - 0.8268)	—
Interference fit of piston pin to piston pin hole	−0.002 to 0.01 (−0.0001 to 0.0004)	—
Piston pin to connecting rod bearing clearance	0.005 - 0.017 (0.0002 - 0.0007)	0.023 (0.0009)

PISTON RING

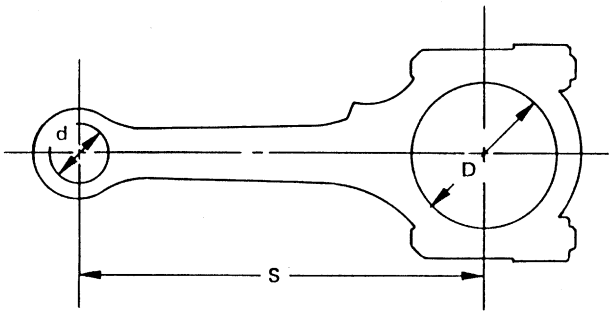
NEEM0114S03
Unit: mm (in)

		Standard	Limit
Side clearance	Top	0.040 - 0.080 (0.0016 - 0.0031)	0.1 (0.004)
	2nd	0.030 - 0.070 (0.0012 - 0.0028)	0.1 (0.004)
Ring gap	Top	0.28 - 0.52 (0.0110 - 0.0205)	1.0 (0.039)
	2nd	0.45 - 0.69 (0.0177 - 0.0272)	1.0 (0.039)
	Oil (rail ring)	0.20 - 0.69 (0.0079 - 0.0272)	1.0 (0.039)

Connecting Rod

NEEM0115

Unit: mm (in)



SEM570A

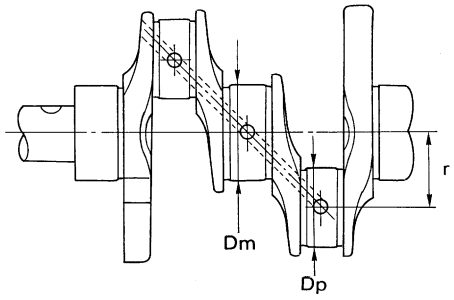
	Standard	Limit
Center distance (S)	164.95 - 165.05 (6.4941 - 6.4980)	—
Bend [per 100 mm (3.94 in)]	—	0.15 (0.0059)
Torsion [per 100 mm (3.94 in)]	—	0.30 (0.0118)
Connecting rod small end inner diameter (d)*	23.970 - 24.000 (0.9437 - 0.9449)	—
Piston pin bushing inner diameter	21.000 - 21.012 (0.8268 - 0.8272)	—
Connecting rod big end inner diameter (D)*	53.000 - 53.013 (2.0866 - 2.0871)	—
Side clearance	0.2 - 0.4 (0.008 - 0.016)	0.6 (0.024)

* Without bearing

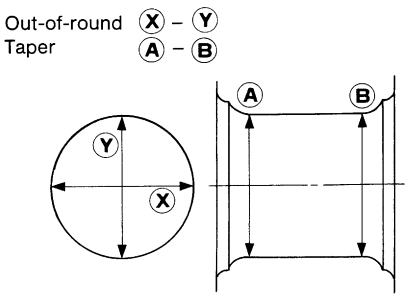
Crankshaft

NEEM0116

Unit: mm (in)



SEM394



EM715

Main journal diameter (Dm)	Grade No. 0	59.967 - 59.975 (2.3609 - 2.3612)	
	Grade No. 1	59.959 - 59.967 (2.3606 - 2.3609)	
	Grade No. 2	59.951 - 59.959 (2.3603 - 2.3606)	
Pin journal diameter (Dp)	Grade No. 0	49.968 - 49.974 (1.9672 - 1.9675)	
	Grade No. 1	49.962 - 49.968 (1.9670 - 1.9672)	
	Grade No. 2	49.956 - 49.962 (1.9668 - 1.9670)	
Center distance (r)		47.95 - 48.05 (1.8878 - 1.8917)	
		Standard	Limit
Taper of journal and pin [A - B]	Journal	—	0.01 (0.0004)
	Pin	—	0.005 (0.0002)

Crankshaft (Cont'd)

Out-of-round of journal and pin [X - Y]	Journal	—	0.01 (0.0004)
	Pin	—	0.005 (0.0002)
Runout [TIR]*		—	0.10 (0.0039)
Free end play		0.05 - 0.18 (0.0020 - 0.0071)	0.3 (0.012)
Fillet roil		More than 0.1 (0.004)	

* Total indicator reading

Bearing Clearance

NEEM0117

Unit: mm (in)

	Standard	Limit
Main bearing clearance	0.020 - 0.047 (0.0008 - 0.0019)	0.1 (0.004)
Connecting rod bearing clearance	0.010 - 0.035 (0.0004 - 0.0014)	0.09 (0.0035)

Available Main Bearing

NEEM0118

STANDARD

NEEM0118S01

Unit: mm (in)

Grade number	Thickness	Identification color
0	1.821 - 1.825 (0.0717 - 0.0719)	Black
1	1.825 - 1.829 (0.0719 - 0.0720)	Brown
2	1.829 - 1.833 (0.0720 - 0.0722)	Green
3	1.833 - 1.837 (0.0722 - 0.0723)	Yellow
4	1.837 - 1.841 (0.0723 - 0.0725)	Blue

UNDERSIZE (SERVICE)

NEEM0118S02

Unit: mm (in)

	Thickness	Main journal diameter "Dm"
0.25 (0.0098)	1.952 - 1.960 (0.0769 - 0.0772)	Grind so that bearing clearance is the specified value.

Available Connecting Rod Bearing

NEEM0119

STANDARD

NEEM0119S01

Unit: mm (in)

Grade number	Thickness	Identification color
0	1.505 - 1.508 (0.0593 - 0.0594)	—
1	1.508 - 1.511 (0.0594 - 0.0595)	Brown
2	1.511 - 1.514 (0.0595 - 0.0596)	Green

UNDERSIZE (SERVICE)

NEEM0119S02

Unit: mm (in)

	Thickness	Crank pin journal diameter "Dp"
0.08 (0.0031)	1.540 - 1.548 (0.0606 - 0.0609)	Grind so that bearing clearance is the specified value.
0.12 (0.0047)	1.560 - 1.568 (0.0614 - 0.0617)	
0.25 (0.0098)	1.625 - 1.633 (0.0640 - 0.0643)	

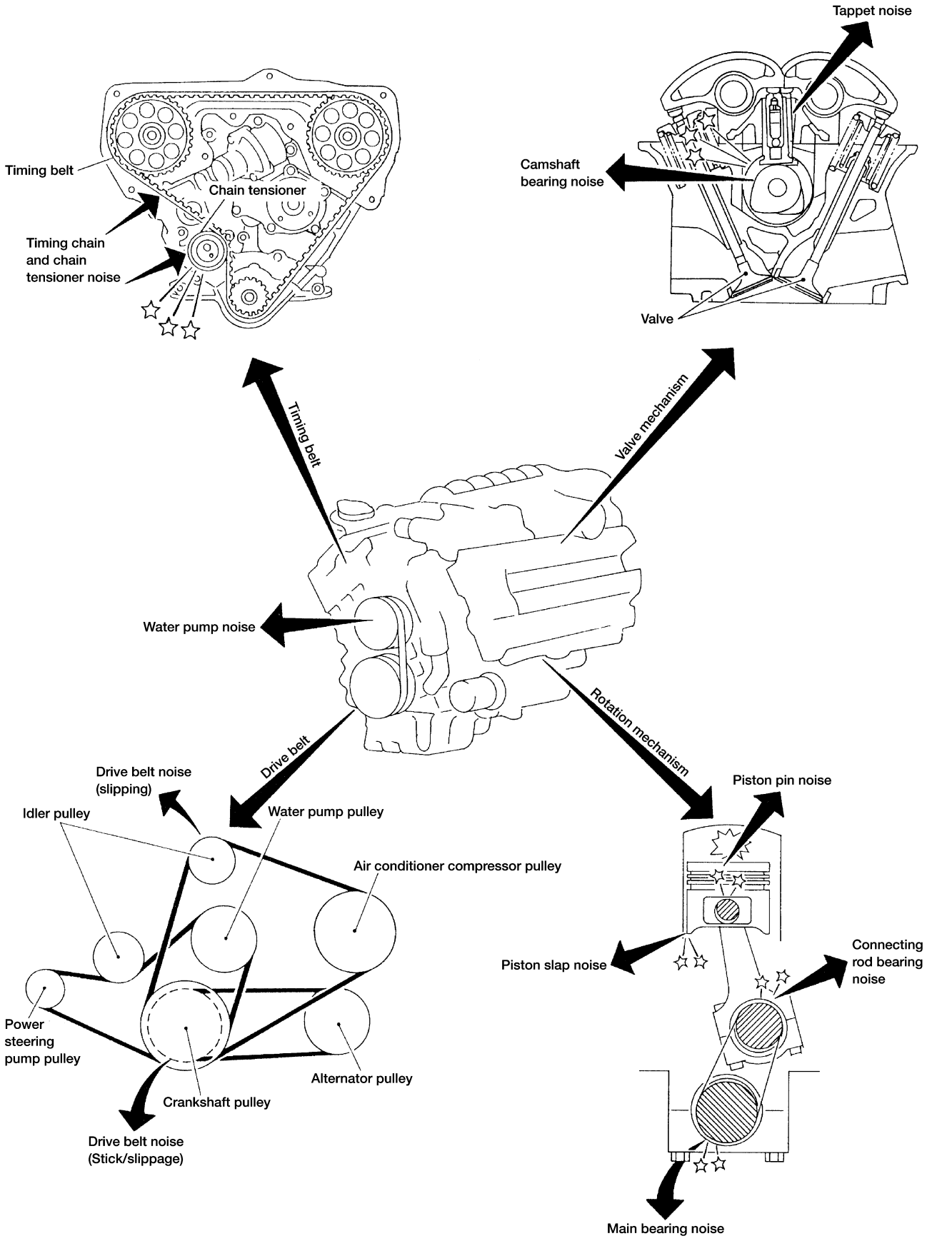
Miscellaneous Components

NEEM0120

Unit: mm (in)

Camshaft sprocket runout [TIR]*	Less than 0.15 (0.0059)
Flywheel runout [TIR]*	Less than 0.15 (0.006)
Drive plate runout [TIR]*	Less than 0.15 (0.006)

* Total indicator reading


Timing belt
Chain tensioner
Timing chain and chain tensioner noise
Tappet noise
Camshaft bearing noise
Valve
Timing belt
Valve mechanism
Water pump noise
Drive belt
Rotation mechanism
Drive belt noise (slipping)
Idler pulley
Water pump pulley
Air conditioner compressor pulley
Power steering pump pulley
Alternator pulley
Crankshaft pulley
Drive belt noise (Stick/slippage)
Piston pin noise
Piston slap noise
Connecting rod bearing noise
Main bearing noise

AEM475

NVH Troubleshooting Chart — Engine Noise

NEEM0039S01

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	Hydraulic valve lifter	EM-97 *1
	Rattle	C	A	—	A	B	C	Camshaft bearing noise	Camshaft journal clearance Camshaft runout	EM-91, EM-90
Crankshaft pulley Cylinder block (Side of engine) Oil pan	Slap or knock	—	A	—	B	B	—	Piston pin noise	Piston and piston pin clearance Connecting rod bushing clearance	EM-106, EM-112
	Slap or rap	A	—	—	B	B	A	Piston slap noise	Piston-to-bore clearance Piston ring side clearance Piston ring end gap Connecting rod bend and torsion	EM-108, EM-106, EM-106, EM-107
	Knock	A	B	C	B	B	B	Connecting rod bearing noise	Connecting rod bushing clearance (Small end) Connecting rod bearing clearance (Big end)	EM-112, EM-112
	Knock	A	B	—	A	B	C	Main bearing noise	Main bearing oil clearance Crankshaft runout	EM-110, EM-109
Timing belt cover	Whine or hissing	C	A	—	A	A	—	Timing belt noise (too tight)	Loose timing belt Belt contacting case	EM-77
	Clatter	A	B	—	C	A	—	Timing belt noise (too loose)		
Front of engine	Squeaking or fizzing	A	B	—	B	—	C	Other drive belts (Sticking or slipping)	Drive belts deflection	*2
	Creaking	A	B	A	B	A	B	Other drive belts (Slipping)	Idler pulley bearing operation	
	Squall Creak	A	B	—	B	A	B	Water pump noise	Water pump operation	*3

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

*1: Step 19 in “Installation”, “CYLINDER HEAD”

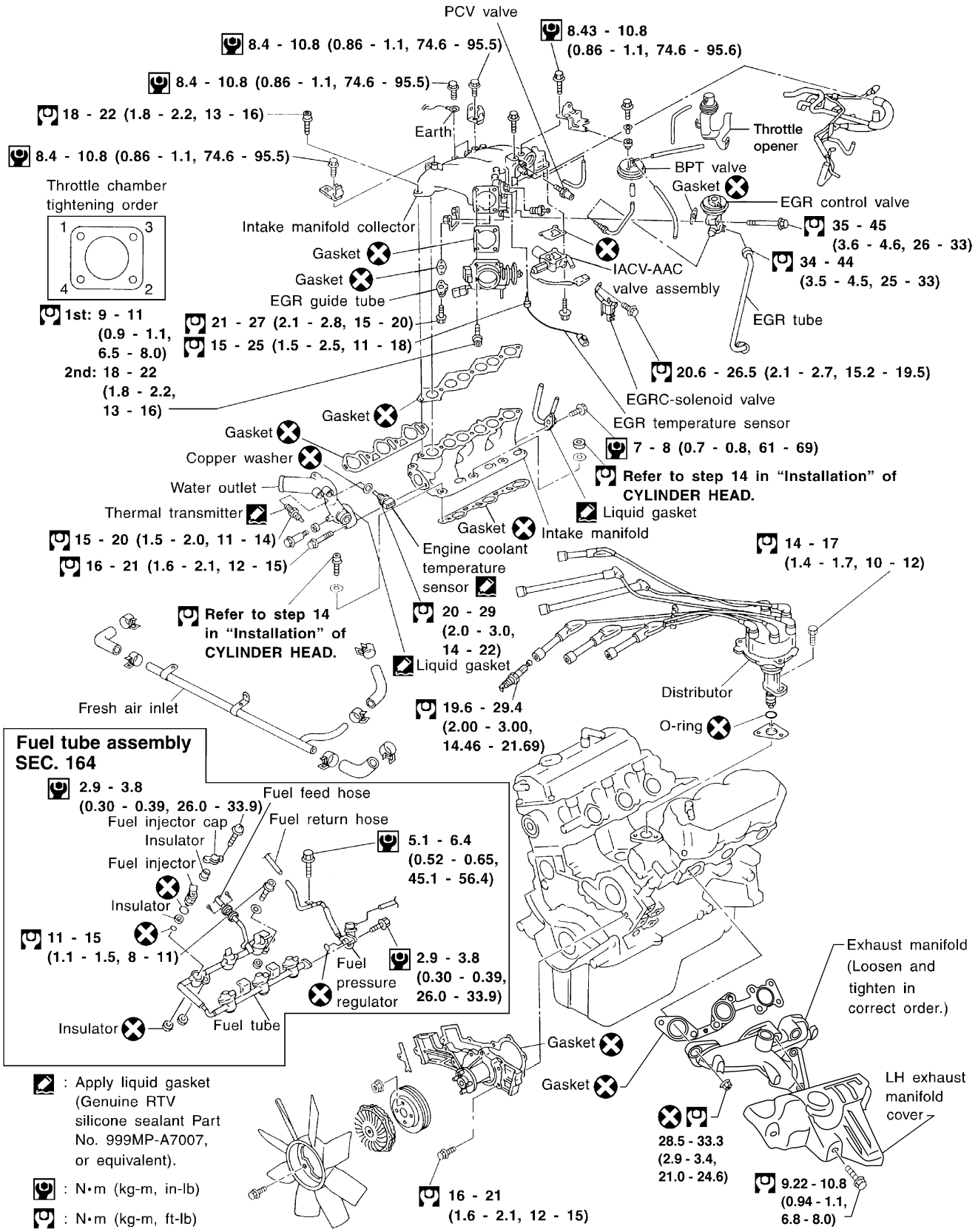
*2: “Checking Drive Belts”, “ENGINE MAINTENANCE”, ***MA-26***.

*3: “Water Pump Inspection”, “ENGINE COOLING SYSTEM”, ***LC-30***.

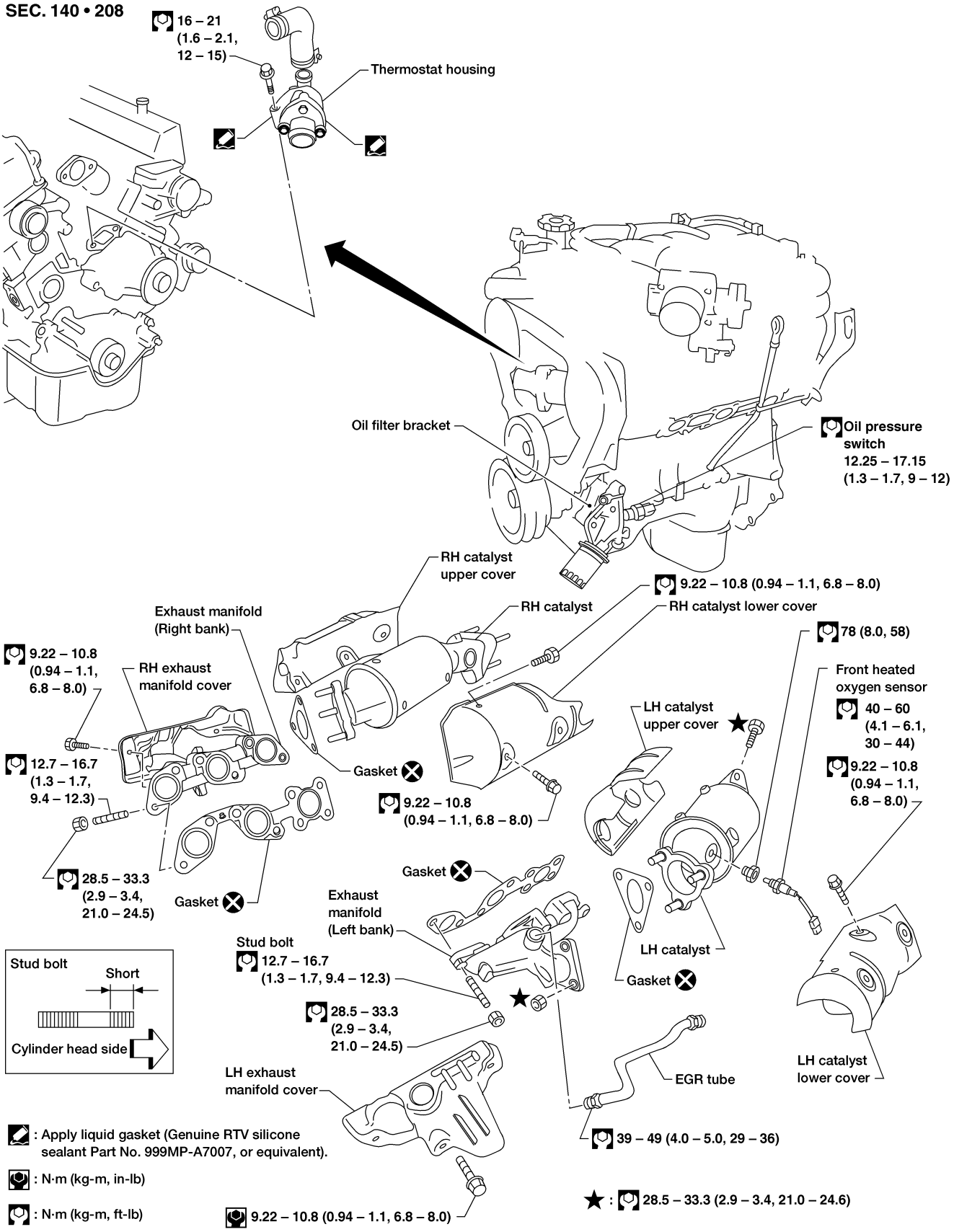
Removal and Installation

NEEM0005

SEC. 140•147•148•163•164•173•210•221



AEM478


SEC. 140 • 208
16 – 21 (1.6 – 2.1, 12 – 15)
Thermostat housing
Oil filter bracket
Oil pressure switch 12.25 – 17.15 (1.3 – 1.7, 9 – 12)
RH catalyst upper cover
9.22 – 10.8 (0.94 – 1.1, 6.8 – 8.0)
RH catalyst
RH catalyst lower cover
Exhaust manifold (Right bank)
78 (8.0, 58)
9.22 – 10.8 (0.94 – 1.1, 6.8 – 8.0)
RH exhaust manifold cover
Front heated oxygen sensor
40 – 60 (4.1 – 6.1, 30 – 44)
LH catalyst upper cover
12.7 – 16.7 (1.3 – 1.7, 9.4 – 12.3)
Gasket
9.22 – 10.8 (0.94 – 1.1, 6.8 – 8.0)
28.5 – 33.3 (2.9 – 3.4, 21.0 – 24.5)
Gasket
Gasket
Exhaust manifold (Left bank)
Stud bolt
12.7 – 16.7 (1.3 – 1.7, 9.4 – 12.3)
LH catalyst
Gasket
28.5 – 33.3 (2.9 – 3.4, 21.0 – 24.5)
Stud bolt
Short
Cylinder head side
LH exhaust manifold cover
EGR tube
LH catalyst lower cover
: Apply liquid gasket (Genuine RTV silicone sealant Part No. 999MP-A7007, or equivalent).
: N·m (kg-m, in-lb)
: N·m (kg-m, ft-lb)
9.22 – 10.8 (0.94 – 1.1, 6.8 – 8.0)
39 – 49 (4.0 – 5.0, 29 – 36)
★ : 28.5 – 33.3 (2.9 – 3.4, 21.0 – 24.6)

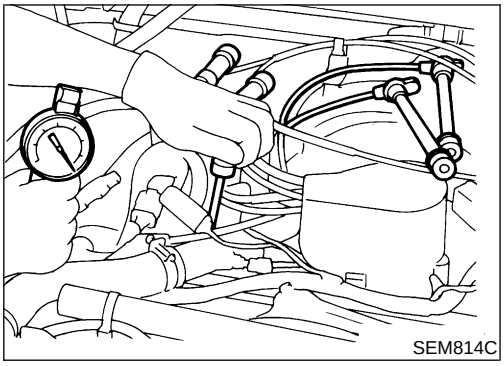
AEM474

MEASUREMENT OF COMPRESSION PRESSURE

1. Warm up engine.
2. Turn ignition switch OFF.
3. Release fuel pressure.
   Refer to “Releasing Fuel Pressure”, ***EC-620***.
4. Remove all spark plugs.

- **Clean area around plug with compressed air before removing the spark plugs.**

5. Disconnect camshaft position sensor harness connector at the distributor.
6. Remove fuel injector fuse **3** on FUSE BLOCK (J/B) behind the instrument lower panel.
   Refer to “FUSE BLOCK-Junction Box (J/B)”, ***EL-271***.


SEM814C


20 mm (0.79 in) dia.

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

SEM387C

7. Attach a compression tester to No. 1 cylinder.
8. Depress accelerator pedal fully to keep throttle valve wide open.
9. Crank engine and record highest gauge indication.
10. Repeat the measurement on each cylinder as shown above.

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

Compression pressure: kPa (kg/cm^2, psi)/300 rpm

Standard

1,196 (12.2, 173)

Minimum

883 (9.0, 128)

Difference limit between cylinders

98 (1.0, 14)

11. If cylinder compression in one or more cylinders is low, pour a small amount of engine oil into cylinders through spark plug holes and retest compression.

- **If adding oil improves cylinder compression, piston rings may be worn or damaged. If so, replace piston rings after checking piston.**
- **If pressure stays low, a valve may be sticking or seating improperly. Inspect and repair valve and valve seat. (Refer to SDS.) If valve or valve seat is damaged excessively, replace them.**
- **If compression in any two adjacent cylinders is low and if adding oil does not improve compression, there is leakage past the gasket surface. If so, replace cylinder head gasket.**

12. Reinstall spark plugs, fuel injector fuse, fuel pump fuse, and reconnect camshaft position sensor harness connector at the distributor.
13. Erase the DTC stored in the ECM.

CAUTION:
Always erase the DTC after checking compression.
Refer to "HOW TO ERASE EMISSION-RELATED DIAGNOSTIC INFORMATION", *EC-651*.

Removal

NEEM0007

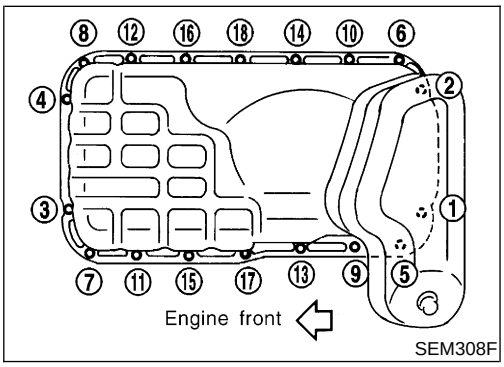
WARNING:

- **Place vehicle on a flat and solid surface.**
- **Place chocks at front and rear of rear wheels.**
- **You should not remove oil pan until exhaust system and cooling system have completely cooled off.**
  Otherwise, you may burn yourself and/or fire may break out in the fuel line.
- **When removing front and/or rear engine mounting bolts or nuts, lift engine slightly to ensure safety.**

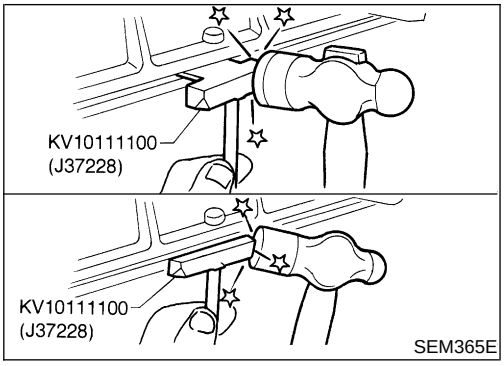
CAUTION:

- **In lifting engine, be careful not to hit against adjacent parts, especially against accelerator wire casing end, brake tube and brake master cylinder.**
- **Fortighteningtorque,refertoAT-402,MT-45,PD-44andPD-114 sections.**

1. Remove undercover.
2. Drain engine oil.
3. Remove stabilizer bracket bolts (RH & LH).
4. Remove front propeller shaft from front differential carrier.
5. Remove front drive shaft fixing bolts (RH & LH).
6. Remove front differential carrier bleeder hose.
7. Remove front suspension crossmember.
8. Remove differential front mounting bolts (RH & LH) and rear mounting bolts.
9. Remove front differential carrier.
10. Remove front differential carrier mounting bracket.
11. Remove starter motor.
12. Remove transmission to rear engine mounting bracket nuts (RH & LH).
13. Remove engine mounting bolts or nuts (RH & LH).
14. Remove power steering mounting brackets (RH & LH).
15. Lift up engine. If necessary, disconnect exhaust tube.
16. Remove relay rod. It is not necessary to disconnect pitman arm.



