TOYOTA 1C, 2C, 2C-T ENGINE REPAIR MANUAL

HOW TO USE THIS MANUAL

To assist in finding your way through this manual, the Section Title and major heading are given at the top of every page.

An **INDEX** is provided on the 1st page of each section to guide you to the item to be repaired.

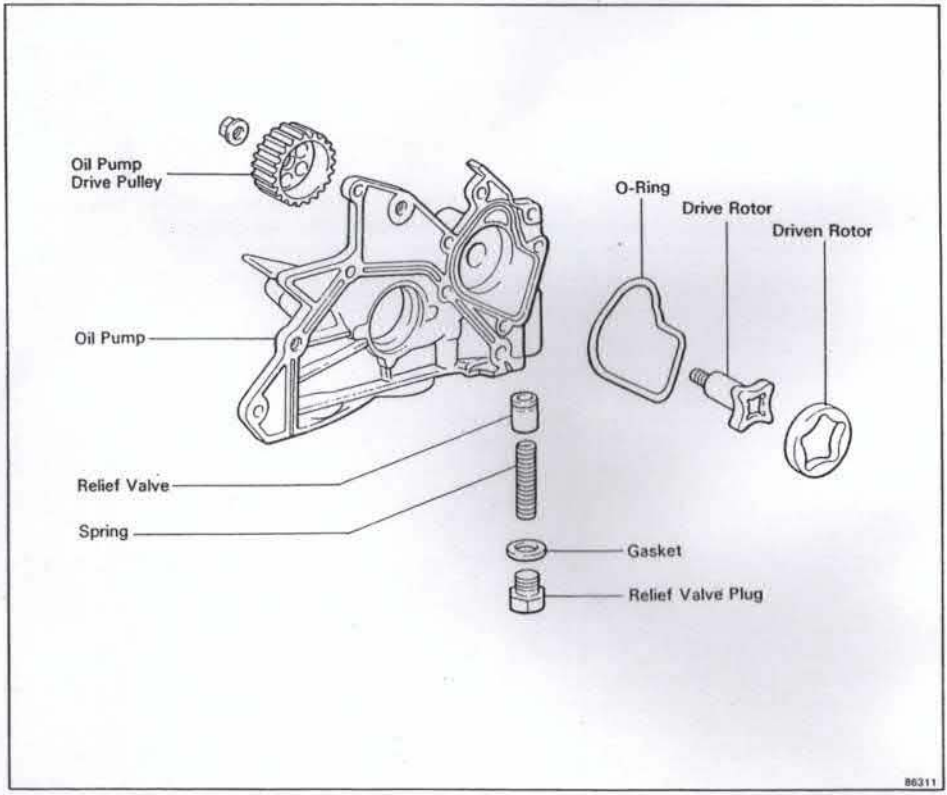
At the beginning of each section, **PRECAUTIONS** are given that pertain to *all* repair operations contained in that section. *Read these precautions before starting any repair task.*

TROUBLESHOOTING tables are included for each system to help you diagnose the system problem and find the cause. The repair for each possible cause is referenced in the remedy column to quickly lead you to the solution.

REPAIR PROCEDURES

Most repair operations begin with an overview illustration. It identifies the components and shows how the parts fit together.

Example:



The procedures are presented in a step-by-step format:

- The illustration shows *what* to do and *where* to do it.
- The task heading tells *what* to do.
- The detailed text tells *how* to perform the task and gives other information such as specifications and warnings.

Example:

Illustration: what to do and where

Task heading: what to do

INSTALL FLYWHEEL

Using SST and a press, press out the bushing.

SST 09222-64010 (09222-02020, 09222-02040)

Set part No. *Components part NO.*

Tighten the bolts to the specified torque in two or three passes and in the sequence shown.

Torque: 900 kg-cm (65 ft-lb, 88 N·m)

Specification

Detail text: how to do it

This format provides the experienced technician within FAST TRACK to the information needed. He can read the task headings and only refer to the detailed text when he needs it. Important specifications and warnings always stand out in bold type.

REFERENCES

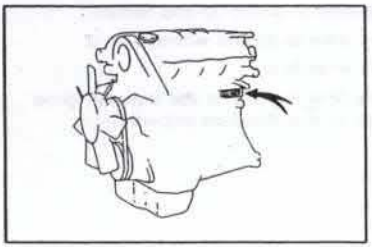
References have been kept to a minimum. However, when they are required you are given the *page* to go to.

SPECIFICATIONS

Specifications are presented in bold type throughout the text in the applicable step. You never have to leave the procedure to look up your specs. All specifications are also found in Appendix A, Specifications, for quick reference.

WARNINGS, CAUTIONS, NOTES:

- WARNINGS are presented in bold type, and indicate there is a possibility of injury to you or other people.
- CAUTIONS are also presented in bold type, and indicate there is a possibility of damage to the components being repaired.
- NOTES are separated from the text but do not appear in bold. They provide additional information to more efficiently help you perform the repair.



IDENTIFICATION INFORMATION

ENGINE SERIAL NUMBER

The engine serial number is stamped on the left side of the cylinder block.

GENERAL REPAIR INSTRUCTIONS

1. Use fender, seat and floor covers to keep the vehicle clean and prevent damage.
2. During disassembly, keep parts in order to facilitate reassembly.
3. Observe the following:
   (a) Before performing electrical work, disconnect the negative cable from the battery terminal.
   (b) If it is necessary to disconnect the battery for inspection or repair, always disconnect the cable from the negative (−) terminal which is grounded to the vehicle body.
   (c) To prevent damage to the battery terminal post, loosen the terminal nut and raise the cable straight up without twisting or prying it.
   (d) Clean the battery terminal posts and cable terminals with a shop rag. Do not scrape them with a file or other abrasive object.
   (e) Install the cable terminal to the battery post with the nut loose, and tighten the nut after installation. Do not use a hammer to tap the terminal onto the post.
   (f) Be sure the cover for the positive (+) terminal is properly in place.
4. Check hose and wiring connectors to make sure that they are secure and correct.
5. Always replace cotter pins gaskets and O-rings with new ones.
6. When necessary, use sealer on gaskets to prevent leaks.
7. Carefully observe all specifications for bolt tightening torques. Always use a torque wrench.
8. Use of special service tools (SST) may be required, depending on the nature of the repair. Be sure to use SST where specified and follow the proper work procedure. A list of SST can be found at the back of this manual.
9. When replacing fuses, be sure the new fuse is the correct amperage. DO NOT exceed the fuse amp rating or use one of a lower rating.
10. Care must be taken when jacking up and supporting the vehicle. Be sure to lift and support the vehicle at the proper locations.
    (a) If the vehicle is to be jacked up only at the front or rear end, be sure to block the wheels in order to ensure safety.
    (b) After the vehicle is jacked up, be sure to support it on stands. It is extremely dangerous to do any work on the vehicle raised on jack alone, even for a small job that can be finished quickly.

11. Observe the following precautions to avoid damage to the parts:
    (a) To disconnect vacuum hoses, pull on the end, not the middle of the hose.
    (b) To pull apart electrical connectors, pull on the connector itself, not the wires.
    (c) Be careful not to drop electrical components, such as sensors or relays. If they are dropped on a hard floor, they should be replaced and not reused.
    (d) When steam cleaning an engine, protect the air filter and injection pump from water.
    (e) Never use an impact wrench to remove or install thermo switches or thermo sensors.
    (f) When checking continuity at the wire connector, insert the tester probe carefully to prevent terminals from bending.
    (g) When using a vacuum gauge, never force the hose onto a connector that is too large. Use a step-down adapter instead. Once the hose has been stretched, it may leak.
12. After removing and reinstalling the injection pump and fuel hoses, clean off the fuel on engine components. In particular, be sure to check the radiator hose and by-pass hose, because deterioration occurs easily if they come into contact with fuel.

ABBREVIATIONS USED IN THIS MANUAL

A/C	Air Conditioner
A/T	Automatic Transmission
BDC	Bottom Dead Center
BTDC	Before Top Dead Center
EX	Exhaust
FF	Front Engine Front Drive
FR	Front Engine Rear Drive
HAC	High Altitude Compensator
IN	Intake
LH	Left-hand
LHD	Left-hand Drive
MP	Multipurpose
OPT	Option
O/S	Oversize
PCV	Positive Crankcase Ventilation
PS	Power Steering
RH	Right-hand
RHD	Right-hand Drive
SST	Special Service Tool
STD	Standard
TDC	Top Dead Center
U/S	Undersize
w/	With
w/o	Without

ENGINE MECHANICAL

DIESEL ENGINE DIAGNOSIS

GENERAL

Diesel engine problems are usually caused by the engine or fuel system. The injection pump is very rarely the cause of fuel system problems.

Before beginning fuel system tests, first check that the engine compression, valve timing and other major systems are within specification.

PRELIMINARY CHECKS

(a) Before performing fuel system checks, insure that the engine is in good running condition. If necessary, first check the compression, timing and major components or systems.

(b) Check the air filter and clean or replace it if necessary.

(c) Confirm that there is sufficient fuel in the tank.

(d) Check if the fuel is contaminated with gasoline or other foreign elements. Only good-quality diesel fuel should be used.

(e) Bleed air from the system by pumping the priming pump 30 – 40 times.

(f) Check for water in the fuel filter and fuel tank and drain as necessary.

(g) If the engine will not crank or if it cranks slowly, first troubleshoot the electrical system.

DIAGNOSIS

PRECAUTION:

1. The basic troubleshooting procedures for the diesel engine itself (valve clearance, compression, bearings, valves, pistons, etc.) are the same checks you would make for a gasoline engine.
2. The repair of the injection pump requires considerable skill and use of a special test bench.

ENGINE WILL NOT CRANK

(Possible Cause)	(Check Procedure and Correction Method)
1. LOOSE OR CORRODED BATTERY CABLES	Check cables from battery to starter and make necessary repairs.
2. DISCHARGED BATTERY	Check alternator output and the drive belt. Repair as necessary. (See page CH-4)
3. INOPERATIVE STARTER	Check for battery voltage at starter terminals 30 and 50. If Okay, see STARTING SYSTEM, page (ST-11 or 12) for repair procedure.

ENGINE CRANKS SLOWLY-WILL NOT START

NOTE: Minimum cranking speed: 100 rpm Cold
150 rpm Hot

(Possible Cause)	(Check Procedure and Correction Method)
1. LOOSE OR CORRODED BATTERY CABLES	
2. DISCHARGED BATTERY	Refer to items 1 and 2 of ENGINE WILL NOT CRANK.
3. IMPROPER ENGINE OIL	Check engine oil. If improper viscosity, drain and refill with oil of viscosity recommended by manufacturer. (See page LU-3)

ENGINE CRANKS NORMALLY BUT WILL NOT START

(Possible Cause)	(Check Procedure and Correction Method)
1. NO FUEL TO NOZZLE HOLDER	Loosen any one injection pipe union nut from its nozzle holder. Crank the engine for about 5 seconds while confirming that fuel is being discharged from the pipe. If fuel is coming out, begin diagnosis from item 4. If not, begin from item 2.
2. NO FUEL CUT SOLENOID OPERATION	With starter switch turned ON, check for fuel cut solenoid operation noise (clicking sound) while repeatedly connecting and disconnecting fuel cut solenoid. If no noise, check if there is battery voltage to the solenoid when the starter switch is ON. If battery voltage is confirmed, fuel cut solenoid is faulty and should be replaced. If no voltage, refer to ELECTRICAL DIAGNOSIS and make necessary repairs.
3. NO FUEL INTO INJECTION PUMP	Disconnect inlet hoses to fuel filter and feed clean fuel from separate container directly into pump. If engine starts, either the fuel filter or line between fuel tank and filter is clogged and should be repaired accordingly. If engine still does not start (no fuel intake), check fuel line between filter and pump. If normal, pump is faulty and should be replaced. **NOTE: When feeding fuel directly into pump, keep container at same level as vehicle fuel tank.**
4. INOPERATIVE PRE-HEATING OPERATION	With starter switch ON and the glow plug indicator lamp illuminated, check that there is voltage applied to the glow plugs. If not, refer to ELECTRICAL DIAGNOSIS and repair as necessary.
5. FAULTY GLOW PLUG OPERATION	Check glow plug continuity (See page ST-6). If no continuity, a broken wire is indicated and glow plug should be replaced.
6. FUEL LEAKAGE FROM INJECTION PIPE	Check for loose unions or cracks. If leaking, tighten to specified torque or, if necessary, replace pipe(s).

7. IMPROPER INJECTION TIMING	Turn crankshaft pulley clockwise to where either No.1 or No. 4 piston is at TDC and, after releasing cold start advance system (CM), check plunger stroke with SST. (See page EM-20) SST 09275-54010 **Plunger stroke: CV 0.67 – 0.73 mm (0.0264 – 0.0287 in.)** **Others 0.77 – 0.83 mm (0.0303 – 0.0327 in.)** If not within specification, injection pump is improperly adjusted. **NOTE: If crankshaft pulley is off more than 10°, it could indicate a jumped timing belt.**
8. IMPROPER COLD START ADVANCE AND FAST IDLE	Measure timer piston stroke and fast idle lever opening angle with injection pump tester when cold start advance is operated.
9. FAULTY NOZZLE OR NOZZLE HOLDER	Check nozzle with nozzle tester. (See page FU-6) **Opening pressure: 135 – 155 kg/cm² (1,920 – 2,205 psi) (13,239 – 15,200 kPa)** If not within specification, nozzle adjustment is improper and pressure should be readjusted. If pressure cannot be adjusted to specification, replace nozzle holder assembly. (See page FU-8)

ROUGH IDLE WITH WARM ENGINE

(Possible Cause)	(Check Procedure and Correction Method)
1. IMPROPER ADJUSTMENT OF ACCELERATOR CABLE	With accelerator pedal released, check that adjusting lever is in contact with idle screw. Also check if accelerator cable is catching on something. If necessary, adjust so lever is in contact with screw, or make other required repairs.
2. IDLE SPEED TOO LOW	Check the idle speed as specified below. (See page EM-23) **Idle speed: 750 – 850 rpm** If not, adjust with idle adjusting screw. **NOTE: If less than specified, idling would normally be rough.**
3. FUEL LEAKAGE	Check for leaks at the pump connections, pump distributive head bolts, nozzle holder and delivery valve. Tighten any loose connections to specified torque or replace parts as necessary.

4. IMPROPER INJECTION TIMING	Refer to item 7 of ENGINE CRANKS NORMALLY BUT WILL NOT START, above.
5. IMPROPER OPERATION OF NOZZLE OR DELIVERY VALVE	With engine idling, loosen the injection pipe to each cylinder in order, and check if the idle speed changes. If no change, a faulty cylinder is indicated. Check according to following procedure. • Faulty Nozzle or Nozzle Holder Check nozzle with nozzle tester. (See page FU-6) **Opening presure: 135 — 155 kg/cm² (1,920 — 2,205 psi) (13,239 — 15,200 kPa)** If pressure is not within specification, nozzle is faulty and injection pressure should be readjusted. (See page FU-8) • Faulty Delivery Valve If injection pressure is within specification, delivery valve is defective and should be replaced.

ENGINE SUDDENLY STOPS

(Possible Cause)	(Check Procedure and Correction Method)
1. ENGINE WILL NOT RE-START	Check to see if engine re-starts according to prescribed procedure. If not, refer to ENGINE CRANKS NORMALLY BUT WILL NOT START, above, and repair as necessary.
2. ROUGH IDLE	If idle is not stable, refer to ROUGH IDLE WITH WARM ENGINE and repair accordingly.
3. MALFUNCTION OF FUEL-CUT SOLENOID	Refer to ENGINE CRANKS NORMALLY BUT WILL NOT START, above, and check accordingly. **NOTE: No operation noise from the fuel cut solenoid may be due to loose electrical connections, so check connectors before proceeding with further repairs.**
4. NO FUEL INTO INJECTION PUMP	Refer to item 3 of ENGINE CRANKS NORMALLY BUT WILL NOT START, above.

LACK OF POWER

NOTE:
1. First confirm that the air cleaner is not clogged or the engine overheating.
2. Not applicable if the customer desires an output power higher than specified for that vehicle. For accuracy, adjust with a chassis dynamo.

(Possible Cause)	(Check Procedure and Correction Method)
1. IMPROPER ACCELERATOR CABLE ADJUSTMENT	With accelerator fully depressed, check that adjusting lever is in contact with maximum speed set screw. (See page EM-23) If not, adjust accordingly.
2. INSUFFICIENT MAXIMUM SPEED	Start engine, depress accelerator pedal to floor and check that maximun speed is as specified below. (See page EM-23) **Maximum speed: CV 5,100 — 5,200 rpm** **Others 5,300 — 5,400 rpm** If not, adjust with maximum speed adjusting screw.
3. INTERCHANGED OVERFLOW SCREW (OUT) AND INLET (NO MARK) FITTING	**NOTE: Overflow screw is marked "OUT" and has an inner jet. Although both fittings are same size, they must not be interchanged.**
4. FUEL LEAKAGE	Refer to item 3 of ROUGH IDLE WITH WARM ENGINE.
5. CLOGGED FUEL FILTER	Disconnect inlet hose to fuel filter and feed clean fuel directly into the pump. If engine condition improves, fuel filter is clogged and should be replaced. (See page FU-2) **NOTE: When feeding fuel directly into pump, keep container at same level as vehicle fuel tank.** If no increase in engine condition after replacing fuel filter, check priming pump or perform other necessary repairs.
6. IMPROPER INJECTION TIMING	Refer to item 7 of ENGINE CRANKS NORMALLY BUT WILL NOT START.
7. FAULTY NOZZLE OR NOZZLE HOLDER	Refer to item 9 of ENGINE CRANKS NORMALLY BUT WILL NOT START.

EXCESSIVE EXHAUST SMOKE

NOTE:
1. Confirm that the air cleaner is not clogged.
2. Confirm with the customer whether or not oil consumption has been excessive.

(Possible Cause)	(Check Procedure and Correction Method)
1. IMPROPER INJECTION TIMING	Refer to item 7 of ENGINE CRANKS NORMALLY BUT WILL NOT START. **NOTE: Black smoke indicates advanced timing while white smoke indicates retarded timing. Adjustments should be made accordingly.**
2. CLOGGED FUEL FILTER	Refer to item 5 of LACK OF POWER. **NOTE: At high speed (2,000 – 3,000 rpm), a clogged filter tends to make the exhaust smoke white.**
3. FAULTY NOZZLE OR NOZZLE HOLDER	Refer to item 9 of ENGINE CRANKS NORMALLY BUT WILL NOT START. **NOTE: Excessive exhaust smoke is often caused by nozzle pressure being too low.**

EXCESSIVE FUEL CONSUMPTION

NOTE: Confirm whether clutch slipping, brakes grabbing, tires wrong size or air filter clogged.

(Possible Cause)	(Check Procedure and Correction Method)
1. FUEL LEAKAGE	Refer to item 3 of ROUGH IDLE WITH WARM ENGINE.
2. IDLE SPEED TOO HIGH	After sufficiently warming up engine, check that idle speed is as specified below. (See page EM-23) **Idle speed: 750 – 850 rpm** If not, adjust with idle adjusting screw.
3. MAXIMUM SPEED TOO HIGH	Start engine, depress accelerator pedal to floor and check that maximum speed is as specified below. (See page EM-23) **Maximum speed: CV 5,100 – 5,200 rpm** **Others 5,300 – 5,400 rpm** If not, adjust with maximum speed adjusting screw.
4. IMPROPER INJECTION TIMING	Refer to item 7 of ENGINE CRANKS NORMALLY BUT WILL NOT START.
5. FAULTY NOZZLE OR NOZZLE HOLDER	Refer to item 9 of ENGINE CRANKS NORMALLY BUT WILL NOT START.

ENGINE NOISE WHEN WARM

(Clanking Noise with Excessive Vibration)

(Possible Cause)	(Check Procedure and Correction Method)
1. COOLANT TEMPERATURE TOO LOW	Check coolant temperature with coolant temperature gauge. If not sufficiently warm, thermostat is faulty and should be replaced.
2. IMPROPER INJECTION TIMING	Refer to item 7 of ENGINE CRANKS NORMALLY BUT WILL NOT START.
3. FAULTY NOZZLE OR NOZZLE HOLDER	Refer to item 9 of ENGINE CRANKS NORMALLY BUT WILL NOT START.

ENGINE WILL NOT RETURN TO IDLE

(Possible Cause)	(Check Procedure and Correction Method)
BINDING ACCELERATOR CABLE	Operate adjusting lever on top of injection pump and check if engine returns to idle. (See page EM-23) If so, accelerator cable is binding or improperly adjusted and should be repaired accordingly. If engine does not return to idle, injection pump is faulty and should be replaced.

ENGINE WILL NOT SHUT OFF WITH KEY

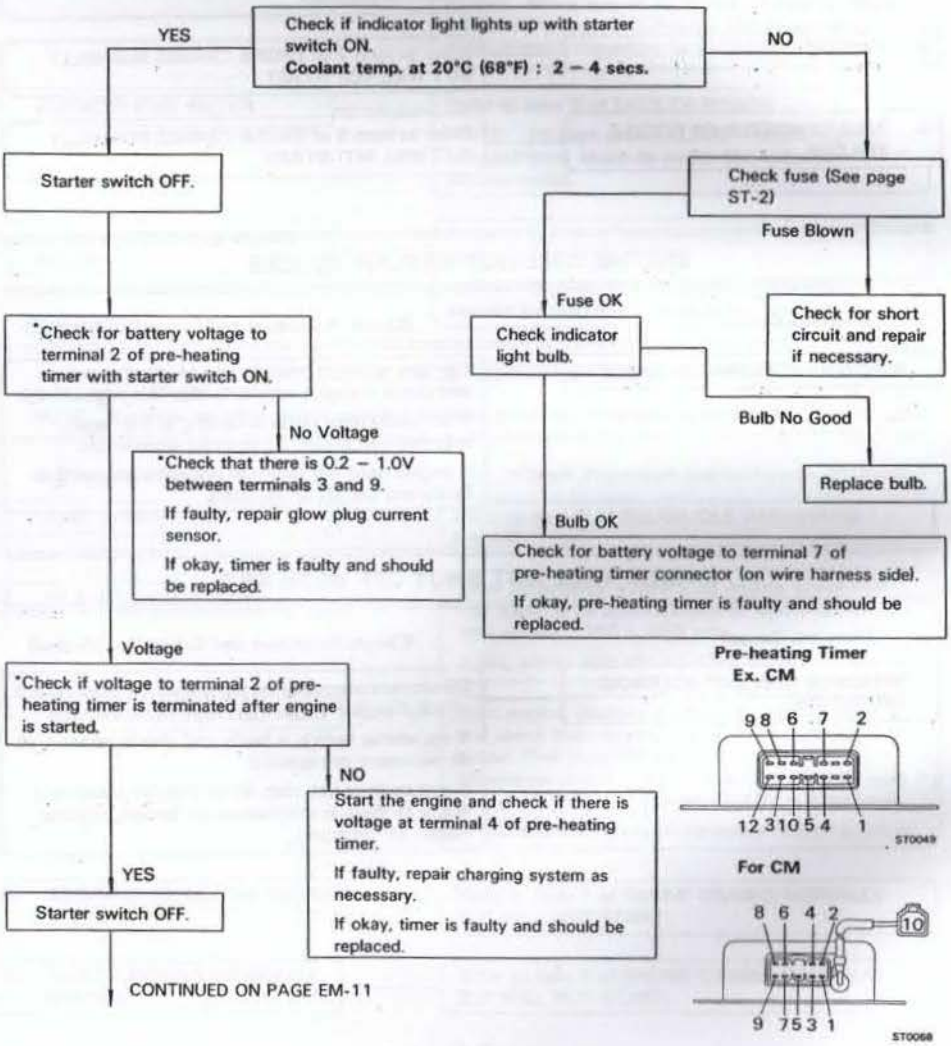
(Possible Cause)	(Check Procedure and Correction Method)
IMPROPER FUEL CUT-SOLENOID OPERATION	Disconnect connector on top of fuel cut solenoid and check if engine stops. If so, starter switch is faulty and should be repaired as necessary or replaced. If engine does not stop, either fuel cut solenoid is faulty or there is interference by foreign particles. Repair as necessary.

DIESEL ELECTRICAL SYSTEM DIAGNOSIS

ENGINE DOES NOT START COLD

NOTE: 1. Battery voltage at least 12 volts – starter switch OFF.
2. Engine cranks normally.
3. Fusible link okay.
4. For voltage marked with an asterisk, check just as starter is turned ON because voltage changes with elapse of time.

1. Super Glow System



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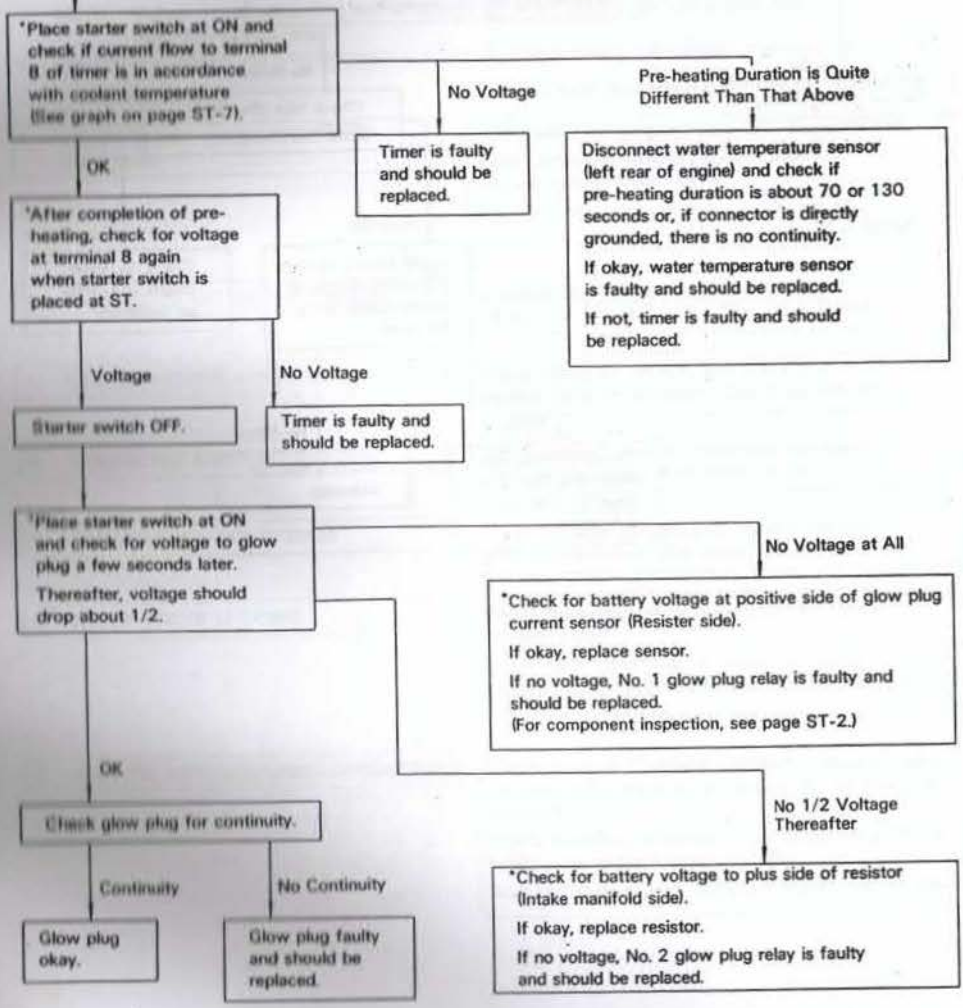
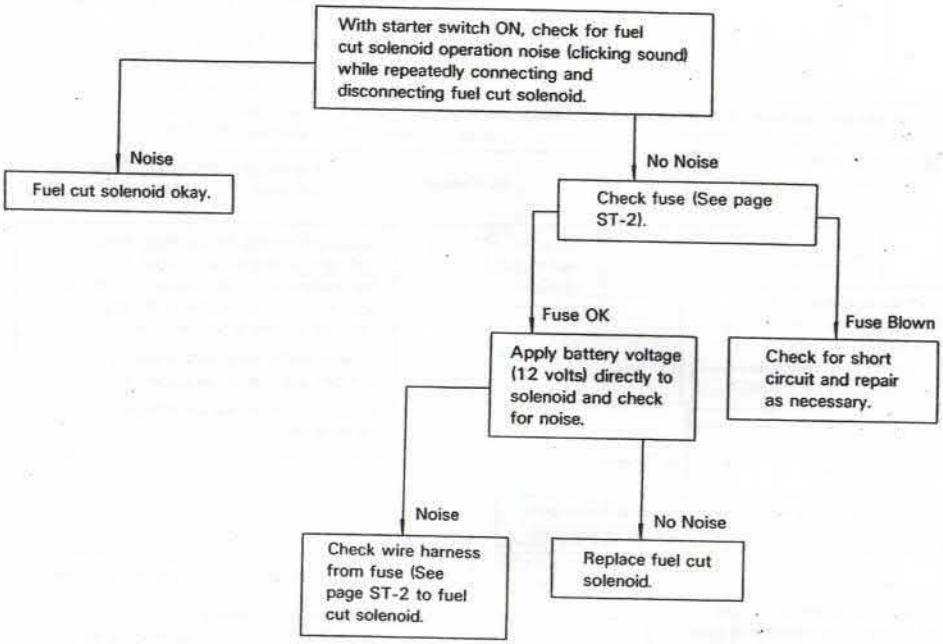


2. Fuel Cut Solenoid



TURBOCHARGER DIAGNOSIS

INSUFFICIENT ACCELERATION, LACK OF POWER OR EXCESSIVE FUEL CONSUMPTION

NOTE: Before troubleshooting the turbocharger, first check the valve clearance, injection timing, etc.

(Possible Cause)	(Check Procedure and Correction Method)
1. INSUFFICIENT TURBOCHARGING PRESSURE	Check turbocharging pressure (See page EM-39). If not within the standard shown below, begin diagnosis from item 2. **Standard pressure: 0.54 — 0.68 kg/cm² (7.7 — 9.7 psi, 53 — 67 kPa)**
2. RESTRICTED INTAKE AIR SYSTEM	Check intake air system, and repair or replace parts as necessary. (See page EM-39)
3. LEAK IN INTAKE AIR SYSTEM	Check intake air system, and repair or replace parts as necessary. (See page EM-39)
4. RESTRICTED EXHAUST SYSTEM	Check exhaust system, and repair or replace parts as necessary. (See page EM-39)
5. LEAK IN EXHAUST SYSTEM	Check exhaust system, and repair or replace parts as necessary. (See page EM-39)
6. RELIEF VALVE LEAKING	Check for excessive oil oozing around outside of relief valve. If not, relief valve okay. If excessive oozing, check performance of relief valve and replace if necessary.
7. ERRATIC TURBOCHARGER OPERATION	Check rotation of impeller wheel. If it does not turn or turns with heavy drag, replace the turbocharger assembly. Check axial play of bearing shaft. If not within limits, replace the turbocharger assembly. **Standard clearance: 0.13 mm (0.0051 in.) or less**

ABNORMAL NOISE

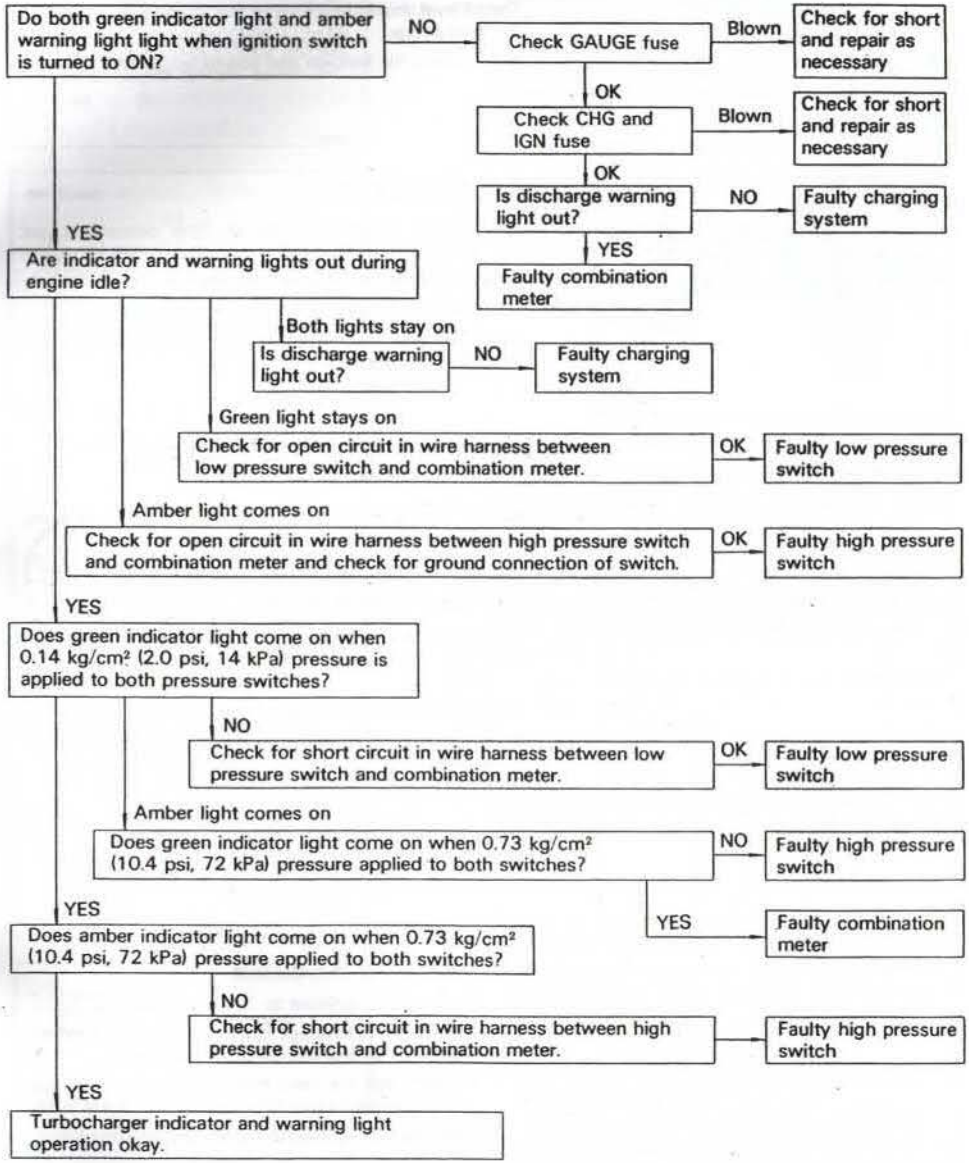
(Possible Cause)	(Check Procedure and Correction Method)
1. TURBO INSULATOR RESONNANCE	Check for loose, improperly installed or deformed insulator mount bolts, and repair or replace as necessary.
2. EXHAUST PIPE LEAKING OR VIBRATING	Check for deformed exhaust pipe, loose mount bolts or damaged gasket, and repair or replace as necessary.
3. ERRATIC TURBOCHARGER OPERATION	Refer to item 7 of INSUFFICIENT ACCELERATION, LACK OF POWER OR EXCESSIVE FUEL CONSUMPTION.

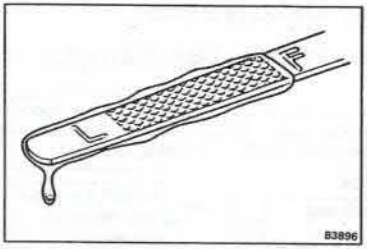
EXCESSIVE OIL CONSUMPTION OR WHITE EXHAUST

(Possible Cause)	(Check Procedure and Correction Method)
FAULTY TURBOCHARGER SEAL	Check for oil leakage in exhaust system. • Remove the turbine elbow from the turbocharger and check for excessive carbon deposits on the turbine wheel. Excessive carbon deposits would indicate a faulty turbocharger. Check for oil leakage in intake air system. • Check for axial play in impeller wheel, and replace the turbocharger if necessary. (See page EM-43). **CAUTION: There is some oil mist from the PCV in the blowby gas so care must be taken not to diagnosis this as an oil leakage from the turbocharger.**

TURBOCHARGER ELECTRICAL SYSTEM DIAGNOSIS

Troubleshooting of Turbocharger Indicator Light and Warning Light Operation



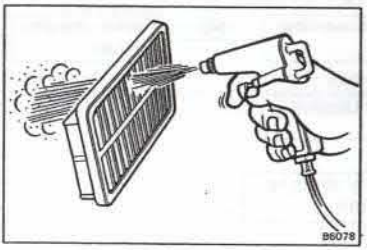


ENGINE TUNE-UP

CHECK OIL LEVEL

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

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



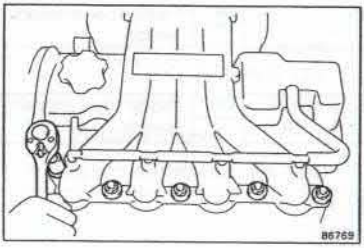
CHECK AIR FILTER

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

If necessary, replace the air filter element.

(b) Clean the element with compressed air.

First blow from the inside thoroughly. Then blow off the outside of the element.

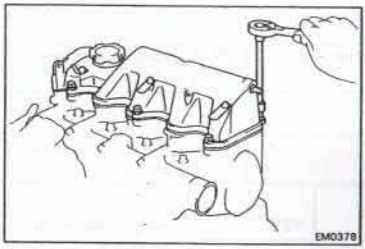


INSPECTION AND ADJUSTMENT OF VALVE CLEARANCE

NOTE: Check and adjust the valve clearance while the engine is cold.

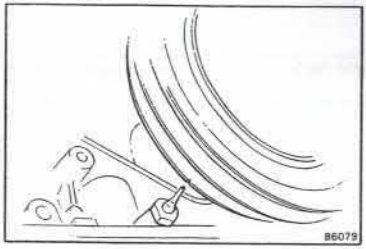
1. **REMOVE NO. 2 AIR INTAKE MANIFOLD (CE 70)** **(See step 1 on page EM-48)**

2. **REMOVE TWO BOLTS FROM NO. 2 TIMING COVER**



3. **REMOVE CYLINDER HEAD COVER**

Remove the six nuts and seal washers, and pull out the head cover with the gasket.

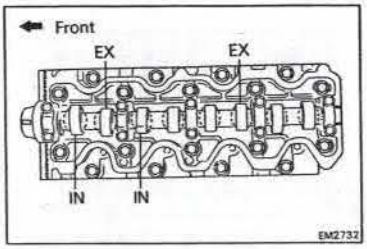


4. **MEASURE VALVE CLEARANCE**

(a) Set the No. 1 cylinder to TDC/compression.

- Turn the crankshaft pulley and align its groove with the timing pointer on the oil pump.
- Check that the valve lifters on the No. 1 cylinder are loose and valve lifters on the No. 4 are tight.

If not, turn the crankshaft one complete revolution.

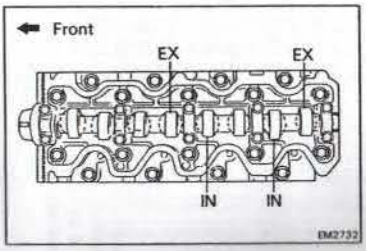


(b) Measure the clearance of half of the valves.

- Measure only those valves indicated in the figure.
- Record the measurements which are out of specification. They will be used later to determine the required replacement shims.

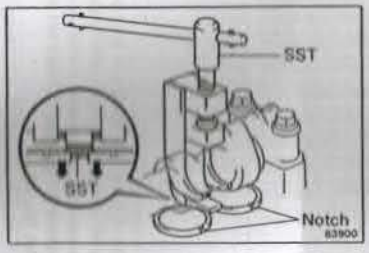
Valve clearance (Cold):

Intake	**0.20 — 0.30 mm (0.008 — 0.012 in.)**
Exhaust	**0.25 — 0.35 mm (0.010 — 0.014 in.)**



(c) Turn the crankshaft pulley one revolution and measure the other valves.

- Turn the crankshaft pulley one revolution and align its groove and timing pointer on the oil pump.
- Measure only the valves indicated by the arrows in the figure.



5. ADJUST VALVE CLEARANCE

NOTE: Valve clearance is adjusted one cylinder at a time.

(a) Turn the crankshaft pulley to position the intake camshaft lobe of the cylinder upward.

(b) Position the notch of the lifter so that it is accessible with a small screwdriver.

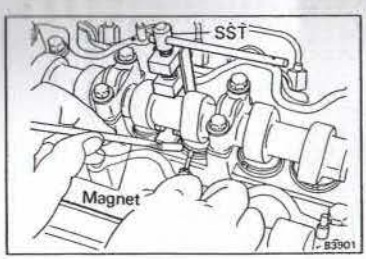
(c) Place the SST between the two cams and turn the handle to press down the valve lifters.

SST 09248-64010

NOTE: Make sure the SST is installed so that it presses evenly on both lifters.

(d) Using a small screwdriver and magnet, remove the shims.

(e) Determine the replacement shim size by using the following Formula and Charts.



- Using a micrometer, measure the thickness of the shim that was removed.
- Calculate the thickness of a new shim so that the valve clearance comes within the specified value.

  T ..... Thickness of shim used
  A ..... Valve clearance measured
- Select a shim with a thickness as close as possible to the calculated value.

NOTE: Shims are available in 25 sizes, in increments of 0.050 mm (0.0020 in.), from 2.200 mm (0.0866 in.) to 3.400 mm (0.1339 in.). Thickness is stamped on the new shims.

Intake side:
New shim thickness
= T + [A — 0.25 mm (0.0098 in.)]

Exhaust side:
New shim thickness
= T + [A — 0.30 mm (0.0118 in.)]

SHIM SELECTION CHART

Intake

Measured Clearance (mm)	Installed Shim Thickness (mm)																																																
	2.200	2.225	2.250	2.275	2.300	2.325	2.350	2.375	2.400	2.425	2.450	2.475	2.500	2.525	2.550	2.575	2.600	2.625	2.650	2.675	2.700	2.725	2.750	2.775	2.800	2.825	2.850	2.875	2.900	2.925	2.950	2.975	3.000	3.025	3.050	3.075	3.100	3.125	3.150	3.175	3.200	3.225	3.250	3.275	3.300	3.325	3.350	3.375	3.400
0.000–0.025									01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39
0.026–0.050								01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41
0.051–0.075							01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41
0.076–0.100						01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43
0.101–0.125					01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43
0.126–0.150				01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45
0.151–0.175			01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45
0.176–0.199		01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47
0.200–0.300																																																	
0.301–0.325	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49	
0.326–0.350	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49		
0.351–0.375	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49			
0.376–0.400	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49				
0.401–0.425	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49					
0.426–0.450	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49						
0.451–0.475	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49							
0.476–0.500	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49								
0.501–0.525	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49									
0.526–0.550	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49										
0.551–0.575	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49											
0.576–0.600	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49												
0.601–0.625	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49													
0.626–0.650	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49														
0.651–0.675	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49															
0.676–0.700	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																
0.701–0.725	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																	
0.726–0.750	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																		
0.751–0.775	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																			
0.776–0.800	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																				
0.801–0.825	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																					
0.826–0.850	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																						
0.851–0.875	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																							
0.876–0.900	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																								
0.901–0.925	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																									
0.926–0.950	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																										
0.951–0.975	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																											
0.976–1.000	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																												
1.001–1.025	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																													
1.026–1.050	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																														
1.051–1.075	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																															
1.076–1.100	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																																
1.101–1.125	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																																	
1.126–1.150	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																																		
1.151–1.175	37	39	39	41	41	43	43	45	45	47	47	49	49	49																																			
1.176–1.200	39	39	41	41	43	43	45	45	47	47	49	49	49																																				
1.201–1.225	39	41	41	43	43	45	45	47	47	49	49	49																																					
1.226–1.250	41	41	43	43	45	45	47	47	49	49	49																																						
1.251–1.275	41	43	43	45	45	47	47	49	49	49																																							
1.276–1.300	43	43	45	45	47	47	49	49	49																																								
1.301–1.325	43	45	45	47	47	49	49	49																																									
1.326–1.350	45	45	47	47	49	49	49																																										
1.351–1.375	45	47	47	49	49	49																																											
1.376–1.400	47	47	49	49	49																																												
1.401–1.425	47	49	49	49																																													
1.426–1.450	49	49	49																																														
1.451–1.475	49	49																																															
1.476–1.500	49																																																

Intake valve clearance (Cold):

0.20 – 0.30 mm (0.008 – 0.012 in.)

Example: 2.700 mm (0.1063 in.) shim installed
Measured clearance is 0.350 mm (0.0138 in.)
Replace 2.700 mm (0.1063 in.) shim with shim No. 25.

Shim Thickness

Shim No.	Thickness mm (in.)	Shim No.	Thickness mm (in.)
01	2.20 (0.0866)	27	2.85 (0.1122)
03	2.25 (0.0886)	29	2.90 (0.1142)
05	2.30 (0.0906)	31	2.95 (0.1161)
07	2.35 (0.0925)	33	3.00 (0.1181)
09	2.40 (0.0945)	35	3.05 (0.1201)
11	2.45 (0.0965)	37	3.10 (0.1220)
13	2.50 (0.0984)	39	3.15 (0.1240)
15	2.55 (0.1004)	41	3.20 (0.1260)
17	2.60 (0.1024)	43	3.25 (0.1280)
19	2.65 (0.1043)	45	3.30 (0.1299)
21	2.70 (0.1063)	47	3.35 (0.1319)
23	2.75 (0.1083)	49	3.40 (0.1339)
25	2.80 (0.1102)		

SHIM SELECTION CHART

Exhaust

Installed Shim Thickness (mm)

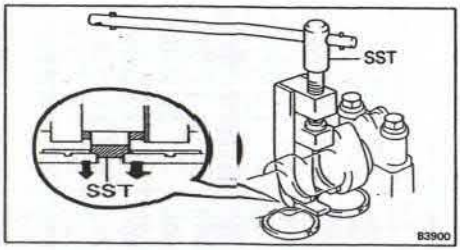
Measured Clearance (mm)	2.200	2.225	2.250	2.275	2.300	2.325	2.350	2.375	2.400	2.425	2.450	2.475	2.500	2.525	2.550	2.575	2.600	2.625	2.650	2.675	2.700	2.725	2.750	2.775	2.800	2.825	2.850	2.875	2.900	2.925	2.950	2.975	3.000	3.025	3.050	3.075	3.100	3.125	3.150	3.175	3.200	3.225	3.250	3.275	3.300	3.325	3.350	3.375	3.400
0.000-0.025											01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37
0.026-0.050										01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39
0.051-0.075									01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39
0.076-0.100								01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41
0.101-0.125							01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41
0.126-0.150						01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43
0.151-0.175					01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43
0.176-0.200				01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45
0.201-0.225			01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45
0.226-0.249		01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47
0.250-0.350																																																	
0.351-0.375	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49	
0.376-0.400	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49		
0.401-0.425	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49			
0.426-0.450	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49				
0.451-0.475	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49					
0.476-0.500	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49						
0.501-0.525	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49							
0.526-0.550	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49								
0.551-0.575	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49									
0.576-0.600	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49										
0.601-0.625	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49											
0.626-0.650	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49												
0.651-0.675	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49													
0.676-0.700	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49														
0.701-0.725	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49															
0.726-0.750	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																
0.751-0.775	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																	
0.776-0.800	21	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																		
0.801-0.825	21	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																			
0.826-0.850	23	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																				
0.851-0.875	23	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																					
0.876-0.900	25	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																						
0.901-0.925	25	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																							
0.926-0.950	27	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																								
0.951-0.975	27	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																									
0.976-1.000	29	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																										
1.001-1.025	29	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																											
1.026-1.050	31	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																												
1.051-1.075	31	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																													
1.076-1.100	33	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																														
1.101-1.125	33	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																															
1.126-1.150	35	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																																
1.151-1.175	35	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																																	
1.176-1.200	37	37	39	39	41	41	43	43	45	45	47	47	49	49	49																																		
1.201-1.225	37	39	39	41	41	43	43	45	45	47	47	49	49	49																																			
1.226-1.250	39	39	41	41	43	43	45	45	47	47	49	49	49																																				
1.251-1.275	39	41	41	43	43	45	45	47	47	49	49	49																																					
1.276-1.300	41	41	43	43	45	45	47	47	49	49	49																																						
1.301-1.325	41	43	43	45	45	47	47	49	49	49																																							
1.326-1.350	43	43	45	45	47	47	49	49	49																																								
1.351-1.375	43	45	45	47	47	49	49	49																																									
1.376-1.400	45	45	47	47	49	49	49																																										
1.401-1.425	45	47	47	49	49	49																																											
1.426-1.450	47	47	49	49	49																																												
1.451-1.475	47	49	49	49																																													
1.476-1.500	49	49	49																																														
1.501-1.525	49	49																																															
1.526-1.550	49																																																

Exhaust valve clearance (Cold):
0.25 – 0.35 mm (0.010 – 0.014 in.)

Example: 2.700 mm (0.1063 in.) shim installed
Measured clearance is 0.450 mm (0.0177 in.)
Replace 2.700 mm (0.1063 in.) shim with shim No. 27.

Shim Thickness

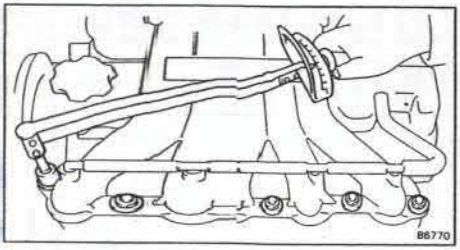
Shim No.	Thickness mm (in.)	Shim No.	Thickness mm (in.)
01	2.20 (0.0866)	27	2.85 (0.1122)
03	2.25 (0.0886)	29	2.90 (0.1142)
05	2.30 (0.0906)	31	2.95 (0.1161)
07	2.35 (0.0925)	33	3.00 (0.1181)
09	2.40 (0.0945)	35	3.05 (0.1201)
11	2.45 (0.0965)	37	3.10 (0.1220)
13	2.50 (0.0984)	39	3.15 (0.1240)
15	2.55 (0.1004)	41	3.20 (0.1260)
17	2.60 (0.1024)	43	3.25 (0.1280)
19	2.65 (0.1043)	45	3.30 (0.1299)
21	2.70 (0.1063)	47	3.35 (0.1319)
23	2.75 (0.1083)	49	3.40 (0.1339)
25	2.80 (0.1102)		



(f) Remove the SST.

(g) Recheck the valve clearance.

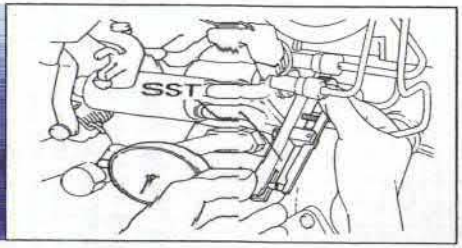
(h) Adjust the valve clearance of the remaining cylinders as required.



6. INSTALL CLINDER HEAD COVER
(See step 3 on page EM-67)

7. INSTALL TWO BOLTS TO NO. 2 TIMING COVER

8. INSTALL NO. 2 AIR INTAKE MANIFOLD (CE70)



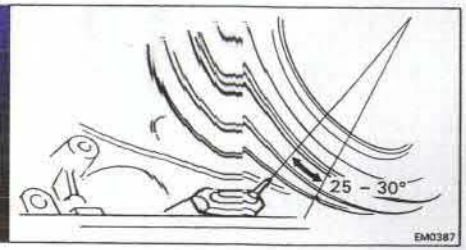
INSPECTION AND ADJUSTEMENT OF INJECTION TIMING

1. INSTALL PLUNGER STROKE MEASURING TOOL (SST) AND DIAL INDICATOR

(a) Remove the distributive head plug bolt from the injection pump.

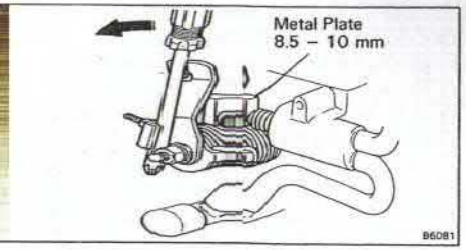
(b) Install SST and the dial indicator to the distributive head plug hole.

SST 09275-54010



2. SET NO. 1 OR NO. 4 CYLINDER TO ABOUT 25 – 30° BTDC/ COMPRESSION

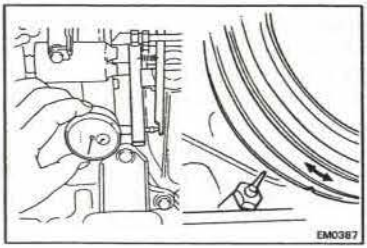
Turn the crankshaft pulley clockwise so the pulley groove is 25 – 30° from the oil pump pointer.



3. RELEASE COLD STARTING SYSTEM

(a) Using a screwdriver, turn the cold starting lever counterclockwise about 20° as shown.

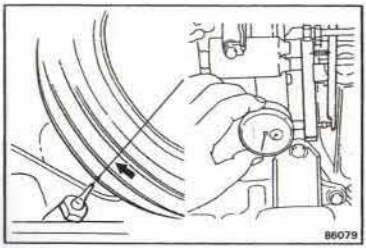
(b) Put a metal plate 8.5 – 10 mm (0.33 – 0.39 in.) thick between the cold starting lever and thermo wax plunger.



4. CHECK INJECTION TIMING

(a) Set the dial indicator at 0 mm (0 in.).

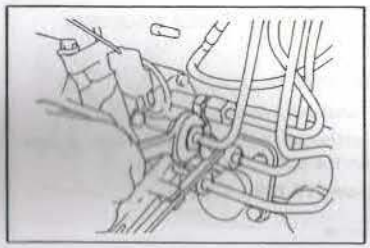
(b) Recheck to see that the dial indicator remains at 0 mm (0 in.) while rotating the crankshaft pulley slightly to the left and right.



(c) Slowly rotate the crankshaft pulley clockwise until the pulley groove is aligned with the timing pointer.

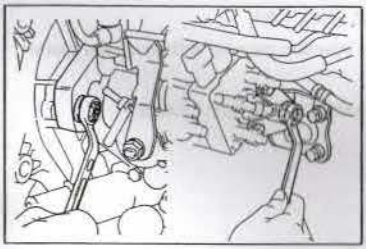
(d) Measure the plunger stroke.

Plunger stroke:	**CV**	**0.67 – 0.73 mm (0.264 – 0.0287 in.)**
	Others	**0.77 – 0.83 mm (0.0303 – 0.0327 in.)**

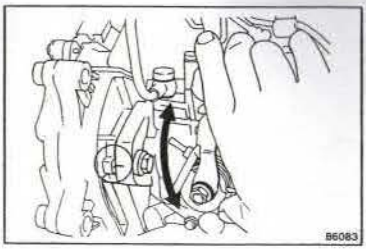


5. ADJUST INJECTION TIMING

(a) Loosen the four injection pipe union nuts on the pump side.



(b) Loosen the injection pump mounting bolt and nuts.

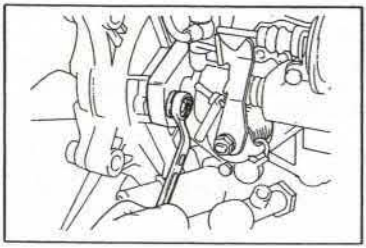


(c) Adjust the plunger stroke by slightly tilting the injection pump body.

If the stroke is less than specification, tilt the pump toward the engine.

If greater than specification, tilt the pump away from the engine.

Plunger stroke:	**CV**	**0.67 – 0.73 mm (0.0264 – 0.0287 in.)**
	Others	**0.77 – 0.83 mm (0.0303 – 0.0327 in.)**

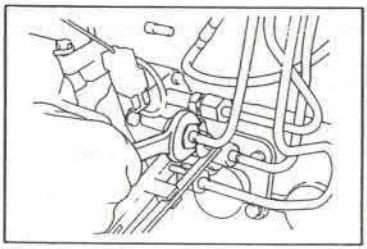


(d) Tighten the injection pump mounting bolt and nuts. Torque the bolt and nuts.

Torque: Bolt 475 kg-cm (34 ft-lb, 47 N·m)
Nut 180 kg-cm (13 ft-lb, 18 N·m)

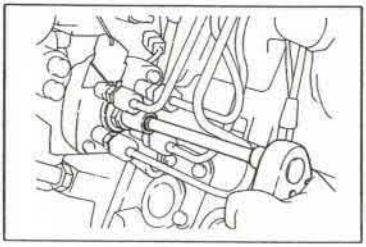
(e) Recheck the plunger stroke.

Plunger stroke: CV 0.67 – 0.73 mm (0.0264 – 0.0287 in.)
Others 0.77 – 0.83 mm (0.0303 – 0.0327 in.)



(f) Tighten all union nuts on the injection pipes.

Torque: 300 kg-cm (22 ft-lb, 29 N·m)



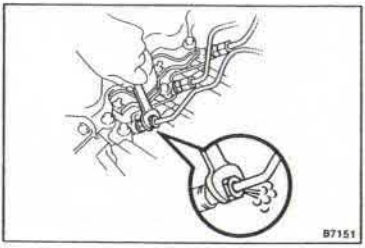
6. REMOVE METAL PLATE FROM COLD STARTING LEVER

7. REMOVE SST AND DIAL INDICATOR

(a) Remove SST and dial indicator.

(b) Install the distributive head plug bolt with a new gasket. Torque the bolt.

Torque: 170 kg-cm (12 ft-lb, 17 N·m)



8. BLEED AIR FROM FUEL LINE

Bleed air from the injection pipe by activating the starter motor.

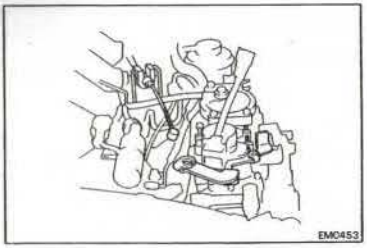
9. START ENGINE AND CHECK FOR LEAKS

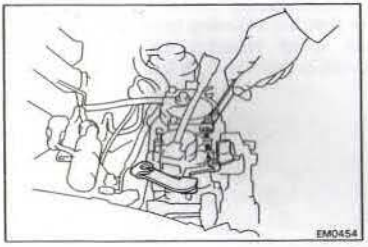
INSPECTION AND ADJUSTEMENT OF IDLE AND MAXIMUM SPEED

1. **INITAL CONDITIONS:**
   (a) Air cleaner installed
   (b) Engine coolant normal operating temperature
   (c) Accessories switched off
   (d) Transmission in neutral

2. **CONNECT TACHOMETER TO ENGINE**

3. **DISCONNECT ACCELERATOR CABLE**
   Disconnect the accelerator cable from the injection pump.


EM0453


EM0454

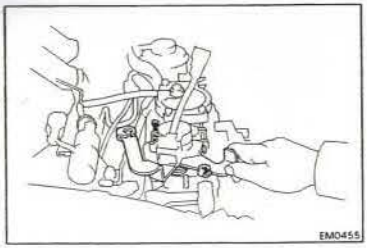
4. **INSPECT AND ADJUST IDLE SPEED**
   (a) Check that the adjusting lever is in contact with the idle speed adjusting screw.

   If not, check if the air conditioner switch is OFF or if engine is running at normal operating temperature.

   (b) Start the engine and check the idle speed.

   Idle speed: 750 — 850 rpm

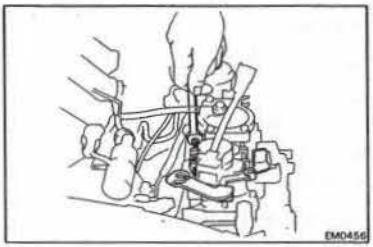
   (c) Loosen the lock nut and adjust by turning the idle adjusting screw.
   (d) Securely tighten the lock nut and recheck the idle speed.


EM0455

5. **INSPECT AND ADJUST MAXIMUM SPEED**
   (a) Inspect the engine maximum speed with the adjusting lever fully depressed.

   Maximum speed: CV 5,100 — 5,200 rpm
   Others 5,300 — 5,400 rpm

   CAUTION: This check should be performed in as short a time as possible.



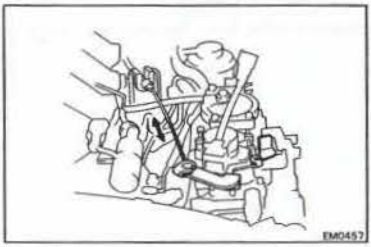
(b) Cut the maximum adjusting screw wire.

(c) Loosen the lock nut and adjust by turning the maximum speed adjusting screw.

CAUTION: Perform adjustment at low rpm, and then recheck at maximum speed.

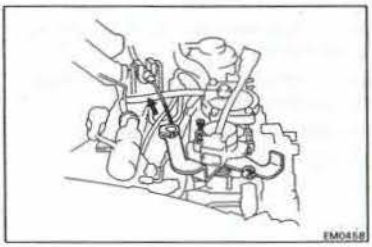
(d) Securely tighten the lock nut and recheck the maximum speed.

(e) Lock the maximum speed adjusting screw with the wire.



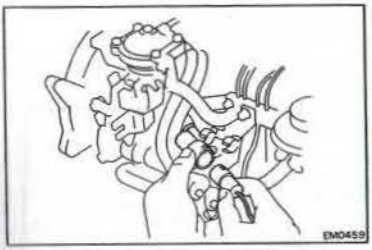
6. CONNECT ACCELERATOR CABLE

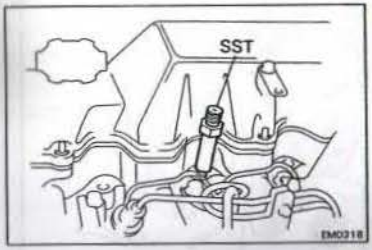
(a) Connect the accelerator cable and adjust so there is no slack in it.

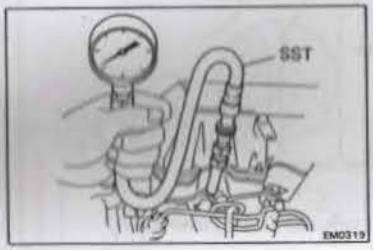


(b) Inspect to see that the adjusting lever is stopped by the maximum speed adjusting screw when the accelerator pedal is depressed all the way.

7. DISCONNECT TACHOMETER







COMPRESSION CHECK

NOTE: If there is lack of power, excessive oil or fuel consumption, measure the cylinder compression pressure.

1. **WARM UP ENGINE**
2. **DISCONNECT FUEL CUT SOLENOID WIRE CONNECTOR**
3. **REMOVE NO. 2 AIR INTAKE MANIFOLD (CE70)**
   (See step 1 on page EM-48)
4. **REMOVE FOUR GLOW PLUGS**
   (See step 10 on page EM-49)

   CAUTION: Make sure the load wire is not grounded.
5. **INSTALL GAUGE ADAPTER (SST) TO GLOW PLUG MOUNTING HOLE**

   SST 09992-00160
6. **MEASURE CYLINDER COMPRESSION PRESSURE**

   (a) Connect a compression gauge (SST) to the gauge adapter (SST).

   SST 09992-00023

   (b) While cranking the engine with the starter motor, measure the compression.

   NOTE: A fully charged battery is necessary to obtain engine revolution of more than 250 rpm.

   (c) Repeat steps (a) and (b) for each cylinder.

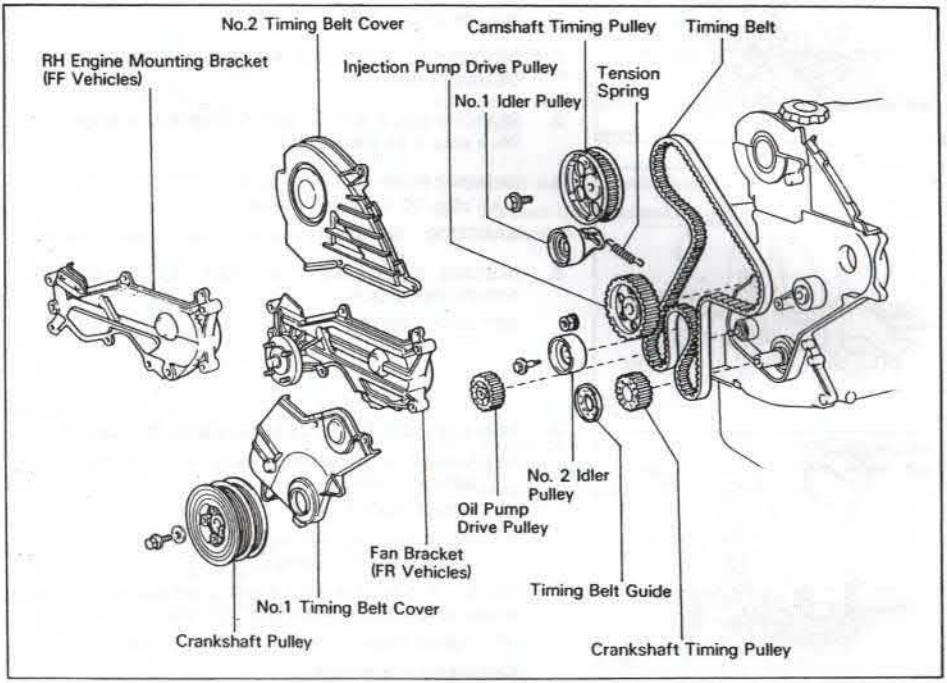
   Compression pressure:
   30.0 kg/cm² (427 psi, 2,942 kPa)
   Minimum pressure:
   25.0 kg/cm² (356 psi, 2,452 kPa)
   Difference between each cylinder:
   Less than 5.0 kg/cm² (71 psi, 490 kPa)

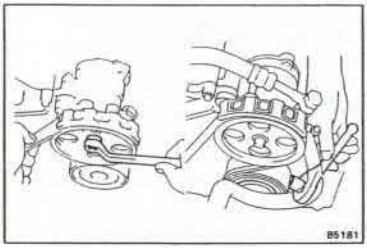
   (d) If the cylinder compression in one or more cylinders is low, pour a small amount of engine oil into the cylinder through the glow plug hole and repeat steps (a) and (b) for the cylinder with low compression.

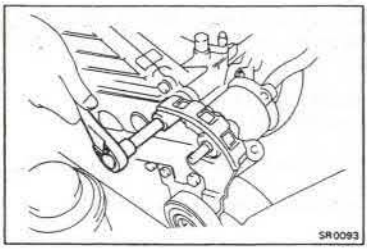
   - If adding oil helps the compression, chances are that the piston rings and/or cylinder bore are worn or damaged.
   - If pressure stays low, a valve may be sticking or seating improperly, or there may be leakage past the gasket.
7. **INSTALL FOUR GLOW PLUGS**
   (See step 8 on page EM-68)
8. **CONNECT FUEL CUT SOLENOID WIRE CONNECTOR**
9. **INSTALL NO. 2 AIR INTAKE MANIFOLD (CE70)**

TIMING BELT

COMPONENTS



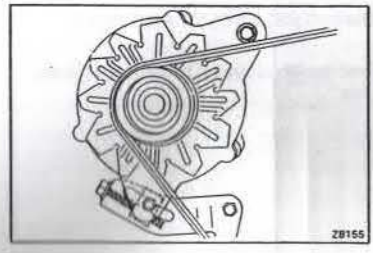




REMOVAL OF TIMING BELT

1. **REMOVE PS PUMP PULLEY AND DRIVE BELT (FF Vehicles)**
   (a) Push on the drive belt to hold the pulley in place and remove the pulley nut.
   (b) Loosen the drive belt adjusting bolt.
   (c) Remove the drive belt.
   (d) Remove the pulley and woodruff key.

2. **REMOVE PS PUMP (FF Vehicles)**
   Remove the three bolts and PS pump.



3. REMOVE DRIVE BELT

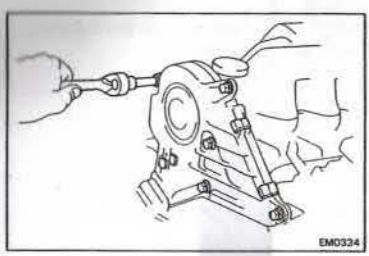
(a) Loosen the four fan pulley nuts. (FR Vehicles)

(b) Loosen the alternator pivot, adjusting lock bolt and adjusting nut or bolt.

(c) Swing the alternator toward the engine and remove the drive belt.

4. REMOVE FLUID COUPLING AND FAN PULLEY (FR Vehicles)

5. REMOVE PS PUMP DRIVE BELT (FR Vehicles)

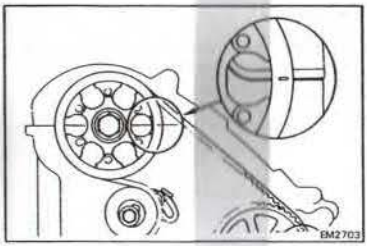


6. REMOVE NO. 2 TIMING BELT COVER

Remove the three clips, five bolts and the No. 2 timing belt cover with the gasket.

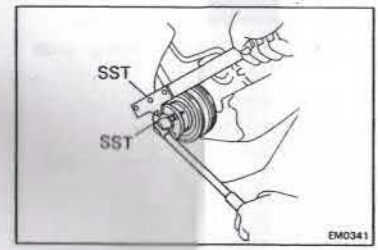
7. REMOVE FOUR GLOW PLUGS
(See step 10 on page EM-49)

NOTE: It is necessary to remove the glow plugs so that the crankshaft will turn smoothly and enable the belt to be adjusted properly.



8. SET NO. 1 CYLINDER AT TDC/COMPRESSION

Align the line mark of the camshaft timing pulley with the top end of the cylinder head by turning the crankshaft pulley clockwise.



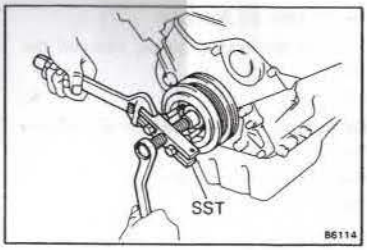
9. REMOVE CRANKSHAFT PULLEY

(a) Install the SST to the crankshaft pulley.

SST 09213-14010

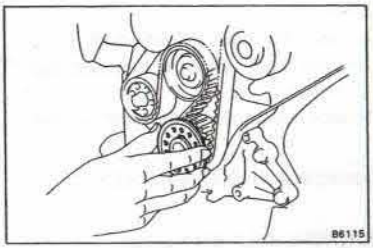
(b) Using SST to hold the crankshaft pulley, remove the pulley bolt.

SST 09330-00021



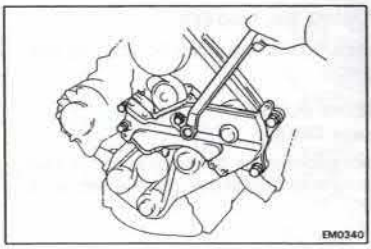
(c) Using SST, remove the crankshaft pulley.

