

# 1MZ-FE ENGINE

# ENGINE MECHANICAL

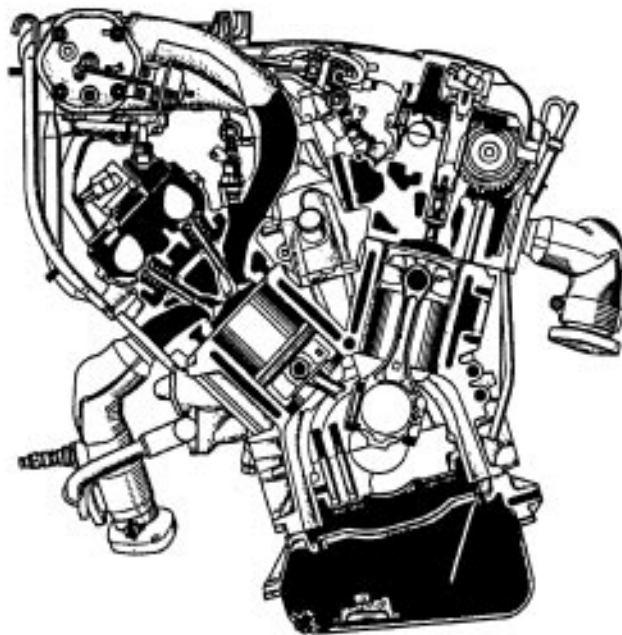
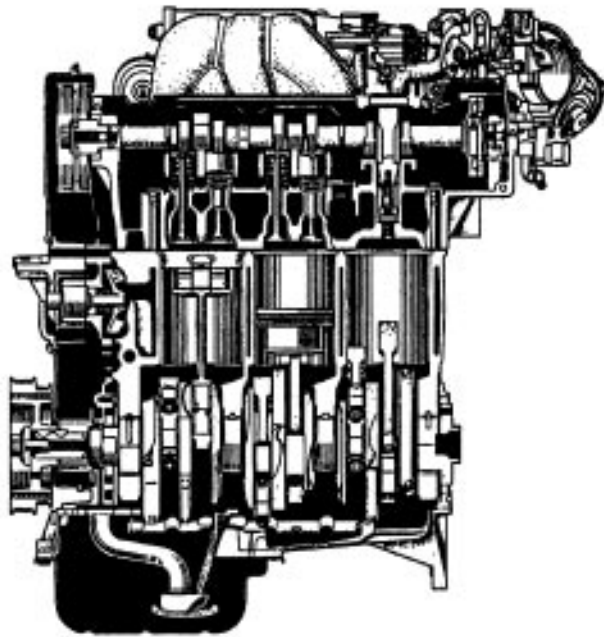
## DESCRIPTION

The 1MZ-FE engine is a V-6, 3.0 liter 24 valve DOHC engine.

E00P0-04

## OPERATION

E00P1-01



The 1 MZ-FE engine has 6 cylinders in a V arrangement at a bank angle of 60°. From the front of the RH bank cylinders are numbered 1-3-5, and from the front of the LH bank cylinders are numbered 2-4-6. The crankshaft is supported by 4 bearings inside the crankcase. These bearings are made of copper and lead alloy.

The crankshaft is integrated with 9 semi counterweights for balance. Oil holes are placed in the center of the crankshaft for supply oil to the connecting rods, bearings, pistons and other components.

This engine's firing order is 1-2-3-4-5-6. The cylinder head is made of aluminum alloy, with a cross flow type intake and exhaust layout and with pent-roof type combustion chambers. The spark plugs are located in the center of the combustion chambers.

At the front and rear of the intake manifold, a water passage has been provided which connects the RH and LH cylinder heads.

Exhaust and intake valves are equipped with irregular pitch springs made of special valve spring carbon steel which are capable of following the cam profile at all engine speeds.

The RH and LH exhaust camshafts are driven by a single timing belt, and a gear on the exhaust camshaft engages with a gear on the intake camshaft to drive it. The camshaft journal is supported at 5 places between the valve lifters of each cylinder and on the front end of the cylinder head. Lubrication of the cam journals and gears is accomplished by oil being supplied through the oiler port in the center of the camshaft.

Adjustment of the valve clearance is done by means of an outer shim type system, in which valve adjusting shims are located above the valve lifters. This permits replacement of the shims without removal of the camshafts.

The timing belt covers consist of the resin type No.2 and No.1 above and below the engine RH mounting bracket.

Pistons are made of high temperature-resistant aluminum alloy, and a depression is built into the piston head to prevent interference with the valves.

Piston pins are the full-floating type, with the pins fastened to neither the piston boss nor the connecting rods. Instead, snap rings are fitted on both ends of the pins, preventing the pins from falling out.

The No.1 compression ring is made of steel and the No.2 compression ring is made of cast iron. The oil ring also is made of a combination of steel and stainless steel. The outer diameter of each piston ring is slightly larger than the diameter of the piston and the flexibility of the rings allows them to hug the cylinder walls when they are mounted on the piston. Compression rings No. 1 and No.2 work to prevent gas leakage from the cylinder and the oil ring works to clear oil off the cylinder walls to prevent it from entering the combustion chambers.








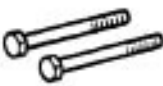





The cylinder block is made of aluminum alloy with a bank angle of 60°. It has 6 cylinders which are approximately 1.6 times the length of the piston stroke. The top of the cylinders is closed off by the cylinder heads and the lower end of the cylinders becomes the crankcase, in which the crankshaft is installed. In addition, the cylinder block contains a water jacket, through which coolant is pumped to cool the cylinders.













The No. 1 and No.2 oil pans are bolted onto the bottom of the cylinder block. The No. 1 oil pan is made of aluminum alloy. The No.2 oil pan is an oil reservoir made of pressed sheet steel. An oil pan baffle plate keeps sufficient oil in the bottom of the No.2 oil pan even when the vehicle is tilted. This dividing plate also prevents the oil from sloshing when the vehicle is stopped suddenly and the oil shifts away from the oil pump suction pipe.

Plastic region tightening bolts are used for the cylinder head, main bearing caps and connecting rods.






**PREPARATION****SST (SPECIAL SERVICE TOOLS)**

1999-01

	09201-01055 Valve Guide Bushing Remover & Replacer 5.5	
	09201-41020 Valve Stem Oil Seal Replacer	
	09202-70010 Valve Spring Compressor	
	09213-54015 Crankshaft Pulley Holding Tool	
	09213-60017 Crankshaft Pulley & Gear Puller Set	
	(09213-00020) Body With Bolt	
	(09213-00030) Handle	
	(09213-00050) Bolt set	Crankshaft timing pulley
	(09213-00060) Bolt set	Crankshaft pulley
	08223-00010 Cover & Seal Replacer	Crankshaft front oil seal
	09223-15030 Oil Seal & Bearing Replacer	Crankshaft rear oil seal
	09223-46011 Crankshaft Front Oil Seal Replacer	Crankshaft timing pulley
	09248-55040 Valve Clearance Adjust Tool set	

	(09248-05410) Valve Lifter Press	
	(09248-05420) Valve Lifter Stopper	
	09249-63010 Torque Wrench Adaptor	RH camshaft timing pulley
	09330-00021 Companion Flange Holding Tool	Crankshaft pulley
	09608-20012 Front Hub & Drive Pinion Bearing Tool Set	
	(09608-03020) Handle	Crankshaft rear oil seal Valve guide bushing
	(09608-03070) Replacer	Spark plug tube gasket
	09631-22020 Power Steering Hose Nut 14 x 17 mm Wrench Set	
	09816-30010 Oil Pressure Switch Socket	Knock sensor Oil pressure switch
	09843-18020 Diagnosis Check Wire	
	09960-10010 Variable Pin Wrench Set	
	(09962-01000) Variable Pin Wrench Arm Assy	Camshaft timing pulley