17. Remove oil pan bolts in numerical order.



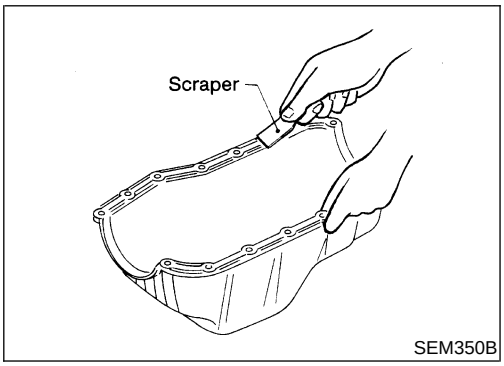
SEM365E

18. Remove oil pan.
a. Insert Tool between cylinder block and oil pan.
- **Do not drive seal cutter into oil pump or rear oil seal retainer portion, or aluminum mating face will be damaged.**
- **Do not insert screwdriver, or oil pan flange will be deformed.**

b. Slide Tool by tapping its side with a hammer, and remove oil pan.

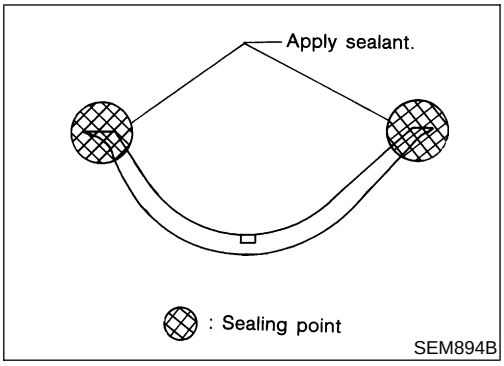
Installation

NEEM0008



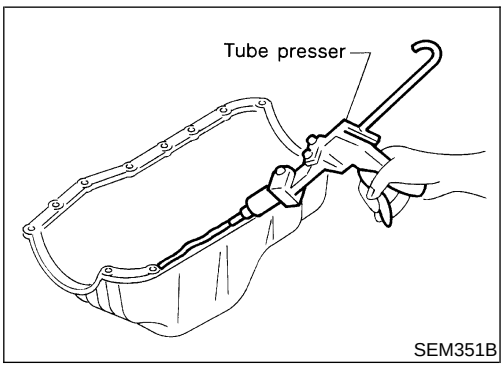
SEM350B

1. Before installing oil pan, remove all traces of liquid gasket from mating surface using a scraper.
- Also remove traces of liquid gasket from mating surface of cylinder block.



SEM894B

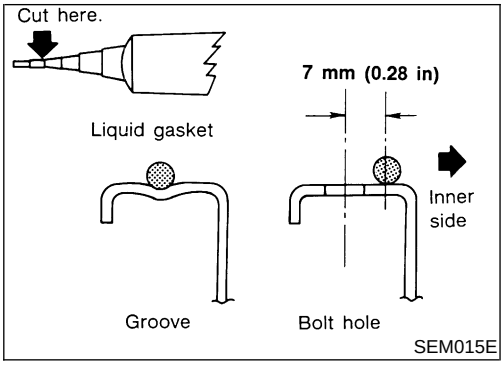
2. Apply sealant to oil pump gasket and rear oil seal retainer gasket.

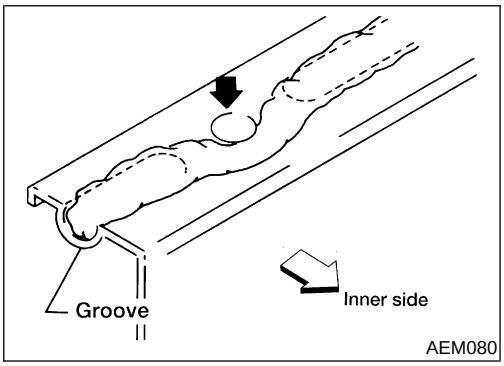


SEM351B

3. Apply a continuous bead of liquid gasket to mating surface of oil pan.
- **Use Genuine RTV silicone sealant Part No. 999MP-A7007 or equivalent.**

Installation (Cont'd)





- **Be sure liquid gasket is 3.5 to 4.5 mm (0.138 to 0.177 in) wide.**

4. Apply liquid gasket to inner sealing surface as shown in figure.

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

5. Install oil pan.

- **Install bolts/nuts in their reverse order of removal.**
- **Wait at least 30 minutes before refilling engine oil.**

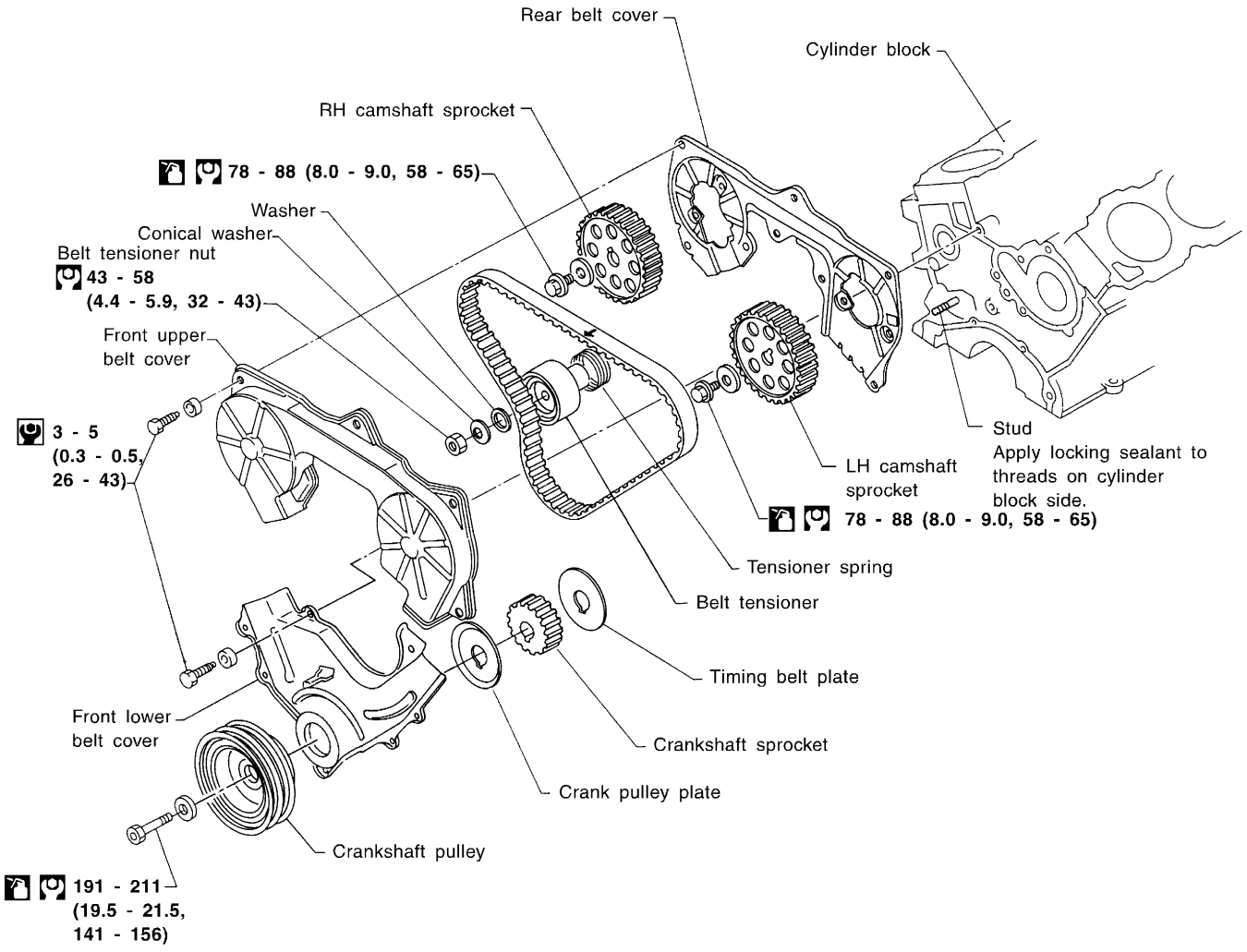
Components

NEEM0009

CAUTION:

- **Do not bend or twist timing belt.**
- **After removing timing belt, do not turn crankshaft and camshaft separately because valves will strike piston heads.**
- **Make sure that timing belt, camshaft sprocket, crankshaft sprocket and belt tensioner are clean and free from oil and water.**
- **Installation should be carried out when engine is cold.**

SEC. 120•130•135



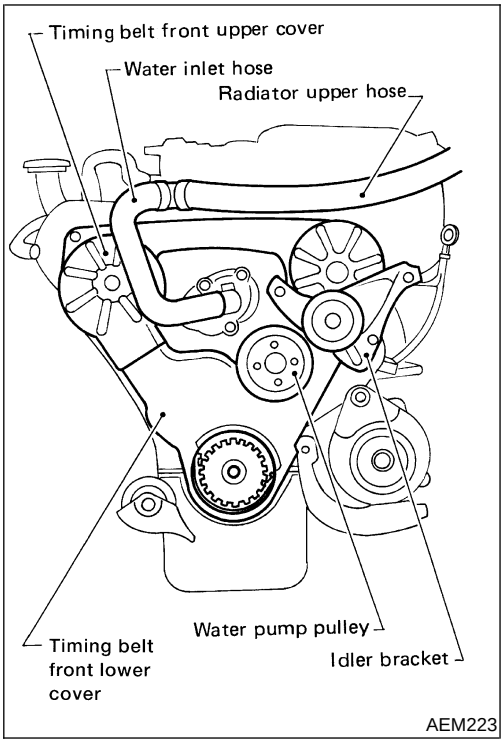
: N•m (kg-m, in-lb)
: N•m (kg-m, ft-lb)
: Lubricate with new engine oil

SEM311FA

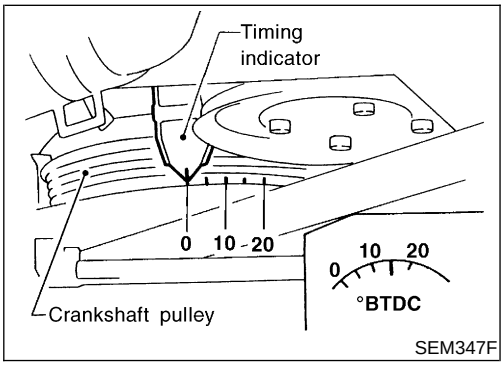
Removal

NEEM0010

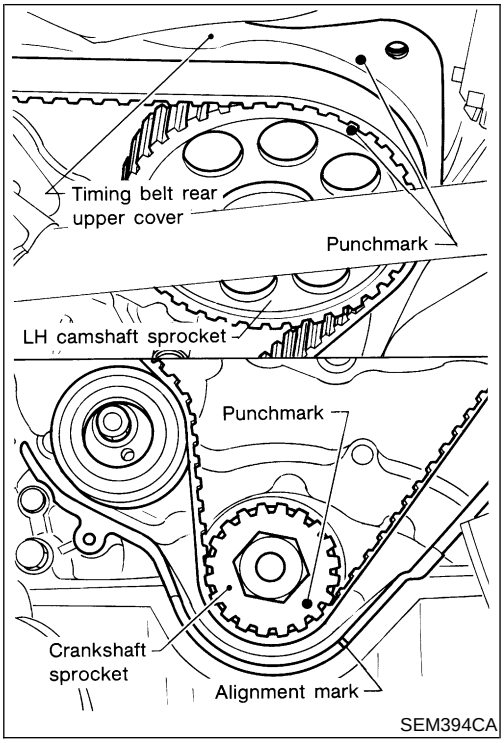
1. Remove engine under cover.
2. Drain engine coolant from radiator. Refer to “Changing Engine Coolant”, ***MA-27***.
   Be careful not to spill coolant on drive belts.
3. Remove radiator. (Refer to ***LC-32***.)
4. Remove engine cooling fan and water pump pulley.
5. Remove the following belts.
- Power steering pump drive belt
- Compressor drive belt
- Alternator drive belt
6. Remove all spark plugs.
7. Remove distributor protector.



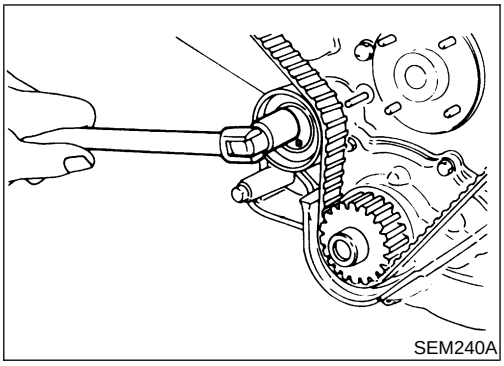
8. Remove compressor drive belt idler bracket.
9. Remove fresh-air intake tube for rocker cover.
10. Remove water hose for thermostat housing.



11. Set No. 1 piston at TDC on its compression stroke by rotating crankshaft.
12. Remove crankshaft pulley bolt.
13. Remove crankshaft pulley using a suitable puller.
14. Remove front upper and lower belt covers.



- **Align punchmark on LH camshaft sprocket with punchmark on timing belt rear cover.**
- **Align punchmark on crankshaft sprocket with alignment mark on oil pump housing.**
- **Temporarily install crankshaft pulley bolt on crankshaft so the crankshaft can be rotated.**

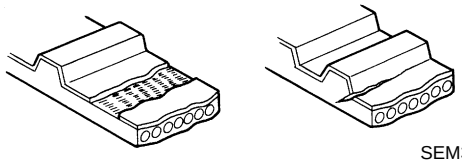
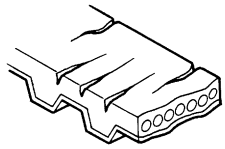


15. Loosen timing belt tensioner nut, rotate tensioner, then remove timing belt.

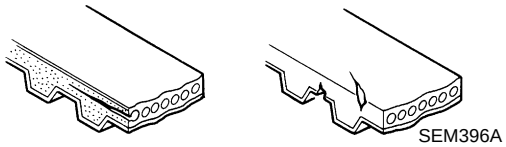
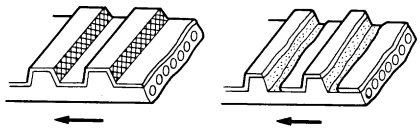
Inspection

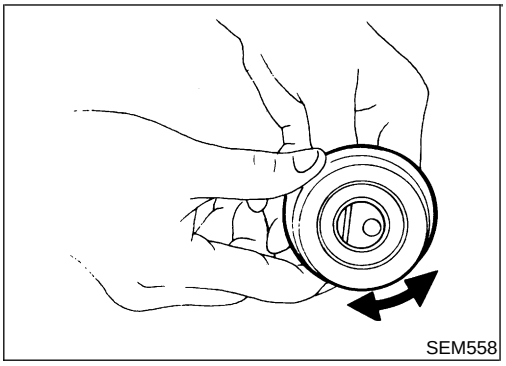
NEEM0011

Visually check the condition of timing belt.
Replace if any abnormality is found.

Item to check	Problem	Cause
Tooth is broken/tooth root is cracked.	 SEM394A	• Camshaft jamming • Distributor jamming • Damaged camshaft/crankshaft oil seal
Back surface is cracked/worn.	 SEM395A	• Tensioner jamming • Overheated engine • Interference with belt cover

Inspection (Cont'd)

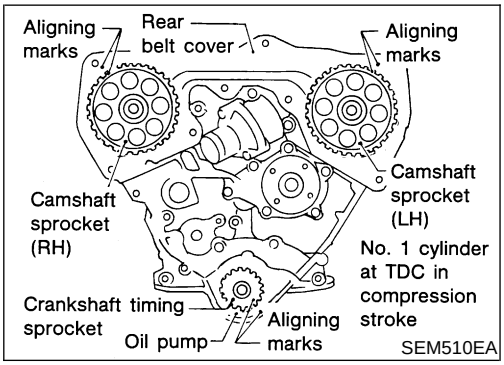
Item to check	Problem	Cause
Side surface is worn.	 SEM396A • Belt corners are worn and round. • Wicks are frayed and coming out.	• Improper installation of belt • Malfunctioning crankshaft pulley plate/timing belt plate
Teeth are worn.	 Rotating direction SEM397A • Canvas on tooth face is worn down. • Canvas on tooth is fluffy, rubber layer is worn down and faded white, or weft is worn down and invisible.	• Poor belt cover sealing • Coolant leakage at water pump • Camshaft not functioning properly • Distributor not functioning properly • Excessive belt tension
Oil/Coolant or water is stuck to belt.	—	• Poor oil sealing of each oil seal • Coolant leakage at water pump • Poor belt cover sealing



BELT TENSIONER AND TENSIONER SPRING

NEEM0011S01

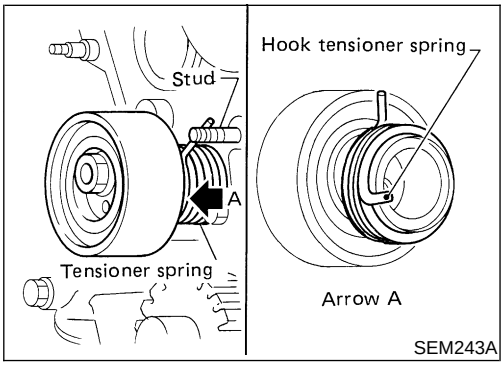
1. Check belt tensioner for smooth turning.
2. Check condition of tensioner spring.



Installation

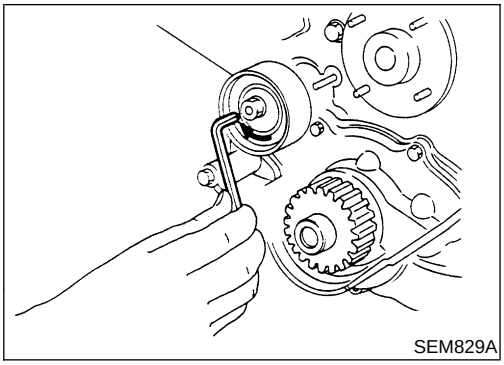
NEEM0012

1. Confirm that No. 1 piston is set at TDC on its compression stroke.

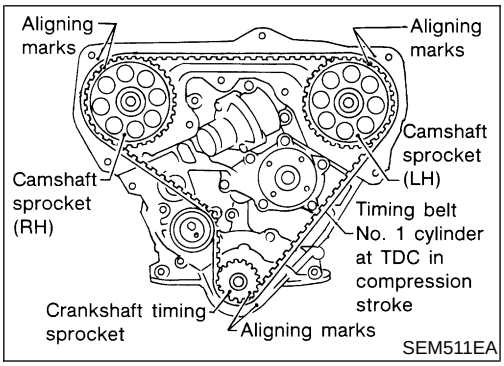


2. Install tensioner and tensioner spring.

Once stud is removed, apply locking sealant to threads of stud on cylinder block side before installing.


SEM829A

3. Turn tensioner fully outward with hexagon wrench, and temporarily tighten lock nut.

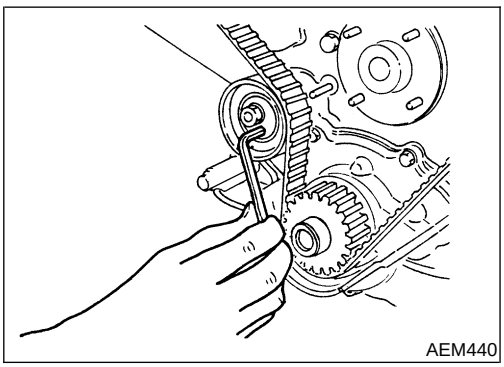


SEM511EA

4. Set timing belt when engine is cold.
1) Align white lines on timing belt with punchmarks on camshaft sprockets and crankshaft sprocket.
2) Point arrow on timing belt toward front belt cover.

Number of teeth (reference):

Number of timing belt teeth		133
Number of teeth between timing marks	Between LH and RH camshaft sprockets	40
	Between LH camshaft sprocket and crankshaft timing sprocket	43


AEM440

Tension Adjustment

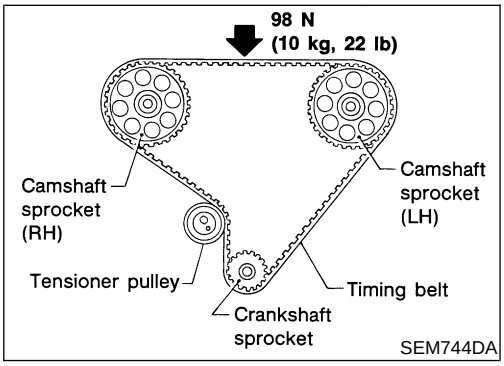
NEEM0040

AFTER BELT REPLACEMENT

NEEM0040S01

If the timing belt was replaced (or to adjust tension on a used belt), follow the steps below.

1. Loosen tensioner lock nut, then turn tensioner clockwise and counterclockwise with hexagon wrench at least 2 times.



SEM744DA

2. Tighten tensioner lock nut.
3. Turn crankshaft clockwise at least 2 times, then slowly set No. 1 piston at TDC on its compression stroke.
4. Measure deflection of timing belt midway between camshaft pulleys while pushing with 98 N (10 kg, 22 lb) force.

Belt deflection when engine is cold (Reference value):
13 - 15 mm (0.51 - 0.59 in)/98 N (10 kg, 22 lb)

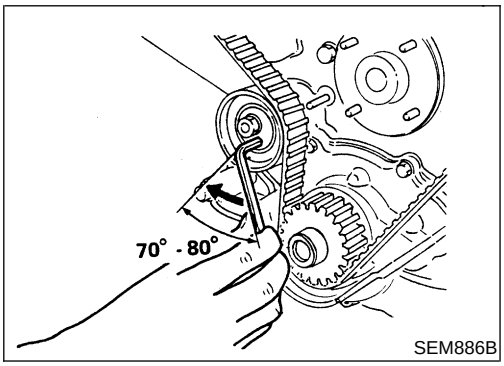
5. If NG, return to step 1.

AFTER ENGINE OVERHAUL OR ENGINE REASSEMBLY (WITH ROCKER COVERS REMOVED)

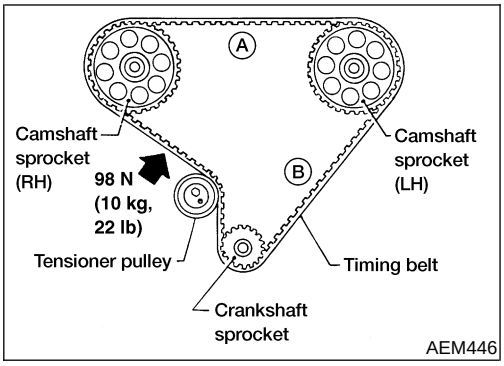
NEEM0040S02

If the engine was overhauled or previously disassembled (i.e. intake manifold and/or cylinder head were removed), follow the steps below.

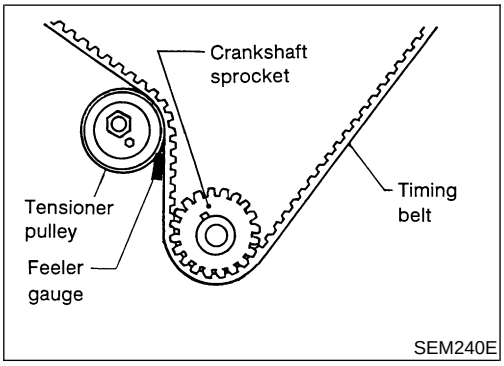
1. Loosen rocker shaft bolts to relieve belt tension caused by the cam shafts.



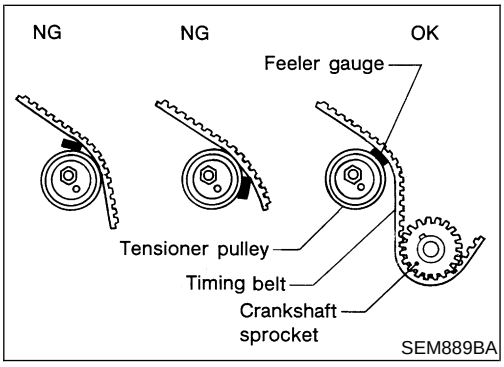
2. Loosen tensioner lock nut, keeping tensioner steady with hexagon wrench.
3. Turn tensioner 70 to 80 degrees clockwise with hexagon wrench to release belt tension, and temporarily tighten lock nut.
4. Turn crankshaft clockwise at least two times, then slowly set No. 1 piston at TDC on its compression stroke.



5. Push middle of timing belt between RH camshaft sprocket and tensioner pulley with force of 98 N (10 kg, 22 lb) to apply tensions on part A and part B.
6. Loosen tensioner lock nut, keeping tensioner steady with hexagon wrench.

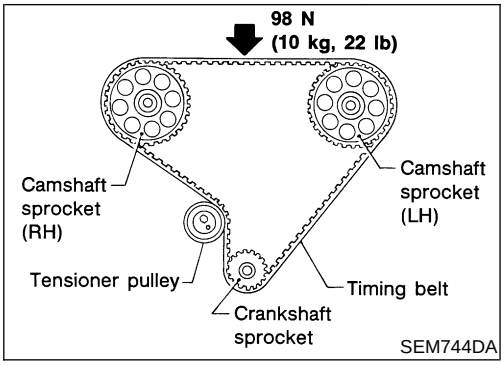


7. Set feeler gauge as shown in figure which is 0.5 mm (0.0206 in) thick and 12.7 mm (0.500 in) wide.



8. Turn crankshaft clockwise until feeler gauge is positioned as shown in figure.
- Timing belt will move about 2.5 teeth.