SST 09213-31021

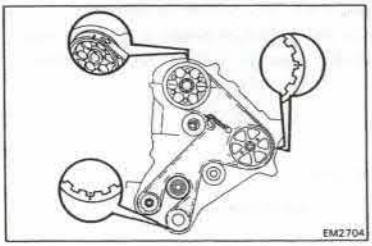


10. REMOVE NO. 1 TIMING BELT COVER AND BELT GUIDE

Remove five bolts and the No. 1 timing belt cover with the gasket and belt guide.

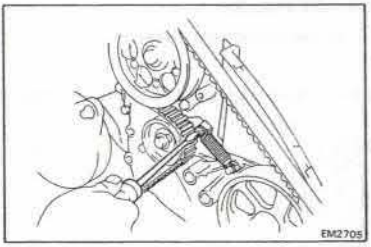


11. REMOVE FAN BRACKET (FR Vehicles) OR RH ENGINE MOUNTING BRACKET (FF Vehicles)



12. REMOVE TIMING BELT

NOTE: If reusing the timing belt, draw a direction arrow on the belt (in direction of engine revolution), and place matchmarks on the pulleys and timing belt.

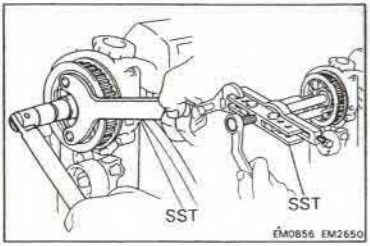


(a) Using a screwdriver, remove the tension spring.

CAUTION: Do not pinch the tension spring with pliers or such.

(b) Loosen the No. 1 idler pulley bolt.

(c) Remove the timing belt from each pulley.



13. REMOVE CAMSHAFT TIMING PULLEY

(a) Using SST to hold the timing pulley, remove the pulley mount bolt.

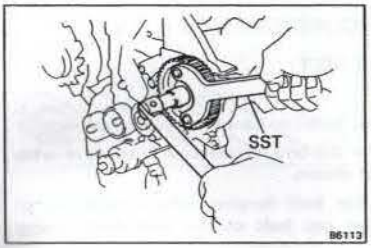
SST 09278-54012

CAUTION: Avoid turning the camshaft or the valves will hit against the pistons.

(b) Using SST, remove the timing pulley.

SST 09950-20014

14. REMOVE NO. 1 IDLER PULLEY

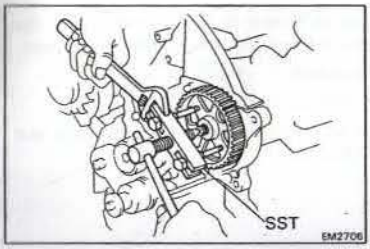


15. REMOVE INJECTION PUMP DRIVE PULLEY

(a) Using SST to hold the drive pulley, remove the pulley nut.

SST 09278-54012

CAUTION: Do not use an impact wrench.

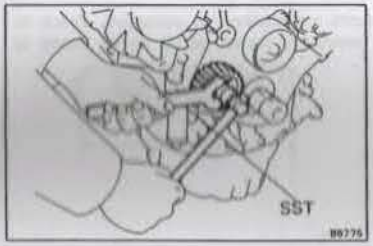


(b) Using SST, remove the drive pulley.

SST 09213-60017

CAUTION: The pulley will spring out so be careful not to drop it.

16. REMOVE NO. 2 IDLER PULLEY

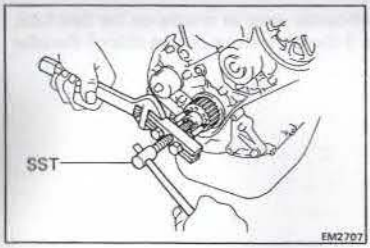


17. REMOVE OIL PUMP DRIVE PULLEY

(a) Using SST to hold the pulley, remove the pulley nut.

SST 09612-24013

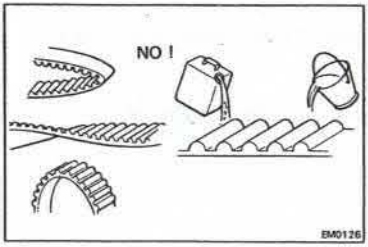
(b) Remove the drive pulley.



18. REMOVE CRANKSHAFT TIMING PULLEY

Using SST, remove the timing pulley.

SST 09213-60017



INSPECTION OF COMPONENTS

1. **INSPECT TIMING BELT**

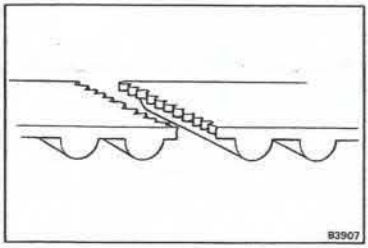
CAUTION:

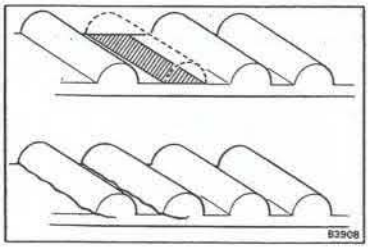
1. **Do not bend, twist or turn the belt inside out.**
2. **Do not allow the belt to come into contact with oil, water or steam.**
3. **Do not utilize belt tension when installing or removing the set bolt of the camshaft timing pulley.**

If there are defects as shown in the figures, check the following points and replace the timing belt if necessary.

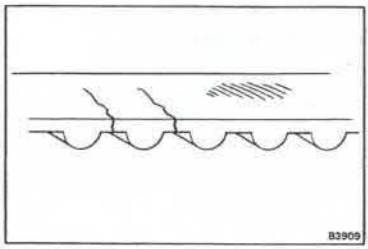
(a) Premature severance

- Check for proper installation.
- Check the timing cover gasket for damage and proper installation.

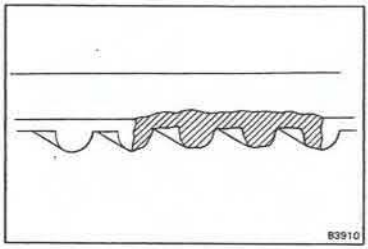




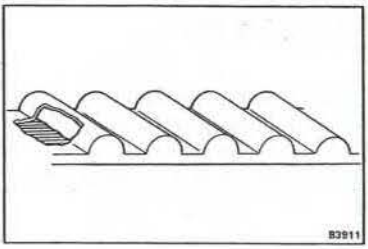
(b) If the belt teeth are cracked or damaged, check to see if the camshaft, water pump or oil pump is locked.



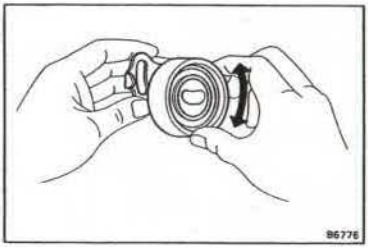
(c) If there is noticeable wear or cracks on the belt face, check to see if there are nicks on one side of the idler pulley lock.



(d) If there is wear or damage on only one side of the belt, check the belt guide and the alignment of each pulley.



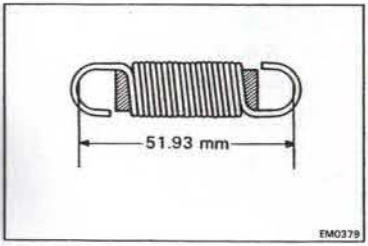
(e) If there is noticeable wear on the belt theeth, check the timing cover gasket for damage and proper installation. Check for foreign material on the pulley teeth.



2. INSPECT IDLER PULLEYS

Check the turning smoothness of the timing belt idler pulleys.

If necessary, replace the idler pulley.



3. INSPECT TENSION SPRING

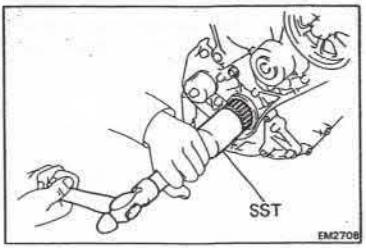
(a) Check the free length of the spring.

Free length: 51.93 mm (2.0445 in.)

(b) Check the tension of the spring at the specified installed length.

Installed tension: 4.3 kg (9.5 lb, 42 N) at 63 mm (2.48 in.)

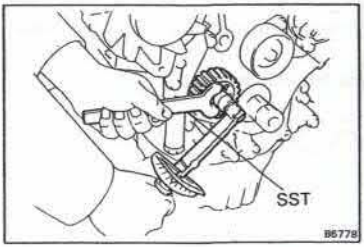
If not as specified, replace the spring.



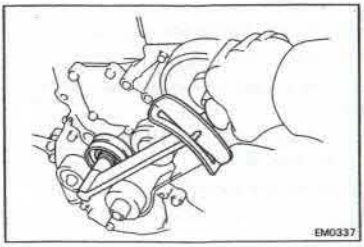
INSTALLATION OF TIMING BELT

(See page EM-26)

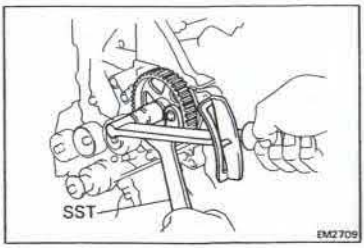
1. **INSTALL CRANKSHAFT TIMING PULLEY**
   (a) Align the woodruff key groove of the timing pulley with the woodruff key on the crankshaft.
   (b) Using SST and a hammer, drive in the timing pulley.
   SST 09214-60010



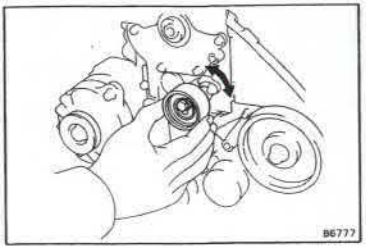
2. **INSTALL OIL PUMP DRIVE PULLEY**
   Using SST to hold the pulley, install and torque the pulley nut.
   SST 09612-24013
   Torque: 475 kg-cm (34 ft-lb, 47 N·m)



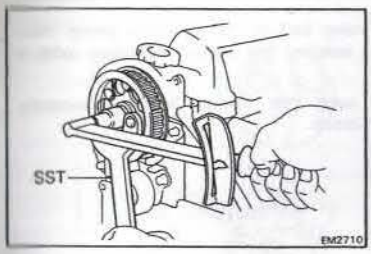
3. **INSTALL NO. 2 IDLER PULLEY**
   Torque: 375 kg-cm (27 ft-lb, 37 N·m)
   NOTE: Check that the pulley moves smoothly.



4. **INSTALL INJECTION PUMP DRIVE PULLEY**
   (a) Match the woodruff key groove of the drive pulley with the woodruff key on the drive shaft.
   (b) Using SST to hold the drive pulley, install and torque the pulley nut.
   SST 09278-54012
   Torque: 650 kg-cm (47 ft-lb, 64 N·m)
   CAUTION: Do not use an impact wrench.



5. **PROVISIONALLY INSTALL NO. 1 IDLER PULLEY**
   (a) Place the idler pulley on the cylinder head and finger tighten the pulley bolt to the extent that the idler pulley is free.
   (b) Install and torque the pulley guide bolt.
   Torque: 75 kg-cm (65 in.-lb, 7.4 N·m)
   (c) Check that the idler pulley bracket can be moved to the left and right by hand.



6. **INSTALL CAMSHAFT TIMING PULLEY**

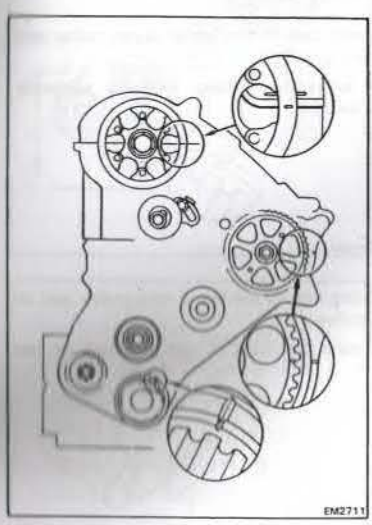
(a) Match the pin hole of the timing pulley with the knock pin on the camshaft.

(b) Using SST to hold the timing pulley, install and torque the pulley bolt with the plate washer.

SST 09278-54012

Torque: 900 kg-cm (65 ft-lb, 88 N·m)

CAUTION: Avoid turning the camshaft or the valves will hit against the pistons.



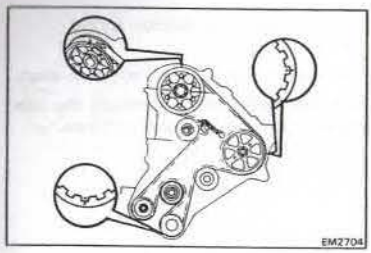
7. **SET TIMING AND DRIVE PULLEYS**

(a) Align the line mark of the camshaft timing pulley with the top end of the cylinder head.

(b) Align the grooves of the crankshaft timing pulley and oil pump.

CAUTION: When turning the crankshaft or camshaft, the valves will hit against the pistons so do not turn them more than necessary.

(c) Align the cavity of the injection pump drive pulley with the line mark on the water pump.

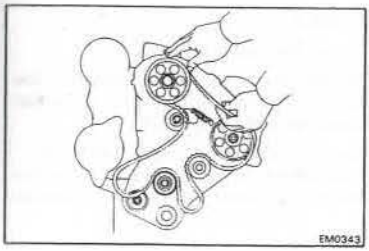


8. **INSTALL TIMING BELT**

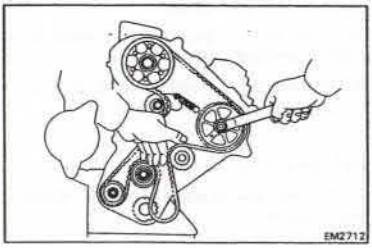
CAUTION: The engine should be cold.

NOTE:

- If reusing the timing belt, align the points marked during removal (See step 12 on page EM-28) and install the timing belt with the arrow pointing in the direction of engine revolution.
- Install the new belt so the numbers and letters can be read from the rear end of the engine.

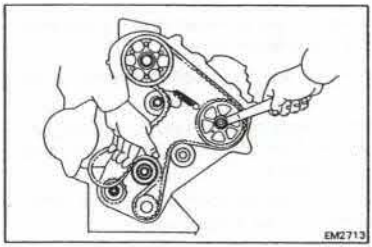


(a) Place the timing belt on the camshaft timing pulley.



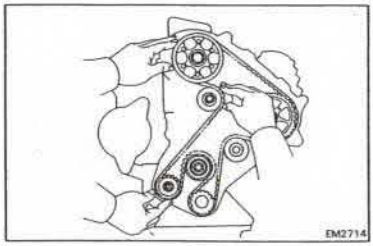
(b) Place the timing belt to the injection pump drive pulley while holding the pulley stationary with a wrench.

CAUTION: Be sure the timing belt is securely meshed and not loose.



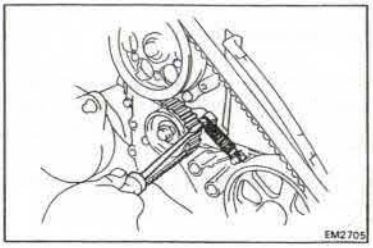
(c) Place the timing belt to the water pump pulley and crankshaft timing pulley.

CAUTION: Be sure the timing belt is securely meshed and not loose.



(d) Place the timing belt to the No. 2 idler pulley and oil pump drive pulley.

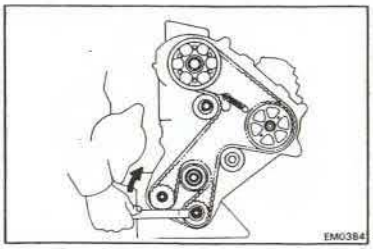
CAUTION: Be sure the belt is not twisted or too tight.



(e) Using a screwdriver, install the tension spring.

CAUTION:

- **Do not pinch the tension spring with pliers or such.**
- **Loosen the No. 1 idler pulley bolt to where the idle pulley lightly moves with tension spring force.**

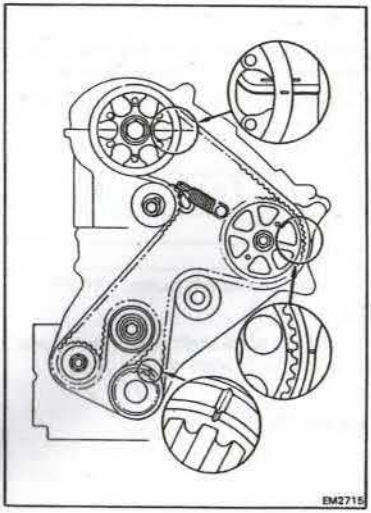


9. CHECK VALVE TIMING

(a) Temporarily install the crankshaft pulley bolt.

(b) Turn the crankshaft two revolutions to where the line mark of the camshaft pulley and the upper surface of the cylinder head are again aligned.

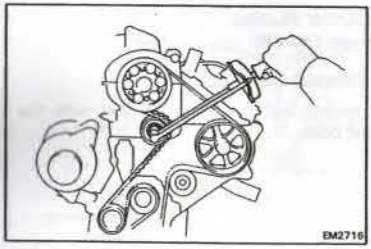
CAUTION: Always turn the crankshaft clockwise. It turned counterclockwise, there is possibility of the belt teeth becoming unmeshed and the belt tension changing.



(c) After turning the crankshaft, insure that each pulley aligns with the marks as shown.

If the marks do not align, repeat the above procedure from step 7.

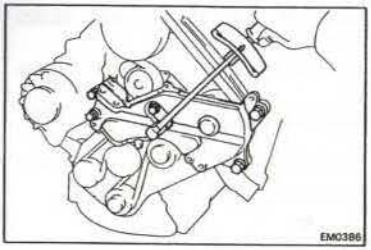
(d) Remove the crankshaft pulley bolt.



10. TORQUE NO. 1 IDLER PULLEY

Torque: 375 kg-cm (27 ft-lb, 37 N·m)

CAUTION: While tightening the pulley bolt, do not move the idler pulley bracket.

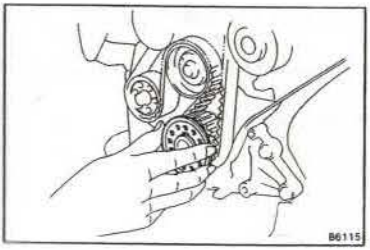


11. INSTALL FAN BRACKET (FR Vehicles) OR RH ENGINE MOUNTING BRACKET (FF Vehicles)

Torque:

14 mm bolt head 375 kg-cm (27 ft-lb, 37 N·m)
17 mm bolt head 650 kg-cm (47 ft-lb, 64 N·m)

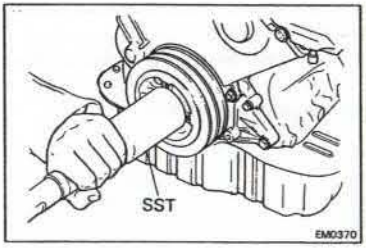
NOTE: If the vehicle has a PS pump, do not install the 17 mm bolts.



12. INSTALL BELT GUIDE AND NO. 1 TIMING BELT COVER

(a) Place the belt guide on the crankshaft timing pulley, facing the cup side outward.

(b) Install No. 1 timing belt cover and gasket with the five bolts.

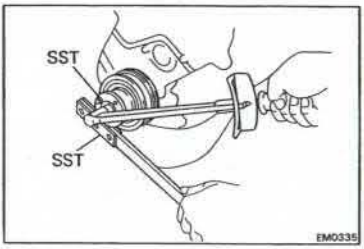


13. INSTALL CRANKSHAFT PULLEY

(a) Align the woodruff key groove of the crankshaft pulley with the woodruff key on the crankshaft.

(b) Using SST and hammer, drive in the crankshaft pulley.

SST 09214-60010



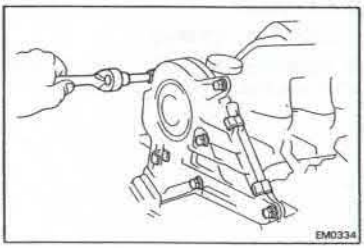
(c) Install the SST to the crankshaft pulley.

SST 09213-14010

(d) Using SST to hold the crankshaft pulley, install and torque the pulley bolt with plate washer.

SST 09330-00021

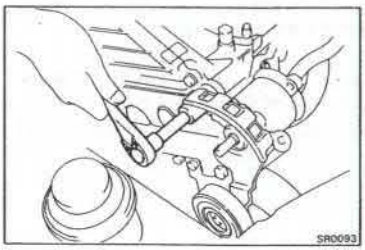
Torque: 1,000 kg-cm (72 ft-lb, 98 N·m)



14. INSTALL FOUR GLOW PLUGS
(See step 8 on page EM-68)

15. INSTALL NO. 2 TIMING BELT COVER

Install the No. 2 timing belt cover and gasket with the three clips and five bolts.



16. PROVISIONALLY INSTALL FAN PULLEY AND FLUID COUPLING (FR Vehicles)

(a) Place the fan pulley and fluid coupling on the fan bracket.

(b) Finger tighten the four fan pulley nuts.

17. INSTALL PS PUMP (FF Vehicles)

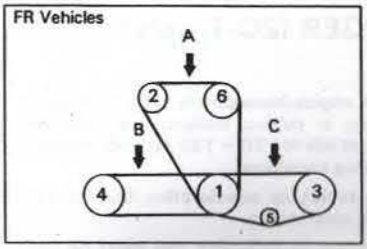
Install the PS pump with three bolts.
Torque the bolts.

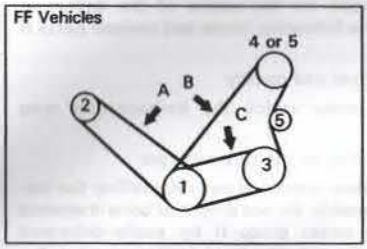
Torque: 400 kg-cm (29 ft-lb, 39 N·m)

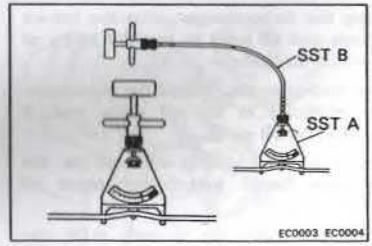
18. PROVISIONALLY INSTALL PS PUMP PULLEY (FF Vehicles)

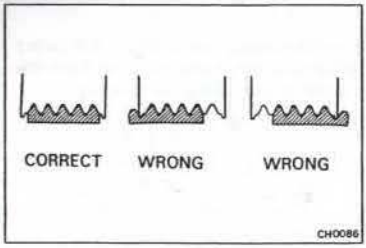
(a) Place the pump pulley and woodruff key on the pump drive shaft.

(b) Finger tighten the pump pulley nut.









19. INSTALL AND ADJUST DRIVE BELT

Drive belt deflection at 10 kg (22.0 lb, 98 N)

FR Vehicles mm (in.)

Position	New belt	Used belt
A	9.0 – 11.0 (0.354 – 0.433)	12.0 – 14.0 (0.472 – 0.551)
B	7.5 – 9.5 (0.295 – 0.374)	9.5 – 12.5 (0.374 – 0.492)
C	6.5 – 7.5 (0.256 – 0.295)	7.5 – 10.0 (0.295 – 0.394)

FF Vehicles mm (in.)

Position	New belt	Used belt
A	9.0 – 11.0 (0.354 – 0.433)	12.0 – 14.0 (0.472 – 0.551)
B	11.0 – 14.0 (0.433 – 0.551)	15.0 – 18.0 (0.591 – 0.709)
C (CE80)	5.0 – 6.0 (0.197 – 0.236)	6.0 – 7.0 (0.236 – 0.276)

1 – Crankshaft
2 – Alternator
3 – A/C compressor
4 – PS pump
5 – Idler
6 – Fan

[Reference]
Using SST, check the drive belt tension.

SST A 09216-00020
SST B 09216-00030

FR Vehicles

Position	New belt	Used belt
A	40 – 60 kg	20 – 40 kg
B	45 – 55 kg	20 – 35 kg
C	45 – 55 kg	20 – 35 kg

FF Vehicles

Position	New belt	Used belt
A	40 – 60 kg	20 – 40 kg
B	55 – 65 kg	25 – 40 kg
C (CE80)	70 – 80 kg	30 – 45 kg

NOTE:

- "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 drive 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 crankshaft pulley.
- After installing the belt, run the engine for about 5 minutes and then recheck the deflection.

20. TORQUE FAN PULLEY (FR Vehicles) AND PS PUMP PULLEY (FF Vehicles)

Push down on the drive belt to hold the pulley in place and torque the pulley nuts.

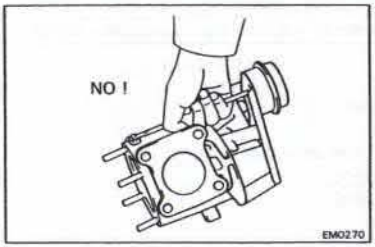
Torque:

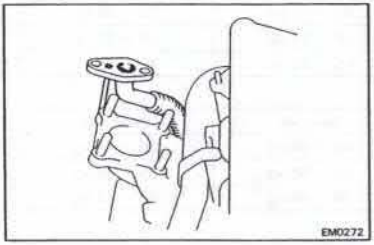
Fan pulley	**75 kg-cm (65 in.-lb, 7.4 N·m)**
PS pump pulley	**440 kg-cm (32 ft-lb, 43 N·m)**

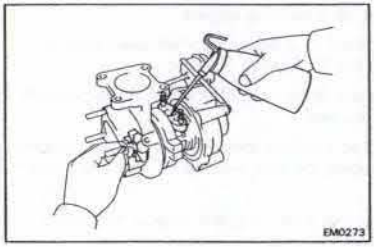
21. INSPECT AND ADJUST INJECTION TIMING

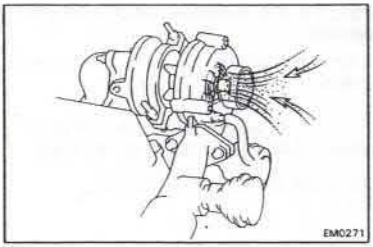
(See page EM-20)

TURBOCHARGER (2C-T only)









CAUTION:

- **Do not stop the engine immediately after high-speed or uphill driving or pulling trailers, but keep the engine running at idle for 20 – 120 seconds depending on the driving condition.**
- **Avoid sudden racing or acceleration immediately after starting a cold engine.**
- **If the turbocharger is defective and must be replaced, first check for the cause of the defect in reference to the following items and replace parts if necessary:**

  Engine oil level and quality

  Conditions under which the turbocharger was used

  Oil lines leading to the turbocharger
- **Use caution when removing and reinstalling the turbocharger assembly. Do not drop it or bang it against anything, and never grasp it by easily-deformed parts such as the actuator or rod when moving it.**
- **Before removing the turbocharger, plug the intake and exhaust ports and oil inlet to prevent entry of dirt or other foreign particles.**
- **If replacing the turbocharger, check for accumulation of sludge particles in the oil pipes and, if necessary, replace the oil pipes.**
- **Completely remove the gaskets adhered to the lubrication oil pipe flange and turbocharger oil flange.**
- **If replacing bolts or nuts, do so only with the specified new ones to guard against breakage or deformation.**
- **If replacing the turbocharger, put in 20 cc (1.2 cu in.) of oil in the oil inlet of the new one and turn the impeller by hand to spread oil to the bearing.**
- **If the engine is run with the air cleaner, case cover and hose removed, foreign particles entering will damage the wheels which run at extremely high speed.**
- **If the engine was replaced or overhauled, shut off fuel and glow function after reassembly and crank the engine for 30 seconds to spread oil throughtout. Then, allow the engine to idle for 60 seconds.**

ON-VEHICLE INSPECTION OF TURBOCHARGER

1. INSPECT INTAKE AIR SYSTEM

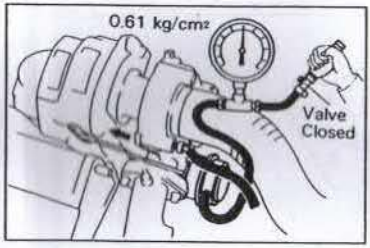
Check for leakage or clogging between the air cleaner and turbocharger inlet and between the turbocharger outlet and cylinder head.

- Clogged air cleaner . . . . Clean or replace the element
- Hoses collapsed or deformed . . . . Repair or replace
- Leakage from connections . . . . Check each connection and repair
- Cracks in components . . . . Check and replace

2. INSPECT EXHAUST SYSTEM

Check for leakage or clogging between the cylinder head and turbocharger inlet and between the turbocharger outlet and exhaust pipe.

- Deformed components . . . . Repair or replace
- Foreign material in passages . . . . Remove
- Leakage from components . . . . Repair or replace
- Cracks in components . . . . Check and replace



3. INSPECT OPERATION OF ACTUATOR AND WASTE GATE VALVE

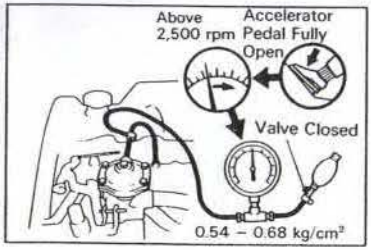
(a) Disconnect the actuator hose.

(b) Using a turbocharger pressure gauge (SST), apply about 0.61 kg/cm² (8.7 psi, 60 kPa) of pressure to the actuator hose and check that the rod moves 0.25 mm (0.0098 in.) or more.

If less, replace the turbocharger assembly.

SST 09992-00240

CAUTION: Never apply more than 0.8 kg/cm² (11.4 psi, 78 kPa) of pressure to the actuator.



4. CHECK TURBOCHARGING PRESSURE

(a) Connect a 3-way union to the boost compensator pressure hose and install a turbocharger pressure gauge (SST) to it.

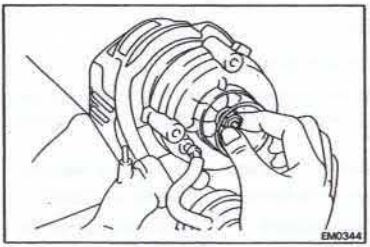
SST 09992-00240

(b) While driving with the engine running at 2,500 rpm or more (accelerator pedal fully open in first gear), check the turbocharging pressure.

Standard pressure: 0.54 – 0.68 kg/cm² (7.7 – 9.7 psi, 53 – 67 kPa)

If the pressure is less than that specified, first check the intake air and exhaust systems and the relief valve for leakage. If there is no leakage, replace the turbocharger assembly.

If the pressure is above specification, first check if the actuator hose is disconnected or cracked. If not, replace the turbocharger assembly.



5. INSPECT IMPELLER WHEEL ROTATION

(a) Disconnect the air cleaner hose.

(b) Grasp the edge of the impeller wheel and turn it. Check that it turns smoothly.

If it does not turn or if it turns with drag, replace the turbocharger assembly.

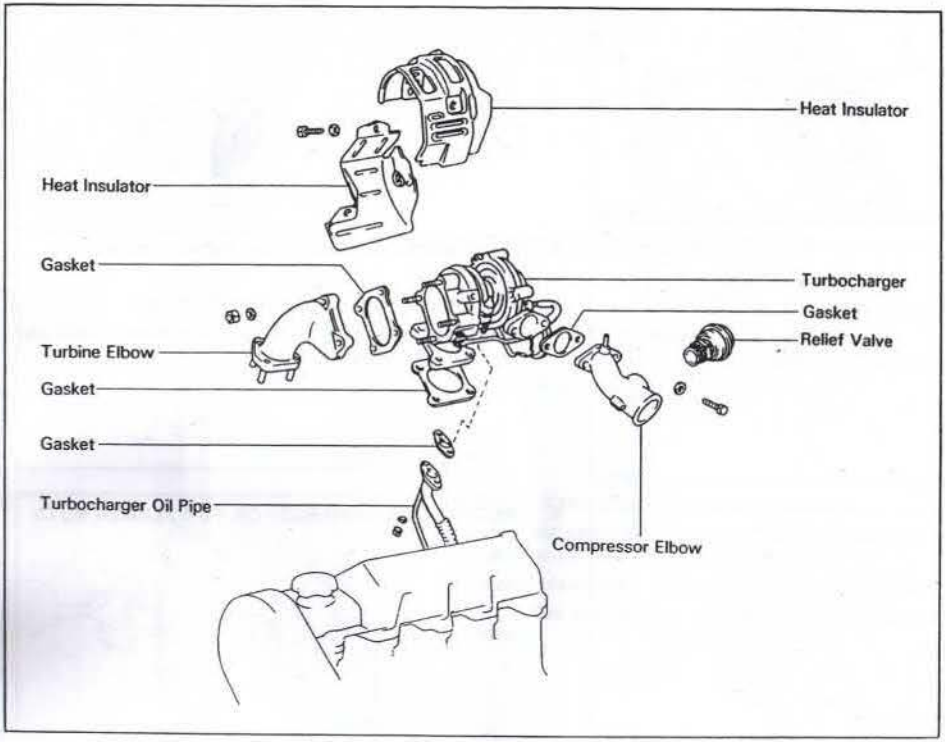
6. INSPECT RELIEF VALVE

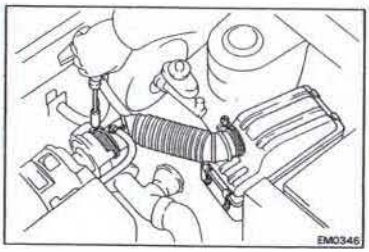
Check the outside of the relief valve for excessive oil oozing.

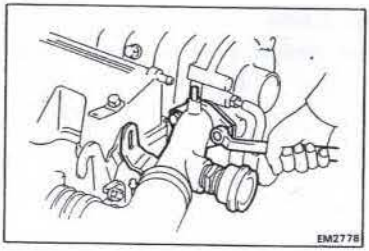
If no oil oozing is found, the relief valve is okay.

If oil oozing is found, replace the relief valve and check the performance. If there is no change in performance, the relief valve is okay.

COMPONENTS

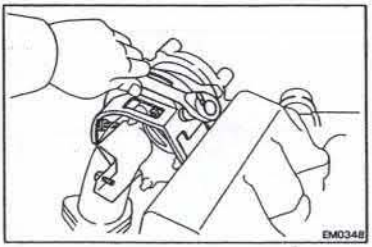




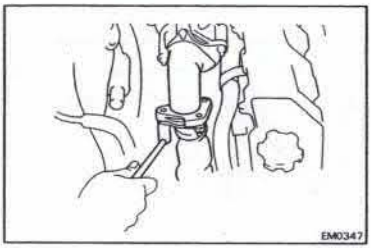


REMOVAL OF TURBOCHARGER

1. **REMOVE AIR CLEANER HOSE WITH CLEANER CASE COVER**
   (a) Disconnect the PCV hose from the cylinder head cover.
   (b) Loosen the clamp and disconnect the air cleaner hose from the turbocharger.
   (c) Remove the four clips and remove the air cleaner hose with the air cleaner case cover.
2. **DISCONNECT TURBOCHARGER PRESSURE HOSE FOR INDICATOR AND WARNING LIGHTS**
3. **REMOVE COMPRESSOR ELBOW WITH RELIEF VALVE AND AIR INTAKE HOSE**
   (a) Loosen the clamp and disconnect the air intake hose from the intake manifold.
   (b) Remove the bolt holding the elbow stay to the engine No. 2 hanger.
   (c) Remove the two bolts and compressor elbow with the relief valve and air intake hose.
   (d) Remove the compressor elbow gasket.



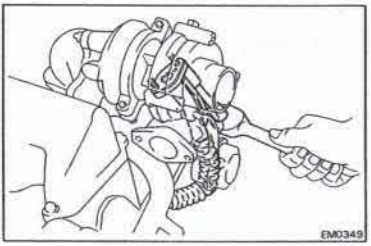
4. REMOVE TURBOCHARGER HEAT INSULATORS



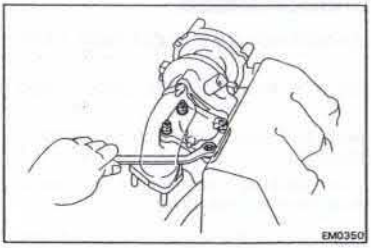
5. DISCONNECT EXHAUST PIPE FROM TURBINE ELBOW

(a) Remove the three nuts from the flange.

(b) Disconnect the exhaust pipe from the manifold and remove the gasket.

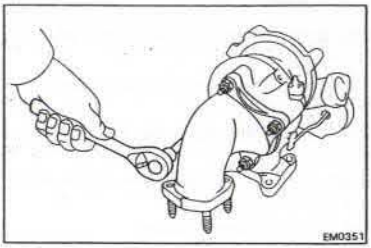


6. REMOVE TURBOCHARGER OIL PIPE FLANGE NUTS



7. REMOVE TURBOCHARGER FROM EXHAUST MANIFOLD

Remove the four nuts and remove the turbocharger, turbocharger gasket and flange gasket.

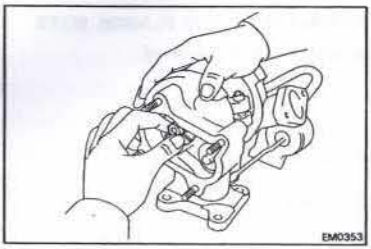


8. REMOVE TURBINE ELBOW

Remove the four nuts, washers, turbine elbow and gasket.

9. **REMOVE RELIEF VALVE FROM COMPRESSOR ELBOW**

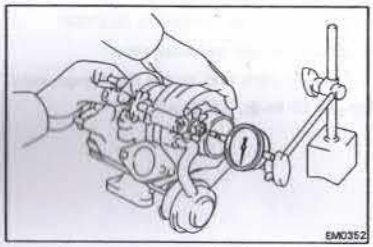
INSPECTION OF TURBOCHARGER



1. **INSPECT IMPELLER WHEEL ROTATION**

Grasp the edge of the turbine wheel and turn it. Check that the impeller wheel turns smoothly.

If the impeller wheel does not turn or if it turns with a drag, replace the turbocharger assembly.



2. **INSPECT AXIAL PLAY OF SHAFT BEARING**

Insert a dial gauge into the intake side, hold the turbine wheel edge by hand and check the axial play.

Standard clearance: 0.13 mm (0.0051 in.) or less

If not within specification, replace the turbocharger assembly.

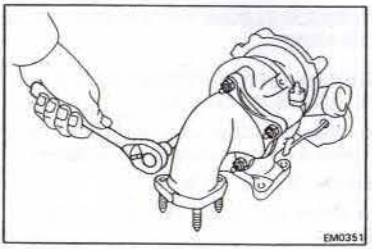
INSTALLATION OF TURBOCHARGER

(See page EM-41)

CAUTION: After replacing a turbocharger assembly, pour about 20 cc (1.2 cu in.) of new oil into the oil inlet and then turn the impeller wheel by hand to splash oil on the bearing.

1. **INSTALL RELIEF VALVE TO COMPRESSOR ELBOW**

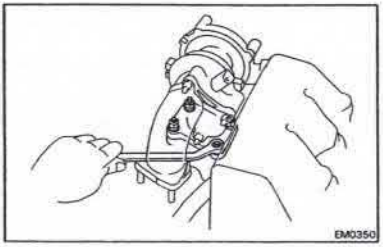
Torque: 375 kg-cm (27 ft-lb, 37 N·m)



2. **INSTALL TURBINE ELBOW**

Install the gasket and turbine elbow with the four nuts and washer.

Torque: 250 kg-cm (18 ft-lb, 25 N·m)



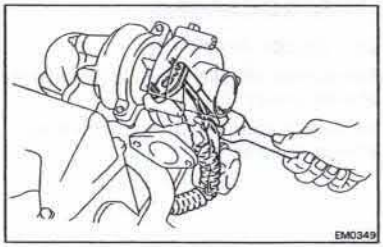
3. INSTALL TURBOCHARGER

(a) Place a new gasket with the protrusion on the oppsite side of the cylinder head.

(b) Install the turbocharger, with a new oil pipe gasket, to the exhaust manifold and oil pipe.

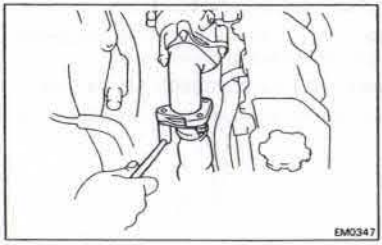
(c) Install and torque the nuts.

Torque: 530 kg-cm (38 ft-lb, 52 N·m)



4. INSTALL TURBOCHAGER OIL PIPE FLANGE NUTS

Torque: 185 kg-cm (13 ft-lb, 18 N·m)

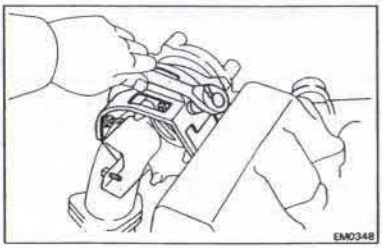


5. CONNECT EXHAUST PIPE TO TURBINE ELBOW

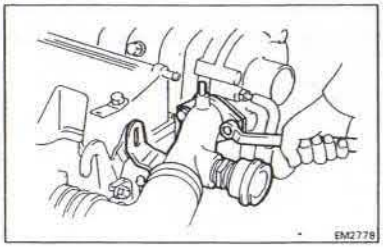
(a) Place a new gasket on the exhaust pipe.

(b) Connect the exhaust pipe and install the flange nuts.

Torque: 130 kg-cm (9 ft-lb, 13 N·m)



6. INSTALL TURBOCHAGER HEAT INSULATORS



7. INSTALL COMPRESSOR ELBOW WITH RELIEF VALVE AND AIR INTAKE HOSE

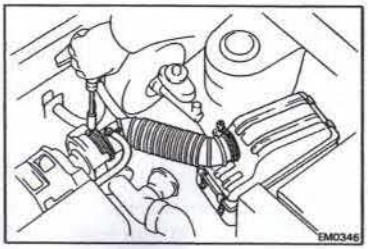
8. CONNECT TURBOCHARGER PRESSURE HOSE FOR INDICATOR AND WARNING LIGHTS

(a) Install the compressor elbow with relief valve and air intake hose with the two bolts and a new gasket.

Torque: 130 kg-cm (9 ft-lb, 13 N·m)

(b) Connect the elbow stay to the engine No. 2 hanger.

(c) Connect the air intake hose to the intake manifold with the clamp.



9. INSTALL AIR CLEANER HOSE WITH CLEANER CASE COVER

(a) Install the air cleaner case cover and the air cleaner hose with the four clips.

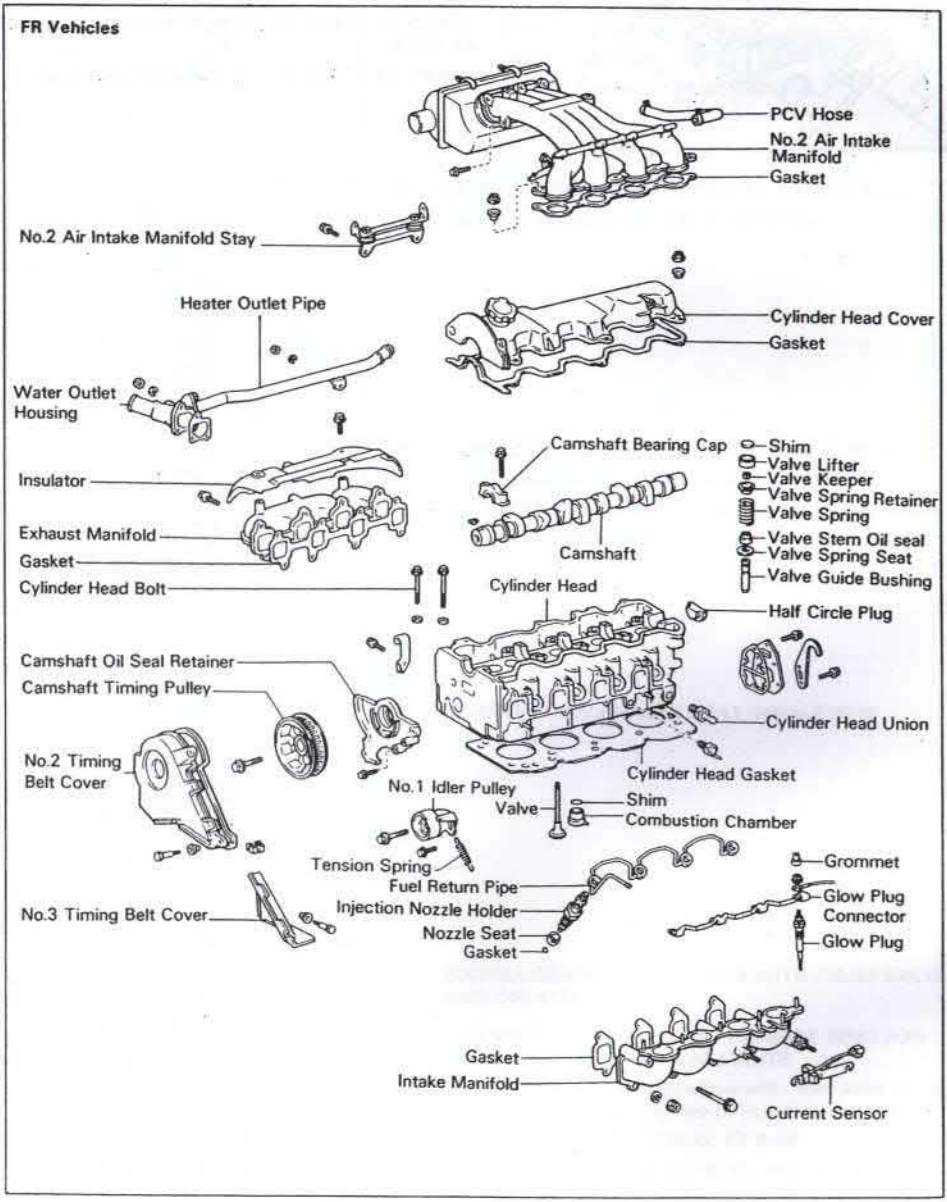
(b) Connect the air cleaner hose to the turbocharger with the clamp.

(c) Connect the PCV hose to the cylinder head cover.

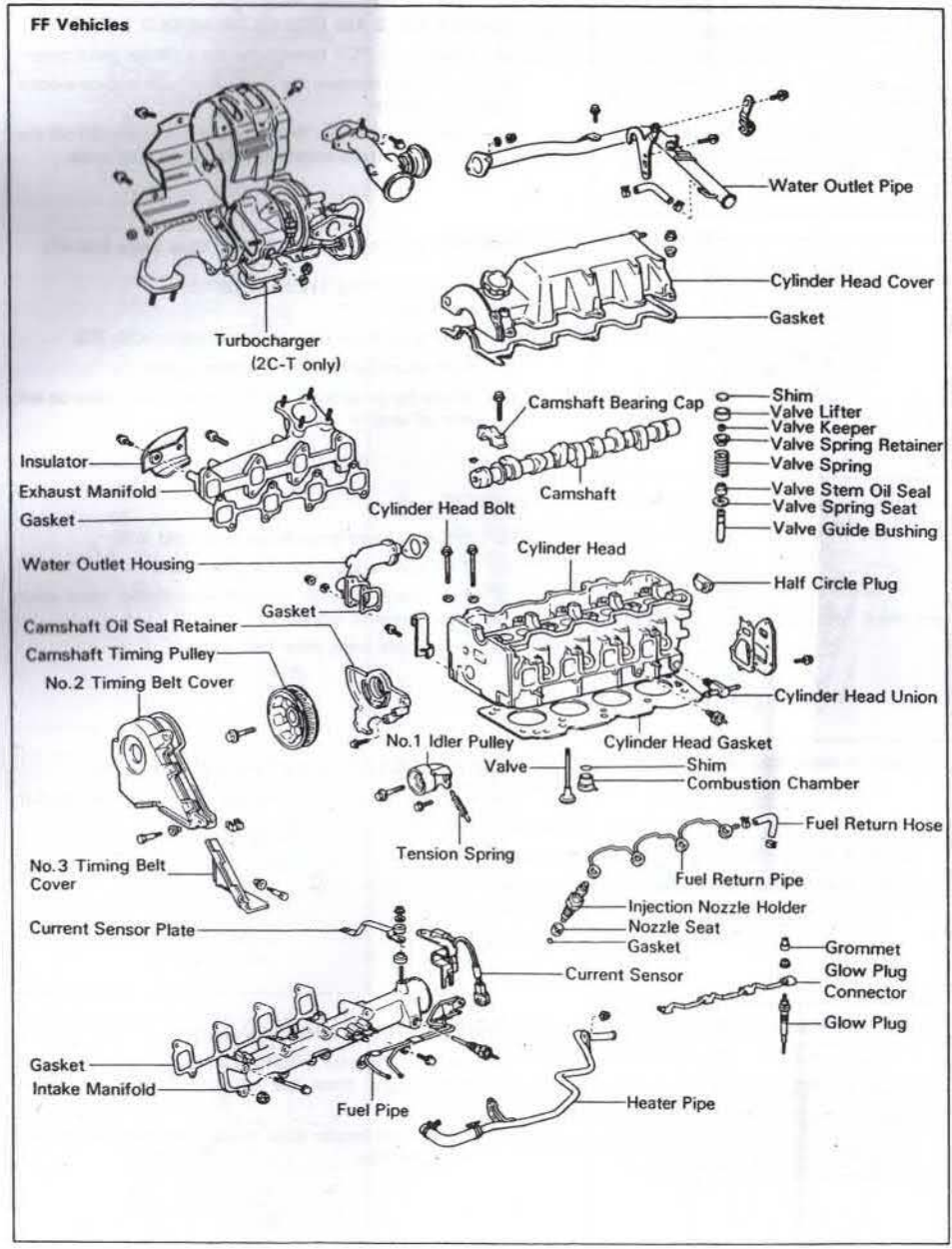
CYLINDER HEAD

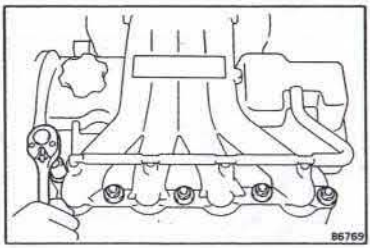
COMPONENTS

FR Vehicles



COMPONENTS (Cont'd)





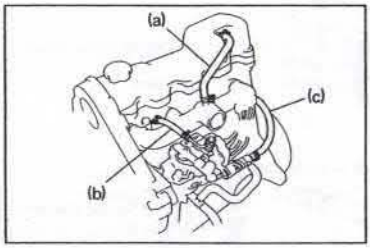
REMOVAL OF CYLINDER HEAD

1. REMOVE NO. 2 AIR INTAKE MANIFOLD (CE70)

(a) Disconnect PCV hose from the cylinder head cover.

NOTE: Do not remove the ventilation tube and connector unless necessary.

(b) Remove two bolts, five nuts and seals, and lift off the No. 2 air intake manifold with air cleaner case.



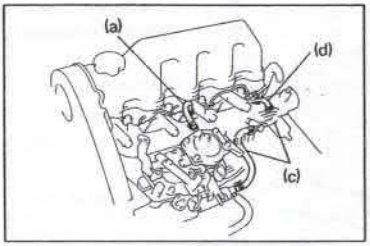
2. REMOVE TURBOCHARGER (CV) (See page EM-41)

3. DISCONNECT FOLLOWING HOSES:
(FR Vehicles)

(a) PCV hose from cylinder head cover (CM, CR)

(b) Fuel return hose from injection pump

(c) Water by-pass hose from cylinder head union on left rear of engine



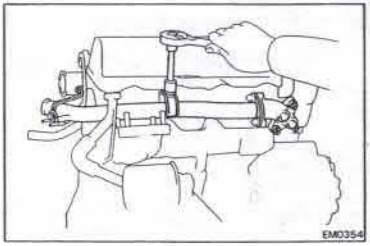
(FF Vehicles)

(a) Pressure hose from intake manifold (CV)

(b) Two fuel hoses from injection pump

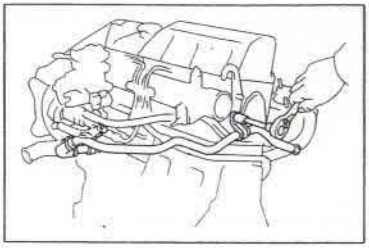
(c) Two water by-pass hoses from cylinder head union on left rear of engine

(d) Fuel return hose from fuel pipe



4. REMOVE WATER OUTLET PIPE (FF Vehicles)

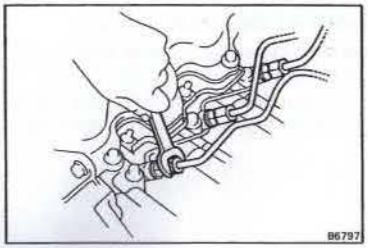
Remove two bolts, three nuts and water pipe with gasket.



5. REMOVE HEATER PIPE (FF Vehicles)

(a) Remove the pipe mounting bolt and nut with engine rear hanger from the cylinder head and injection pump.

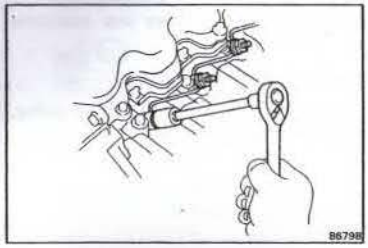
(b) Loosen the heater hose clamp and pull out the hose with the pipe.



6. REMOVE INJECTION PIPES

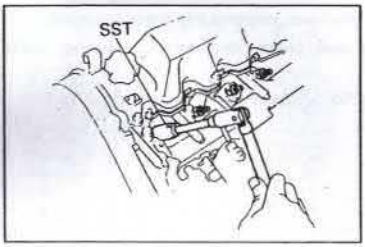
(a) Remove the injection pipe clamps.

(b) Disconnect both ends of the injection pipes from the injection pump and nozzle holders.



7. REMOVE FUEL RETURN PIPE

Remove the four lock nuts and return pipe with four gaskets.



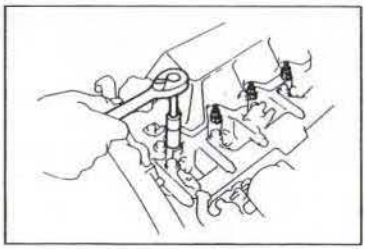
8. REMOVE INJECTION NOZZLE HOLDERS

(a) Using SST, remove the injection nozzle holders.

SST 09268-64010

(b) Arrange the injection nozzle holders in order.

(c) Remove the nozzle seats and gaskets from the cylinder head.



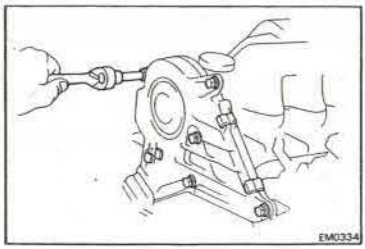
9. REMOVE GLOW PLUG CURRENT SENSOR FROM INTAKE MANIFOLD

10. REMOVE GLOW PLUGS

(a) Remove the four grommets from the glow plugs.

(b) Remove the four nuts, current sensor plate and glow plug connector.

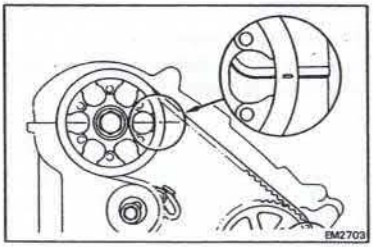
(c) Remove the four glow plugs.



11. REMOVE OIL LEVEL GAUGE GUIDE SUPPORT BOLT FROM INTAKE MANIFOLD

12. REMOVE NO. 2 TIMING BELT COVER WITH GASKET

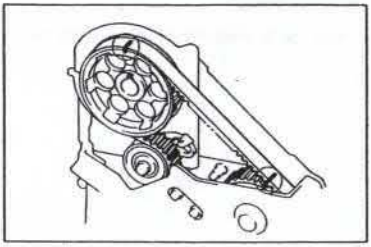
Remove the three clips, five bolts and the No. 2 timing belt cover with the gasket.



13. SET NO. 1 CYLINDER AT TDC/COMPRESSION

(a) Turn the crankshaft pulley and align its groove with the pointer on the oil pump.

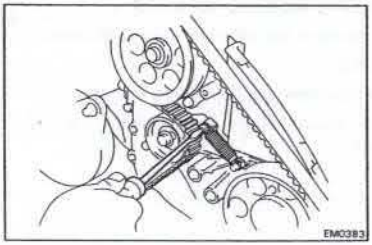
(b) Check that the line mark of the camshaft timing pulley aligns with the top end of the cylinder head.



If necessary, turn the crankshaft pulley one complete revolution.

14. REMOVE CAMSHAFT TIMING PULLEY

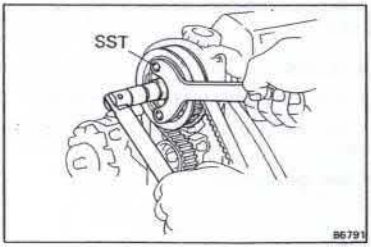
(a) Place matchmarks on the camshaft timing pulley, injection pump pulley and timing belt.



(b) Using a screwdriver, remove the tension spring.

CAUTION: Do not pinch the tension spring with pliers or such.

(c) Loosen the No. 1 idler pulley bolt.

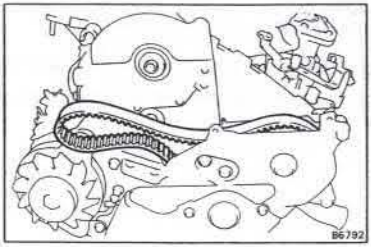


(d) Using SST, to hold the camshaft timing pulley, remove the pulley bolt with the plate washer.

SST 09278-54012

CAUTION: Avoid turning the camshaft because the valves will hit against the piston.

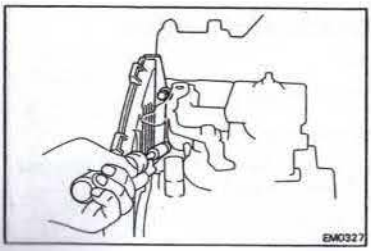
(e) Remove the camshaft timing pulley with the timing belt.



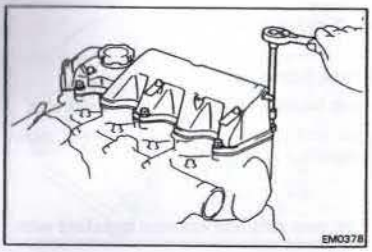
(f) Support the belt so the meshing of the injection pump timing pulley and timing belt does not shift.

CAUTION:

- **Be careful not to drop anything inside the timing belt cover.**
- **Do not allow the belt to come into contact with oil, water or dust.**

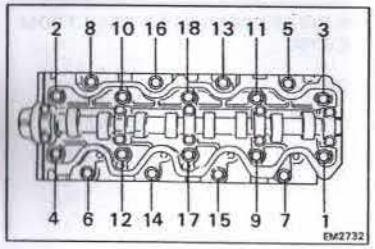


15. REMOVE NO. 3 TIMING BELT COVER



16. REMOVE CYLINDER HEAD COVER

Remove the six nuts and seal washers and, lift off the head cover with the gasket.

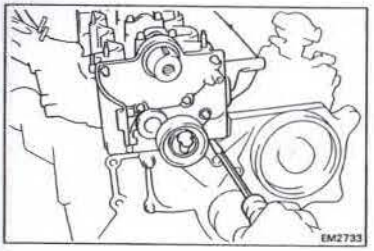


17. REMOVE CYLINDER HEAD

(a) Remove the engine front hanger.

(b) Gradually loosen and remove the eighteen head bolts in three passes and in the numerical order shown.

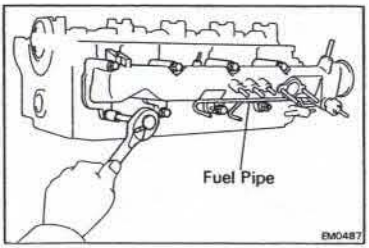
CAUTION: Head warpage or cracking could result from removing in incorrect order.



(c) Lift the cylinder head from the dowels on the cylinder block and place the head on wooden blocks on a bench.

NOTE: If the cylinder head is difficult to lift off, pry with a screwdriver between the cylinder head and block projection.

CAUTION: Be careful not to damage the cylinder head and block surface on the head gasket sides.



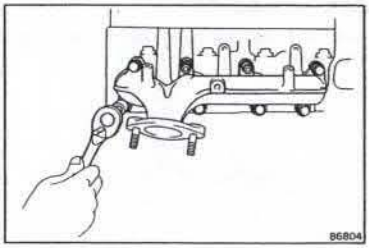
DISASSEMBLY OF CYLINDER HEAD

(See page EM-46 or 47)

1. REMOVE NO. 1 IDLER PULLEY

2. REMOVE INTAKE MANIFOLD

Remove the six bolts, two nuts, fuel pipes (FF vehicles) and intake manifold with the gasket.



3. REMOVE EXHAUST MANIFOLD

(FR Vehicles)

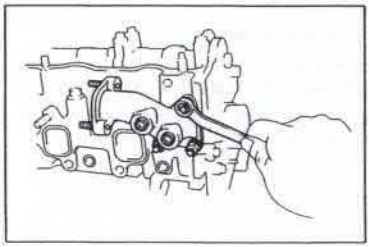
(a) Remove the three bolts and insulator.

(b) Remove the two heater outlet pipe mounting bolts.

(c) Remove the six bolts, two nuts, heater outlet pipe and exhaust manifold with gasket.

(FF Vehicles)

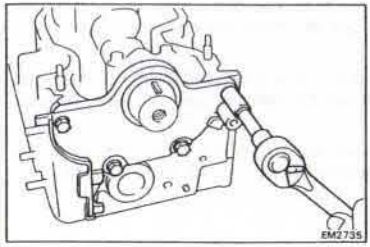
Remove the six bolts, two nuts and exhaust manifold with the gasket.



4. REMOVE NO. 2 AIR INTAKE MANIFOLD STAY FROM CYLINDER HEAD (CE70)

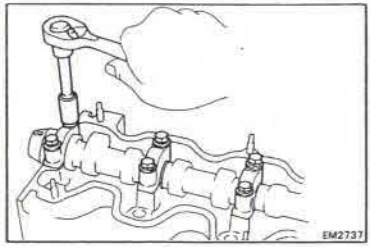
5. REMOVE WATER OUTLET HOUSING

Remove the three nuts and outlet housing with the gasket.



6. REMOVE CAMSHAFT OIL SEAL RETAINER

Remove five bolts and remove oil seal retainer.



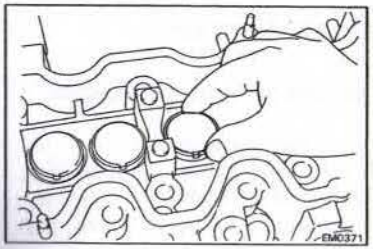
7. REMOVE CAMSHAFT

(a) Gradually loosen and remove the bearing cap bolts from outside in three passes.

CAUTION: Loosen each cam bearing cap bolt a little time.

(b) Remove the bearing caps and camshaft.

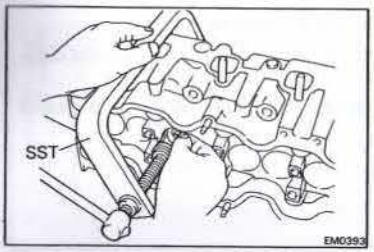
8. REMOVE HALF CIRCLE PLUG FROM CYLINDER HEAD REAR SIDE



9. REMOVE VALVE LIFTERS WITH SHIMS

(a) Pull out the valve lifter with shim by hand.

(b) Arrange the valve lifters and shims in order.



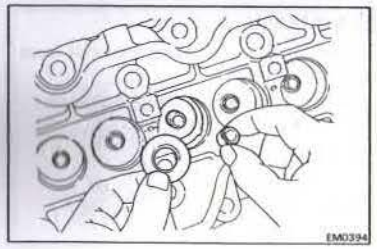
10. REMOVE VALVES

(a) Using SST, press the retainer until two keepers can be removed.

SST 09202-43013

(b) Remove the two keepers and SST.

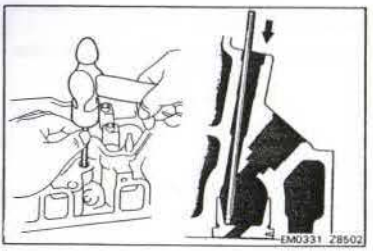
(c) Remove the retainer, spring and valve.



(d) Remove the oil seal.

(e) Using a magnet, remove the spring seat.

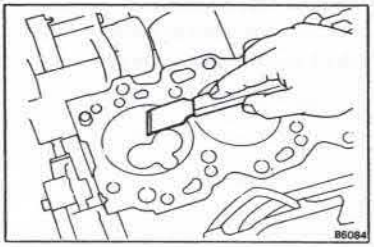
(f) Arrange the disassembled parts in order.



11. REMOVE COMBUSTION CHAMBERS

(a) Insert a rod 4 mm in diameter into the glow plug holes and tap out the combustion chambers.

(b) Arrange the combustion chambers in order.



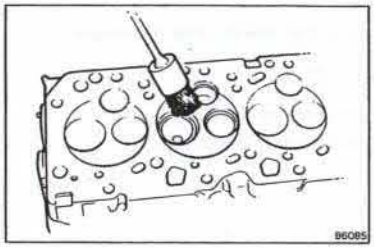
INSPECTION AND CLEANING OF COMPONENTS

1. CLEAN TOP OF PISTONS AND TOP OF CYLINDER BLOCK

(a) Scrape the carbon from the piston top.

(b) Remove all gasket material from the top of the block. Blow carbon and oil from the bolt holes.

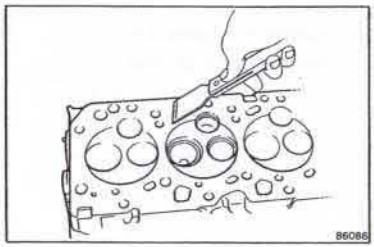
WARNING: Protect your eyes when using high pressure air.



2. CLEAN COMBUSTION CHAMBER

Using a wire brush, remove all the carbon from the combustion chambers.

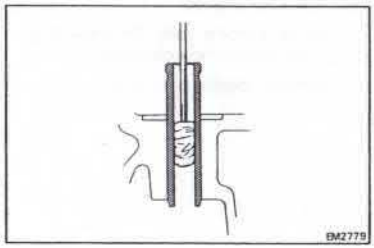
CAUTION: Be careful not to scratch the head gasket contact surface.



3. REMOVE GASKET MATERIAL

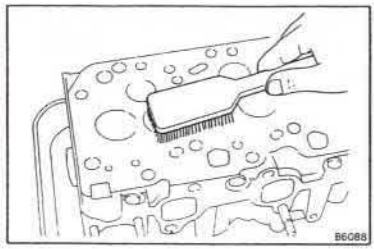
Using a gasket scraper, remove all gasket material from the head and manifold surfaces.

CAUTION: Be careful not to scratch the surfaces.



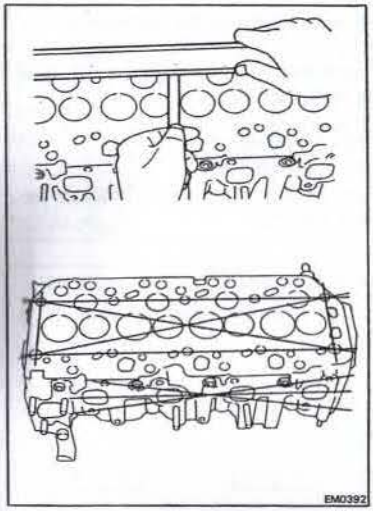
4. CLEAN VALVE GUIDE BUSHINGS

Using a valve guide brush and solvent, clean all the valve guide bushings.



5. CLEAN CYLINDER HEAD

Using a soft brush and solvent, clean the head.



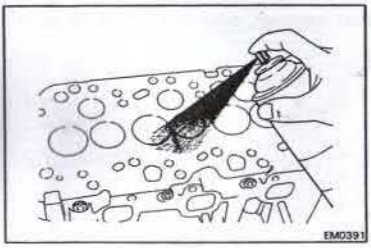
6. INSPECT CYLINDER HEAD FOR FLATNESS

Using a precision straight edge and feeler gauge, measure the surfaces contacting the cylinder block and manifold for warpage.

Maximum warpage:

Cylinder block side	**0.2 mm (0.008 in.)**
Manifold side	**0.2 mm (0.008 in.)**

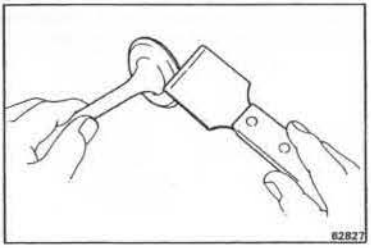
If warpage is greater than maximum, replace the cylinder head.



7. INSPECT CYLINDER HEAD FOR CRACKS

Using a dye penetrant, check the combustion chamber, intake and exhaust ports, head surface and the top of the head for cracks.

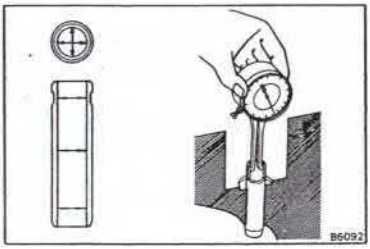
If a crack is found, replace the head.



8. CLEAN VALVES

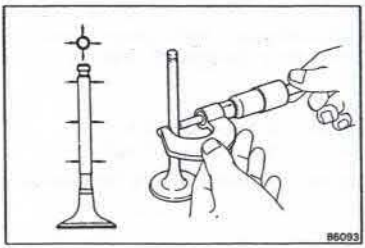
(a) Use a gasket scraper to chip any carbon from the valve head.

(b) Using a wire brush, clean the valve thoroughly.



9. INSPECT VALVE STEM OIL CLEARANCE

(a) Using a dial indicator or telescoping gauge, measure the inside diameter of the valve guide bushing.



(b) Using a micrometer, measure the diameter of the valve stem.

(c) Subtract the valve stem measurement from the valve guide bushing measurement.

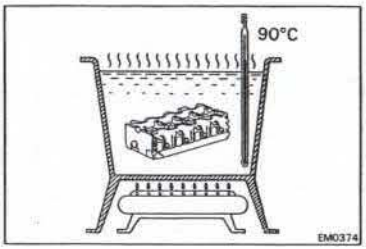
Maximum oil clearance:

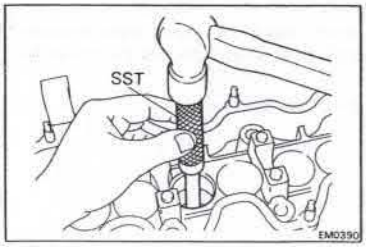
Intake	**0.08 mm (0.0031 in.)**
Exhaust	**0.10 mm (0.0039 in.)**

If the clearance is greater than the maximum, replace the valve and valve guide bushing.