## RECOMMENDED TOOLS

	09040-00010 Hexagon Wrench Set	
	09090-04010 Engine Sling Device	For suspending engine
	09200-00010 Engine Adjust Kit	
	09258-00030 Hose Plug set	Plug for the vacuum hose, fuel hose etc.
	09904-00010 Expander Set	

## EQUIPMENT

Battery specific gravity gauge	
Caliper gauge	
CO/HC meter	
Connecting rod aligner	
Cylinder gauge	
Dial indicator	
Dye penetrant	
Engine tune-up tester	
Heater	
Micrometer	
Piston ring compressor	
Piston ring expander	
Plastigage	
Precision straight edge	
Magnetic finger	

Soft brush	
Spring tester	Valve spring
Steel square	Valve spring
Thermometer	
Torque wrench	
Valve seat cutter	
Vernier calipers	

887M-01

**COOLANT**

Item	Capacity	Classification
Engine coolant	8.7 liters (9.2 US qts, 7.7 Imp. qts)	Ethylene-glycol base

887M-01

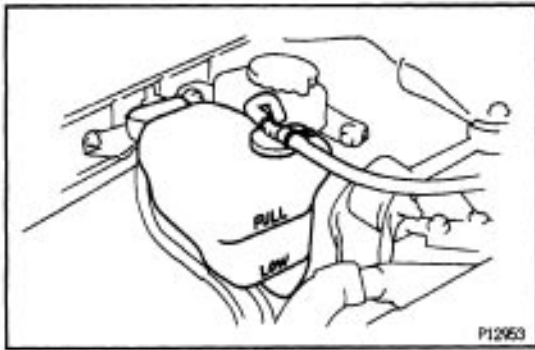
**LUBRICANT**

Item	Capacity	Classification
Engine oil	5.5 liters (5.8 US qts, 4.8 Imp. qts)	API grade SG or SH, Energy-Conserving II or ILSC multigrade and recommended viscosity oil with SAE 5W-30 being the preferred engine oil
Dry fill	4.7 liters (5.0 US qts, 4.1 Imp. qts)	
Drain and refill w/ Oil filter change w/o Oil filter change	4.5 liters (4.8 US qts, 4.0 Imp. qts)	

887M-02

**SSM (SERVICE SPECIAL MATERIALS)**

08826-00080 Seal packing or equivalent	Camshaft bearing cap Semi-circular plug Spark plug tube Cylinder head cover
08826-00080 Seal packing or equivalent	Intake air control valve Rear oil seal retainer No. 1 oil pan No.2 oil pan
08826-00100 Seal Packing 1282B, THREE BOND 1282B or equivalent	Engine coolant drain cock Water seal plate Water inlet housing
08833-00070 Adhesive 1311, THREE BOND 1311 or equivalent	Drive plate bolt TVV
08833-00080 Adhesive 1344, THREE BOND 1344, LOCTITE 242 or equivalent	Oil pressure switch



## TUNE-UP

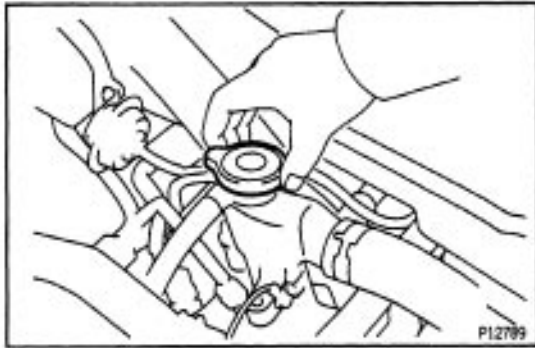
8047P-01

### ENGINE COOLANT INSPECTION

#### 1. CHECK ENGINE COOLANT LEVEL AT RESERVOIR TANK

The engine coolant level should be between the "LOW" and "FULL" lines.

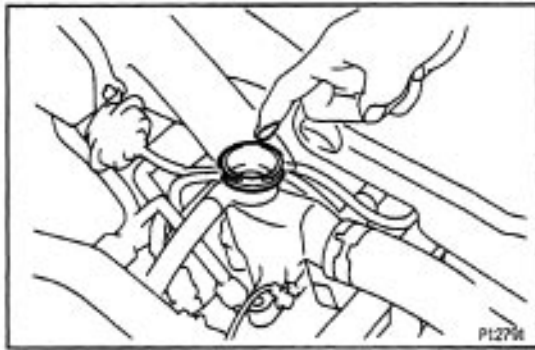
If low, check for leaks and add engine coolant up to the "FULL" line.



#### 2. CHECK ENGINE COOLANT QUALITY

(a) Remove the radiator cap from the water outlet.

**CAUTION:** To avoid the danger of being burned, do not remove the radiator cap while the engine and radiator are still hot, as fluid and steam can be blown out under pressure.



(b) There should not be any excessive deposits of rust or scale around the radiator cap or water outlet filler hole, and the coolant should be free from oil.

If excessively dirty, clean the coolant passages and replace the coolant.

#### Capacity:

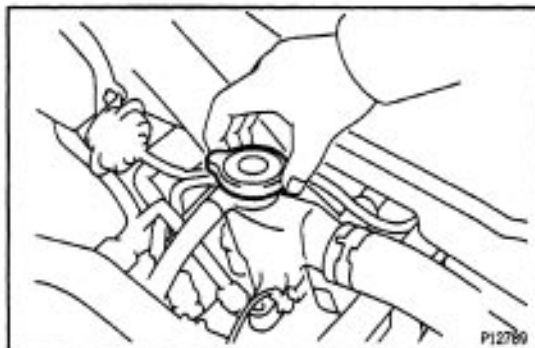
**8.7 liters (9.2 US qts, 7.7 Imp. qts)**

#### HINT:

- Use a good brand of ethylene-glycol base coolant and mix it according to the manufacturer's directions.
- Using coolant which includes more than 50 % ethylene-glycol (but not more than 70 %) is recommended.

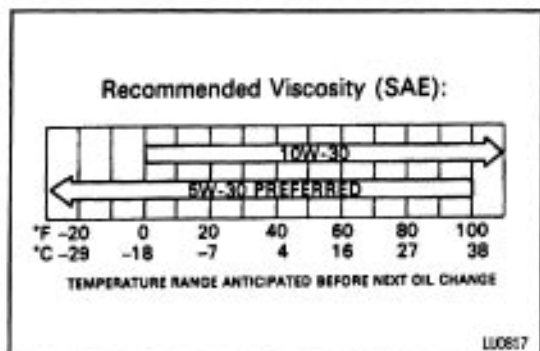
#### NOTICE:

- **Do not use an alcohol type coolant.**
- **The coolant should be mixed with demineralized water or distilled water.**



(c) Reinstall the radiator cap.





## ENGINE OIL INSPECTION

### 1. CHECK OIL QUALITY

Check the oil for deterioration, entry of water, discoloring or thinning.

If oil quality is visibly poor, replace the oil.

#### Oil grade:

API grade SG or SH, Energy – Conserving H or ILSAC multigrade engine oil. Recommended viscosity is as shown in the illustration, with SAE 5W-30 being the preferred engine oil.