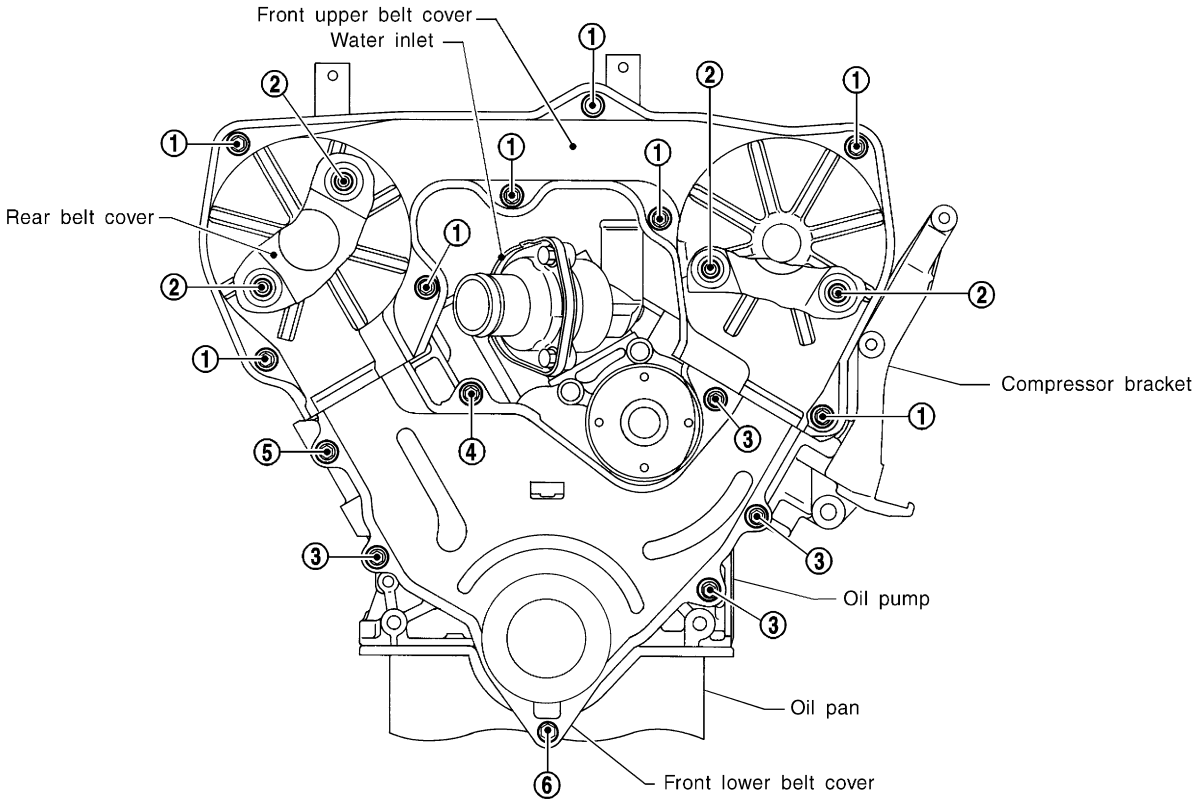
9. Tighten tensioner lock nut, keeping tensioner steady with hexagon wrench.
10. Turn crankshaft clockwise or counterclockwise, and remove feeler gauge.
11. Turn crankshaft clockwise at least two times, then slowly set No. 1 piston at TDC on its compression stroke.



12. Measure deflection of timing belt midway between camshaft pulleys while pushing with 98 N (10 kg, 22 lb) force.

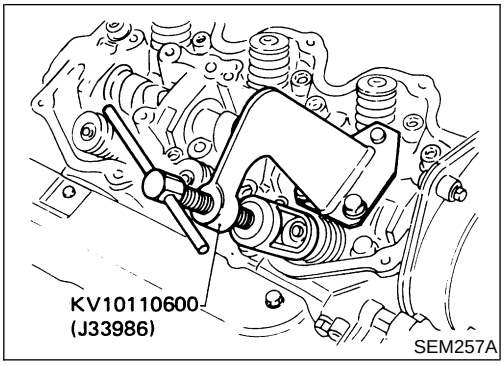
Belt deflection when engine is cold (Reference value): 13 - 15 mm (0.51 - 0.59 in)/98 N (10 kg, 22 lb)

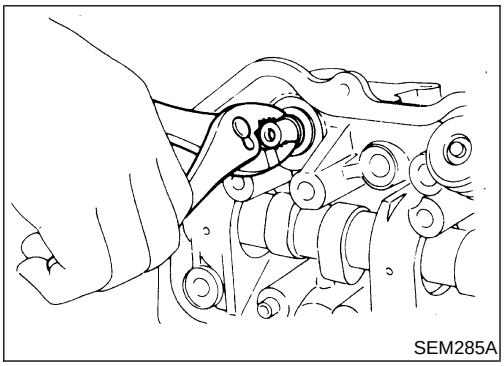
13. If NG, return to step 1.
14. Install lower and upper belt covers.

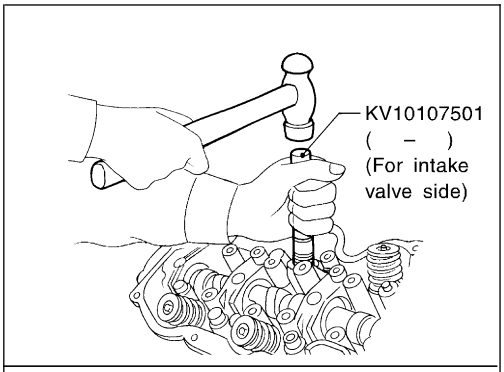


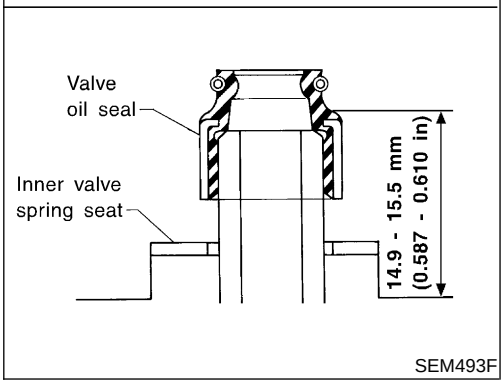
No.	Tightened parts		No.	Tightened parts	
①	Bolt, Rubber washer, Front upper belt cover, Welded nut	8 pcs.	④	Bolt, Rubber washer, Front lower belt cover	1 pc.
②	Hexagon bolt with washer, Rear belt cover	4 pcs.	⑤	Bolt, Rubber washer, Front lower belt cover	1 pc.
③	Bolt, Rubber washer, Front lower belt cover	4 pcs.	⑥	Bolt, Front lower belt cover, Lock spring washer	1 pc.

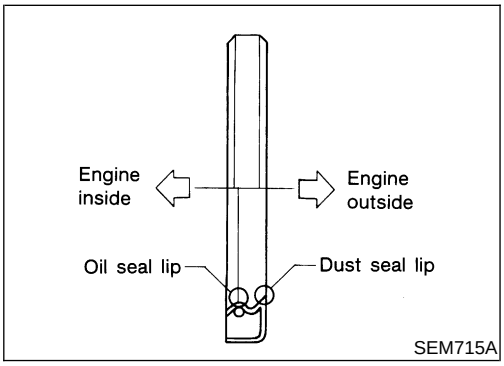
SEM313F











Replacement

NEEM0013

VALVE OIL SEAL

NEEM0013S01

1. Remove rocker cover.
2. Remove rocker shaft assembly and valve lifters with valve lifter guide.
3. Remove valve springs and valve oil seal.

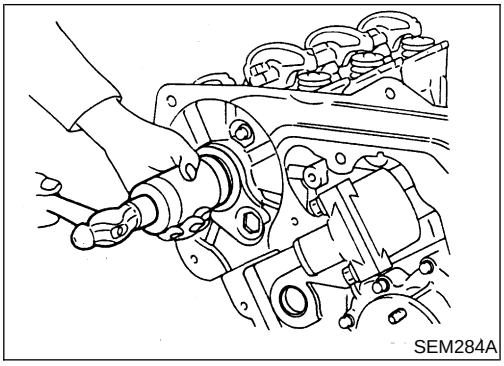
- Piston concerned should be set at TDC to prevent valve from falling.
- When removing intake side valve oil seal, use Tool or suitable tool.
- When removing exhaust side valve oil seal, pull it out with suitable tool.

4. Apply engine oil to new valve oil seal and install it.

- Before installing valve oil seal, install inner valve spring seat.
- When installing intake side valve oil seal, use Tool.
- When installing exhaust side valve oil seal, set it by hand.

OIL SEAL INSTALLING DIRECTION

NEEM0013S02


SEM284A

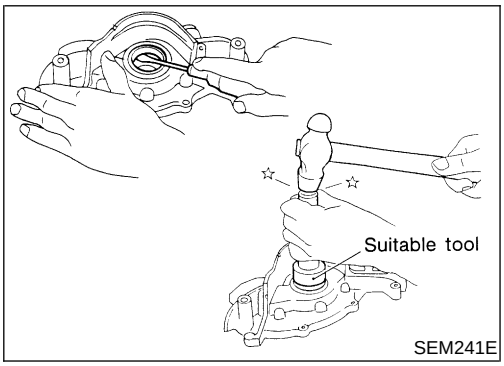
CAMSHAFT OIL SEAL

NEEM0013S03

1. Remove timing belt.
2. Remove camshaft sprocket.
3. Remove camshaft.
4. Remove camshaft oil seal.

Be careful not to scratch camshaft.

5. Apply engine oil to new camshaft oil seal.

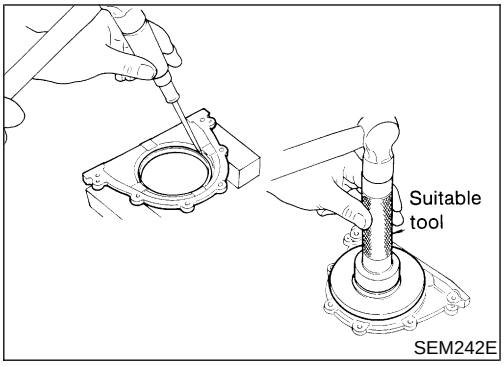


SEM241E

FRONT OIL SEAL

NEEM0013S04

1. Remove timing belt and crankshaft sprocket.
2. Remove oil pump assembly.
3. Remove front oil seal from oil pump body.
4. Apply engine oil to new oil seal and install it using suitable tool.



SEM242E

REAR OIL SEAL

NEEM0013S05

1. Remove drive plate.
2. Remove rear oil seal retainer.
3. Remove rear oil seal from retainer.

- Be careful not to scratch rear oil seal retainer.

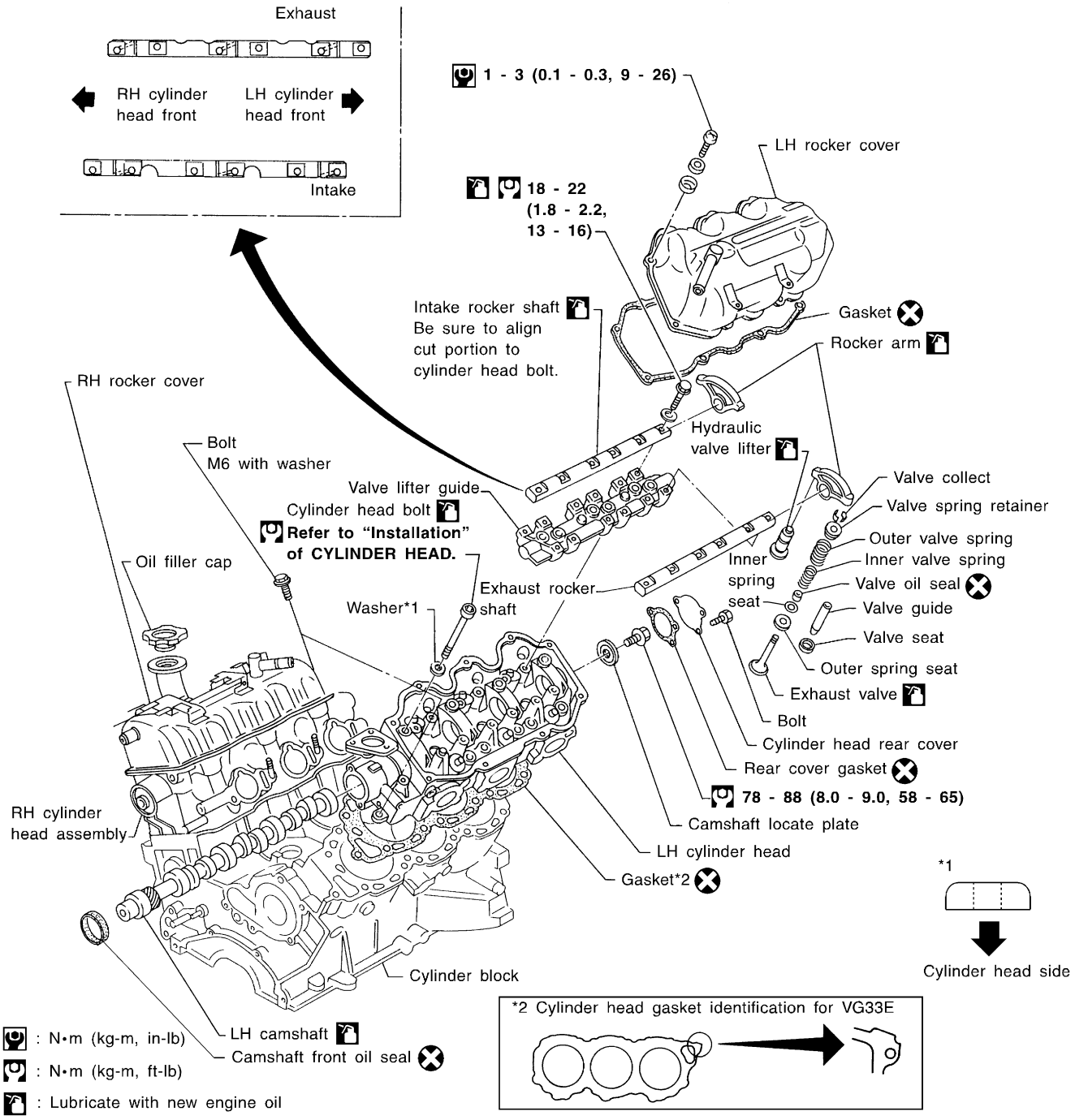
4. Apply engine oil to new oil seal and install it using suitable tool.
5. Install rear oil seal retainer with a new gasket to cylinder block.

- Always use a new oil seal retainer to cylinder block gasket.

Components

NEEM0014

SEC. 102•111•130

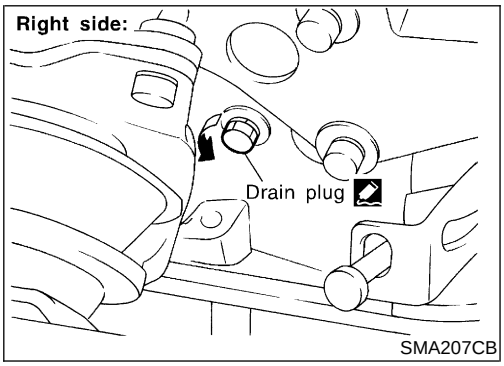


AEM473

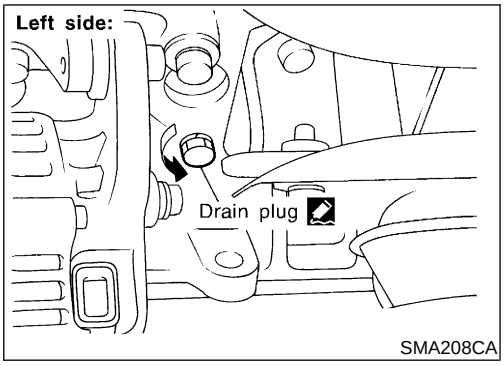
Removal

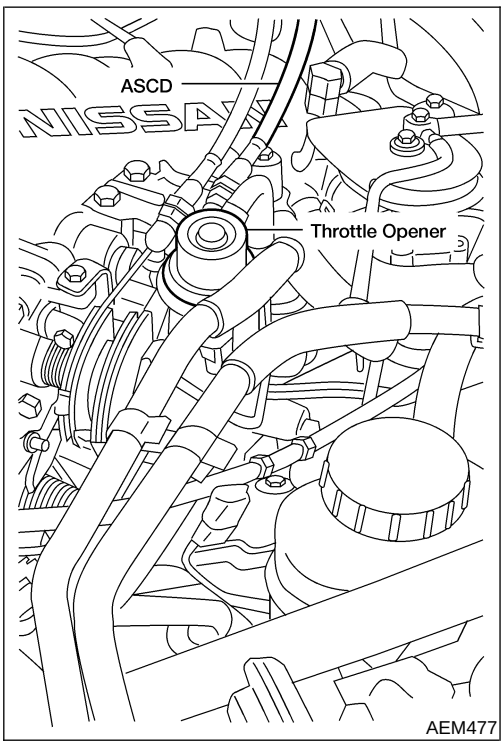
NEEM0015

1. Release fuel pressure.
   Refer to “Releasing Fuel Pressure”, ***EC-620***.
2. Remove timing belt.
   Refer to “TIMING BELT”, “Removal”, EM-78.



3. Drain coolant by removing drain plugs from both sides of cylinder block.





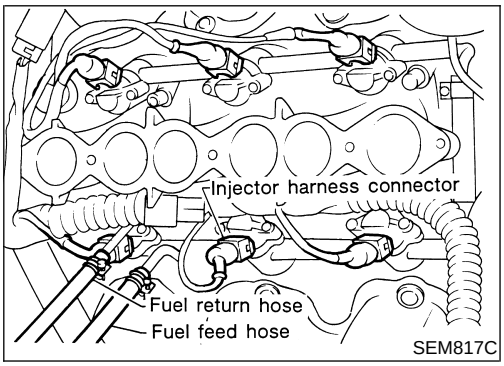
4. Separate ASCD and accelerator control wire from intake manifold collector.
5. Remove intake manifold collector from engine. The following parts should be disconnected to remove intake manifold collector.

a. Harness connectors for:
- IACV-AAC valve
- Throttle position sensor
- Throttle position switch
- Ignition coil
- Power transistor
- EGRC-solenoid valve
- EGR temperature sensor

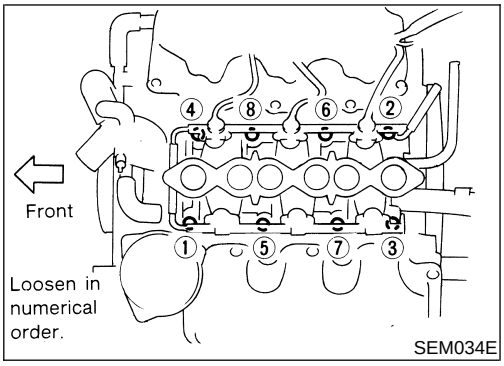
b. Water hoses from collector
c. Heater hoses
d. PCV hose from RH rocker cover
e. Vacuum hoses for:
- EVAP canister
- Master brake cylinder
- Pressure regulator

f. Purge hose from EVAP canister

g. EGR tube
h. Spark plug wires
i. Distributor cap
j. 3 left bank injector connectors
k. Thermal transmitter
l. Ground harness
m. Breather pipe

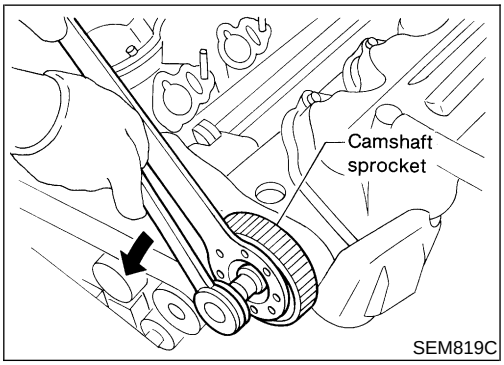


6. Remove fuel feed and fuel return hoses from injector fuel tube assembly.
7. Disconnect the right injector harness connectors.
8. Remove injector fuel tube assembly.



9. Remove intake manifold from engine. The following parts should be disconnected to remove intake manifold.

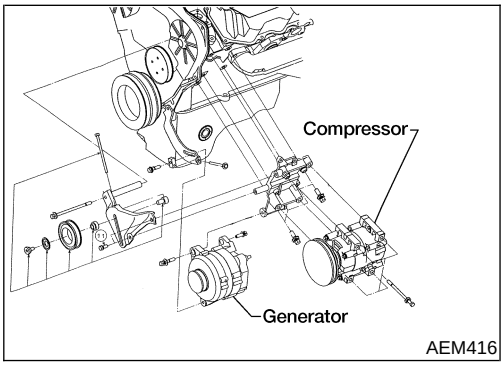
a. Engine coolant temperature switch harness connector
b. Thermal transmitter harness connector
c. Water hose from thermostat housing



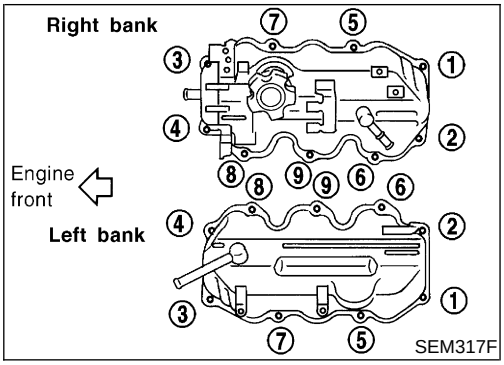
10. Remove both camshaft sprockets.
11. Remove rear timing belt cover.
12. Remove distributor and ignition wires.

After pulling out distributor from cylinder head, do not rotate distributor rotor.

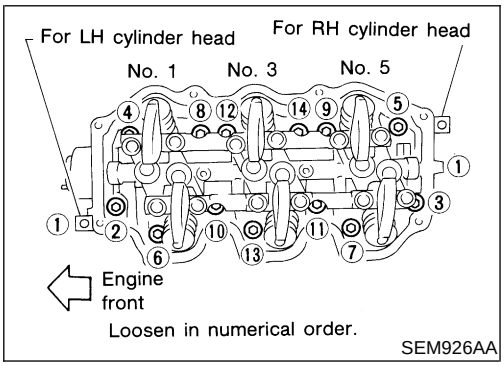
13. Remove harness clamp from RH rocker cover.
14. Remove exhaust tube from exhaust manifold.



15. Remove compressor and generator.
16. Remove power steering pump.
17. Remove the compressor, generator and power steering pump brackets.



18. Remove both rocker covers.

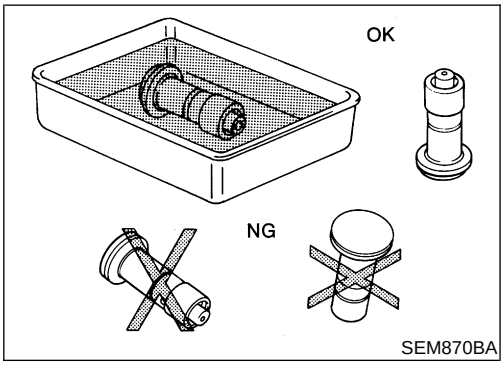


19. Remove cylinder head with exhaust manifold.
- **A warped or cracked cylinder head could result from removing in incorrect order.**
- **Cylinder head bolts should be loosened in two or three steps.**

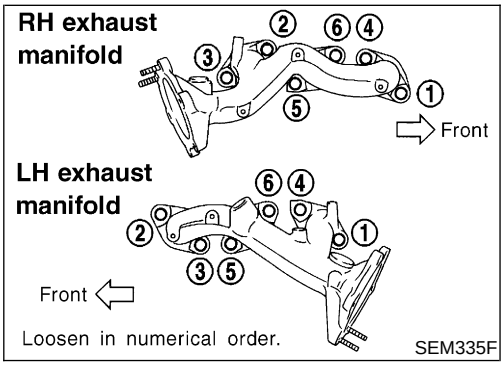
Disassembly

NEEM0016

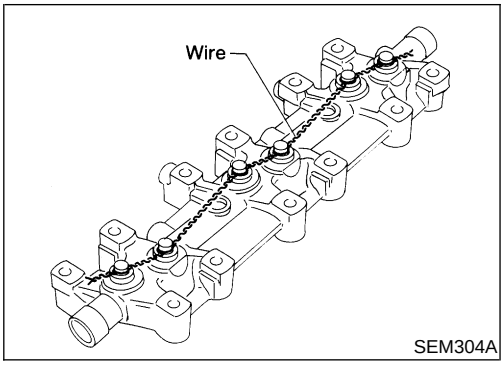
CAUTION:
- **When installing sliding parts such as rocker arms, camshaft and oil seal, be sure to apply new engine oil on their sliding surfaces.**
- **When tightening cylinder head bolts and rocker shaft bolts, apply new engine oil to thread portions and seat surfaces of bolts.**



- **If hydraulic valve lifter is kept on its side, there is a risk of air entering it. After removal, always set hydraulic valve lifter straight up, or when laying it on its side, have it soak in new engine oil.**
- **Do not disassemble hydraulic valve lifter.**
- **Attach tags to valve lifters so as not to mix them up.**



1. Remove exhaust manifolds from cylinder head.



2. Remove rocker shafts with rocker arms.

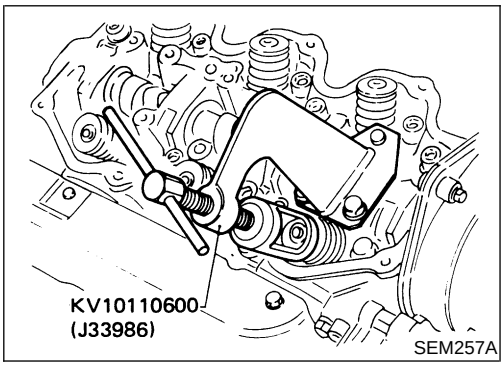
Bolts should be loosened in two or three steps.

3. Remove hydraulic valve lifters and lifter guide.

- **Hold hydraulic valve lifters with wire so that they will not drop from lifter guide.**

4. Remove oil seal and camshaft.

- **Before removing camshaft, measure camshaft end play.**



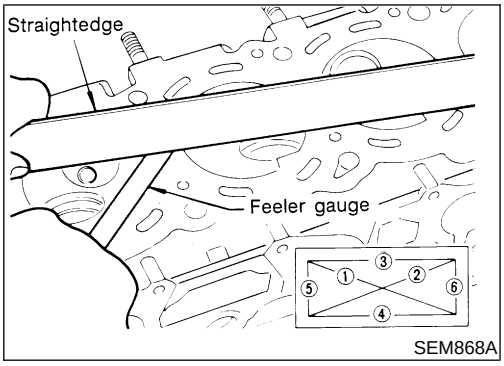
5. Remove valve components with Tool.
6. Remove valve oil seals with Tool or suitable tool.