10. IF NECESSARY, REPLACE VALVE GUIDE BUSHING

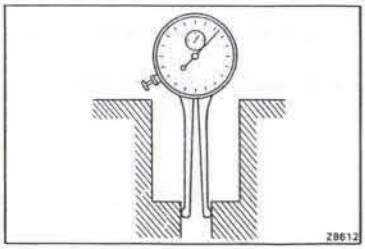
(a) Gradually heat the cylinder head to about 90°C (194°F).





(b) Using SST and hammer, drive out the valve guide bushing.

SST 09201-60011



(c) Using a dial indicator or telescoping gauge, measure the valve guide bushing bore of the cylinder head.

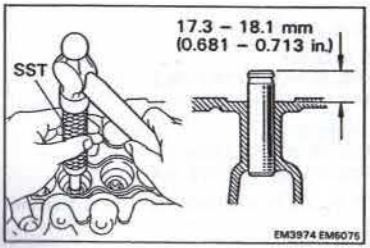
Both intake and exhaust

Bushing bore mm (in.)	Bushing size
13.000 – 13.027 (0.5118 – 0.5129)	Use STD
Over 13.027 (0.5129)	Use O/S 0.05

(d) Select a new valve guide bushing.

If the valve guide bushing bore of the cylinder head is more than 13.027 mm (0.5129 in.), machine the bore to the following dimension.

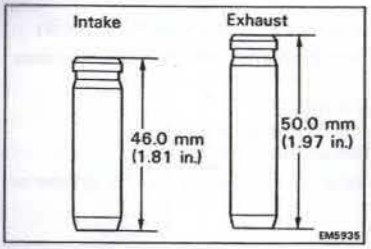
Rebored valve guide bushing bore dimension:
13.050 – 13.077 mm (0.5138 – 0.5148 in.)



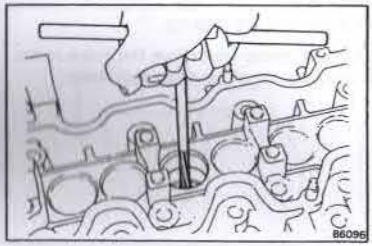
(e) Gradually heat the cylinder head to about 90°C (194°F).

(f) Using SST and a hammer, new valve guide bushing to where there is 17.3 – 18.1 mm (0.681 – 0.713 in.) protruding from the cylinder head.

SST 09201-60011



HINT: Different the bushings are used for the intake and exhaust.



(g) Using a sharp 8 mm reamer, ream the valve guide bushing to obtain the specified clearance between the bushing and new valve stem.

Standard oil clearance:

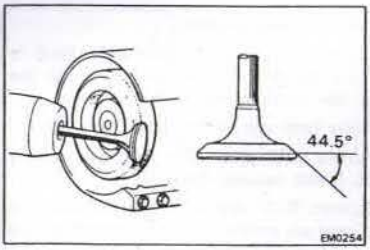
Intake	**0.020 – 0.055 mm (0.0008 – 0.0022 in.)**
Exhaust	**0.035 – 0.070 mm (0.0014 – 0.0028 in.)**

11. INSPECT AND GRIND VALVES

(a) Grind the valves only enough to remove pits and carbon.

(b) Check that the valves are ground to the correct valve face angle.

Valve face angle: 44.5°

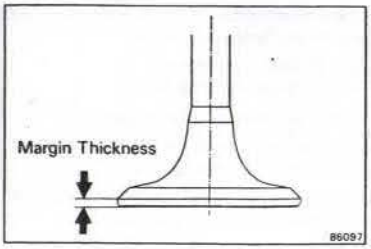


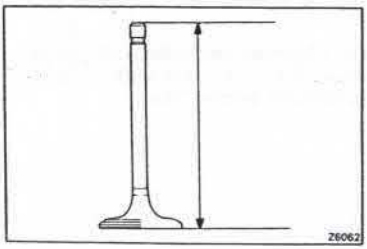
(c) Check the valve head margin thickness.

Minimum margin thickness:

Intake	**0.9 mm**	**(0.035 in.)**
Exhaust	**1.0 mm**	**(0.039 in.)**

If the valve head margin thickness is less than minimum replace the valve.



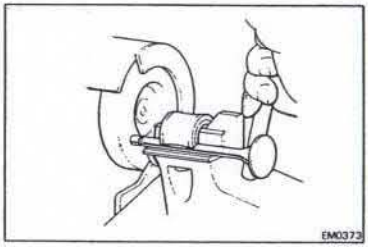


(d) Check the valve overall length.

Minimum overall length:
Intake 105.20 mm (4.1417 in.)
Exhaust 104.85 mm (4.1279 in.)

Standard overall length:
Intake 105.70 mm (4.1614 in.)
Exhaust 105.35 mm (4.1476 in.)

If the valve overall length is less than minumum, replace the valve.

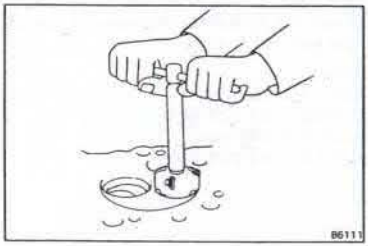


(e) Check the surface of the valve stem tip for wear.

CAUTION: Do not grind off more than the minimum amount.

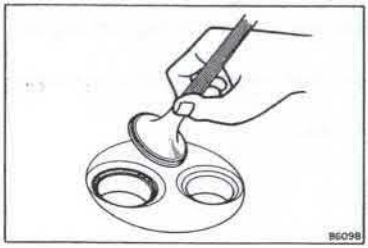
Minimum overall length:
Intake 105.20 mm (4.1417 in.)
Exhaust 104.85 mm (4.1279 in.)

If the valve stem tip is worn, resurface it with a grinder or replace the valve.



12. INSPECT AND CLEAN VALVE SEATS

(a) Using a 45° carbide cutter, resurface the valve seats. Remove only enough metal to clean the seats.

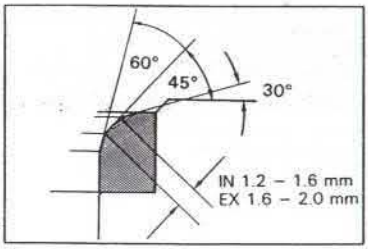


(b) Check the valve seating position.

Apply a thin coat of prussian blue (or white lead) to the valve face. Install the valve. Lightly press the valve against the seat. Do not rotate the valve.

(c) Check the valve face and seat for the following:

- If blue appears 360° around the face, the valve is concentric. If not, replace the valve.
- If blue appears 360° around the valve seat, the guide and seat are concentric. If not, resurface the seat.
- Check that the seat contact is on the middle of the valve face with the following width:

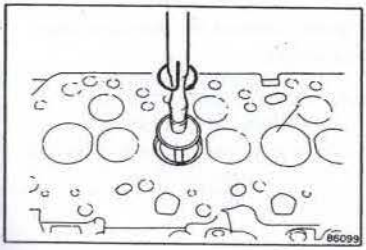


IN: 1.2 – 1.6 mm (0.047 – 0.063 in.)
EX: 1.6 – 2.0 mm (0.063 – 0.079 in.)

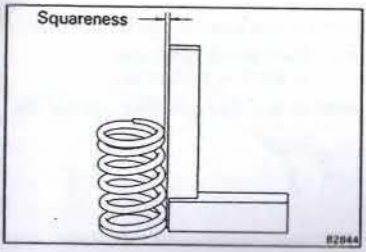
If not, correct the valve seat as follows:

If seating is too high on the valve face, use 30° and 45° cutters to correct the seat.

If seating is too low on the valve face, use 60° and 45° cutters to correct the seat.



(d) Hand-lap the valve and valve seat with abrasive compound.

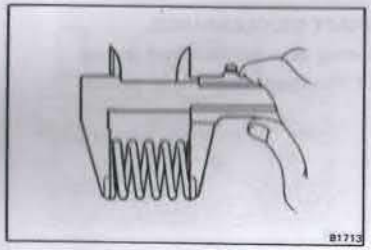


13. INSPECT VALVE SPRINGS

(a) Using a steel square, measure the squareness of the valve springs.

Maximum squareness: 2.0 mm (0.079 in.)

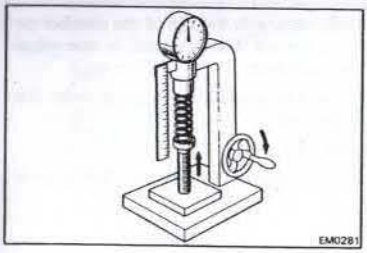
If squareness is greater than maximum, replace the valve spring.



(b) Using calipers, measure the free length of the valve spring.

Free length: 47.5 mm (1.870 in.)

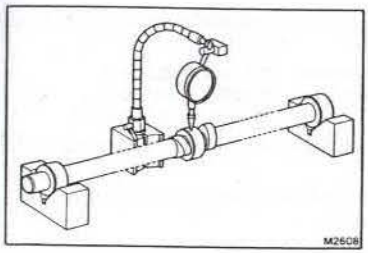
If not as specified, replace the valve spring.



(c) Using a spring tester, measure the tension of the valve spring at the specified installed length.

Installed tension:
22.9 – 25.3 kg (50.5 – 55.8 lb, 225 – 248 N) at 40.3 mm (1.587 in.)

If not as specified, replace the valve spring.

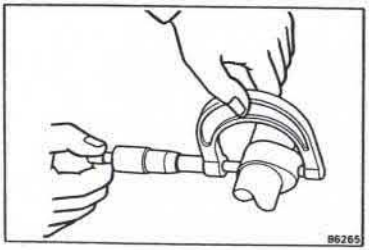


14. INSPECT CAMSHAFT AND BEARING CAPS

(a) Place the camshaft on V-blocks and measure the circle runout at the center journal.

Maximum circle runout: 0.06 mm (0.0024 in.)

If the circle runout is greater than the maximum, replace the camshaft.

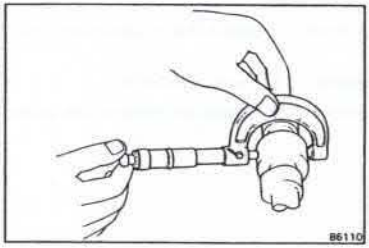


(b) Using a micrometer, measure the cam lobe height.

Minimum cam lobe height:

Intake	**CV**	**45.925 mm (1.8081 in.)**
	Others	**46.325 mm (1.8238 in.)**
Exhaust		**46.835 mm (1.8439 in.)**

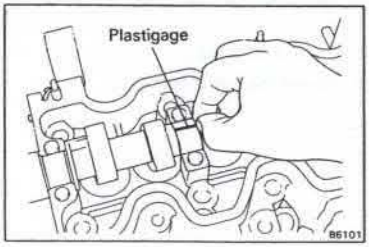
If the cam lobe height is less than minimum, replace the camshaft.



(c) Using a micrometer, measure the journal diameter.

Standard diameter: 27.979 — 27.995 mm (1.1015 — 1.1022 in.)

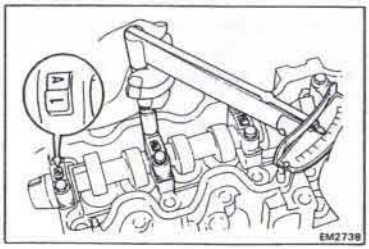
If the journal diameter is less than specified, replace the camshaft.



15. INSPECT CAMSHAFT OIL CLEARANCE

(a) Clean the bearing caps and camshaft journal.

(b) Lay a strip of Plastigage across each journal.

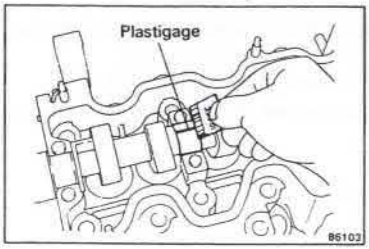


(c) Place the bearing caps with the top of the number on the cap pointing toward the front and in numerical order from the front side.

(d) Install and torque the cap bolts gradually from the inside in three passes.

Torque: 185 kg-cm (13 ft-lb, 18 N·m)

NOTE: Do not turn the camshaft while the Plastigage is in place.

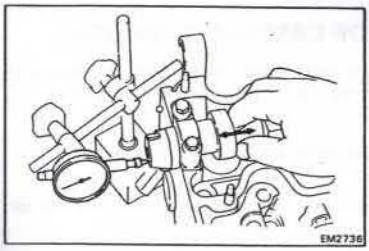


(e) Remove the caps and measure the Plastigage at its widest point.

Maximum oil clearance: 0.1 mm (0.004 in.)
Standard oil clearance: 0.037 — 0.073 mm (0.0015 — 0.0029 in.)

If clearance is greater than the maximum, replace the head and/or camshaft.

(f) Clean out the pieces of Plastigage from the bearing caps and journals.



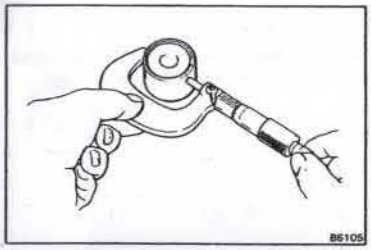
16. INSPECT CAMSHAFT THRUST CLEARANCE

(a) Clean and install the camshaft and bearing caps.

(b) Using a dial gauge, measure the thrust clearance while moving the camshaft back and forth.

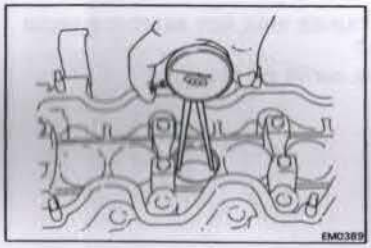
Maximum thrust clearance: 0.25 mm (0.0098 in.)
Standard thrust clearance: 0.08 – 0.18 mm (0.0031 – 0.0071 in.)

If clearance is greater than the maximum, replace the head and/or camshaft.



17. MEASURE VALVE LIFTER OIL CLEARANCE

(a) Using a micrometer, measure the diameter of the valve lifter.

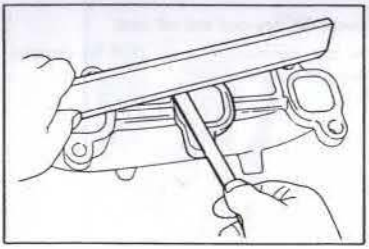


(b) Using a dial indicator, measure the inside diameter of the cylinder head bore.

(c) Subtract the valve lifter measurement from the cylinder head bore.

Maximum oil clearance: 0.10 mm (0.0039 in.)
Standard oil clearance: 0.028 – 0.053 mm (0.0011 – 0.0021 in.)

If clearance is greater than the maximum, replace the head and/or valve lifter.

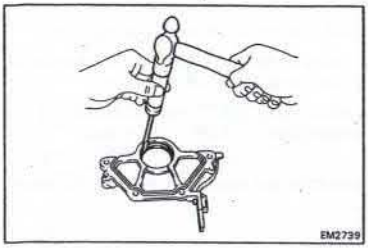


18. INSPECT INTAKE, EXHAUST AND NO. 2 AIR INTAKE MANIFOLDS

Using a precision straight edge and feeler gauge, check the surfaces contacting the cylinder head or intake manifold for warpage.

Maximum warpage: All 0.4 mm (0.016 in.)

If warpage is greater than maximum, replace the manifold.

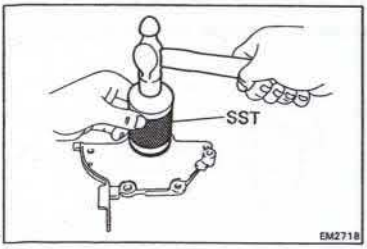


REPLACEMENT OF CAMSHAFT OIL SEAL

NOTE: There are two ways of oil seal replacement depending on whether the oil seal retainer was removed or not.

1. IF OIL SEAL RETAINER WAS REMOVED FROM CYLINDER HEAD

(a) Using a screwdriver and hammer, drive out the oil seal.



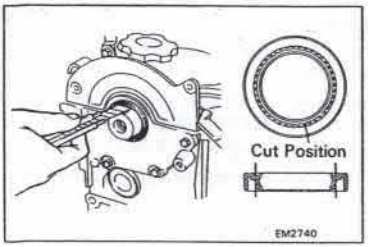
(b) Apply MP grease to the oil seal.

(c) Using SST and a hammer, drive in a new oil seal until its surface is flush with the oil seal retainer edge.

SST 09214-60010

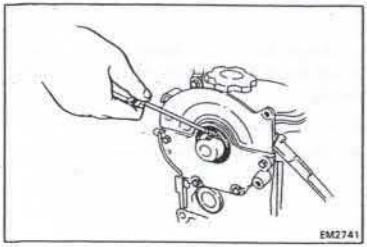
2. IF OIL SEAL RETAINER WAS NOT REMOVED FROM CYLINDER HEAD

(a) Using a knife, cut off the oil seal lip.



(b) Using a screwdriver, pry out the oil seal.

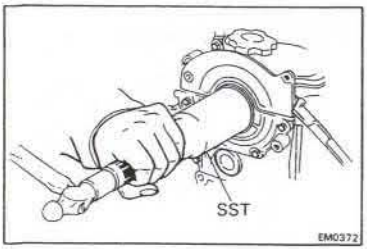
CAUTION: Tape the screwdriver tip and be careful not to damage the camshaft.



(c) Apply MP grease to a new oil seal.

(d) Using SST and a hammer, drive in the oil seal until its surface is flush with oil seal retainer edge.

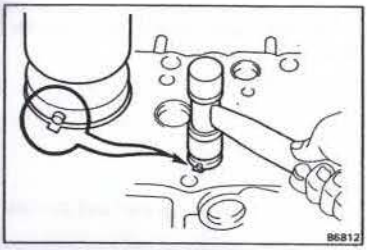
SST 09214-60010



ASSEMBLY OF CYLINDER HEAD

(See page EM-46 or 47)

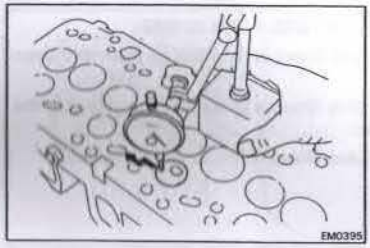
NOTE:
- Thoroughly clean all parts to be assembled.
- Before installing the parts, apply new oil to all sliding and rotating surfaces.
- Replace all gaskets and oil seals with new parts.



1. INSTALL COMBUSTION CHAMBERS

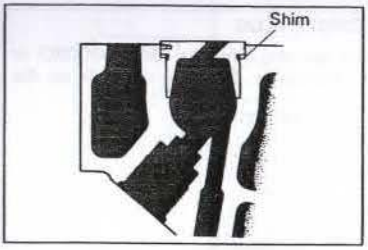
(a) Match the combustion chamber knock pin with the cylinder head notch.

(b) Using plastic hammer, drive in the combustion chamber.



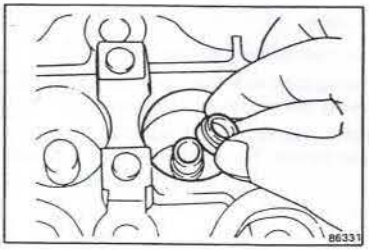
(c) Using a dial indicator, check the combustion chamber protrusion.

Combustion chamber protrusion:
0.01 – 0.07 mm (0.0004 – 0.0028 in.)



If the protrusion is not within specification, adjust it with a combustion chamber adjust shim.

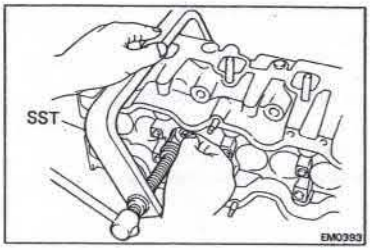
Adjust shim thickness:
Shim No. 1 0.05 mm (0.0020 in.)
Shim No. 2 0.10 mm (0.0039 in.)



2. INSTALL VALVES

(a) Insert the valve in the valve guide bushing. Check that the valves are installed in the correct order.

(b) Install the spring seat and a new oil seal.



(c) Place the spring and retainer on the spring seat.

(d) Using SST, press the retainer and place the two keepers around the valve stem.

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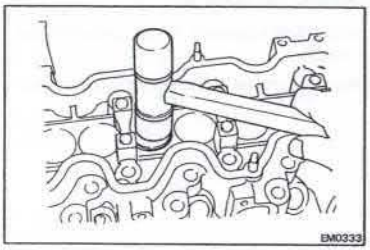
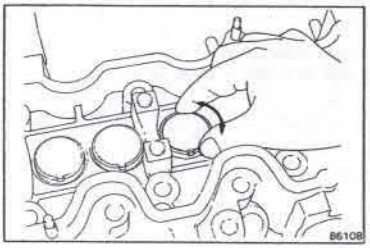
(e) Unscrew the SST and confirm proper fit of the keepers.



(f) Using a pastic hammer, lightly tap the valve stem tip to assure proper fit.

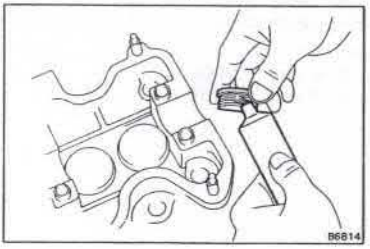


3. INSTALL VALVE LIFTERS WITH SHIMS

(a) Install the valve lifters with shims on the valve stem tips.

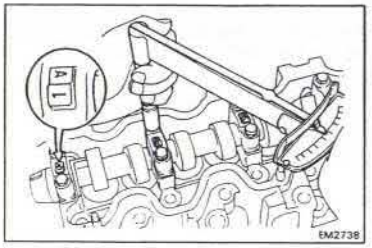
(b) Check the valve lifters and shims are installed in the correct order.

(c) Check the valve lifters rotate smoothly by hand.



4. INSTALL HALF CIRCLE PLUG

Apply No. 102 seal packing (Part No. 08826-00080) or equivalent to the half circle plug and install it on the cylinder head.



5. INSTALL CAMSHAFT

(a) Place the camshaft in the cylinder head.

(b) Place the bearing caps with the top of the number on the cap pointing toward the front as shown.

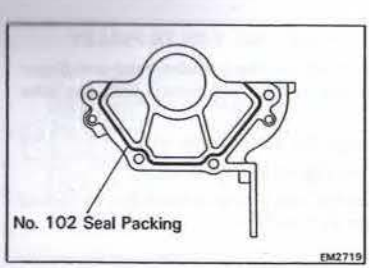
(c) Gradually install and tighten the cap bolts from the inside in three passes. Torque the bolts on the final pass.

Torque: 185 kg-cm (13 ft-lb, 18 N·m)

6. INSPECT AND ADJUST VALVE CLEARANCE

NOTE: Refer to INSPECTION AND ADJUSTMENT OF VALVE CLEARANCE on page EM-16.

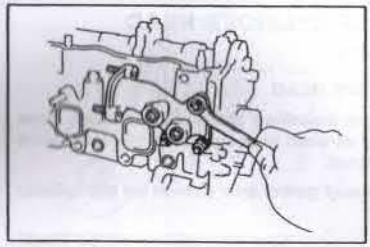
Valve clearance: (Cold)
Intake 0.20 – 0.30 mm (0.008 – 0.012 in.)
Exhaust 0.25 – 0.35 mm (0.010 – 0.014 in.)



7. INSTALL CAMSHAFT OIL SEAL RETAINER

(a) Apply No. 102 seal packing (Part No. 08826-00080) or equivalent to the camshaft oil seal retainer.

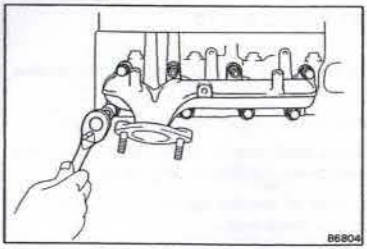
(b) Install the camshaft oil seal retainer with four bolts.



8. INSTALL WATER OUTLET HOUSING

Install a new gasket and water outlet housing with three bolts.

9. INSTALL NO. 2 AIR INTAKE MANIFOLD STAY TO CYLINDER HEAD (CE70)



10. INSTALL EXHAUST MANIFOLD
(FR Vehicles)

(a) Install a new manifold gasket, exhaust manifold and heater outlet pipe with the gasket.

(b) Install the two heater outlet pipe mounting bolts.

(c) Install and torque the six bolts and two nuts.

Torque: 475 kg-cm (34 ft-lb, 47 N·m)

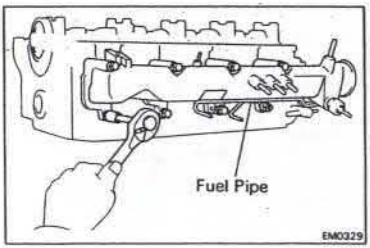
(d) Install the insulator with three bolts.

(FF Vehicles)

(a) Install a new manifold gasket and exhaust manifold with six bolts and two nuts.

(b) Torque the bolts and nuts.

Torque: 475 kg-cm (34 ft-lb, 47 N·m)

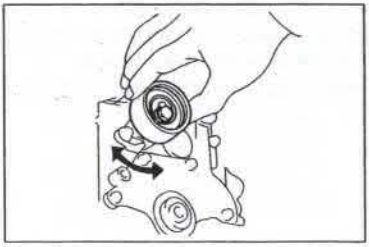


11. INSTALL INTAKE MANIFOLD

(a) Install a new manifold gasket, fuel pipes (FF vehicles) and intake manifold with six bolts and two nuts.

(b) Torque the bolts and nuts.

Torque: 185 kg-cm (13 ft-lb, 18 N·m)



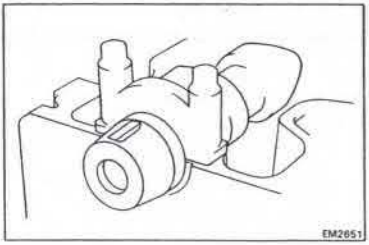
12. PROVISIONALLY INSTALL NO. 1 IDLER PULLEY

(a) Place the idler pulley on the cylinder head and finger tighten the pulley bolt to the extent that the idler pulley is free.

(b) Install and torque the pulley guide bolt.

Torque: 75 kg-cm (65 in.-lb, 7.4 N·m)

NOTE: Check that the idler pulley bracket can be moved to the left and right by hand.



INSTALLATION OF CYLINDER HEAD

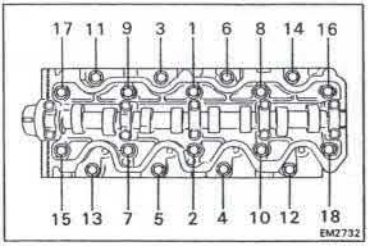
(See page EM-46 or 47)

1. INSTALL CYLINDER HEAD

CAUTION: When installing the cylinder head, face the camshaft key upward to prevent interference with the valve and piston.

(a) Place a new head gasket over dowels on the cylinder block.

(b) Position the cylinder head over dowels on the block.



2. TIGHTEN CYLINDER HEAD BOLTS

NOTE:

- The cylinder head bolts are tighten in three progressive steps.
- If any of the bolts break or deform, replace them.
- If the cylinder head bolts are to be replaced, use only cylinder head bolts with a cavity in the head.

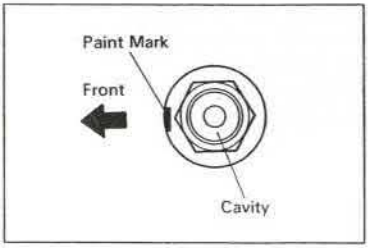
(a) Apply a light coat of engine oil on the threads and under the cylinder head bolts.

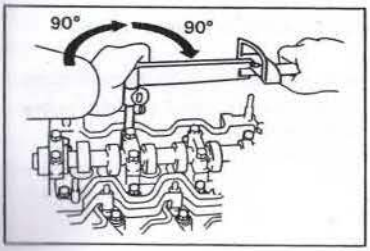
(b) First, uniformly tighten the eighteen cylinder head bolts in several passes and in the sequence shown.

Torque: 450 kg-cm (33 ft-lb, 44 N·m)

If any one of the bolts does not meet the torque specification, replace the bolt.

(c) Mark the front side of the top of head bolt with paint.

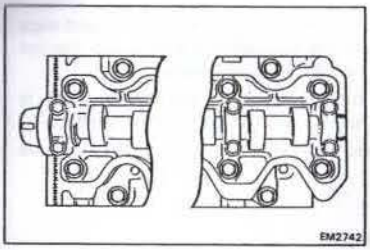




(d) Tighten the eighteen head bolts 90° in the numerical order shown.

(e) Then tighten the bolts by an additional 90°.

(f) Check that the paint mark is now facing rearward.



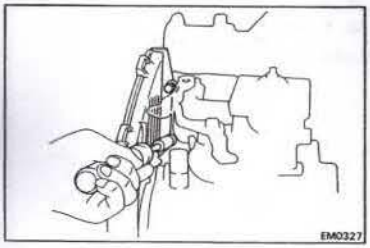
3. INSTALL CYLINDER HEAD COVER

(a) Place the head cover gasket on the head cover.

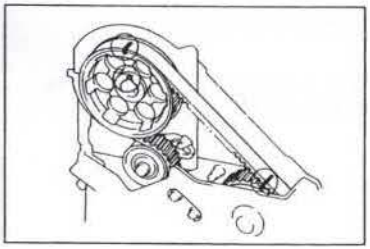
(b) Apply seal packing black (Part No. 08826-00080) to four locations shown.

(c) Place the head cover on the cylinder head and install the six seal washers and nuts. Torque the nuts.

Torque: 75 kg-cm (65 in.-lb, 7.4 N·m)



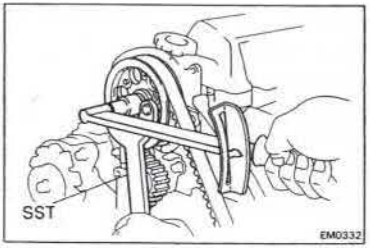
4. INSTALL NO. 3 TIMING BELT COVER



5. INSTALL CAMSHAFT TIMING PULLEY

(a) Align the points marked during removal, and install the timing belt on the timing pulley.

(b) Match the key hole of the timing pulley with the key on the camshaft.

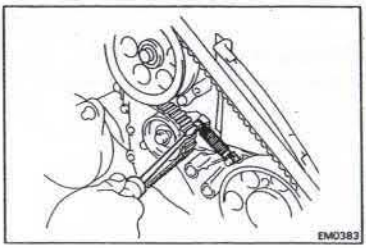


(c) Using SST to hold the timing pulley, install and torque the pulley bolt with the plate washer.

SST 09278-54012

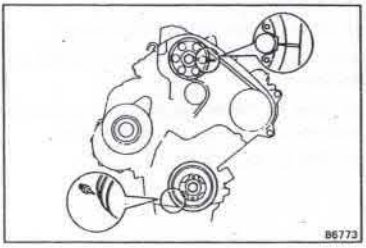
Torque: 900 kg-cm (65 ft-lb, 88 N·m)

CAUTION: Avoid turning the camshaft or the valves will hit against the piston.



(d) Using a screwdriver, install the tension spring.

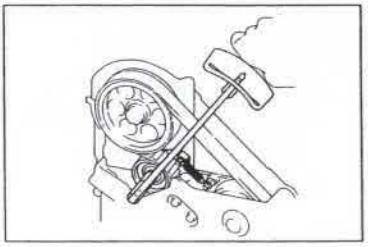
CAUTION:
- **Do not pinch the tension spring with pliers or such.**
- **Loosen the idler pulley bolt to where the idler pulley lightly moves with tension spring force.**



(e) Turn the crankshaft pulley two revolutions and align its groove with the pointer on the oil pump. Always turn the crankshaft pulley clockwise.

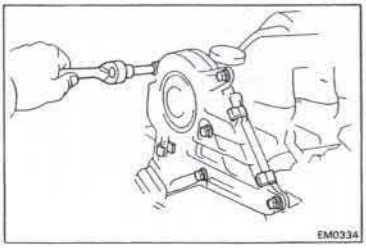
(f) Check that the line mark of the timing pulley is aligned with the top end of the cylinder head.

If the mark are not aligned, repeat the procedure above from (a).



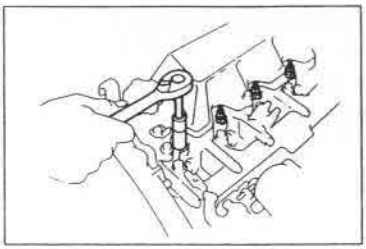
(g) Torque the No. 1 idler pulley bolt.

Torque: 375 kg-cm (27 ft-lb, 37 N·m)



6. **INSTALL NO. 2 TIMING BELT COVER WITH GASKET**

7. **INSTALL OIL LEVEL GAUGE GUIDE CLAMP WITH BOLT TO INTAKE MANIFOLD**



8. **INSTALL GLOW PLUGS**

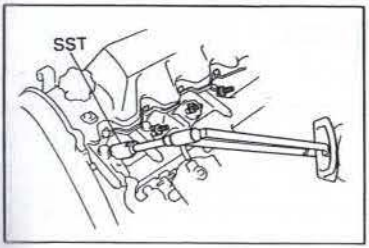
(a) Install and torque the four glow plugs.

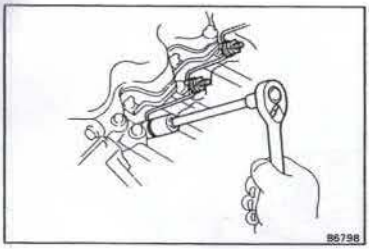
Torque: 130 kg-cm (9 ft-lb, 13 N·m)

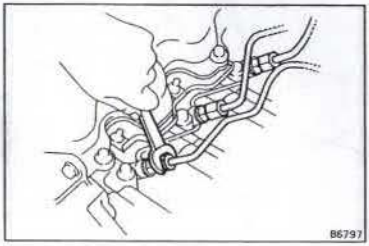
(b) Install the glow plug connector and current sensor plate with four nuts.

(c) Install four grommets on the glow plugs.

9. **INSTALL GLOW PLUG CURRENT SENSOR TO INTAKE MANIFOLD**







10. INSTALL INJECTION NOZZLE HOLDERS

(a) Clean off all carbon deposits on the nozzle seats.

(b) Place four new gaskets and the nozzle seats in the cylinder head.

(c) Using SST, install and torque the four injection nozzle holders.

SST 09268-64010

Torque: 650 kg-cm (47 ft-lb, 64 N·m)

CAUTION: Over torquing could cause nozzle deformation and needle adhesion or other defects.

11. INSTALL FUEL RETURN PIPE

Install the four new gaskets and return pipe with the four lock nuts. Torque the lock nuts.

Torque: 300 kg-cm (22 ft-lb, 29 N·m)

12. INSTALL INJECTION PIPES

(a) Connect both ends of the injection pipes to the injection pump and nozzle holder.

(b) Install the clamps holding the four injection pipes.

(c) Torque the union nuts of the injection pipes.

Torque: 300 kg-cm (22 ft-lb, 29 N·m)

13. INSTALL HEATER PIPE (FF Vehicles)

14. INSTALL WATER OUTLET PIPE (FF Vehicles)

15. CONNECT FOLLOWING HOSES:
(FR Vehicles)

(a) Water by-pass pipe to cylinder head union on left rear of engine.

(b) Fuel return hose to injection pump.

(c) PCV hose to cylinder head cover (CM, CR).

(FF Vehicles)

(a) Fuel return hose to fuel pipe.

(b) Two water by-pass hoses to cylinder head union on left rear of engine.

(c) Two fuel hoses to injection pump.

(d) Pressure hose to intake manifold (CV).

16. INSTALL TURBOCHARGER (2C-T) (See page EM-43)

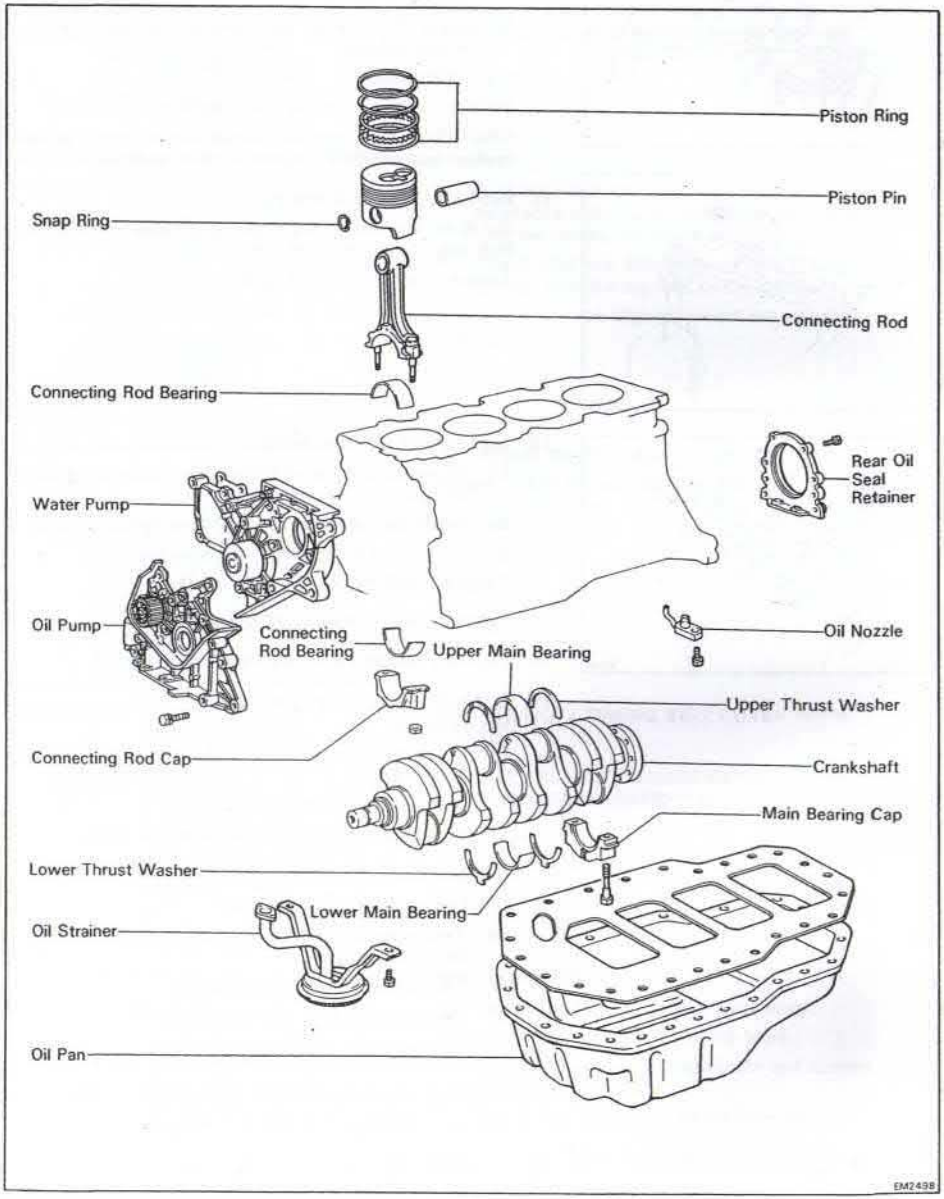
17. INSTALL NO. 2 AIR INTAKE MANIFOLD (CE70)

Torque: 185 kg-cm (13 ft-lb, 18 N·m)

18. INSPECT AND ADJUST INJECTION TIMING
(See page EM-20)

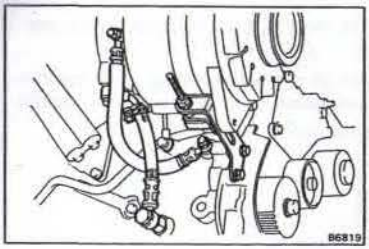
CYLINDER BLOCK

COMPONENTS

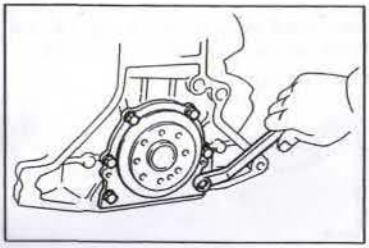


DISASSEMBLY OF CYLINDER BLOCK

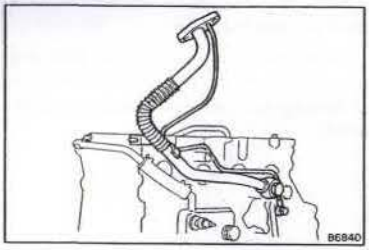
1. REMOVE CLUTCH COVER AND DISC (M/T only)
2. REMOVE FLYWHEEL OR DRIVE PLATE
3. REMOVE REAR END PLATE
4. INSTALL ENGINE TO ENGINE STAND FOR DISASSEMBLY
5. REMOVE TIMING BELT AND EACH PULLEY (See steps 3 to 18 on pages EM-27 to 29)



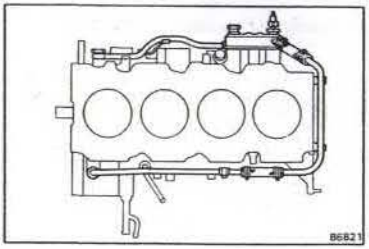
6. REMOVE CYLINDER HEAD (See steps 1 to 6, 11, 16 and 17 on pages EM-48, 49 and 51)
7. REMOVE INJECTION PUMP (See step 9 on page FU-13)
8. REMOVE WATER PUMP (See step 4 on page CO-4)
9. REMOVE ALTERNATOR AND BRACKET WITH OIL HOSES
10. REMOVE OIL PAN AND OIL STRAINER (See steps 5 to 7 on page LU-6)



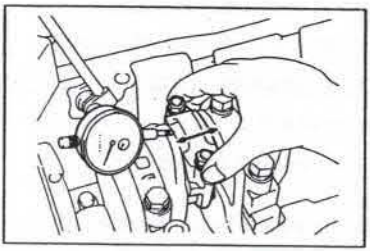
11. REMOVE OIL PUMP (See step 8 on page LU-6)
12. REMOVE DUST SEAL AND REAR OIL SEAL RETAINER
13. REMOVE OIL FILTER AND BRACKET



14. REMOVE TUBOCHARGER OIL PIPES



15. REMOVE OIL COOLER AND PIPES

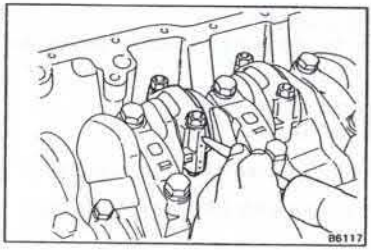


16. MEASURE CONNECTING ROD THRUST CLEARANCE

Using a dial indicator, measure the thrust clearance while moving the rod back and forth.

Maximum thrust clearance: 0.4 mm (0.016 in.)
Standard thrust clearance: 0.08 – 0.30 mm (0.0031 – 0.0118 in.)

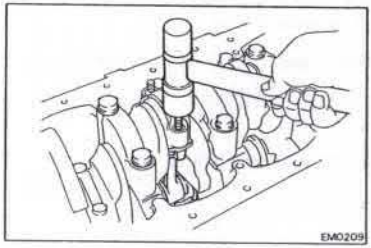
If clearance is greater than the maximum, replace the connecting rod.



17. REMOVE CONNECTING ROD CAPS AND MEASURE OIL CLEARANCE

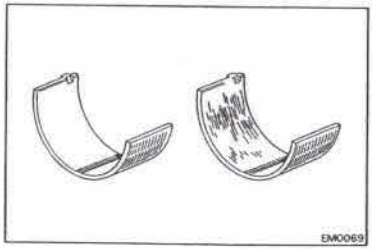
(a) Using a punch or numbering stamp, mark the connecting rods and caps to ensure correct reassembly.

(b) Remove the cap nuts.



(c) Using a plastic-faced hammer, lightly tap the rod bolts and lift off the cap with the lower bearing.

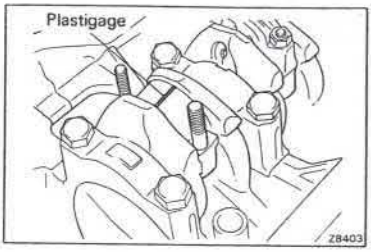
NOTE: Arrange the bearings in order.



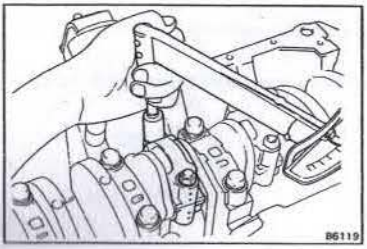
(d) Clean the crank pin and bearing.

(e) Check the crank pin and bearing for pits and scratches.

If the crank pin or bearing are damaged replace the bearing and/or crankshaft.



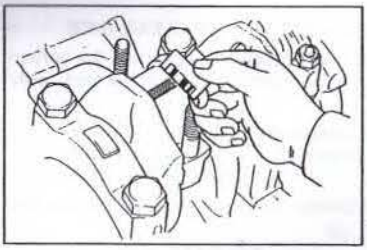
(f) Lay a strip of Plastigage across the crank pin.



(g) Align the punched marks on the rod and cap. Install and torque the cap nuts alternately and in two or three passes.

Torque: 650 kg-cm (47 ft-lb, 64 N·m)

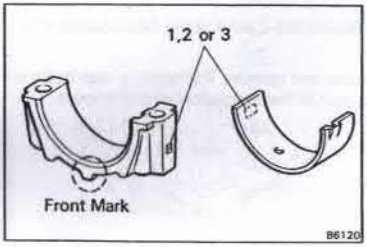
NOTE:
- Do not turn the crankshaft.
- Apply a light coating of engine oil on the nut threads and under the nut before installing.



(h) Remove the rod cap and measure the Plastigage at its widest point.

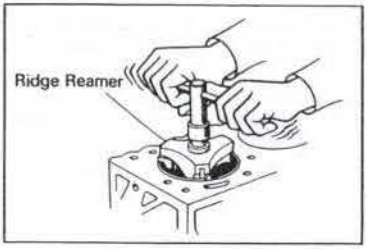
Maximum oil clearance: 0.1 mm (0.004 in.)
Standard oil clearance: 0.044 — 0.072 mm (0.0017 — 0.0028 in.)

If the clearance is greater than the maximum, replace the bearings and/or crankshaft.



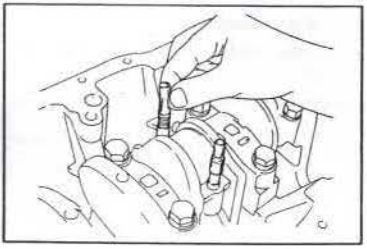
NOTE: For replacement of bearings, select a new bearing with the same number as the connecting rod cap number. Be sure to recheck the oil clearance after installing a new bearing.

(i) Clean out the pieces of Plastigage from the bearing and crank pin.



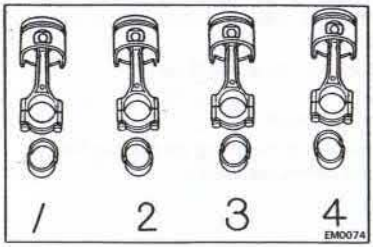
18. REMOVE PISTON AND CONNECTING ROD

(a) Remove all the carbon from the top of the cylinder.



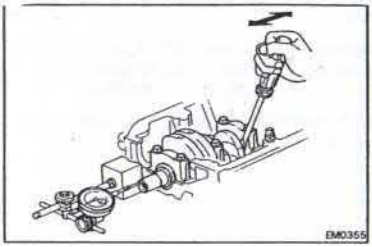
(b) Cover each rod bolt with a short piece of hose to protect the crank pin from damage.

(c) Push out the piston and connecting rod from the cylinder head side.



(d) Arrange the piston and connecting rod with the rod cap in order.

NOTE: Keep the bearing insert with the rod and rod cap.



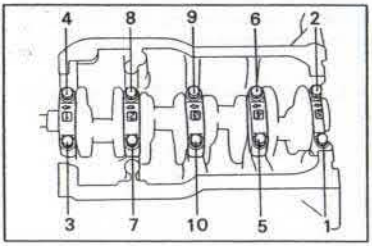
19. MEASURE CRANKSHAFT THRUST CLEARANCE

Set a dial indicator as shown and measure the thrust clearance while prying the crankshaft back and forth with a screwdriver.

Maximum thrust clearance: 0.3 mm (0.012 in.)
Standard thrust clearance: 0.04 – 0.24 mm (0.0016 – 0.0094 in.)

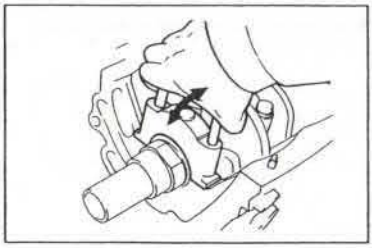
If the clearance is greater than the maximum, replace the thrust washers as set.

Over size thrust washer: O/S 0.125, 0.250



20. REMOVE MAIN BEARING CAPS AND MEASURE OIL CLEARANCE

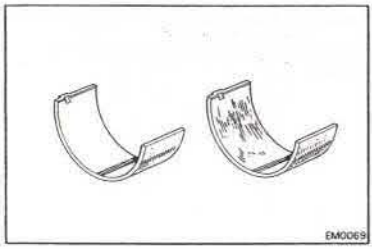
(a) Gradually loosen and remove the bearing cap bolts in three passes and in the numerical order shown.



(b) Using the removed bearing cap bolts, pry the bearing cap fore-and- aft, and remove it with the lower bearing and thrust washers No. 3 journal only.

(c) Lift out the crankshaft and remove the upper bearings and upper thrust washers (for the No. 3 journal only) from the cylinder block.

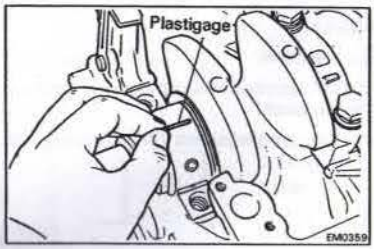
NOTE: Arrange the caps, bearings and thrust washers in order.



(d) Clean each journal and bearing.

(e) Check each journal and bearing for pits and scratches.

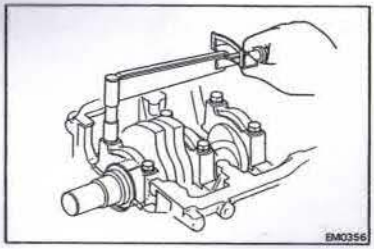
If the journal or bearing are damaged, replace the bearing and/or crankshaft.



(f) Install the upper bearings and upper thrust washers on the cylinder block.

(g) Place the crankshaft on the upper bearings.

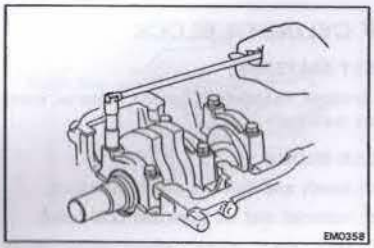
(h) Lay a strip of Plastigage across the journals.



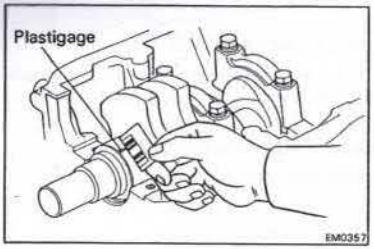
(i) Install the bearing caps with the lower bearing and lower thrust washers.
(See step 3 on page EM-87)

Torque: 1,050 kg-cm (76 ft-lb, 103 N·m)

NOTE: Do not turn the crankshaft.



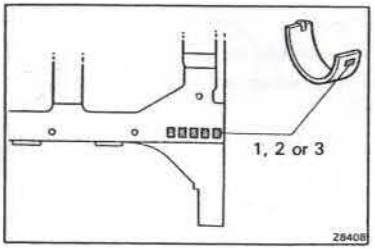
(j) Remove the bearing caps with the lower bearing and lower thrust washers.
(See procedure (a) and (b) above)



(k) Measure the Plastigage at its widest point.

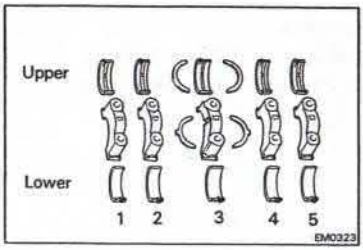
Maximum oil clearance: 0.1 mm (0.004 in.)
Standard oil clearance: 0.034 – 0.065 mm (0.0013 – 0.0026 in.)

If the clearance is greater than the maximum, replace the bearings and/or crankshaft.



NOTE: For replacement of bearings, select a new bearing with the same number as the number on the cylinder block under surface. Be sure to recheck the oil clearance after installing a new bearing.

(l) Clean out the pieces of Plastigage from the bearing and journals.

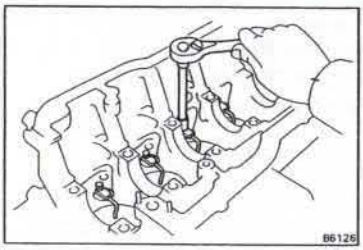


21. REMOVE CRANKSHAFT

(a) Remove the crankshaft.

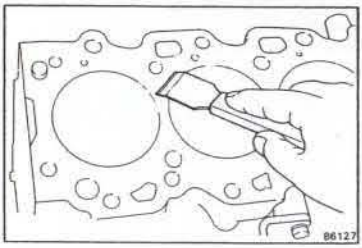
(b) Remove the upper bearings and upper thrust washers from the cylinder block.

(c) Arrange the caps, bearings and thrust washers in order.



22. REMOVE OIL NOZZLES

INSPECTION OF CYLINDER BLOCK



1. REMOVE GASKET MATERIAL

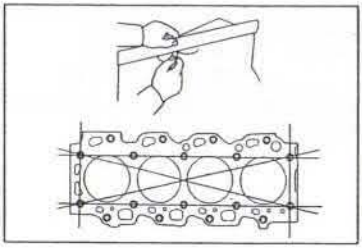
Using a gasket scraper, remove all gasket material from the cylinder block surface.

2. CLEAN CYLINDER BLOCK

(a) Using a soft brush and solvent, clean the block.

(b) Blow gasket material and oil from the bolt holes.

WARNING: Protect your eyes when using high pressure air.

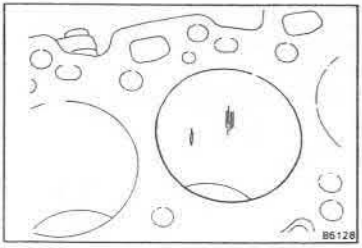


3. INSPECT TOP OF CYLINDER BLOCK

Using a precision straight edge and feeler gauge, measure the surface contacting the cylinder head gasket for warpage.

Maximum warpage: 0.20 mm (0.0079 in.)

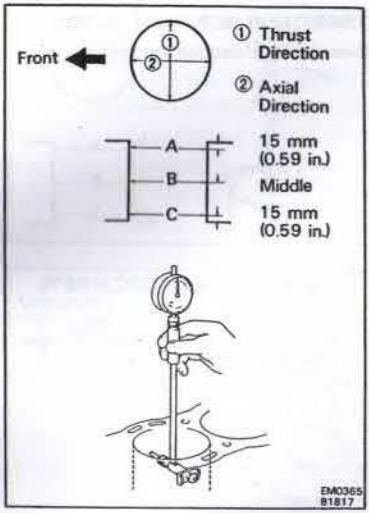
If warpage is greater than maximum, replace the cylinder block.



4. INSPECT CYLINDERS

Visually inspect the cylinders for vertical scratches.

If deep scratches are present, rebore all four cylinders.
(See page EM-82)

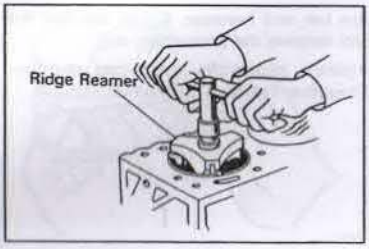


5. MEASURE CYLINDER BORE DIAMETER

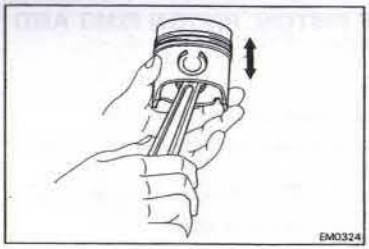
Using a cylinder micrometer, measure the cylinder bore diameter at positions A, B and C in the thrust and axial directions.

On piston size	Maximum cylinder bore diameter mm (in.)	
	1C series	2C series
STD	83.23 (3.2768)	86.23 (3.3949)
O/S 0.50	83.73 (3.2965)	86.73 (3.4146)

If the cylinder bore diameter is greater than the maximum, replace the cylinder block (On oversized piston) or rebore all four cylinder (On standard piston).
(See page EM-82)



If the cylinder bore diameter is less than maximum use a ridge reamer to ream off the upper step.

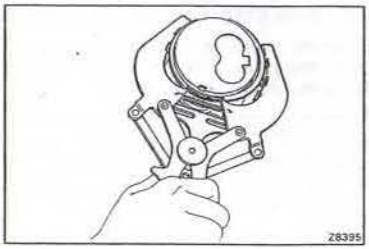


DISASSEMBLY OF PISTON AND CONNECTING ROD

1. CHECK FIT BETWEEN PISTON AND PIN

Try to move the piston back and forth on the piston pin.

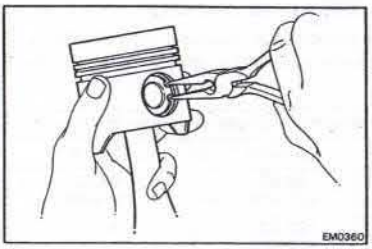
If any movement is felt, replace the connecting rod bushing or piston with the pin.



2. REMOVE PISTON RINGS

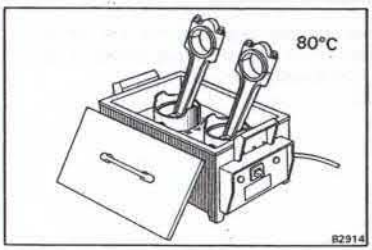
(a) Using a piston ring expander, remove the piston rings.

(b) Arrange the rings for each cylinder in order.

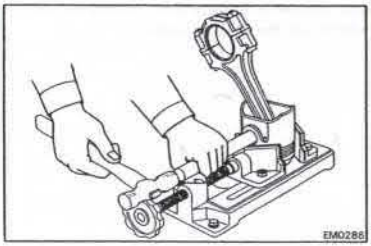


3. DISCONNECT CONNECTING ROD FROM PISTON

(a) Using needle-nose pliers, remove the snap rings.



(b) Gradually heat the piston to about 80°C (176°F).



(c) Using a brass bar and hammer, lightly tap out the piston pin and remove the connecting rod.

(d) Arrange the piston, piston pin, piston ring and connecting rod together for each cylinder.

INSPECTION OF PISTON, PISTON RING AND CONNECTING ROD

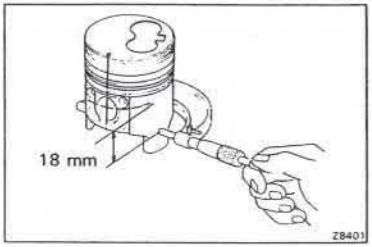
1. CLEAN PISTON

(a) Scrape carbon from the piston top.

(b) Using a groove cleaning tool or broken ring, clean the ring grooves.

(c) Using solvent and brush, clean the piston thoroughly.

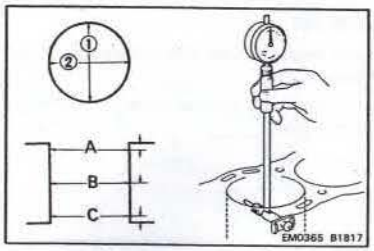
CAUTION: Do not use a wire brush.



2. MEASURE PISTON DIAMETER AND OIL CLEARANCE

(a) Using a micrometer, measure the piston diameter at right angles to the piston pin center line, 18 mm (0.71 in.) below the piston pin center line.

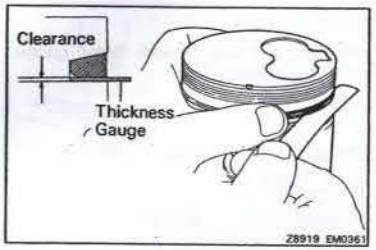
Piston size	Piston diameter mm (in.)	
	1C series	2C series
STD	82.95 – 82.98 (3.2657 – 3.2669)	85.95 – 85.98 (3.3839 – 3.3850)
O/S 0.50	83.45 – 83.48 (3.2854 – 3.2866)	86.45 – 86.48 (3.4035 – 3.4047)



(b) Measure the cylinder bore diameter (See page EM-77) and subtract the piston diameter measurement from the cylinder bore diameter.

Maximum oil clearance: 0.15 mm (0.0059 in.)
Standard oil clearance: 0.04 — 0.06 mm (0.0016 — 0.0024 in.)

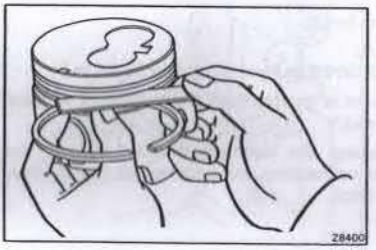
If the clearance is greater than maximum, replace the all four pistons, rebore all four cylinders or replace cylinder block.



3. MEASURE CLEARANCE BETWEEN PISTON GROOVE AND NEW PISTON RING

(a) Install a new No. 1 ring to the piston and, using a feeler gauge, measure the No. 1 ring clearance between the new piston ring and the ring land when the ring is flush with the piston surface.

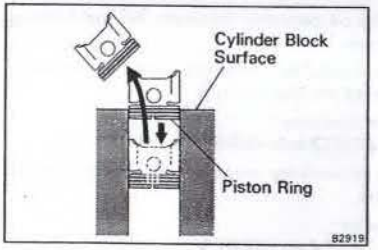
Maximum clearance: 0.2 mm (0.008 in.)



(b) Using a feeler gauge, measure the No. 2 ring or oil ring clearance between the new piston ring and the ring land.

Maximum clearance: 0.2 mm (0.008 in.)

If the clearance is greater than the maximum, replace the piston.

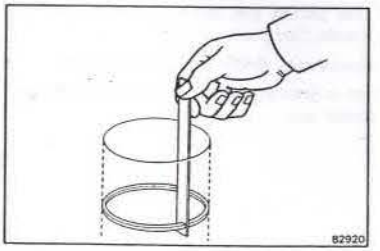


4. MEASURE PISTON RING END GAP

(a) Insert the piston ring into the cylinder.

CAUTION: Do not file the ring end.

(b) Using a piston, push the piston ring to the bottom of the ring travel.

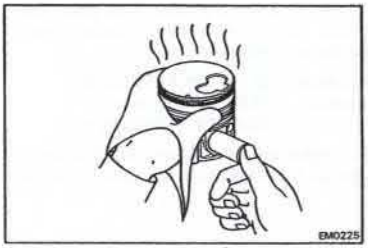


(c) Using a feeler gauge, measure the end gap.

Standard end gap:
No. 1 0.27 — 0.54 mm (0.0106 — 0.0213 in.)
No. 2 0.25 — 0.52 mm (0.0098 — 0.0205 in.)
Oil 0.20 — 0.82 mm (0.0079 — 0.0323 in.)

Maximum end gap:
No. 1 1.34 (0.0528 in.)
No. 2 1.32 (0.0520 in.)
Oil 1.62 (0.0638 in.)

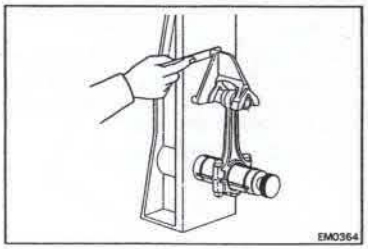
If not within specification, replace the ring.



5. CHECK PISTON PIN FIT

At 80°C (176°F), the pin should be able to be pushed into the piston with your thumb.

If the pin can be installed at a normal room temperature, replace the piston and pin.

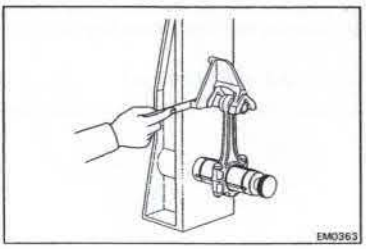


6. INSPECT CONNECTING RODS

(a) Using a connecting rod aligner and feeler gauge, check the rod alignmement.

- Check for bend.

Maximum bend:
0.05 mm (0.0020 in.) per 100 mm (3.94 in.)

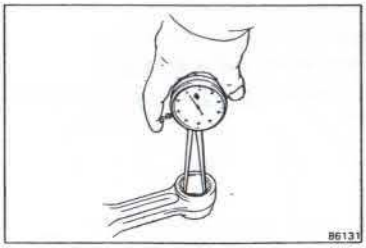


- Check for twist.

Maximum twist:
0.15 mm (0.0059 in.) per 100 mm (3.94 in.)

If the bent or twist is greater than the maximum, replace the connecting rod.

NOTE: If replacing the connecting rods, replace the same number of connecting rod bearings as that of new connecting rod caps.



(b) Measure the oil clearance between the rod bushing and piston pin.

- Using an inside dial indicator, measure the inside diameter of the rod bushing.

Standard inside diameter:
27.011 – 27.023 mm (1.0634 – 1.0639 in.)

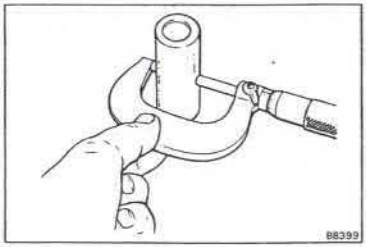
- Using a micrometer, measure the diameter of the piston pin.

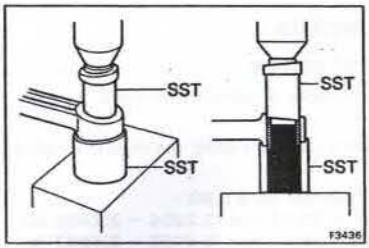
Standard diameter:
27.000 – 27.012 mm (1.0630 – 1.0635 in.)

- Subract the piston pin diameter from the rod bushing inside diameter.

Maximum oil clearance: 0.05 mm (0.0020 in.)

If the oil clearance is greater than maximum, replace the rod bushing or piston pin.



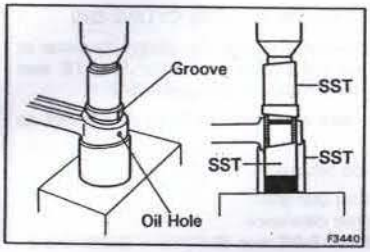


REPLACEMENT OF CONNECTING ROD BUSHING

1. REMOVE ROD BUSHING

Using SST and a press, press out the bushing.

SST 09222-64010 (09222-02020, 09222-02040)

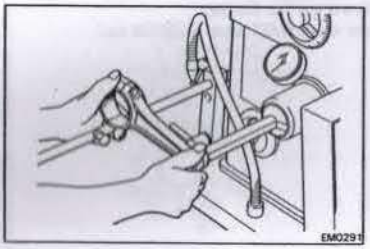


2. INSTALL NEW ROD BUSHING

(a) Align the oil holes of the bushing and rod.

(b) Using SST and a press, press in the bushing.

SST 09222-64010 (09222-02020, 09222-02030, 09222-02040)

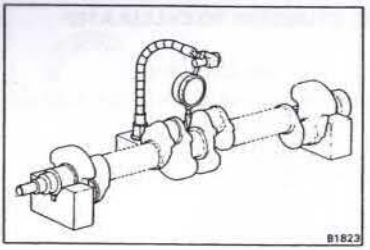


3. HONE ROD BUSHING AND CHECK PISTON PIN FIT IN CONNECTING ROD

(a) Using a pin hole grinder, hone the bushing and check that the oil clearance is within standard specification.

Standard oil clearance: 0.007 – 0.015 mm (0.0003 – 0.0006 in.)

(b) Check the piston pin fit at normal room temperature. Coat the piston pin with engine oil and push it into the rod with your thumb.



INSPECTION OF CRANKSHAFT

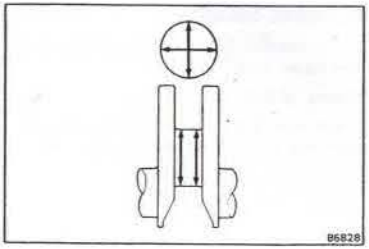
MEASURE CRANKSHAFT

(a) Place the crankshaft on V-blocks.

(b) Using a dial indicator, measure the circle runout at the center journal.

Maximum circle runout: 0.1 mm (0.004 in.)

If the circle runout is greater than the maximum, replace the crankshaft.



(c) Using a micrometer, measure the diameter of the journal and crank pin.

(d) Measure the journals for out-of-round and taper as shown.

Journal diameter: 56.985 – 57.000 mm (2.2435 – 2.2441 in.)

Crank pin diameter: 50.488 – 50.500 mm (1.9877 – 1.9882 in.)

Maximum taper and out-of -round: 0.02 mm (0.0008 in.)

If not within specification, replace the crankshaft.

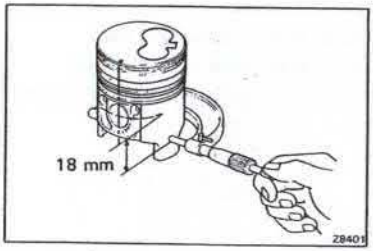
BORING OF CYLINDERS

1. SELECT OVERSIZED PISTON

If using a O/S piston, bore all cylinders for the O/S piston outside diameter.

NOTE: If oversized pistons are used, the rings must also be oversized.

Oversize piston diameter (O/S 0.50):
1C series 83.45 — 83.48 mm (3.2854 — 3.2866 in.)
2C series 86.45 — 86.48 mm (3.4035 — 3.4047 in.)



2. CALCULATE DIMENSION TO BORE CYLINDERS

(a) Using a micrometer, measure the piston diameter at right angles to the piston pin center line, 18 mm (0.71 in.) below the piston pin center line.

(b) Calculate the size each cylinder is to be rebored as follows:

Size to be rebored = P + C − H

P = Piston diameter

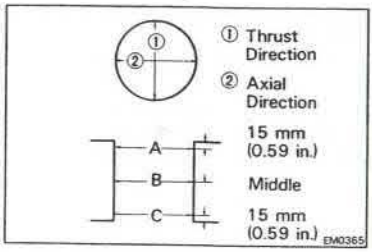
C = Piston clearance
0.04 — 0.06 mm (0.0016 — 0.0024 in.)

H = Allowance for honing
Less than 0.02 mm (0.0008 in.)

3. BORE AND HONE CYLINDERS TO CALCULATED DIMENSIONS

Maximum honing: 0.02 mm (0.0008 in.)

CAUTION: Excess honing will destroy the finished roundness.



4. INSPECT CYLINDER BORE DIAMETER

(a) The difference between A, B and C measurements is greater than the taper limit.