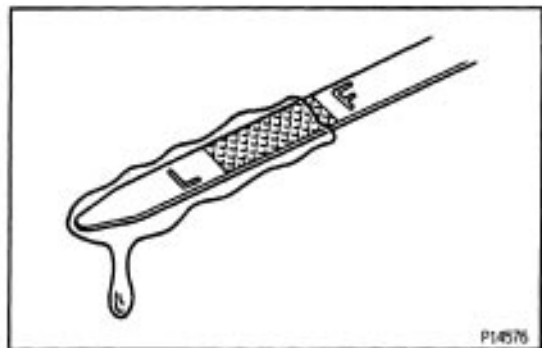
#### Drain and refill capacity:

w/ Oil filter change

4.7 liters (5.0 US qts, 4.1 Imp. qts)

w/o Oil filter change

4.5 liters (4.8 US qts, 4.0 Imp. qts)



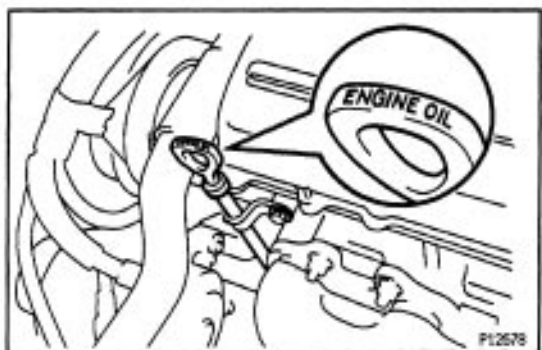
### 2. CHECK ENGINE OIL LEVEL

The oil level should be between the "L" and "F" marks on the dipstick.

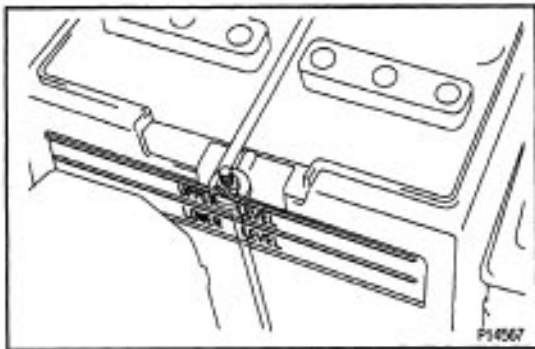
If low, check for leakage and add oil up to the "F" mark.

#### NOTICE:

- Do not fill with engine oil above the 'F' mark.



- Install the oil dipstick facing the direction shown in the illustration.



## BATTERY INSPECTION

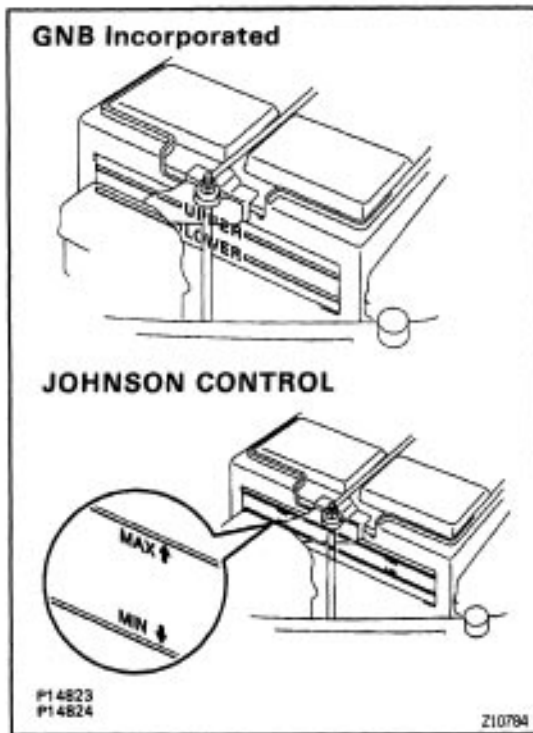
### 1. Except Delco Battery:

#### CHECK BATTERY ELECTROLYTE LEVEL

Check the electrolyte quantity of each cell.

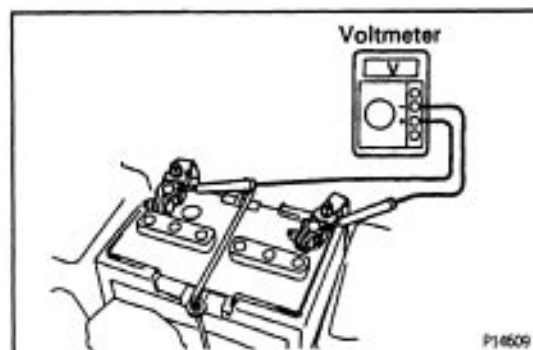
##### A. Maintenance Free Battery

If under the lower level, replace the battery (or add distilled water if possible). Check the charging system.



##### B. Except Maintenance Free Battery

If under the "LOWER" or "MIN" line, add distilled water.



### 2. Except Delco Battery:

#### CHECK BATTERY VOLTAGE AND SPECIFIC GRAVITY

##### A. Maintenance Free Battery

Measure the battery voltage between the terminals negative (-) and positive (+) of the battery.

##### Standard voltage:

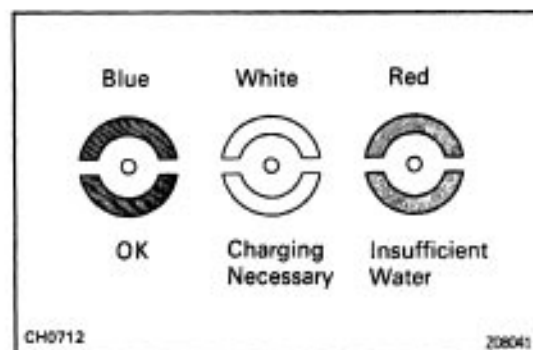
**12.7 – 12.9 V at 20°C (68°F)**

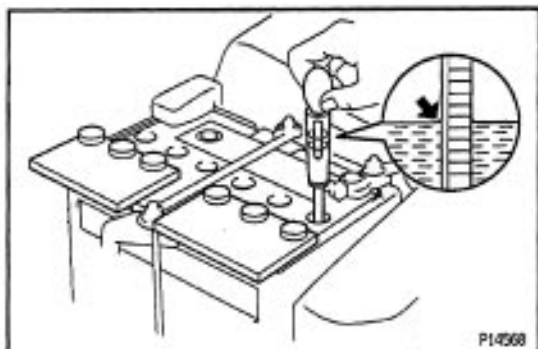
HINT:

- Before measuring the voltage, turn the ignition switch to LOCK and turn off the electrical systems (headlight, blower motor, rear defogger etc.; for 60 seconds to remove the surface charge.
- If the vehicle has been running, wait 5 minutes or more after the vehicle stops before measuring the battery voltage.

If the voltage is less than specification, charge the battery.

HINT: Check the indicator as shown in the illustration.





## B. Except Maintenance Free Battery

Check the specific gravity of each cell.

### Standard specific gravity:

**55D23L battery for GNB Incorporated**

1.25 – 1.27 at 20°C (60°F)

**5513231- battery for JOHNSON CONTROLS**

1.26 – 1.28 at 27°C (81°F)

**80D26L battery for GNB Incorporated**

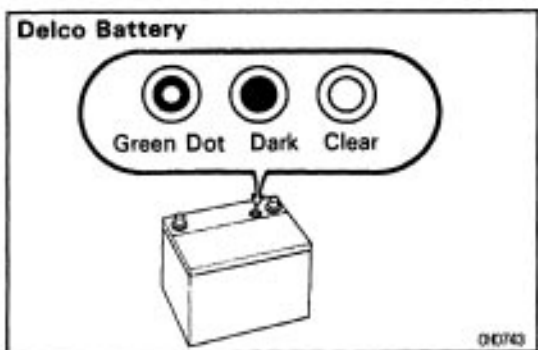
1.27 – 1.29 at 20°C (68°F)

**80D26L battery for JOHNSON CONTROLS**

1.28 – 1.30 at 27°C (80°F)

If the gravity is less than specification, charge the battery.