Inspection

NEEM0017

CYLINDER HEAD DISTORTION

NEEM0017S01



Head surface flatness:

Less than 0.1 mm (0.004 in)

If beyond the specified limit, resurface it or replace it.

Resurfacing limit:

The resurfacing limit of cylinder head is determined by the cylinder block resurfacing in an engine.

Amount of cylinder head resurfacing is "A".

Amount of cylinder block resurfacing is "B".

The maximum limit is as follows:

A + B = 0.2 mm (0.008 in)

After resurfacing cylinder head, check that camshaft rotates freely by hand. If resistance is felt, cylinder head must be replaced.

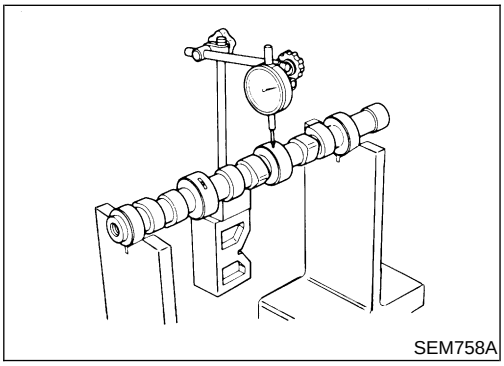
Nominal cylinder head height:

106.8 - 107.2 mm (4.205 - 4.220 in)

CAMSHAFT VISUAL CHECK

NEEM0017S02

Check camshaft for scratches, seizure and wear.



CAMSHAFT RUNOUT

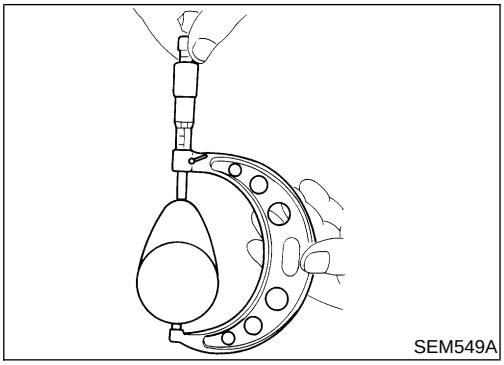
NEEM0017S03

1. Measure camshaft runout at the center journal.

Runout (Total indicator reading):

Limit 0.1 mm (0.004 in)

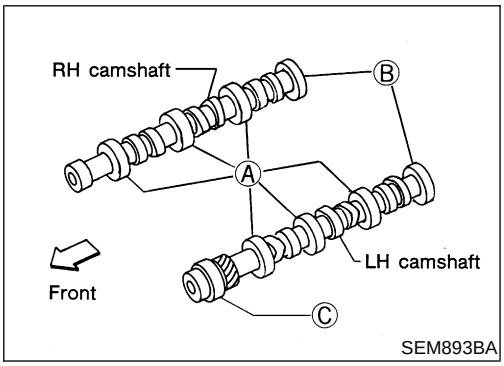
2. If it exceeds the limit, replace camshaft.


SEM549A

CAMSHAFT CAM HEIGHT

NEEM0017S04

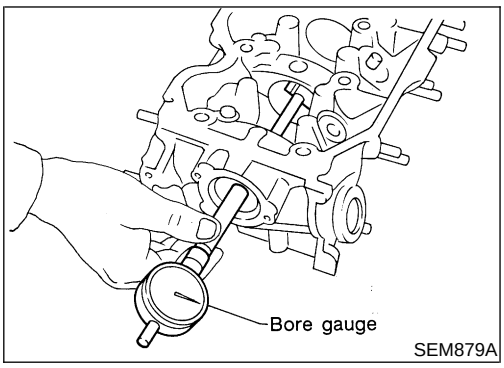
1. Measure camshaft cam height.
   Standard cam height:
   Intake and exhaust:
   38.943 - 39.133 mm (1.5332 - 1.5407 in)
   Cam wear limit:
   0.15 mm (0.0059 in)
2. If wear is beyond the limit, replace camshaft.



SEM893BA

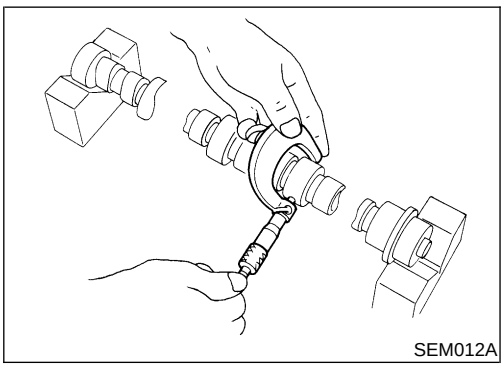
CAMSHAFT JOURNAL CLEARANCE

NEEM0017S05

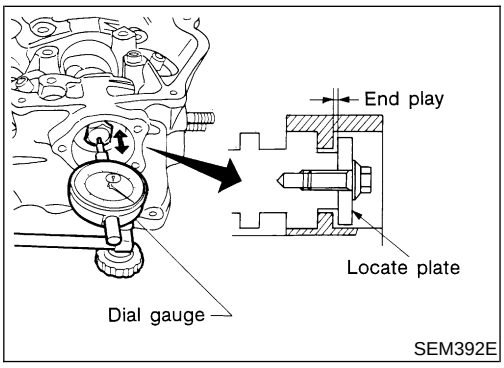


SEM879A

1. Measure inner diameter of camshaft bearing.
   Standard inner diameter:
   A 47.000 - 47.025 mm (1.8504 - 1.8514 in)
   B 42.500 - 42.525 mm (1.6732 - 1.6742 in)
   C 48.000 - 48.025 mm (1.8898 - 1.8907 in)


SEM012A

2. Measure outer diameter of camshaft journal.
   Standard outer diameter:
   A 46.920 - 46.940 mm (1.8472 - 1.8480 in)
   B 42.420 - 42.440 mm (1.6701 - 1.6709 in)
   C 47.920 - 47.940 mm (1.8866 - 1.8874 in)
3. If clearance exceeds the limit, replace camshaft and/or cylinder head.
   Camshaft journal clearance limit:
   0.15 mm (0.0059 in)



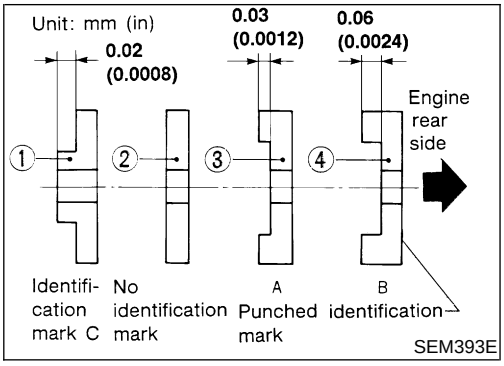
SEM392E

CAMSHAFT END PLAY

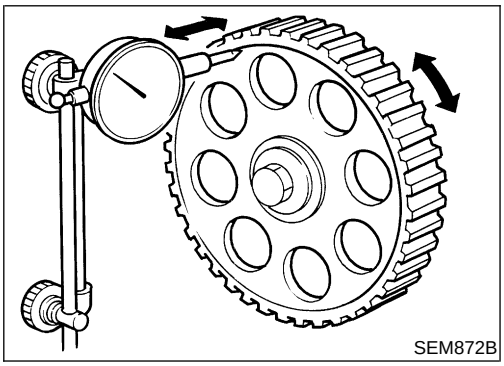
NEEM0017S06

1. Install camshaft and locate plate in cylinder head.
2. Measure camshaft end play.
   Camshaft end play:
   Standard:
   0.03 - 0.06 mm (0.0012 - 0.0024 in)

Inspection (Cont'd)



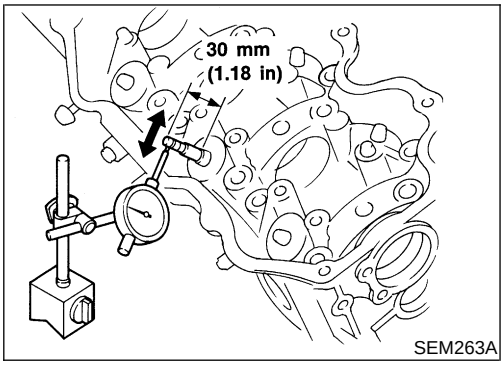
3. If it is out of the specified range, select thickness of camshaft locate plate to obtain standard specified end play.
   Example:
   When camshaft end play is 0.08 mm (0.0031 in) with camshaft locate plate 2, replace camshaft locate plate 2 with camshaft locate plate 3 to set the end play at 0.05 mm (0.0020 in).



CAMSHAFT SPROCKET RUNOUT

NEEM0017S07

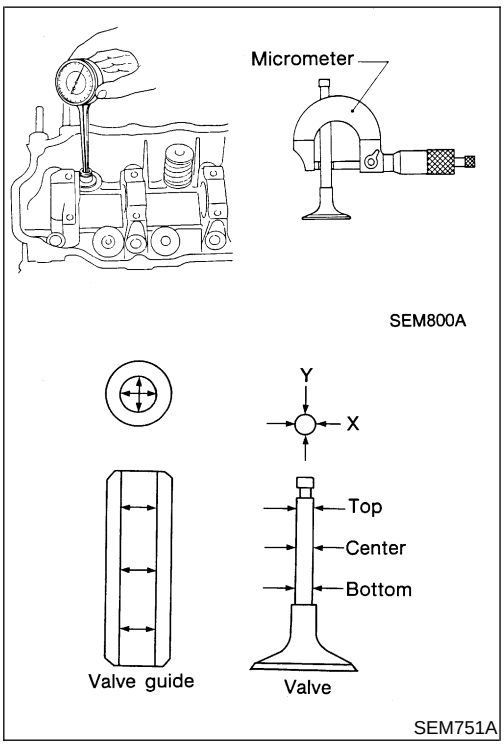
1. Install sprocket on camshaft.
2. Measure camshaft sprocket runout.
   Runout (Total indicator reading):
   Limit:
   0.1 mm (0.004 in)
3. If it exceeds the limit, replace camshaft sprocket.



VALVE GUIDE CLEARANCE

NEEM0017S08

1. Measure valve deflection in a right-angled direction with camshaft. (Valve and valve guide mostly wear in this direction.)
   Valve deflection limit (Dial gauge reading):
   0.20 mm (0.0079 in)

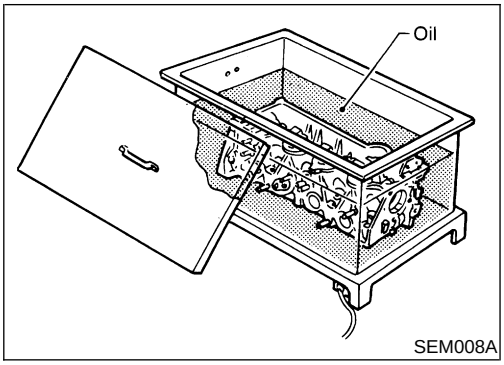


2. If it exceeds the limit, check valve to valve guide clearance.

a. Measure valve stem diameter and valve guide inner diameter.

b. Check that clearance is within specification.
   Valve to valve guide clearance:
   Intake:
   0.020 - 0.053 mm (0.0008 - 0.0021 in)
   Exhaust:
   0.030 - 0.049 mm (0.0012 - 0.0019 in)
   Limit:
   0.10 mm (0.0039 in)

c. If it exceeds the limit, replace valve or valve guide.

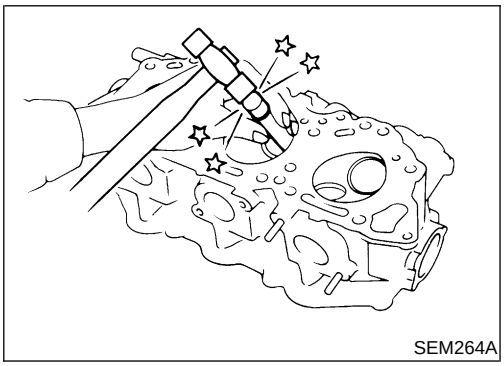


SEM008A

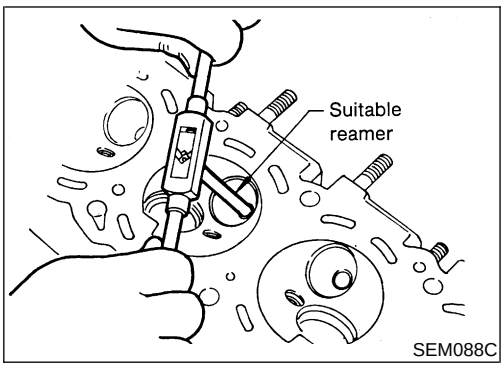
VALVE GUIDE REPLACEMENT

NEEM0017S09

1. To remove valve guide, heat cylinder head to 150 to 160°C (302 to 320°F) by soaking in heated oil.

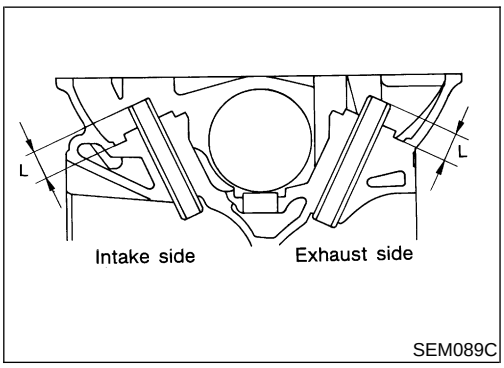

SEM264A

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



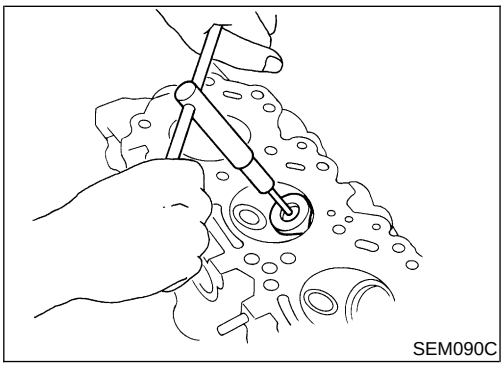
SEM088C

3. Ream cylinder head valve guide hole.
   Valve guide hole diameter (for service parts):
   Intake:
   11.175 - 11.196 mm (0.4400 - 0.4408 in)
   Exhaust:
   12.175 - 12.196 mm (0.4793 - 0.4802 in)



SEM089C

4. Heat cylinder head to 150 to 160°C (302 to 320°F) and press service valve guide onto cylinder head.
   Projection "L":
   13.2 - 13.4 mm (0.520 - 0.528 in)
5. Ream valve guide.
   Finished size:
   Intake:
   7.000 - 7.018 mm (0.2756 - 0.2763 in)
   Exhaust:
   8.000 - 8.011 mm (0.3150 - 0.3154 in)

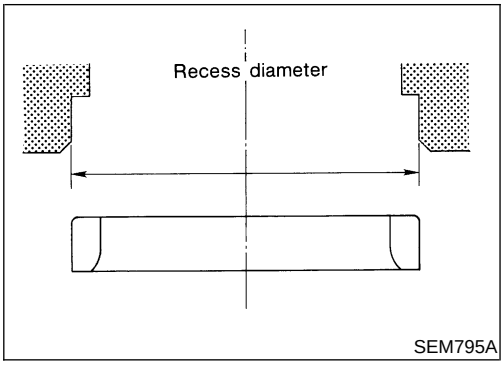

SEM090C

VALVE SEATS

NEEM0017S10

Check valve seats for any evidence of pitting at valve contact surface, and reseat or replace if it has worn out excessively.

- **Before repairing valve seats, check valve and valve guide for wear. If they have worn, replace them. Then correct valve seat.**
- **Use both hands to cut uniformly.**



SEM795A

REPLACING VALVE SEAT FOR SERVICE PARTS

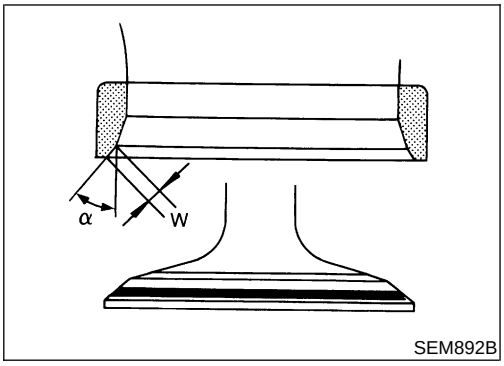
=NEEM0017S11

1. Bore out old seat until it collapses. The machine depth stop should be set so that boring cannot continue beyond the bottom face of the seat recess in cylinder head.
2. Ream cylinder head recess.

Reaming bore for service valve seat:
Oversize [0.5 mm (0.020 in)]:
Intake:
44.500 - 44.516 mm (1.7520 - 1.7526 in)
Exhaust:
37.500 - 37.516 mm (1.4764 - 1.4770 in)

Reaming should be done in circles concentric to the valve guide center so that valve seat will have the correct fit.

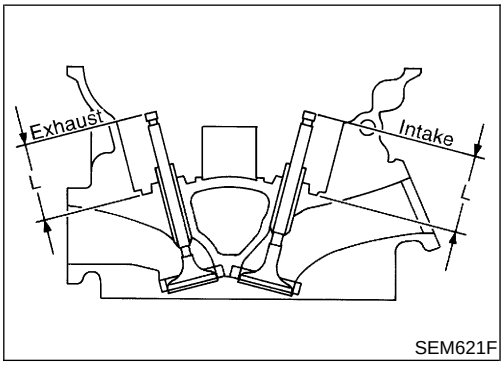
3. Heat cylinder head to 150 to 160°C (302 to 320°F) by soaking in heated oil.
4. Press fit valve seat until it seats on the bottom.



SEM892B

5. Cut or grind valve seat using suitable tool at the specified dimensions as shown in SDS (EM-117).
6. After cutting, lap valve seat with abrasive compound.
7. Check valve seating condition.

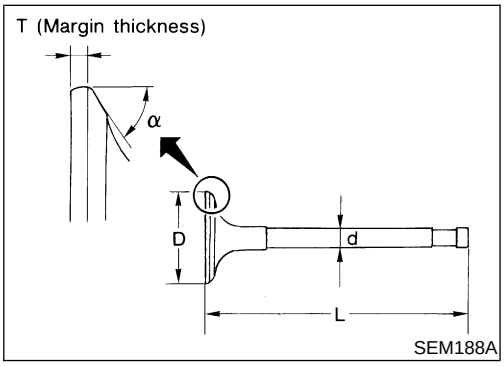
	Intake	Exhaust
Seat face angle "α" degree	45	45
Contacting width "W" mm (in)	1.75 (0.0689)	1.7 (0.067)



SEM621F

8. Use a depth gauge to measure the distance between the mounting surface of the cylinder head spring seat and the valve stem end. If the distance is shorter than specified, repeat step 5 above to adjust it. If it is longer, replace the valve seat with a new one.

Intake:
44.7 - 44.9 mm (1.760 - 1.768 in)
Exhaust:
45.4 - 45.6 mm (1.787 - 1.795 in)

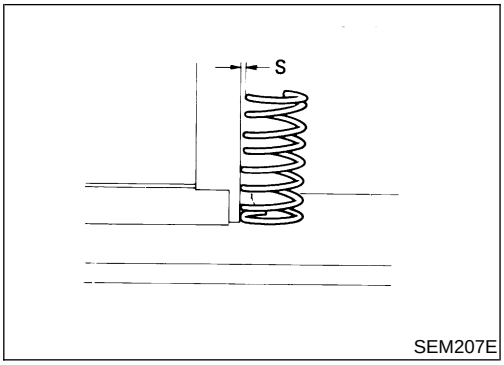


SEM188A

VALVE DIMENSIONS

NEEM0017S12

Check dimensions in each valve. For dimensions, refer to SDS.
When valve head has been worn down to 0.5 mm (0.020 in) in margin thickness, replace valve.
Grinding allowance for valve stem tip is 0.2 mm (0.008 in) or less.



SEM207E

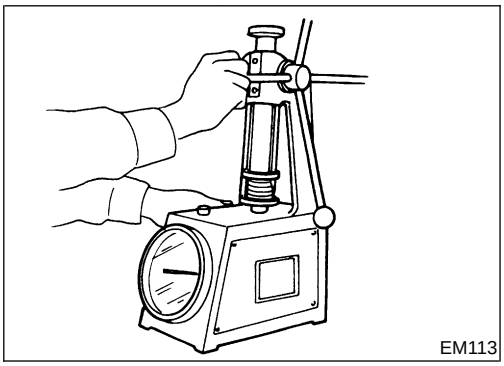
VALVE SPRING

NEEM0017S13

Squareness

NEEM0017S1301

1. Measure "S" dimension.
   Out-of-square:
   Outer:
   Less than 2.2 mm (0.087 in)
   Inner:
   Less than 1.9 mm (0.075 in)
2. If it exceeds the limit, replace spring.


EM113

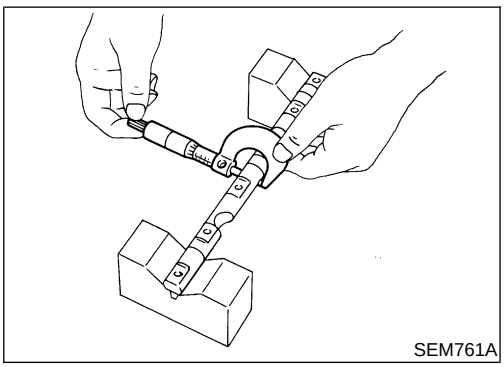
Pressure

NEEM0017S1302

Check valve spring pressure.

Standard pressure: N (kg, lb) at height mm (in)
Outer:
523.7 (53.4, 117.7) at 30.0 (1.181)
Inner:
255.0 (26.0, 57.3) at 25.0 (0.984)
Limit pressure: N (kg, lb) at height mm (in)
Outer:
More than 228.5 (23.3, 51.4) at 25.0 (0.984)
Inner:
More than 225.6 (23.0, 50.7) at 25.0 (0.984)

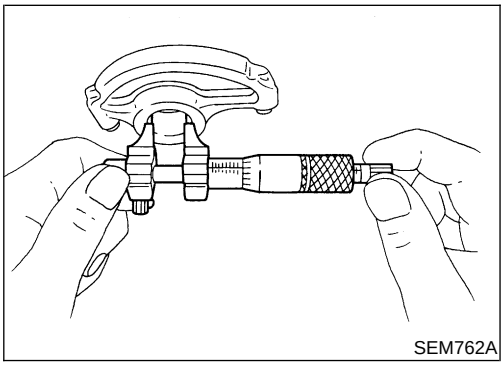
If it exceeds the limit, replace spring.


SEM761A

ROCKER SHAFT AND ROCKER ARM

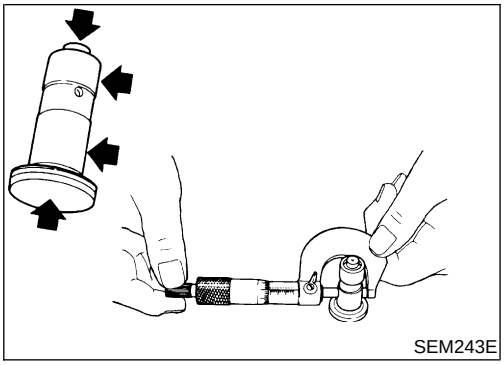
NEEM0017S14

1. Check rocker shafts for scratches, seizure and wear.
2. Check outer diameter of rocker shaft.
   Diameter:
   17.979 - 18.000 mm (0.7078 - 0.7087 in)


SEM762A

3. Check inner diameter of rocker arm.
   Diameter:
   18.007 - 18.028 mm (0.7089 - 0.7098 in)
   Rocker arm to shaft clearance:
   0.007 - 0.049 mm (0.0003 - 0.0019 in)

- **Keep rocker arm with hydraulic valve lifter standing to prevent air from entering hydraulic valve lifter when checking.**

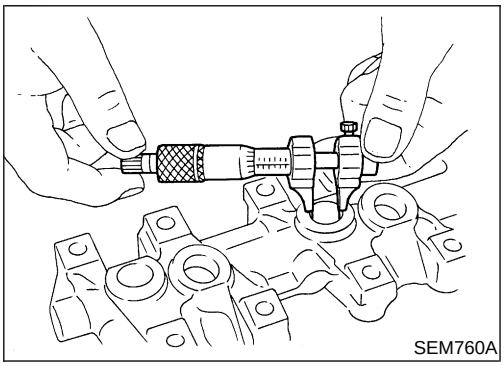

SEM243E

HYDRAULIC VALVE LIFTER

NEEM0017S15

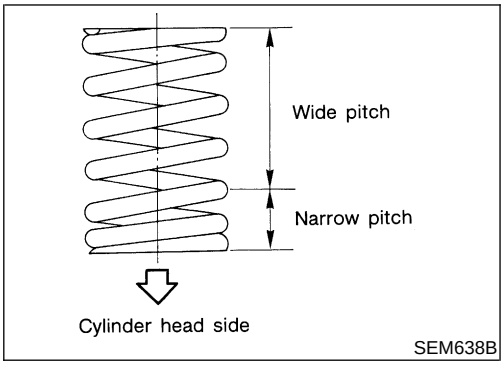
1. Check contact and sliding surfaces for wear or scratches.
2. Check diameter of valve lifter.