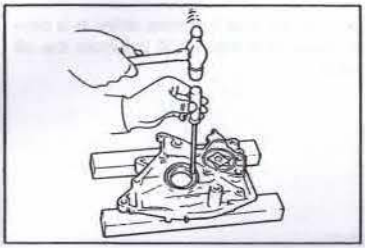
Taper limit: 0.01 mm (0.0004 in.)

(b) The difference between the thrust and axial measurements is greater than the out-of-round limit.

Out-of-round limit: 0.006 mm (0.0002 in.)

REPLACEMENT OF OIL SEALS

NOTE: There are two ways of oil seal replacement depending on whether the oil pump or rear oil seal retainer was removed or not.

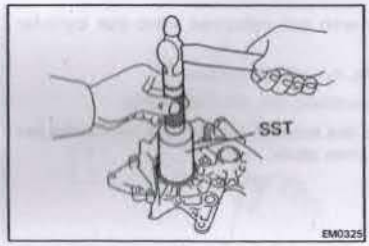


1. REPLACEMENT OF CRANKSHAFT FRONT OIL SEAL

If the oil pump was removed from the cylinder block:

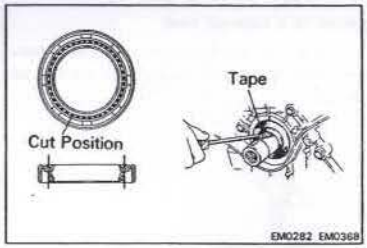
(a) Using a screwdriver and hammer, drive out the oil seal.

(b) Apply MP grease to a new oil seal.



(c) Using SST and hammer, drive in a new oil seal until its surface is flush with the oil pump body edge.

SST 09214-60010



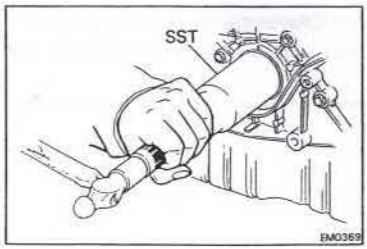
If the oil pump was not removed from the cylinder block:

(a) Using a knife, cut off the oil seal lip.

(b) Using a screwdriver, pry off the oil seal.

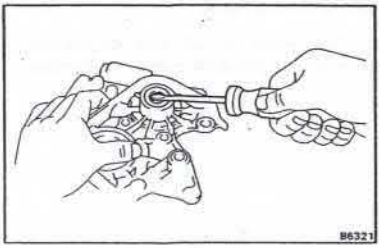
CAUTION: Tap the screwdriver tip and be careful not to damage the crankshaft.

(c) Apply MP grease to a new oil seal.



(d) Using SST and hammer, drive in a new oil seal until its surface is flush with the oil pump body edge.

SST 09214-60010

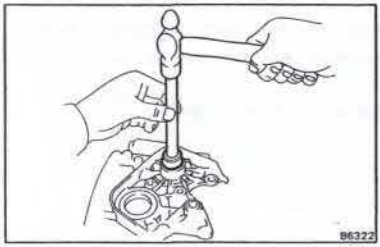


2. REPLACEMENT OF OIL PUMP SEAL

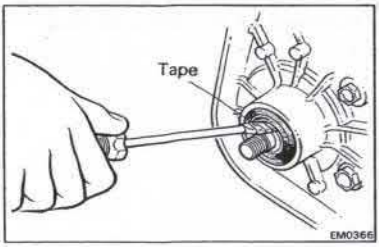
If the oil pump was removed from the cylinder block:

(a) Using a screwdriver, pry off the oil seal.

(b) Apply MP grease to a new oil seal.



(c) Using a socket wrench and hammer, drive in a new oil seal to the depth of 1 mm (0.04 in.) from the oil pump body edge.

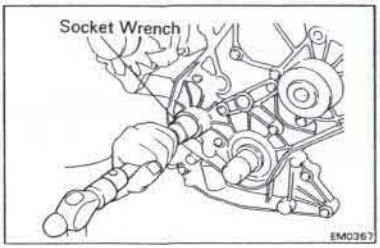


If the oil pump was not removed from the cylinder block:

(a) Using a knife, cut off the oil seal lip.

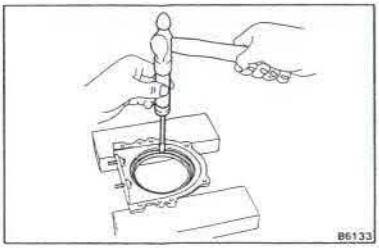
(b) Using a screwdriver, pry off the oil seal.

CAUTION: Tap the screwdriver tip and be careful not to damage the drive shaft.



(c) Apply MP grease to a new oil seal.

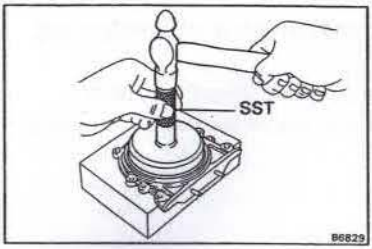
(d) Using a socket wrench and hammer, drive in a new oil seal to the depth of 1 mm (0.04 in.) from the oil pump body edge.



3. REPLACEMENT OF CRANKSHAFT REAR OIL SEAL

If the rear oil seal retainer was removed from the cylinder block:

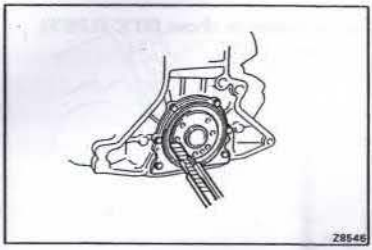
(a) Using a screwdriver and hammer, drive out the oil seal.



(b) Apply MP grease to a new oil seal.

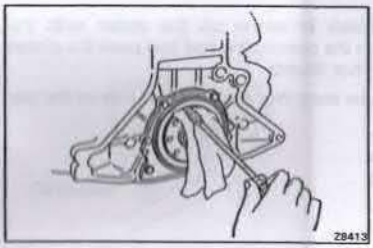
(c) Using SST and a hammer, drive in a new oil seal until its surface is flush with the rear oil seal retainer edge.

SST 09223-56010



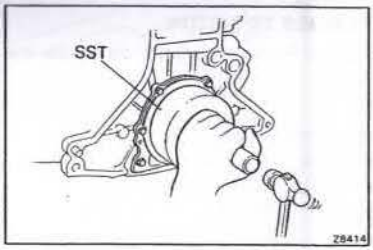
If the rear oil seal retainer was not removed from the cylinder block:

(a) Using a knife, cut off the oil seal lip.



(b) Using a screwdriver, pry out the oil seal.

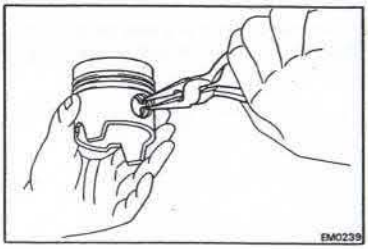
CAUTION: Tape the screwdriver tip and be careful not to damage the crankshaft.



(c) Apply MP grease to a new oil seal.

(d) Using SST and a hammer, drive in the oil seal until its surface is flush with the rear oil seal retainer edge.

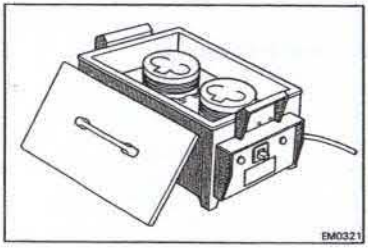
SST 09223-56010



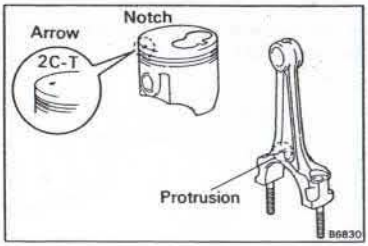
ASSEMBLY OF PISTON AND CONNECTING ROD

1. ASSEMBLE PISTON AND CONNECTING ROD

(a) Install a new snap ring on one side of the piston pin hole.

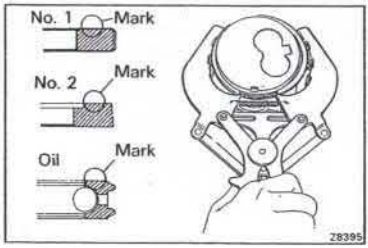


(b) Gradually heat the piston to about 80°C (176°F).



(c) Align the notch or arrow on the piston with the protrusion on the connecting rod and push the piston pin in with your thumb.

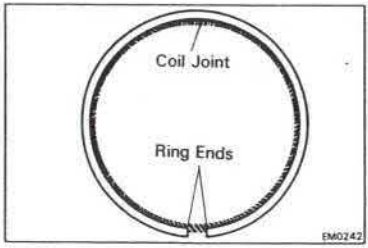
(d) Install the new snap ring on the other side of the pin.

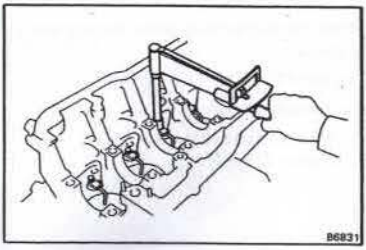


2. INSTALL PISTON RINGS TO PISTON

Using a ring expander, install the piston rings with the code marks facing up.

CAUTION: Face the end gap of the oil ring in opposite direction of the coil joint.





ASSEMBLY OF CYLINDER BLOCK

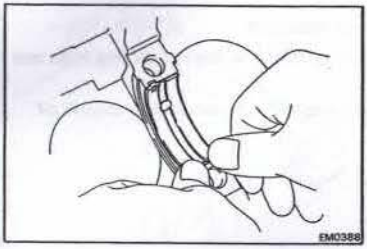
(See page EM-70)

NOTE:

- Thoroughly clean all parts to be assembled.
- Before installing the parts, apply new engine oil to all sliding and rotating surfaces.
- Replace all gaskets O-rings and oil seals with new parts.

1. INSTALL OIL NOZZLES

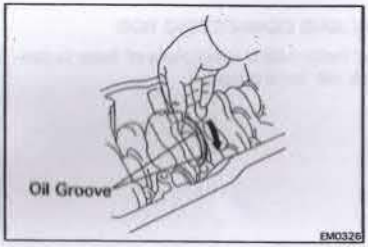
Torque: 55 kg-cm (48 in.-lb, 5.4 N·m)



2. INSTALL MAIN BEARINGS

Install the bearing in the cylinder block and bearing caps.

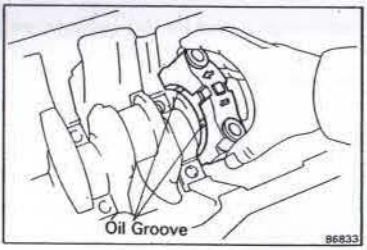
CAUTION: Install the bearing with the oil hole in the block.



3. INSTALL CRANKSHAFT AND UPPER THRUST WASHERS

(a) Place the crankshaft on the upper main bearings.

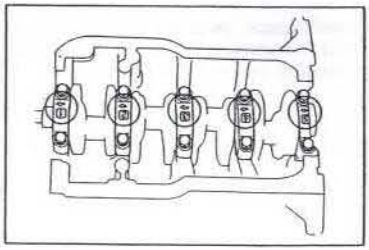
(b) Insert the upper thrust washers on the No. 3 journal with the oil grooves facing outward.



4. INSTALL MAIN BEARINGS CAPS AND LOWER THRUST WASHERS

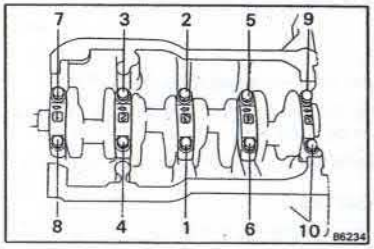
NOTE: Each bearing cap is numbered.

(a) Place the thrust washers on the No. 3 bearing cap with the oil grooves facing outward.



(b) Install the bearing caps in numbered order with arrows facing forward.

(c) Apply a light coating of engine oil on the threads and heads under of the cap bolts.

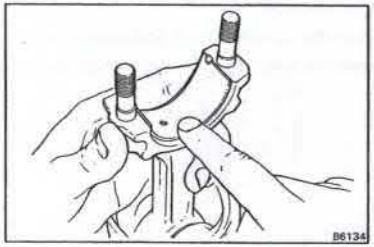


(d) Install and tighten the cap bolts in three passes and in the sequence shown.

Torque: 1,050 kg-cm (76 ft-lb, 103 N·m)

(e) Check that the crankshaft turns.

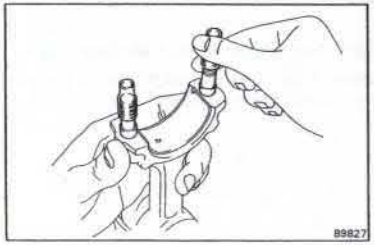
(f) Check the crankshaft thrust clearance.
(See step 19 on page EM-74)



5. INSTALL BEARING INSERTS

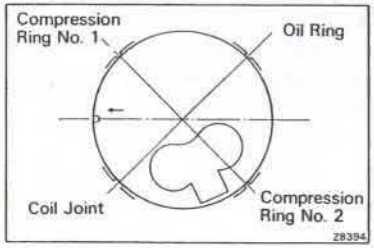
(a) Install the bearing inserts in the connecting rods and rod caps.

(b) Lubricate the face of the bearings with engine oil.



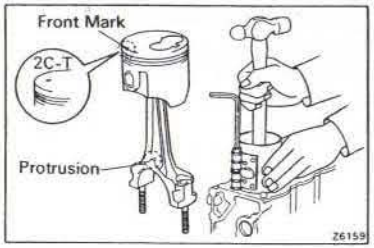
6. INSTALL PISTON AND CONNECTING ROD

(a) Cover the rod bolts with a short piece of hose to protect the crank pin from damage.

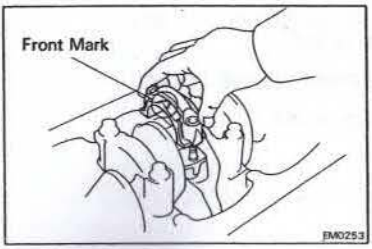


(b) Position the piston rings so that the ring end gaps are as shown.

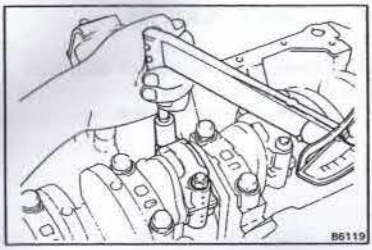
CAUTION: Do not align the end gaps.



(c) Using a ring compressor, push the correctly numbered piston and connecting rod into each cylinder with the front mark of the piston facing forward.



7. **INSTALL CONNECTING ROD CAPS**
   (a) Check the numbered rod cap with the numbered rod.
   (b) Install the rod caps with the front mark facing forward.



   (c) Apply a light coat of the engine oil on the threads and under of the rod nuts.
   (d) Install and tighten the rod nuts alternately and in two or three passes.

   Torque: 650 kg-cm (47 ft-lb, 64 N·m)

   (e) Check that the crankshaft turns smoothly.
   (f) Check the rod thrust clearance.
   (See step 16 on page EM-72)

8. **INSTALL OIL COOLER AND PIPES**

   Torque: Oil cooler 575 kg-cm (42 ft-lb, 56 N·m)
   Oil pipe 525 kg-cm (34 ft-lb, 51 N·m)

9. **INSTALL TURBOCHARGER OIL PIPES**

   Torque: Inlet pipe 250 kg-cm (18 ft-lb, 25 N·m)
   Outlet pipe 475 kg-cm (34 ft-lb, 47 N·m)

10. **INSTALL OIL FILTER BRACKET AND NEW FILTER**

11. **INSTALL REAR OIL SEAL RETAINER AND DUST SEAL**

    Apply seal packing to the crankshaft oil seal retainer.

    Seal packing: Part No. 08826-00080 or equivalent.

12. **INSTALL OIL PUMP** **(See step 1 on page LU-9)**

13. **INSTALL OIL STRAINER AND OIL PAN**
    (See steps 2 to 4 on page LU-10)

14. **INSTALL ALTERNATOR WITH OIL HOSES**

15. **INSTALL WATER PUMP** **(See step 1 on page CO-6)**

16. **INSTALL INJECTION PUMP**
    (See step 3 on page FU-52)

17. **INSTALL CYLINDER HEAD**
    (See pages EM-66 to 69)

18. INSTALL EACH TIMING PULLEY AND BELT
(See pages EM-32 to 37)

19. REMOVE ENGINE FROM ENGINE STAND

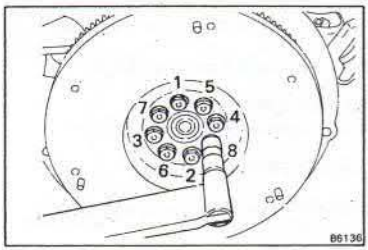
20. INSTALL REAR END PLATE

21. INSTALL FLYWHEEL OR DRIVE PLATE ON CRANKSHAFT

(a) Clean the set bolt threads and crankshaft bolt holes of any sealer, oil or foreign particles.
Remove any oil with kerosene or gasoline.

(b) Apply anaerobic adhesive and sealant* [THREE BOND 1324 (Part No. 08833-00070) or equivalent] to 2 or 3 threads of the bolt end.

* This adhesive will not harden while exposed to air. It will act as a sealer or binding agent only when applied to threads, etc. and air is cut off.



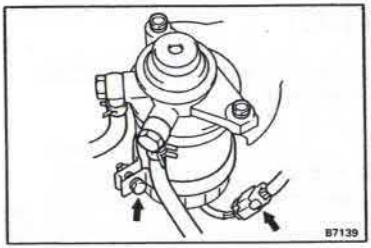
(c) Install the flywheel or drive plate on the crankshaft. Tighten the bolts to the specified torque in two or three passes in the sequence shown.

Torque: Flywheel 900 kg-cm (65 ft-lb, 88 N·m)
Drive plate 750 kg-cm (54 ft-lb, 74 N·m)

22. INSTALL CLUTCH DISC AND COVER (M/T only)

FUEL SYSTEM

NOTE: For troubleshooting procedures, refer to DIESEL ENGINE DIAGNOSIS (EM Section).



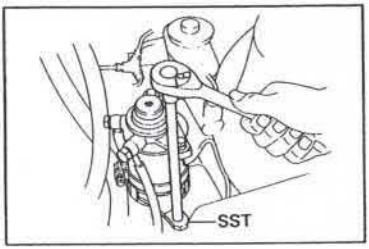
REPLACEMENT OF FUEL FILTER

1. **DISCONNECT FUEL FILTER WARNING SWITCH CONNECTOR**

2. **LOOSEN FUEL FILTER CLAMP BOLT**

3. **DRAIN FUEL FROM FUEL FILTER**

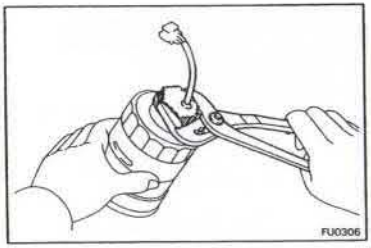
   NOTE: Put a suitable container or shop towel under the fuel filter.



4. **REMOVE FUEL FILTER**

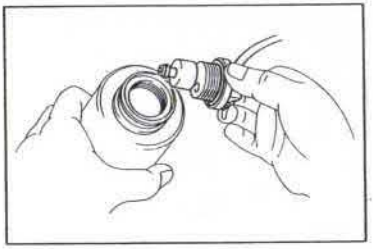
   (a) Using SST, remove the fuel filter with the gasket.

   SST 09228-64010



   (b) Using pliers, remove the fuel filter warning switch with the O-ring.

   CAUTION: Be careful not to damage the warning switch.

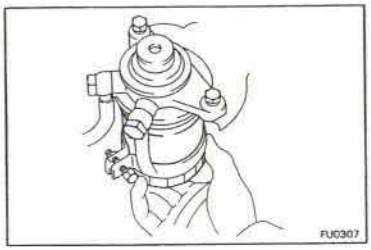


5. **INSTALL NEW FUEL FILTER**

   (a) Install a new O-ring to the fuel filter warning switch.

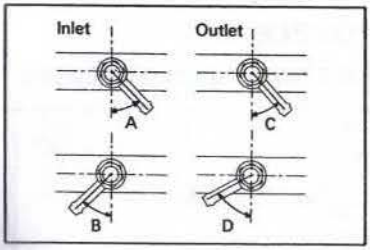
   (b) Apply fuel to the O-ring of the fuel filter warning switch.

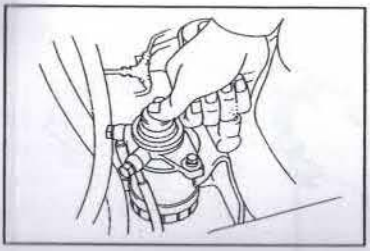
   (c) Install the fuel filter warning switch to the fuel filter by hand.



   (d) Apply fuel to the gasket of the new fuel filter.

   (e) Install the fuel filter to the fuel filter bracket by hand.





NOTE: If the fuel unions were removed, re-install them as shown in the illustration and following table.

Item	Inlet		Outlet	
	A	B	C	D
CE70	50°	—	15°	—
CE80 (RHD)	75°	—	0°	
CE80 (LHD), CT, CV	—	15°	10°	—
CA (LHD)	—	60°	—	45°
CA (RHD)	45°	—	30°	—
CM, CR	30°	—	—	40°

6. **TIGHTEN FUEL FILTER CLAMP BOLT**

7. **CONNECT FUEL FILTER WARNING SWITCH CONNECTOR**

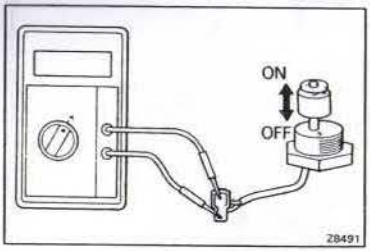
8. **CHECK FOR FUEL LEAKS**

   Using a priming pump, fill with fuel and check for leaks.

FUEL FILTER WARNING SWITCH

INSPECTION OF FUEL FILTER WARNING SWITCH

1. **REMOVE FUEL FILTER WARNING SWITCH**
   (See page FU-2)



2. **INSPECT WARNING SWITCH**

   (a) Check that there is continuity between terminals when the warning switch is ON (float up).

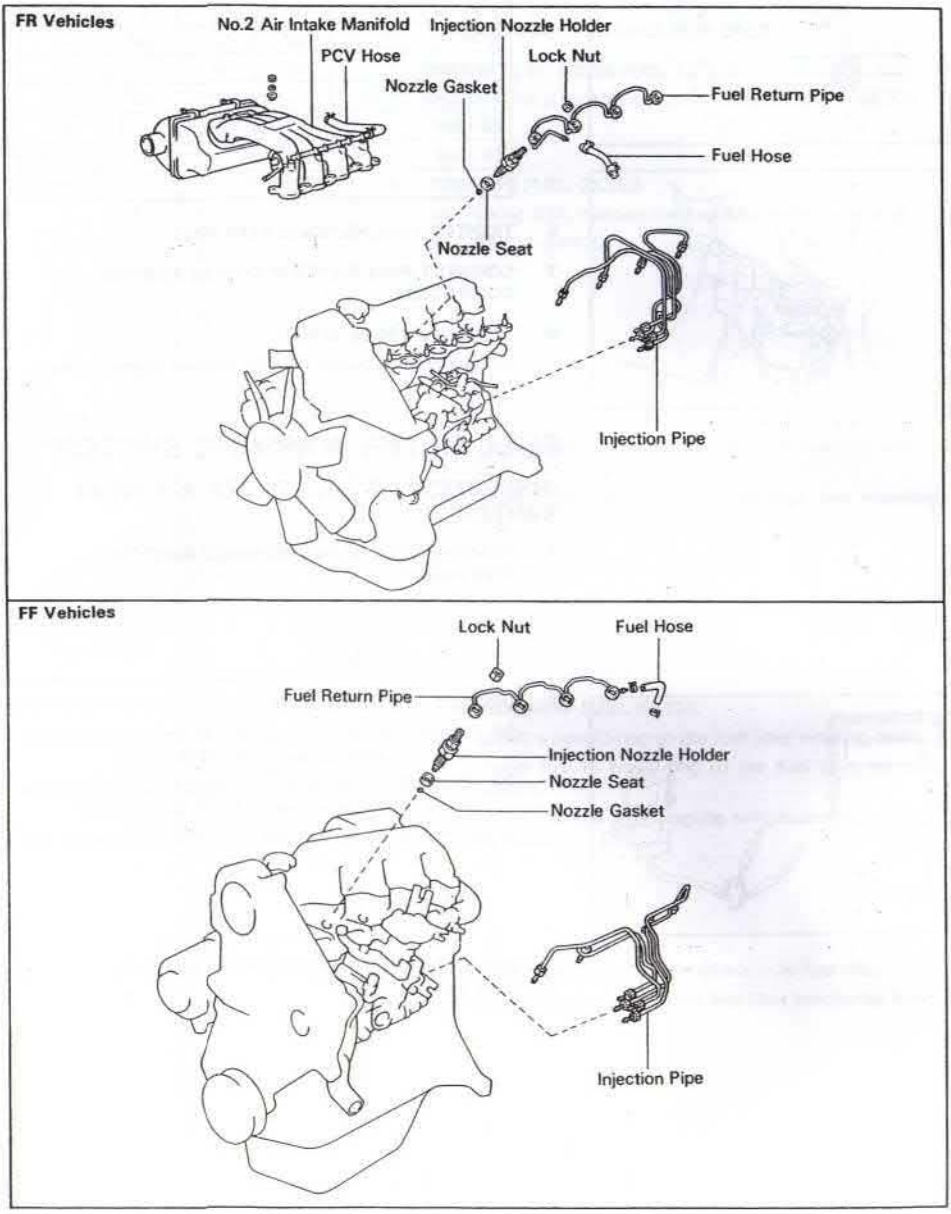
   (b) Check that there is no continuity between terminals when the warning switch is OFF (float down).

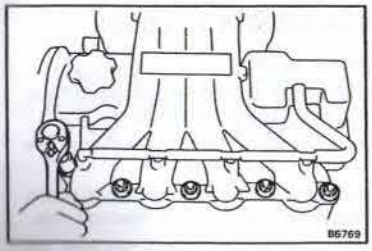
   If operation is not as specified, replace the warning switch.

3. **INSTALL FUEL FILTER WARNING SWITCH**
   (See page FU-2)

INJECTION NOZZLE

REMOVAL OF INJECTION NOZZLE HOLDERS



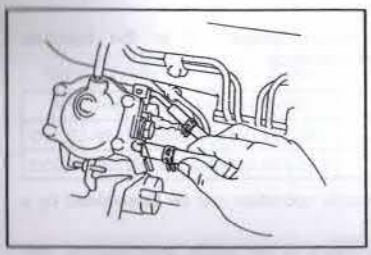


1. **REMOVE NO. 2 AIR INTAKE MANIFOLD WITH AIR CLEANER CASE (CE70)**

(a) Disconnect PCV hose from the cylinder head cover.

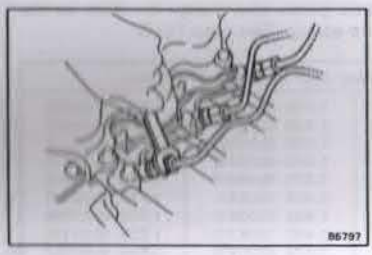
NOTE: Do not remove the ventilation tube and connector unless necessary.

(b) Remove the two bolts, five nuts and seals and lift off the No. 2 air intake manifold with the air cleaner case.



2. **DISCONNECT FUEL HOSES FROM INJECTION PUMP (CV, CT150 w/HAC)**

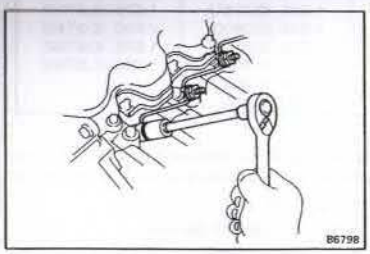
Loosen the clips and disconnect the fuel hoses between the injection pump and fuel pipes from the injection pump side.



3. **REMOVE INJECTION PIPES**

(a) Remove the injection pipe clamps.

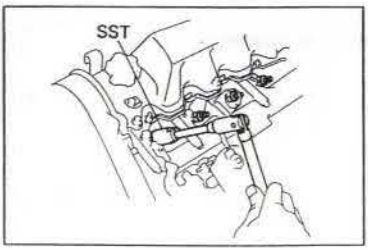
(b) Disconnect both ends of the injection pipes from the injection pump and injection holders.



4. **REMOVE FUEL RETURN PIPE**

(a) Disconnect the fuel hose from the return pipe.

(b) Remove the four lock nuts and return pipe with the four gaskets.



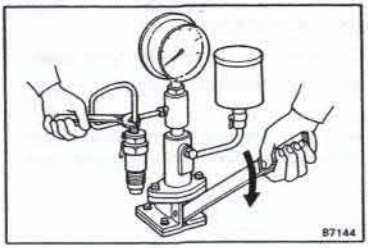
5. **REMOVE INJECTION NOZZLE HOLDERS**

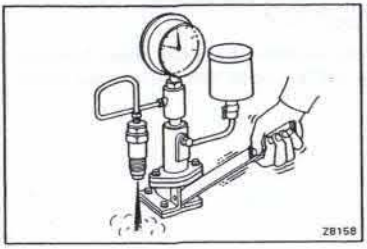
(a) Using SST, remove the four injection nozzle holders.

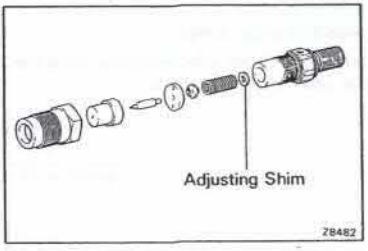
SST 09268-64010

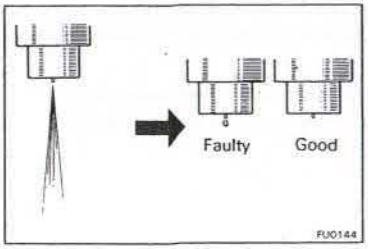
(b) Arrange the injection nozzle holders in order.

(c) Remove the nozzle seats and nozzle gaskets.









TEST OF INJECTION NOZZLE HOLDERS

1. INJECTION PRESSURE TEST

(a) Install the nozzle holder to the injection nozzle hand tester and bleed air from the union nut.

WARNING: Do not place your finger over the nozzle injection hole.

(b) Pump the tester handle a few times as fast as possible to discharge the carbon from the injection hole.

(c) Pump the tester handle slowly and observe the pressure gauge.

(d) Read the pressure gauge just as the injection pressure begins to drop.

	Opening pressure kg/cm² (psi, kPa)
Reused nozzle	135-155 (1,920-2,205, 13,239-15,200)
New nozzle	145-155 (2,062-2,205, 14,220-15,200)

NOTE: Proper nozzle operation can be determined by a swishing sound.

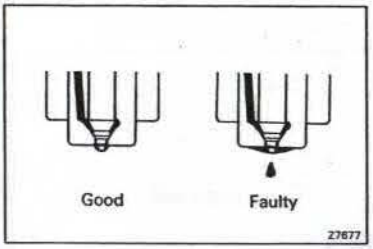
If the opening pressure is not within specification, disassemble the nozzle holder and change the shim on the top of the pressure spring. (See page FU-8)

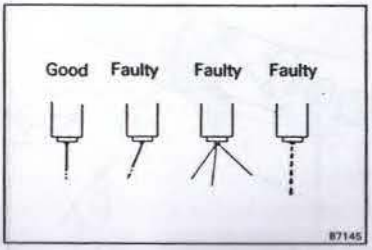
Adjusting shim thickness mm (in.)		
0.900 (0.0354)	1.275 (0.0502)	1.650 (0.0650)
0.925 (0.0364)	1.300 (0.0512)	1.675 (0.0659)
0.950 (0.0374)	1.325 (0.0522)	1.700 (0.0669)
0.975 (0.0384)	1.350 (0.0531)	1.725 (0.0679)
1.000 (0.0394)	1.375 (0.0541)	1.750 (0.0689)
1.025 (0.0404)	1.400 (0.0551)	1.775 (0.0699)
1.050 (0.0413)	1.425 (0.0561)	1.800 (0.0709)
1.075 (0.0423)	1.450 (0.0571)	1.825 (0.0719)
1.100 (0.0433)	1.475 (0.0581)	1.850 (0.0728)
1.125 (0.0443)	1.500 (0.0591)	1.875 (0.0738)
1.150 (0.0453)	1.525 (0.0600)	1.900 (0.0748)
1.175 (0.0463)	1.550 (0.0610)	1.925 (0.0758)
1.200 (0.0472)	1.575 (0.0620)	1.950 (0.0768)
1.225 (0.0482)	1.600 (0.0630)	
1.250 (0.0492)	1.625 (0.0640)	

NOTE:

- Varying the adjusting shim thickness by 0.025 mm (0.0010 in.) changes the injection pressure by about 3.5 kg/cm² (50 psi, 343 kPa).
- Only one adjusting shim should be used.
- If adjusting the opening pressure, use the specification for a new nozzle.

(e) There should be no dripping after injection.





2. LEAKAGE TEST

While maintaining pressure at about 10 – 20 kg/cm² (142 – 284 psi, 981 – 1,961 kPa) below opening pressure (adjust by tester handle), check that there is no dripping for 10 seconds from the injection hole or around the retaining nut.

If the nozzle drips within 10 seconds, replace or clean and overhaul the nozzle assembly.

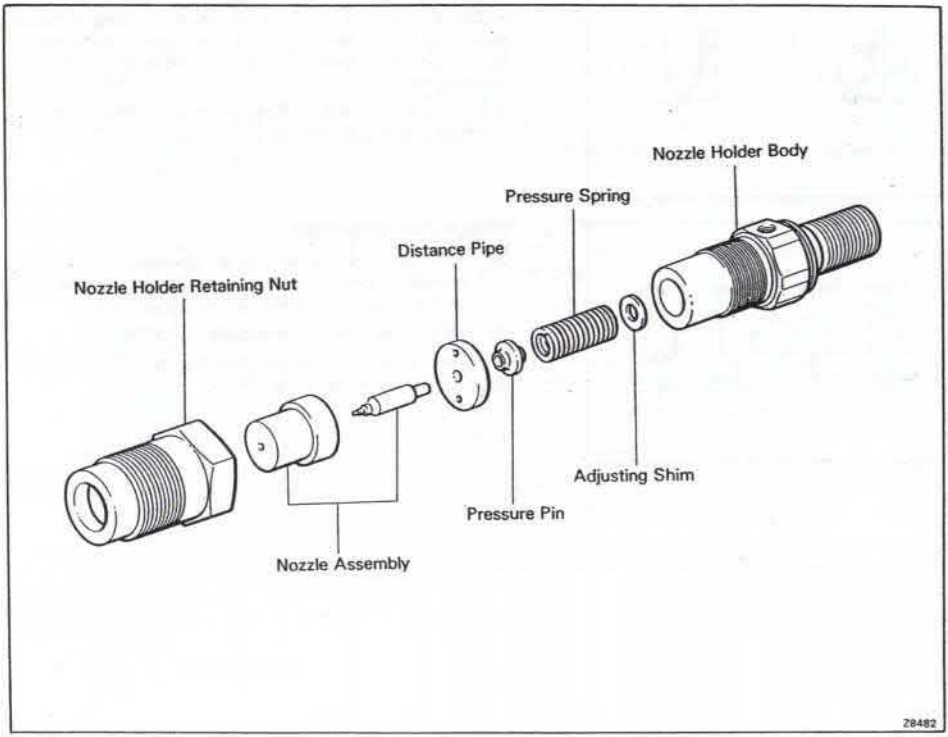
3. SPRAY PATTERN TEST

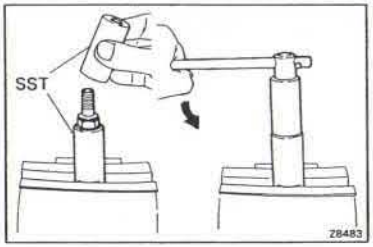
(a) The injection nozzle should shudder at a certain pumping speed between 15 – 60 times (old nozzle) or 30 – 60 times (new nozzle) per minute.

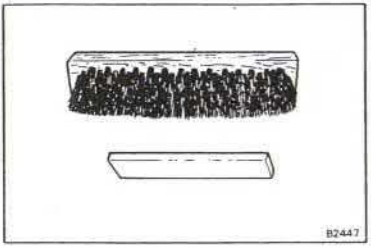
(b) Check the spray pattern during shuddering.

If the spray pattern is not correct during shuddering, the nozzle must be replaced or cleaned.

COMPONENTS







DISASSEMBLY, CLEANING AND TEST OF INJECTION NOZZLE HOLDER

1. **DISASSEMBLE INJECTION NOZZLE HOLDER**

   (a) Using SST, unscrew the nozzle holder retaining nut.

   SST 09268-64010

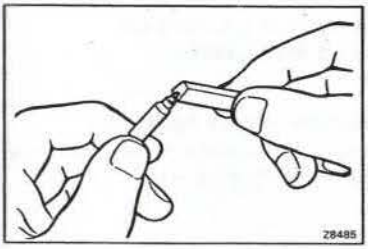
   CAUTION: When disassembling the nozzle holder, be careful not to drop the inner parts.

   (b) Remove the pressure spring, shim, pressure pin, distance piece and nozzle assembly.

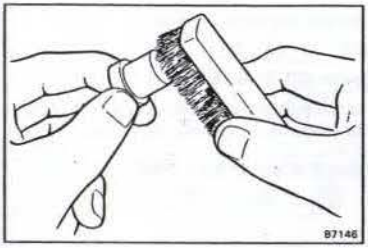
2. **NOZZLE CLEANING**

   (a) Use a wooden stick and brass brush to wash the nozzles.
   Wash in clean diesel fuel.

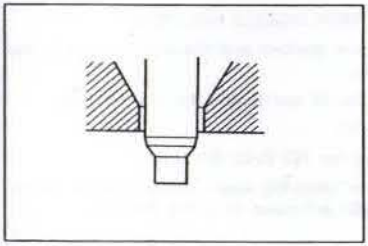
   NOTE: Do not touch the nozzle mating surfaces with your fingers.



(b) Use a wooden stick to remove any carbon adhering to the nozzle needle tip.



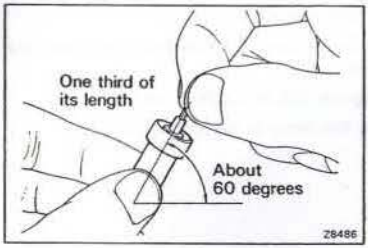
(c) Remove the carbon from the exterior of the nozzle body (except wrapping angle) with a brass brush.



(d) Inspect the seat of the nozzle body for burns or corrosion.

(e) Inspect the nozzle needle tip for damage or corrosion.

If any of these conditions are present, replace the nozzle assembly.

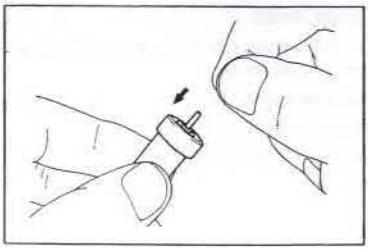


3. **SINKING TEST**

(a) Wash the nozzle in clean diesel fuel.

NOTE: Do not touch the nozzle mating surfaces with your fingers.

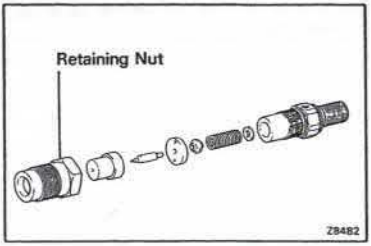
(b) Tilt the nozzle body about 60 degrees and pull the needle out about one third of its length.



(c) When released, the needle should sink down into the body vent smoothly by its own weight.

(d) Repeat this test, rotating the needle slightly each time.

If the needle does not sink freely, replace the nozzle assembly.

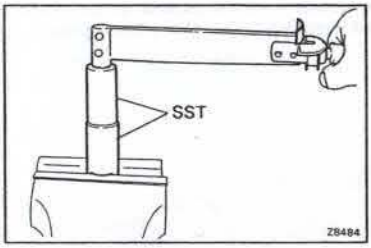


ASSEMBLY AND INSTALLATION OF INJECTION NOZZLE HOLDERS

(See page FU-8)

1. ASSEMBLY INJECTION NOZZLE HOLDERS

(a) As shown in the figure, assemble the injection nozzle and finger tighten the retaining nut.



(b) Using SST, torque the retaining nut.

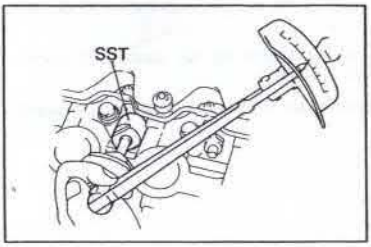
SST 09268-64010

Torque: 375 kg-cm (27 ft-lb, 37 N·m)

CAUTION: Over torquing could cause nozzle deformation and needle adhesion or other defects.

2. PERFORM PRESSURE AND SPRAY PATTERN TEST

(See page FU-6)



3. INSTALL INJECTION NOZZLE HOLDERS

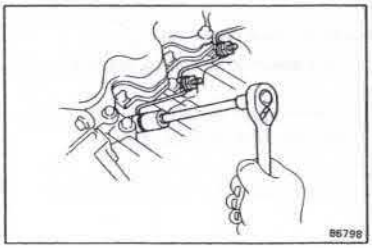
(a) Place four new gaskets and the nozzle seats in the cylinder head.

(b) Using SST, install and torque the four nozzles.

SST 09268-64010

Torque: 650 kg-cm (47 ft-lb, 64 N·m)

CAUTION: Over torquing could cause nozzle deformation and needle adhesion or other defects.

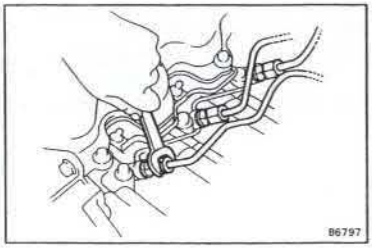


4. INSTALL FUEL RETURN PIPE

(a) Install four new gaskets and the return pipe with the four lock nuts.

Torque: 300 kg-cm (22 ft-lb, 29 N·m)

(b) Connect the fuel hose to the return pipe.



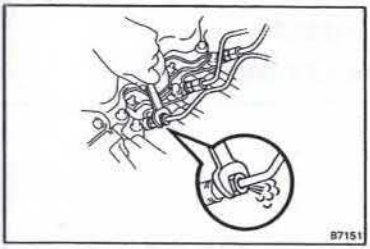
5. INSTALL INJECTION PIPES

(a) Connect both ends of the injection pipes to the injection pump and nozzle holder.

(b) Install the injection pipe clamps.

(c) Torque the injection pipe union nuts.

Torque: 300 kg-cm (22 ft-lb, 29 N·m)

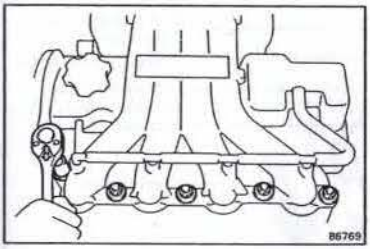


6. **CONNECT FUEL HOSES TO INJECTION PUMP (CV, CT w/HAC)**

7. **BLEED INJECTION NOZZLES**

   (a) Loosen all union nuts of the injection pipe on the nozzle holder side.

   (b) Crank the engine to bleed the air and force out the fuel from the injection pipe.



8. **INSTALL NO. 2 AIR INTAKE MANIFOLD (CE70)**

   (a) Install the No. 2 air intake manifold with the five seals, five bolts and two nuts.

   Torque: Bolt 130 kg-cm (9 ft-lb, 13 N·m)
   Nut 185 kg-cm (13 ft-lb, 18 N·m)

   (b) Connect the PCV hose to the cylinder head cover.

   NOTE: If the ventilation tube and connector are disconnected, clean off the oil on the ventilation tube, connector and manifold holes before reconnecting them.

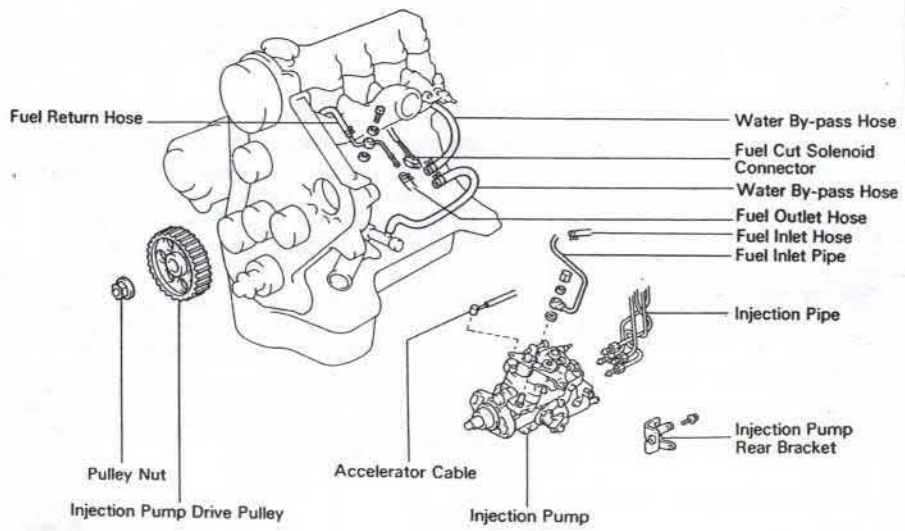
9. **START ENGINE AND CHECK FOR FUEL LEAKS**

10. **CHECK ENGINE IDLE SPEED AND MAXIMUM SPEED (See page EM-23)**

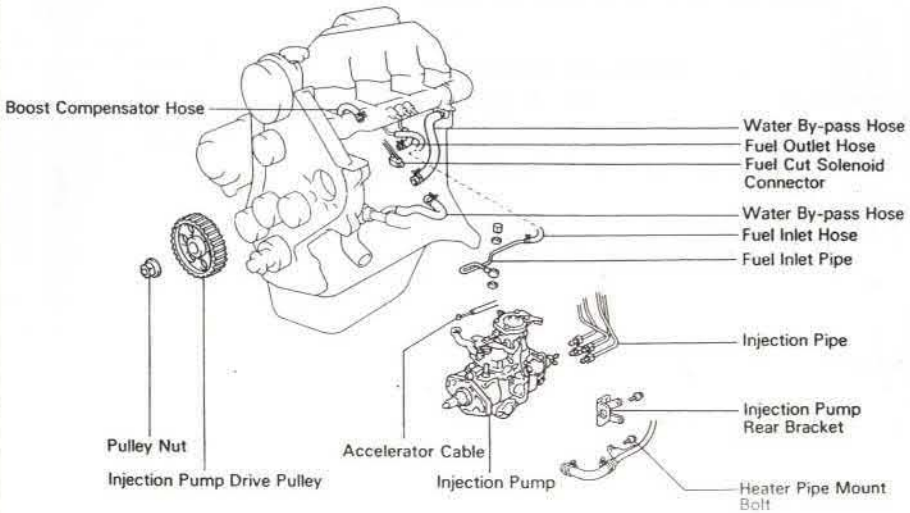
INJECTION PUMP

REMOVAL OF INJECTION PUMP

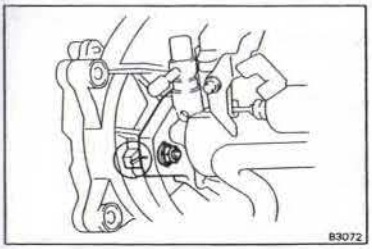
FR Vehicles



FF Vehicles



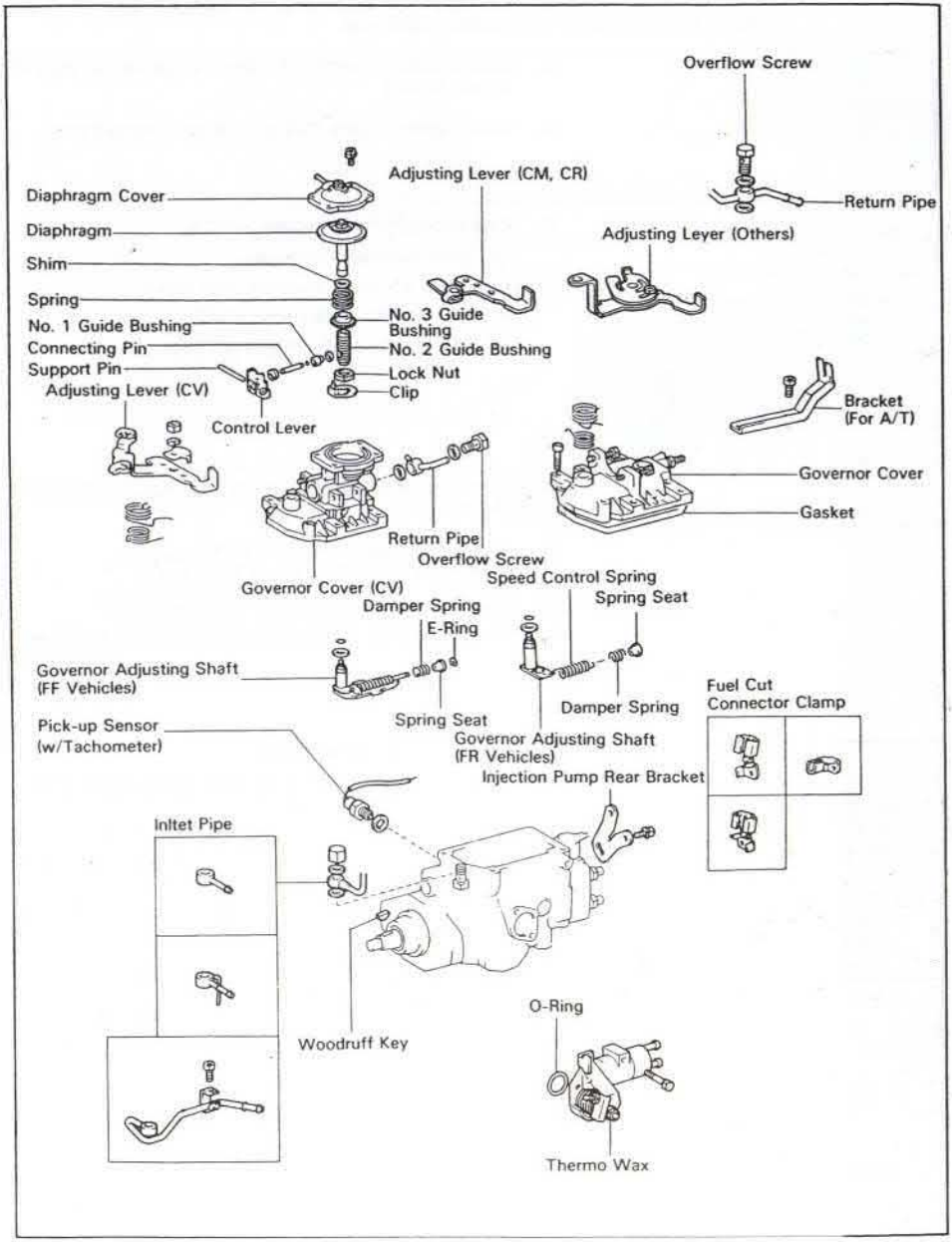
1. **DRAIN COOLANT**
2. **DISCONNECT ACCELERATOR CABLE FROM INJECTION PUMP**
3. **DISCONNECT THROTTLE CABLE FROM INJECTION PUMP (w/AT)**
4. **DISCONNECT FUEL CUT SOLENOID CONNECTOR**
5. **DISCONNECT FOLLOWING HOSES:**
   (a) Fuel inlet and outlet hoses.
   (b) No. 1 and No. 2 water by-pass hoses.
   (c) Boost compensator hose (CV).
   (d) A/C or heater idle up vacuum hose.
6. **REMOVE HEATER PIPE MOUNTING BOLT AND NUT (FF Vehicles)**
7. **REMOVE FOUR INJECTION PIPES**
   (See steps 1 and 3 on pages FU-4 and 5)
8. **REMOVE INJECTION PUMP DRIVE PULLEY**
   (See steps 1 to 12 and 15 on pages EM-26 to 29)



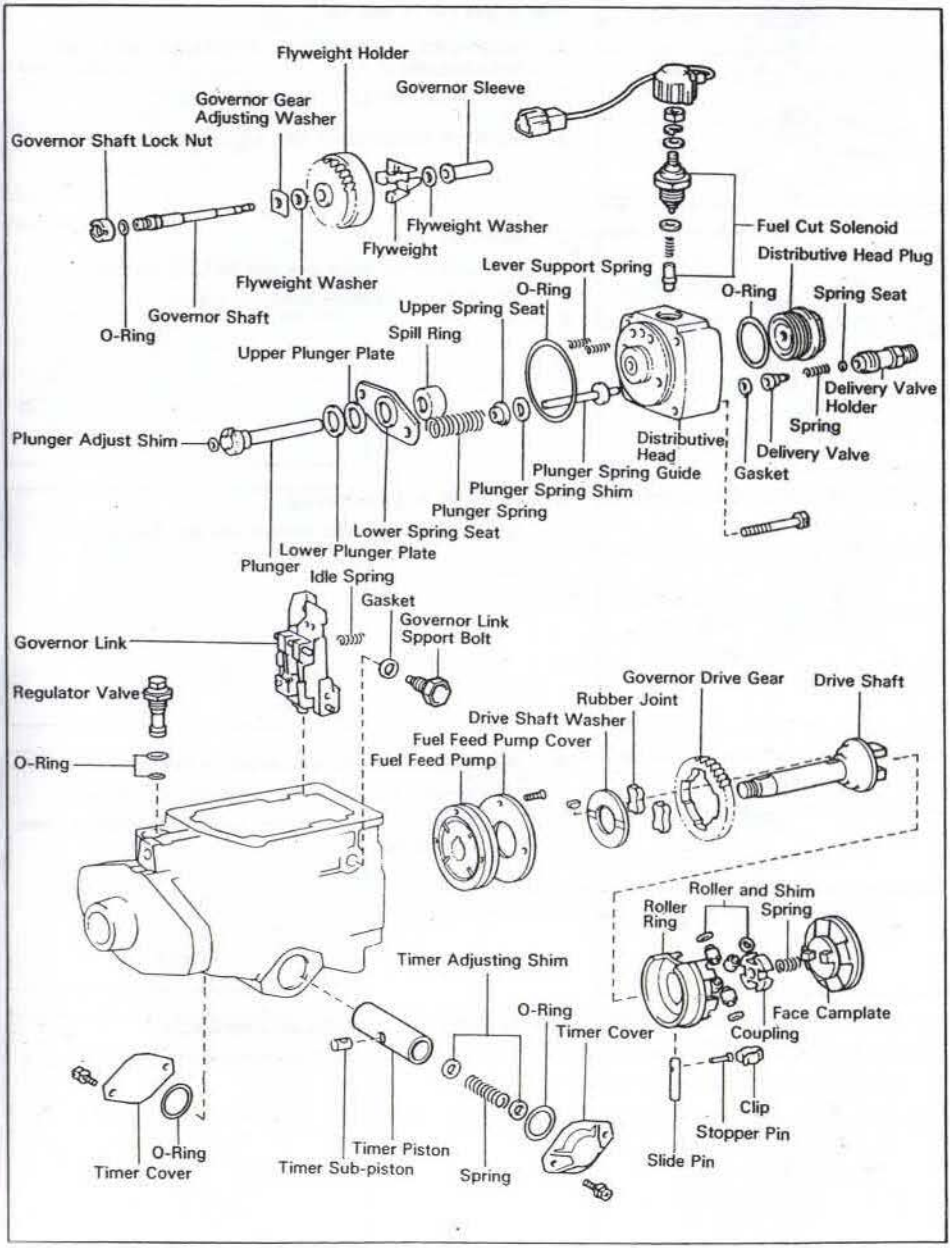
9. **REMOVE INJECTION PUMP**
   (a) Before removing the injection pump, check if the matchmarks are aligned.
   If not, place new matchmarks for reinstallation.
   (b) Remove the injection pump mount bolt and two nuts, and then remove the injection pump.

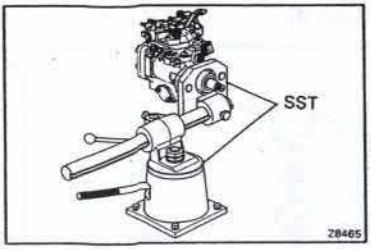
   CAUTION: Do not hold or carry the pump by the adjusting lever.
10. **REMOVE INJECTION PUMP REAR BRACKET**
11. **REMOVE FUEL INLET PIPE FROM INJECTION PUMP**

COMPONENTS


Overflow Screw
Return Pipe
Adjusting Lever (CM, CR)
Adjusting Lever (Others)
Diaphragm Cover
Diaphragm
Shim
Spring
No. 1 Guide Bushing
Connecting Pin
Support Pin
Adjusting Lever (CV)
No. 3 Guide Bushing
No. 2 Guide Bushing
Lock Nut
Clip
Control Lever
Bracket (For A/T)
Governor Cover
Gasket
Return Pipe
Overflow Screw
Governor Cover (CV)
Speed Control Spring
Spring Seat
Damper Spring
E-Ring
Governor Adjusting Shaft (FF Vehicles)
Spring Seat
Damper Spring
Governor Adjusting Shaft (FR Vehicles)
Fuel Cut Connector Clamp
Pick-up Sensor (w/Tachometer)
Injection Pump Rear Bracket
Inltet Pipe
Woodruff Key
O-Ring
Thermo Wax

COMPONENTS (Cont'd)





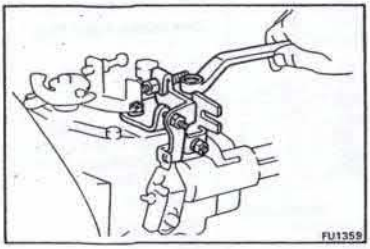
DISASSEMBLY OF INJECTION PUMP

(See pages FU-14 and 15)

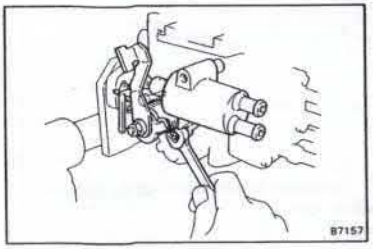
1. **MOUNT INJECTION PUMP TO STAND (SST) FOR DISASSEMBLY**

   SST 09241-76022 and 09245-54010

2. **REMOVE WOODRUFF KEY FROM DRIVE SHAFT**

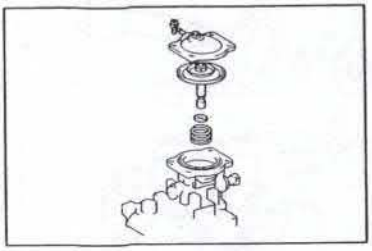


3. **REMOVE IDLE-UP**
   (a) Loosen the collar lock bolt and pull out the collar.
   (b) Remove the three bolts and idle-up.

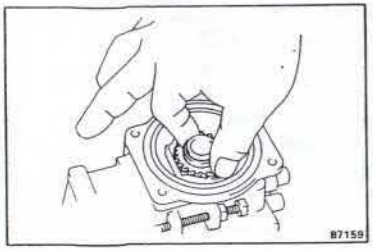


4. **REMOVE THERMO WAX**

   Remove the two bolts, thermo wax and O-ring.

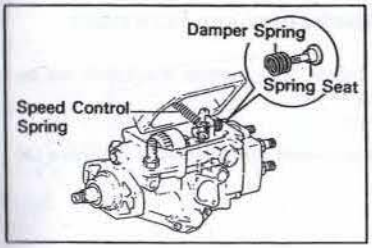


5. **REMOVE BOOST COMPENSATOR DIAPHRAGM (CV)**
   (a) Remove the four bolts and diaphragm cover.
   (b) Remove the diaphragm, boost compensator shim and spring.



6. **REMOVE NO. 3 GUIDE BUSHING (CV)**

   Turn the guide bushing counterclockwise to remove it.

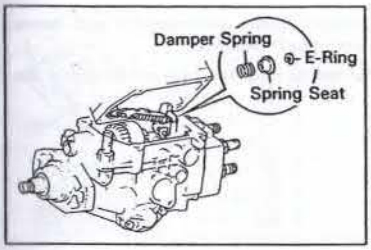


7. REMOVE GOVERNOR COVER
(FR with M/T and CV with M/T Vehicles)

(a) Using an allen wrench remove the four bolts.

(b) Disconnect the speed control spring from the spring seat and then remove the spring seat and damper spring.

(c) Remove the governor cover with the gasket.

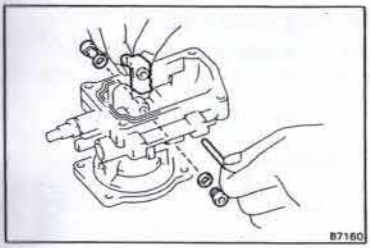


(FF with M/T except CV and A/T Vehicles)

(a) Using an allen wrench, remove the four bolts.

(b) Remove the E-ring, spring seat and damper spring.

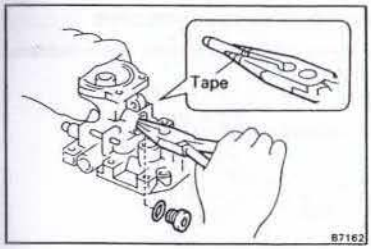
(c) Remove the governor cover with the gasket.



8. REMOVE CONTROL LEVER FROM GOVERNOR COVER (CV)

(a) Using an allen wrench, remove the two bolts and the gaskets.

(b) Remove the support pin and control lever.

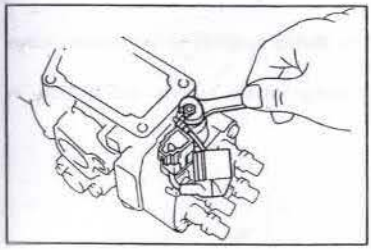


9. REMOVE CONNECTING PIN FROM GOVERNOR COVER (CV)

(a) Using an allen wrench, remove the screw plug with the gasket.

(b) Using pliers, pull out the connecting pin.

CAUTION: Tape the tip of the pliers, and be careful not damage the connecting pin.

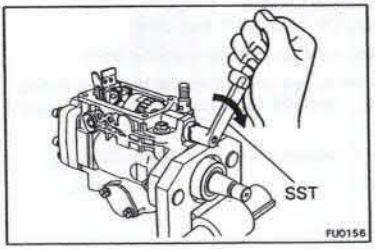


10. REMOVE FUEL CUT SOLENOID

(a) Disconnect the lead wire from the fuel cut solenoid.

(b) Remove the fuel cut solenoid, spring and valve.

11. REMOVE PICK UP SENSOR (w/Tachometer Vehicles)

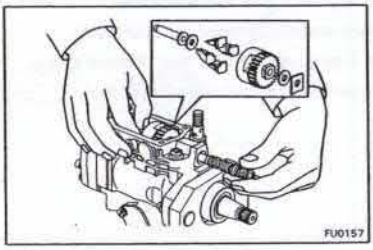


12. REMOVE GOVERNOR SHAFT AND FLYWEIGHT HOLDER

(a) Using SST, loosen the governor shaft lock nut by turning it clockwise.

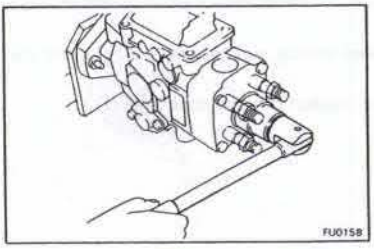
SST 09260-54012

CAUTION: The governor shaft and lock nut have LH threads.



(b) Hold the flyweight holder subassembly and screw out the governor shaft clockwise.

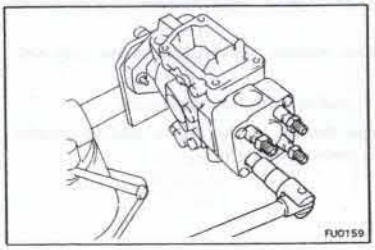
NOTE: Be careful not to drop the two washers into the pump housing.



13. REMOVE DISTRIBUTIVE HEAD PLUG

Using SST, remove the distributive head plug.

SST 09260-54012

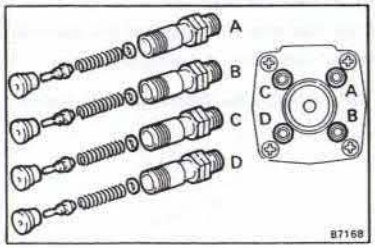


14. REMOVE FOUR DELIVERY VALVE HOLDERS

(a) Using SST, remove the four delivery valve holders, springs and spring seats.

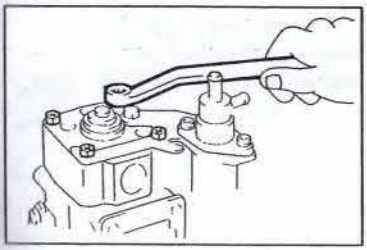
SST 09260-54012

(b) Remove four delivery valves and gaskets.



NOTE:

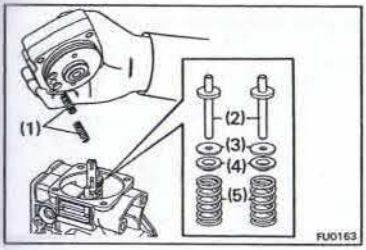
- Do not touch the sliding surfaces of the delivery valve with your hand.
- Arrange the delivery valves, springs and holders in order.



15. REMOVE DISTRIBUTIVE HEAD BOLTS

(a) Remove the four head bolts and connector clamp.

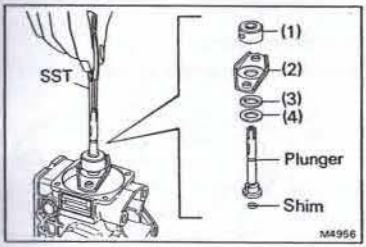
(b) Remove the idle-up bracket with a bolt. (ex. CM)



16. REMOVE DISTRIBUTIVE HEAD

Remove the distributive head and following parts:

(1) Lever support springs
(2) Plunger spring guides
(3) Plunger spring shims
(4) Upper spring seats
(5) Plunger springs



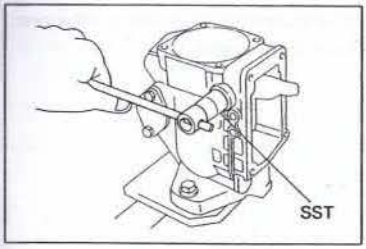
17. REMOVE PUMP PLUNGER

Using SST, remove the pump plunger and plunger adjusting shim with the following parts:

(1) Spill ring
(2) Lower spring seat
(3) Upper plunger plate
(4) Lower plunger plate

SST 09260-54012

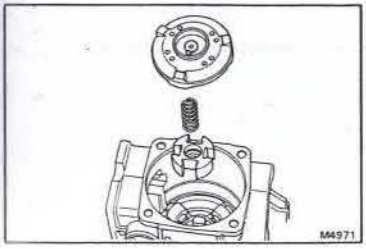
NOTE: Do not touch the sliding surfaces of the pump plunger with your hand.



18. REMOVE GOVERNOR LINK

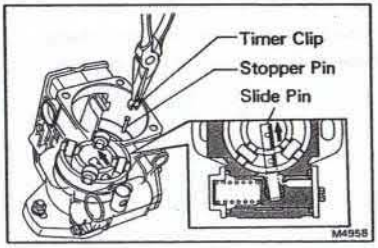
Using SST, remove the two support bolts and governor link.

SST 09260-54012



19. REMOVE FACE CAMPLATE AND COUPLING

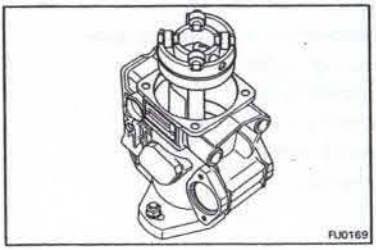
Remove the face camplate, spring and coupling.



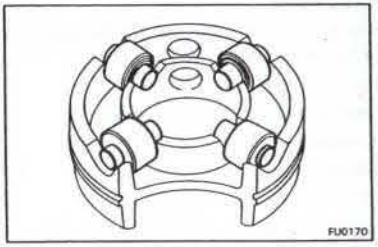
20. REMOVE ROLLER RING AND DRIVE SHAFT

(a) Remove the timer clip and stopper pin.

(b) Push on the slide pin as shown.

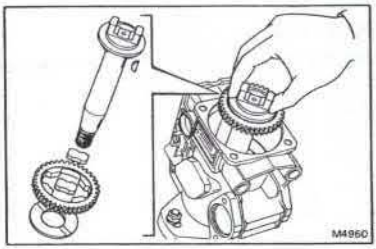


(c) Push the drive shaft and remove the roller ring.



NOTE:

- Be careful not to drop the rollers.
- Do not alter the position or assembly of the rollers.

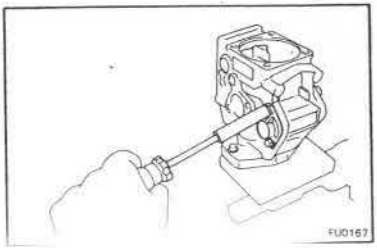


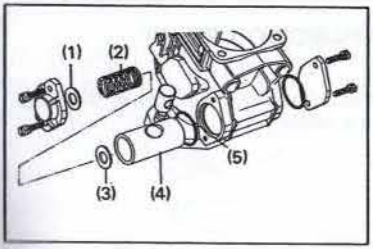
(d) Remove the drive shaft with the governor drive gear.

(e) Remove the drive shaft washer.

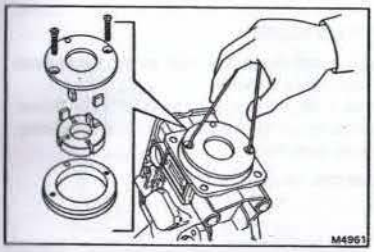
21. REMOVE TIMER

(a) Remove the two timer covers and O-rings.





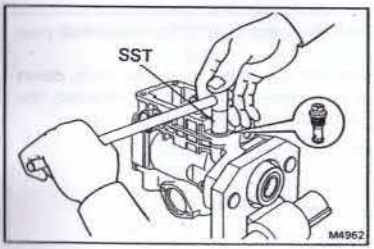
(b) Remove the following parts:
(1) Timer adjusting shim
(2) Spring
(3) Timer adjusting shim
(4) Piston
(5) Sub-piston



22. REMOVE FEED PUMP

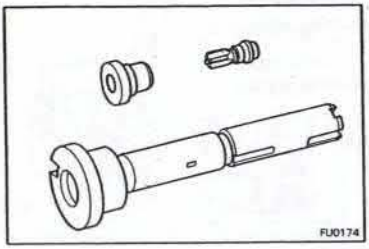
(a) Remove the two screws.
(b) Using a piece of wire, remove the feed pump cover.
(c) Remove the feed pump rotor, four blades and liner.