HINT: Check the indicator as shown in the illustration.



## 3. Delco Battery:

### CHECK HYDROMETER

Green Dot visible:

Battery is adequately charged

Dark (Green Dot not visible):

Battery must be charged

Clear or Light Yellow:

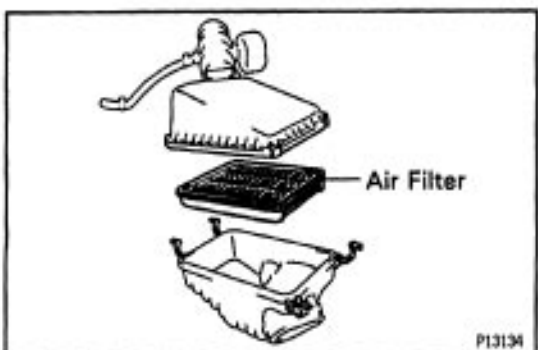
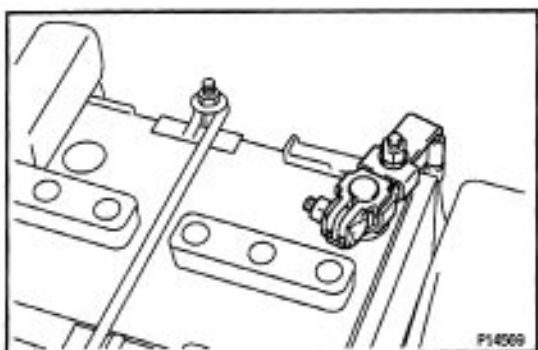
Replace battery

HINT: There is no need to add water during the entire service life of the battery.

## 4. CHECK BATTERY TERMINALS, FUSIBLE LINK AND FUSES

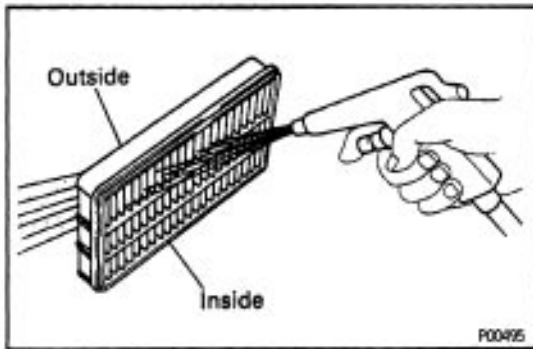
(a) Check that the battery terminals are not loose or corroded.

(b) Check the fusible link and fuses for continuity.



## AIR FILTER INSPECTION AND CLEANING

### 1. REMOVE AIR FILTER



## 2. INSPECT AND CLEAN AIR FILTER

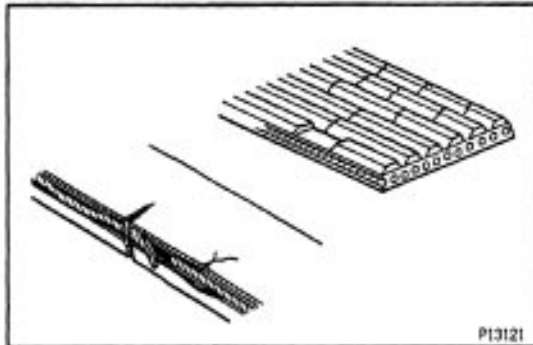
(a) Visually check that the air filter is not excessively dirty, damaged or oily.

If necessary, replace the air filter.

(b) Clean the air filter with compressed air.

First blow from the inside thoroughly, then blow from the outside of the air filter.

## 3. REINSTALL AIR FILTER



## GENERATOR DRIVE BELT INSPECTION

### INSPECT DRIVE BELT

(a) Visually check the belt for excessive wear, frayed cords etc.

If necessary, replace the drive belt.

HINT: Cracks on the rib side of a belt are considered acceptable. If the belt has chunks missing from the ribs, it should be replaced.

(b) Using a belt tension gauge, measure the drive belt tension.

**Belt tension gauge:**

**Nippondenso BTG - 20 (95506-00020)**

**Borroughs No. BT-33-73F**

**Drive belt tension:**

**New belt**

**175 ± 5 lbf**

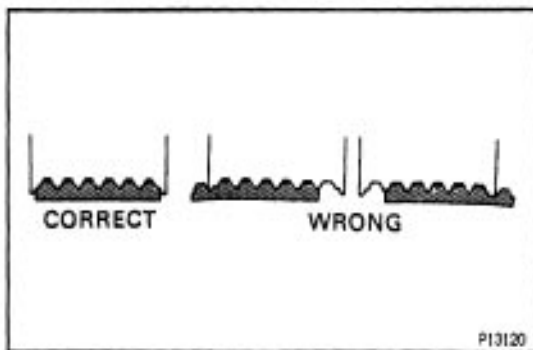
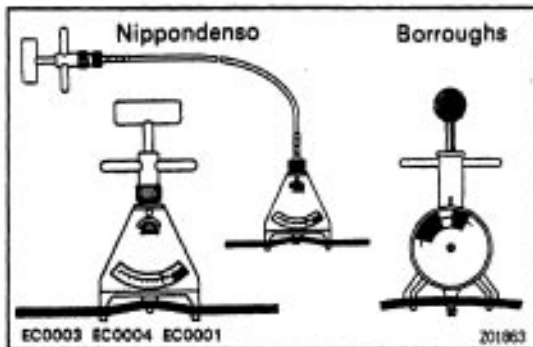
**Used belt**

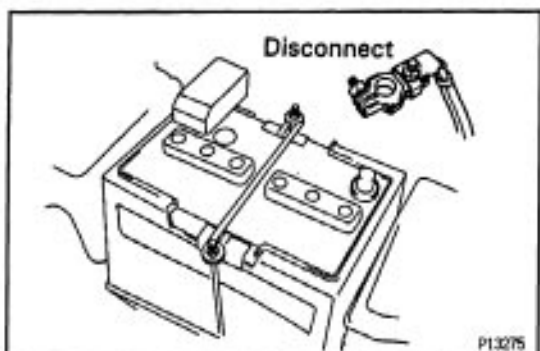
**115 ± 20 lbf**

If the belt tension is not as specified, adjust it.

HINT:

- "New belt" refers to a belt which has been used less than 5 minutes on a running engine.
- "Used belt" refers to a belt which has been used on a running engine for 5 minutes or more.
- After installing the belt, check that it fits properly in the ribbed grooves.
- Check by hand to confirm that the belt has not slipped out of the groove on the bottom of the pulley.
- After installing a new belt, run the engine for about 5 minutes and recheck the belt tension.





## VALVE CLEARANCE INSPECTION AND ADJUSTMENT

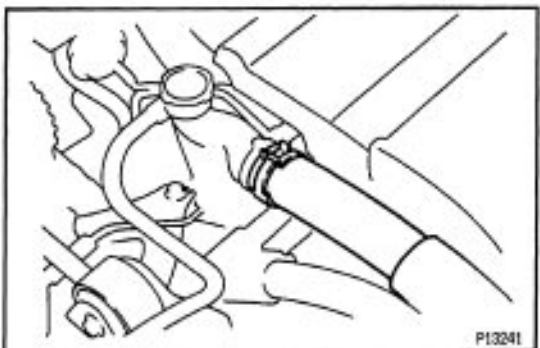
HINT: Inspect and adjust the valve clearance when the engine is cold.