Outer diameter:
15.947 - 15.957 mm (0.6278 - 0.6282 in)


SEM760A

3. Check valve lifter guide inner diameter.

Inner diameter:
16.000 - 16.013 mm (0.6299 - 0.6304 in)
Standard clearance between valve lifter and lifter guide:
0.043 - 0.066 mm (0.0017 - 0.0026 in)



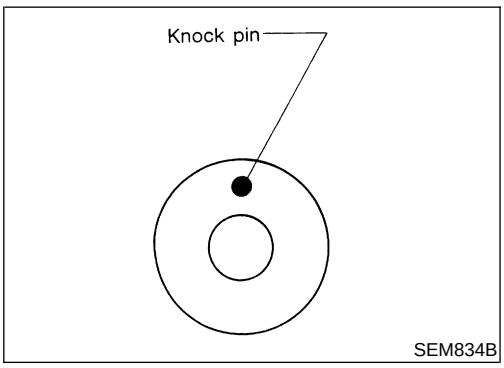
SEM638B

Assembly

NEEM0018

1. Install valve component parts.

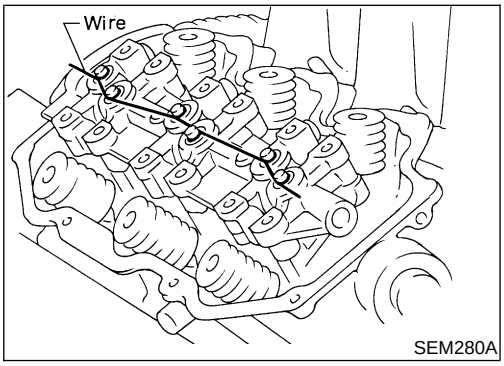
- **Always use new valve oil seal. Refer to OIL SEAL REPLACEMENT (EM-84).**
- **Before installing valve oil seal, install inner valve spring seat.**
- **Install outer valve spring (uneven pitch type) with its narrow pitch side toward cylinder head side.**
- **After installing valve component parts, use plastic hammer to lightly tap valve stem tip to assure a proper fit.**



SEM834B

2. Install camshafts, locate plates and cylinder head rear covers.

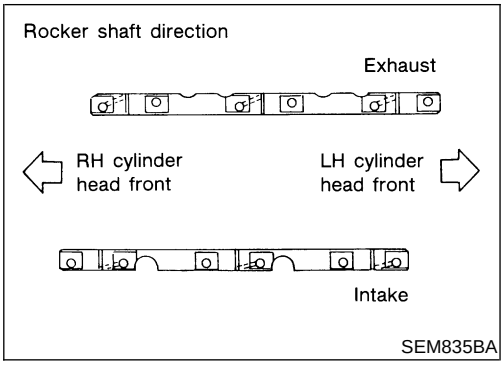
- **Set knock pin of camshaft at the top.**



SEM280A

3. Install valve lifters into valve lifter guide.

- **Assemble valve lifters to their original position and hold all valve lifters with wire to prevent lifters from falling off.**
- **After installing, remove the wire.**



4. Install rocker shafts with rocker arms.
- **Tighten bolts gradually in two or three stages.**
- **Before tightening, be sure to set camshaft the lobe at the position where lobe is not lifted.**

a. Set No. 1 piston at TDC on its compression stroke and tighten rocker shaft bolts for No. 2, No. 4 and No. 6 cylinders.
b. Set No. 4 piston at TDC on its compression stroke and tighten rocker shaft bolts for No. 1, No. 3 and No. 5 cylinders.

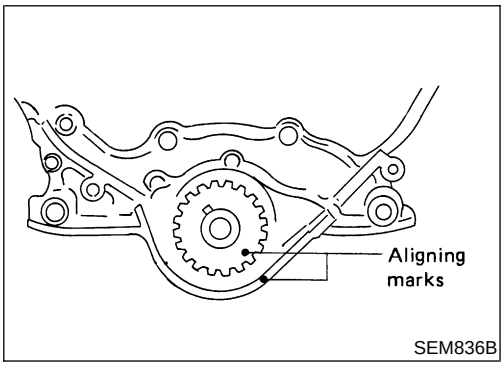
5. Install exhaust manifold to cylinder head in reverse order of removal.

Installation

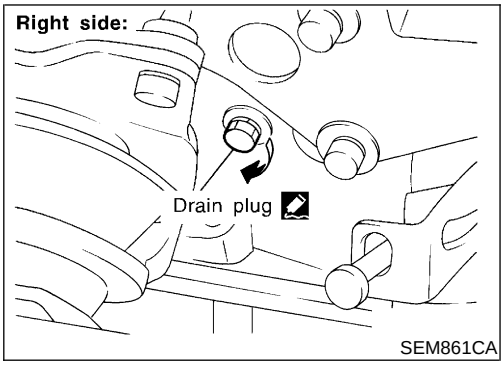
NEEM0019

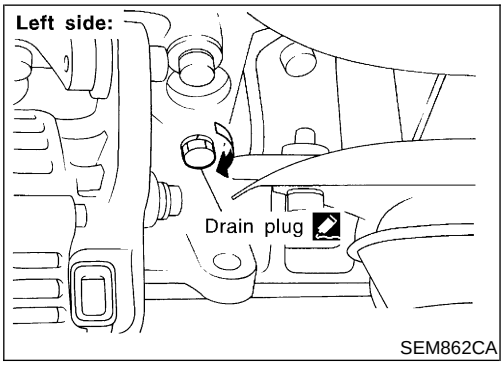
1. Set No. 1 piston at TDC on its compression stroke as follows:

a. Align crankshaft sprocket aligning mark with mark on oil pump body.
b. Confirm that knock pin on camshaft is set at the top.

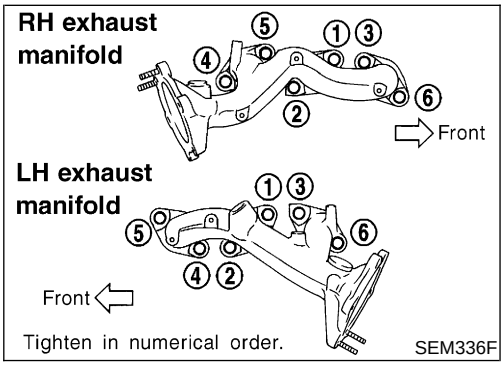


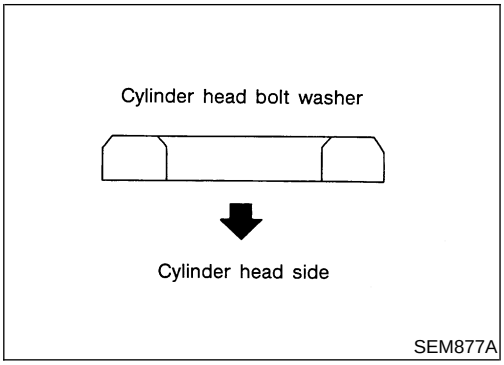
2. Install both drain plugs.
- Use Genuine RTV silicone sealant Part No. 999MP-A7007 or equivalent.





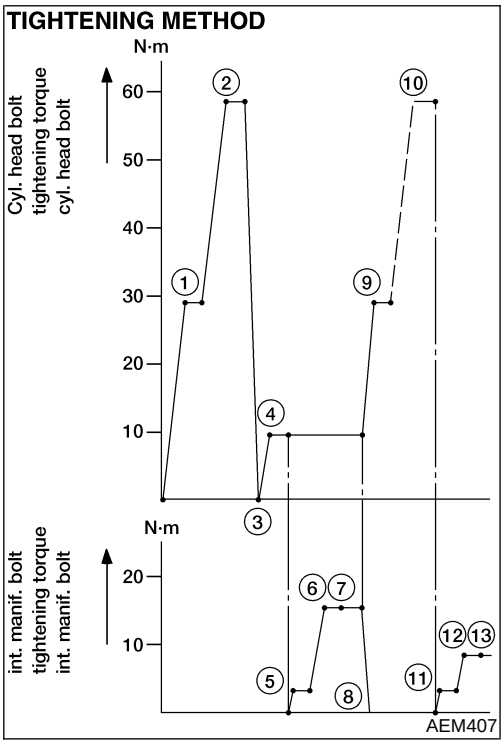
3. Install exhaust manifolds to cylinder head.





4. Install cylinder head with new gasket.

- **Be sure to install washers between bolts and cylinder head.**
- **Do not rotate crankshaft and camshaft separately, or valves will hit piston heads.**

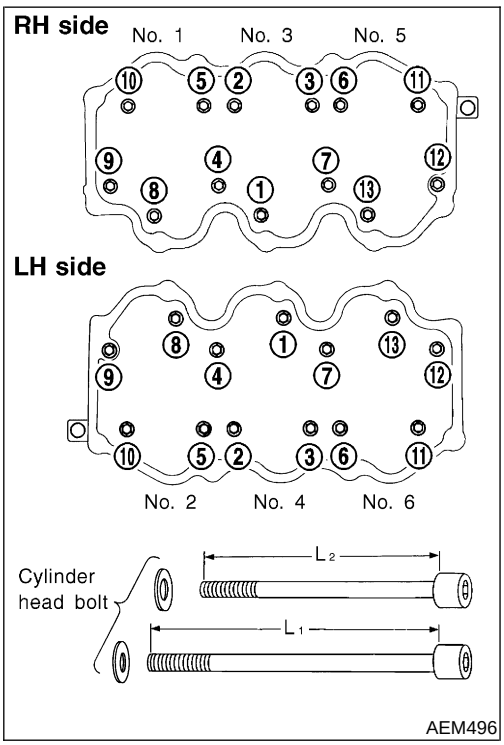


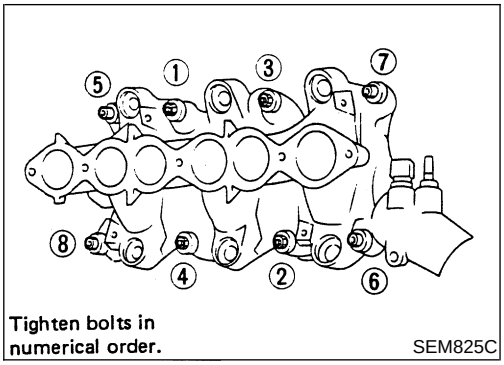
5. Tighten cylinder head bolts in numerical order using angle wrench [ST10120000 (J24239-01)].

Apply engine oil to threads and seating surfaces of cylinder head bolts before installing them.

- **Cylinder head bolts for 4, 7, 9 and 12 are longer than the others.**
  L_1: 127 mm (5.00 in) for 4, 7, 9 and 12
  L_2: 106 mm (4.17 in) for others
- **Install intake manifold and cylinder head at the same time using the following procedure:**

1) Tighten cylinder head bolts to 29 N·m (3.0 kg-m, 22 ft-lb).
2) Tighten cylinder head bolts to 59 N·m (6.0 kg-m, 43 ft-lb).
3) Loosen cylinder head bolts completely.
4) Tighten cylinder head bolts to 10 N·m (1.0 kg-m, 7 ft-lb).
5) Tighten intake manifold bolts and nuts to 4 N·m (0.4 kg-m, 2.9 ft-lb).
6) Tighten intake manifold bolts and nuts to 18 N·m (1.8 kg-m, 13 ft-lb).
7) Tighten intake manifold bolts and nuts to 16 to 20 N·m (1.6 to 2.0 kg-m, 12 to 14 ft-lb).
8) Loosen intake manifold bolts and nuts completely.
9) Tighten cylinder head bolts to 29 N·m (3.0 kg-m, 2.2 ft-lb).
10) Turn cylinder head bolts to 60 to 65 degrees clockwise. If an angle wrench is not available, tighten cylinder head bolts to 54 to 64 N·m (5.5 to 6.5 kg-m, 40 to 47 ft-lb).
11) Tighten cylinder head sub-bolts to 9.0 to 11.8 N·m (0.92 to 1.20 kg-m, 6.7 to 8.7 ft-lb).
12) Tighten intake manifold bolts and nuts to 4 N·m (0.4 kg-m, 2.9 ft-lb).
13) Tighten intake manifold bolts and nuts to 9 N·m (0.9 kg-m, 6.5 ft-lb).
14) Tighten intake manifold bolts and nuts to 8 to 10 N·m (0.8 to 1.0 kg-m, 5.8 to 7 ft-lb).



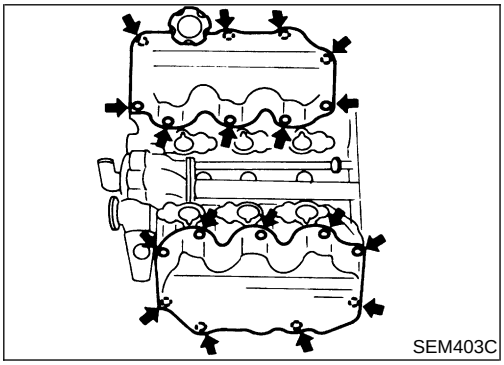


Tighten bolts in numerical order.
SEM825C

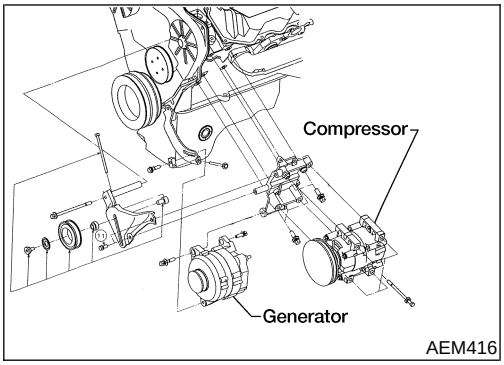
- **If only intake manifold is removed and to be used again, install it using the following procedure:**

1) Tighten all bolts and nuts to 4 N·m (0.4 kg-m, 2.9 ft-lb).
2) Tighten all bolts and nuts to 9 N·m (0.9 kg-m, 6.5 ft-lb).
3) Tighten all bolts and nuts to 8 to 10 N·m (0.8 to 1.0 kg-m, 5.8 to 7 ft-lb).

CAUTION:
If replacing intake manifold with a new one, cylinder head gasket must also be replaced with a new one. Refer to step 4.

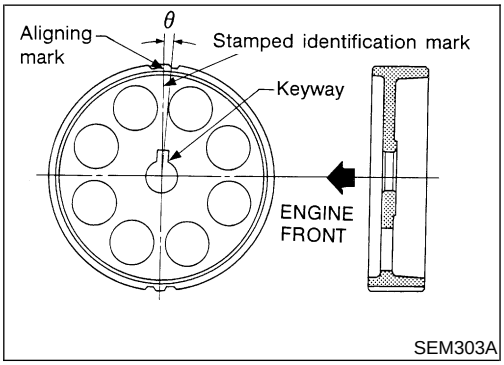

SEM403C

6. Install both rocker covers.



AEM416

7. Install compressor, generator and power steering pump brackets.
8. Install power steering pump.
9. Install compressor and generator.
10. Install exhaust front tube to exhaust manifold.



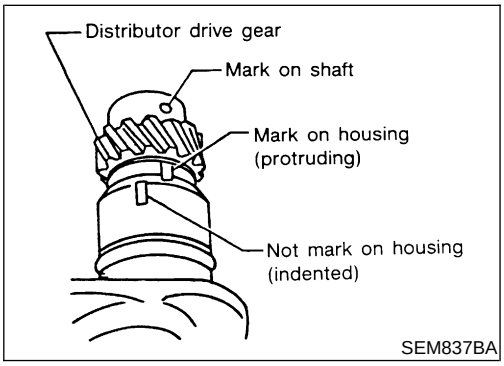
SEM303A

11. Install rear belt cover and camshaft sprocket.

- **RH camshaft sprocket and LH camshaft sprocket are different parts. Be sure to install them in the correct location.**

	Identification mark	θ
RH camshaft sprocket	R3	0°53′
LH camshaft sprocket	L3	−3°27′

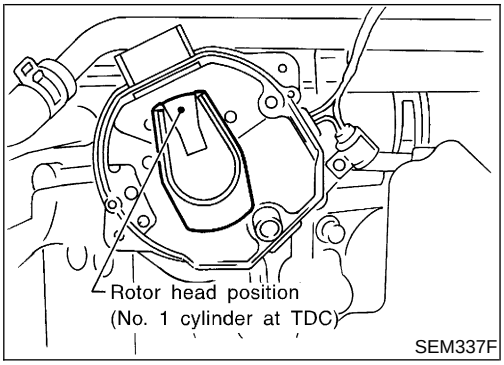
12. Install timing belt and adjust belt tension.
Refer to "TIMING BELT", "Installation", EM-80.



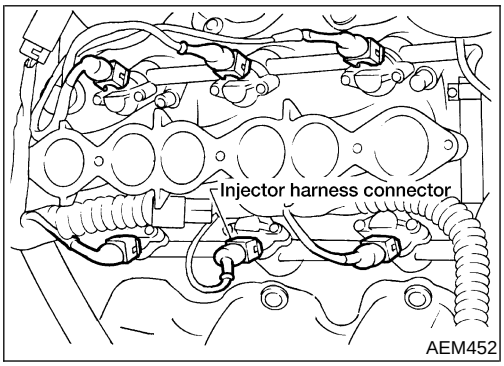
SEM837BA

13. Install distributor.
1) Align mark on shaft with protruding mark on housing.

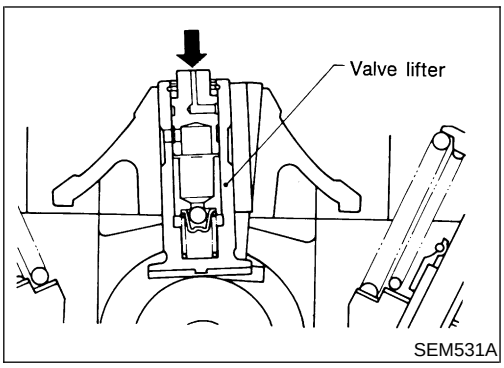
Installation (Cont'd)



2) After installing, confirm that distributor rotor head is set as shown in figure.



14. Install injector fuel tube assembly.
15. Connect all injector harness connectors.
16. Install fuel feed and fuel return hoses to injector fuel tube assembly.
17. Install intake manifold collector. Install all parts which were removed in step 5 under "CYLINDER HEAD", "Removal", EM-87.
18. Install ASCD and accelerator control wire.



19. Check hydraulic valve lifter.

a. Push plunger forcefully with your finger.

- **Be sure to check it with rocker arm in its free position (not on the lobe).**

b. If valve lifter moves more than 1 mm (0.04 in), air may be inside it.

c. Bleed air off by running engine at 1,000 rpm under no load for about 10 minutes.

d. If hydraulic valve lifters are still noisy, replace them and bleed air off again in the same manner as in step 19 (c).

Removal and Installation

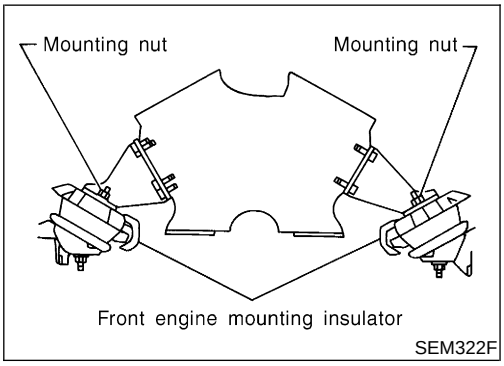
NEEM0020

WARNING:

- **Situate vehicle on a flat and solid surface.**
- **Place chocks at front and back of rear wheels.**
- **Do not remove engine until exhaust system has completely cooled off. Otherwise, you may burn yourself and/or fire may break out in fuel line.**
- **For safety during subsequent steps, the tension of wires should be slackened against the engine.**
- **Before disconnecting fuel hose, release fuel pressure from fuel line.**
  Refer to *EC-620*, "Fuel Pressure Release" .
- **Before removing front axle from transmission, place safety stands under designated front supporting points. Refer to *GI-46*, "Lifting Points and Tow Truck Towing".**
- **Be sure to hoist engine and transmission in a safe manner.**
- **For engines not equipped with engine slingers, attach proper slingers and bolts described in PARTS CATALOG for 1999 models.**

CAUTION:

- **When lifting engine, be careful not to strike adjacent parts, especially accelerator wire casing, brake lines, and brake master cylinder.**
- **In hoisting the engine, always use engine slingers in a safe manner.**
- **Before separating engine and transmission, remove crankshaft position sensor (OBD) from the assembly.**
- **Always take extra care not to damage edge of crankshaft position sensor (OBD), or ring gear teeth.**



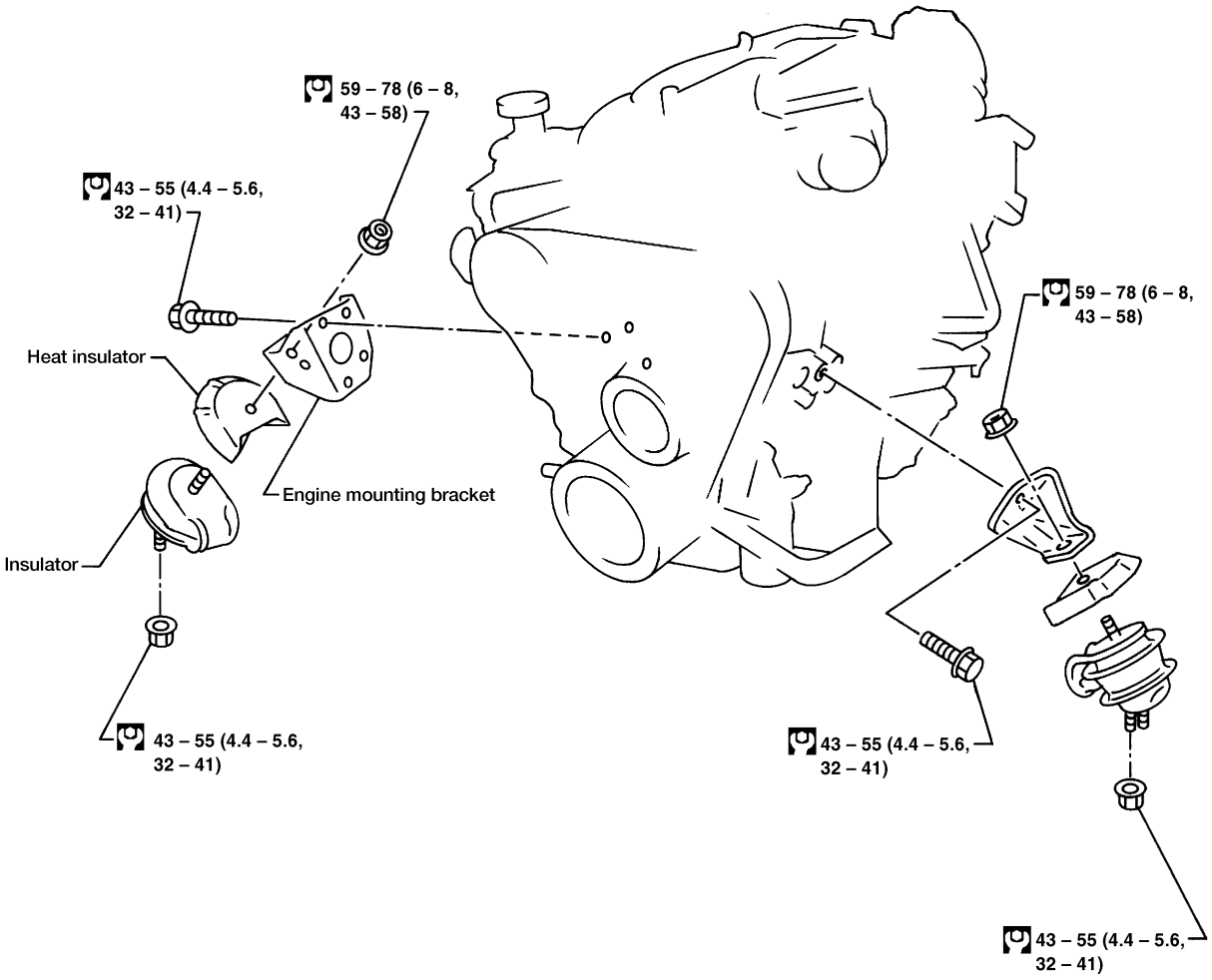
- **Do not loosen front engine mounting insulator cover securing bolts.**
- **When cover is removed, damper oil flows out and mounting insulator will not function.**
- **Refer to *AT-402*, *MT-45*, and *PD-114* for tightening torque. Sealant should be applied between engine and transmission.**

REMOVAL
Engine Mounting

NEEM0020S01

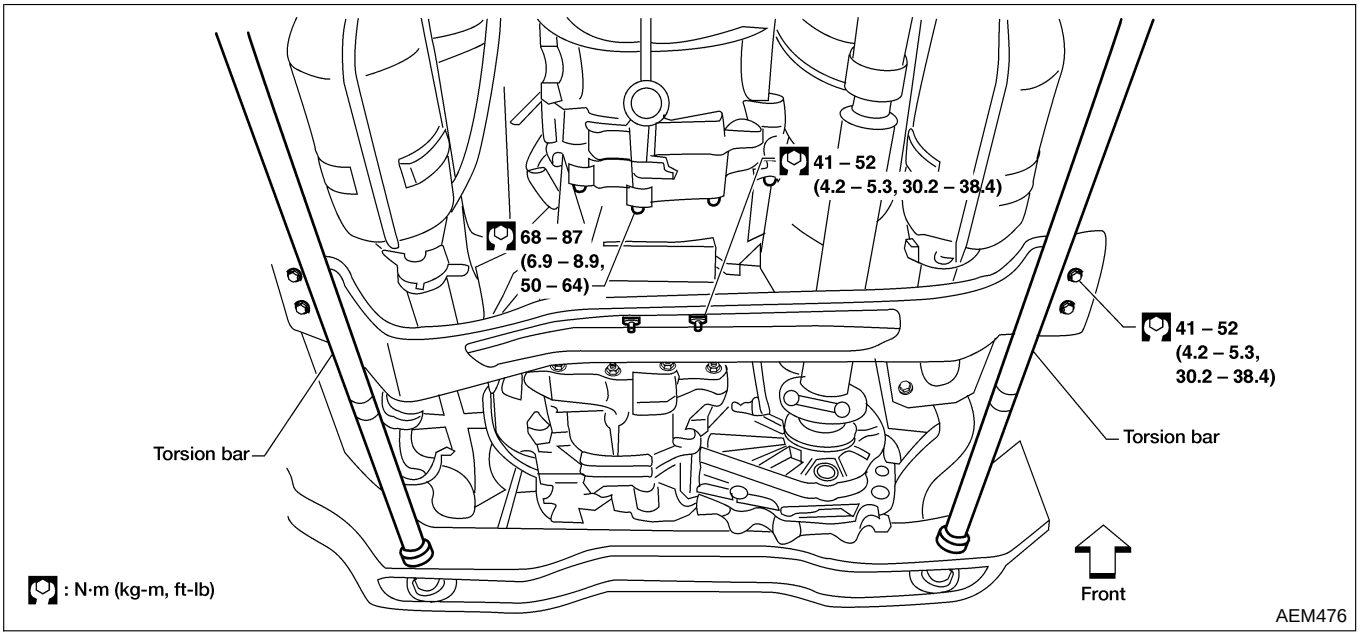
NEEM0020S0101

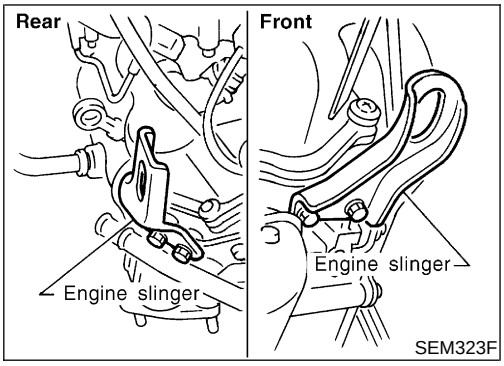
SEC. 112



: N•m (kg-m, ft-lb)

AEM471





1. Remove engine undercover and hood.
2. Drain coolant from cylinder block and radiator. Refer to "Changing Engine Coolant", ***MA-27***.
3. Remove vacuum hoses, fuel tubes, wires, harnesses and connectors.
4. Remove radiator with shroud and cooling fan.
5. Remove drive belts.
6. Discharge refrigerant, refer to "R-134a Service Procedure", ***HA-71***.
7. Remove A/C compressor manifold.
8. Remove power steering oil pump from engine.
9. Remove front exhaust tubes.
10. Remove transmission from vehicle.