CAUTION: Be careful not to interchange the blade positions.



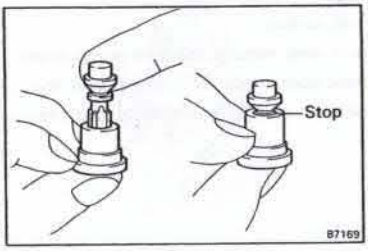
23. REMOVE REGULATOR VALVE

Using SST, remove the regulator valve.
SST 09260-54012



INSPECTION OF INJECTION PUMP COMPONENTS

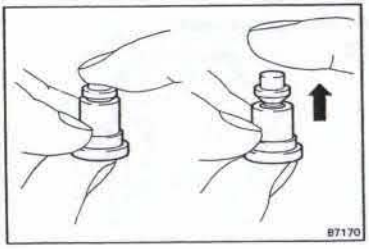
NOTE: Do not touch the sliding surfaces of the pump plunger and delivery valves.



1. INSPECT DELIVERY VALVES

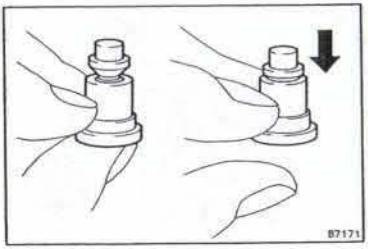
(a) Pull up the valve and close the hole at the valve seat bottom end with your thumb.
When the valve is released, it should sink down quickly and stop at the position where the relief ring closes the valve seat hole.

If defective, replace the valve as a set.



(b) Close the hole at the valve seat bottom end with your thumb.
Insert the valve into the valve seat and press down with your finger. When your finger is released, the valve should rise back to its original position.

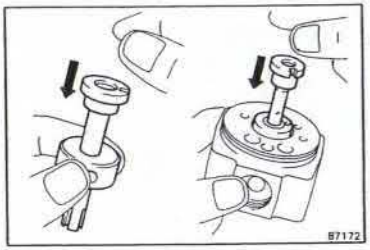
Replace if defective.



(c) Remove your thumb from the valve seat hole.
The valve should close completely by its own weight.

Replace if defective.

NOTE: Before using a new valve set, wash off the rust prevention compound with light oil or gasoline.
Then re-wash with diesel fuel and perform the above tests.



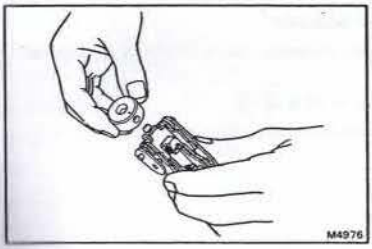
2. INSPECT PUMP PLUNGER, SPILL RING AND DISTRIBUTIVE HEAD

(a) Tilt the spill ring (distributive head) slightly and pull out the plunger.

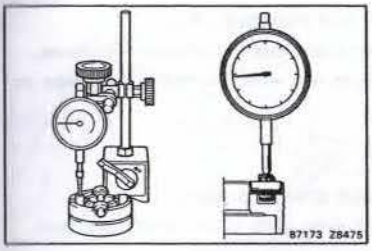
(b) When released, the plunger should sink down smoothly into the spill ring (distributive head) by its own weight.

(c) Rotate the plunger and repeat the test at various positions.

If the plunger sticks at any position, replace the parts as a set.



(d) Insert the governor link ball pin into the spill ring and check that it moves smoothly without any play.

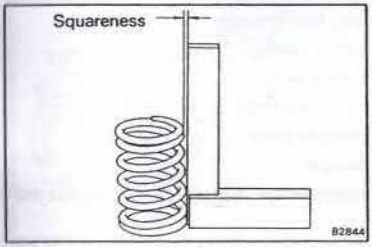


3. INSPECT ROLLER RING AND ROLLERS

Using a dial indicator, measure the roller height.

Roller height variation: 0.02 mm (0.0008 in.)

If not within specification, replace the roller ring and roller as a set.

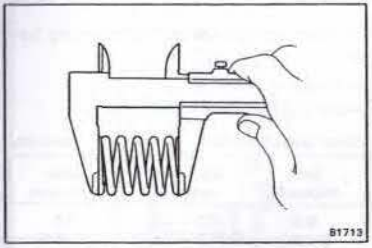


4. INSPECT PLUNGER SPRINGS FOR SQUARENESS

Using a steel square, check the squareness of the plunger springs.

Maximum squareness: 2.0 mm (0.079 in.)

If one spring is out of square more than the maximum, replace both springs.



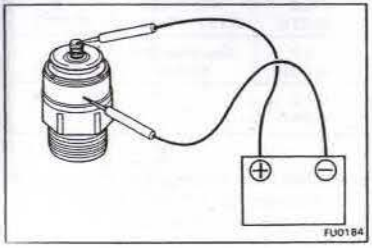
5. INSPECT SPRING LENGTH

Using calipers, measure the free length of each spring.

Spring length mm (in.)

	Delivery valve spring	Plunger spring
Standard	24.4 (0.961)	30.0 (1.181)
Minimum	23.5 (0.925)	29.5 (1.161)

If the length is less than minimum, replace the spring.

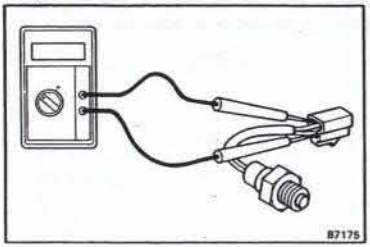


6. INSPECT FUEL CUT SOLENOID

(a) Connect the solenoid valve body and terminal to the battery terminals.

(b) You should feel the click from the solenoid valve when the battery power is connected and disconnected.

If the solenoid valve is not operating properly, replace it.

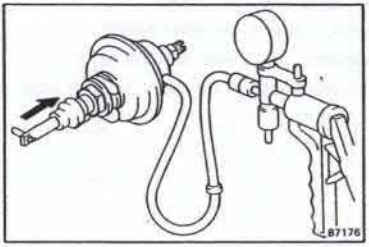


7. INSPECT PICKUP SENSOR

Using an ohmmeter, measure the resistance between terminals.

Resistance: 600 – 800 Ω

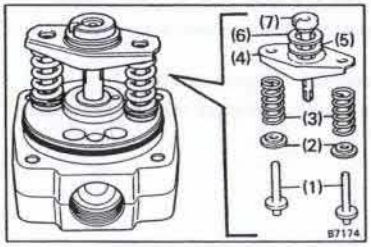
If not within specification, replace the sensor.



8. INSPECT ACTUATOR FOR IDLE-UP

Apply vacuum and check that the actuator rod moves.

If the actuator does not work, replace the actuator as necessary.



9. ADJUST PLUNGER SPRING SHIM

(a) Install the following parts to the distributive head.

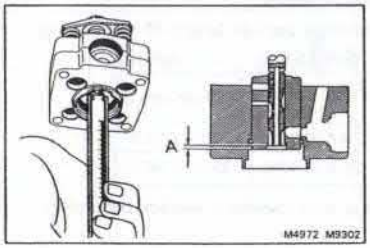
(1) Two plunger spring guides
(2) Two upper spring seats
(3) Two plunger springs
(4) Lower spring seat
(5) Upper plunger plate
(6) Lower plunger plate
(7) Pump plunger

NOTE: Do not assemble the plunger spring shims at this time.

(b) Using calipers, measure clearance A indicated in the figure.

(c) Determine the shim size by using the following formula and chart.

New shim thickness = 5.8 – A
A . . . . Plunger position measured

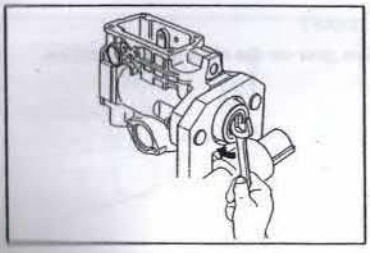


Shim selection chart mm (in.)

Measured clearance	Shim thickness	Measured clearance	Shim thickness
More than 5.3 (0.209)	0.5 (0.020)	4.3 – 4.5 (0.169 – 0.177)	1.5 (0.059)
5.0 – 5.2 (0.196 – 0.205)	0.8 (0.031)	4.0 – 4.2 (0.157 – 0.165)	1.8 (0.071)
4.8 – 4.9 (0.189 – 0.193)	1.0 (0.039)	Less than 3.9 (0.154)	2.0 (0.079)
4.6 – 4.7 (0.181 – 0.185)	1.2 (0.047)	—	—

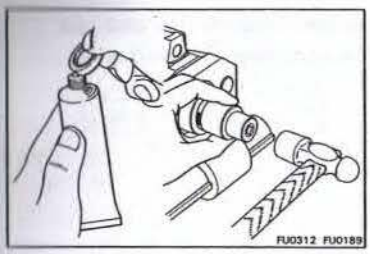
NOTE:

- For a measurement between listed sizes, use the next larger size. Ex. If thickness is 1.1 mm (0.043 in.) by calculation, use a 1.2 mm (0.047 in.) shim.
- Select two shin s which have the same thickness.



10. IF NECESSARY, REPLACE OIL SEAL

(a) Using a wrench, pry out the oil seal.

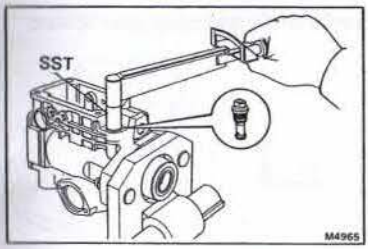


(b) Apply MP grease to the lip of a new oil seal.

(c) Apply liquid sealer to the outer circumference of the oil seal.

CAUTION: Do not apply sealer to the lip of the oil seal.

(d) Using a socket wrench, drive in the oil seal until its surface is flush with the pump housing.



ASSEMBLY OF INJECTION PUMP

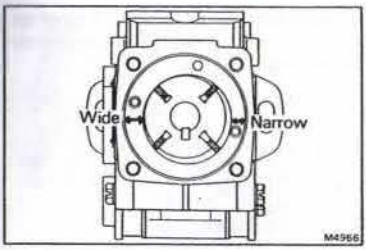
(See pages FU-14 and 15)

1. INSTALL REGULATOR VALVE

Using SST, install and torque the regulator valve.

SST 09260-54012

Torque: 90 kg-cm (78 in.-lb, 8.8 N·m)

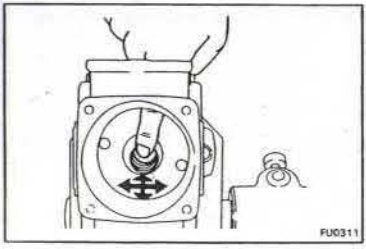


2. INSTALL FEED PUMP

(a) Install the liner, rotor and four blades.

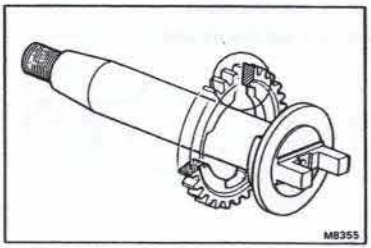
(b) Check that the liner and blades are facing in the correct direction, as shown.

(c) Check that the blades move smoothly.



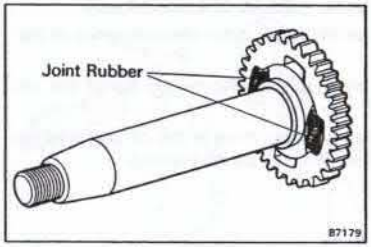
(d) Install the pump cover with the two screws and check that the rotor moves smoothly.

NOTE: Check that the fuel outlet hole of the cover is aligned with the liner.



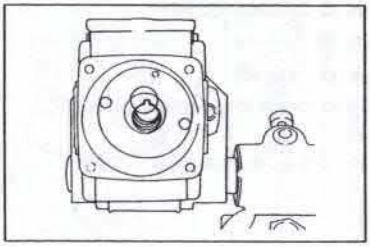
3. INSTALL DRIVE SHAFT

(a) Install the drive gear on the drive shaft as shown.

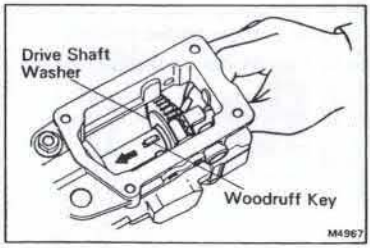


(b) Install new two joint rubbers into the drive gear.

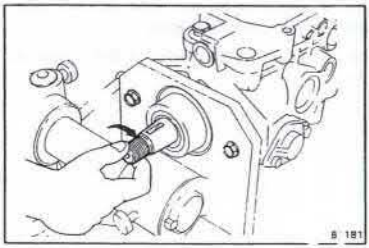
NOTE: Replace the joint rubber when overhauling.



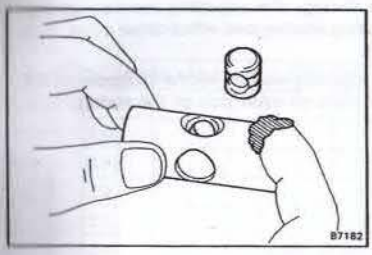
(c) Position the notch of the feed pump rotor upward.



(d) Install the woodruff key and drive shaft washer on the drive shaft and insert the drive shaft assembly into the pump housing.



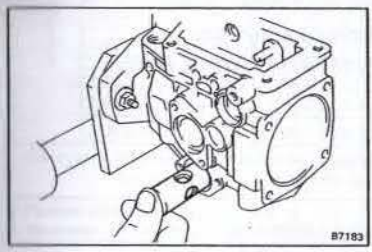
(e) Check that the drive shaft turns without catching.



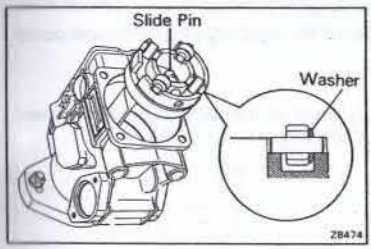
4. INSTALL TIMER PISTON

(a) Apply No. 50 Denso grease to the timer piston.

(b) Install the sub-piston in the timer piston.



(c) Insert the timer piston into the pump housing.

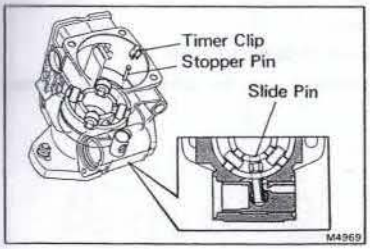


5. INSTALL ROLLER RING

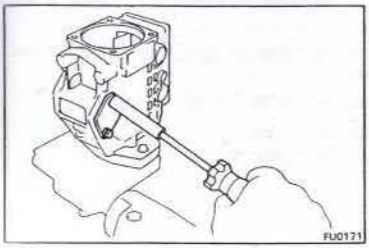
(a) Install the slide pin, four rollers and washers on the roller ring.

(b) Check that the roller is facing the flat surface of the washer.

(c) Install the roller ring in the pump housing.

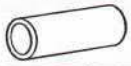


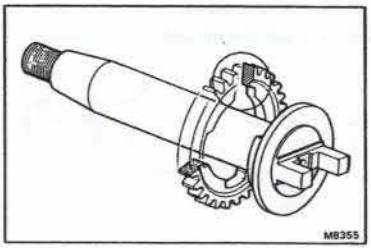
(d) Carefully push down the slide pin and install the stopper pin and clip.



(e) Install a new O-ring and the flat timer cover with the two bolts.

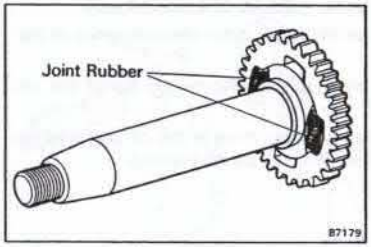
SST (SPECIAL SERVICE TOOLS) (Cont'd)

Section / Classification / Part Name / Part No. / Illustration				EM	FU	CO	LU	ST	CH
	09278-54012	(Drive Shaft Holding Tool)	A	●	●	●			
	09286-46011	(Injection Pump Spline Shaft Puller)	C					●	●
	09330-00021	(Companion Flange Holding Tool)	A	●	●	●	●		
	09612-24013	(Steering Gear Housing Overhaul Tool Set)	B	●					
	09820-00021	(Alternator Rear Bearing Puller)	B						●
	09820-00030	(Alternator Rear Bearing Replacer)	B						●
	09992-00023	(Cylinder Compression Check Gauge Set)	A	●					
	09992-00160	(Compression Gauge No. 5 Attachment)	A	●					
	09992-00240	(Turbocharger Pressure Gauge)	C	●	●				



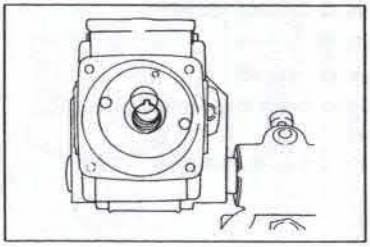
3. INSTALL DRIVE SHAFT

(a) Install the drive gear on the drive shaft as shown.

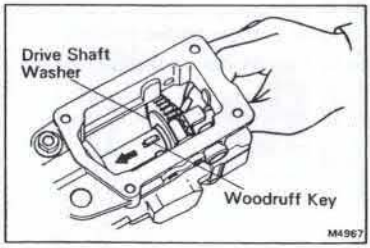


(b) Install new two joint rubbers into the drive gear.

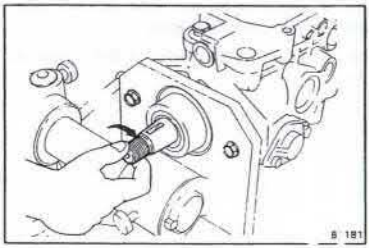
NOTE: Replace the joint rubber when overhauling.



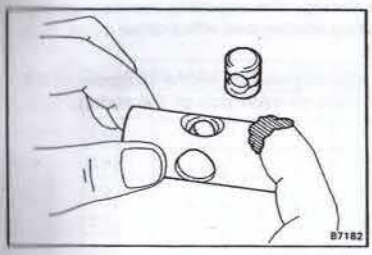
(c) Position the notch of the feed pump rotor upward.



(d) Install the woodruff key and drive shaft washer on the drive shaft and insert the drive shaft assembly into the pump housing.



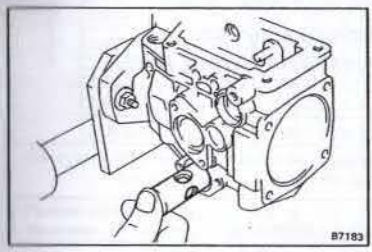
(e) Check that the drive shaft turns without catching.



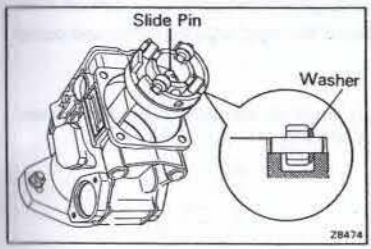
4. INSTALL TIMER PISTON

(a) Apply No. 50 Denso grease to the timer piston.

(b) Install the sub-piston in the timer piston.



(c) Insert the timer piston into the pump housing.

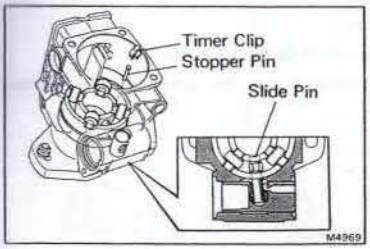


5. INSTALL ROLLER RING

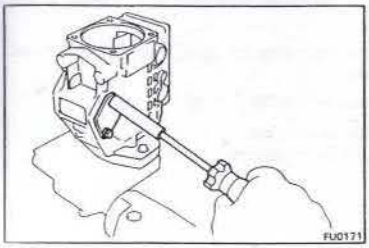
(a) Install the slide pin, four rollers and washers on the roller ring.

(b) Check that the roller is facing the flat surface of the washer.

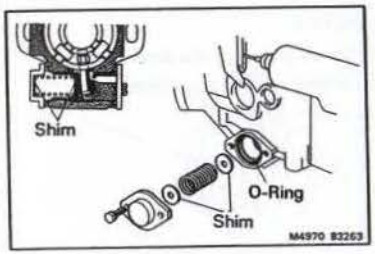
(c) Install the roller ring in the pump housing.



(d) Carefully push down the slide pin and install the stopper pin and clip.

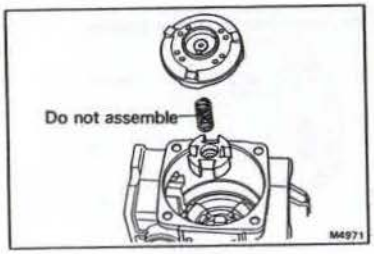


(e) Install a new O-ring and the flat timer cover with the two bolts.



(f) Install a new O-ring, the adjusting washer, spring, another adjusting washer and other timer cover with the two bolts.

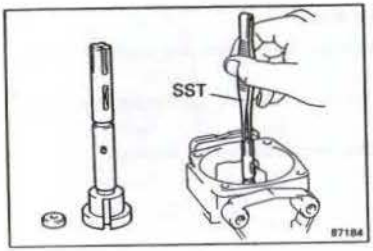
NOTE: Insert an adjusting washer with a thickness of 0.5 mm (0.020 in.) or more on each side of the spring.



6. ADJUST PLUNGER ADJUSTING SHIM

(a) Install the coupling and camplate.

NOTE: Do not assemble the coupling spring.

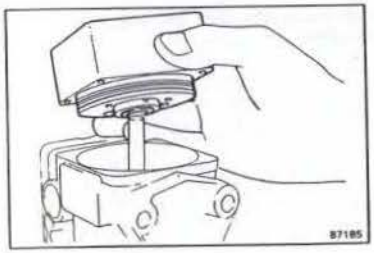


(b) Clean the adjusting shim and contacting surface area.

(c) Using SST, install the used adjusting shim and pump plunger.

SST 09260-54012

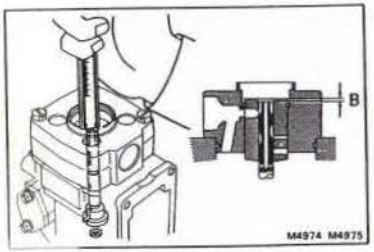
(d) Check that the notch on the pump plunger is aligned with the camplate pin.



(e) Install the distributive head with the four bolts. Torque the bolts.

Torque: 120 kg-cm (9 ft-lb, 12 N·m)

CAUSTION: Be careful not to damage the pump plunger.



(f) Using calipers, measure clearance B indicated in the figure.

(g) Determine the shim size by using the following formula and chart.

New shim thickness = T + (B − 3.3)

T. . . Thickness of shim used

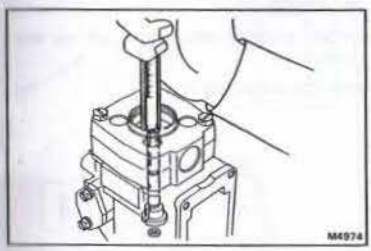
B. . . Plunger position measured

Shim selection chart

Installed shim (mm) \ Measured clearance (mm)	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2 – 3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4
1.9											2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	2.9
2.0									1.9		2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	2.9	
2.1								1.9	1.9		2.3	2.4	2.5	2.6	2.7	2.8	2.9	2.9		
2.2							1.9	1.9	2.0		2.4	2.5	2.6	2.7	2.8	2.9	2.9			
2.3						1.9	1.9	2.0	2.1		2.5	2.6	2.7	2.8	2.9	2.9				
2.4					1.9	1.9	2.0	2.1	2.2		2.6	2.7	2.8	2.9	2.9					
2.5				1.9	1.9	2.0	2.1	2.2	2.3		2.7	2.8	2.9	2.9						
2.6			1.9	1.9	2.0	2.1	2.2	2.3	2.4		2.8	2.9	2.9							
2.7		1.9	1.9	2.0	2.1	2.2	2.3	2.4	2.5		2.9	2.9								
2.8	1.9	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6		2.9									
2.9	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7											

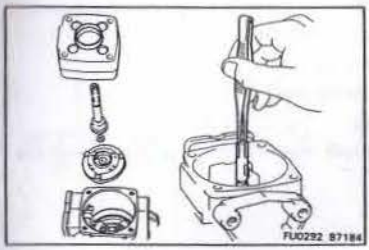
Example: 2.5 mm (0.098 in.) shim installed. Measured clearance is 3.0 mm (0.118 in.).
Replace with 2.2 mm (0.087 in.) shim.

Plunger adjusting shim thickness mm (in.)	1.9 (0.075)	2.0 (0.079)	2.1 (0.083)	2.2 (0.087)	2.3 (0.091)	2.4 (0.094)	2.5 (0.098)	2.6 (0.102)	2.7 (0.106)	2.8 (0.110)	2.9 (0.114)



(h) Install a new shim and recheck clearance B.

B: 3.3 ± 1 mm (0.130 ± 0.039 in.)



(i) Remove the distributive head and the following parts with SST:

(1) Pump plunger

(2) Plunger adjusting shim

(3) Camplate

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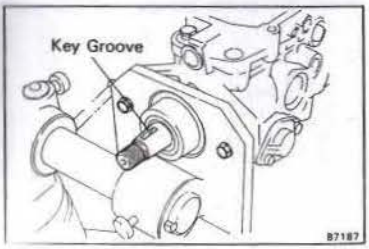
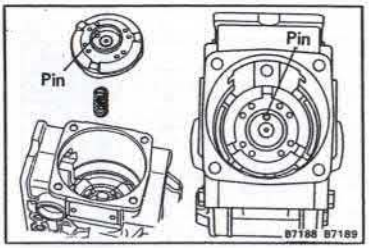
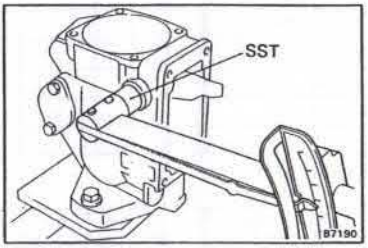


7. INSTALL CAMPLATE

(a) Face the key groove of the drive shaft upward.



(b) Install the coupling spring and camplate with the camplate pin facing toward the governor cover side.



8. INSTALL GOVERNOR LINK

(a) Using SST, install the governor link with the two support bolts and gaskets. Torque the bolts.

Torque: 115 kg-cm (8 ft-lb, 11 N·m)

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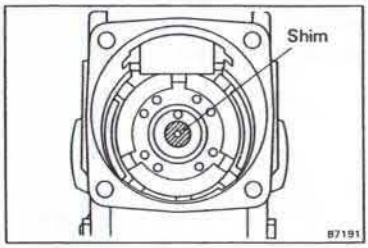
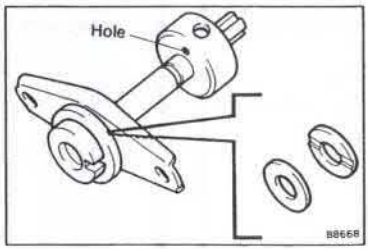
(b) Check that the governor link moves smoothly after assembly.



9. INSTALL PUMP PLUNGER

(a) Place the selected plunger adjusting shim on the center of the camplate.

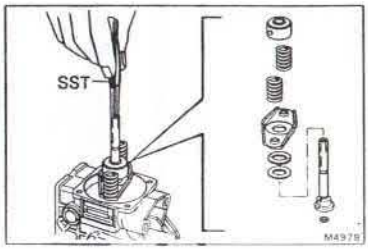
NOTE: Do not apply grease to the shim.



(b) Install the following parts to the pump plunger:

(1) Lower plunger plate
(2) Upper plunger plate
(3) Lower spring seat
(4) Spill ring

NOTE: Face the spill ring with the hole side toward the lower seat.



(c) Using SST, install the pump plunger and plunger springs.

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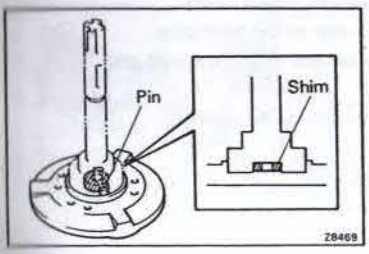
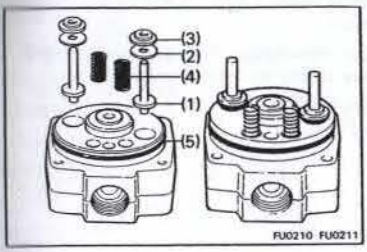


(d) Check that the camplate pin and plunger notch are aligned.

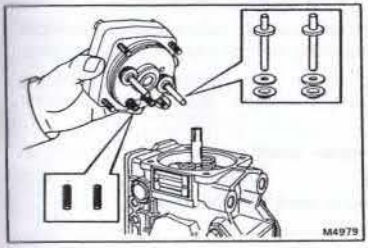
(e) Check that the spill ring hole and governor link ball pin are aligned.



10. INSTALL DISTRIBUTIVE HEAD

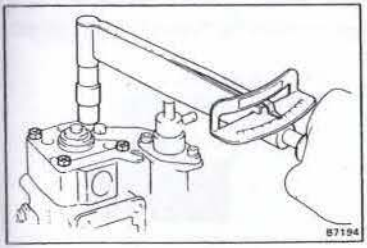
(a) Apply No. 50 Denso grease to the following parts and install them to the distributive head:

(1) Plunger spring guides
(2) Plunger spring shims
(3) Upper spring seats
(4) Lever support springs
(5) New O-ring



(b) Install the distributive head.

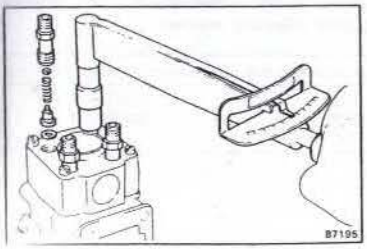
CAUTION: Be careful not to damage the pump plunger.



(c) Install the connector clamp and idle-up bracket. (ex. CM)

(d) Install and torque the four head bolts.

Torque: 120 kg-cm (9 ft-lb, 12 N·m)



11. INSTALL FOUR DELIVERY VALVE HOLDERS

(a) Install four new gaskets and the valves into the distributive head.

(b) Install the spring seats and springs into the delivery valve holders.

(c) Using SST, install and torque the delivery valve holders.

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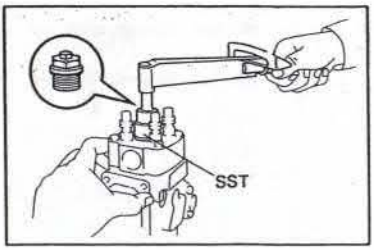
Torque: 500 kg-cm (36 ft-lb, 49 N·m)



12. INSTALL DISTRIBUTIVE HEAD PLUG

(a) Install a new O-ring on the head plug.

(b) Using SST, install and torque the head plug.

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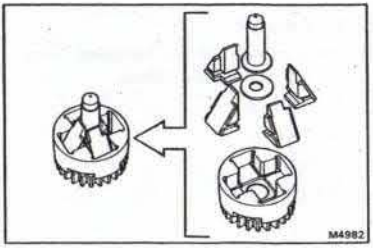
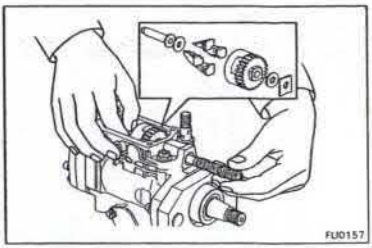
Torque: 700 kg-cm (51 ft-lb, 69 N·m)



13. INSTALL GOVERNOR SHAFT AND FLYWEIGHT HOLDER ASSEMBLY

(a) Install the four flyweights, flyweight washer and governor sleeve on the flyweight holder.

NOTE: Replace the four flyweights as a set.



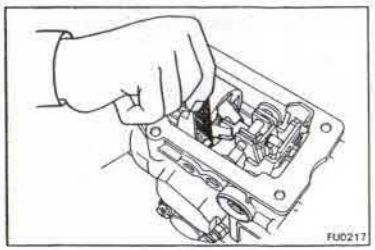
(b) Install a new O-ring to the governor shaft.

(c) Put the flyweight holder subassembly, flyweight washer and adjusting washer into the pump housing.

(d) Install the governor shaft through the adjusting washer, flyweight washer and flyweight holder subassembly.

(e) Turn the governor shaft counterclockwise with an allen wrench.

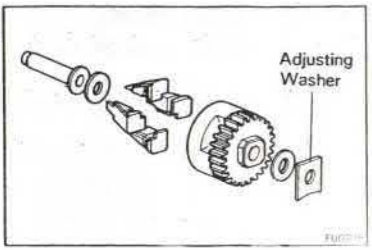
NOTE: The governor shaft has LH threads.



14. CHECK FLYWEIGHT HOLDER THRUST CLEARANCE

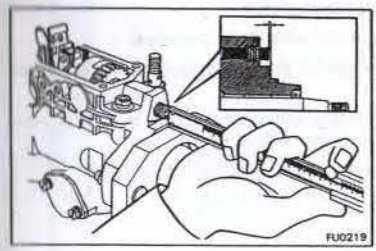
Using a feeler gauge, measure the flyweight holder thrust clearance.

Thrust clearance: 0.15 — 0.35 mm (0.0059 — 0.0138 in.)



If the thrust clearance is not within specification, adjust with an governor gear adjusting washer.

Governor gear adjusting washer thickness mm (in.)	
1.05 (0.0413) 1.25 (0.0492) 1.45 (0.0571)	1.65 (0.0650) 1.85 (0.0728)



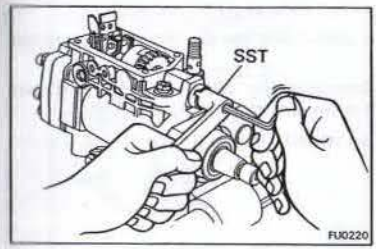
15. ADJUST PROTRUSION OF GOVERNOR SHAFT

(a) Using calipers, measure the protrusion of the governor shaft.

Protrusion: 2.0 – 2.5 mm (0.079 – 0.098 in.)

If the protrusion is not within specification, adjust by turning the governor shaft with an allen wrench.

NOTE: The governor shaft has LH threads.



(b) Using SST, install and torque the lock nut while holding the governor shaft with an allen wrench.

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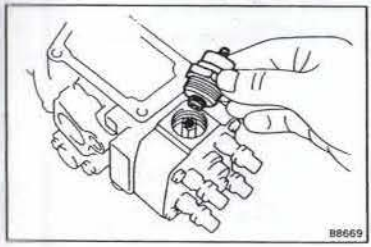
NOTE: The governor shaft and lock nut have LH threads.

16. INSTALL PICKUP SENSOR



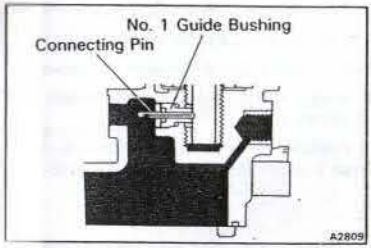
17. INSTALL FUEL CUT SOLENOID

(a) Install a new O-ring on the fuel cut solenoid.

(b) Insert the valve and spring to the distributive head.

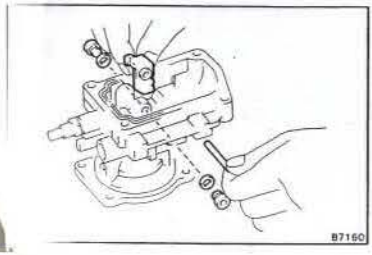
(c) Install the fuel cut solenoid.

(d) Connect the lead wire to the fule cut solenoid.



18. INSTALL CONNECTING PIN TO GOVERNOR COVER (CV)

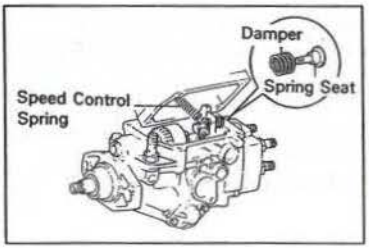
Insert the connecting pin into the No. 1 guide bushing.



19. INSTALL CONTROL LEVER TO GOVERNOR COVER (CV)

(a) Install the control lever and support pin.

(b) Using an allen wrench, install the two bolts with the gaskets.



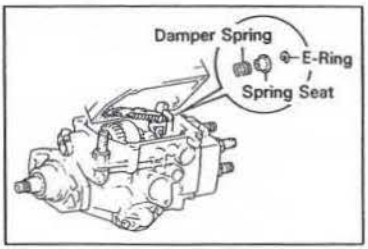
20. INSTALL GOVERNOR COVER

(FR with M/T and CV with M/T Vehicles)

(a) Install a new gasket into the groove of the governor cover.

(b) Install the damper spring and spring seat, and connect them with the control spring.

(c) Using an allen wrench, install the four bolts.

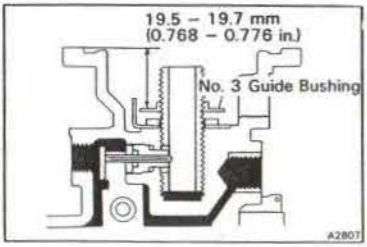


(FF with M/T except CV and A/T Vehicles)

(a) Install a new gasket into the groove of the governor cover.

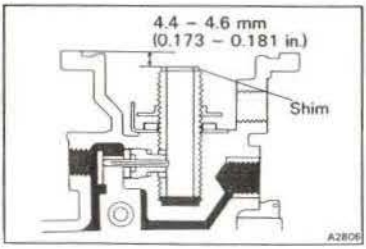
(b) Install the damper spring and governor spring seat and connect them with the E-ring.

(c) Using an allen wrench, install the four bolts.



21. INSTALL NO. 3 GUIDE BUSHING (CV)

Install and adjust the guide bushing as shown.



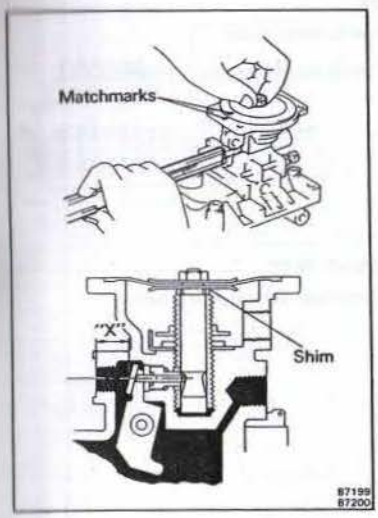
22. SELECT BOOST COMPENSATOR SHIMS (CV)

(a) Put the shims on the No. 2 guide bushing.

(b) Using calipers, measure the dimension as shown.

If the dimension is not within specification, select and install the correct shims.

NOTE: Shim are available in 11 sizes, in increment of 0.2 mm (0.008 in.), from 1.3 mm (0.051 in.) to 3.3 mm (0.130 in.).



23. ADJUST BOOST COMPENSATOR DIAPHRAGM (CV)

(a) Install the shims and diaphragm.

NOTE: Do not assemble the spring.

(b) While the pushing on the diaphragm, measure dimension "X" with calipers as shown.

Dimension "X": 10.9 – 11.1 mm (0.429 – 0.437 in.)

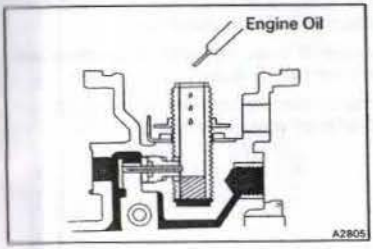
NOTE: Measure at the center of the hole.

If dimension "X" is not within specification, turn the diaphragm.

(c) Place matchmarks on the diaphragm and housing.

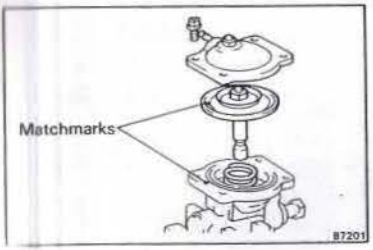
(d) Remove the diaphragm.

(e) Using an allen wrench, install the screw plug with the gasket.



24. INSTALL BOOST COMPENSATOR DIAPHRAGM (CV)

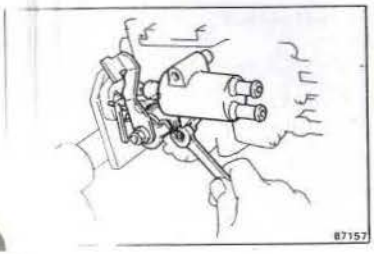
(a) Insert 3 – 4 cc (0.18 – 0.24 cu in.) of engine oil into the No. 2 guide bushing.



(b) Install the shims, spring and diaphragm.

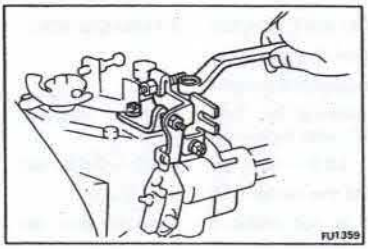
(c) Align the matchmarks on the diaphragm and housing.

(d) Install the diaphragm cover with four bolts.



25. INSTALL THERMO WAX

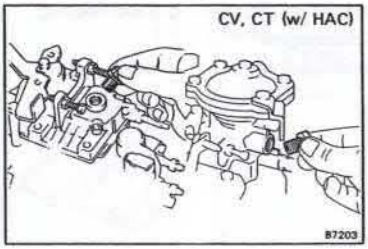
Install a new O-ring and thermo wax with two bolts.



26. INSTALL IDLE-UP

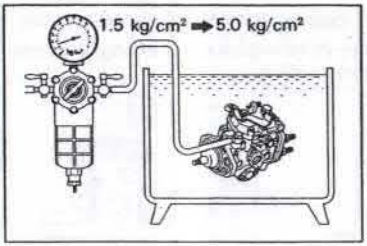
Install the idle-up with three bolts.

27. REMOVE INJECTION PUMP FROM STAND



28. PERFORM AIR TIGHT TEST

(a) Replace the overflow screw with a bolt.

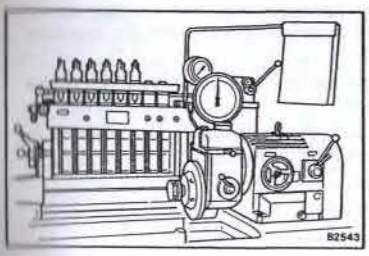


(b) Connect an air hose to the fuel inlet hole and submerge the injection pump in diesel fuel.

(c) Apply 1.5 kg/cm² (21 psi, 147 kPa) of pressure and confirm that there are no leaks.

(d) Next check that there are no leaks with 5.0 kg/cm² (71 psi, 490 kPa) of pressure applied.

29. INSTALL WOODRUFF KEY ON DRIVE SHAFT

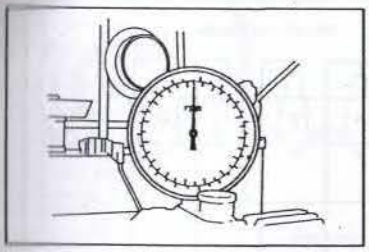


ADJUSTMENT OF INJECTION PUMP

1. PRE-TEST CHECK AND PREPARATION

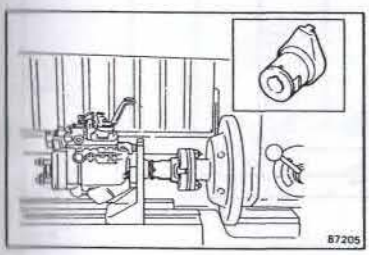
(a) The specifications for test nozzle and nozzle holders are as follows.

Test nozzle: DN 12 SD 12
Test nozzle holder valve opening pressure:
145 – 155 kg/cm² (2,062 – 2,205 psi, 14,220 – 15,200 kPa)



(b) Check the accuracy of the tachometer.

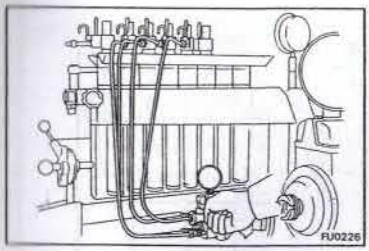
Allowable error: ± 40 rpm



(c) Install the angle gauge stand.

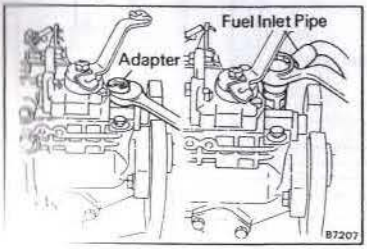
(d) Mount the injection pump body on the pump tester.

NOTE: Place a mark on the key groove portion of the coupling.

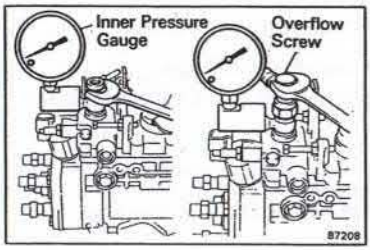


(e) Install an injection pipe with the following specifications.

Outer diameter: 6.0 mm (0.236 in.)
Inner diameter: 2.0 mm (0.079 in.)
Length: 840 mm (33.07 in.)
Minimum bending radius: More than 25 mm (0.98 in.)



(f) Connect the fuel inlet pipe with an adapter.

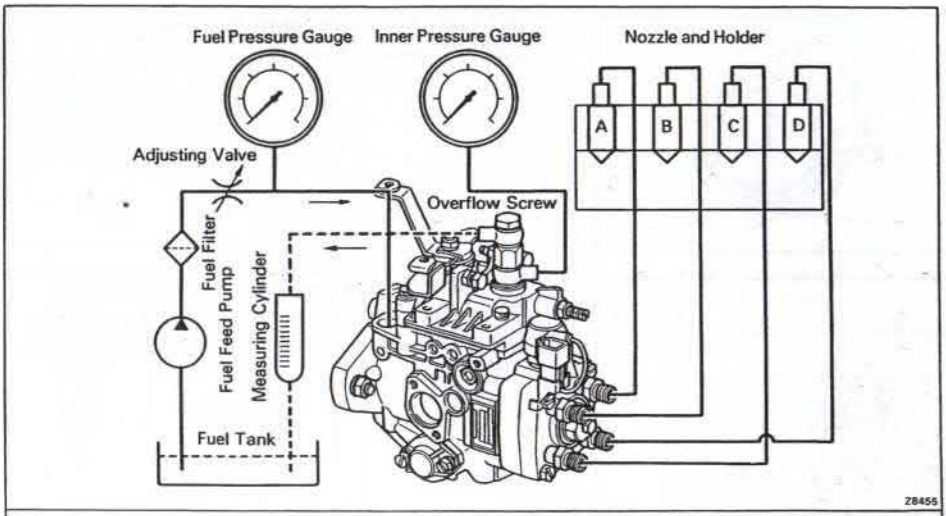


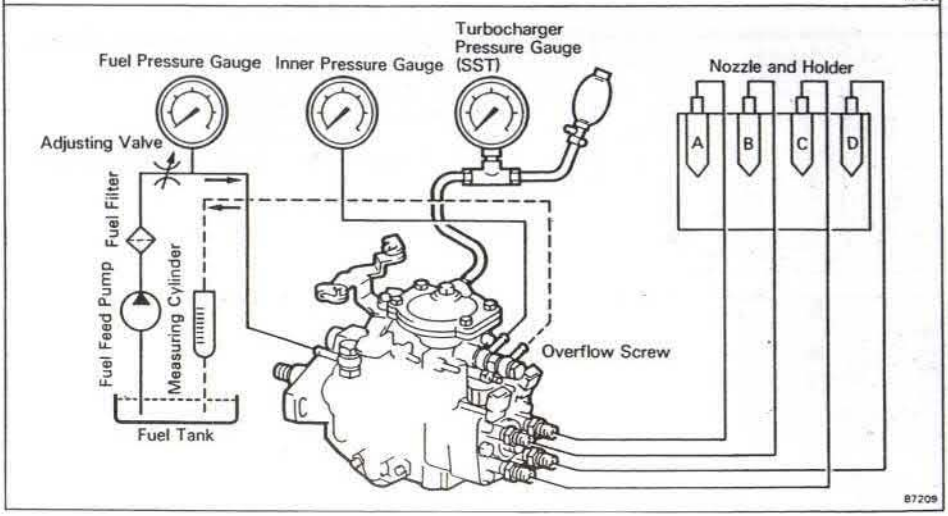
(g) Install the inner pressure gauge with a hollow screw. On top, install an overflow hose with the overflow screw.

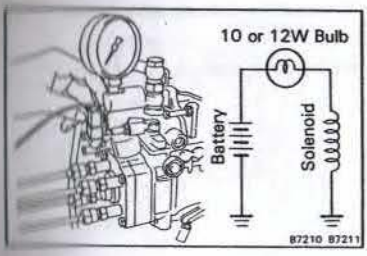
NOTE: Always use the overflow screw installed on the pump to be adjusted.

(h) Connect the turbocharger pressure gauge (SST) to the boost compensator. (CV)

SST 09992-00240







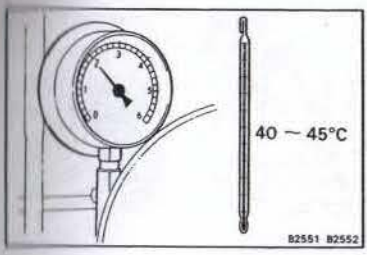
(i) Apply about 6 volts of DC power to the fuel cut solenoid.

CAUTION:

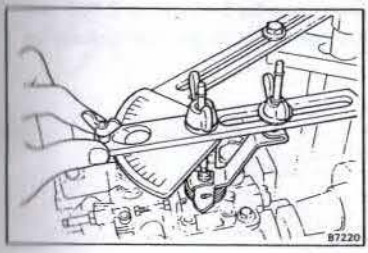
1. When applying voltage to the solenoid, position the battery as far away from the solenoid as possible so that a spark does not occur.

2. When connecting the battery cable, connect the solenoid side first.

NOTE: For a 12V battery, connect the battery through a 10 or 12W bulb.

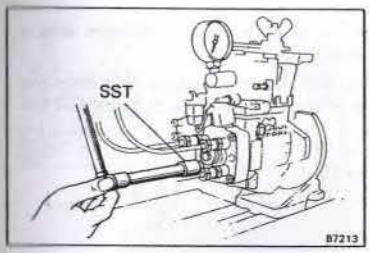


(j) The pressure for feeding fuel to the injection pump should be 0.2 kg/cm² (2.8 psi, 20 kPa).
The fuel temperature for pump testing should be 40 – 45°C (104 – 113°F).



(k) Install an angle gauge to the stand and set it to the adjusting lever.

(l) Secure the adjusting lever fully on the maximum speed side.



(m) Check the installation direction of the camplate.

(1) Disconnect the injection pipe from the position marked "C" on the distributive head.

(2) Using SST, remove the delivery valve holder.

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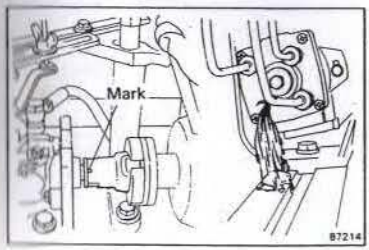
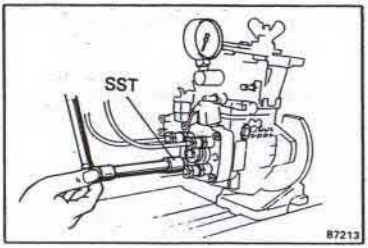


(3) Check that fuel is flowing out when the mark is in the position shown in the figure.
If not, it is improperly assembled.

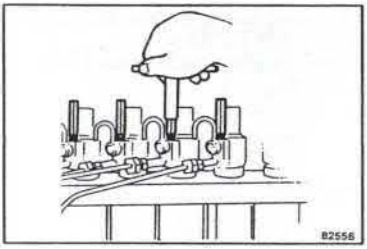
(4) Disassemble and charge the camplate position 180° in the opposite direction.

NOTE: At this time, disconnect the fuel cut solenoid wire harness.

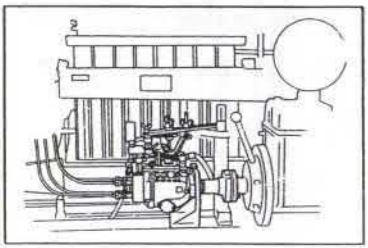


(5) Using SST, install the delivery valve holder.
SST 09260-54012

(6) Connect the injection pipe.

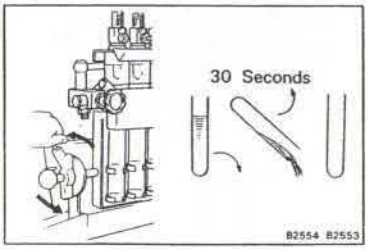


(n) Bleed the air from the injection pipes.

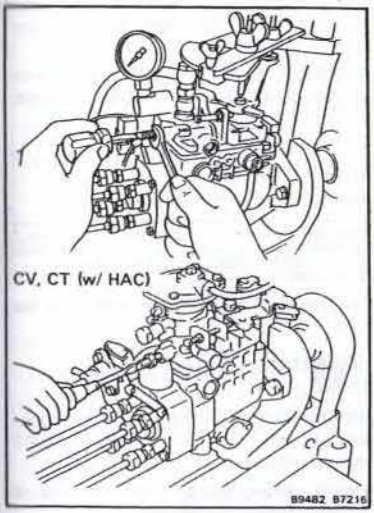


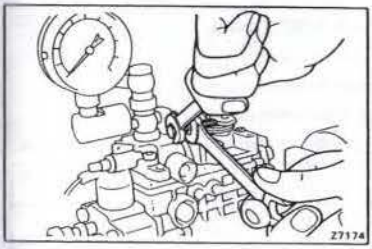
(o) Race the injection pump for 5 minutes at 2,000 rpm.

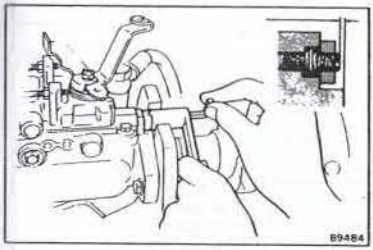
CAUTION: Check that there is no fuel leakage or abnormal noise.

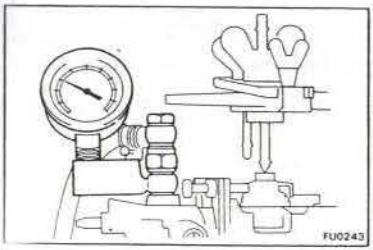


NOTE:
- Measure the volume of each injection cylinder with a measuring cylinder.
- Before measuring the injection volume, first hold the cylinder tilted for at least 30 seconds to discard all the fuel.









2. PRE-SETTING OF FULL LOAD INJECTION VOLUME

(a) Set the adjusting lever to maximum position.

(b) Adjust the injection volume with the full load set screw.

Item	Pump rpm	No. of measuring strokes	Injection volume cc (cu in.)
CE70	1,500	200	7.9-8.3 (0.48-0.51)
CE80, CM (STD)			7.7-8.1 (0.47-0.49)
CV *1			10.1-10.5 (0.62-0.64)
CT (w/o HAC), CR			8.1-8.5 (0.49-0.52)
CT (w/ HAC) *2			7.9-8.3 (0.48-0.51)
CM (OPT) *3			7.1-7.5 (0.43-0.46)

*1: Apply 0.48 kg/cm² (6.8 psi, 47 kPa) pressure
*2: Apply 730 ± 1.5 mm Hg (28.74 ± 0.06 in. Hg, 97.3 ± 0.2 kPa) absolute pressure
*3: High altitude

NOTE: The injection volume will increase about 3 cc (0.18 cu in.) with each 1/2 turn of the screw.

3. PRE-SETTING OF MAXIMUM SPEED

(a) Set the adjusting lever to maximum position.

(b) Adjust the injection volume with the maximum adjusting screw.

Item	Pump rpm	No. of measuring strokes	Injection volume cc (cu in.)
CE, CT CM, CR	2,550	200	2.0-3.2 (0.12-0.19)
CV	2,600		2.6-3.8 (0.16-0.23)

4. PRE-SETTING OF LOAD SENSING TIMER

Using SST and an allen wrench, adjust the protrusion of the governor shaft.

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Protrusion: 2.0 – 2.5 mm (0.079 – 0.098 in.)

5. MEASURE PUMP INNER PRESSURE

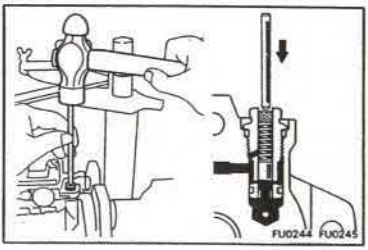
Measure the pump inner pressure at the below-listed rpm.

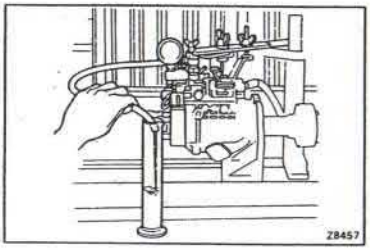
Others

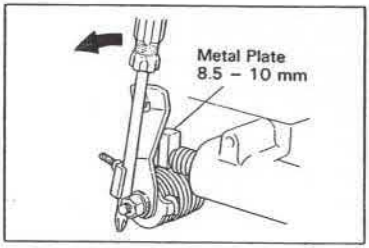
Pump rpm	Inner pressure kg/cm² (psi, kPa)
500	2.2 – 2.8 (31 – 40, 216 – 275)
2,350	6.7 – 7.3 (95 – 104, 657 – 716)

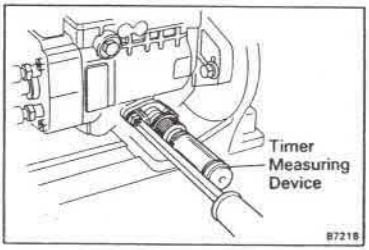
CV

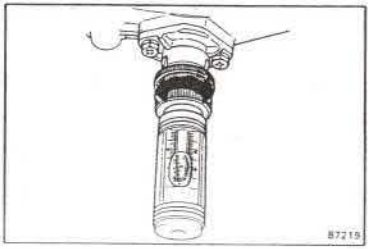
Pump rpm	Inner pressure kg/cm² (psi, kPa)
500	2.45 – 3.05 (35 – 43, 240 – 299)
2,350	6.85 – 7.45 (97 – 106, 672 – 731)











- If the pressure is low, adjust by lightly tapping the regulator valve piston while watching the pressure gauge.
- If the pressure is too high or if the regulator valve was tapped in too far, the regulator valve must be replaced.

6. MEASURE OVERFLOW VOLUME

Measure the overflow volume at the below listed rpm.

Pump rpm	Overflow volume	cc/min. (cu in./min.)
2,200	370 – 800	(22.6 – 48.8)

NOTE: Always use the overflow screw installed on the pump to be adjusted.

7. RELEASE COLD STARTING SYSTEM FOR NEXT INSPECTIONS (CM)

Using a screwdriver, turn the cold start lever counterclockwise and put a metal plate of 8.5 – 10 mm (0.33 – 0.39 in.) in thickness between the lever and thermo wax.

NOTE: Keep the cold starting system released until all measurements and adjustments are finished.

8. MEASURE AND ADJUST TIMER

(a) Remove the timer cover.

(b) Install the timer measuring device.

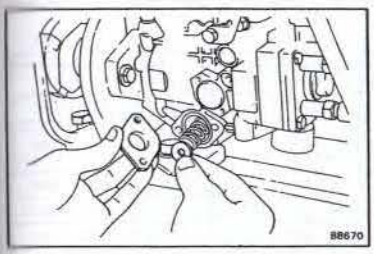
(c) Set the timer measuring device at zero.

(d) Measure the piston stroke at the below listed rpms.

Item	Pump rpm	Piston strokes mm (in.)
CE70, 80 CM (STD) CT CR	800	0.20 – 1.20 (0.0079 – 0.0472)
	1,800	3.67 – 4.67 (0.1445 – 0.1839)
	2,350	5.58 – 6.58 (0.2197 – 0.2591)
CM (OPT*1)	800	0.61 – 1.61 (0.0240 – 0.0634)
	1,800	4.08 – 5.08 (0.1606 – 0.2000)
	2,350	5.99 – 6.99 (0.2358 – 0.2752)
CV	700	0.24 – 1.24 (0.0094 – 0.0488)
	1,800	4.32 – 5.32 (0.1701 – 0.2094)
	2,250	5.99 – 6.99 (0.2358 – 0.2752)

NOTE: Confirm that the hysteresis is within 0.3 mm (0.012 in.).

*1: High altitude

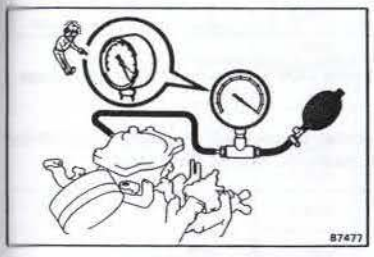


If any stroke is not within specification, adjust with an adjusting washer.

Timer adjusting washer thickness mm (in.)	
0.2 (0.008)	1.0 (0.039)
0.5 (0.020)	—

NOTE: The stroke will decrease with a thicker washer and increase with a thinner one.

CAUTION: Insure that there is a washer on both sides of the spring.

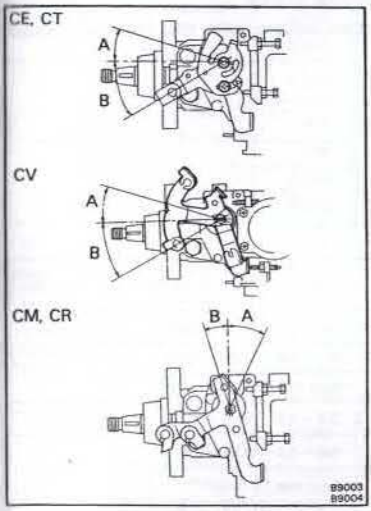


9. INSPECT AIR TIGHT OF BOOST COMPENSATOR (CV)

(a) Apply 1.00 kg/cm² (14.2 psi, 98 kPa) of pressure to the boost compensator.

(b) Measure the time it takes for the pressure to drop to 0.97 kg/cm² (13.8 psi, 95 kPa).

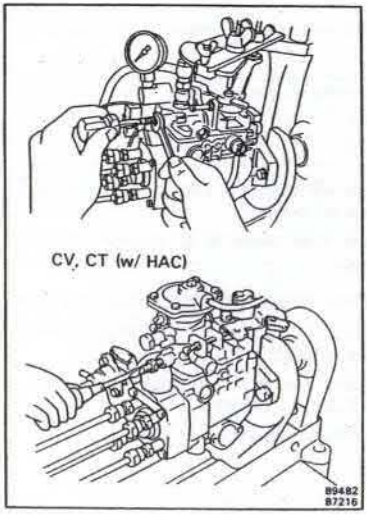
Pressure drop: More than 10 seconds



10. MEASURE AND ADJUST FULL LOAD INJECTION VOLUME

(a) The adjusting lever angle for the adjustment below should be as shown in the figure.

Item	Adjusting lever angle	
	A (Maximum speed side)	B (Idle speed side)
CE70	Plus 9–19°	Minus 24–34°
CE80, CT	Plus 13–23°	Minus 24–34°
CM, CR	Plus 3–13°	Minus 30–40°
CV	Plus 14–22°	Minus 24–34°

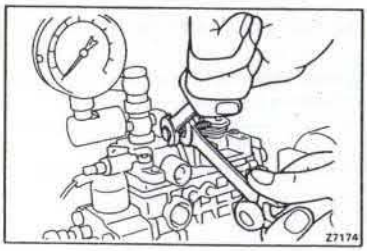


(b) Adjust the injection volume with the full load set screw.

Item	Adjusting lever angle	Pump rpm	Injection volume cc (cu in.)
CE70	Plus 9 – 19°	1,500	7.9 – 8.3 (0.48 – 0.51)
CE80	Plus 13 – 23°		7.7 – 8.1 (0.47 – 0.49)
CM (STD)	Plus 3 – 10°		
CV •1	Plus 14 – 22°		10.1 – 10.5 (0.62 – 0.64)
CT (w/o HAC)	Plus 13 – 23°		8.1 – 8.5 (0.49 – 0.52)
CT (w/ HAC) •2	Plus 13 – 23°		7.9 – 8.4 (0.48 – 0.51)
CR	Plus 3 – 10°		8.1 – 8.5 (0.49 – 0.52)
CM (OPT) •3	Plus 3 – 10°		7.1 – 7.5 (0.43 – 0.46)

•1: Apply 0.48 kg/cm² (6.8 psi, 47 kPa) pressure
•2: Apply 730 ± 1.5 mm Hg (28.74 ± 0.06 in. Hg, 97.3 ± 0.2 kPa) absolute pressure
•3: High altitude

NOTE: The injection volume will increase about 3 cc (0.18 cu in.) with each 1/2 turn of the screw.



11. ADJUST MAXIMUM SPEED

Adjust the injection volume with the maximum speed adjusting screw.

Item	Adjusting lever angle	Pump rmp	No. of measuring strokes	Injection volume cc (cu in.)	Remarks
CE70 CE80	Plus 9 – 19° (Others) Plus 13 – 23° (CE80)	2,700	200	2.0 – 3.2 (0.12 – 0.20)	Adjust
		2,600		4.1 – 5.8 (0.25 – 0.35)	—
		2,850		Less than 1.5 (0.09)	
CV •1	Plus 14 – 22°	2,600	200	2.6 – 3.8 (0.16 – 0.23)	Adjust
		2,500		5.9 – 8.3 (0.36 – 0.51)	—
		2,800		Less than 1.5 (0.09)	
CT •2	Plus 13 – 23°	2,700	200	2.0 – 3.2 (0.12 – 0.20)	Adjust
		2,600		4.3 – 6.1 (0.26 – 0.37)	—
		2,850		Less than 1.5 (0.09)	
CM, CR	Plus 3 – 10°	2,700	200	2.2 – 3.0 (0.13 – 0.18)	Adjust
		2,600		4.3 – 6.1 (0.26 – 0.37) •3 4.0 – 5.8 (0.24 – 0.35)	—
		2,850		Less than 1.5 (0.09)	

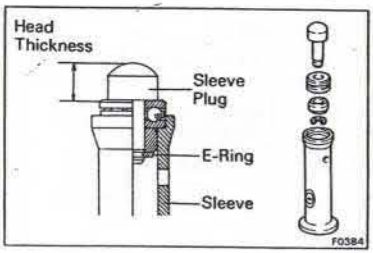
•1 Apply 0.48 kg/cm² (6.8 psi, 47 kPa) pressure
•2 w/ HAC Apply 730 ± 1.5 mm Hg (28.74 ± 0.06 in. Hg, 97.3 ± 0.2 kPa) absolute pressure
•3 For CM (OPT: High altitude)

12. INSPECT INJECTION VOLUME

Measure the injection volume for each pump rpm.

Item	Adjusting lever angle	Pump rmp	No. of measuring strokes	Injection volume cc (cu in.)	Varation limit cc (cu in.)	Remarks
CE70	Plus 9 – 19°	1,500	200	7.9 – 8.3 (0.48 – 0.51)	0.4 (0.02)	Basic full-load injection volume
		100		8.6 – 13.4 (0.52 – 0.82)	0.8 (0.05)	Volume during starting
		500		6.4 – 7.4 (0.39 – 0.45)	0.5 (0.03)	—
		2,350		6.9 – 7.9 (0.42 – 0.48)		—
		2,500		5.7 – 7.0 (0.35 – 0.43)		—
CE80 CM (STD)	Plus 13 – 23° (CE80) 3 – 13° (CM)	1,500	200	7.7 – 8.1 (0.47 – 0.49)	0.4 (0.02)	Basic full-load injection volume
		100		8.6 – 13.4 (0.52 – 0.82)	0.8 (0.05)	Volume during starting
		500		6.2 – 7.2 (0.38 – 0.44)	0.5 (0.03)	—
		2,350		6.7 – 7.7 (0.41 – 0.47)		—
		2,500		5.8 – 6.9 (0.35 – 0.42)		—
CV Apply 0.48 kg/cm² (6.8 psi, 47 kPa) pressure	Plus 14 – 22°	1,500	200	10.1 – 10.5 (0.62 – 0.64)	0.4 (0.02)	Basic full-load injection volume
		100		9.6 – 14.4 (0.59 – 0.88)	0.8 (0.05)	Volume during starting
		2,250		4.5 – 10.5 (0.27 – 0.64)	0.5 (0.03)	—
		2,350		8.8 – 10.1 (0.54 – 0.62)		—
CT (w/o HAC)	Plus 13 – 23°	1,500	200	8.1 – 8.5 (0.49 – 0.52)	0.4 (0.02)	Basic full-load injection volume
		100		8.6 – 13.4 (0.52 – 0.82)	0.8 (0.05)	Volume during starting
		500		6.6 – 7.6 (0.40 – 0.46)	0.5 (0.03)	—
		2,350		7.1 – 8.1 (0.43 – 0.49)		—
		2,500		6.0 – 7.4 (0.37 – 0.45)		—
CT (w/HAC) Apply 730 ± 1.5 mm Hg (28.74 ± 0.06 in. Hg, 97.3 ± 0.2 kPa) absolutely pressure	Plus 13 – 23°	1,500	200	7.9 – 8.4 (0.48 – 0.51)	0.4 (0.02)	Basic full-load injection volume
		100		8.6 – 13.4 (0.52 – 0.82)	0.8 (0.05)	Volume during starting
		500		6.5 – 7.4 (0.40 – 0.45)	0.5 (0.03)	—
		2,350		7.0 – 7.9 (0.43 – 0.48)		—
		2,500		6.0 – 7.4 (0.37 – 0.45)		—
		*1,300		6.7 – 7.6 (0.41 – 0.46)		—
CR	Plus 3 – 13°	1,500	200	8.1 – 8.5 (0.49 – 0.52)	0.4 (0.02)	Basic full-load injection volume
		100		8.6 – 13.4 (0.52 – 0.82)	0.8 (0.05)	Volume during starting
		500		6.6 – 7.6 (0.40 – 0.46)	0.5 (0.03)	—
		2,350		7.1 – 8.1 (0.43 – 0.49)		—
		2,500		6.0 – 7.4 (0.37 – 0.45)		—
CM OPT: High altitude	Plus 3 – 13°	1,500	200	7.1 – 7.5 (0.43 – 0.46)	0.4 (0.02)	Basic full-load injection volume
		100		8.6 – 13.4 (0.52 – 0.82)	0.8 (0.05)	Volume during starting
		500		5.6 – 6.6 (0.34 – 0.40)	0.5 (0.03)	—
		2,350		6.1 – 7.1 (0.37 – 0.43)		—
		2,500		5.3 – 6.7 (0.32 – 0.41)		—

* Apply 530 ± 1.5 mm Hg (20.87 ± 0.06 in. Hg, 70.6 ± 0.2 kPa) absolute pressure

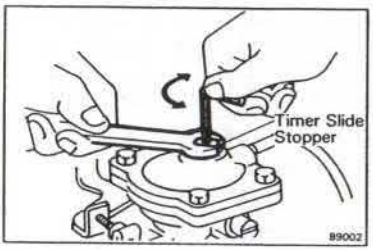


If the injection volume at 100 rpm is not within specification, replace the governor sleeve plug.