### 1. DISCONNECT NEGATIVE (-) TERMINAL CABLE TO BATTERY

**CAUTION:** Work must be started after 90 seconds from the time the ignition switch is turned to the "LOCK" position and the negative (-) terminal cable is disconnected from the battery.

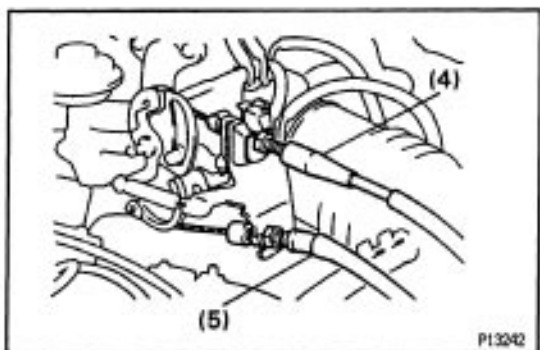
### 2. DRAIN ENGINE COOLANT

### 3. DISCONNECT RADIATOR INLET HOSE



### 4. DISCONNECT ACCELERATOR CABLE

### 5. DISCONNECT THROTTLE CABLE



### 6. REMOVE AIR CLEANER CAP, VOLUME AIR FLOW METER AND AIR CLEANER HOSE

(a) Disconnect the volume air flow meter connector and wire clamp.

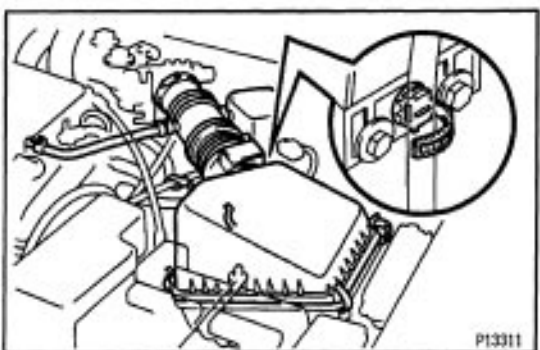
(b) Disconnect the accelerator cable clamp.

(c) Disconnect the PCV hose.

(d) Loosen the air cleaner hose clamp bolt.

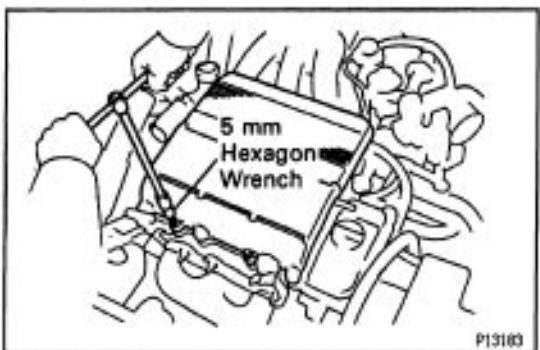
(e) Disconnect the 4 air cleaner cap clips.

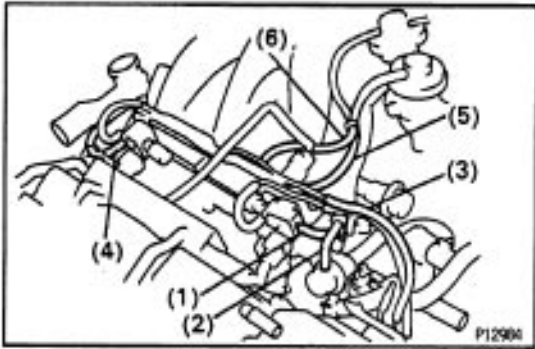
(f) Remove the air cleaner cap and volume air flow meter together with the air cleaner hose.



### 7. REMOVE V-BANK COVER

Using a 5 mm hexagon wrench, remove the 2 nuts and V-bank cover.

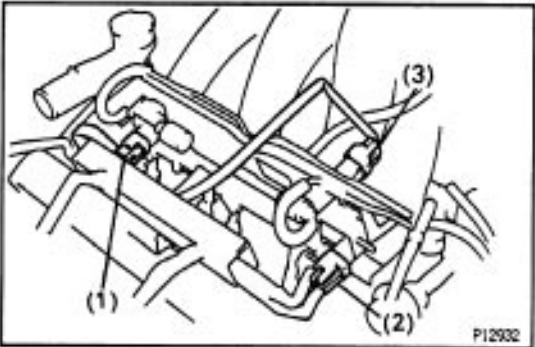




## 8. REMOVE EMISSION CONTROL VALVE SET

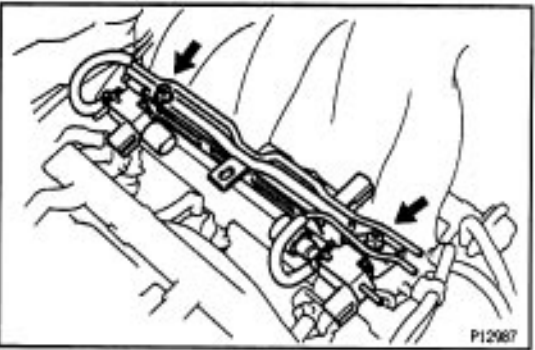
(a) Disconnect the following vacuum hoses:

- (1) Vacuum hose from fuel pressure control VSV
- (2) Vacuum hose from fuel pressure regulator
- (3) Vacuum hose from cylinder head rear plate
- (4) Vacuum hose from intake air control valve VSV
- (5) Vacuum hose from EGR vacuum modulator
- (6) Vacuum hose from EGR valve

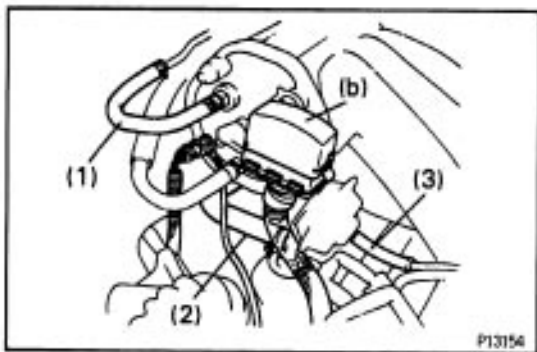


(b) Disconnect the following connectors:

- (1) Intake air control valve connector
- (2) Fuel pressure connector
- (3) EGR VSV connector



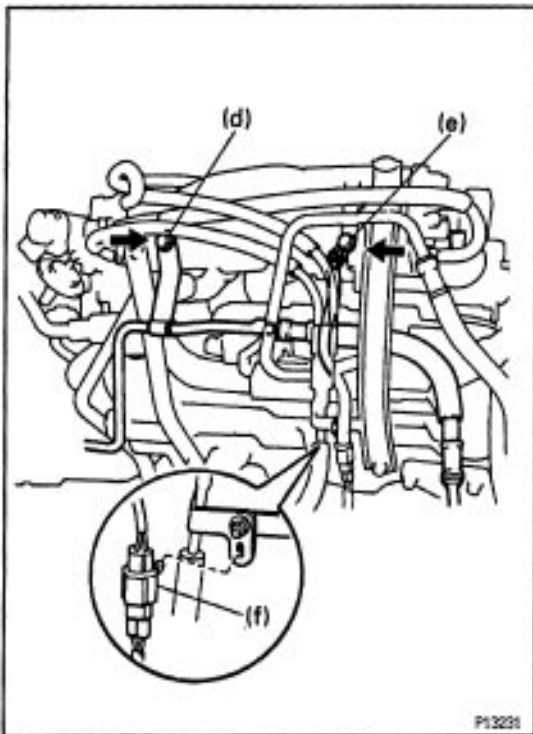
(c) Remove the 2 nuts and emission control valve set.