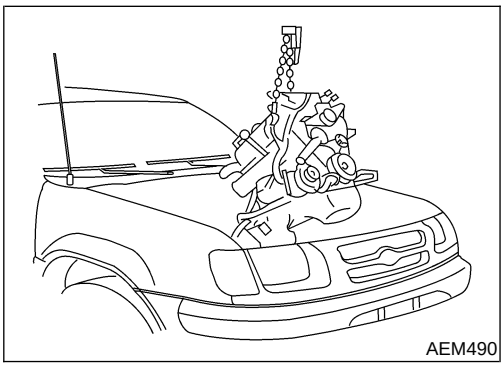
Refer to "Removal" in *AT-402* and *MT-45*.

11. Install engine slingers.

Slinger bolts:

: 20 − 26 N·m (2.1 − 2.7 kg−m, 15 − 20 ft−lb)

12. Hoist engine with engine slingers and remove engine mounting nuts from both sides.

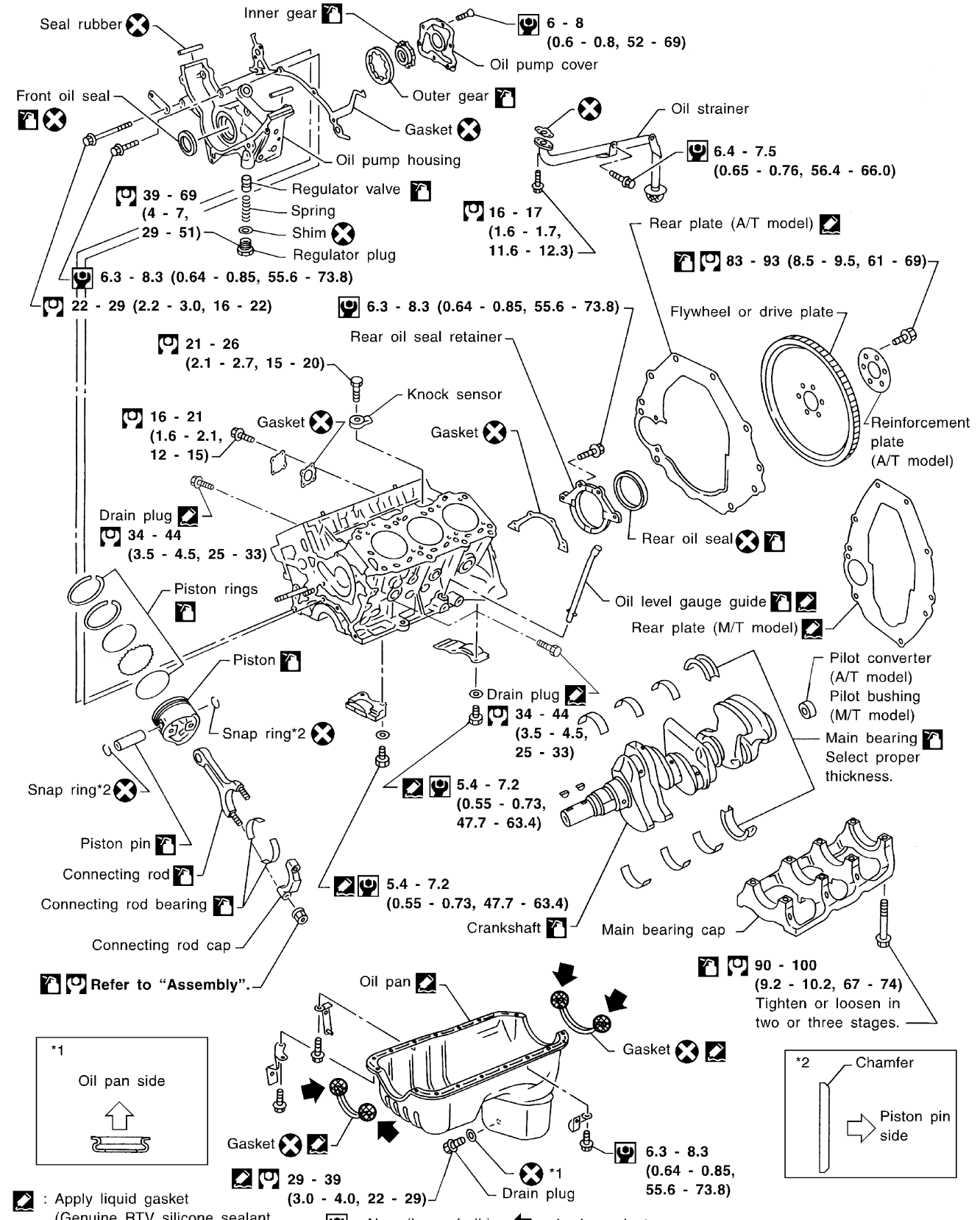


13. Remove engine from vehicle

Components

NEEM0021

SEC. 110•120•150•313



: Apply liquid gasket (Genuine RTV silicone sealant Part No. 999MP-A7007, Three Bond TB1207D or equivalent).
: N•m (kg-m, in-lb)
: N•m (kg-m, ft-lb)
: Apply sealant.
: Lubricate with new engine oil.

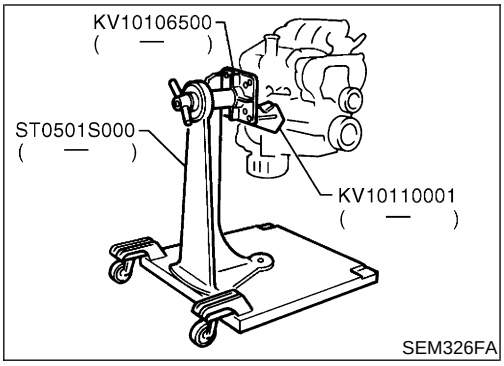
SEM647F

Removal and Installation

NEEM0022

CAUTION:

- **When installing sliding parts such as bearings and pistons, be sure to apply engine oil on the sliding surfaces.**
- **Place removed parts such as bearings and bearing caps in their proper order and direction.**
- **When installing connecting rod bolts and main bearing cap bolts, apply new engine oil to threads and seating surfaces.**
- **Do not allow any magnetic materials to contact the ring gear teeth on drive plate and rear plate.**



SEM326FA

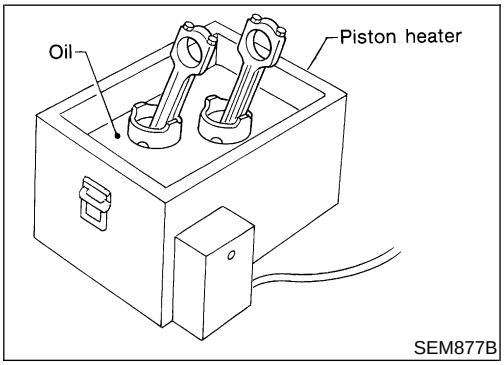
Disassembly

NEEM0023

PISTON AND CRANKSHAFT

NEEM0023S01

1. Place engine on a work stand.
2. Drain coolant and oil.
3. Remove timing belt.
4. Remove oil pan and oil pump.
5. Remove water pump.
6. Remove cylinder head.

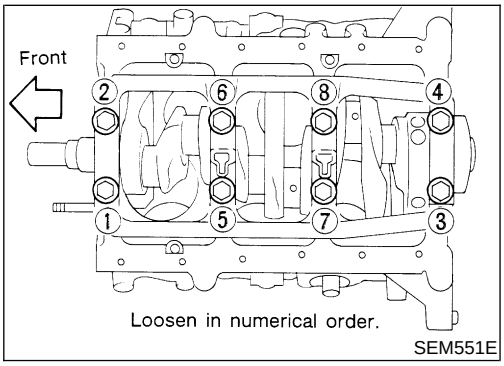


SEM877B

7. Remove pistons with connecting rods.
   - When disassembling piston and connecting rod, remove snap ring first, then heat piston to 60 to 70°C (140 to 158°F) or use piston pin press stand at room temperature.

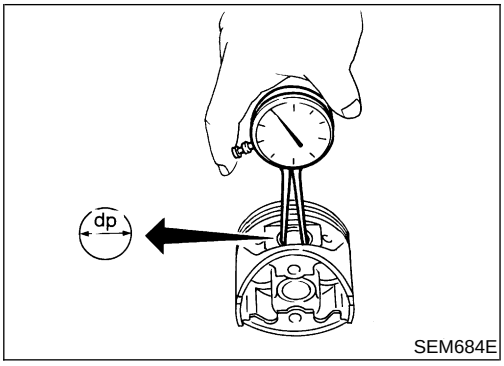
CAUTION:

- **When piston rings are not replaced, make sure that piston rings are mounted in their original positions.**
- **When replacing piston rings, if there is no punchmark, install with either side up.**



SEM551E

8. Remove bearing cap and crankshaft.
   - **Before removing bearing cap, measure crankshaft end play.**
   - **Bolts should be loosened in two or three steps.**



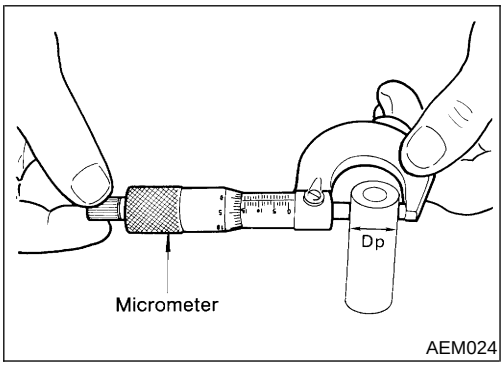
Inspection

NEEM0024

PISTON AND PISTON PIN CLEARANCE

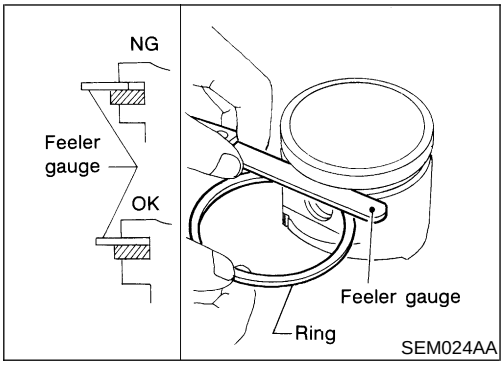
NEEM0024S01

1. Measure inner diameter of piston pin hole “dp”.
   Standard diameter “dp”:
   20.969 - 20.981 mm (0.8255 - 0.8260 in)



2. Measure outer diameter of piston pin “Dp”.
   Standard diameter “Dp”:
   20.971 - 20.983 mm (0.8256 - 0.8261 in)
3. Calculate piston pin clearance.
   dp − Dp = 0 - 0.004 mm (0 - 0.0002 in)

If it exceeds the above value, replace piston assembly with pin.

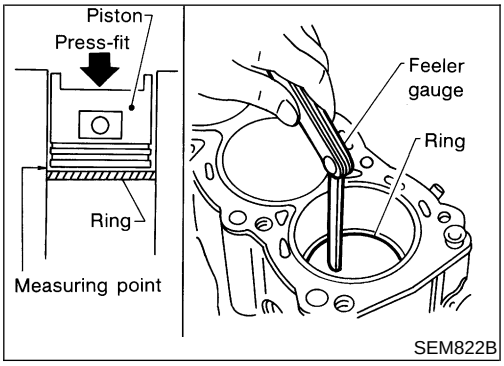


PISTON RING SIDE CLEARANCE

NEEM0024S02

Side clearance:
Top ring: 0.024 - 0.076 mm (0.0009 - 0.0030 in)
2nd ring: 0.030 - 0.070 mm (0.0012 - 0.0028 in)
Max. limit of side clearance:
Top ring: 0.11 mm (0.0043 in)
2nd ring: 0.1 mm (0.004 in)

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



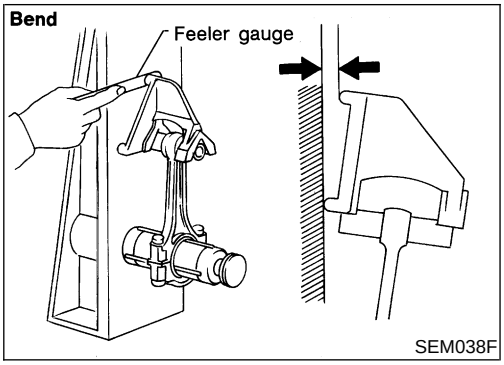
PISTON RING END GAP

NEEM0024S03

End gap:
Top ring: 0.21 - 0.40 mm (0.0083 - 0.0157 in)
2nd ring: 0.50 - 0.69 mm (0.0197 - 0.0272 in)
Oil ring: 0.20 - 0.69 mm (0.0079 - 0.0272 in)
Max. limit of ring gap:
Top ring: 0.54 mm (0.0213 in)
2nd ring: 0.80 mm (0.0315 in)
Oil ring: 0.95 mm (0.0374 in)

If out of specification, replace piston ring. If gap still exceeds the limit even with a new ring, rebore cylinder and use oversized piston and piston rings.
Refer to SDS (EM-124).

- When replacing the piston, check the cylinder block surface for scratches or seizure. If scratches or seizure are found, hone or replace the cylinder block.



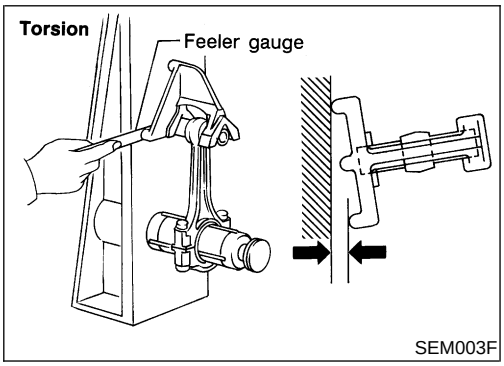
CONNECTING ROD BEND AND TORSION

NEEM0024S04

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

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

If it exceeds the limit, replace connecting rod assembly.

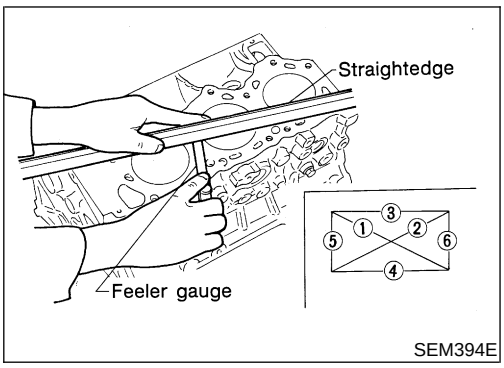


CYLINDER BLOCK DISTORTION AND WEAR

NEEM0024S05

1. Clean upper face of cylinder block and measure the distortion.

Limit:
0.10 mm (0.0039 in)



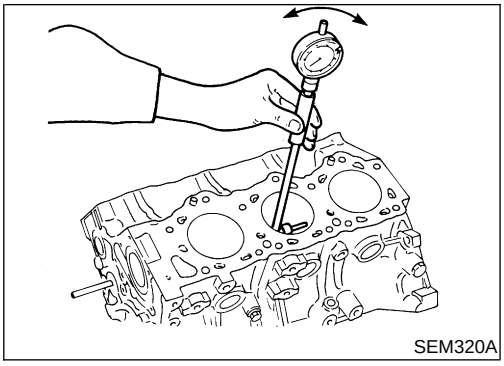
2. If out of specification, resurface it.
The resurfacing limit is determined by cylinder head resurfacing in engine.

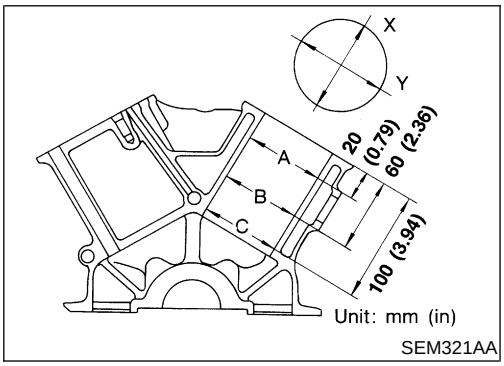
Amount of cylinder head resurfacing is "A".
Amount of cylinder block resurfacing is "B".

The maximum limit is as follows:
A + B = 0.2 mm (0.008 in)

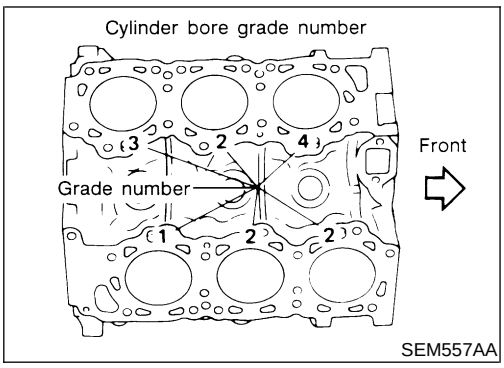
Nominal cylinder block height from crankshaft center:
227.60 - 227.70 mm (8.9606 - 8.9645 in)

3. If necessary, replace cylinder block.

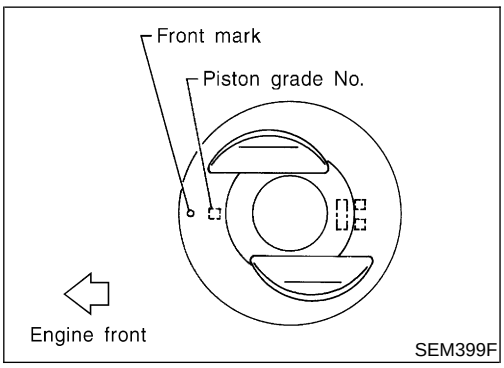

SEM320A



SEM321AA



SEM557AA



SEM399F

PISTON-TO-BORE CLEARANCE

NEEM0024S06

1. Using a bore gauge, measure cylinder bore for wear, out-of-round and taper.

Standard inner diameter:

Engine serial number before VG33–424030

91.500 - 91.530 mm (3.6024 - 3.6035 in)

Engine serial number from VG33–424030

Except No. 5 cylinder

91.500 - 91.530 mm (3.6024 - 3.6035 in)

For No. 5 cylinder

91.515 - 91.545 mm (3.6029 - 3.6041 in)

Refer to "CYLINDER BLOCK" in SDS.

Wear limit:

0.20 mm (0.0079 in)

If it exceeds the limit, rebore all cylinders. Replace cylinder block if necessary.

Out-of-round (X − Y) standard:

0.015 mm (0.0006 in)

Taper (A − B or A − C) standard:

0.015 mm (0.0006 in)

2. Check for scratches and seizure. If seizure is found, hone it.

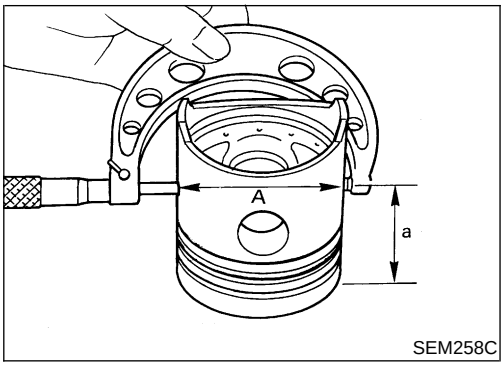
- **If both cylinder block and piston are replaced with new ones, select piston of the same grade number according to the following table. These numbers are punched on cylinder block and piston in either Arabic or Roman numerals.**

Combination of grade number for cylinder bore and piston
Engine serial number before VG33–424030

	For No. 3 and 4 cylinders						Except No. 3 and 4 cylinders		
Cylinder bore grade No.	1	2	3	4	5	6	1	2	3
Piston grade No.	2-1	3-2	3-3	4-4	4-5	5-6	1	2	3

Combination of grade number for cylinder bore and piston
Engine serial number from VG33–424030

	For No. 3, 4 and 5 cylinders						For No. 1, 2 and 6 cylinders		
Cylinder bore grade No.	1	2	3	4	5	6	1	2	3
Piston grade No.	2-1	3-2	3-3	4-4	4-5	5-6	1	2	3



3. Measure piston skirt diameter.
   Piston diameter "A":
   Refer to SDS (EM-124).
   Measuring point "a" (Distance from the top):
   49.0 mm (1.929 in)
4. Check that piston-to-bore clearance is within specification.
   Piston-to-bore clearance "B":
   Engine serial number before VG33–424030
   0.015 - 0.025 mm (0.0006 - 0.0010 in) for No. 3 and 4 cylinders
   0.025 - 0.045 mm (0.0010 - 0.0018 in) except for No. 3 and 4 cylinders
   Engine serial number from VG33–424030
   0.015 - 0.025 mm (0.0006 - 0.0010 in) for No. 3 and 4 cylinders
   0.025 - 0.045 mm (0.0010 - 0.0018 in) for No. 1, 2 and 6 cylinders
   0.030 - 0.040 mm (0.0012 - 0.0016 in) for No. 5 cylinder
5. Determine piston oversize according to amount of cylinder wear.

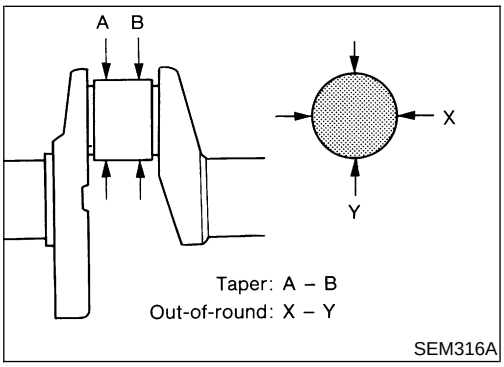
Oversize pistons are available for service. Refer to SDS (EM-124).

6. Cylinder bore size is determined by adding piston-to-bore clearance to piston diameter "A".
   Rebored size calculation:
   D = A + B − C
   where,
   D: Bored diameter
   A: Piston diameter as measured
   B: Piston-to-bore clearance
   C: Honing allowance 0.02 mm (0.0008 in)
7. Install main bearing caps, and tighten to the specified torque to prevent distortion of cylinder bores in final assembly.
8. Cut cylinder bores.

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

9. Hone cylinders to obtain specified piston-to-bore clearance.
10. Measure finished cylinder bore for out-of-round and taper.

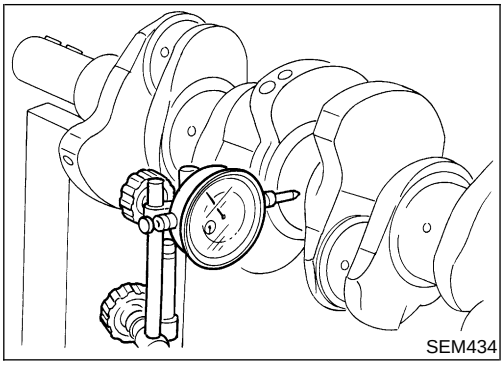
- **Measurement should be done after cylinder bore cools down.**



CRANKSHAFT

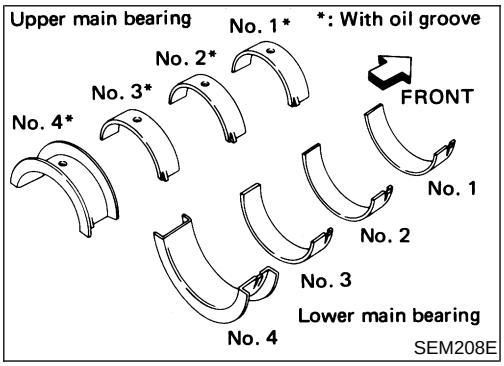
NEEM0024S07

1. Check crankshaft main and pin journals for score, wear or cracks.
2. With a micrometer, measure journals for taper and out-of-round.
   Out-of-round (X − Y):
   Less than 0.005 mm (0.0002 in)
   Taper (A − B):
   Less than 0.005 mm (0.0002 in)


SEM434

3. Measure crankshaft runout.

Runout (Total indicator reading):
Less than 0.10 mm (0.0039 in)



SEM208E

BEARING CLEARANCE

NEEM0024S08

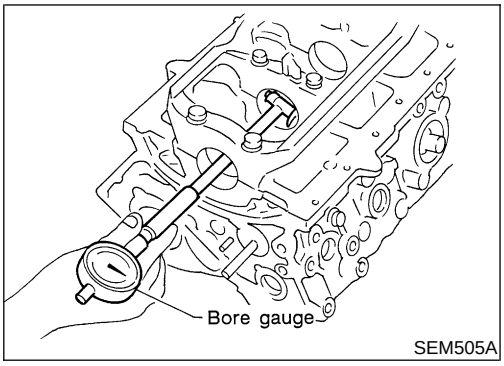
- Either of the following two methods may be used, however, method A gives more reliable results and is preferable.

Method A (Using bore gauge & micrometer)

Main Bearing

NEEM0024S0801

1. Set main bearings in their proper positions on cylinder block and main bearing cap.

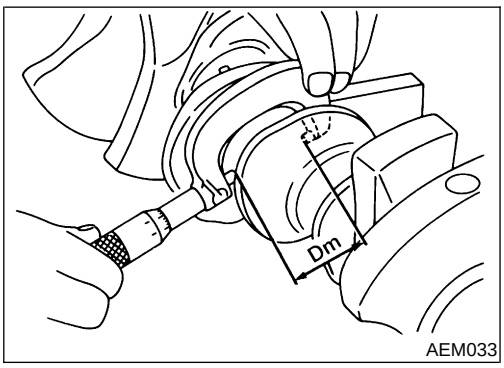


SEM505A

2. Install main bearing cap to cylinder block.

Tighten all bolts in correct order in two or three stages.

3. Measure inner diameter "A" of each main bearing.

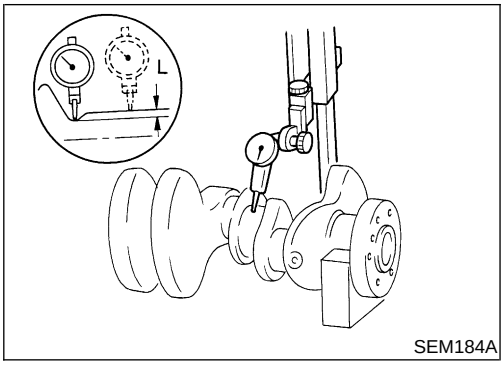


AEM033

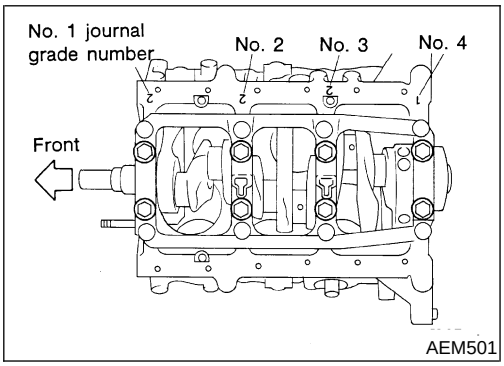
4. Measure outer diameter "Dm" of each crankshaft main journal.
5. Calculate main bearing clearance.