Governor sleeve plug head thickness mm (in.)	
3.3 (0.130)	3.7 (0.146)
3.4 (0.134)	3.8 (0.150)
3.5 (0.138)	3.9 (0.154)
3.6 (0.142)	4.0 (0.157)

NOTE: Lengthening the plug 0.1 mm (0.004 in.) will increase injection volume by 0.6 cc (0.04 cu in.).

If the variation limit exceeds specification, replace the delivery valve.

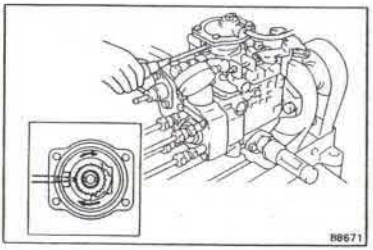


13. MEASURE AND ADJUST FULL LOAD MINIMUM INJECTION VOLUME (CV)

(a) Measure the injection volume.

Pump rpm	No. of measuring strokes	Injection volume cc (cu in.)
500	200	6.9 – 7.6 (0.42 – 0.46)

(b) Using an allen wrench, adjust the timer slide stopper.



14. MEASURE AND ADJUST BOOST COMPENSATOR CHARACTERISTIC (CV)

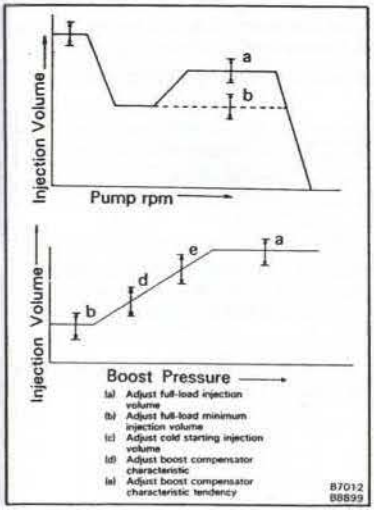
(a) Apply 0.14 kg/cm² (2.0 psi, 14 kPa) of pressure to the boost compensator.

(b) Measure the injection volume.

Pump rpm	No. of measuring strokes	Injection volume cc (cu in.)
1,500	200	8.4 – 9.2 (0.51 – 0.56)

(c) Using a screwdriver, adjust the No. 3 guide bushing.

NOTE: When the guide bushing is turned clockwise, as seen from above, the injection volume will increase.



15. INSPECT BOOST COMPENSATOR CHARACTERISTIC TENDENCY (CV)

(a) Apply 0.27 kg/cm² (3.8 psi, 26 kPa) of pressure to the boost compensator.

(b) Measure the injection volume.

Pump rpm	No. of measuring strokes	Injection volume cc (cu in.)
1,500	200	9.4 – 10.3 (0.57 – 0.63)

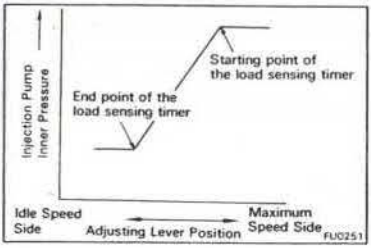
16. CHECK HYSTERESIS (CV)

Compare the injection volume when the boost compensator pressure is lowered from 0.48 to 0.27 and 0.14 to 0 kg/cm² and, conversely, when it is raised from zero.

NOTE: Make measurements after moving the adjusting lever between idle and maximum three times for each lowering of the pressure.

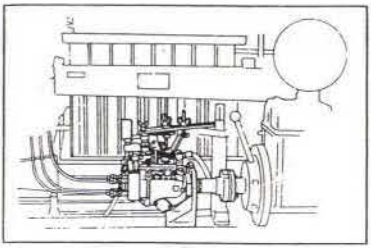
Pump rpm	Pressure kg/cm²(psi, kPa)	No. of measuring strokes	Injection volume cc (cu in.)	Hysteresis cc (cu in.)
1,500	0.48 (6.8, 47)	200	10.1 – 10.5 (0.62 – 0.64)	–
	0.27 (3.8, 26)		9.4 – 10.3 (0.57 – 0.63)	Less than 0.3 (0.02)
	0.14 (2.0, 14)		8.4 – 9.2 (0.51 – 0.56)	–
	0		6.9 – 7.6 (0.42 – 0.46)	

If not within standard value, check each sliding part of the boost compensator and check whether or not there is any oil.



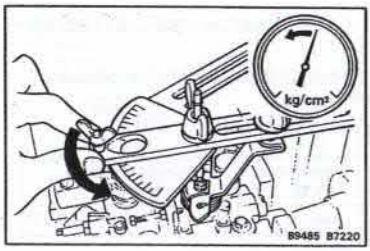
17. ADJUST LOAD SENSING TIMER

(a) Adjust the starting and end points of the load sensing timer with the governor shaft.



(b) Measure the injection volume.

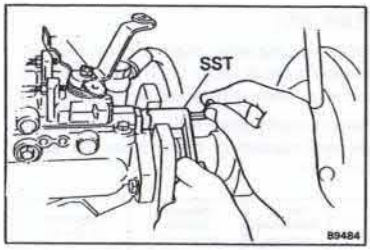
Adjusting lever position	Pump rpm	No. of measuring strokes
Maximum speed side	1,800	200



(c) Slowly move the adjusting lever from the maximum speed side to the idle speed side, and secure it at the point where the pump inner pressure begins to drop.

(d) Measure the injection volume at the drop point (starting point).

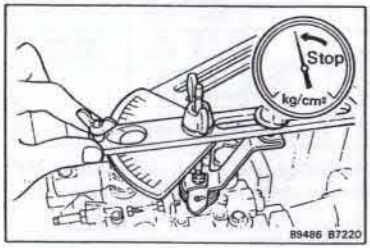
Pump revolution (rpm)	Measuring strokes	Injection volume cc (cu in.)
1,800	200	Measured value at Step (b) minus 1.0 (0.06) ± 0.3 (0.02)



If the injection volume is not within standard, adjust by turning the governor shaft with SST, and perform the measurement again until it is within standard.

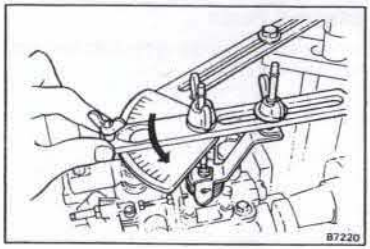
SST 09260-54012

NOTE: One-half turn of the governor shaft will alter the injection volume by 3 cc (0.2 cu in.).



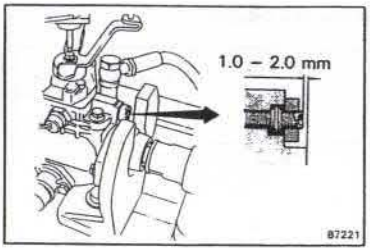
(e) Check the end point injection volume by slowly moving the adjusting lever from the maximum speed side to the idle speed side, and secure it at the point where the pump inner pressure stops dropping.

Pump revolution (rpm)	Measuring strokes	Injection volume cc (cu in.)
1,800	200	1.7 – 2.3 (0.10 – 0.14)



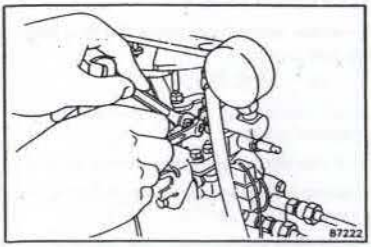
(f) Check the timer piston fluctuation when the adjusting lever is moved from the full side to the idle side.

Pump rpm	Timer piston fluctuation mm (in.)
1,100	0.93 – 1.53 (0.057 – 0.093)



(g) Check the protrusion of the governor shaft.

Protrusion: 1.0 – 2.0 mm (0.039 – 0.079 in.)

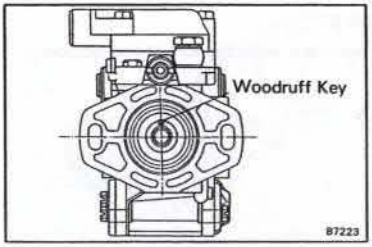


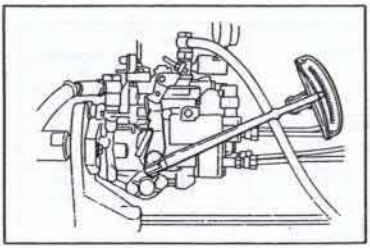
18. ADJUST IDLE SPEED

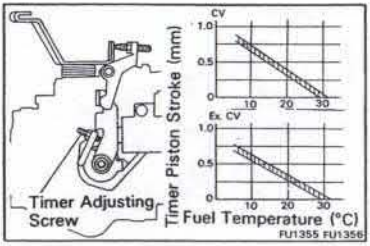
Adjust the injection volume with the idle speed adjusting screw.

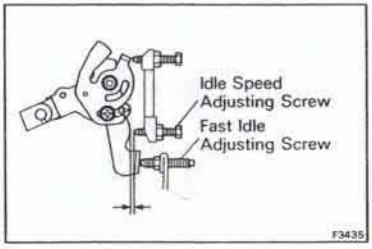
Item	Adjusting lever angle	Pump rpm	No. of measuring strokes	Injection volume cc (cu in.)	Variation limit cc (cu in.)	Remarks
CE70, 80 CV CT *1	Minus 24 – 34°	400	200	q=1.65 – 2.55 (0.10 – 0.16)	0.34 (0.02)	Adjust
		375		More than q Plus 0.5 (0.03)	—	—
		475		q Minus [1.2 – 2.2 (0.07 – 0.13)]		
CM CR	Minus 30 – 40°	400	200	q=1.65 – 2.55 (0.10 – 0.16)	0.34 (0.02)	Adjust
		375		More than q Plus 0.5 (0.03)	—	—
		475		q Minus [1.2 – 2.2 (0.07 – 0.13)]		

*1: w/HAC Apply 730 ± 1.5 mm Hg (28.74 ± 0.06 in. Hg, 97.3 ± 0.2 kPa) absolute pressure









19. ADJUST COLD STARTING SYSTEM

(a) Remove the overflow screw and check the fuel temperature in the fuel pump.

Fuel temperature: 15 – 35°C (59 – 95°F)

(b) Set the woodruff key on the pump drive shaft in a vertical or horizontal position.

(c) Set the scale of the timer measuring device to zero.

(d) Check the adjusting lever opening angle and consider this angle as zero.

(e) Remove the metal plate put between the cold starting lever and thermo wax.

(f) Torque the cold starting lever clockwise to approx. 50 kg-cm (43 in.-lb, 4.9 N·m) and keep the lever tightened for about 10 seconds. Then release the torque.

(g) Measure the timer piston stroke.

If not within specification, adjust with the timer adjusting screw.

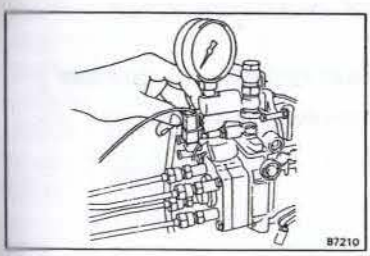
NOTE: Screw in for stroke decrease.

20. ADJUST FAST IDLE

(a) Measure the clearance between the adjusting lever and idle speed adjusting screw.

Fuel temperature	Clearance
15°C (59°F)	1.5 mm (0.059 in.)
40°C (104°F)	0 mm (0 in.)

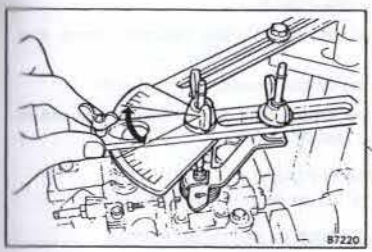
(b) Adjust the fast idle adjusting screw.



21. POST ADJUSTMENT CHECK

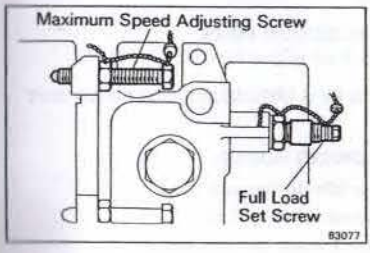
(a) Check that injection stops when the fuel cut solenoid harness is removed.

Pump revolution: 100 rpm



(b) Check the adjusting lever movement.

CE80, CV, CT	CE70, CM, CR
42 – 52°	39 – 47°

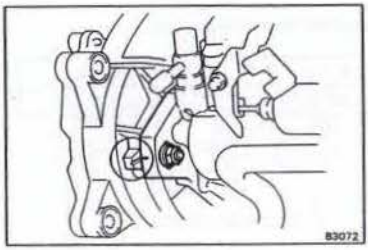


(c) Lock the maximum speed adjusting screw and full load set screw with the wires as shown in the figure.

INSTALLATION OF INJECTION PUMP

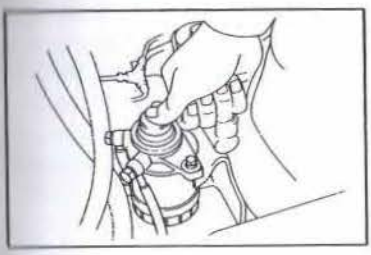
(See page FU-12)

1. INSTALL FUEL INLET PIPE TO INJECTION PUMP
2. INSTALL INJECTION PUMP REAR BRACKET



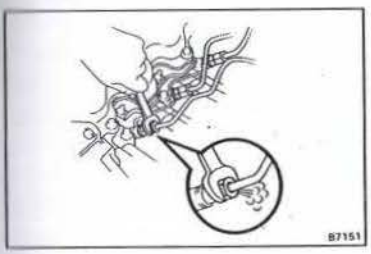
3. INSTALL INJECTION PUMP
   (a) Align the matchmarks on the injection pump and water pump.
   (b) Temporarily install the mount bolt and nuts.

   NOTE: Torque the mount bolt and nut to specification after adjusting the injection timing.
4. INSTALL INJECTION PUMP DRIVE PULLEY
   (See steps 4, 7 to 19 on pages EM-32 to 37)
5. INSPECT AND ADJUST INJECTION TIMING
   (See page EM-20)
6. INSTALL FOUR INJECTION PIPES
   (See steps 5 and 8 on pages FU-10 and 11)
7. INSTALL HEATER PIPE MOUNTING BOLT AND NUT (FF Vehicles)
8. CONNECT FOLLOWING HOSES:
   (a) A/C or heater idle-up vacuum hose
   (b) Boost compensator hose (CV)
   (c) No. 1 and No. 2 water by-pass hoses
   (d) Fuel inlet and outlet hoses
9. CONNECT FUEL CUT SOLENOID CONNECTOR
10. CONNECT THROTTLE CABLE TO INJECTION PUMP (w/ AT)
11. CONNECT ACCELERATOR CABLE TO INJECTION PUMP
12. FILL WITH COOLANT (See step 3 on page CO-3)



13. FILL INJECTION PUMP WITH FUEL

Operate the priming pump until you feel more resistance.



14. BLEED INJECTION NOZZLES

(a) Loosen all union nuts of the injection pipe on the nozzle holder side.

(b) Crank the engine to bleed the air and force out the fuel from the injection pipe.

15. START ENGINE AND CHECK FOR FUEL LEAKS

16. CHECK ENGINE IDLE SPEED AND MAXIMUM SPEED (See page EM-23)

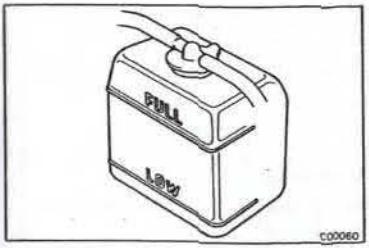
17. RECHECK COOLANT LEVEL

COOLING SYSTEM

TROUBLESHOOTING

Problem	Possible cause	Remedy	Page
Engine overheats	Fan belt loose or missing	Adjust or replace belt	CH-4
	Dirt, leaves or insects on radiator or condenser	Clean radiator or condenser	CO-7
	Hoses, water pump, thermostat housing, radiator, heater, core plugs or head gasket leakage	Repair as necessary	
	Thermostat faulty	Check thermostat	CO-6
	Injection timing retarded	Set timing	EM-20
	Electric cooling system faulty	Inspect electric cooling system	CO-12
	Radiator hose plugged or rotted	Replace hose	
	Water pump faulty	Replace water pump	CO-4
	Radiator plugged or cap faulty	Check radiator and cap	CO-7
	Cylinder head or block cracked or water passage clogged	Repair as necessary	

NOTE: If the engine tends to overheat, removal of the thermostat would have an adverse effect, causing a lowering of cooling efficiency.

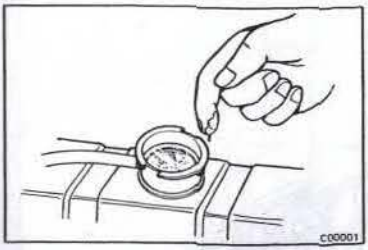


CHECK AND REPLACEMENT OF ENGINE COOLANT

1. CHECK COOLANT LEVEL

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

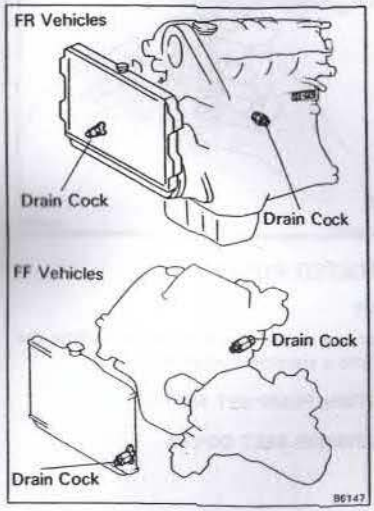
If low, check for leakage and add coolant up to the FULL line.



2. CHECK COOLANT QUALITY

There should not be any excessive deposit of rust or scales around the radiator acp or radiator filler hole, and the coolant should also be free from oil.

If excessively dirty, replace the coolant.



3. REPLACE ENGINE COOLANT

(a) Drain the coolant from the radiator and engine drain cocks. (Engine drain is at right rear of engine block.)

(b) Close the drain cocks.

(c) Fill the system with coolant.

Use a good brand of ethylene-glycol base coolant, mixed according to the manufacturer's directions.

Coolant capacity (w/ heater):

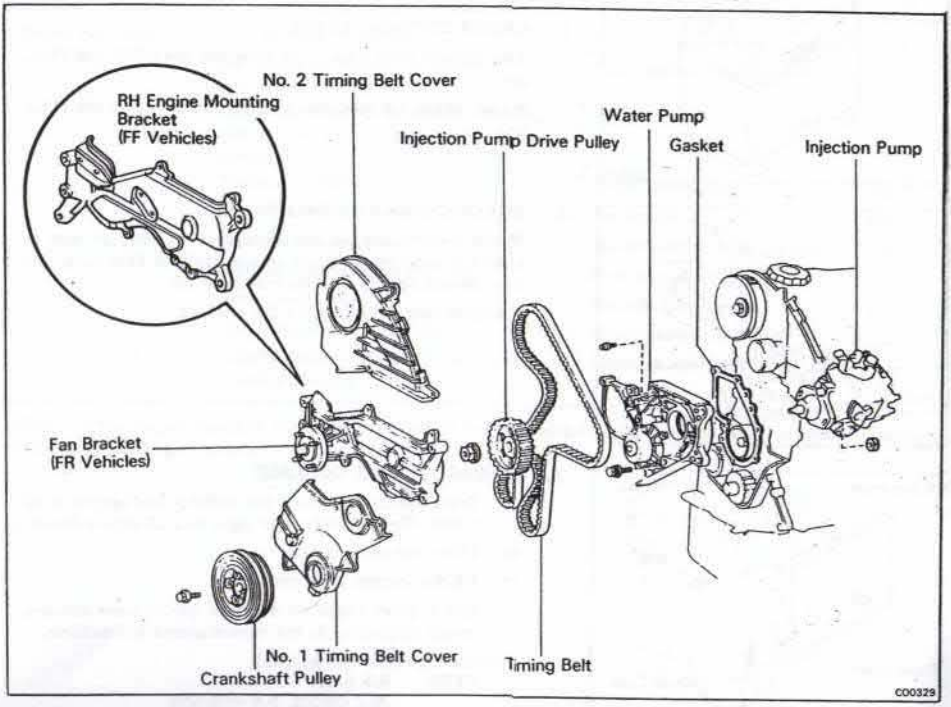
CE70	6.3 liters (6.7 USqts, 5.5 Imp.qts)
CE80	7.3 liters (7.7 USqts, 6.4 Imp.qts)
CV, CT	7.5 liters (7.9 USqts, 6.6 Imp.qts)
CM	7.0 liters (7.4 USqts, 6.2 Imp.qts)
CR	7.1 liters (7.5 USqts, 6.2 Imp.qts)

(d) Start the engine and check for leaks.

(e) Recheck the coolant level and refill as necessary.

WATER PUMP

COMPONENTS



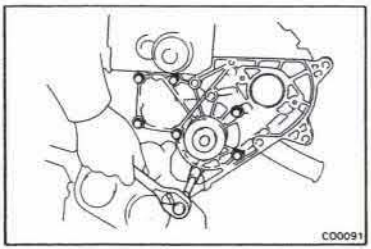
REMOVAL OF WATER PUMP

1. **DRAIN COOLANT**

   Open the radiator and engine drain cocks, and allow the coolant to drain into a suitable container.

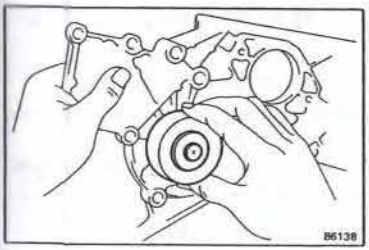
2. **REMOVE INJECTION PUMP SET NUTS**

3. **REMOVE NO. 3 TIMING BELT COVER**



4. **REMOVE WATER PUMP**

   Remove seven bolts, and remove the water pump with its gasket.

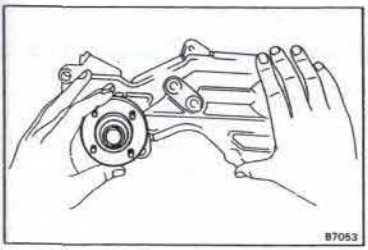


INSPECTION OF WATER PUMP

1. INSPECT WATER PUMP PULLEY

Check that water pump pulley operation is not rough or noisy.

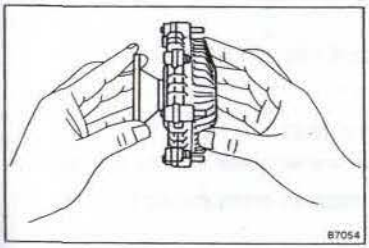
If neccessary, replace the water pump.



2. INSPECT FAN BRACKET (FR Vehicles)

Check that fan bracket operation is not rough or noisy.

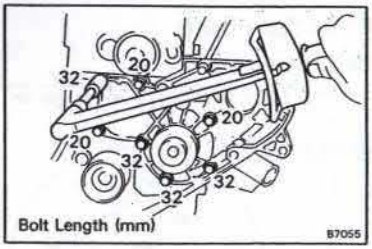
If necessary, replace the fan bracket.



3. INSPECT FLUID COUPLING (FR Vehicles)

Check the fluid coupling for damage and silicon oil leakage.

If necessary, replace the fluid coupling.



INSTALLATION OF WATER PUMP

(See page CO-4)

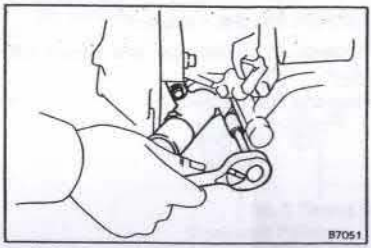
1. **INSTALL WATER PUMP OVER NEW GASKET**

   Install the water pump on a new gasket with seven bolts. Torque the bolts.

   NOTE: Each bolt length (mm) is indicated in the figure.

   Torque: 185 kg-cm (13 ft-lb, 18 N·m)

2. **INSTALL NO.3 TIMING BELT COVER**
3. **INSTALL INJECTION PUMP SET NUTS**
4. **REFILL WITH COOLANT (See step 3 on page CO-3)**
5. **START ENGINE AND CHECK FOR LEAKS**



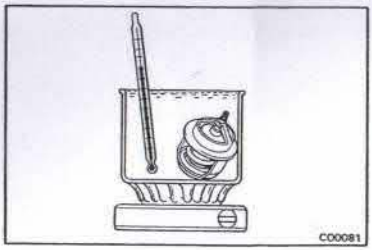
THERMOSTAT

REMOVAL OF THERMOSTAT

1. **DRAIN COOLANT**
2. **REMOVE WATER INLET**

   Remove two bolts and water inlet from the cylinder block.

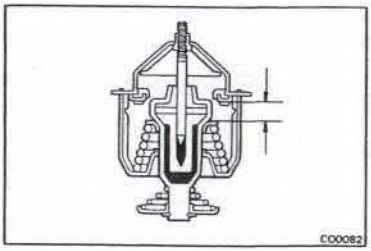
3. **REMOVE THERMOSTAT WITH GASKET**



INSPECTION OF THERMOSTAT

NOTE: Thermostat is numbered with the valve opening temperature.

(a) Immerse the thermostat in water and heat the water gradually.



(b) Check the valve opening temperature and the valve lift.

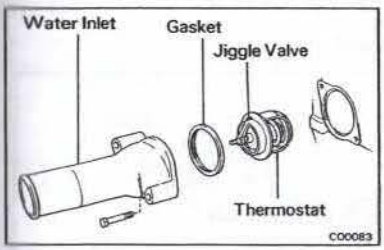
Valve opening temperature: 80 — 84°C (176 — 183°F)

Valve lift: More than 8 mm (0.31 in.) at 95°C (203°F)

If the valve opening temperature and valve lift are not within the specifications above, replace the thermostat.

(c) Check that the valve spring is tight when the thermostat is fully closed.

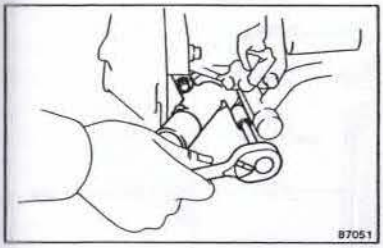
If not closed, replace the thermostat.



INSTALLATION OF THERMOSTAT

1. PLACE THERMOSTAT IN CYLINDER BLOCK

Install a new gasket to the thermostat and set the thermostat in the cylinder block with the jiggle valve on top.



2. INSTALL WATER INLET

Install the water inlet with two bolts. Torque the bolts.

Torque: 75 kg-cm (65 in.-lb, 7.4 N·m)

3. REFILL WITH COOLANT (See step 3 on page CO-3)

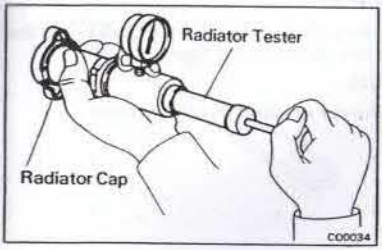
4. START ENGINE AND CHECK FOR LEAKS

RADIATOR

CLEANING OF RADIATOR

Using water or a steam cleaner, remove any mud and dirt from the radiator core.

CAUTION: If using a high pressure type cleaner, be careful not to deform the fins of the radiator core. If the cleaner nozzle pressure is 30 – 35 kg/cm² (427 – 498 psi, 2,942 – 3,432 kPa), keep a distance of at least 40 – 50 cm (15.75 – 19.69 in.) between the radiator core and cleaner nozzle.



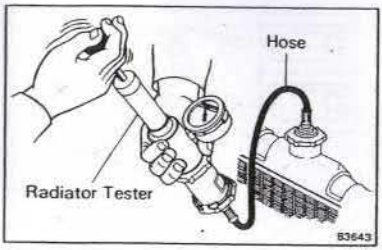
INSPECTION OF RADIATOR

1. CHECK RADIATOR CAP

Using a radiator tester, pump the tester until the relief valve opens. Check that the valve opens between 0.75 kg/cm² (10.7 psi, 74 kPa) and 1.05 kg/cm² (14.9 psi, 103 kPa).

Check that the pressure does not drop rapidly when pressure on the cap is below 0.6 kg/cm² (8.5 psi, 59 kPa).

If either check is not within limits, replace the cap.

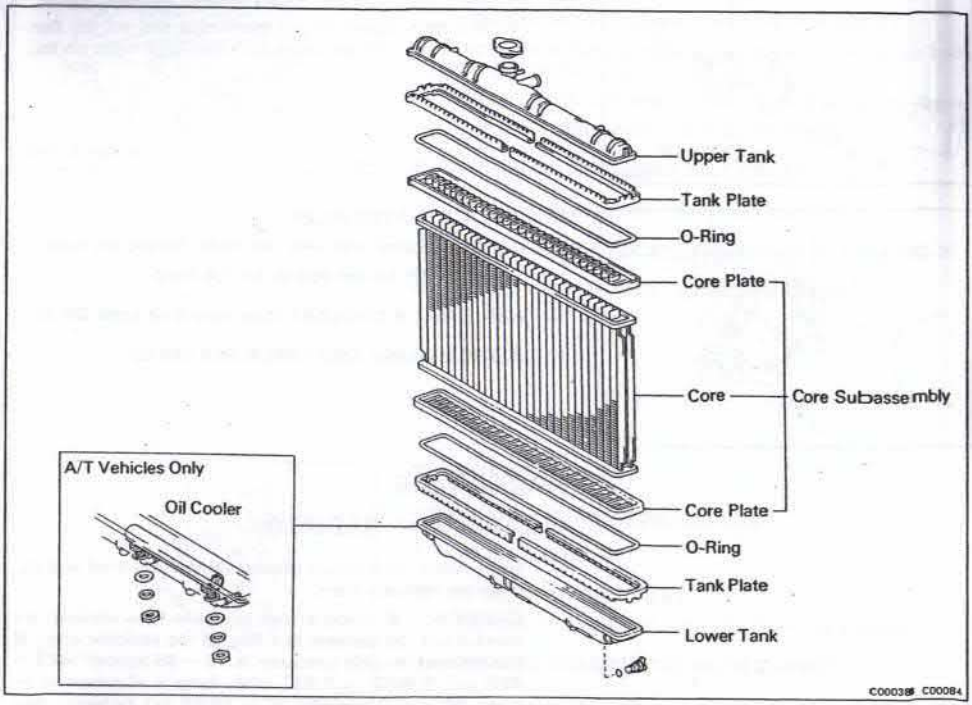


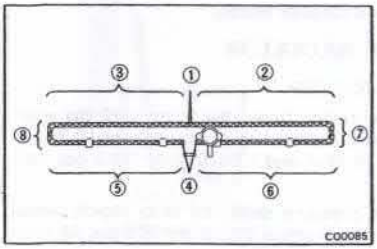
2. CHECK COOLING SYSTEM FOR LEAKS

Attach radiator tester to the radiator, and pump the tester to 0.9 kg/cm² (12.8 psi, 88 kPa). Check that pressure does not drop.

If the pressure drops, check for leaks from the hoses, radiator or water pump. If no external leaks are found, check the heater core, block and head.

DISASSEMBLY OF RADIATOR (RESIN TANK Only)



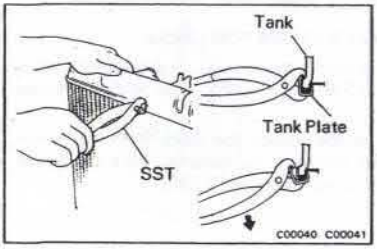


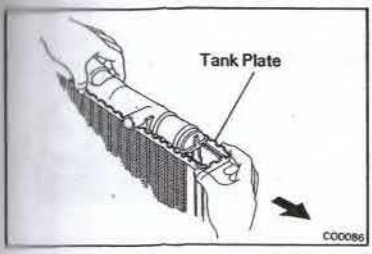
1. **REMOVE TANK PLATE**

(a) Raise the claws of the tank plates with SST in the numerical order shown in the figure.

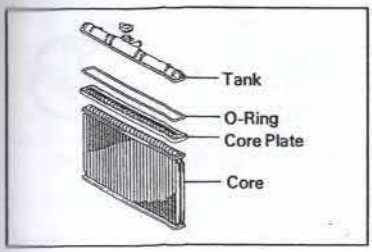
SST 09230-00010

NOTE: Be careful not to damage the core plate.





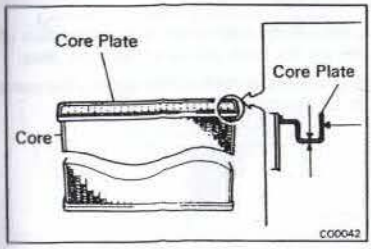
(b) Pull the tank plates outward.



2. **REMOVE TANK AND O-RING**
   (a) Pull the tank upward.
   (b) Remove the O-ring.

ASSEMBLY OF RADIATOR

(See page CO-8)

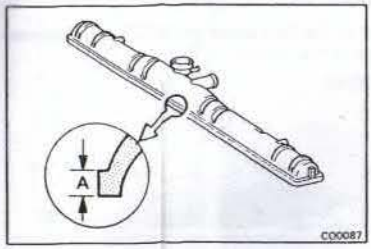


1. **INSPECT CORE PLATE**

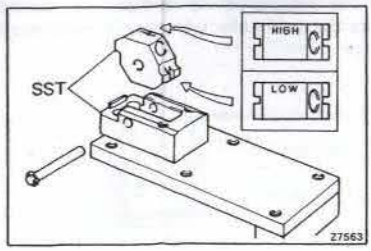
   Inspect the core plate for damage.

   NOTE:

   - If the sides of the core plate groove are deformed, reassembly of the tank will be impossible. Therefore, first correct any deformation with a pliers or such.
   - Water leakage will result if the bottom of the core plate groove is damaged or dented. Therefore, repair or replace if so damaged.



2. **MEASURE HEIGHT AND SELECT SST PUNCH**
   (a) Measure the height of A, as shown, for the lower and upper tanks.

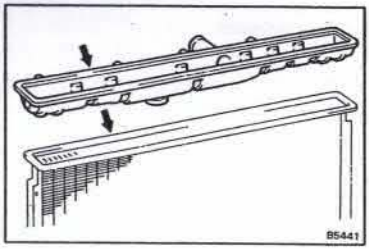


   (b) Select a low punch SST.

   SST 09230-00010

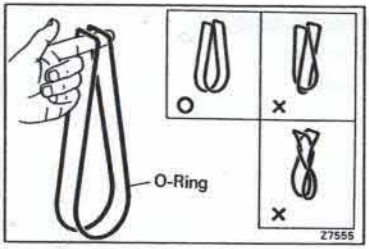
   NOTE: Use high punch if height (A) is 6 mm (0.236 in.).

   (c) Install SST.

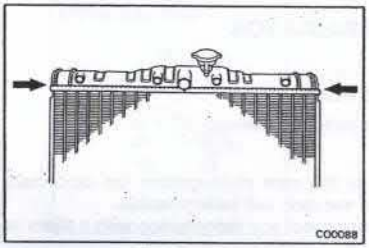


3. **INSTALL NEW O-RING AND TANK**

NOTE:
(1) Clean the tank and core plate.



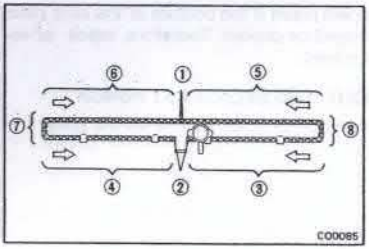
(2) Inspect the O-ring for twists.



4. **INSTALL TANK PLATES**

Insert the tank plates from both ends in the direction of the arrows. Firmly set the tank plates in the core plate.

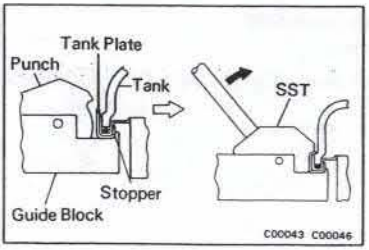
NOTE: The upper and lower tank plates are not the same so be careful not to interchange them.



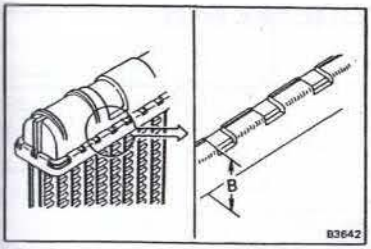
5. **STAKE CLAW OF TANK PLATES**

Stake the claws of the tank plates with SST in the numerical order shown in the figure.

SST 09230-00010



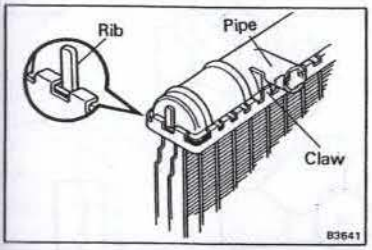
CAUTION: If the bottom of the core plate is staked with the SST on the guide block stopper, it may result in water leakage.



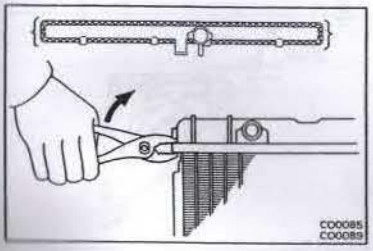
NOTE:

(1) Stake with just enough pressure to leave a mark on the claw. The staked plate height (B) should be as follows:

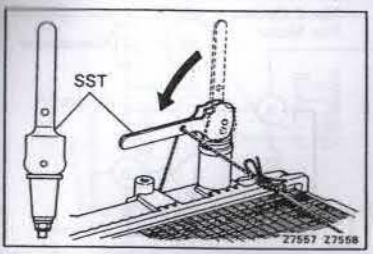
Height (B): 9.0 – 9.4 mm (0.354 – 0.370 in.)



(2) Do not stake the areas protruding around the pipes, brackets or tank ribs.



(3) The points shown in the illustration cannot be staked with the SST. Use a pliers or such and be careful not to damage the core plates.



6. **INSPECT FOR WATER LEAKS**

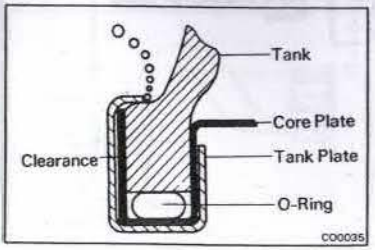
(a) Tighten the drain plug.

(b) Plug the inlet and outlet pipes of the radiator with SST.

SST SST 09230-00010

(c) Using a radiator tester, apply pressure to the radiator.

Test pressure: 1.8 kg/cm² (26 psi, 177 kPa)



(d) Inspect for water leaks.

NOTE: On radiators with resin tanks, there is a clearance between the core plate and tank plate where a minute amount of air will remain, causing an appearance of an air leak when the radiator is submerged in water. Therefore, before performing the water leak test, first swish the radiator around in the water until all air bubbles disappear.

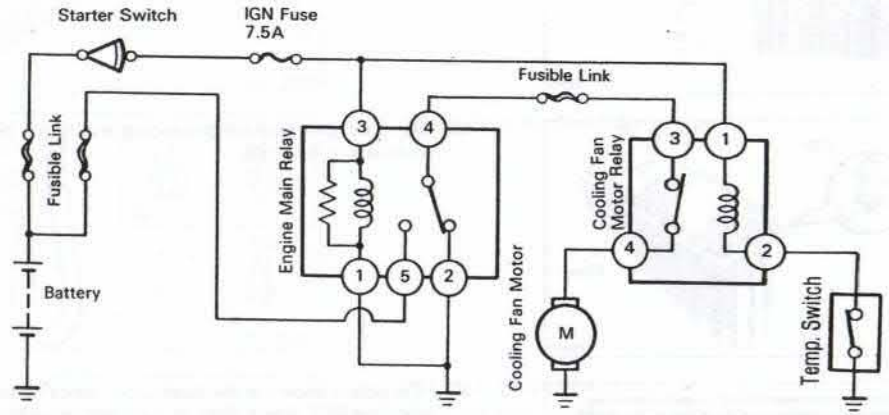
7. **PAINT TANK PLATES**

NOTE: If the water leak test checks out okay, allow the radiator to completely dry and then paint the tank plate.

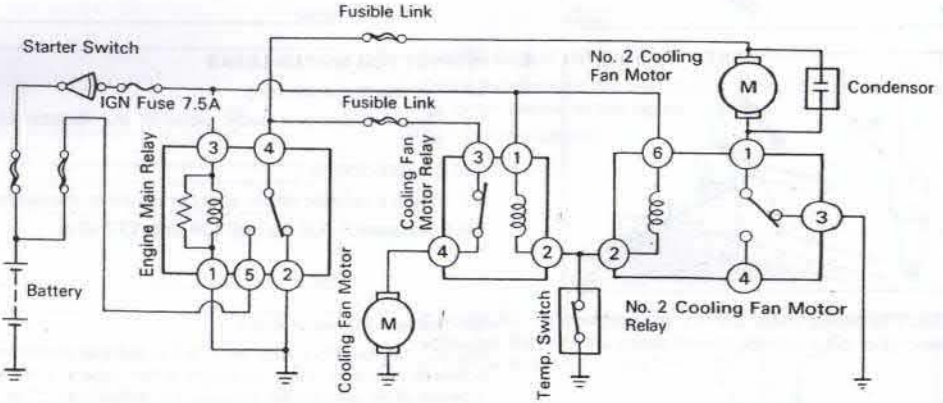
ELECTRIC COOLING FAN

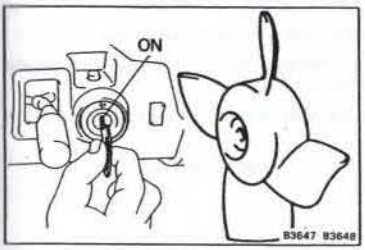
SYSTEM CIRCUIT

Ex. CV with A/T



CV with A/T only





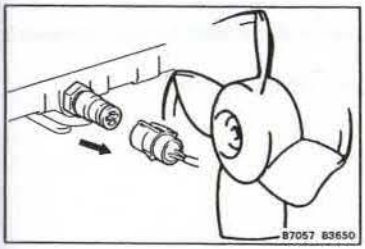
ON-VEHICLE INSPECTION

Low Temperature [below 83°C or 181°F]

1. **TURN STARTER SWITCH ON**

   Confirm that the fan stops.

   If it does not, check the fan relay and temperature switch, and check for a separated connector or severed wire between the relay and temperature switch.

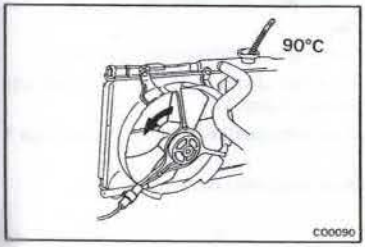


2. **DISCONNECT TEMPERATURE SWITCH CONNECTOR**

   Confirm that the fan turns.

   If not, check the fan relay, fan motor, main relay and fuse, and check for a short circuit between the fan relay and temperature switch.

3. **CONNECT TEMPERATURE SWITCH CONNECTOR**



High Temperature [above 90°C or 194°F]

4. **START ENGINE**

   (a) Raise the engine temperature to above 90°C (194°F).

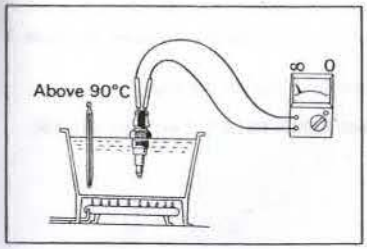
   (b) Confirm that the fan turns.

   If not, replace the temperature switch.

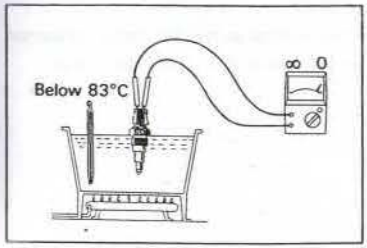
INSPECTION OF ELECTRIC COOLING FAN

1. **INSPECT TEMPERATURE SWITCH**

   LOCATION: On the radiator.

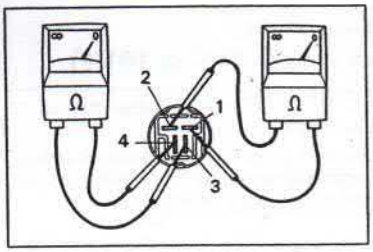


   (a) Using an ohmmeter, check that there is no continuity when the coolant temperature is above 90°C (194°F).



   (b) Check that there is continuity when the coolant temperature is below 83°C (181°F).

   If continuity is not as specified, replace the switch.



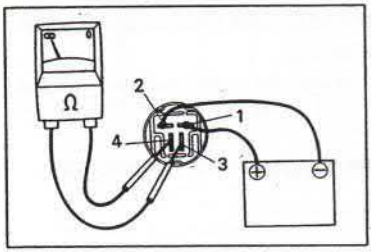
2. INSPECT COOLING FAN MOTER RELAY

LOCATION: In the engine compartment relay box.

(a) Using an ohmmeter, check that there is continuity between terminals 1 and 2.

(b) Check that there is continuity between terminals 3 and 4.

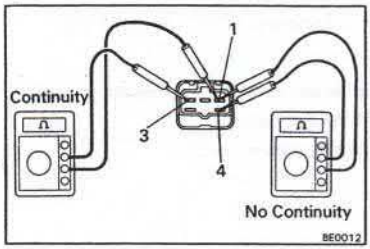
If there is no continuity, replace the relay.



(c) Apply battery voltage between terminals 1 and 2.

(d) Check that there is no continuity between terminals 3 and 4.

If there is continuity, replace the relay.



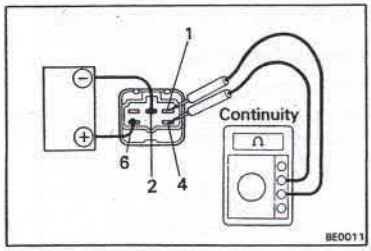
3. INSPECT NO. 2 COOLING FAN MOTOR RELAY (CV with A/T only)

LOCATION: In the engine compartment relay box.

(a) Using an ohmmeter, check that there is continuity between terminals 1 and 3.

(b) Check that there is no continuity between terminals 1 and 4.

If continuity is not as specified, replace the relay.

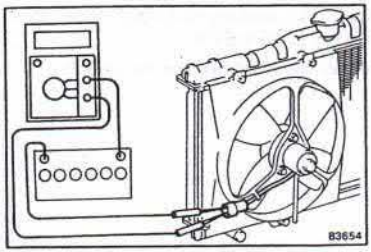


(c) Apply battery voltage between, terminals 6 and 2.

(d) Check that there is continuity between terminals 1 and 4.

If there is no continuity, replace the relay.

4. INSPECT ENGINE MAIN RELAY (See page CH-19)



5. INSPECT FAN MOTOR

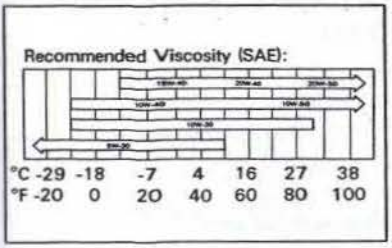
(a) Connect battery voltage to the fan motor connector.

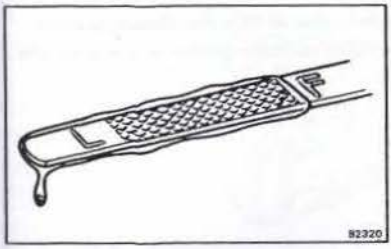
(b) Check to see that the motor rotates smoothly.

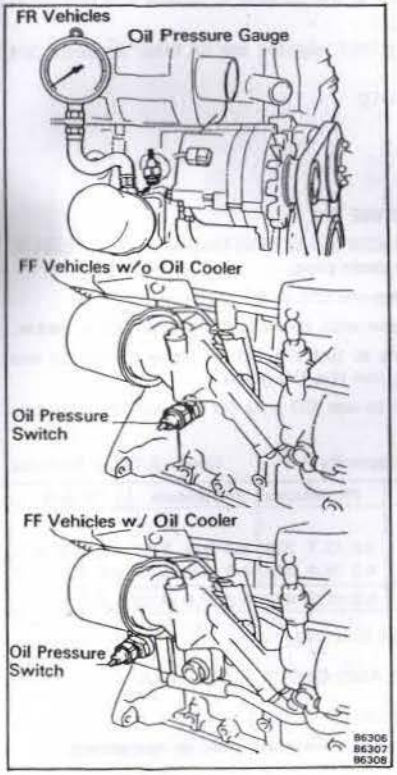
LUBRICATION SYSTEM

TROUBLESHOOTING

Problem	Possible cause	Remedy	Page
Oil leakage	Cylinder head, cylinder block or oil pump body damaged or cracked	Repair as necessary	
	Oil seal faulty	Replace oil seal	EM-62 or EM-83
	Gasket faulty	Replace gasket	
Low oil pressure	Oil leakage	Repair as necessary	
	Relief valve faulty	Repair relief valve	LU-5
	Oil pump faulty	Repair oil pump	LU-5
	Engine oil poor quality	Replace engine oil	LU-4
	Crankshaft bearing faulty	Replace bearing	EM-74
	Connecting rod bearing faulty	Replace bearing	EM-72
	Oil filter clogged	Replace oil filter	LU-4
High oil pressure	Relief valve faulty	Repair relief valve	LU-8







OIL PRESSURE CHECK

1. CHECK OIL QUALITY

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

If the oil quality is poor, change the oil.

Use API grade CD or better and recommended viscosity oil.

If it is impossible to get the CD or better grade by any means, you may use the CC grade.

NOTE: Be sure to use CD type for the vehicle with turbocharger.

2. CHECK OIL LEVEL

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

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

3. REMOVE OIL PRESSURE SWITCH

4. INSTALL OIL PRESSURE GAUGE

5. START ENGINE

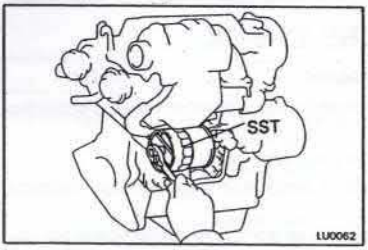
Start the engine and warm it up to normal operating temperature.

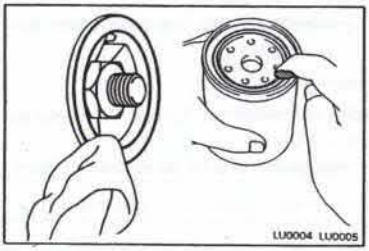
6. MEASURE OIL PRESSURE

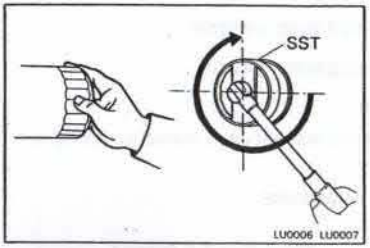
Oil pressure:

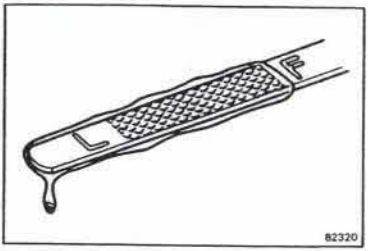
At idle	**More than 0.3 kg/cm² (4.3 psi, 29 kPa)**
At 3,000 rpm	**2.5–6.0 kg/cm² (36–85 psi, 245–588 kPa)**

NOTE: Check for oil leakage after reinstalling the oil pressure switch.









REPLACEMENT OF ENGINE OIL AND OIL FILTER

1. DRAIN ENGINE OIL

(a) Remove the oil filler cap.

(b) Remove the oil drain plug and drain the oil into a container.

2. REPLACE OIL FILTER

(a) Using SST, remove the oil filter.

SST 09228-44010

(b) Inspect and clean the oil filter installation surface.

(c) Apply clean engine oil to the gasket of a new oil filter.

(d) Lightly screw in the oil filter to where you feel resistance.

(e) Then, using SST, tighten the oil filter an extra 3/4 turn.

SST 09228-44010

3. FILL WITH ENGINE OIL

(a) Clean and install the oil drain plug with a new gasket. Torque the drain plug.

Torque: 400 kg-cm (29 ft-lb, 39 N-m)

(b) Fill the engine with new oil, API grade CD or better.

If it is impossible to get the CD or better grade by any means, you may use the CC grade.

NOTE: Be sure to use CD type for the vehicle with turbocharger.

Oil capacity Liters (USqts, Imp.qts)

	FR vehicles	FF vehicles	CV only
Drain and refill			
w/o Oil filter change	3.5 (3.7, 2.9)	3.8 (4.0, 3.3)	3.8 (4.0 ,3.3)
w/ Oil filter change	4.2 (4.4, 3.6)	4.3 (4.5, 3.8)	4.3 (4.5, 3.8)
Dry fill	5.0 (5.3, 4.4)	4.8 (5.1, 4.2)	5.0 (5.3, 4.4)

(c) Install the oil filler cap.

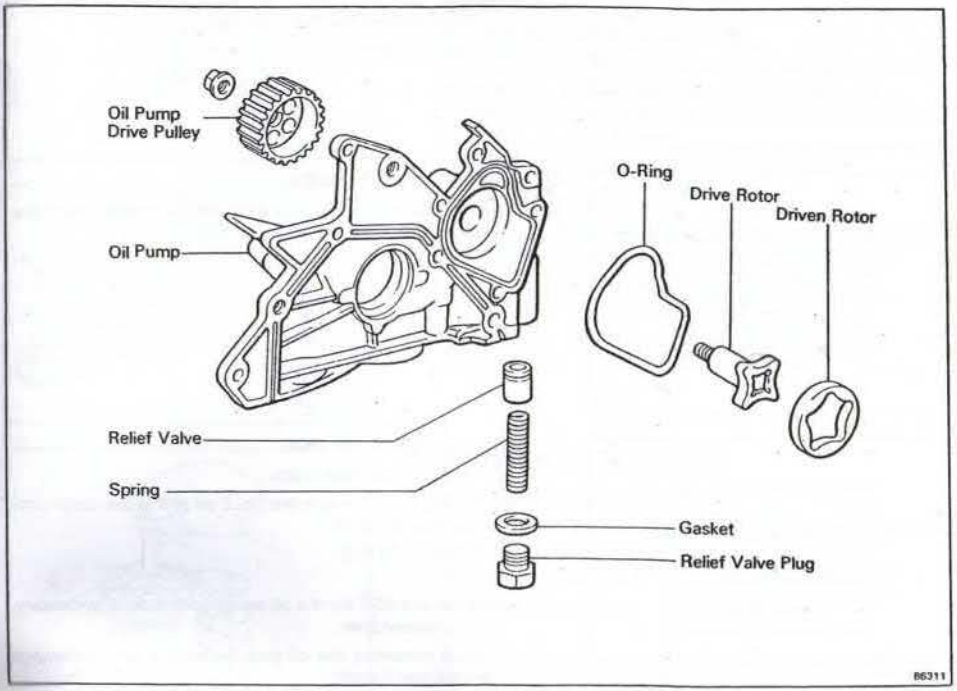
4. START ENGINE AND CHECK FOR LEAKS

5. RECHECK OIL LEVEL

Recheck the engine oil level and refill as necessary.

OIL PUMP

COMPONENTS



REMOVAL OF OIL PUMP

NOTE: When repairing the oil pump, the oil pan and strainer should be removed and cleaned.

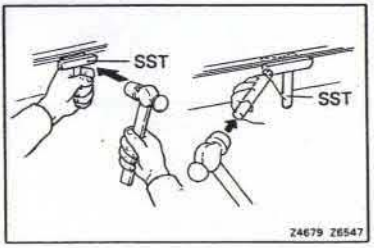
1. **RAISE VEHICLE**

   CAUTION: Be sure the vehicle is securely supported.

2. **DRAIN ENGINE OIL**

3. **REMOVE TIMING BELT**
   (See steps 1 to 12 on pages EM-26 to 28)

4. **REMOVE NO. 2 IDLER AND CRANKSHAFT TIMING PULLEYS (See steps 16 and 18 on page EM-29)**

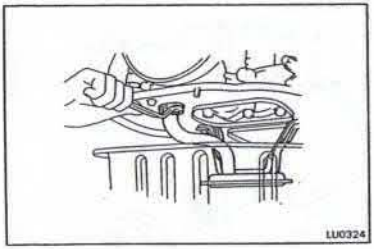


5. REMOVE NO. 1 OIL PAN

(a) Remove the bolts and nuts.

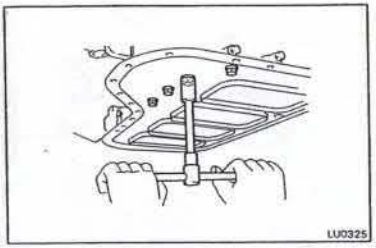
(b) Insert the blade of SST between the No. 1 oil pan, No. 2 oil pan and cylinder block, cut off the sealer and then remove the No. 1 oil pan.

SST 09032-00100



6. REMOVE OIL STRAINER

Remove the two bolts, two nuts and oil strainer with the gasket.



7. REMOVE NO. 2 OIL PAN

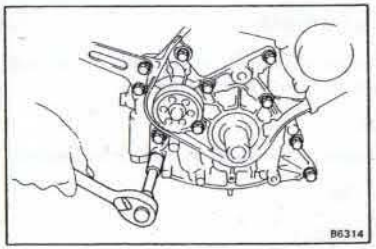
(a) Remove the four bolts.

(b) Using SST, remove the No. 2 oil pan in the same procedure (step 5).

SST 09032-00100

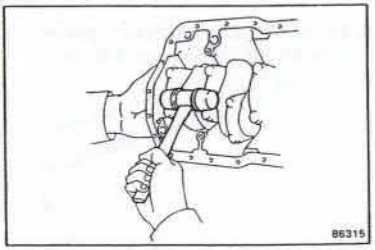
NOTE:

- Do not use SST for the oil pump body side. If necessary, use a screwdriver.
- When removing the oil pan, be careful not to damage the oil pan flange.



8. REMOVE OIL PUMP

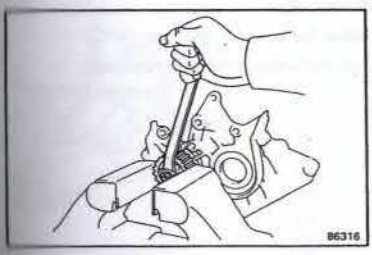
(a) Remove the eleven bolts and alternator stay.



(b) Using a plastic hammer, carefully tap off the oil pump and remove it.

CAUTION:

- **Be careful not to damage the crankshaft oil seal with the crankshaft woodruff key.**
- **Do not drop the driven rotor.**



DISASSEMBLY OF OIL PUMP

(See page LU-5)

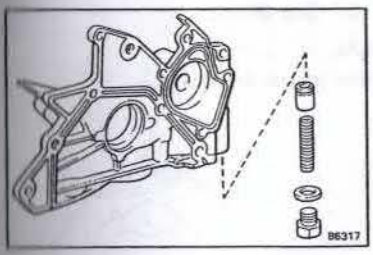
1. REMOVE PULLEY AND ROTORS

(a) Pull out the driven rotor.

(b) Hold the pulley in a soft jaw vise, and remove the nut.

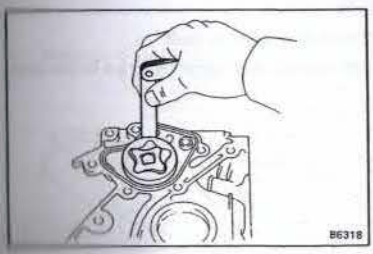
CAUTION: Be careful not to scratch the pulley. If the pulley is scratched, repair it with sandpaper (#400).

(c) Pull out the drive rotor and pump body.



2. REMOVE RELIEF VALVE

Unscrew the relief valve pulg and remove the spring and relief valve piston.



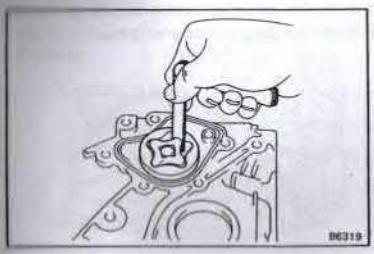
INSPECTION OF OIL PUMP

1. MEASURE BODY CLEARANCE

Using a feeler gauge, measure the clearance between the driven rotor and pump body.

Maximum clearance:	**0.20 mm (0.0079 in.)**
Standard clearance:	**0.10 – 0.17 mm (0.0039 – 0.0067 in.)**

If the clearance is greater than the maximum, replace the oil pump rotor set and/or pump body.

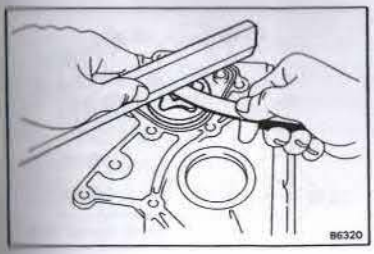


2. MEASURE TIP CLEARANCE

Using a feeler gauge, measure the clearance between both rotor tips.

Maximum clearance:	**0.20 mm (0.0079 in.)**
Standard clearance:	**0.05 – 0.15 mm (0.0020 – 0.0059 in.)**

If the clearance is greater than the maximum, replace the oil pump rotor set.

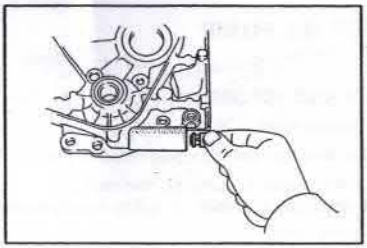


3. MEASURE SIDE CLEARANCE

Using a feeler gauge and flat block, measure the side clearance as shown.

Maximum clearance:	**0.15 mm (0.0059 in.)**
Standard clearance:	**0.03 – 0.09 mm (0.0012 – 0.0035 in.)**

If the clearance is greater than the maximum, replace the rotor and/or pump body.

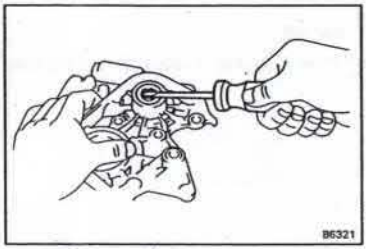


4. INSPECT RELIEF VALVE

Check the relief valve for scoring or wear.

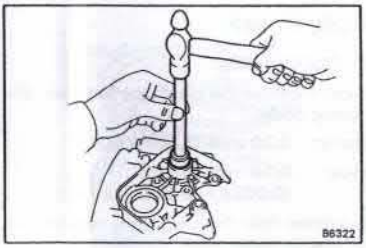
If damaged, replace the valve or pump assembly.

REPLACEMENT OF OIL SEAL



1. REMOVE OIL SEAL

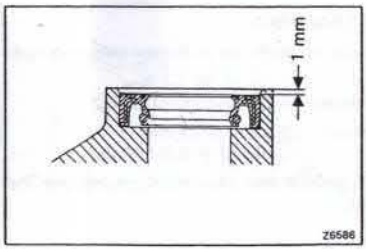
Using a screwdriver, pry out the oil seal.



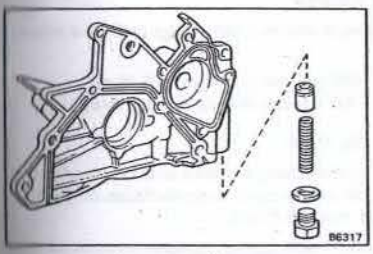
2. INSTALL OIL SEAL

(a) Apply MP grease to a new oil seal.

(b) Using a socket wrench and hammer, drive in the new oil seal.



CAUTION: Drive in the oil seal to the depth of about 1 mm (0.04 in.) from the pump body edge.

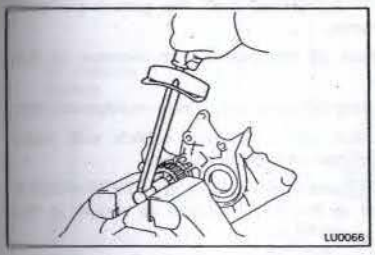


ASSEMBLY OF OIL PUMP

(See page LU-5)

1. INSTALL RELIEF VALVE

Insert the relief valve and spring, and then screw on the relief valve plug.



2. INSTALL ROTORS AND PULLEY

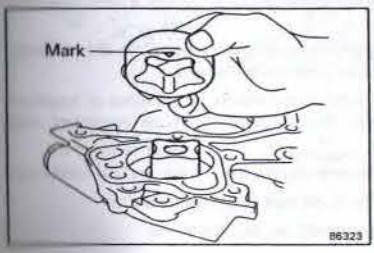
(a) Place the drive rotor and pulley on the pump body.

(b) Finger tighten the nut.

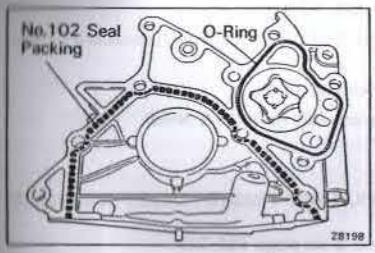
(c) Hold the pulley in a soft jaw vise, and torque the nut.

Torque: 475 kg-cm (34 ft-lb, 47 N·m)

CAUTION: Be careful not to scratch the pulley teeth. If the teeth are scratched, repair with sandpaper (#400).



(d) Place the driven rotor into the pump body with the delta mark facing the pump body.



INSTALLATION OF OIL PUMP

(See page LU-5)

1. INSTALL OIL PUMP

(a) Place a new O-ring into the groove.

(b) Apply No. 102 seal packing (Part No. 08826-00080) or equivalent to the oil pump body indicated by the dotted line in the figure.

NOTE:

- Do not apply excessive sealer around the bolt hole.
- Install the oil pump as soon as the seal packing is applied.

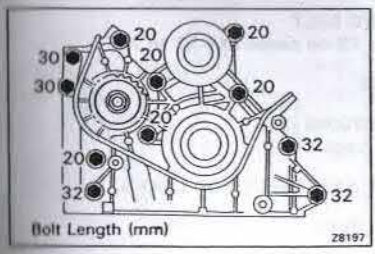
(c) Install the oil pump and alternator stay with the eleven bolts.

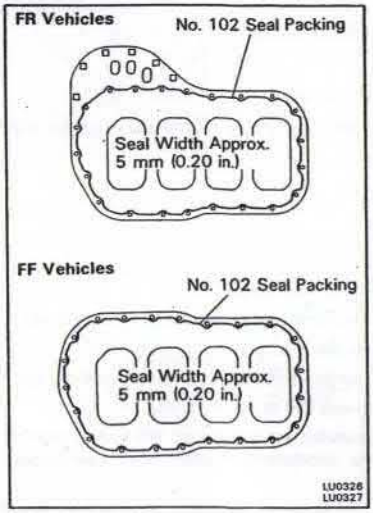
Torque: 185 kg-cm (13 ft-lb, 18 N·m)

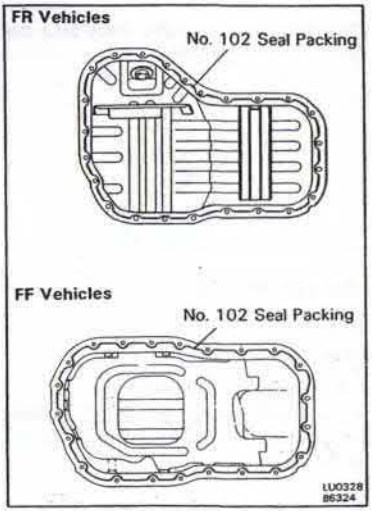
CAUTION:

- **When installing the oil pump, be careful not to damage the oil seal.**
- **Do not drop the driven rotor.**

NOTE: Each bolt length (mm) is indicated in the figure.







2. INSTALL OIL STRAINER

Install the strainer with the two bolts, two nuts and a new gasket.

Torque: Bolt 185 kg-cm (13 ft-lb, 18 N·m)
Nut 55 kg-cm (48 in.-lb, 5.4 N·m)

3. INSTALL NO. 2 OIL PAN

(a) Remove any old packing material and be careful not to drop any oil on the contacting surfaces of the No. 2 oil pan and cylinder block.

- Using a razor blade and gasket scraper remove all the old packing (FIPG) material from the gasket surfaces and sealing groove.
- Thoroughly clean all components to remove all the loose material.
- Clean both sealing surfaces with a non-residue solvent.

CAUTION: Do not use a solvent which will have adverse affect on the painted surfaces.

(b) Apply No. 102 seal packing (Part No. 08826-00080) or equivalent to the No. 2 oil pan as shown in the figure.

- Install a nozzle that has been cut to the 5 mm (0.20in.) opening.

NOTE: Avoid applying an excess amount to the surface. Be especially careful near oil passages.

- Parts must be assembled within 15 minutes of application. Otherwise, the material must be removed and reapplied.
- Immediately remove nozzle from tube and reinstall cap.

(c) Install the No. 2 oil pan with seven bolts.

Torque: 75 kg-cm (65 in.-lb, 7.4 N·m)

4. INSTALL NO. 1 OIL PAN

(a) Install the No. 1 oil pan in the same procedure of step 3.

(b) Install the bolts and nuts.