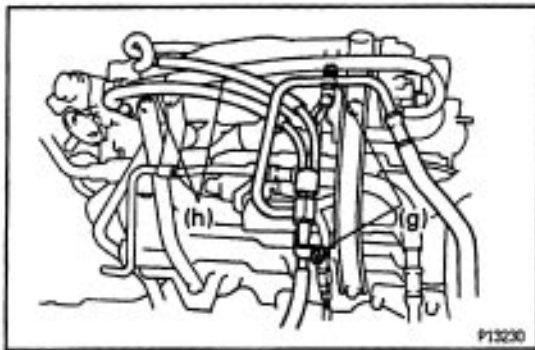
## 9. REMOVE AIR INTAKE CHAMBER

(a) Disconnect the following hoses:

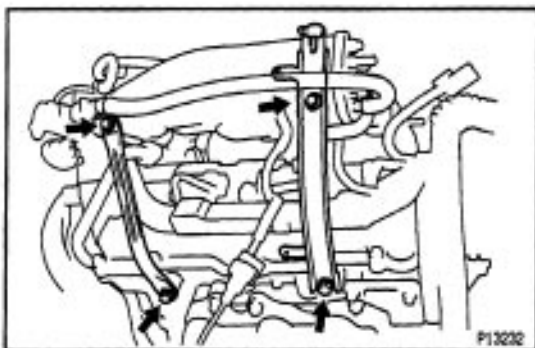
- (1) Brake booster vacuum hose
  - (2) PCV hose
  - (3) Intake air control valve vacuum hose
- (b) Disconnect the data link connector 1.
- (c) Remove the nut and disconnect the 2 ground straps.



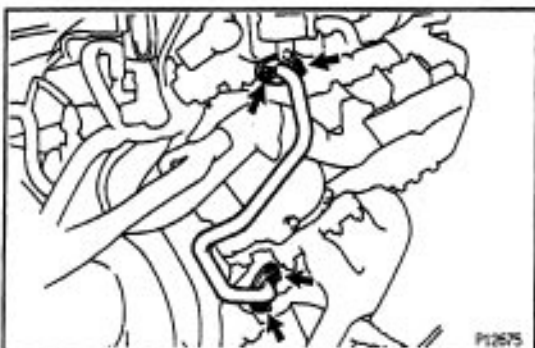
- (d) Remove the bolt and disconnect the hydraulic motor pressure hose from the air intake chamber.  
 (e) Remove the bolt, and disconnect the ground strap.  
 (f) Disconnect the RH oxygen sensor connector clamp from the PS pressure tube.



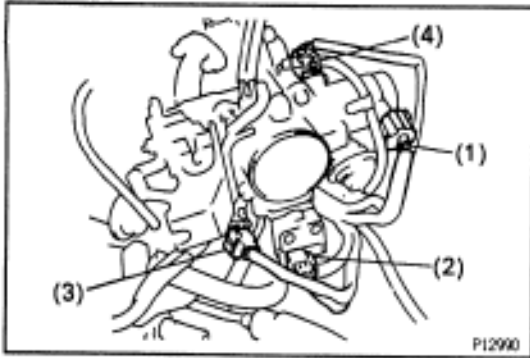
- (g) Remove the 2 nuts, and disconnect the PS pressure tube.  
 (h) Disconnect the 2 PS air hoses.



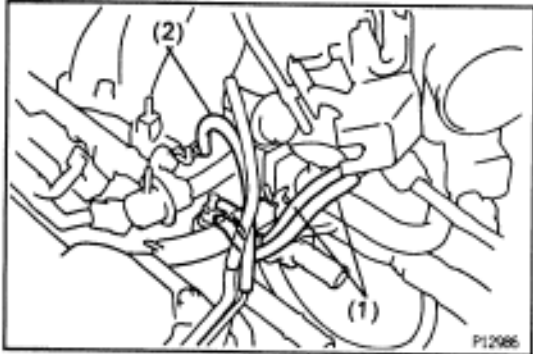
- (i) Remove the 2 bolts and No.1 engine hanger.  
 (j) Remove the 2 bolts and air intake chamber stay.



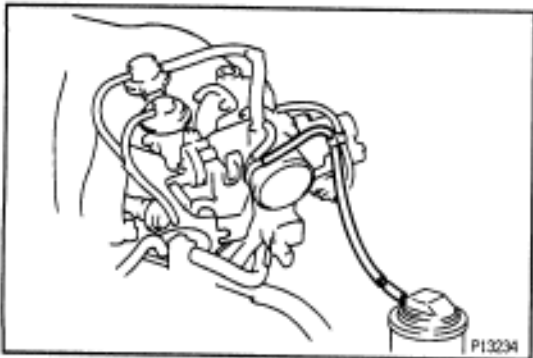
- (k) Remove the 4 nuts, EGR pipe and 2 gaskets.



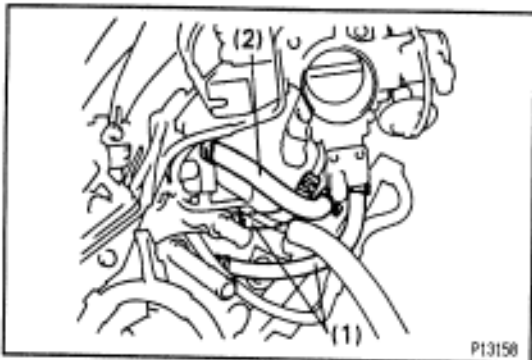
- (l) Disconnect the following connectors:
- (1) Throttle position sensor connector
  - (2) IAC valve connector
  - (3) EGR gas temperature sensor connector
  - (4) A/C idle-up connector



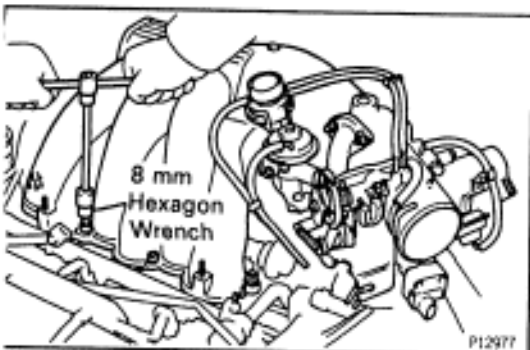
- (m) Disconnect the following vacuum hoses:
- (1) 2 vacuum hoses from TVV
  - (2) Vacuum hose from cylinder head rear plate



- (3) Vacuum hose from charcoal canister

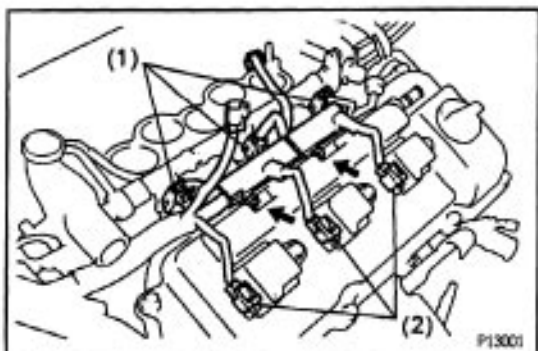


- (n) Disconnect the following hoses:
- (1) 2 water bypass hoses
  - (2) Air assist hose



- (o) Using an 8 mm hexagon wrench, remove the 2 bolts, 2 nuts, air intake chamber and gasket.