No.1 main bearing clearance (A – Dm):
Standard
0.020 - 0.038 mm (0.0008 - 0.0015 in)
Limit
0.060 mm (0.0024 in)
No. 2, 3 and No. 4 main bearing clearance (A − Dm):
Standard
0.028 - 0.055 mm (0.0011 - 0.0022 in)
Limit
0.080 mm (0.0031 in)

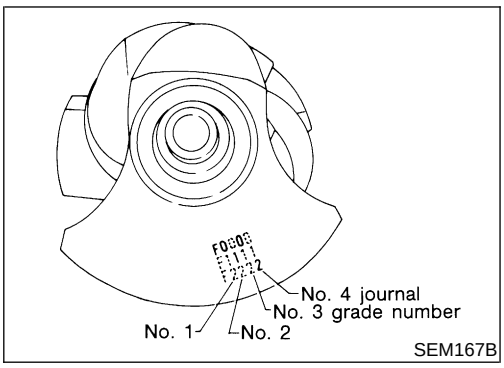
6. If it exceeds the limit, replace bearing.
7. If clearance cannot be adjusted within the standard of any bearing, grind crankshaft journal and use undersized bearing.



a. When grinding crankshaft journal, confirm that "L" dimension in fillet roll is more than the specified limit.
"L": 0.1 mm (0.004 in)
b. Refer to SDS for grinding crankshaft and available service parts.



8. If crankshaft is reused, measure main bearing clearances and select thickness of main bearings.
If crankshaft is replaced with a new one, it is necessary to select thickness of main bearings as follows:
a. Grade number of each cylinder block main journal is punched on the respective cylinder block. These numbers are punched in either Arabic or Roman numerals.



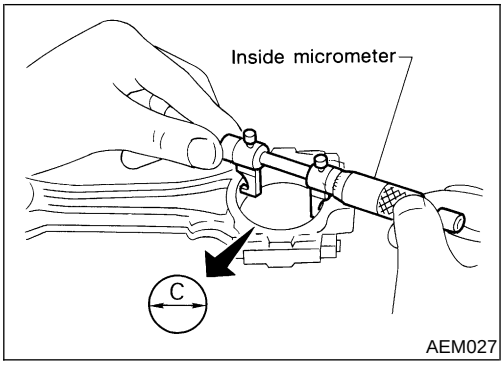
b. Grade number of each crankshaft main journal is punched on the respective crankshaft. These numbers are punched in either Arabic or Roman numerals.
c. Select main bearing with suitable thickness according to the following example or table.
For example:
Main journal grade number: 1
Crankshaft journal grade number: 2
Main bearing grade number = 1 + 2 = 3 (Yellow)

No. 1 main bearing grade number (Identification color):

	Main journal grade number			
	3	4	5	6
3	0 (Black)	1 (Brown)	2 (Green)	3 (Yellow)
4	1 (Brown)	2 (Green)	3 (Yellow)	4 (Blue)
5	2 (Green)	3 (Yellow)	4 (Blue)	5 (Pink)
6	3 (Yellow)	4 (Blue)	5 (Pink)	6 (Purple)

Except No. 1 main bearing grade number (Identification color):

		Main journal grade number		
		0	1	2
Crankshaft journal grade number	0	0 (Black)	1 (Brown)	2 (Green)
	1	1 (Brown)	2 (Green)	3 (Yellow)
	2	2 (Green)	3 (Yellow)	4 (Blue)



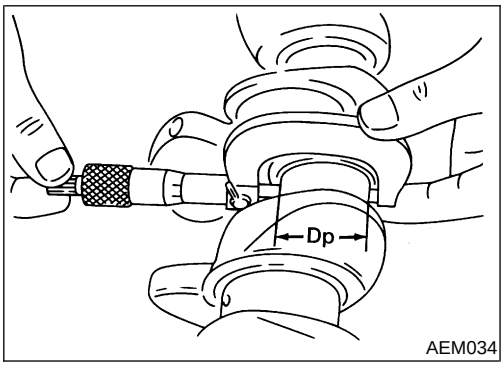
Connecting Rod Bearing (Big end)

NEEM0024S0802

1. Install connecting rod bearing to connecting rod and cap.
2. Install connecting rod cap to connecting rod.

Tighten bolts to the specified torque.

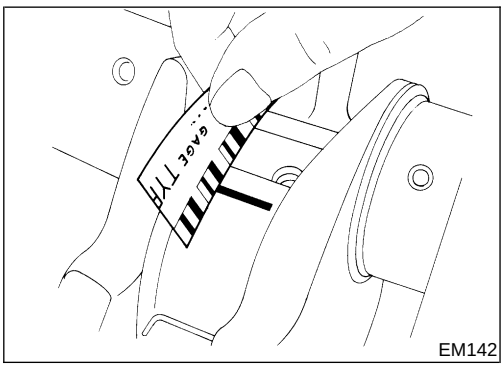
3. Measure inner diameter "C" of each bearing.



4. Measure outer diameter "Dp" of each crankshaft pin journal.
5. Calculate connecting rod bearing clearance.

Connecting rod bearing clearance (C − Dp):
Standard
0.014 - 0.054 mm (0.0006 - 0.0021 in)
Limit
0.090 mm (0.0035 in)

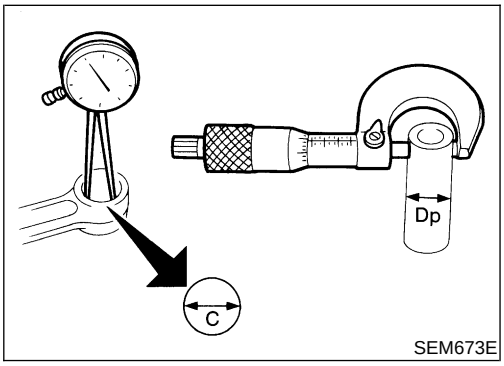
6. If it exceeds the limit, replace bearing.
7. If clearance cannot be adjusted within the standard of any bearing, grind crankshaft journal and use undersized bearing. Refer to step 7 of "BEARING CLEARANCE", "Main bearing", EM-110.



Method B (Using plastigage)

CAUTION:

- **Do not turn crankshaft or connecting rod while plastigage is being inserted.**
- **When bearing clearance exceeds the specified limit, ensure that the proper bearing has been installed. Then if excessive bearing clearance exists, use a thicker main bearing or undersized bearing so that the specified bearing clearance is obtained.**



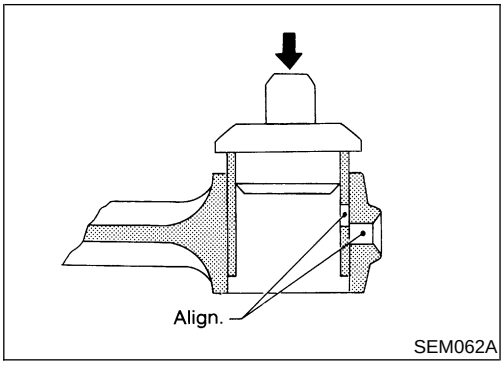
CONNECTING ROD BUSHING CLEARANCE (SMALL END)

NEEM0024S09

1. Measure inner diameter "C" of bushing.
2. Measure outer diameter "Dp" of piston pin.
3. Calculate connecting rod bushing clearance.

Connecting rod bushing clearance = C − Dp
Standard: 0.005 - 0.017 mm (0.0002 - 0.0007 in)
Limit: 0.023 mm (0.0009 in)

If it exceeds the limit, replace connecting rod assembly or connecting rod bushing and/or piston set with pin.



REPLACEMENT OF CONNECTING ROD BUSHING (SMALL END)

NEEM0024S10

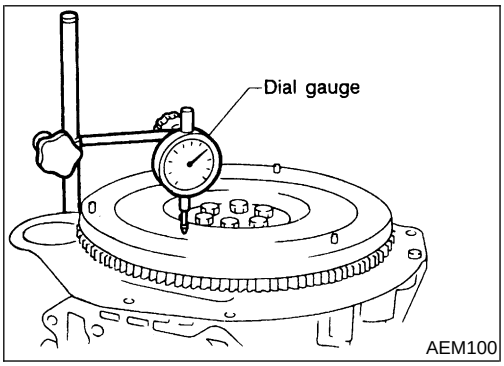
1. Drive in small end bushing until it is flush with end surface of rod.

Be sure to align the oil holes.

2. After driving in small end bushing, ream the bushing so that clearance between connecting rod bushing and piston pin is the specified value.

Clearance between connecting rod bushing and piston pin:

0.005 - 0.017 mm (0.0002 - 0.0007 in)



FLYWHEEL/DRIVE PLATE RUNOUT

NEEM0024S11

Runout (Total indicator reading):

Flywheel (M/T model)

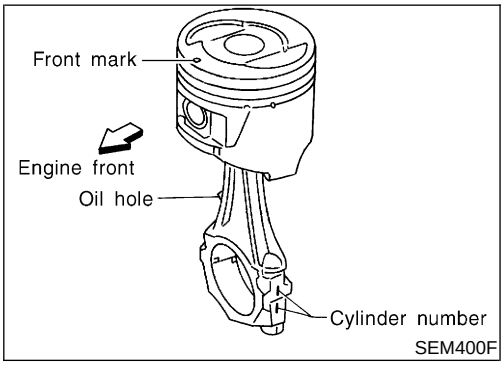
Less than 0.15 mm (0.0059 in)

Drive plate (A/T model)

Less than 0.15 mm (0.0059 in)

CAUTION:

- **Be careful not to damage the ring gear teeth.**
- **Check the drive plate for deformation or cracks.**
- **Do not allow any magnetic materials to contact the ring gear teeth.**
- **Do not surface flywheel or drive plate. Replace as necessary.**



Assembly

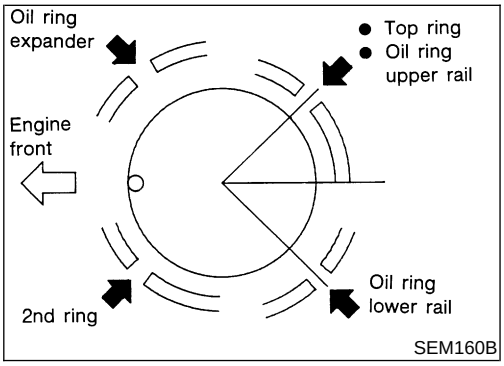
NEEM0025

PISTON

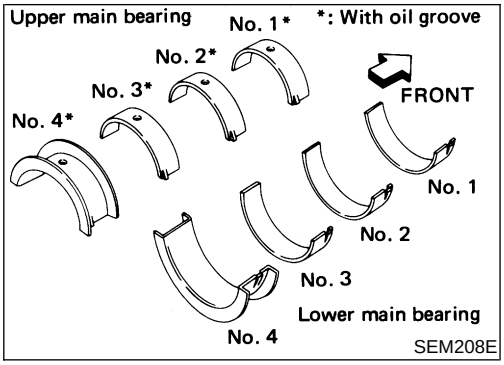
NEEM0025S01

1. Install new snap ring on one side of piston pin hole.
2. Heat piston to 60 to 70°C (140 to 158°F) and assemble piston, piston pin, connecting rod and new snap ring.

- **Align the direction of piston and connecting rod.**
- **Numbers stamped on connecting rod and cap correspond to each cylinder.**
- **After assembly, make sure connecting rod swings smoothly.**



3. Set piston rings as shown.



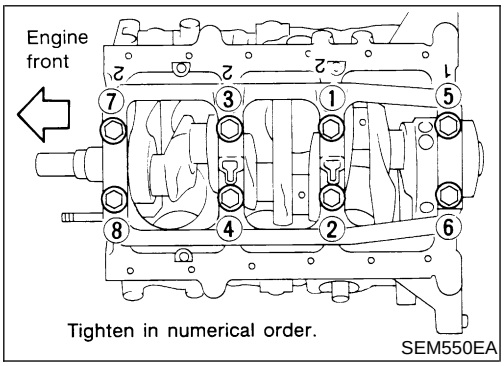
CRANKSHAFT

NEEM0025S02

1. Set main bearings in their proper positions on cylinder block and main bearing cap.

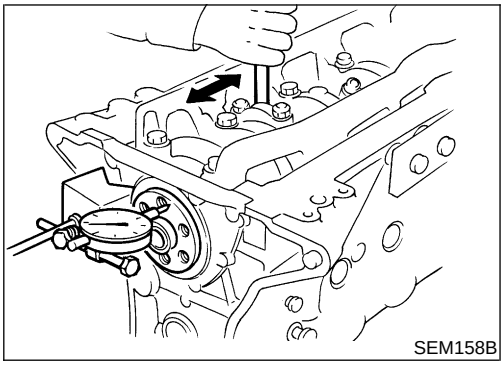
- **Confirm that correct main bearings are used.**
- **Apply new engine oil to bearing surfaces.**

Refer to "BEARING CLEARANCE", EM-110.



2. Install crankshaft and main bearing caps and tighten bolts to the specified torque.

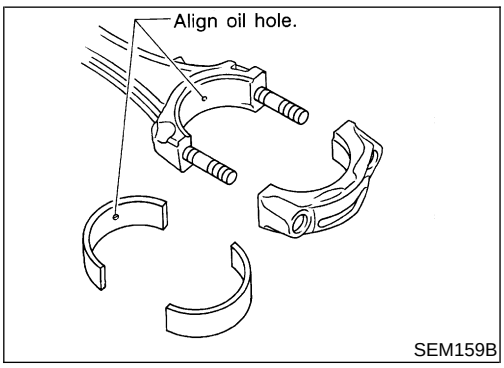
- **Prior to tightening bearing cap bolts, place bearing cap in its proper position by shifting crankshaft in the axial direction.**
- **Tighten bearing cap bolts gradually in two or three stages. Start with center bearing and move outward sequentially.**
- **After securing bearing cap bolts, make sure crankshaft turns smoothly by hand.**
- **Lubricate threads and seat surfaces of the bolts with new engine oil.**



3. Measure crankshaft end play.

Crankshaft end play:
Standard
0.050 - 0.170 mm (0.0020 - 0.0067 in)
Limit
0.30 mm (0.0118 in)

If beyond the limit, replace bearing with a new one.

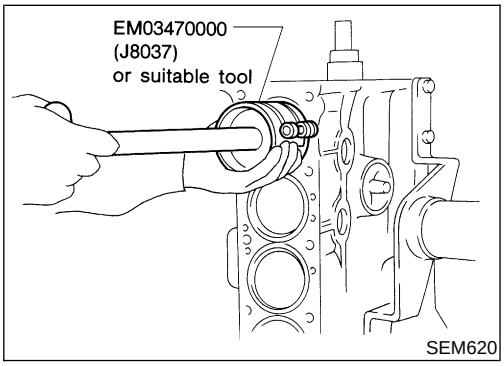


4. Install connecting rod bearings in connecting rods and connecting rod caps.

- **Confirm that correct bearings are used.**

Refer to "Inspection".

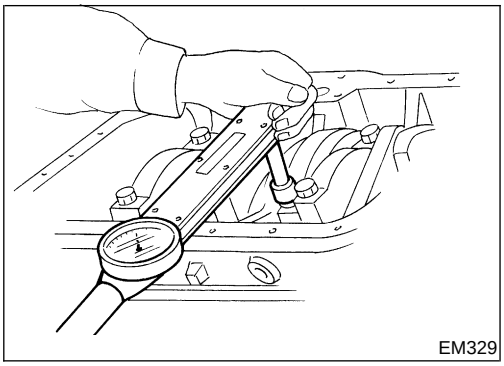
- Install bearings so that oil hole in connecting rod aligns with oil hole of bearing.



5. Install pistons with connecting rods.

a. Install them into corresponding cylinders with Tool.

- **Be careful not to scratch cylinder wall by connecting rod.**
- **Arrange so that front mark on piston head faces toward front of engine.**


EM329

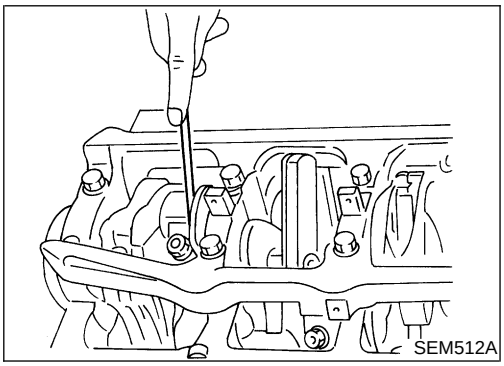
b. Install connecting rod bearing caps.

- **Lubricate threads and seat surfaces with new engine oil.** Tighten connecting rod bearing cap nuts to the specified torque.

: Connecting rod bearing nut

(1) Tighten to 14 to 16 N·m (1.4 to 1.6 kg-m, 10 to 12 ft-lb).

(2) Turn nuts 60 to 65 degrees clockwise. If an angle wrench is not available, tighten nuts to 38 to 44 N·m (3.9 to 4.5 kg-m, 28 to 33 ft-lb).


SEM512A

6. Measure connecting rod side clearance.

Connecting rod side clearance:

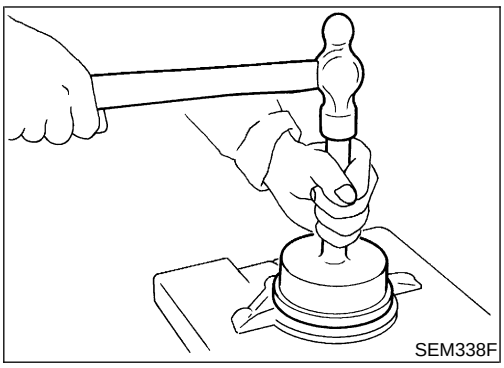
Standard

0.20 - 0.35 mm (0.0079 - 0.0138 in)

Limit

0.40 mm (0.0157 in)

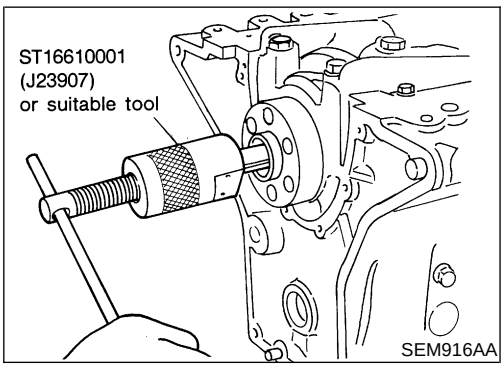
If beyond the limit, replace connecting rod and/or crankshaft.


SEM338F

7. Install rear oil seal retainer.

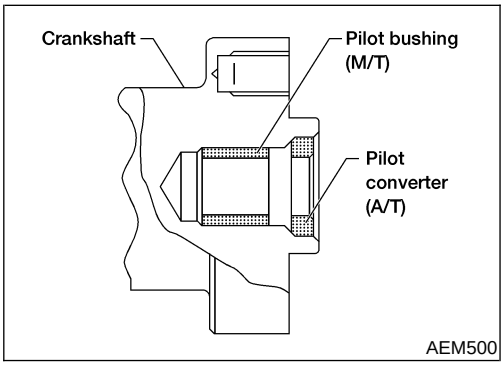
REPLACING PILOT BUSHING (M/T) OR PILOT CONVERTER (A/T)

NEEM0025S03



SEM916AA

1. Remove pilot bushing (M/T) or pilot converter (A/T).



AEM500

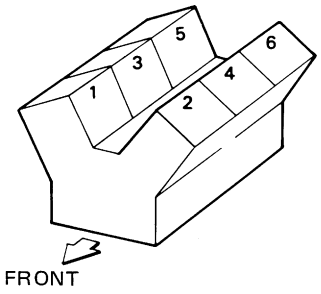
2. Install pilot bushing (M/T) or pilot converter (A/T).

General Specifications

=NEEM0026

Cylinder arrangement		V-6
Displacement		3,275 cm^3 (199.84 cu in)
Bore and stroke		91.5 x 83 mm (3.602 x 3.27 in)
Valve arrangement		OHC
Firing order		1-2-3-4-5-6
Number of piston rings	Compression	2
	Oil	1
Number of main bearings		4
Compression ratio		8.9

Cylinder number



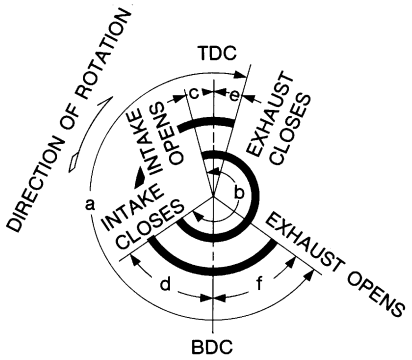
SEM713A

Unit: kPa (kg/cm^2, psi)/300 rpm

Compression pressure	Standard	1,196 (12.2, 173)
	Minimum	883 (9.0, 128)
	Differential limit between cylinders	98 (1.0, 14)

Unit: degree

Valve timing



EM120

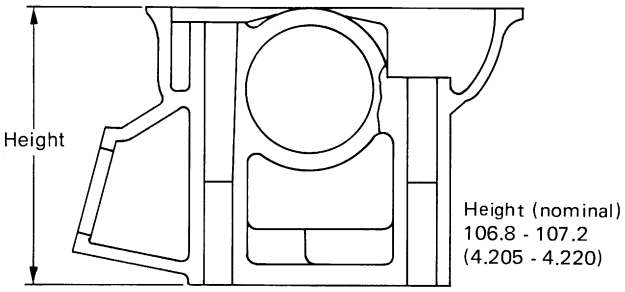
a	b	c	d	e	f
240	244	4	60	9	51

Cylinder Head

NEEM0027

Unit: mm (in)

	Standard	Limit
Head surface distortion	Less than 0.03 (0.0012)	0.1 (0.004)



SEM082B

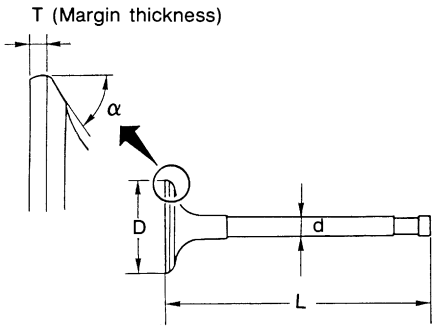
Valve

VALVE

NEEM0028

NEEM0028S01

Unit: mm (in)



SEM188

Valve head diameter “D”	Intake	42.0 - 42.2 (1.654 - 1.661)
	Exhaust	34.95 - 35.25 (1.376 - 1.388)
Valve length “L”	Intake	125.3 - 125.9 (4.933 - 4.957)
	Exhaust	124.2 - 124.8 (4.890 - 4.913)
Valve stem diameter “d”	Intake	6.965 - 6.980 (0.2742 - 0.2748)
	Exhaust	7.962 - 7.970 (0.3135 - 0.3138)
Valve seat angle “α”	Intake	45°15′ - 45°45′
	Exhaust	
Valve margin “T”	Intake	1.15 - 1.45 (0.0453 - 0.0571)
	Exhaust	1.35 - 1.65 (0.0531 - 0.0650)
Valve margin “T” limit		More than 0.5 (0.020)
Valve stem end surface grinding limit		Less than 0.2 (0.008)
Valve clearance	Intake	0 (0)
	Exhaust	0 (0)

Valve (Cont'd)

VALVE SPRING

NEEM0028S02

Free height	Outer	51.2 mm (2.016 in)
	Inner	44.1 mm (1.736 in)
Pressure	Outer	523.7 N (53.4 kg, 117.7 lb) at 30.0 mm (1.181 in)
	Inner	255.0 N (26.0 kg, 57.3 lb) at 25.0 mm (0.984 in)
Out-of-square	Outer	2.2 mm (0.087 in)
	Inner	1.9 mm (0.075 in)

HYDRAULIC VALVE LIFTER

NEEM0028S03

Unit: mm (in)

Lifter outside diameter	15.947 - 15.957 (0.6278 - 0.6282)
Lifter guide inside diameter	16.000 - 16.013 (0.6299 - 0.6304)
Clearance between lifter and lifter guide	0.043 - 0.066 (0.0017 - 0.0026)

VALVE GUIDE

NEEM0028S04

Unit: mm (in)

			Standard	Service
Valve guide	Outer diameter	Intake	11.023 - 11.034 (0.4340 - 0.4344)	11.223 - 11.234 (0.4418 - 0.4423)
		Exhaust	12.023 - 12.034 (0.4733 - 0.4738)	12.223 - 12.234 (0.4812 - 0.4817)
	Inner diameter (Finished size)	Intake	7.000 - 7.018 (0.2756 - 0.2763)	
		Exhaust	8.000 - 8.011 (0.3150 - 0.3154)	
Cylinder head valve guide hole diameter		Intake	10.975 - 10.996 (0.4321 - 0.4329)	11.175 - 11.196 (0.4400 - 0.4408)
		Exhaust	11.975 - 11.996 (0.4715 - 0.4723)	12.175 - 12.196 (0.4793 - 0.4802)
Interference fit of valve guide		Intake	0.027 - 0.059 (0.0011 - 0.0023)	
		Exhaust		
			Standard	Max. tolerance
Stem to guide clearance		Intake	0.020 - 0.053 (0.0008 - 0.0021)	0.10 (0.0039)
		Exhaust	0.030 - 0.049 (0.0012 - 0.0019)	
Valve deflection limit			—	0.20 (0.0079)

ROCKER SHAFT AND ROCKER ARM

NEEM0028S05

Unit: mm (in)