Torque: 75 kg-cm (65 in.-lb, 7.4 N·m)

5. INSTALL CRANKSHAFT TIMING PULLEY AND NO. 2 IDLER PULLEY
(See steps 1 and 3 on page EM-32)

6. INSTALL TIMING BELT
(See steps 7 to 20 on pages EM-33 to 37)

7. LOWER ENGINE

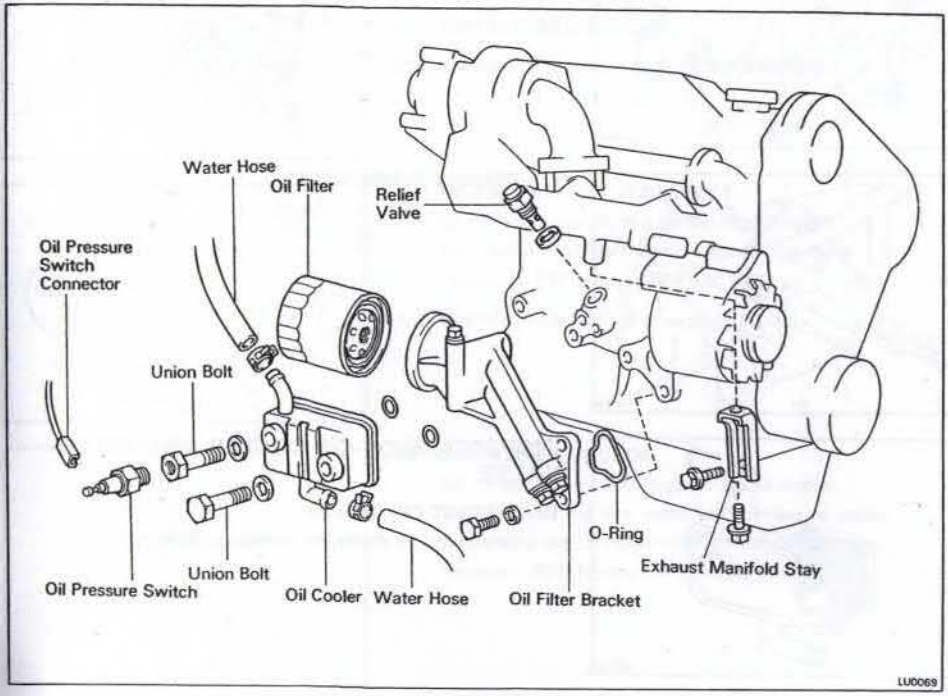
8. REFILL WITH ENGINE OIL
(See step 3 on page LU-4)

9. START ENGINE AND CHECK FOR LEAKS

10. RECHECK OIL LEVEL

OIL COOLER AND RELIEF VALVE

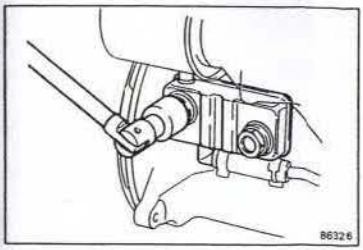
COMPONENTS



REMOVAL OF OIL COOLER AND RELIEF VALVE

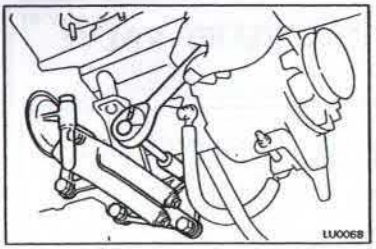
1. **DRAIN COOLANT**

2. **REMOVE OIL PRESSURE SWITCH**
   (a) Disconnect the connector from the oil pressure switch.
   (b) Remove the oil pressure switch.

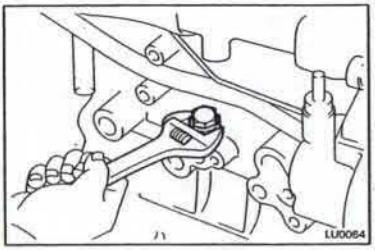


3. **REMOVE OIL COOLER**
   (a) Remove the two union bolts.
   (b) Disconnect the two water hoses and remove the oil cooler with the two O-rings.

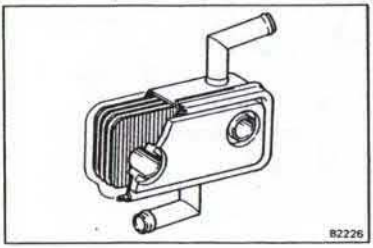
4. **REMOVE OIL FILTER (See page LU-4)**



5. **REMOVE OIL FILTER BRACKET**
   Remove the five bolts and oil filter bracket with the O-ring.
6. **REMOVE EXHAUST MANIFOLD STAY (CV)**

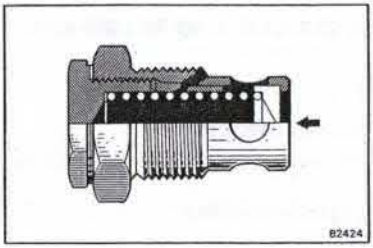


7. **REMOVE RELIEF VALVE**

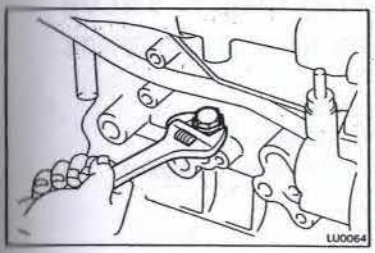


INSPECTION OF OIL COOLER AND RELIEF VALVE

1. **INSPECT OIL COOLER**
   Check the oil cooler for damage or clogging.



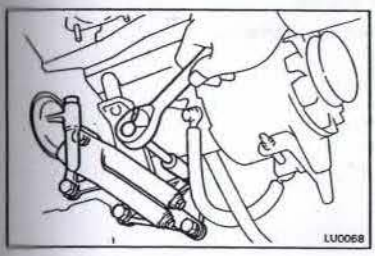
2. **INSPECT RELIEF VALVE**
   Push the valve with a screwdriver to check if it is stuck.



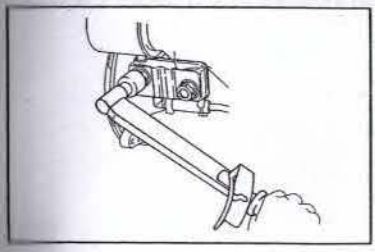
INSTALLATION OF OIL COOLER AND RELIEF VALVE

(See page LU-11)

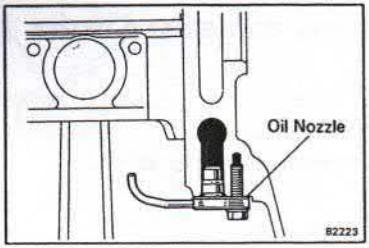
1. INSTALL RELIEF VALVE
2. INSTALL EXHAUST MANIFOLD STAY (CV)



3. INSTALL OIL FILTER BRACKET
   (a) Place a new O-ring on the filter bracket.
   (b) Install the filter bracket with the five bolts.
   Torque: 375 kg-cm (27 ft-lb, 37 N·m)
4. INSTALL OIL FILTER (See page LU-4)



5. INSTALL OIL COOLER
   (a) Place two new O-rings on the oil cooler.
   (b) Connect the two water hoses to the oil cooler.
   (c) Install the oil cooler with the two union bolts.
   Torque: 525 kg-cm (38 ft-lb, 51 N·m)
6. INSTALL OIL PRESSURE SWITCH
   (a) Install the oil pressure switch.
   (b) Connect the connector to the oil pressure switch.
7. REFILL WITH COOLANT
   (See step 3 on page CO-3)
8. START ENGINE AND CHECK FOR LEAKS
9. CHECK OIL LEVEL AND COOLANT LEVEL
   Fill with engine oil and/or coolant if necessary.



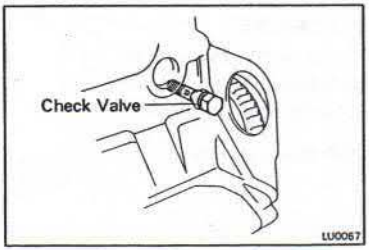
OIL NOZZLE AND CHECK VALVE

INSPECTION OF OIL NOZZLE AND CHECK VALVE

1. **INSPECT OIL NOZZLES**

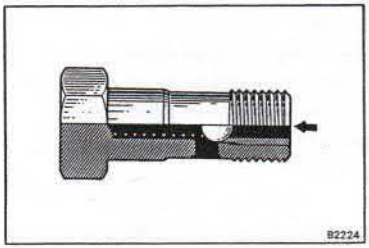
   LOCATION: In the cylinder block.

   Check the oil nozzles for damage or clogging.



2. **INSPECT CHECK VALVE**

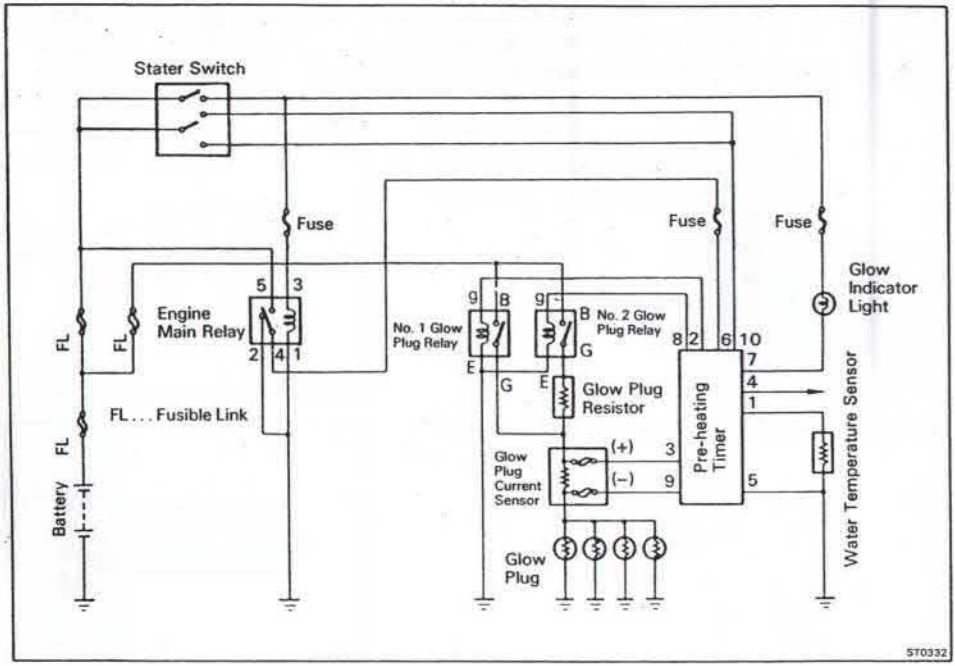
   LOCATION: Behind the starter.



Push the valve with a wooden stick to check if it is stuck.

STARTING SYSTEM

PRE-HEATING SYSTEM
Super Glow Type
SYSTEM CIRCUIT



INSPECTION OF COMPONENTS

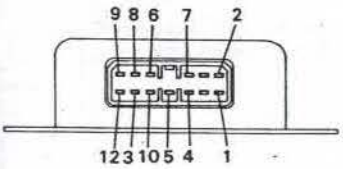
Pre-heating Timer

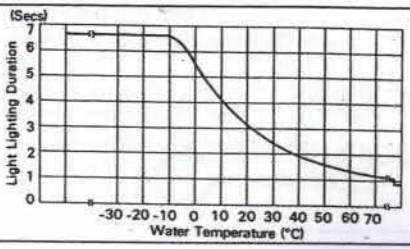
LOCATION

CE80:	In the cowl on the passenger's side.
CV:	Under the center glove compartment door.
CM:	Front of center heater unit.
CR:	In the left center pillar.
Others:	Top of glove box.

Refer to Diesel Electrical System Diagnosis for inspection procedures. (See pages EM-10 and 11)

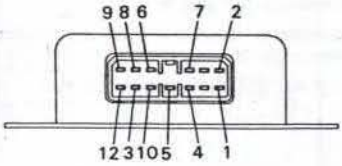
CR

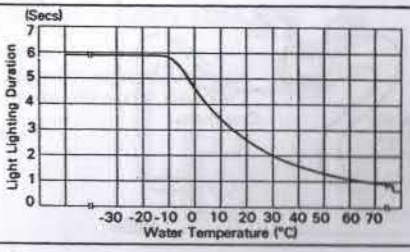




ST0049

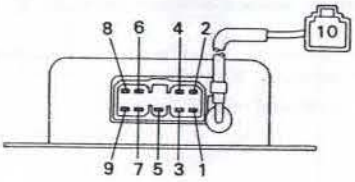
CV, CT

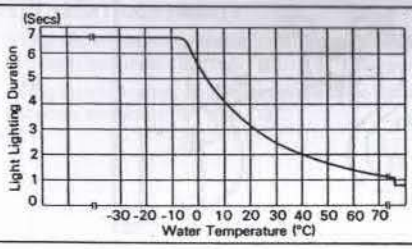




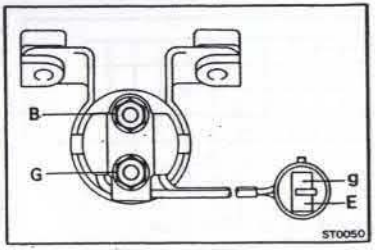
ST0049

CM





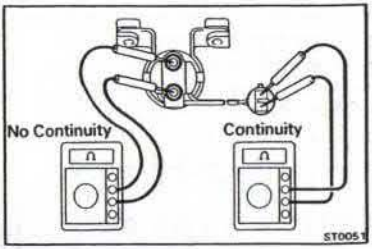
ST0068



No. 1 Glow Plug Relay

LOCATION

CE80, CV, CT: On the right fender apron.
CM, CR: Under the left seat.

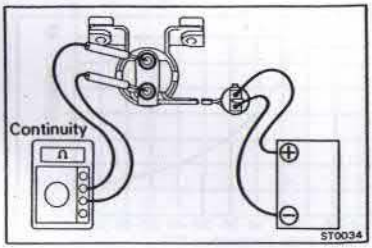


1. **INSPECT RELAY CONTINUITY**

(a) Using an ohmmeter, check that there is continuity between terminals "g" and "E".

(b) Using an ohmmeter, check that there is no continuity between terminals "B" and "G".

If continuity is not as specified, replace the relay.

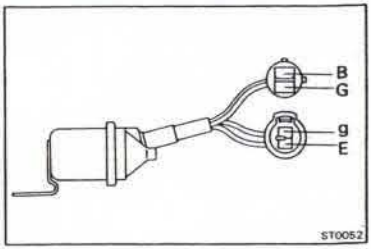


2. **INSPECT RELAY OPERATION**

(a) Apply battery voltage between terminals "g" and "E".

(b) Using an ohmmeter, check that there is continuity between terminals "B" and "G".

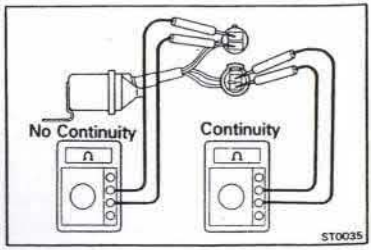
If there is no continuity, replace the relay.



No. 2 Glow Plug Relay [CE, CV, CT]

LOCATION

CE80, CV, CT: On the right fender apron.

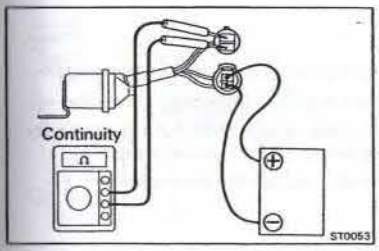


1. **INSPECT RELAY CONTINUITY**

(a) Using an ohmmeter, check that there is continuity between terminals "g" and "E".

(b) Using an ohmmeter, check that there is no continuity between terminals "B" and "G".

If continuity is not as specified, replace the relay.

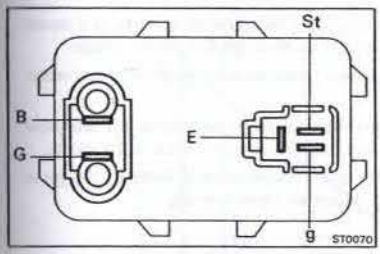


2. **INSPECT RELAY OPERATION**

(a) Apply battery voltage between terminals "g" and "E".

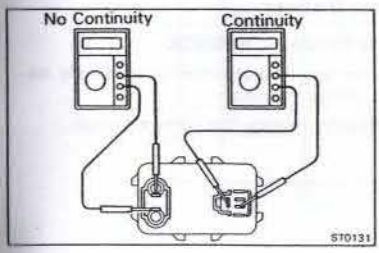
(b) Using an ohmmeter, check that there is continuity between terminals "B" and "G".

If there is no continuity, replace the relay.



No. 2 Glow Plug Relay [CM, CR]

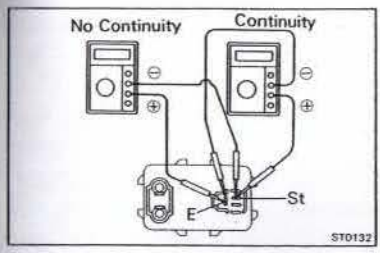
LOCATION
CM: Front of center heater unit.
CR: In the left center pillar.



1. **INSPECT RELAY CONTINUITY**

(a) Using an ohmmeter, check that there is continuity between terminals "E" and "g".

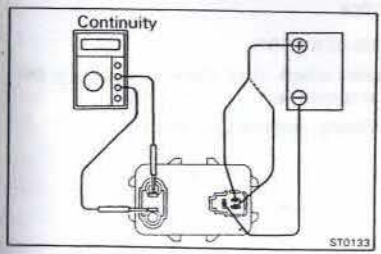
(b) Using an ohmmeter, check that there is no continuity between terminals "B" and "G".



(c) Connect an ohmmeter positive lead to terminal "St" and negative lead to terminal "E" and check that there is continuity.

(d) Reverse polarity of the test leads, and check that there is no continuity.

If continuity is not as specified, replace the relay.



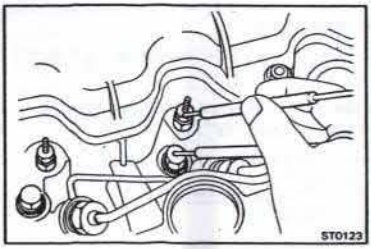
2. **INSPECT RELAY OPERATION**

(a) Connect the positive lead from the battery to terminal "St" or "g".

(b) Connect the negative lead from the battery to terminal "E".

(c) Check that there is continuity between terminals "B" and "G".

If there is no continuity, replace the relay.



Glow Plug

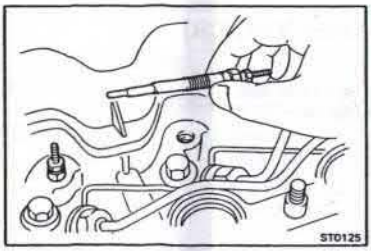
INSPECT GLOW PLUG

(a) Remove the four grommets from the glow plugs.

(b) Remove the four nuts and glow plug connector.

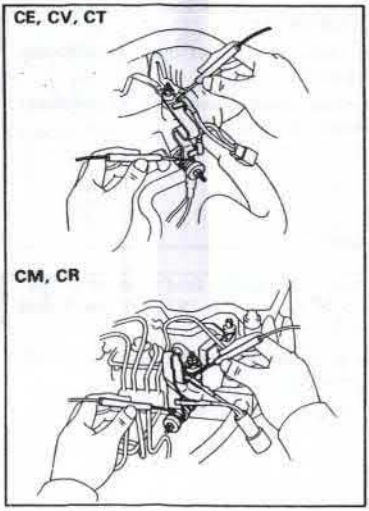
(c) Using an ohmmeter, check that there is continuity between the glow plug terminal and ground.

If there is no continuity, replace the glow plug.



NOTE:

- Be careful not to damage the glow plug pipes as it could cause an open circuit or shorten life of the plugs.
- Avoid getting oil and gasoline on the glow plugs when cleaning.
- During inspection, be sure to wipe any oil off the glow plug terminals and bakelite washer with a dry cloth.
- Be careful not to apply more than 7 volts to the glow plug as it could cause an open circuit.

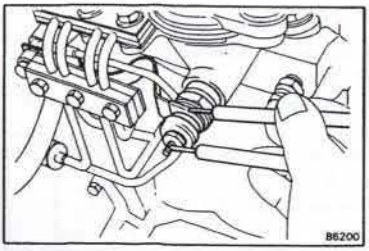


Glow Plug Current Sensor

INSPECT GLOW PLUG CURRENT SENSOR

Using an ohmmeter, check that there is continuity between the current sensor terminals.

If there is no continuity, replace the current sensor.

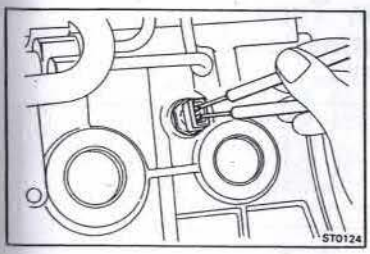


Glow Plug Resistor

INSPECT GLOW PLUG RESISTOR

Using an ohmmeter, check that there is continuity between the resistor terminals.

If there is no continuity, replace the resistor.

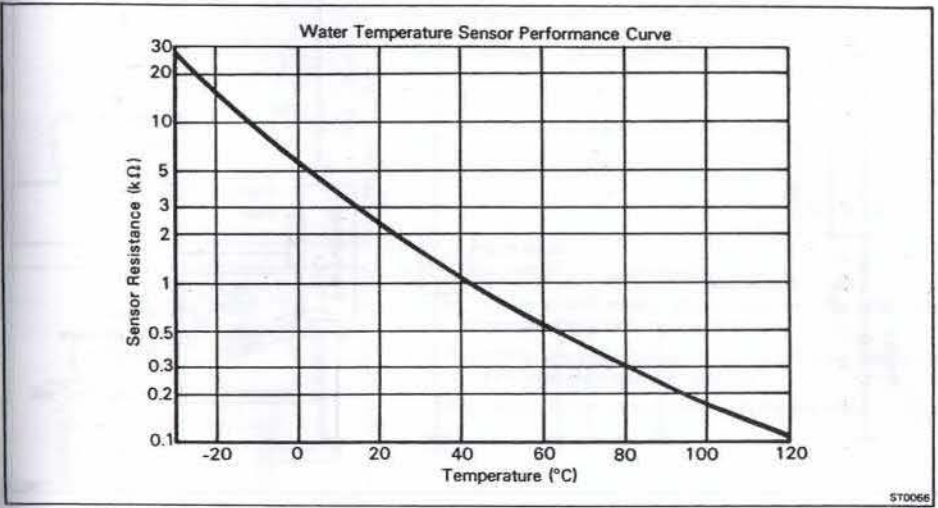


Water Temperature Sensor

INSPECT WATER TEMPERATURE SENSOR

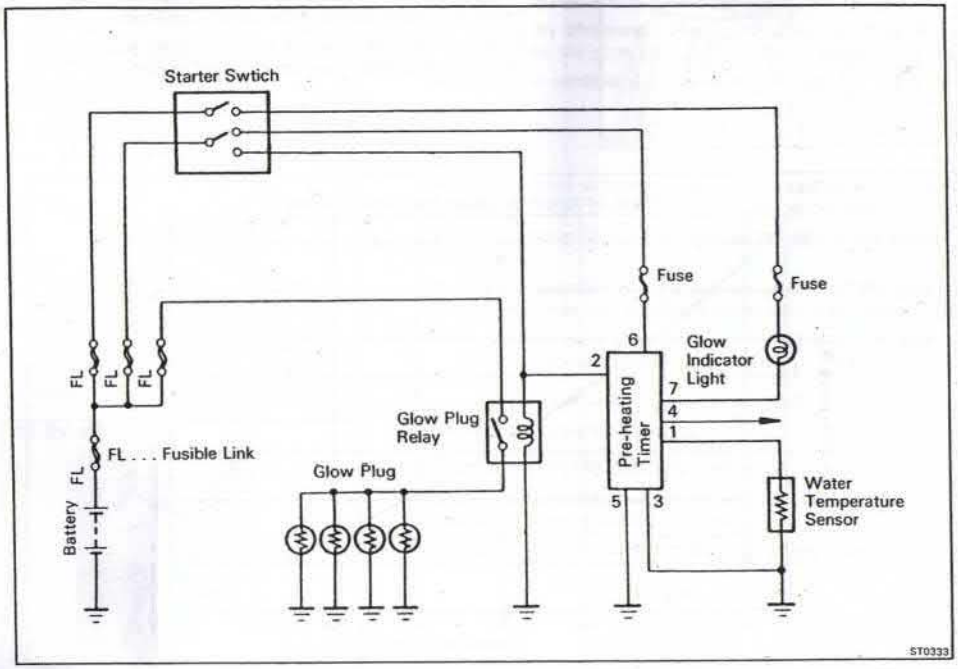
Remove the connector and measure the resistance between the water temperature sensor terminals.

If each resistance value is not as shown in the gragh below, replace the water temperature sensor.



Variable Delay Type [General Destinations]

SYSTEM CIRCUIT



INSPECTION OF COMPONENTS

Pre-heating Timer

LOCATION
CE80: In the cowl on the passenger's side.
CE70: Top of glove box.

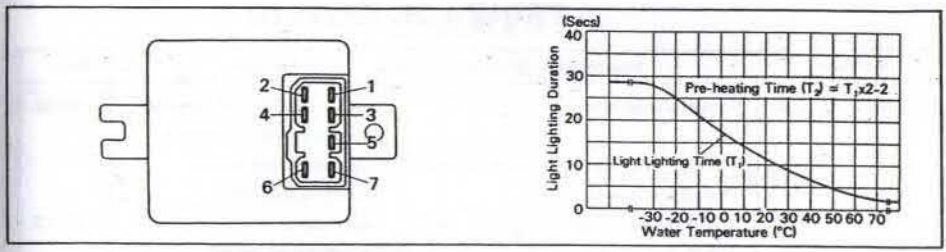
INSPECT PRE-HEATING TIMER

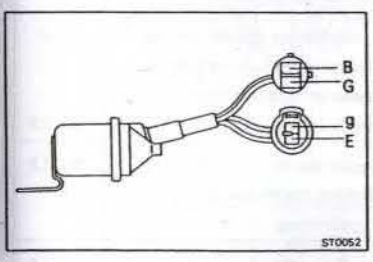
(a) Turn the starter switch "ON" and measure the lighting time of the glow indicator light.

(b) Check that there is voltage at terminal 2 of the pre-heating timer when the starter switch is turned to "ON".

(c) Turn the starter switch to "START", and then check that there is no voltage at terminal 2 after starting the engine.

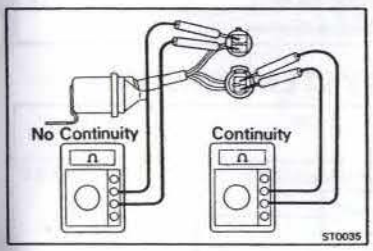
(d) Turn the starter switch "OFF" and then turn the starter switch to "ON" and measure the current passing time (from battery to glow plug) at glow plug terminal.





Glow Plug Relay

LOCATION: On the left fender apron.

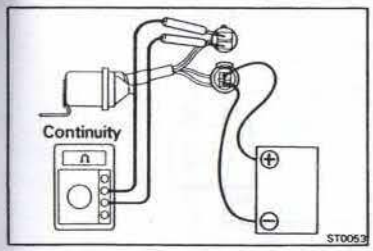


1. **INSPECT RELAY CONTINUITY**

   (a) Using an ohmmeter, check that there is continuity between terminals "g" and "E".

   (b) Using an ohmmeter, check that there is no continuity between terminals "B" and "G".

   If continuity is not as specified, replace the relay.



2. **INSPECT RELAY OPERATION**

   (a) Apply battery voltage between terminals "g" and "E".

   (b) Using an ohmmeter, check that there is continuity between terminals "B" and "G".

   If there is no continuity, replace the relay.

Glow Plug

(See page ST-6)

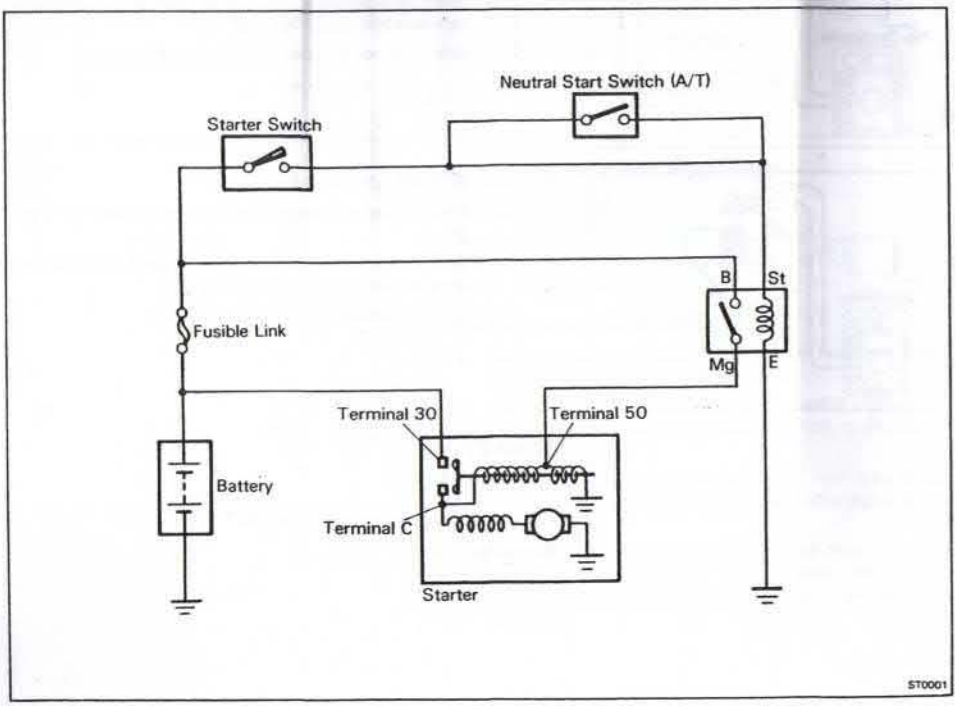
Water Temperature Sensor

(See page ST-7)

TROUBLESHOOTING

Problem	Possible cause	Remedy	Page
Engine will not crank	Battery charge low	Check battery specific gravity Charge or replace battery	CH-4
	Battery cables loose, corroded or worn	Repair or replace cables	
	Fusible link blown	Replace fusible link	
	Starter faulty	Repair starter	ST-12
	Starter switch faulty	Replace starter switch	
Engine cranks slowly	Battery charge low	Check battery specific gravity Charge or replace battery	CH-4
	Battery cables loose, corroded or worn	Repair or replace cables	
	Starter faulty	Repair starter	ST-12
Starter keeps running	Starter faulty	Repair starter	ST-12
	Starter switch faulty	Replace starter switch	
	Short in wiring	Repair wiring	
Starter spins - engine will not crank	Pinion gear teeth broken or faulty starter	Repair starter	ST-12
	Flywheel teeth broken	Replace flywheel	

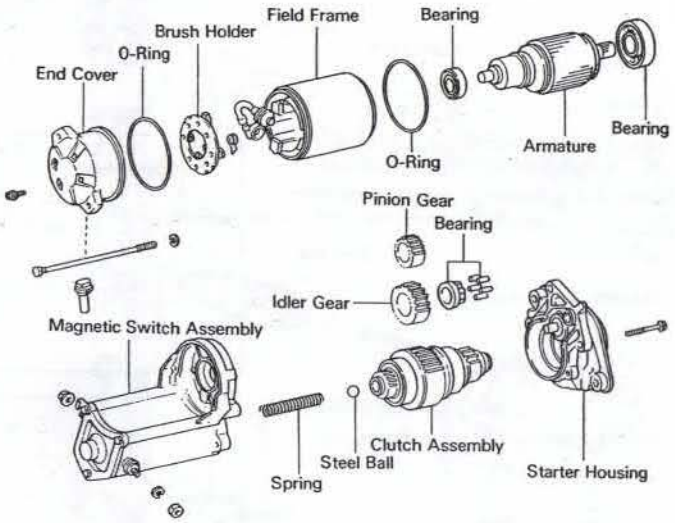
STARTING SYSTEM CIRCUIT



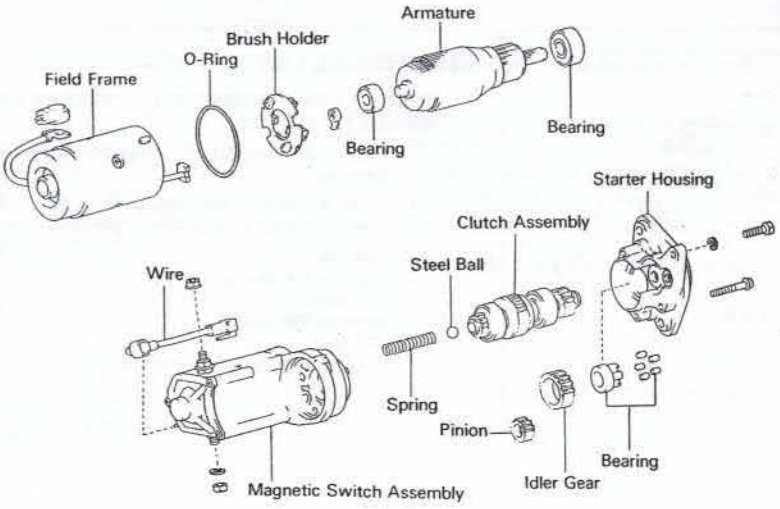
STARTER

COMPONENTS

[1.4 kW]

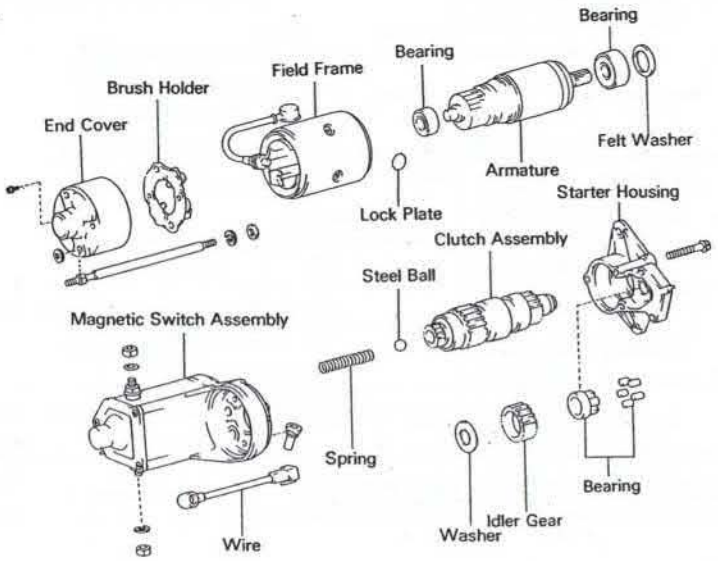


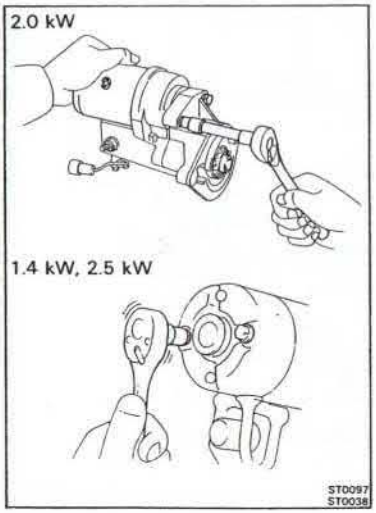
[2.0 kW]



COMPONENTS (Cont'd)

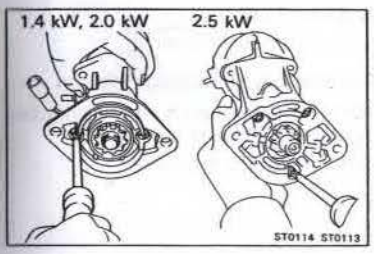
[2.5 kW]





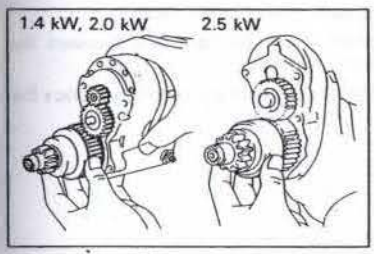
DISASSEMBLY OF STARTER

1. **REMOVE FIELD FRAME WITH ARMATURE FROM MAGNETIC SWITCH**
   (a) Disconnect the lead wire from the magnetic switch terminal.
   (b) Remove the two through bolts. Pull out the field frame with the armature from the magnetic switch.
   (c) [1.4 kW]
   Remove the O-ring.
   [2.0 kW]
   Remove the O-ring.
   [2.5 kW]
   Remove the lock plate and felt seal.



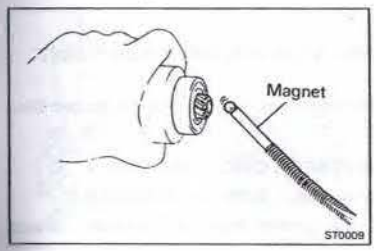
2. REMOVE STARTER HOUSING FROM MAGNETIC SWITCH ASSEMBLY

Remove the two (1.4 kW, 2.0 kW) three (2.5 kW) screws and remove the starter housing.



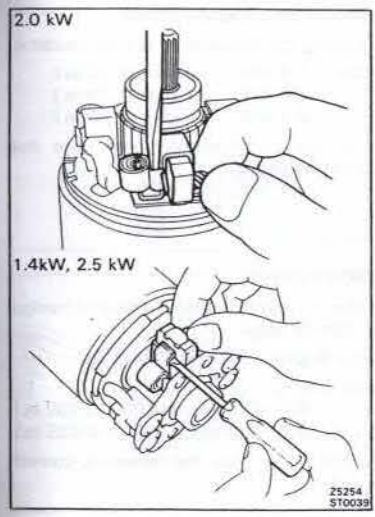
3. REMOVE CLUTCH ASSEMBLY AND GEARS FROM MAGNETIC SWITCH ASSEMBLY

Remove the clutch assembly, spring, pinion gear (ex. 2.5 kW), idle gear and bearing.



4. REMOVE STEEL BALL

Using a magnet, remove the steel ball from the clutch shaft hole.



5. REMOVE BRUSHES AND BRUSH HOLDER

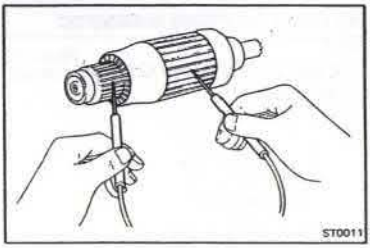
(a) [1.4 kW, 2.5 kW]

Remove the two screws and pull the end cover with O-ring (1.4 kW) off the field frame.

(b) Using a screwdriver, separate the brush and brush spring, and remove the brush from the brush holder.

(c) Pull the brush holder off the field frame.

6. REMOVE ARMATURE FROM FIELD FRAME



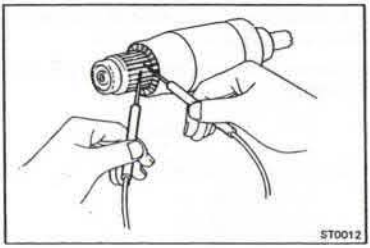
INSPECTION OF STARTER

Armature Coil

1. INSPECT THAT ARMATURE IS NOT GROUNDED

Using an ohmmeter, check that there is no continuity between the commutator and armature coil core.

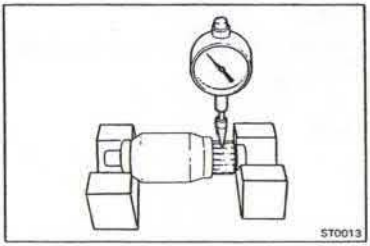
If there is continuity, replace the armature.



2. INSPECT ARMATURE FOR OPEN CIRCUIT

Using an ohmmeter, check for continuity between the segments of the commutator.

If there is no continuity between any segment, replace the armature.



Commutator

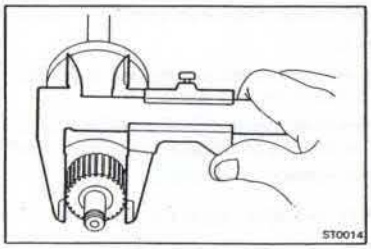
1. INSPECT COMMUTATOR FOR DIRTY AND BURNT SURFACES

If the surface is dirty or burnt, correct with sandpaper (No. 400) or a lathe.

2. INSPECT COMMUTATOR CIRCLE RUNOUT

Maximum circle runout: 0.05 mm (0.0020 in.)

If the circle runout is greater than the maximum, correct with a lathe.

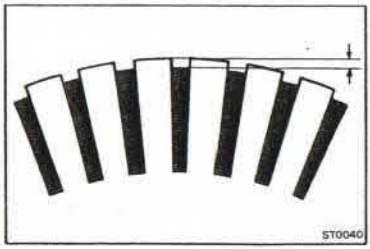


3. MEASURE DIAMETER OF COMMUTATOR

Using calipers, measure the diameter of the commutator.

Minimum diameter:	**1.4 kW**	**29 mm (1.14 in.)**
	2.0 kW	**34 mm (1.34 in.)**
	2.5 kW	**35 mm (1.38 in.)**

If the diameter of the commutator is less than the minimum, replace the armature.



4. INSPECT UNDERCUT DEPTH

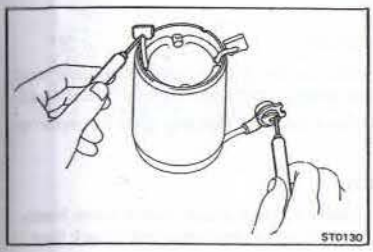
Check that the undercut depth is clean and free of foreign particles. Smooth out the edge.

Minimum undercut depth: 0.2 mm (0.008 in.)

Standard undercut depth:

1.4 kW	**0.5 – 0.8 mm (0.020 – 0.032 in.)**
2.0 kW, 2.5 kW	**0.7 – 0.9 mm (0.028 – 0.035 in.)**

If the undercut depth is less than the minimum, correct with a hacksaw blade.

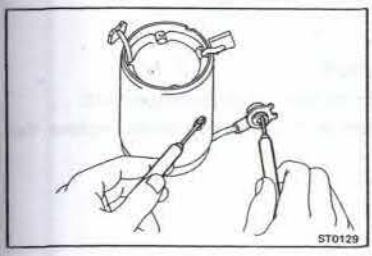


Field Coil

1. **INSPECT FIELD COIL FOR OPEN CIRCUIT**

Using an ohmmeter, check for continuity between the lead wire and field coil brush lead.

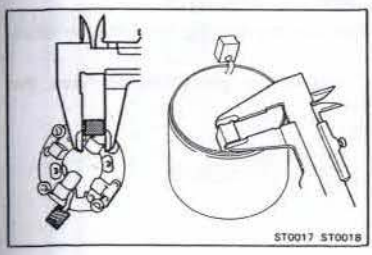
If there is no continuity, replace the field coil.



2. **INSPECT THAT FIELD COIL IS NOT GROUNDED**

Using an ohmmeter, check for continuity between the field coil end and field frame.

If there is continuity, repair or replace the field coil.



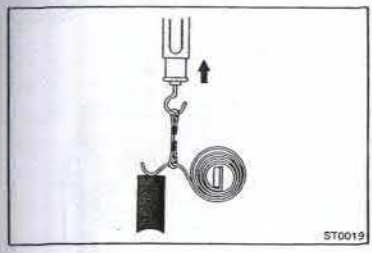
Brushes

INSPECT BRUSH LENGTH

Using calipers, measure each brush length.

Minimum length:	**1.4 kW**	**10.0 mm (0.394 in.)**
	2.0 kW	**9.5 mm (0.374 in.)**
	2.5 kW	**12.0 mm (0.472 in.)**
Standard length:	**1.4 kW**	**15.0 mm (0.591 in.)**
	2.0 kW	**14.5 mm (0.571 in.)**
	2.5 kW	**20.5 mm (0.807 in.)**

If length is less than the minimum, replace the brush.



Brush Spring

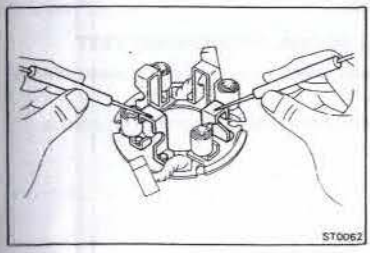
MEASURE BRUSH SPRING LOAD WITH PULL SCALE

Take the pull scale reading at the very instant the brush spring separates from the brush.

Minimum installed load:

1.4 kW	**1.44 kg (3.2 lb, 14 N)**
2.0 kW	**2.0 kg (4.4 lb, 20 N)**
2.5 kW	**2.2 kg (4.9 lb, 22 N)**

If the reading is minimum, replace the brush spring.

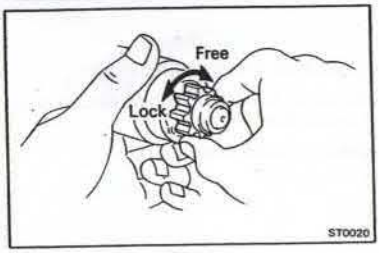


Brush Holder

INSPECT INSULATION OF BRUSH HOLDER

Using an ohmmeter, check for continuity between the positive and negative brush holders.

If there is continuity, repair or replace the brush holder.



Clutch and Gears

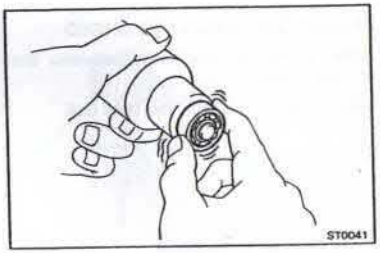
1. INSPECT GEAR TEETH

Check the gear teeth on the pinion gear, idler gear and clutch assembly for wear or damage. Replace if damaged.

If damaged, also check the flywheel ring gear for wear or damage.

2. INSPECT CLUTCH

Rotate the pinion clockwise and check that it turns freely. Try to rotate the pinion counterclockwise and check that it locks.

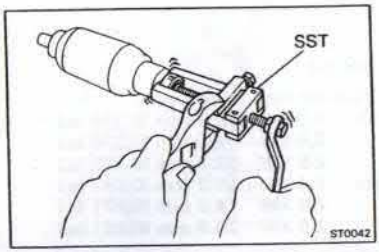


Bearings

1. INSPECT BEARINGS

Turn each bearing by hand while pushing inward.

If resistance is felt or if the bearing sticks, replace the bearing.

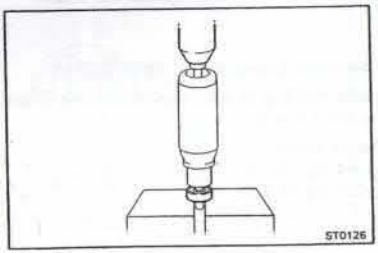


2. IF NECESSARY, REPLACE BEARINGS

(a) Using SST, remove the bearing from the armature shaft.

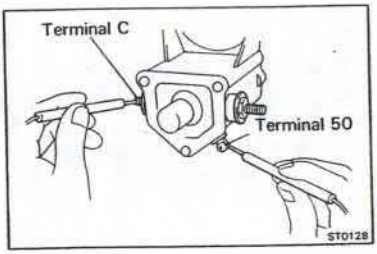
(b) Using SST, remove the other bearing from the opposite side.

SST 09286-46011



(c) Using a press, install the front and rear bearings onto the shaft.

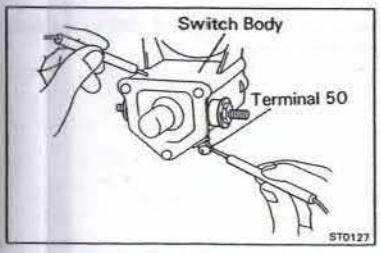
Magnetic Switch



1. PERFORM PULL-IN COIL OPEN CIRCUIT TEST

Using an ohmmeter, check for continuity between terminal 50 and terminal C.

If there is no continuity, replace the magnetic switch.



2. PERFORM HOLD-IN COIL OPEN CIRCUIT TEST

Using an ohmmeter, check for continuity between terminal 50 and the switch body.

If there is no continuity, replace the magnetic switch.

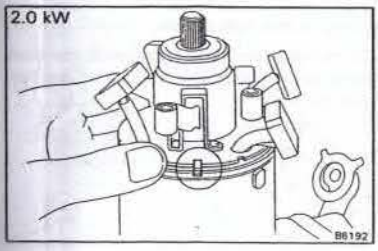
ASSEMBLY OF STARTER

(See page ST-11 or 12)

NOTE: Use high-temperature grease to lubricate the bearings and gears when assembling the starter.

1. PLACE ARMATURE INTO FIELD FRAME

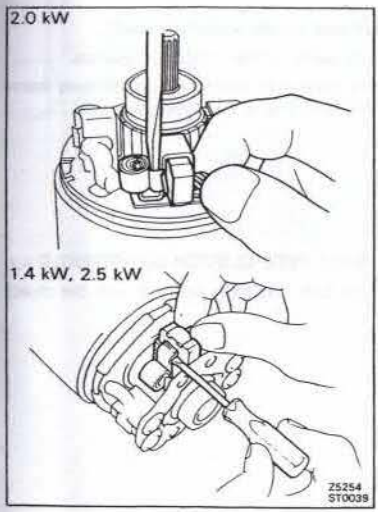
Apply grease to the armature bearings and insert the armature into the field frame.



2. INSTALL BRUSH HOLDER AND BRUSHES

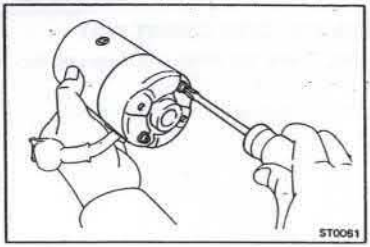
(a) Place the brush holder over the field frame.

(b) [2.0 kW]
Align the tab on the holder with the notch in the field frame.



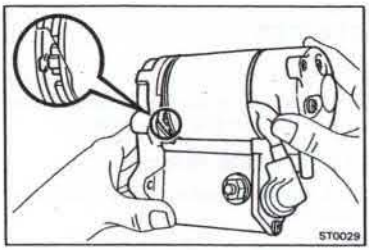
(c) Using a screwdriver, hold the brush spring back and install the brush into the brush holder. Install four brushes.

NOTE: Make sure that the positive lead wires are not grounded.



(d) [1.4 kW, 2.5 kW]

Install the end cover and O-ring (1.4 kW) to the field frame with the two screws.

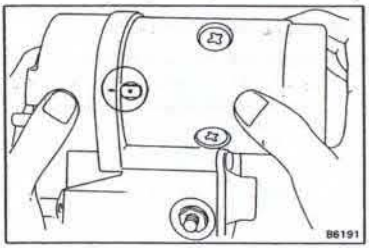


3. INSTALL FIELD FRAME WITH ARMATURE IN MAGNETIC SWITCH

[1.4 kW]

(a) Place the O-ring on the field frame.

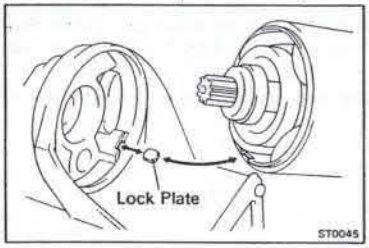
(b) Align the protrusion of the field frame with the notch on the magnetic switch assembly and insert the field frame with the armature.



[2.0 kW]

(a) Place the O-ring on the field frame.

(b) Align the bolt anchor of the field frame with the mark on the magnetic switch assembly and insert the field frame with the armature.

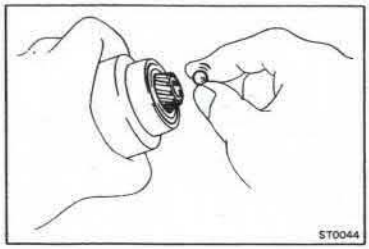


[2.5 kW]

(a) Place the felt seal on the armature shaft.

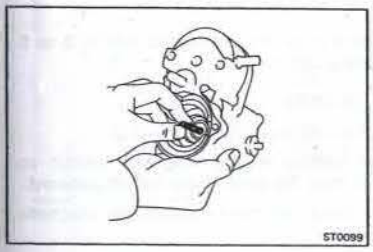
(b) Place the lock plate on the magnetic switch.

(c) Align the lock plate with the notch on the field frame and insert the field frame with the armature.



4. INSERT STEEL BALL INTO CLUTCH SHAFT HOLE

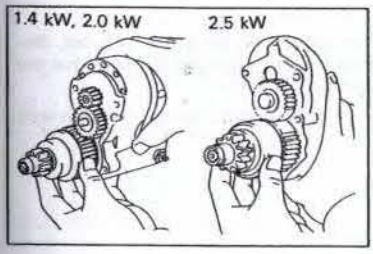
Apply grease to the ball, and then insert it into the clutch shaft hole.



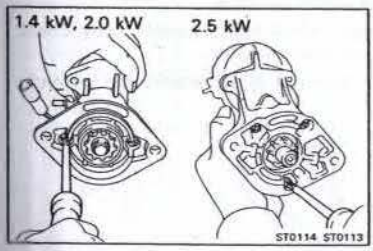
5. INSTALL GEARS AND CLUTCH ASSEMBLY

(a) Apply grease to the gears and clutch assembly.

(b) Install the spring to the magnetic switch assembly.

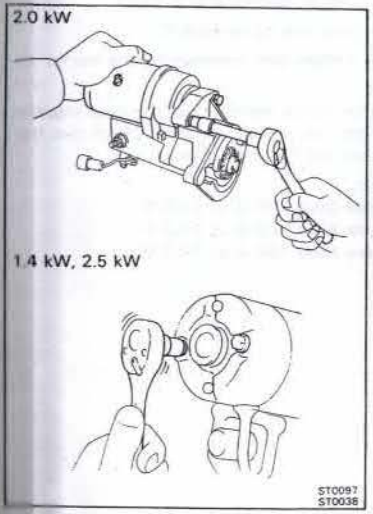


(c) Place the clutch assembly, idle gear, bearing and pinion gear (ex. 2.5 kW) in the magnetic switch assembly.
Make sure that the gears mesh.



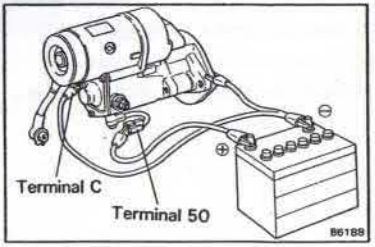
6. INSTALL STARTER HOUSING

(a) Place the starter housing on the magnetic switch and install the two (1.4 kW, 2.0 kW) or three (2.5 kW) screws.



(b) Install the two through bolts.

(c) Connect the lead wire to the magnetic switch terminal.



PERFORMANCE TEST OF STARTER

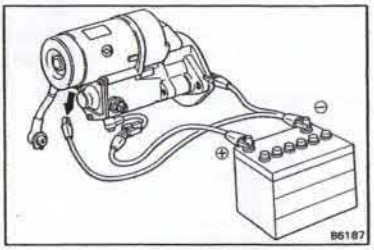
CAUTION: These tests must be performed within 3 to 5 seconds to avoid burning out the coil.

1. PERFORM PULL-IN TEST

(a) Disconnect the lead wire from terminal C.

(b) Connect the battery to the magnetic switch as shown. Check that the pinion gear moves outward.

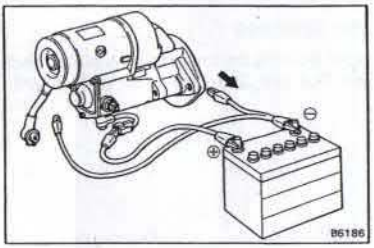
If the pinion gear does not move, replace the magnetic switch.



2. PERFORM HOLD-IN TEST

While connected as above with the pinion gear out, disconnect the negative lead from terminal C. Check that the pinion gear remains out.

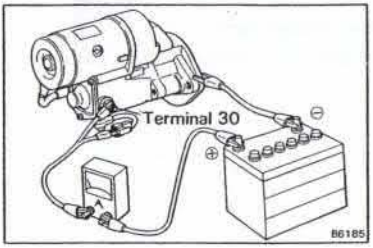
If the pinion gear returns inward, replace the magnetic switch.



3. INSPECT PINION GEAR RETURN

Disconnect the negative lead from the switch body. Check that the pinion gear returns inward.

If the pinion gear does not return, replace the magnetic switch.



4. PERFORM NO-LOAD PERFORMANCE TEST

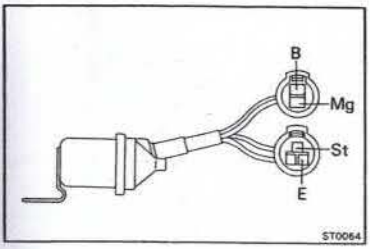
(a) Connect the lead wire to terminal C.

(b) Connect the battery and ammeter to the starter as shown.

(c) Check that the starter rotates smoothly and steadily with the pinion gear moving outward. Check that the ammeter reads the specified current.

Specified current:

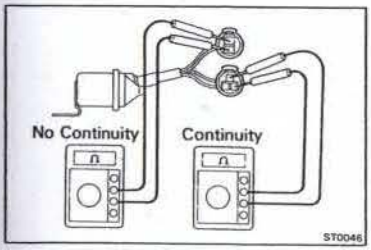
1.4 kW	**Less than 90 A at 11.5 V**
2.0 kW	**Less than 120 A at 11.5 V**
2.5 kW	**Less than 180 A at 11.0 V**



STARTER RELAY

(CV with A/T)

LOCATION: On the left fender apron.



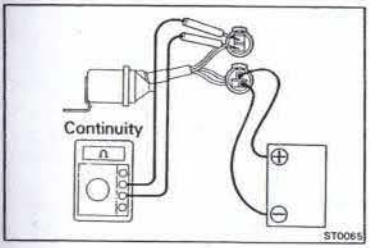
INSPECTION OF STARTER RELAY

1. **INSPECT RELAY CONTINUITY**

   (a) Using an ohmmeter, check that there is continuity between terminals "St" and "E".

   (b) Using an ohmmeter, check that there is no continuity between terminals "B" and "Mg".

   If continuity is not as specified, replace the relay.



2. **INSPECT RELAY OPERATION**

   (a) Apply battery voltage between terminals "St" and "E".

   (b) Using an ohmmeter, check that there is continuity between terminals "B" and "Mg".

   If there is no continuity, replace the relay.

CHARGING SYSTEM

PRECAUTIONS

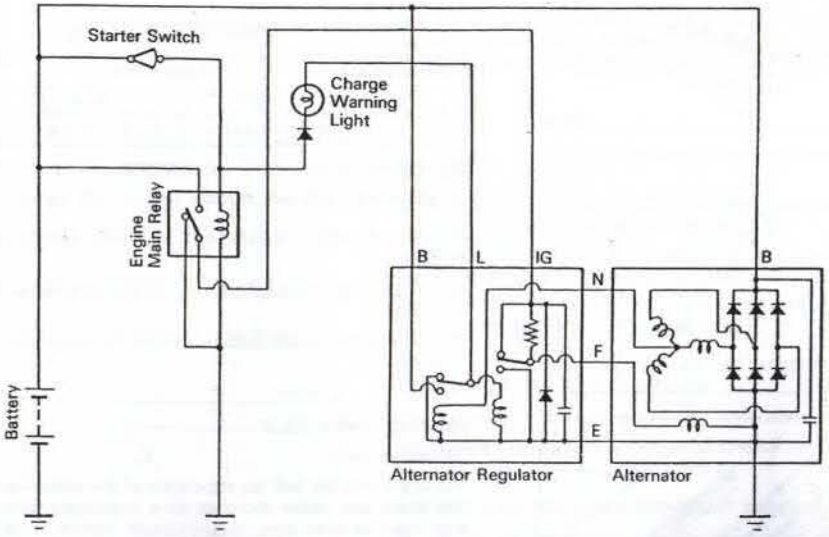
1. **Check that the battery cables are connected to the correct terminals.**
2. **Disconnect the battery cables when the battery is given a quick charge.**
3. **Do not perform tests with a high voltage insulation resistance tester.**
4. **Never disconnect the battery when the engine is running.**

TROUBLESHOOTING

Problem	Possible cause	Remedy	Page
Charge warning light does not light with starter switch at "ON" and engine not running	Fuse blown	Check fuses • Fuse: TURN-GAUGE IGN (Others) • Fuse: CHARGE • Fuse: ENGINE	CH-3
	Light burned out	Replace light	
	Wiring connection loose	Tighten loose connections	
	Alternator regulator faulty	Check regulator	CH-21
	Charge light relay	Check relay	CH-23
	IC regulator faulty	Replace IC regulator	CH-9
Charge warning light does not go out when engine running (battery requires frequent recharging)	Drive belt loose or worn	Adjust or replace drive belt	CH-5
	Battery cables loose, corroded or worn	Repair or replace cables	
	Fuse blown	Check fuse • Fuse: ENGINE	CH-3
	Engine main relay faulty	Check engine main relay	CH-24 or 25
	Fusible link blown	Replace fusible link	
	Alternator regulator, charge light relay, IC regulator or alternator faulty	Check charging system	CH-4
	Wiring faulty	Repair wiring	

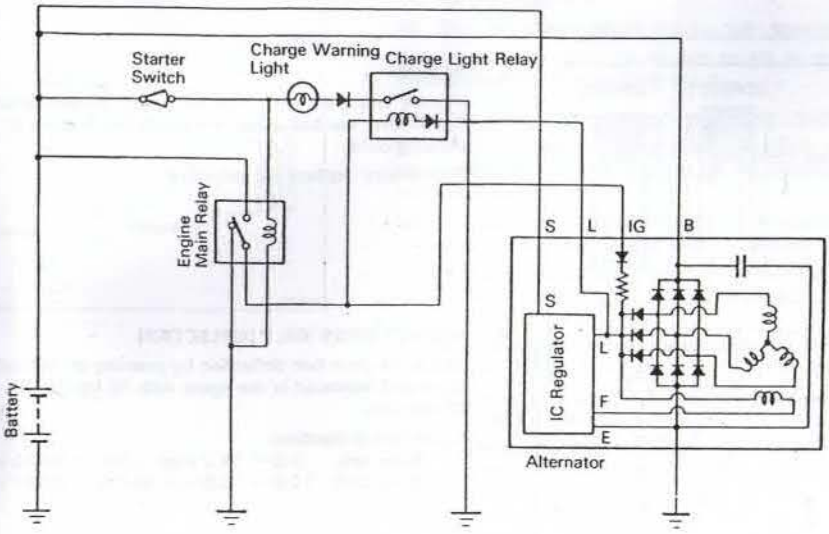
CHARGING SYSTEM CIRCUIT

w/o IC Regulator

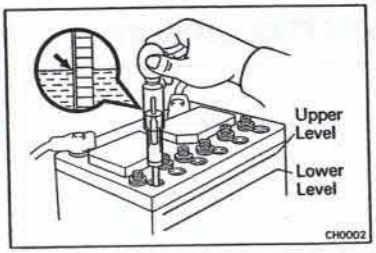


CH0426

w/ IC Regulator



CH0427



ON-VEHICLE INSPECTION

1. INSPECT BATTERY SPECIFIC GRAVITY

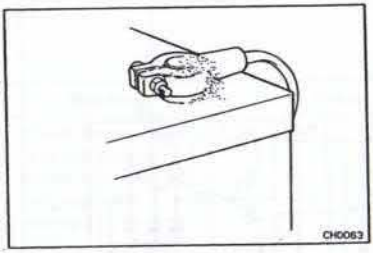
(a) Check the specific gravity of each cell.

Standard specific gravity:
When fully charged at 20°C (68°F)

Specific gravity	Battery models
1.27 – 1.29	NT 80 – S6(S) NX110 – 5, NX110 – 5L, NX110 –5L – MF, NX120 – 7, NX120 – 7L, NX120 – 7L –MF

(b) Check the electrolyte quantity of each cell.

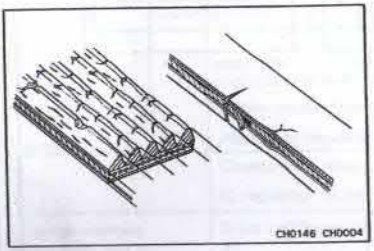
If insufficient, refill with distilled (or purified) water.



2. CHECK BATTERY TERMINALS, FUSIBLE LINKS AND FUSES

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

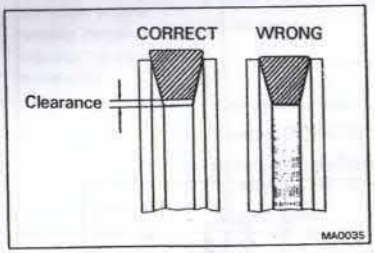
(b) Check the fusible links and fuses for continuity.



3. INSPECT DRIVE BELT

(V-ribbed belt)

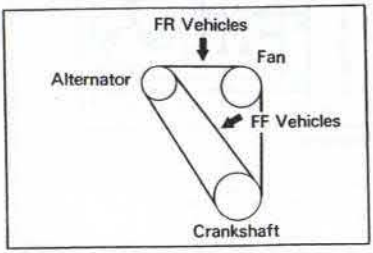
Visually check the belt for separation of the adhesive rubber above and below the core, core separating from the belt side, severed core, separation of the rib from the adhesive rubber, cracking or separation of the ribs, torn or worn ribs or cracks in the inner ridges of the ribs.



(V-belt)

Visually check the drive belt for cracks, oiliness or wear. Check that the belt does not touch the bottom of the pulley groove.

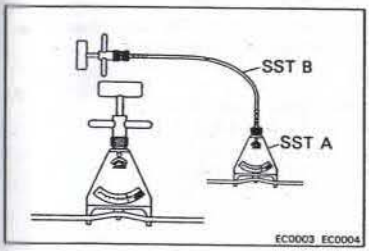
If necessary, replace the drive belt.



4. INSPECT DRIVE BELT DEFLECTION

Check the drive belt deflection by pressing on the belt at the points indicated in the figure with 10 kg (22.0 lb, 98 N) pressure.

Drive belt deflection:
New belt 9.0 – 11.0 mm (0.354 – 0.433 in.)
Used belt 12.0 – 14.0 mm (0.472 – 0.551 in.)



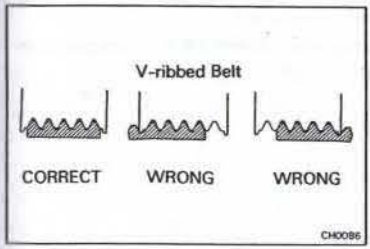
[Reference]

Using SST, check the drive belt tension.

SST A 09216-00020
SST B 09216-00030

Drive belt tension:

New belt	**40 — 60 kg**
Used belt	**20 — 40 kg**



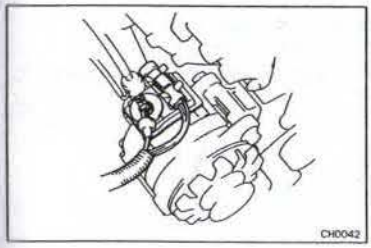
NOTE:

- "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 drive belt, check that it fits properly in the ribbed grooves. (V-ribbed belt)

5. VISUALLY CHECK ALTERNATOR WIRING AND LISTEN FOR ABNORMAL NOISES

(a) Check that the wiring is in good condition.

(b) Check that there is no abnormal noise from the alternator while the engine is running.



6. INSPECT CHARGE WARNING LIGHT CIRCUIT

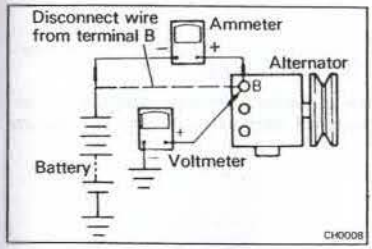
(a) Warm up the engine and then turn it off.

(b) Turn off all accessories.

(c) Turn the starter switch to ON. Check that the charge warning light is lit.

(d) Start the engine. Check that the light goes out.

If the light does not come on and go off as specified, troubleshoot the warning light circuit.

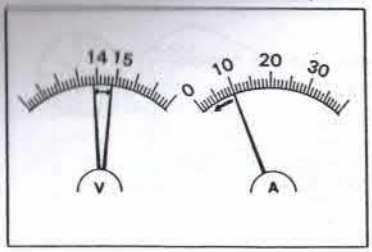


7. INSPECT CHARGING CIRCUIT WITHOUT LOAD

NOTE: If a battery/alternator tester is available, connect the tester to the charging circuit as per the manufacturer's instructions.

(a) If a tester is not available, connect a voltmeter and ammeter to the charging circuit as follows:

- Disconnect the wire from terminal B of the alternator and connect the wire to the negative terminal of the ammeter.
- Connect the test lead from the positive terminal of the ammeter to terminal B of the alternator.
- Connect the positive lead of the voltmeter to terminal B of the alternator.
- Connect the negative lead of the voltmeter to body ground.

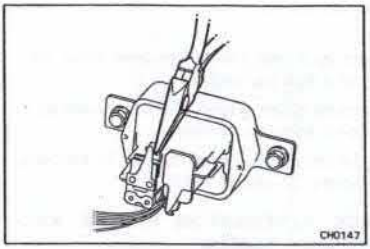


(b) Check the amperage and voltage.

With the engine running at 2,000 rpm, check the reading on the ammeter and voltmeter.

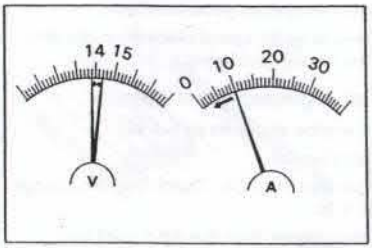
[w/o IC Regulator]

Standard amperage: Less than 10 A
Standard voltage: 13.8 – 14.8 V
(CE OPT: Cold area of the Europe)
13.8 – 14.4 V



If the voltage reading is greater than standard voltage, adjust the regulator or replace it.

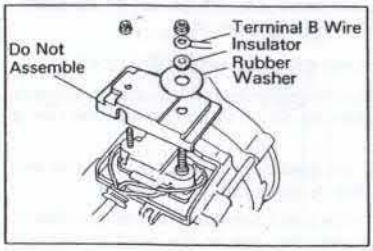
If the voltage reading is less than 13.8 V, check the alternator.



[w/ IC Regulator]

Standard amperage: Less than 10 A
Standard voltage: 13.8 – 14.4 V

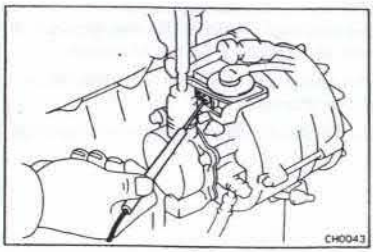
If the voltage reading is greater than 14.4 V, replace the IC regulator.



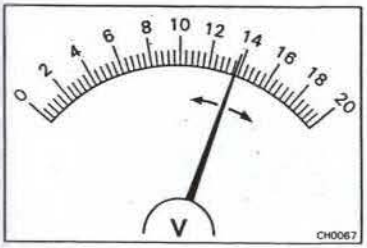
If the voltage reading is less than 13.8 V, check the alternator as follows:

- Remove the brush holder cover and connect the terminal B wire in the original position.

CAUTION: There is battery voltage applied to terminal B so disconnect the battery terminal before beginning work.

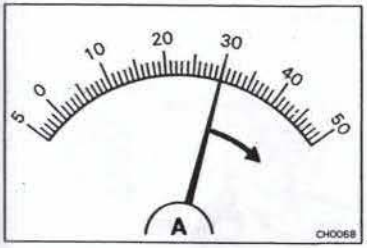


- With the engine running at 2,000 rpm, connect terminal F to body ground.



If the voltage reading is greater than 14.4 V, replace the IC regulator.

If the voltage reading is less than 13.8 V, repair the alternator.

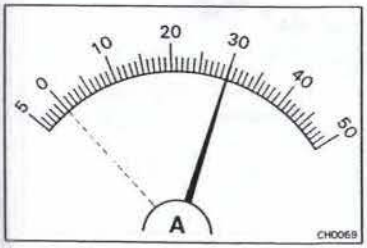


8. CHECK CHARGING CIRCUIT WITH LOAD

(a) With the engine running at 2,000 rpm, turn on the high beam headlights and place the heater fan control switch at HI.

(b) Check the reading on the ammeter.