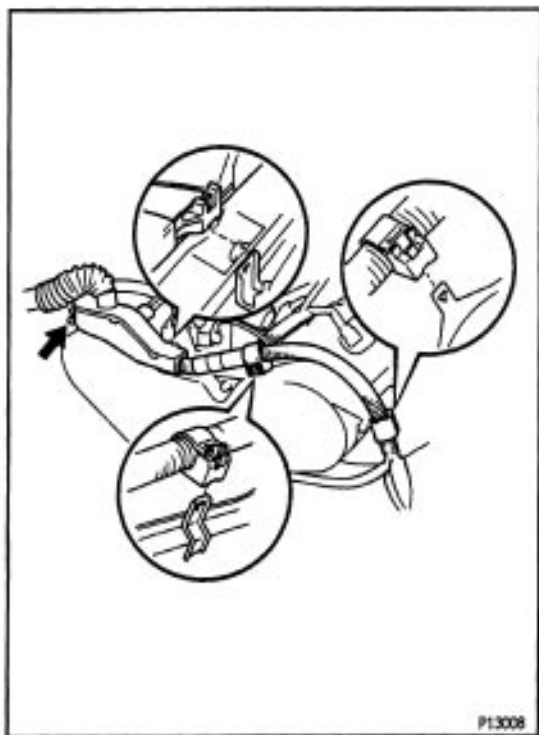


### 10. DISCONNECT ENGINE WIRE FROM ENGINE LH SIDE

(a) Disconnect the following connectors:

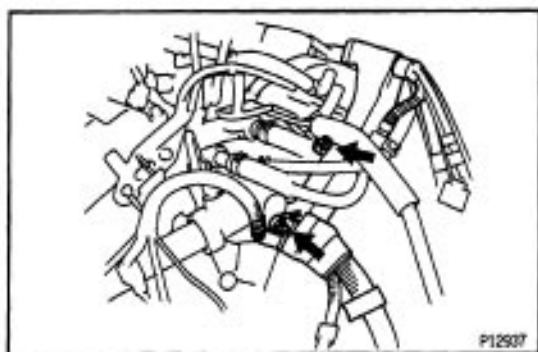
- (1) 3 injector connectors
- (2) 3 ignition coil connectors

(b) Remove the 2 nuts, and disconnect the engine wire.



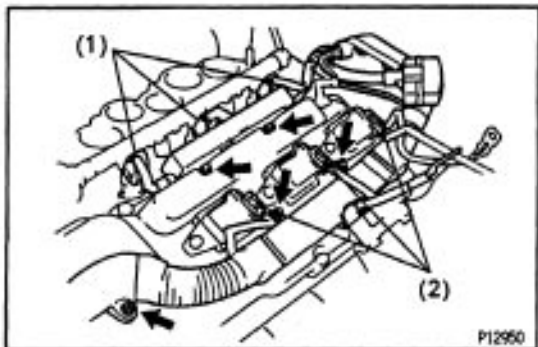
### 11. DISCONNECT ENGINE WIRE FROM NO.3 TIMING BELT COVER

Remove the bolt and 3 clamps, and disconnect the engine wire.



### 12. DISCONNECT ENGINE WIRE FROM ENGINE REAR SIDE

Remove the 2 nuts, and disconnect the engine wire.

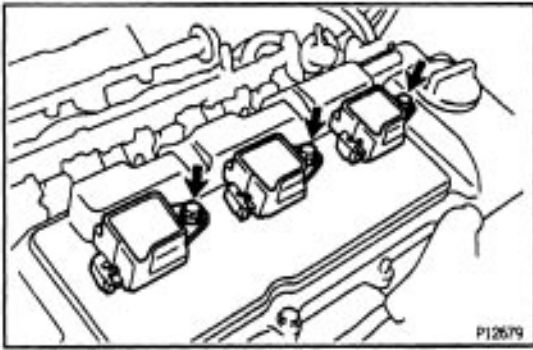


### 13. DISCONNECT ENGINE WIRE FROM ENGINE RH SIDE

(a) Disconnect the following connectors:

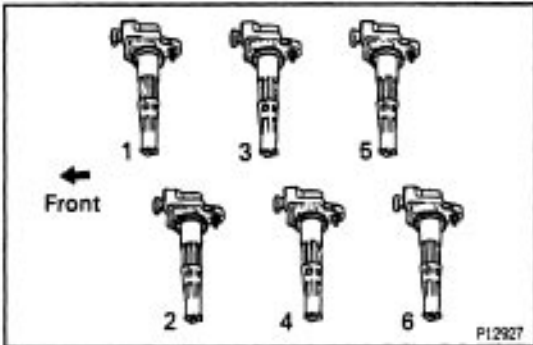
- (1) 3 injector connectors
- (2) 3 ignition coil connectors

(b) Remove the 5 nuts, and disconnect the engine wire.

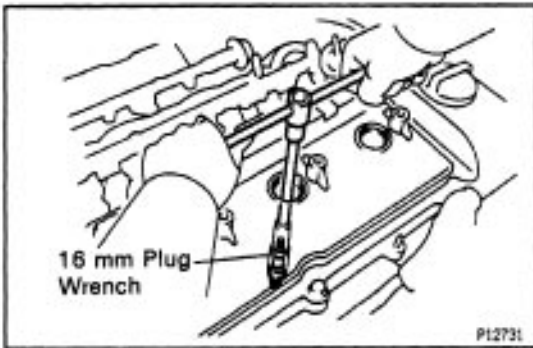


#### 14. REMOVE IGNITION COILS

Remove the 6 bolts and 6 ignition coils from the RH and LH cylinder heads.

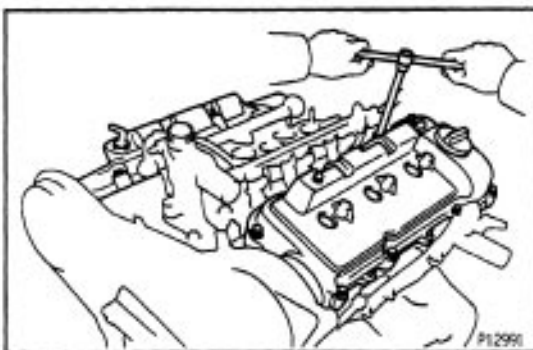


HINT: Arrange the ignition coils in the correct order.



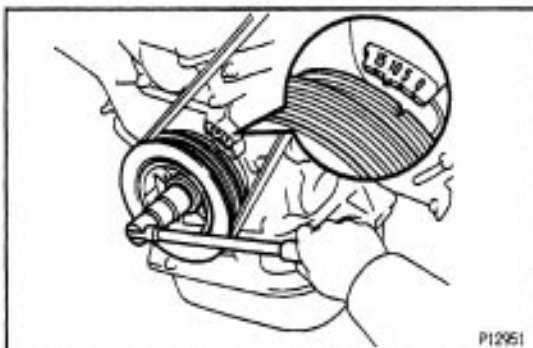
#### 15. REMOVE SPARK PLUGS

Using a 16 mm plug wrench, remove the 6 spark plugs from the RH and LH cylinder heads.