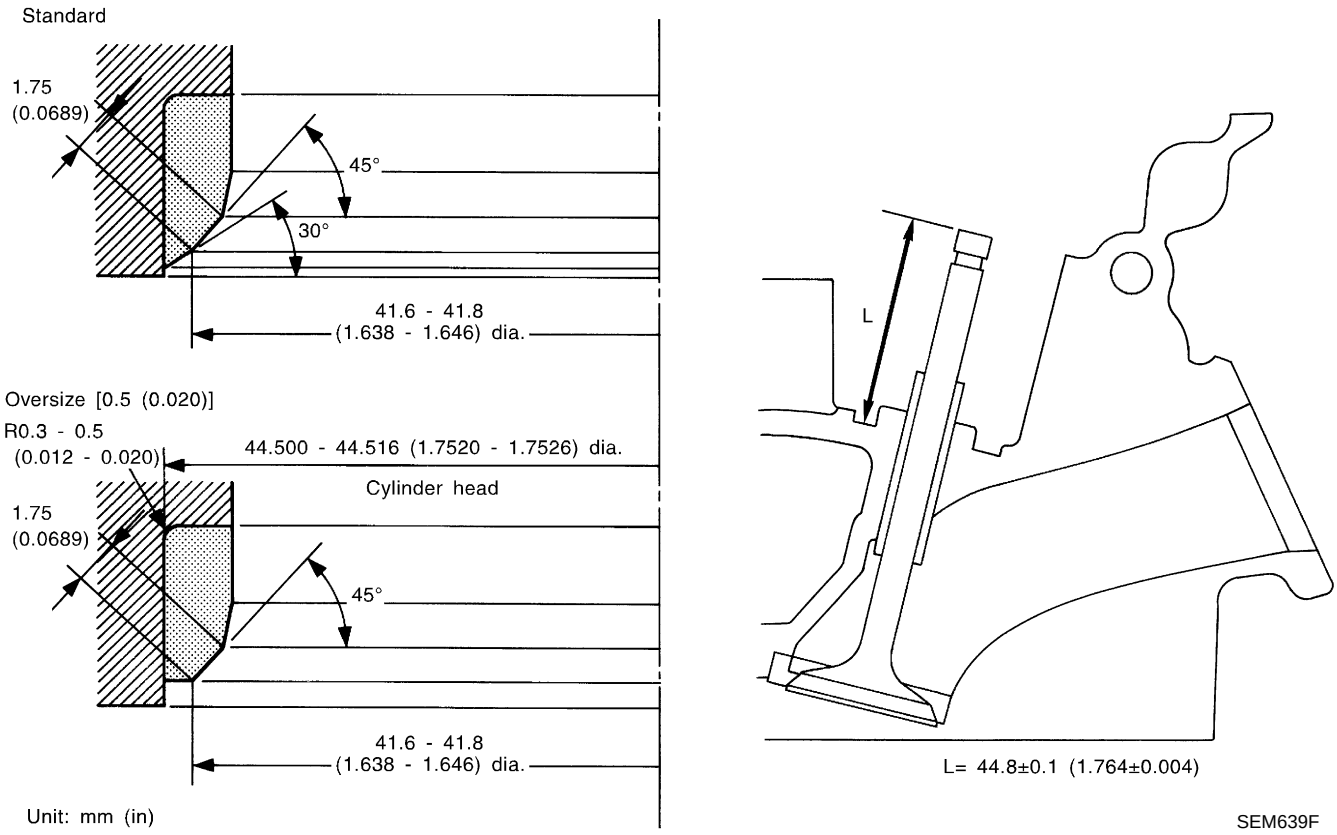
Rocker shaft	Outer diameter	17.979 - 18.000 (0.7078 - 0.7087)
Rocker arm	Inner diameter	18.007 - 18.028 (0.7089 - 0.7098)
Clearance between rocker arm and rocker shaft		0.007 - 0.049 (0.0003 - 0.0019)

Valve Seat

NEEM0029

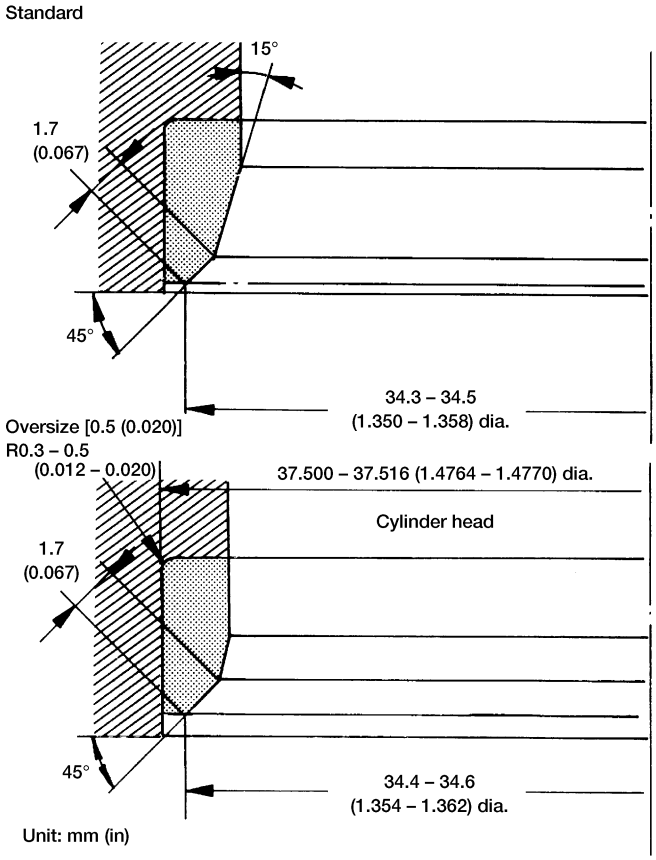
INTAKE VALVE SEAT

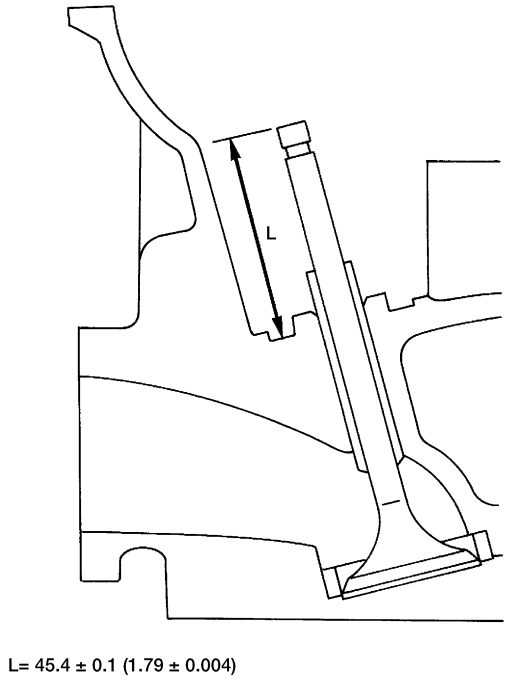
NEEM0029S01



EXHAUST VALVE SEAT

NEEM0029S02



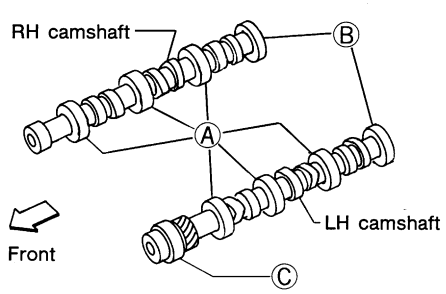


AEM455

Camshaft and Camshaft Bearing

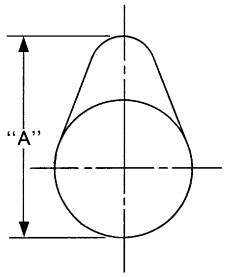
NEEM0030

Unit: mm (in)



SEM893BA

	Standard	Max. tolerance
Camshaft journal to bearing clearance	0.060 - 0.105 (0.0024 - 0.0041)	0.15 (0.0059)
Inner diameter of camshaft bearing	A: 47.000 - 47.025 (1.8504 - 1.8514)	—
	B: 42.500 - 42.525 (1.6732 - 1.6742)	—
	C: 48.000 - 48.025 (1.8898 - 1.8907)	—
Outer diameter of camshaft journal	A: 46.920 - 46.940 (1.8472 - 1.8480)	—
	B: 42.420 - 42.440 (1.6701 - 1.6709)	—
	C: 47.920 - 47.940 (1.8866 - 1.8874)	—
Camshaft runout [TIR*]	Less than 0.04 (0.0016)	0.1 (0.004)
Camshaft end play	0.03 - 0.06 (0.0012 - 0.0024)	—



EM671

Cam height "A"	Intake	38.943 - 39.133 (1.5332 - 1.5407)
	Exhaust	38.943 - 39.133 (1.5332 - 1.5407)
Wear limit of cam height		0.15 (0.0059)

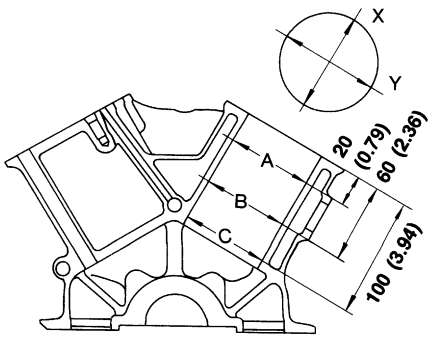
*Total indicator reading

Cylinder Block

=NEEM0031

Engine serial number before VG33–424030

Unit: mm (in)

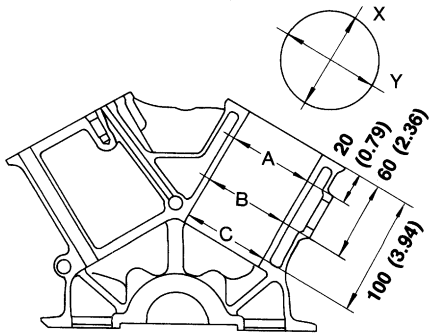


SEM321A

Surface flatness		Standard		Less than 0.03 (0.0012)
		Limit		0.10 (0.0039)
Cylinder bore	Inner diameter	Standard (for No. 3 and 4 cylinders)	Grade No. 1	91.500 - 91.505 (3.6024 - 3.6026)
			Grade No. 2	91.505 - 91.510 (3.6026 - 3.6027)
			Grade No. 3	91.510 - 91.515 (3.6027 - 3.6029)
			Grade No. 4	91.515 - 91.520 (3.6029 - 3.6031)
			Grade No. 5	91.520 - 91.525 (3.6031 - 3.6033)
			Grade No. 6	91.525 - 91.530 (3.6033 - 3.6035)
		Standard (for No. 3 and 4 cylinders)	Grade No. 1	91.500 - 91.510 (3.6024 - 3.6027)
			Grade No. 2	91.510 - 91.520 (3.6027 - 3.6031)
			Grade No. 3	91.520 - 91.530 (3.6031 - 3.6035)
		Wear limit		0.20 (0.0079)
Out-of-round (X − Y)				Less than 0.015 (0.0006)
Taper (A − B or A − C)				Less than 0.015 (0.0006)
Main journal inner diameter		No. 1 main journal	Grade No. 3	66.645 - 66.651 (2.6238 - 2.6240)
			Grade No. 4	66.651 - 66.657 (2.6240 - 2.6243)
			Grade No. 5	66.657 - 62.663 (2.6243 - 2.6245)
			Grade No. 6	66.663 - 66.669 (2.6245 - 2.6248)
		Except No. 1 main journal	Grade No. 0	66.645 - 66.654 (2.6238 - 2.6242)
			Grade No. 1	66.654 - 66.663 (2.6242 - 2.6245)
			Grade No. 2	66.663 - 66.672 (2.6245 - 2.6249)
Difference in inner diameter between cylinders		Standard		Less than 0.05 (0.0020)

Engine serial number from VG33–424030

Unit: mm (in)



SEM321A

Surface flatness		Standard		Less than 0.03 (0.0012)
		Limit		0.10 (0.0039)
Cylinder bore	Inner diameter	Standard (for No. 3 and 4 cylinders)	Grade No. 1	91.500 - 91.505 (3.6024 - 3.6026)
			Grade No. 2	91.505 - 91.510 (3.6026 - 3.6027)
			Grade No. 3	91.510 - 91.515 (3.6027 - 3.6029)
			Grade No. 4	91.515 - 91.520 (3.6029 - 3.6031)
			Grade No. 5	91.520 - 91.525 (3.6031 - 3.6033)
			Grade No. 6	91.525 - 91.530 (3.6033 - 3.6035)
		Standard (for No. 1, 2 and 6 cylinders)	Grade No. 1	91.500 - 91.510 (3.6024 - 3.6027)
			Grade No. 2	91.510 - 91.520 (3.6027 - 3.6031)
			Grade No. 3	91.520 - 91.530 (3.6031 - 3.6035)
		Standard (for No. 5 cylinder)	Grade No. 1	91.515 - 91.520 (3.6029 - 3.6031)
			Grade No. 2	91.520 - 91.525 (3.6031 - 3.6033)
			Grade No. 3	91.525 - 91.530 (3.6033 - 3.6035)
			Grade No. 4	91.530 - 91.535 (3.6035 - 3.6037)
			Grade No. 5	91.535 - 91.540 (3.6037 - 3.6039)
			Grade No. 6	91.540 - 91.545 (3.6039 - 3.6041)
		Wear limit		0.20 (0.0079)
Out-of-round (X − Y)				Less than 0.015 (0.0006)
Taper (A − B or A − C)				Less than 0.015 (0.0006)
Main journal inner diameter		No. 1 main journal	Grade No. 3	66.645 - 66.651 (2.6238 - 2.6240)
			Grade No. 4	66.651 - 66.657 (2.6240 - 2.6243)
			Grade No. 5	66.657 - 62.663 (2.6243 - 2.6245)
			Grade No. 6	66.663 - 66.669 (2.6245 - 2.6248)
		Except No. 1 main journal	Grade No. 0	66.645 - 66.654 (2.6238 - 2.6242)
			Grade No. 1	66.654 - 66.663 (2.6242 - 2.6245)
			Grade No. 2	66.663 - 66.672 (2.6245 - 2.6249)
Difference in inner diameter between cylinders		Standard		Less than 0.05 (0.0020)

Piston, Piston Ring and Piston Pin

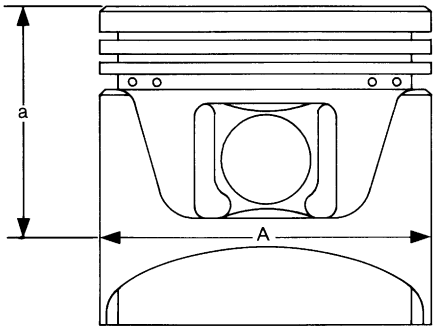
=NEEM0032

AVAILABLE PISTON

NEEM0032S01

Engine serial number before VG33–424030

Unit: mm (in)



SEM882E

Piston skirt diameter “A”	Standard (for No. 3 and 4 cylinders)	Grade No. 2-1	91.480 - 91.485 (3.6016 - 3.6018)
		Grade No. 3-2	91.485 - 91.490 (3.6018 - 3.6020)
		Grade No. 3-3	91.490 - 91.495 (3.6020 - 3.6022)
		Grade No. 4-4	91.495 - 91.500 (3.6022 - 3.6024)
		Grade No. 4-5	91.500 - 91.505 (3.6024 - 3.6026)
		Grade No. 5-6	91.505 - 91.510 (3.6026 - 3.6027)
	Standard (except No. 3 and 4 cylinders)	Grade No. 1	91.465 - 91.475 (3.6010 - 3.6014)
		Grade No. 2	91.475 - 91.485 (3.6014 - 3.6018)
		Grade No. 3	91.485 - 91.495 (3.6018 - 3.6022)
	0.25 (0.0098) oversize (Service)		91.715 - 91.745 (3.6108 - 3.6120)
	0.50 (0.0197) oversize (Service)		91.965 - 91.995 (3.6207 - 3.6218)
“a” dimension			49.0 (1.929)
Piston pin hole diameter		Grade No. 0	20.969 - 20.975 (0.8255 - 0.8258)
		Grade No. 1	20.975 - 20.981 (0.8258 - 0.8260)
Piston clearance to cylinder block	Standard	For No. 3 and 4 cylinders	0.015 - 0.025 (0.0006 - 0.0010)
		For No. 1, 2 and 6 cylinders	0.025 - 0.045 (0.0010 - 0.0018)
		For No. 5 cylinder	0.030 - 0.040 (0.0012 - 0.0016)

PISTON RING

NEEM0032S02

Unit: mm (in)

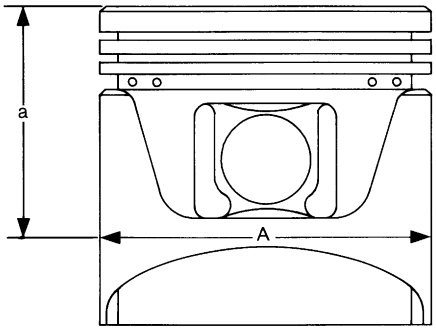
		Standard	Limit
Side clearance	Top	0.040 - 0.080 (0.0016 - 0.0031)	0.11 (0.0043)
	2nd	0.030 - 0.070 (0.0012 - 0.0028)	0.10 (0.004)
	Oil	0.015 - 0.185 (0.0006 - 0.0073)	—
Ring gap	Top	0.21 - 0.31 (0.0083 - 0.0122)	0.43 (0.0169)
	2nd	0.50 - 0.60 (0.0197 - 0.0236)	0.69 (0.0272)
	Oil (rail ring)	0.20 - 0.60 (0.0079 - 0.0236)	0.84 (0.0331)

AVAILABLE PISTON

Engine serial number from VG33–424030

=NEEM0032S05

Unit: mm (in)



SEM882E

Piston skirt diameter "A"	Standard (for No. 3, 4 and 5 cylinders)	Grade No. 2-1	91.480 - 91.485 (3.6016 - 3.6018)
		Grade No. 3-2	91.485 - 91.490 (3.6018 - 3.6020)
		Grade No. 3-3	91.490 - 91.495 (3.6020 - 3.6022)
		Grade No. 4-4	91.495 - 91.500 (3.6022 - 3.6024)
		Grade No. 4-5	91.500 - 91.505 (3.6024 - 3.6026)
		Grade No. 5-6	91.505 - 91.510 (3.6026 - 3.6027)
	Standard (for No. 1, 2 and 6 cylinders)	Grade No. 1	91.465 - 91.475 (3.6010 - 3.6014)
		Grade No. 2	91.475 - 91.485 (3.6014 - 3.6018)
		Grade No. 3	91.485 - 91.495 (3.6018 - 3.6022)
	0.25 (0.0098) oversize (Service)		91.715 - 91.745 (3.6108 - 3.6120)
	0.50 (0.0197) oversize (Service)		91.965 - 91.995 (3.6207 - 3.6218)
"a" dimension			49.0 (1.929)
Piston pin hole diameter		Grade No. 0	20.969 - 20.975 (0.8255 - 0.8258)
		Grade No. 1	20.975 - 20.981 (0.8258 - 0.8260)
Piston clearance to cylinder block	Standard	For No. 3 and 4 cylinders	0.015 - 0.025 (0.0006 - 0.0010)
		For No. 1, 2 and 6 cylinders	0.025 - 0.045 (0.0010 - 0.0018)
		For No. 5 cylinder	0.030 - 0.040 (0.0012 - 0.0016)

PISTON RING

NEEM0032S06

Unit: mm (in)

		Standard	Limit
Side clearance	Top	0.040 - 0.080 (0.0016 - 0.0031)	0.11 (0.0043)
	2nd	0.030 - 0.070 (0.0012 - 0.0028)	0.10 (0.004)
	Oil	0.015 - 0.185 (0.0006 - 0.0073)	—
Ring gap	Top	0.21 - 0.31 (0.0083 - 0.0122)	0.43 (0.0169)
	2nd	0.50 - 0.60 (0.0197 - 0.0236)	0.69 (0.0272)
	Oil (rail ring)	0.20 - 0.60 (0.0079 - 0.0236)	0.84 (0.0331)

PISTON PIN

=NEEM0032S03
Unit: mm (in)/[in]

Piston pin outer diameter	20.971 - 20.983 (0.8256 - 0.8261)
Interference fit of piston pin to piston	0 to (- 0.004) [0 to (- 0.0002)]
Piston pin to connecting rod bushing clearance	0.005 - 0.017 (0.0002 - 0.0007)

Values measured at ambient temperature of 20°C (68°F)

Connecting Rod

NEEM0033
Unit: mm (in)

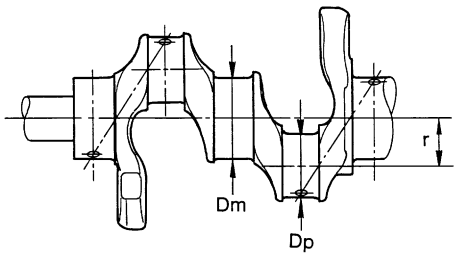
Center distance		154.1 - 154.2 (6.067 - 6.071)
Bend, torsion [per 100 (3.94)]	Limit	Bend: 0.15 (0.0059) Torsion: 0.30 (0.0118)
Piston pin bushing inner diameter*		20.982 - 20.994 (0.8261 - 0.8265)
Connecting rod big end inner diameter		53.000 - 53.013 (2.0866 - 2.0871)
Side clearance	Standard	0.20 - 0.35 (0.0079 - 0.0138)
	Limit	0.40 (0.0157)

*After installing in connecting rod

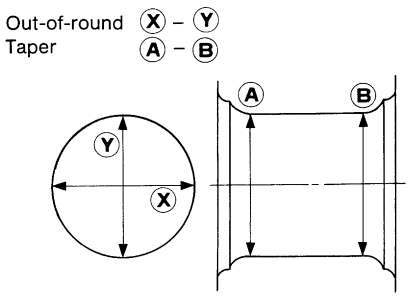
Crankshaft

NEEM0034
Unit: mm (in)

Main journal dia. "Dm"	No. 1 main journal	Grade No. 3	62.696 - 62.975 (2.4683 - 2.4793
		Grade No. 4	62.963 - 62.969 (2.4789 - 2.4791)
		Grade No. 5	62.957 - 62.963 (2.4786 - 2.4789)
		Grade No. 6	62.951 - 62.957 (2.4784 - 2.4786)
	Except No. 1 main journal	Grade No. 0	62.967 - 62.975 (2.4790 - 2.4793)
		Grade No. 1	62.959 - 62.967 (2.4787 - 2.4790)
		Grade No. 2	62.951 - 62.959 (2.4784 - 2.4787)
Pin journal dia. "Dp"			49.955 - 49.974 (1.9667 - 1.9675)
Center distance "r"			41.5 (1.634)
Out-of-round (X − Y)		Standard	Less than 0.005 (0.0002)
Taper (A − B)		Standard	Less than 0.005 (0.0002)
Runout [TIR]		Standard	Less than 0.025 (0.0010)
		Limit	Less than 0.10 (0.0039)
Free end play		Standard	0.050 - 0.170 (0.0020 - 0.0067)
		Limit	0.30 (0.0118)



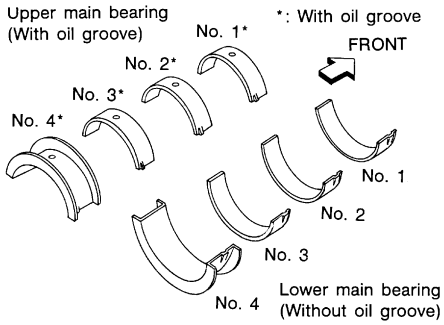
SEM645



EM715

Available Main Bearing

NEEM0035



SEM327A

NO. 1 MAIN BEARING

NEEM0035S01

Grade number	Thickness "T" mm (in)	Width "W" mm (in)	Identification color(mark)
0	1.822 - 1.825 (0.0717 - 0.0719)	22.4 - 22.6 (0.882 - 0.890)	Black (A)
1	1.825 - 1.828 (0.0719 - 0.0720)		Brown (B)
2	1.828 - 1.831 (0.0720 - 0.0721)		Green (C)
3	1.831 - 1.834 (0.0721 - 0.0722)		Yellow (D)
4	1.834 - 1.837 (0.0722 - 0.0723)		Blue (E)
5	1.837 - 1.840 (0.0723 - 0.0724)		Pink (F)
6	1.840 - 1.843 (0.0724 - 0.0726)		Purple (G)

NO. 2 AND 3 MAIN BEARING

NEEM0035S02

Grade number	Thickness "T" mm (in)	Width "W" mm (in)	Identification color
0	1.817 - 1.821 (0.0715 - 0.0717)	18.9 - 19.1 (0.744 - 0.752)	Black
1	1.821 - 1.825 (0.0717 - 0.0719)		Brown
2	1.825 - 1.829 (0.0719 - 0.0720)		Green
3	1.829 - 1.833 (0.0720 - 0.0722)		Yellow
4	1.833 - 1.837 (0.0722 - 0.0723)		Blue

NO. 4 MAIN BEARING

NEEM0035S03

Grade number	Thickness "T" mm (in)	Identification color
0	1.817 - 1.821 (0.0715 - 0.0717)	Black
1	1.821 - 1.825 (0.0717 - 0.0719)	Brown
2	1.825 - 1.829 (0.0719 - 0.0720)	Green
3	1.829 - 1.833 (0.0720 - 0.0722)	Yellow
4	1.833 - 1.837 (0.0722 - 0.0723)	Blue

UNDER SIZE

NEEM0035S04

Unit: mm (in)

		Thickness "T" mm (in)	Main journal diameter "Dm"
0.25 (0.0098)	No.1 main bearing	1.956 - 1.962 (0.0770 - 0.0772)	Grind so that bearing clearance is the specified valve.
	No.2,3 and No.4 main bearing	1.948 - 1956 (0.0767 - 0.0770)	

Available Connecting Rod Bearing

NEEM0036

CONNECTING ROD BEARING UNDERSIZE

NEEM0036S01

Unit: mm (in)

		Thickness	Crank pin journal diameter “Dp”
Standard		1.502 - 1.506 (0.0591 - 0.0593)	49.955 - 49.974 (1.9667 - 1.9675)
Undersize	0.08 (0.0031)	1.542 - 1.546 (0.0607 - 0.0609)	Grind so that bearing clearance is the specified value.
	0.12 (0.0047)	1.562 - 1.566 (0.0615 - 0.0617)	
	0.25 (0.0098)	1.627 - 1.631 (0.0641 - 0.0642)	

Miscellaneous Components

NEEM0037

Unit: mm (in)

Drive plate runout [TIR]	Less than 0.15 (0.0059)

BEARING CLEARANCE

NEEM0037S01

Unit: mm (in)

Main bearing clearance	No.1 main bearing	Standard	0.020 - 0.038 (0.0008 - 0.0015)
		Limit	0.060 (0.0024)
	No.2, 3 and No.4 main bearing	Standard	0.028 - 0.055 (0.0011 - 0.0022)
		Limit	0.080 (0.0031)
Connecting rod bearing clearance	Standard	0.014 - 0.054 (0.0006 - 0.0021	
	Limit	0.090 (0.0035)	