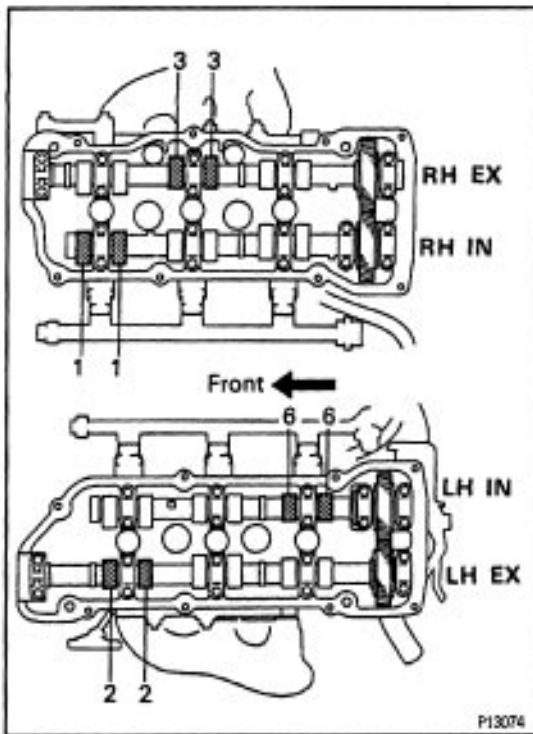
#### 16. REMOVE CYLINDER HEAD COVERS

Remove the 8 bolts, cylinder head cover and gasket. Remove the 2 cylinder head covers.



#### 17. SET NO.1 CYLINDER TO TDC/COMPRESSION

(a) Turn the crankshaft pulley, and align its groove with the timing mark "0" of the No.1 timing belt cover.  
 (b) Check that the valve lifters on the No.1 (IN) are loose and valve lifters on the No.1 (EX) are tight.  
 If not, turn the crankshaft 1 revolution (360°) and align the mark as above.



## 18. INSPECT VALVE CLEARANCE

(a) Check only those valves indicated in the illustration.

- Using a feeler gauge, measure the clearance between the valve lifter and camshaft.
- Record out of specification valve clearance measurements. They will be used later to determine the required replacement adjusting shim.

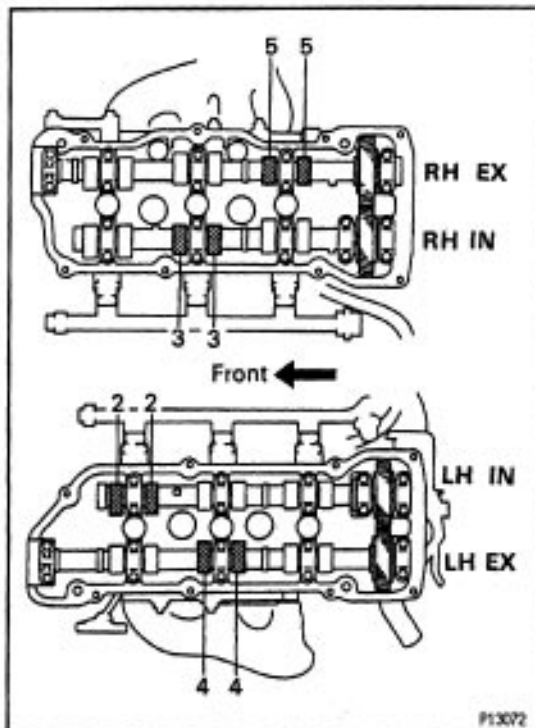
### Valve clearance (Cold):

#### Intake

0.15 – 0.25 mm (0.006 – 0.010 in.)

#### Exhaust

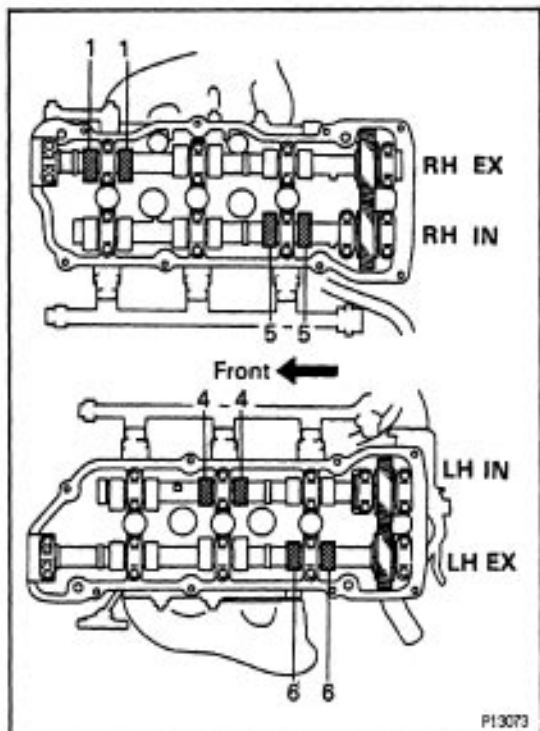
0.25 – 0.35 mm (0.010 – 0.014 in.)



(b) Turn the crankshaft 2/3 of a revolution (240°), and check only the valves indicated in the illustration.

Measure the valve clearance.

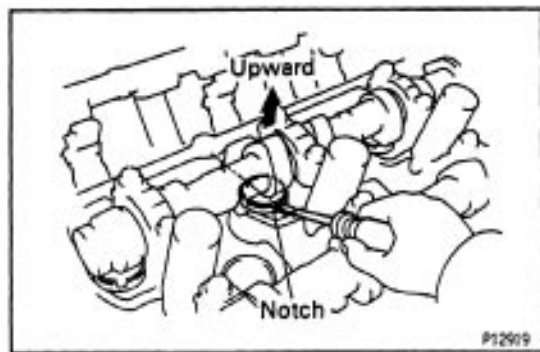
(See procedure step (a))



(c) Turn the crankshaft a further 2/3 of a revolution (240°), and check only the valves indicated in the illustration.

Measure the valve clearance.

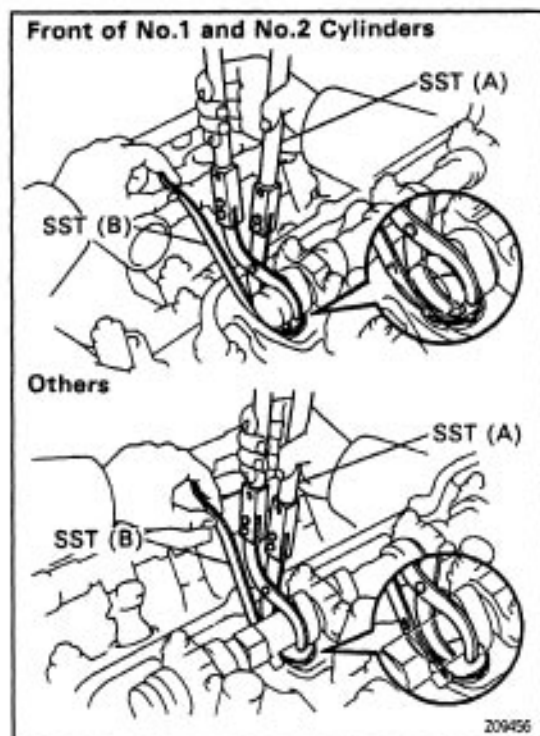
(See procedure step (a))



### 19. ADJUST VALVE CLEARANCE

(a) Remove the adjusting shim.

- Turn the camshaft so that the cam lobe for the valve to be adjusted faces up.
- Turn the valve lifter with a screwdriver so that the notches would be perpendicular to the camshaft.



- Using SST (A), press down the valve lifter and place SST (B) between the camshaft and valve lifter. Remove SST (A).

SST 09248-55040 (09248-05410, 09248-05420)  
 HINT:

- Apply SST (B) at a slight angle on the side marked with "9" or "7", at the position shown in the illustration.
- When SST (B) is inserted too deeply, it will get pinched by the shim. To prevent it from being stuck, insert it gently from the intake side, at a slight angle.