Standard amperage: More than 30 A

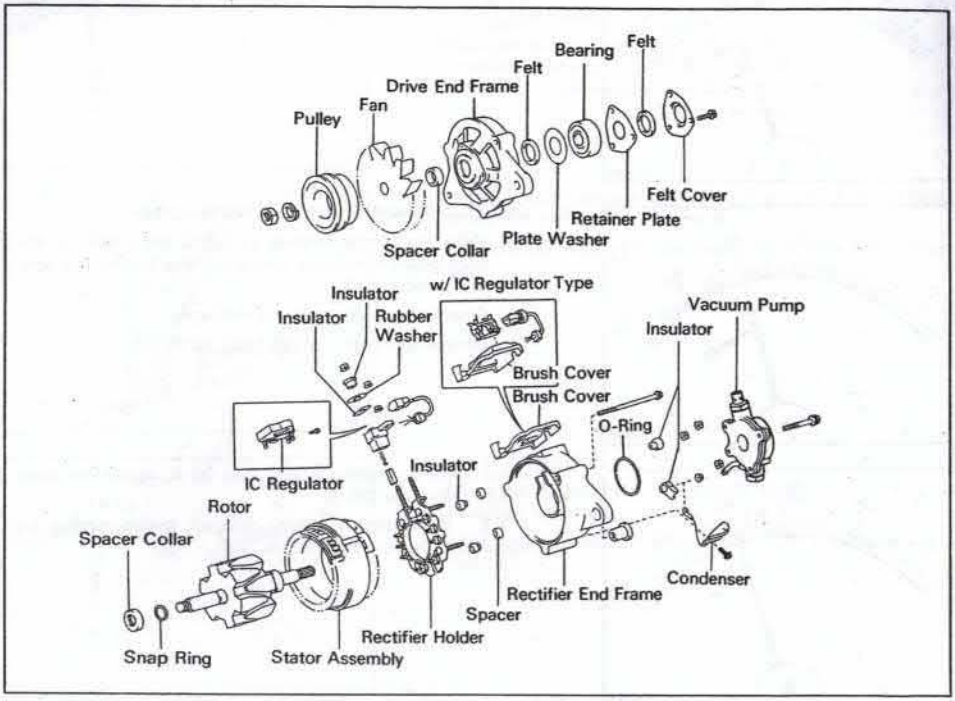


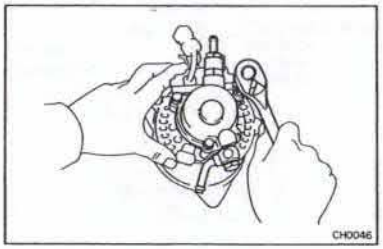
If the ammeter reading is less than 30 A, repair the alternator. (See page CH-9)

NOTE: If the battery is fully charged, the indication will sometimes be less than 30 A.

ALTERNATOR (CV, CT, CE)

COMPONENTS

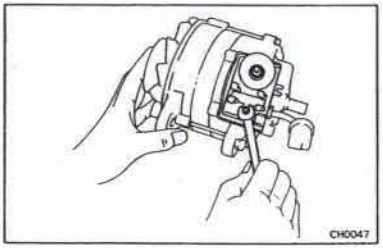




DISASSEMBLY OF ALTERNATOR

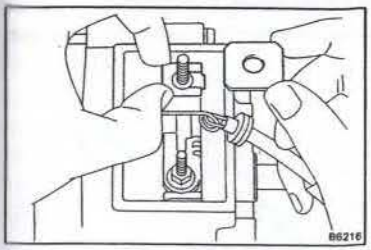
1. **REMOVE VACUUM PUMP**

   Remove three bolts and vacuum pump with the O-ring.



2. **REMOVE BRUSH COVER**

   Remove two nuts, insulator, rubber washer, wire clamp and brush cover.

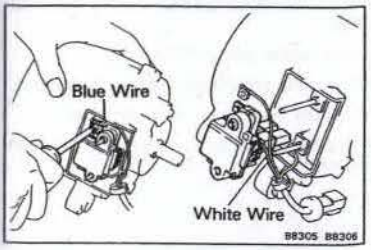


3. REMOVE BRUSH HOLDER

[w/o IC Regulator]

(a) Remove the insulator and disconnect the lead wire.

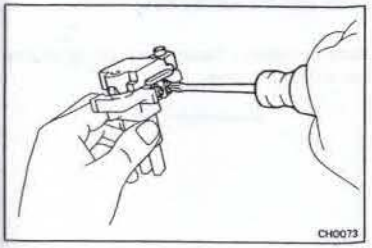
(b) Remove nut and pull out the brush holder.



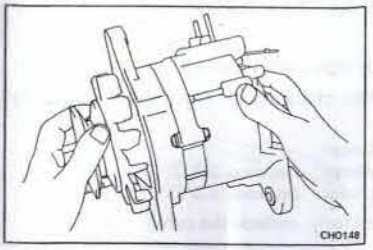
[w/ IC Regulator]

(a) Remove the screw to the brush holder and disconnect the blue wire.

(b) Pull out the brush holder with the IC regulator, and then remove the screw and disconnect the white wire.



(c) Remove the two screws and separate the IC regulator and brush holder.

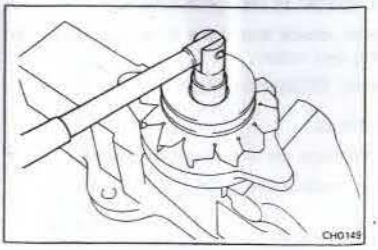


4. REMOVE DRIVE END FRAME FROM STATOR

(a) Remove the three through bolts.

(b) Pull out the drive end frame from the stator.

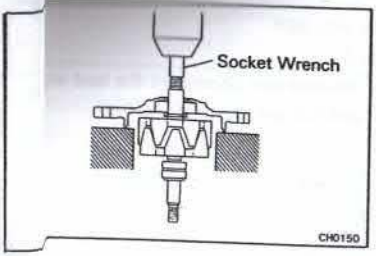
NOTE: If necessary, lightly tap the rotor shaft with a plastic hammer.



5. REMOVE PULLEY AND FAN

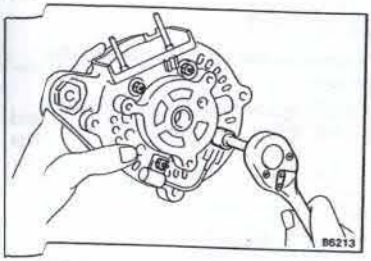
(a) Mount the rotor in a soft jaw vise.

(b) Remove the pulley nut, spring washer, pulley and fan.



6. REMOVE ROTOR FROM DRIVE END FRAME

Using a press and socket wrench, press out the rotor and spacer collars.



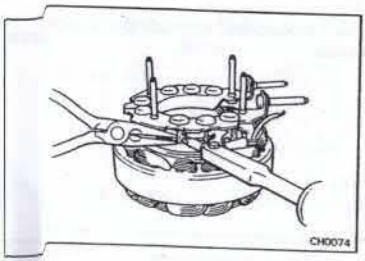
7. REMOVE RECTIFIER END FRAME FROM STATOR AND RECTIFIER HOLDER

(a) Remove the two rubber caps.

(b) Remove the four nuts, condenser and two insulators.

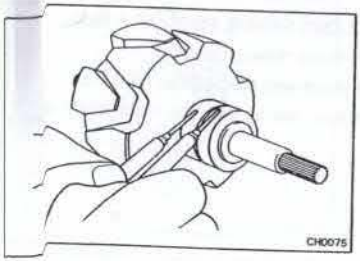
(c) Remove the rectifier end frame from the stator.

(d) Remove the two insulators and two collars from the rectifier holder studs.



8. UNSOLDER STATOR LEADS FROM RECTIFIER HOLDER

CAUTION: Protect rectifiers from heat using pliers and small wattage soldering iron.



INSPECTION OF ALTERNATOR

Rotor

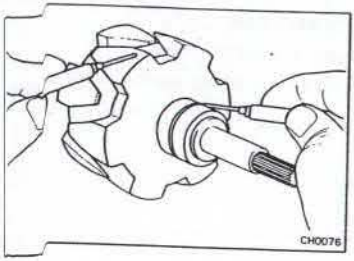
1. INSPECT ROTOR FOR OPEN CIRCUIT

Using an ohmmeter, check for continuity between three slip rings.

Standard resistance:

w/ IC regulator	Approx. 2.9 Ω
w/o IC regulator	Approx. 4.0 Ω

If there is no continuity, replace the rotor.



2. INSPECT THAT ROTOR IS NOT GROUNDED

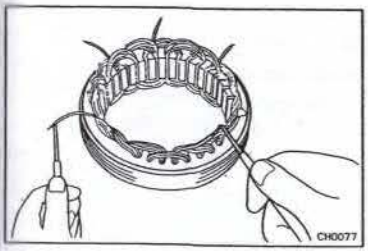
Using an ohmmeter, check that there is no continuity between the slip ring and rotor.

If there is continuity, replace the rotor.

3. INSPECT SLIP RINGS

Check that the slip rings are not rough or scored.

If rough or scored, replace the rotor.



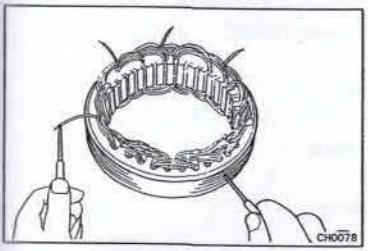
Stator

1. INSPECT STATOR FOR OPEN CIRCUIT

Using an ohmmeter, check all coil leads for continuity.

NOTE: At this time, the meeting wires should be connected with solder.

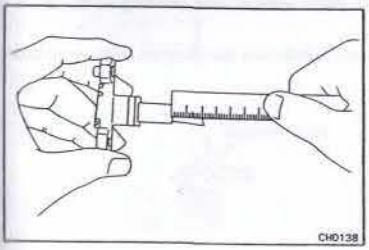
If there is no continuity, replace the stator.



2. INSPECT THAT STATOR IS NOT GROUNDED

Using an ohmmeter, check that there is no continuity between the coil leads and stator core.

If there is continuity, replace the stator.



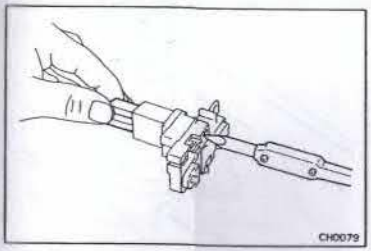
Brush and Brush Holder

1. MEASURE EXPOSED BRUSH LENGTH

Using a scale, measure the exposed brush length.

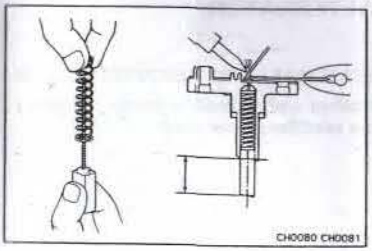
Minimum exposed length: 5.5 mm (0.217 in.)

If the brush length is less than minimum, replace the brush.



2. IF NECESSARY, REPLACE BRUSH

(a) Unsolder and remove the brush and spring.



(b) Insert the brush wire through the spring.

(c) Install the brush in the brush holder.

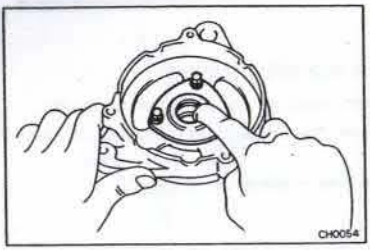
(d) Solder the wire to the brush holder at standard length.

Standard exposed length: 20.0 mm (0.787 in.)

(e) Check that the brush moves smoothly in the brush holder.

(f) Cut off the excess wire.

(g) Apply insulation paint to the soldered point.

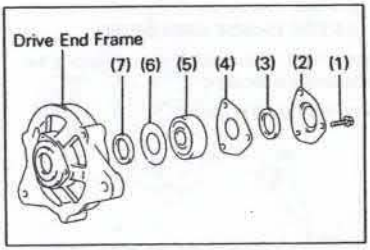


Bearing

1. INSPECT BEARING

Check that the bearing is not rough or worn.

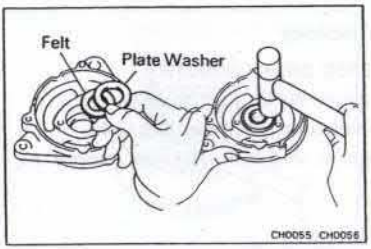
If necessary, replace the bearing.



2. IF NECESSARY, REPLACE BEARING

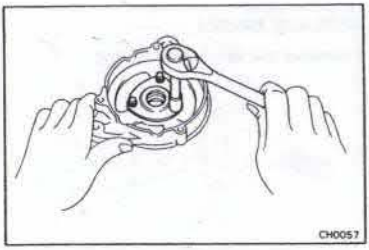
(a) Remove the following parts:

(1) Screws
(2) Felt cover
(3) Felt
(4) Retainer plate
(5) Bearing
(6) Plate washer
(7) Felt

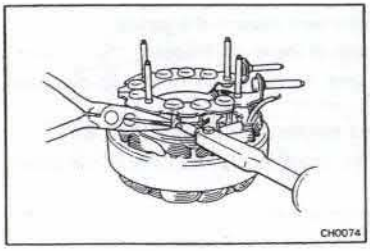


(b) Install the felt, plate washer and bearing in the drive and frame.

NOTE: If necessary, lightly tap the bearing with a plastic hammer.



(c) Install the retainer plate, felt and felt cover with the three bolts.

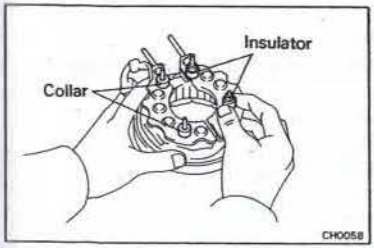


ASSEMBLY OF ALTERNATOR

(See page CH-8)

1. SOLDER EACH STATOR LEAD TO RECTIFIER HOLDER

CAUTION: Use pliers and a small wattage soldering iron to protect the rectifiers from heat.

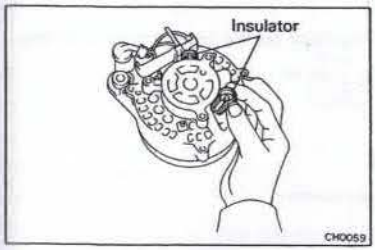


2. ASSEMBLE RECTIFIER END FRAME AND RECTIFIER HOLDER

(a) Place the two insulators on the positive side studs.

(b) Place the two collars on the negative side studs.

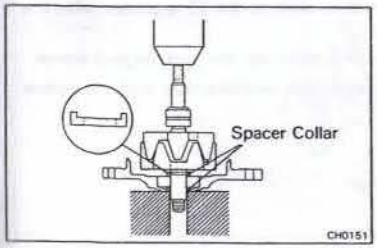
(c) Install the rectifier end frame on the rectifier holder. Check that the wires are not touching the case.



(d) Place the two insulators on the positive side studs.

(e) Install the four nuts and condensor on the studs.

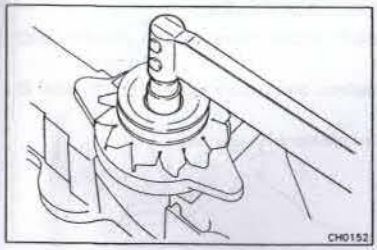
(f) Install the two rubber caps on the positive side studs.



3. INSTALL ROTOR TO DRIVE END FRAME

(a) Slide the thin spacer collar on the rotor shaft with the cup side facing the rotor.

(b) Using a press install the drive end frame together with the thick spacer collar.



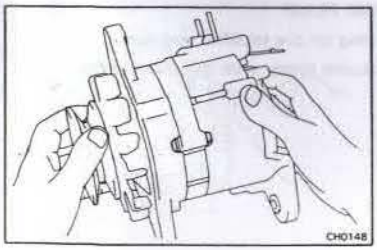
4. INSTALL FAN AND PULLEY

(a) Mount the rotor in a soft jaw vise.

(b) Slide the fan, pulley and spring washer on the rotor shaft.

(c) Install and torque the nut.

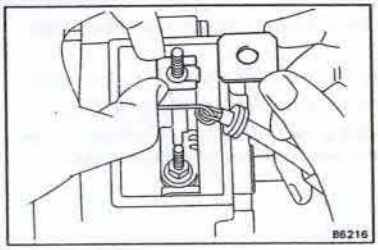
Torque: 900 kg-cm (65 ft-lb, 88 N·m)



5. ASSEMBLE DRIVE END FRAME AND RECTIFIER END FRAME

(a) Install the drive end frame and rectifier end frame with the three through bolts.

(b) Make sure the rotor rotates smoothly.

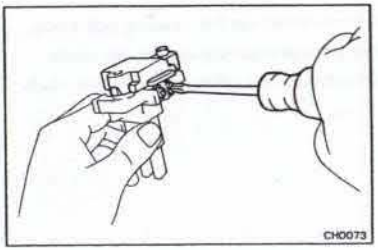


6. INSTALL BRUSH HOLDER

[w/o IC Regulator]

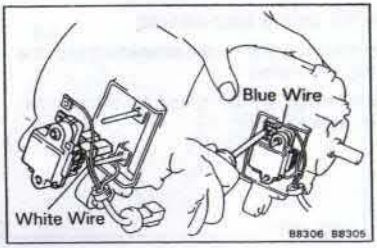
(a) Install the brush holder to the rectifier end frame with a nut.

(b) Install the lead wire and insulator.



[w/ IC Regulator]

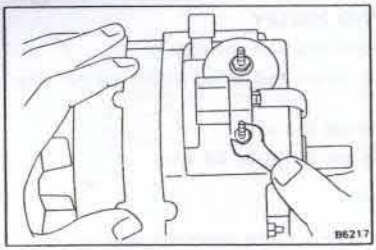
(a) Install the IC regulator on the brush holder with the two screws.



(b) Connect the white wire to the IC regulator with the screw.

(c) Insert the brush holder into the rectifier end frame.

(d) Install the brush holder and blue wire with the screw.

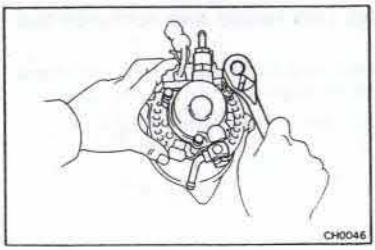


7. INSTALL BRUSH HOLDER COVER

(a) Place the brush holder cover on the rectifier end frame.

(b) Install the insulator and rubber washer to terminal B with the nut.

(c) Install the wire clamp with the nut.



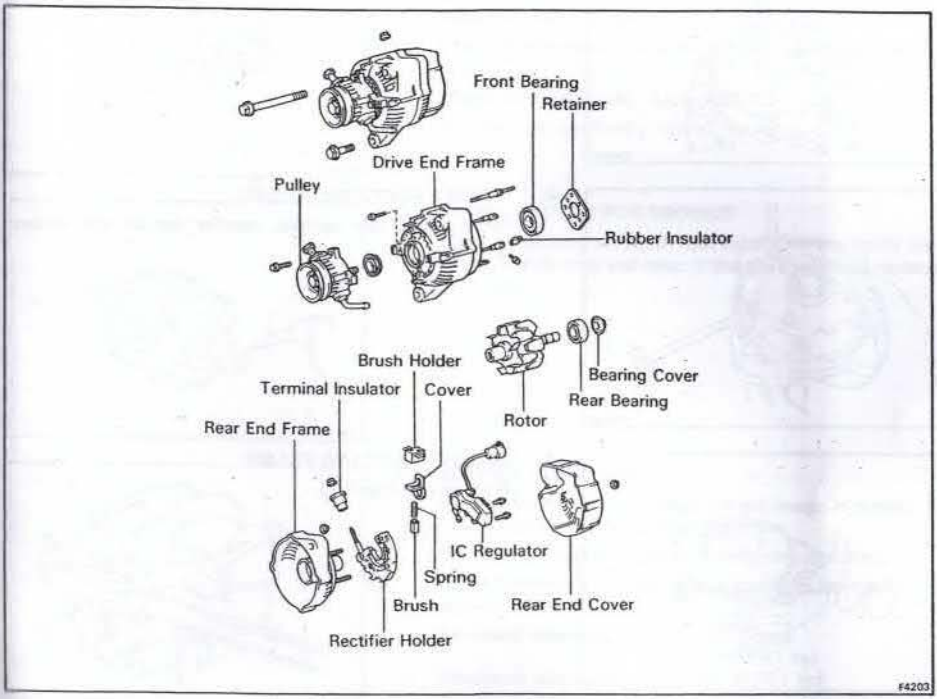
8. INSTALL VACUUM PUMP

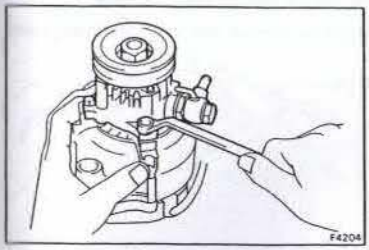
(a) Place the O-ring on the rectifier end frame.

(b) Install the vacuum pump with the three bolts.

ALTERNATOR (CM, CR)

COMPONENTS

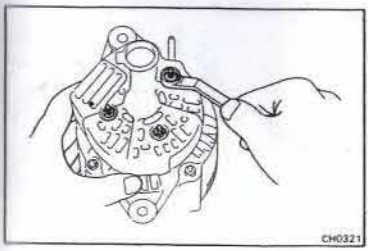




DISASSEMBLY OF ALTERNATOR

1. **REMOVE VACUUM PUMP**

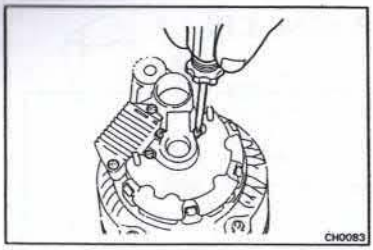
   Remove four bolts and vacuum pump.



2. **REMOVE REAR END COVER**

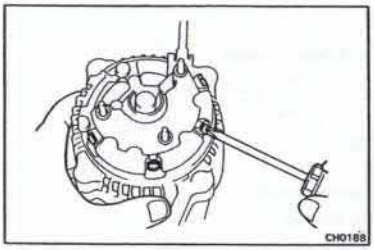
   (a) Remove the nut and terminal insulator.

   (b) Remove the three nuts and end cover.



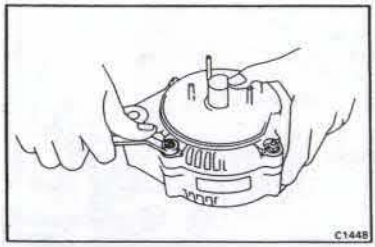
3. REMOVE BRUSH HOLDER AND IC REGULATOR

Remove the five screws, brush holder and IC regulator.



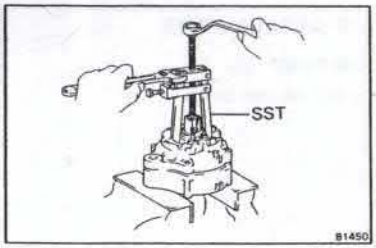
4. REMOVE RECTIFIER HOLDER

Remove the four screws, rectifier holder and rubber insulators.



5. REMOVE REAR END FRAME

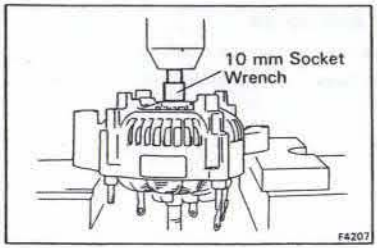
Remove the four nuts.

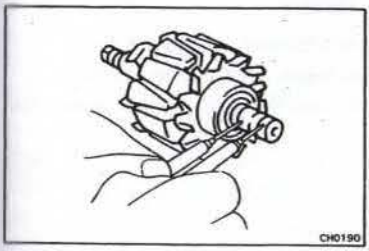


6. REMOVE ROTOR FROM DRIVE END FRAME

Using SST and a press, remove the rotor from drive end frame.

SST 09286-46011





INSPECTION AND REPAIR OF ALTERNATOR

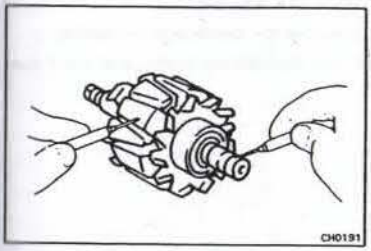
Rotor

1. INSPECT ROTOR FOR OPEN CIRCUIT

Using an ohmmeter, check for continuity between the slip rings.

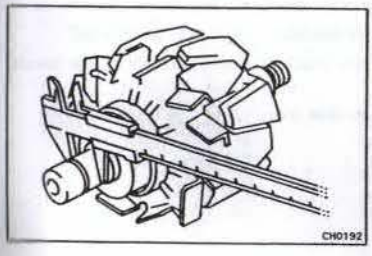
Standard resistance: Less than 3Ω

If there is no continuity, replace the rotor.



2. INSPECT ROTOR FOR GROUND

Using an ohmmeter, check that there is no continuity between the slip ring and rotor. If there is continuity, replace the rotor.



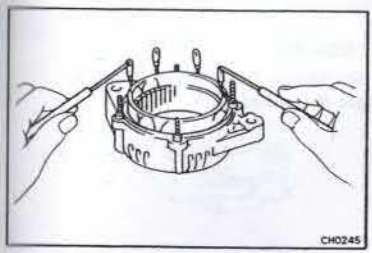
3. INSPECT SLIP RINGS

(a) Check that the slip rings are not rough or scored. If rough or scored, replace the rotor.

(b) Using calipers, measure the slip ring diameter.

If the diameter of the slip ring is less than the minimum, replace the rotor.

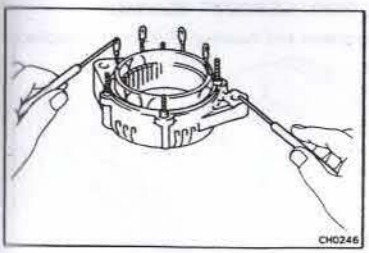
Standard diameter: 14.0 — 14.4 mm (0.551 — 0.567 in.)
Minimum diameter: 14.0 mm (0.551 in.)



Stator

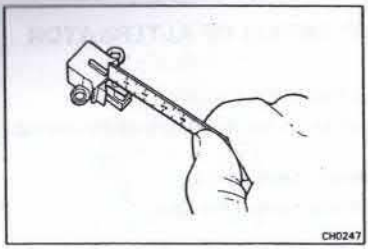
1. INSPECT STATOR FOR OPEN CIRCUIT

Using an ohmmeter, check all leads for continuity. If there is no continuity, replace the drive end frame assembly.



2. INSPECT THAT STATOR IS NOT GROUNDED

Using an ohmmeter, check that there is no continuity between the coil leads and drive end frame.
If there is continuity, replace the drive end frame assembly.

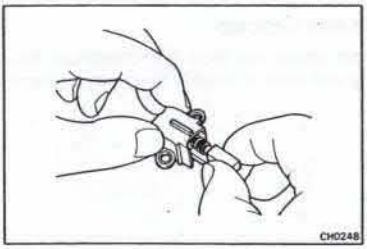


Brush and Brush Holder

1. MEASURE EXPOSED BRUSH LENGTH

Minimum exposed length: 4.5 mm (0.177 in.)

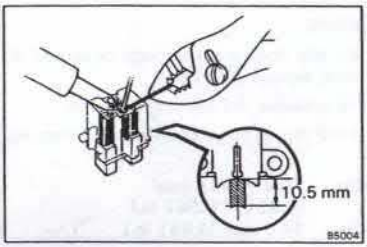
If the brush length is less than the minimum, replace the brush.



2. IF NECESSARY, REPLACE BRUSH

(a) Unsolder and remove the brush and the spring.

(b) Put the brush wire through the spring and insert the brush holder.

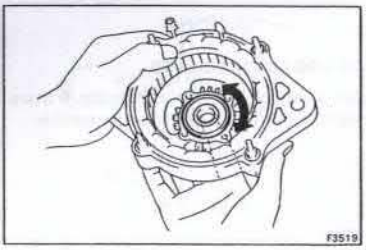


(c) Solder the wire to the brush holder as shown.

Standard exposed length: 10.5 mm (0.413 in.)

(d) Check that the brush moves smoothly in the brush holder.

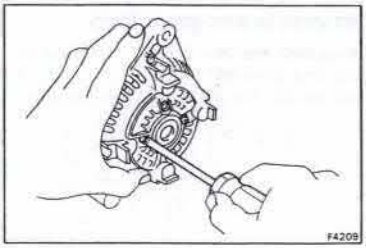
(e) Cut off the excess wire.



Bearings

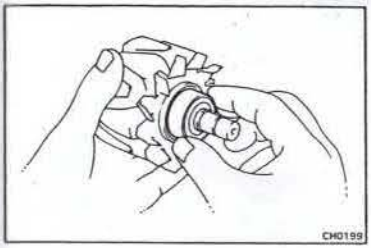
1. INSPECT FRONT BEARING

Check that the front bearing is not rough or worn.
If necessary, replace the bearing.



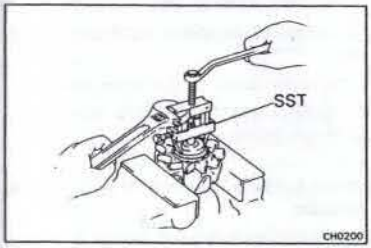
2. IF NECESSARY, REPLACE FRONT BEARING

Remove the four screws and bearing retainer, and replace the front bearing.



3. INSPECT REAR BEARING

Check that the rear bearing is not rough or worn.
If necessary, replace the bearing.

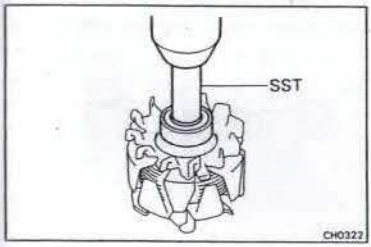


4. IF NECESSARY, REPLACE REAR BEARING

(a) Using SST, remove the rear bearing with the bearing cover from the rotor shaft.

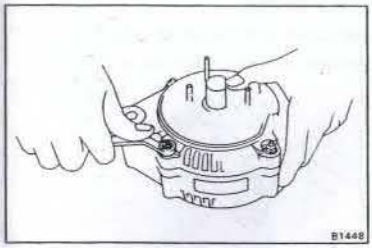
SST 09820-00021

CAUTION: Be careful not to damage the fan.



(b) Using SST, install the rear bearing and bearing cover onto the rotor shaft.

SST 09820-00030



ASSEMBLY OF ALTERNATOR

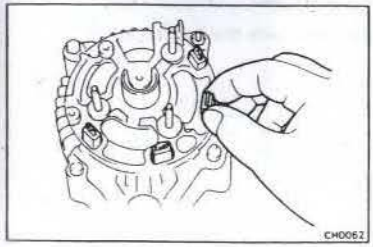
(See page CH-15)

1. INSTALL ROTOR TO DRIVE END FRAME

2. INSTALL REAR END FRAME

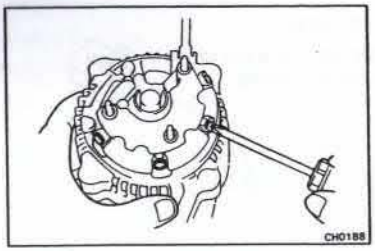
(a) Using a plastic hammer, lightly tap the rear end frame on the drive end frame.

(b) Install the four nuts.

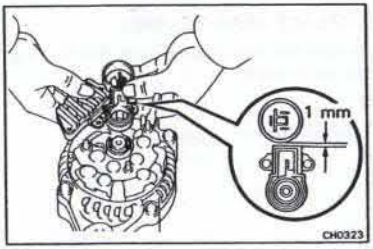


3. INSTALL RECTIFIER HOLDER

(a) Install the four rubber insulators on the lead wires.



(b) Install the rectifier with four screws.



4. INSTALL BRUSH HOLDER AND IC REGULATOR

(a) Temporarily install the IC regulator and brush holder with the screw.

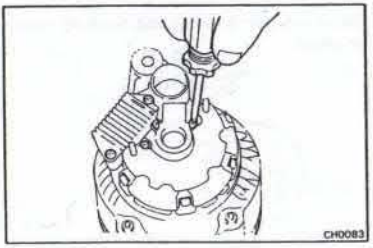
(b) Place the brush holder cover to the brush holder.

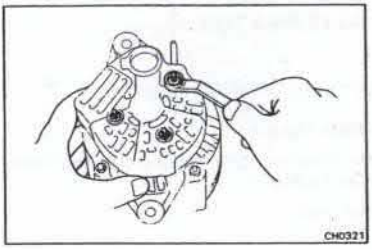
(c) Install the IC regulator and brush holder to the rear end frame as shown in the figure.

NOTE:

- Make sure the brush holder's cover doesn't slip to one side during installation.
- Make sure the gap between the brush holder and connector is at least 1 mm (0.04 in.).

(d) Install the brush holder and IC regulator with the five screws.

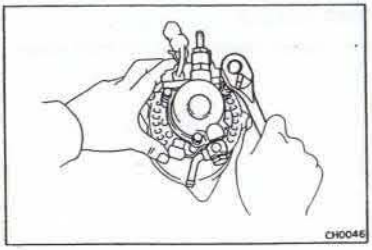




5. INSTALL REAR END COVER

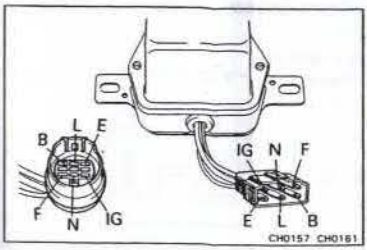
(a) Install the end cover with the three nuts.

(b) Install the terminal insulator with the nut.



6. INSTALL VACUUM PUMP

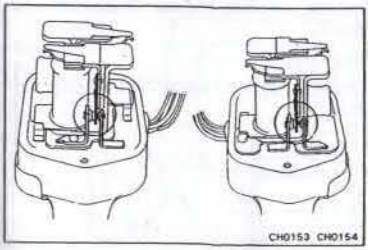
Install the vacuum pump with the four bolts.



ALTERNATOR REGULATOR

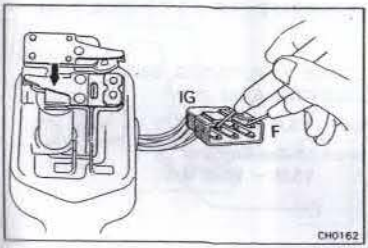
INSPECTION OF ALTERNATOR REGULATOR

1. DISCONNECT REGULATOR CONNECTOR
2. REMOVE TWO MOUNTING BOLTS AND REGULATOR



3. INSPECT POINT SURFACES FOR BURN AND DAMAGE

   If defective, replace the regulator.

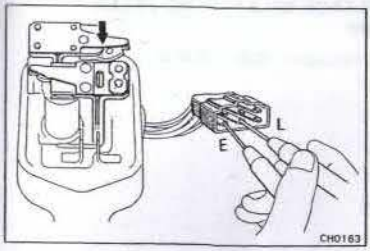


4. MEASURE RESISTANCE BETWEEN TERMINALS

   (a) Using an ohmmeter, measure the resistance between terminals IG and F.

   Resistance (voltage regulator):

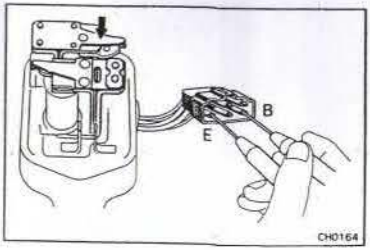
At rest	**0 Ω**
Pulled in	**Approx. 11 Ω**



   (b) Using an ohmmeter, measure the resistance between terminals L and E.

   Resistance (voltage relay):

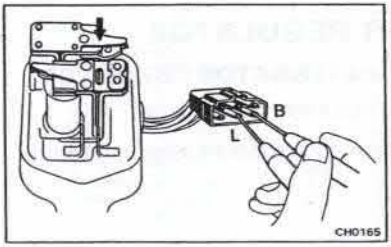
At rest	**0 Ω**
Pulled in	**Approx. 100 Ω**



   (c) Using an ohmmeter, measure the resistance between terminals B and E.

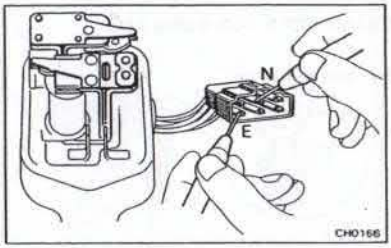
   Resistance (voltage relay):

At rest	**Infinity**
Pulled in	**Approx. 100 Ω**



(d) Using an ohmmeter, measure the resistance between terminals B and L.

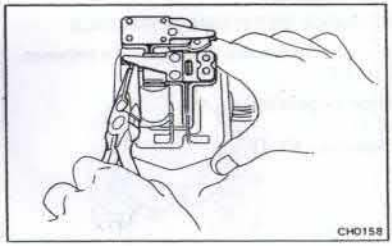
Resistance (voltage relay):
At rest Infinity
Pulled in 0 Ω



(e) Using an ohmmeter, measure the resistance between terminals N and E.

Resistance: Approx. 24 Ω

If any of the above checks are not as specified, replace the alternator regulator.

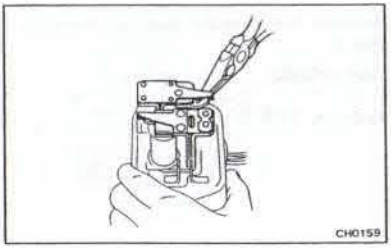


VOLTAGE ADJUSTMENT OF ALTERNATOR REGULATOR

1. **TO ADJUST VOLTAGE REGULATOR, BEND REGULATOR ADJUSTING ARM**

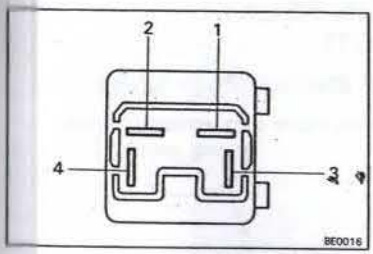
   Regulating voltage: 13.8 — 14.8 V

   (CE OPT: Cold area of the Europe)
   13.8 — 14.4 V



2. **TO ADJUST VOLTAGE RELAY, BEND RELAY ADJUSTING ARM**

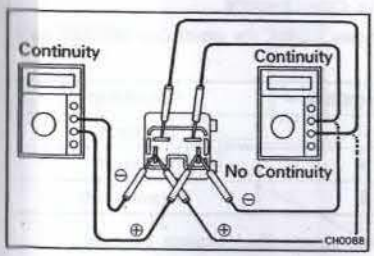
   Relay actuating voltage: 4.0 — 5.8 V



CHARGE LIGHT RELAY (w/ IC Regulator Type)

INSPECTION OF CHARGE LIGHT RELAY

LOCATION: In the driver's kick panel.



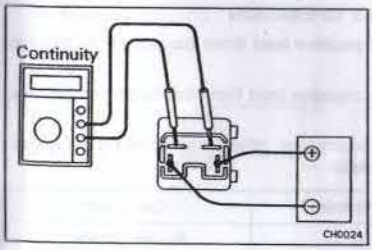
1. **INSPECT RELAY CONTINUITY**

   (a) Using an ohmmeter, check that there is no continuity between terminals 1 and 2.

   (b) Connect an ohmmeter positive lead to terminal 3 and negative lead to terminal 4 and check that there is continuity.

   (c) Reverse polarity of test leads and check that there is no continuity.

   If continuity is not as specified, replace the relay.



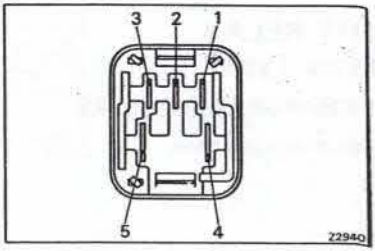
2. **INSPECT RELAY OPERATION**

   (a) Connect a positive lead from the battery to terminal 3.

   (b) Connect a negative lead from the battery to terminal 4.

   (c) Using an ohmmeter, check for continuity between terminals 1 and 2.

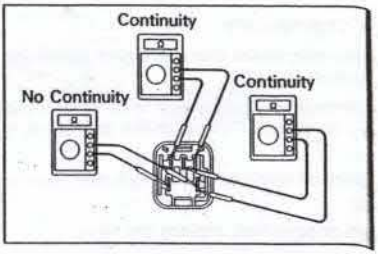
   If there is no continuity, replace the relay.



ENGINE MAIN RELAY (CE80, CV, CT)

INSPECTION OF ENGINE MAIN RELAY

LOCATION: In the engine compartment relay box.

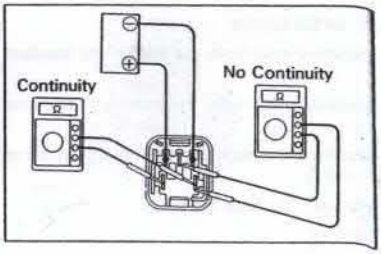


1. INSPECT RELAY CONTINUITY

Using an ohmmeter, check for continuity between each terminal.

Between terminals	Condition
1 – 3	Continuity
2 – 4	Continuity
4 – 5	No continuity

If continuity is not as specified, replace the relay.



2. INSPECT RELAY OPERATION

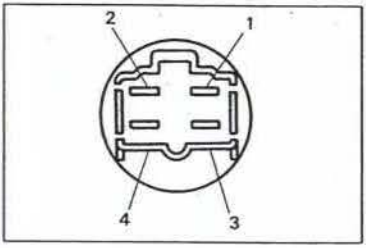
(a) Connect a positive lead from the battery to terminal 3.

(b) Connect a negative lead from the battery to terminal 1.

(c) Using an ohmmeter, check for continuity between each terminal.

Between terminal	Condition
2 – 4	No continuity
4 – 5	Continuity

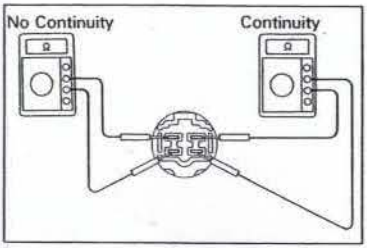
If continuity is not as specified, replace the relay.



ENGINE MAIN RELAY (CE70, CM, CR)

INSPECTION OF ENGINE MAIN RELAY

LOCATION
CE70: In the engine compartment relay box.
CM, CR: Under the instrument panel in the realy box.

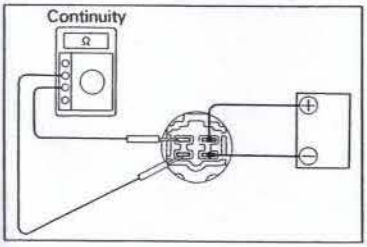


1. INSPECT RELAY CONTINUITY

(a) Using an ohmmeter, check that there is continuity between terminals 1 and 3.

(b) Using an ohmmeter, check that there is no continuity between terminals 2 and 4.

If continuity is not as specfied, replace the relay.



2. INSPECT RELAY OPERATION

(a) Apply battery voltage between terminals 1 and 3.

(b) Using an ohmmeter, check that there is continuity between terminals 2 and 4.

If there is no continuity, replace the relay.

SERVICE SPECIFICATIONS

ENGINE MECHANICAL

Specifications

Drive belt deflection or tension		with 10 kg (22.0 lb, 98 N)		w/SST (Reference)
FR Vehicles				
Fan – Alternator	New belt	9.0 – 11.0 mm	0.354 – 0.433 in.	40 – 60 kg
	Used belt	12.0 – 14.0 mm	0.472 – 0.551 in.	20 – 40 kg
PS Pump – Crankshaft	New belt	7.5 – 9.5 mm	0.295 – 0.374 in.	45 – 55 kg
	Used belt	9.5 – 12.5 mm	0.374 – 0.492 in.	20 – 35 kg
A/C Compressor – Crankshaft				
	New belt	6.5 – 7.5 mm	0.256 – 0.295 in.	45 – 55 kg
	Used belt	7.5 – 10.0 mm	0.295 – 0.394 in.	20 – 35 kg
FF Vehicles				
Alternator – Crankshaft	New belt	9.0 – 11.0 mm	0.354 – 0.433 in.	40 – 60 kg
	Used belt	12.0 – 14.0 mm	0.472 – 0.551 in.	20 – 40 kg
PS Pump – Crankshaft	New belt	11.0 – 14.0 mm	0.433 – 0.551 in.	55 – 65 kg
	Used belt	15.0 – 18.0 mm	0.591 – 0.709 in.	25 – 40 kg
A/C Compressor – Crankshaft				
CE80 w/o PS	New belt	5.0 – 6.0 mm	0.197 – 0.236 in.	70 – 80 kg
	Used belt	6.0 – 7.0 mm	0.236 – 0.276 in.	30 – 45 kg
CE80 w/ PS	New belt	11.0 – 14.0 mm	0.433 – 0.551 in.	55 – 65 kg
and Others	Used belt	15.0 – 18.0 mm	0.591 – 0.709 in.	25 – 40 kg

Engine oil capacity				
FR Vehicles	Dry fill	5.3 liters	5.6 US qts	4.7 Imp. qts
	Drain and refill			
	w/ Oil filter change	4.5 liters	4.8 US qts	4.0 Imp. qts
	w/o Oil filter change	3.8 liters	4.0 US qts	3.3 Imp. qts
FF Vehicles	Dry fill	4.8 liters	5.1 US qts	4.2 Imp. qts
	Drain and refill			
	w/ Oil filter change	4.3 liters	4.5 US qts	3.8 Imp. qts
	w/o Oil filter change	3.8 liters	4.0 US qts	3.3 Imp. qts
2C-T	Dry fill	5.0 liters	5.3 US qts	4.4 Imp. qts
	Drain and refill			
	w/ Oil filter change	4.3 liters	4.5 US qts	3.8 Imp. qts
	w/o Oil filter change	3.8 liters	4.0 US qts	3.3 Imp. qts
Injection timing [At 0.77 – 0.83 mm (0.0303 – 0.0327 in.) Plunger lift]		0°TDC		
Injection order		1–3–4–2		
Valve clearance (Cold)	Intake	0.20 – 0.30 mm		0.008 – 0.012 in.
	Exhaust	0.25 – 0.35 mm		0.010 – 0.014 in.
Idle speed		750 – 850 rpm		
Maximum speed	CV	5,100 – 5,200 rpm		
	Others	5,300 – 5,400 rpm		
Compression pressure	at 250 rpm STD	30.0 kg/cm²	427 psi	2,942 kPa
	Limit	25.0 kg/cm²	356 psi	2,452 kPa
Differential of pressure between each cylinder		Less than 5.0 kg/cm² (71 psi, 490 kPa)		

Specifications (Cont'd)

Cylinder head	Head surface warpage			Limit	0.2 mm	0.008 in.
	Manifold surface warpage		IN & EX	Limit	0.2 mm	0.008 in.
	Valve seat	Refacing angle			30°, 45°, 60°	
		Contacting angle			45°	
		Contacting width		Intake	1.2 – 1.6 mm	0.047 – 0.063 in.
				Exhaust	1.6 – 2.0 mm	0.063 – 0.079 in.
Valve guide bushing	Inner diameter				8.01 – 8.03 mm	0.3154 – 0.3161 in.
	Outer diameter		STD		13.040 – 13.051 mm	0.5134 – 0.5138 in.
			O/S type 0.05		13.090 – 13.101 mm	0.5154 – 0.5158 in.
	Replacing temperature (cylinder head side)				90°C	194°F
Valve	Valve overall length		STD	Intake	105.70 mm	4.1614 in.
				Exhaust	105.35 mm	4.1476 in.
			Limit	Intake	105.20 mm	4.1417 in.
				Exhaust	104.85 mm	4.1476 in.
	Valve face angle			IN & EX	44.5°	
	Stem diameter			Intake	7.975 – 7.990 mm	0.3140 – 0.3146 in.
				Exhaust	7.960 – 7.975 mm	0.3134 – 0.3140 in.
	Stem oil clearance		STD	Intake	0.020 – 0.055 mm	0.0008 – 0.0022 in.
				Exhaust	0.035 – 0.070 mm	0.0014 – 0.0028 in.
			Limit	Intake	0.08 mm	0.0031 in.
				Exhaust	0.10 mm	0.0039 in.
	Valve head edge thickness		Limit	Intake	0.9 mm	0.035 in.
				Exhaust	1.0 mm	0.039 in.
Valve spring	Free length				47.5 mm	1.870 in.
	Installed length				40.3 mm	1.587 in.
	Installed load			STD	22.9 – 25.3 kg	50.5 – 55.8 lb	225 – 248 N
	Squareness			Limit	2.0 mm	0.079 in.
Camshaft	Thrust clearance			STD	0.08 – 0.18 mm	0.0031 – 0.0071 in.
				Limit	0.25 mm	0.0098 in.
	Journal oil clearance			STD	0.037 – 0.073 mm	0.0015 – 0.0029 in.
				Limit	0.1 mm	0.004 in.
	Journal diameter				27.979 – 27.995 mm	1.1015 – 1.1022 in.
	Circle runout			Limit	0.06 mm	0.0024 in.
	Cam lobe hight					
	Intake		STD	2C-T	46.325 – 46.475 mm	1.8238 – 1.8297 in.
				Others	46.725 – 46.875 mm	1.8396 – 1.8455 in.
			Limit	2C-T	45.925 mm	1.8081 in.
				Others	46.325 mm	1.8238 in.
	Exhaust		STD		47.335 – 47.485 mm	1.8636 – 1.8695 in.
			Limit		46.835 mm	1.8439 in.
Valve lifter	Outer diameter			STD	37.922 – 37.932 mm	1.4930 – 1.4934 in.
	Valve lifter oil clearance			STD	0.028 – 0.053 mm	0.0011 – 0.0021 in.
				Limit	0.10 mm	0.0039 in.

Specifications (Cont'd)

Intake and exhaust manifold	Manifold surface warpage Limit IN & EX	0.4 mm	0.016 in.
No. 2 air intake manifold	Manifold surface warpage Limit	0.4 mm	0.016 in.
Combustion chamber	Protrusion	0.01 – 0.07 mm	0.0004 – 0.0028 in.
	Shim size	0.05 mm (0.0020 in.), 0.10 mm (0.0039 in.)	
Idler pulley tension spring	Free length	51.93 mm	2.0445 in.
	Installed tension at 63 mm (2.48 in.)	4.3 kg 9.5 lb	42 N
Cylinder block	Warpage Limit	0.20 mm	0.0079 in.
	Cylinder bore STD 1C series	83.00 – 83.03 mm	3.2677 – 3.2689 in.
	2C series	86.00 – 86.03 mm	3.3858 – 3.3870 in.
	Cylinder bore wear		
	1C series		
	On standard sized piston Limit	83.23 mm	3.2768 in.
	On oversized piston (O/S 0.50) Limit	83.73 mm	3.2965 in.
	2C series		
	On standard sized piston Limit	86.23 mm	3.3949 in.
	On oversized piston (O/S 0.50) Limit	86.73 mm	3.4146 in.
Piston and piston ring	Piston diameter 1C series STD	82.95 – 82.98 mm	3.2657 – 3.2669 in.
	O/S type 0.50	83.45 – 83.48 mm	3.2854 – 3.2866 in.
	2C series STD	85.95 – 85.98 mm	3.3839 – 3.3850 in.
	O/S type 0.50	86.45 – 86.48 mm	3.4035 – 3.4047 in.
	Piston oil clearance STD	0.04 – 0.06 mm	0.0016 – 0.0024 in.
	Limit	0.15 mm	0.0059 in.
	Piston ring end gap		
	STD end gap No. 1	0.27 – 0.54 mm	0.0106 – 0.0213 in.
	No. 2	0.25 – 0.52 mm	0.0098 – 0.0205 in.
	Oil	0.20 – 0.82 mm	0.0079 – 0.0323 in.
	Limit end gap No. 1	1.34 mm	0.0528 in.
	No. 2	1.32 mm	0.0520 in.
	Oil	1.62 mm	0.0638 in.
	Ring to ring groove clearance		
	(New piston ring) Limit	0.2 mm	0.008 in.
	Piston pin installing temperature	80°C	176°F
Connecting rod and bearing	Thrust clearance STD	0.08 – 0.30 mm	0.0031 – 0.0118 in.
	Limit	0.4 mm	0.016 in.
	Bearing oil clearance STD	0.036 – 0.064 mm	0.0014 – 0.0025 in.
	Limit	0.1 mm	0.004 in.
	Pin to bushing oil clearance STD	0.007 – 0.015 mm	0.0003 – 0.0006 in.
	Limit	0.05 mm	0.0020 in.
	Piston pin diameter	27.000 – 27.012 mm	1.0630 – 1.0635 in.
	Bushing inside diameter	27.011 – 27.023 mm	1.0634 – 1.0639 in.
	Rod bend per 100 mm (3.94 in.) Limit	0.05 mm	0.0020 in.
	Rod twist per 100 mm (3.94 in.) Limit	0.15 mm	0.0059 in.

Specifications (Cont'd)

Crankshaft	Thrust clearance	STD	0.04 – 0.24 mm	0.0016 – 0.0094 in.
		Limit	0.3 mm	0.012 in.
	Thrust washer thickness	STD	2.430 – 2.480 mm	0.0957 – 0.0976 in.
		O/S type 0.125	2.555 – 2.605 mm	0.1006 – 0.1026 in.
		O/S type 0.250	2.680 – 2.730 mm	0.1055 – 0.1075 in.
	Main journal oil clearance	STD	0.034 – 0.065 mm	0.0013 – 0.0026 in.
		Limit	0.1 mm	0.004 in.
	Main journal diameter	STD	56.985 – 57.000 mm	2.2435 – 2.2441 in.
	Crank pin oil clearance	STD	0.044 – 0.072 mm	0.0017 – 0.0028 in.
		Limit	0.1 mm	0.004 in.
	Crank pin diameter	STD	50.488 – 50.500 mm	1.9877 – 1.9882 in.
	Circle runout	Limit	0.1 mm	0.004 in.
	Main journal taper and out-of-round	Limit	0.02 mm	0.0008 in.
	Crank pin journal taper and out-of round	Limit	0.02 mm	0.0008 in.
Flywheel	Runout	Limit	0.1 mm	0.004 in.

Torque Specifications

Part tightened		kg-cm	ft-lb	N·m
Cylinder head x Cylinder block	1st Step	450	33	44
	2nd Step		90°	
	3rd Step		90°	
Camshaft bearing cap x Cylinder head		185	13	18
Manifold x Cylinder head	Intake	185	13	18
	Exhaust	475	34	47
No. 2 air intake manifold x Intake manifold		185	13	18
Camshaft pulley x Camshaft		900	65	88
Injection pump drive pulley x Injection pump		650	47	64
Oil pump drive pulley x Oil pump		475	34	47
No. 1 idler pulley x Cylinder head		375	27	37
No. 2 idler pulley x Oil pump x Cylinder block		375	27	37
Water pump x Cylinder block		185	13	18
Oil pump x Cylinder block		185	13	18
Fan bracket or RH engine mounting bracket	14 mm bolt head	375	27	37
	17 mm bolt head	650	47	64
Crankshaft pulley x Crankshaft		1,000	72	98
Crankshaft bearing cap x Cylinder block		1,050	76	103
Connecting rod cap x Connecting rod		650	47	64
Flywheel x Crankshaft		900	65	88
Drive plate x Crankshaft		750	54	74
Nozzle holder x Cylinder head		650	47	64
Oil pan or No. 2 oil pan x Cylinder block		75	65 in.-lb	7.4
Injection pipe	CV	275	20	27
	Others	300	22	29

FUEL SYSTEM

Injection nozzle	Nozzle type		DN0PD4
	Nozzle opening pressure		
	Inspection New nozzle		145 – 155 kg/cm² (2,062 – 2,205 psi, 14,220 – 15,200 kPa)
	Reused nozzle		135 – 155 kg/cm² (1,920 – 2,205 psi, 13,239 – 15,200 kPa)
	Adjustment		145 – 155 kg/cm² (2,062 – 2,205 psi, 14,220 – 15,200 kPa)
	Adjusting shim thickness (For adjusting nozzle opening pressure)		0.90 ... 1.95 mm 0.0354 ... 0.0768 in. [43 sizes in 0.025 mm (0.0010 in.) increment]
Fuel feed pump	Quantity		4 cc 0.2 cu in.
	Inner pressure	400 rpm	2.2 – 2.8 kg/cm² (31 – 40 psi, 216 – 275 kPa)
		2,200 rpm	6.7 – 7.3 kg/cm² (95 – 104 psi, 657 – 716 kPa)
Automatic timer	Timer piston stroke		
	CE70, CM (STD)	800 rpm	0.20 – 1.20 mm 0.0079 – 0.0472 in.
		1,800 rpm	3.67 – 4.67 mm 0.1445 – 0.1839 in.
		2,350 rpm	5.58 – 6.58 mm 0.2197 – 0.2591 in.
	CE80	800 rpm	0.20 – 1.20 mm 0.0079 – 0.0472 in.
		1,800 rpm	3.67 – 4.67 mm 0.1445 – 0.1839 in.
		2,350 rpm	5.58 – 6.58 mm 0.2197 – 0.2591 in.
	CV	700 rpm	0.24 – 1.24 mm 0.0094 – 0.0488 in.
		1,800 rpm	4.32 – 5.32 mm 0.1701 – 0.2094 in.
		2,250 rpm	5.99 – 6.99 mm 0.2358 – 0.2752 in.
	CT	800 rpm	0.20 – 1.20 mm 0.0079 – 0.0472 in.
		1,800 rpm	3.67 – 4.67 mm 0.1445 – 0.1839 in.
		2,350 rpm	5.58 – 6.58 mm 0.2197 – 0.2591 in.
	CM (OPT)	800 rpm	0.61 – 1.61 mm 0.0240 – 0.0633 in.
		1,800 rpm	4.08 – 5.08 mm 0.1606 – 0.2000 in.
		2,350 rpm	5.99 – 6.99 mm 0.2358 – 0.2752 in.
	CR	800 rpm	0.20 – 1.20 mm 0.0079 – 0.0472 in.
		1,800 rpm	3.67 – 4.67 mm 0.1445 – 0.1839 in.
		2,350 rpm	5.58 – 6.58 mm 0.2197 – 0.2591 in.
			[Hysteresis limit less than 0.3 mm (0.012 in.)]
	Adjusting shim thickness		0.2, 0.5, 1.0 mm 0.008, 0.020, 0.039 in.

FUEL SYSTEM (Cont'd)

Injection pump	Direction of rotation		Clockwise as seen from drive side
	Cam lift		2.2 mm 0.087 in.
	Injection order		A–B–C–D (1–3–4–2)
	Adjusting lever moving angle		
		CE70	Plus 9 – 19° Minus 24 – 34°
		CE80, CT150	Plus 13 – 23° Minus 24 – 34°
		CM, CR	Plus 3 – 13° Minus 30 – 40°
		CV	Plus 14 – 22° Minus 24 – 34°
	Plunger spring		
	Free length	STD	30.0 mm 1.181 in.
		Limit	29.5 mm 1.161 in.
	Squareness	Limit	2.0 mm 0.079 in.
	Plunger spring shim		0.5, 0.8, 1.0, 1.2, 1.5, 1.8, 2.0 mm 0.020, 0.031, 0.039, 0.047, 0.059, 0.071, 0.079 in.
	Plunger adjusting shim		1.9 ... 2.9 mm 0.075 ... 0.114 in. [11 sizes in 0.1 mm (0.004 in.)]
	Delivery valve spring		
	Free length	STD	24.4 mm 0.961 in.
		Limit	23.5 mm 0.925 in.
	Squareness	Limit	1.0 mm 0.039 in.
Governor	Governor sleeve plug	2C-T	4.3 ... 6.1 mm 0.169 ... 0.240 in. [11 sizes in 0.2 mm (0.008 in.)]
		Others	4.3 ... 5.7 mm 0.169 ... 0.224 in. [8 sizes in 0.2 mm (0.008 in.)]
	Weight holder thrust clearance		0.15 – 0.35 mm 0.0059 – 0.0138 in.
	Adjusting washer		1.05 ... 1.85 mm 0.0413 ... 0.0728 in. [5 sizes in 0.2 mm (0.008 in.)]
	Top of governor shaft to end of injection pump housing		1.0 – 2.0 mm 0.039 – 0.079 in.
Injection pipe	Overall length		477 – 481 mm 18.78 – 18.94 in.
	Outside diameter		6.0 mm 0.236 in.
	Inside diameter		2.0 mm 0.079 in.

Injection Pump Adjustment and Test

Preparations of pump tester	Test nozzle type		DN12 SD12
	Test nozzle opening pressure		145 – 155 kg/cm² (2,062 – 2,205 psi, 14,220 – 15,200 kPa)
	Injection pipe	Outer diameter	6.0 mm 0.236 in.
		Inner diameter	2.0 mm 0.079 in.
		Length	840 mm 33.07 in.
		Minimum bending radius	More than 25 mm (0.98 in.)
	Fuel temperature		40 – 45°C 104 – 113°F
	Fuel feeding pressure		0.2 kg/cm² 2.8 psi 20 kPa
	Fuel cut solenoid voltage		6V

Over flow volume	Pump rpm	Overflow volume
	2,200	370 – 800 cc/min. 22.6 – 48.8 cu in./min.

Injection Pump Adjustment and Test (Cont'd)

Full load injection volume	Item	Adjusting lever angle	Pump rpm	No. of measuring strokes	Injection volume	
*1 Apply 0.48 kg/cm² (6.8 psi, 47 kPa) pressure *2 Apply 730 ± 1.5 mm Hg (28.74 ± 0.06 in. Hg, 97.3 ± 0.2 kPa) absolute pressure *3 High altitude	CE70	Plus 9 – 19°	1,500	200	7.9 – 8.3 cc	0.48 – 0.51 cu in.
	CE80	Plus 13 – 23°			7.7 – 8.1 cc	0.47 – 0.49 cu in.
	CM (STD)	Plus 3 – 10°				
	CV *1	Plus 14 – 22°			10.1 – 10.5 cc	0.62 – 0.64 cu in.
	CT (w/o HAC)	Plus 13 – 23°			8.1 – 8.5 cc	0.49 – 0.52 cu in.
	CT (w/ HAC)*2	Plus 13 – 23°			7.9 – 8.4 cc	0.48 – 0.51 cu in.
	CR	Plus 3 – 10°			8.1 – 8.5 cc	0.49 – 0.52 cu in.
	CM (OPT*3)	Plus 3 – 10°			7.1 – 7.5 cc	0.43 – 0.46 cu in.

Maximum speed set	Item	Adjusting lever angle	Pump rpm	No. of measuring strokes	Injection volume		Remarks
*1 Apply 0.48 kg/cm² (6.8 psi, 47 kPa) pressure *2 Apply 730 ± 1.5 mm Hg (28.74 ± 0.06 in. Hg, 97.3 ± 0.2 kPa) absolute pressure *3 For CM (OPT: High altitude)	CE70, CE80	Plus 9 – 19° (CE70) Plus 13 – 23° (CE80)	2,700	200	2.0 – 3.2 cc	0.12 – 0.20 cu in.	Adjust
			2,600		4.1 – 5.8 cc	0.25 – 0.35 cu in.	–
			2,850		Less than 1.5 cc (0.09 cu in.)		
	CV *1	Plus 14 – 22°	2,600	200	2.6 – 3.8 cc	0.16 – 0.23 cu in.	Adjust
			2,500		5.0 – 8.3 cc	0.31 – 0.51 cu in.	–
			2,800		Less than 1.5 cc (0.09 cu in.)		
	CT *2	Plus 13 – 23°	2,700	200	2.0 – 3.2 cc	0.12 – 0.20 cu in.	Adjust
			2,600		4.3 – 6.1 cc	0.26 – 0.37 cu in.	–
			2,850		Less than 1.5 cc (0.09 cu in.)		
	CM, CR	Plus 3 – 10°	2,700	200	2.2 – 3.0 cc	0.13 – 0.18 cu in.	Adjust
			2,600		4.3 – 6.1 cc	0.26 – 0.37 cu in.	–
					*3 4.0 – 5.8 cc	0.24 – 0.35 cu in.	
			2,800		Less than 1.5 cc (0.09 cu in.)		

Injection volume for confirmation	Item	Adjusting lever angle	Pump rpm	No. of measuring strokes	Injection volume		Variation limit	Remarks
*1 Apply 0.48 kg/cm² (6.8 psi, 47 kPa) pressure	CE70	Plus 9 – 19°	1,500	200	7.9 – 8.3 cc	0.48 – 0.51 cu in.	0.4 cc 0.02 cu in.	Basic full-load injection volume
			100		8.6 – 13.4 cc	0.52 – 0.82 cu in.	0.8 cc 0.05 cu in.	Volume during starting
			500		6.4 – 7.4 cc	0.39 – 0.45 cu in.	0.5 cc 0.03 cu in.	–
			2,350		6.9 – 7.9 cc	0.42 – 0.48 cu in.		–
			2,500		5.7 – 7.0 cc	0.35 – 0.43 cu in.		–
	CE80 CM (STD)	Plus 13 – 23° (CE80) 3 – 13° (CM)	1,500	200	7.7 – 8.1 cc	0.47 – 0.49 cu in.	0.4 cc 0.02 cu in.	Basic full-load injection volume
			100		8.6 – 13.4 cc	0.52 – 0.82 cu in.	0.8 cc 0.05 cu in.	Volume during starting
			500		6.2 – 7.2 cc	0.38 – 0.44 cu in.	0.5 cc 0.03 cu in.	–
			2,350		6.7 – 7.7 cc	0.41 – 0.47 cu in.		–
			2,500		5.8 – 6.9 cc	0.35 – 0.42 cu in.		–
	CV *1	Plus 14 – 22°	1,500	200	10.1 – 10.5 cc	0.62 – 0.64 cu in.	0.4 cc 0.02 cu in.	Basic full-load injection volume
			100		9.6 – 14.4 cc	0.59 – 0.88 cu in.	0.8 cc 0.05 cu in.	Volume during starting
			2,250		4.5 – 10.5 cc	0.27 – 0.64 cu in.	0.5 cc 0.03 cu in.	–
			2,350		8.8 – 10.1 cc	0.54 – 0.62 cu in.		–
	CT (w/o HAC)	Plus 13 – 23°	1,500	200	8.1 – 8.5 cc	0.49 – 0.52 cu in.	0.4 cc 0.02 cu in.	Basic full-load injection volume
			100		8.6 – 13.4 cc	0.52 – 0.82 cu in.	0.8 cc 0.05 cu in.	Volume during starting
			500		6.6 – 7.6 cc	0.40 – 0.46 cu in.	0.5 cc 0.03 cu in.	–
			2,350		7.1 – 8.1 cc	0.43 – 0.49 cu in.		–
			2,500		6.0 – 7.4 cc	0.37 – 0.45 cu in.		–

Injection Pump Adjustment and Test (Cont'd)

Injection volume for confirmation (Cont'd)	Item	Adjusting lever angle	Pump rpm	No. of measuring strokes	Injection volume	Variation limit	Remarks
	CT *2 (w/ HAC)	Plus 13 – 23°	1,500	200	7.9 – 8.4 cc 0.48 – 0.51 cu in.	0.4 cc 0.02 cu in.	Basic full-load injection volume
			100		8.6 – 13.4 cc 0.52 – 0.82 cu in.	0.8 cc 0.05 cu in.	Volume during starting
			500		6.5 – 7.4 cc 0.40 – 0.45 cu in.	0.5 cc 0.03 cu in.	–
			2,350		7.0 – 7.9 cc 0.43 – 0.48 cu in.		–
			2,500		6.0 – 7.4 cc 0.37 – 0.45 cu.in.		–
			*1 1,300		6.7 – 7.6 cc 0.41 – 0.46 cu in.		–
	CR	Plus 3 – 13°	1,500	200	8.1 – 8.5 cc 0.49 – 0.52 cu in.	0.4 cc 0.02 cu in.	Basic full-load injection volume
			100		8.6 – 13.4 cc 0.52 – 0.82 cu in.	0.8 cc 0.05 cu in.	Volume during starting
			500		6.6 – 7.6 cc 0.40 – 0.46 cu in.	0.5 cc 0.03 cu in.	–
			2,350		7.9 – 8.1 cc 0.43 – 0.49 cu in.		–
			2,500		6.0 – 7.4 cc 0.37 – 0.45 cu in.		–
	CM (OPT: High altitude)	Plus 3 – 13°	1,500	200	7.1 – 7.5 cc 0.43 – 0.46 cu in.	0.4 cc 0.02 cu in.	Basic full-load injection volume
			100		8.6 – 13.4 cc 0.52 – 0.82 cu in.	0.8 cc 0.05 cu in.	Volume during starting
			500		5.6 – 6.6 cc 0.34 – 0.40 cu in.	0.5 cc 0.03 cu in.	–
			2,350		6.1 – 7.1 cc 0.37 – 0.43 cu in.		–
			2,500		5.3 – 6.7 cc 0.32 – 0.41 cu in.		–

*2 Apply 730 ± 1.5 mm Hg (28.74 ± 0.06 in. Hg, 97.3 ± 0.2 kPa) absolute pressure

*3 Apply 530 ± 1.5 mm Hg (20.87 ± 0.06 in. Hg, 70.6 ± 0.2 kPa) absolute pressure

Full-load minimum injection volume (CV Only)	Pump rpm	No. of measuring stroke	Injection volume
	500	200	6.9 – 7.6 cc 0.42 – 0.46 cu in.

Boost compensator characteristic (CV Only)	Pump rpm	No. of measuring stroke	Injection volume
	1,500	200	8.4 – 9.2 cc 0.51 – 0.56 cu in.

Boost compensator characteristic tendency (CV Only)	Pump rpm	Pressure kg/cm² (psi, kPa)	No. of measuring strokes	Injection volume cc (cu in.)	Hysteresis cc (cu in.)
	1,500	0.48 (6.8, 47)	200	10.1 – 10.5 (0.62 – 0.64)	–
		0.27 (3.8, 26)		9.4 – 10.3 (0.57 – 0.63)	Less than 0.3 (0.02)
		0.14 (2.0, 14)		8.4 – 9.2 (0.51 – 0.56)	–
		0		6.9 – 7.6 (0.42 – 0.46)	

Load sensing timer	Pump rpm	Measuring strokes	Injection volume	Remarks
	1,800	200	Full injection volume minus 1.0 cc (0.06 cu in.) ± 0.3 cc (0.02 cu in.)	Set to starting point
	1,800	200	1.7 – 2.3 cc 0.10 – 0.14 cu in.	Confirm end point
	Pump rpm		Timer piston fluctuation	Remarks
	1,100		0.93 – 1.54 mm 0.057 – 0.094 in.	Confirm

Idle speed set	Item	Adjusting lever angle	Pump rpm	No. of measuring strokes	Injection volume cc (cu in.)	Variation limit cc (cu in.)	Remarks
	CT *1 CE70, 80 CV	Minus 24 – 34°	400	200	q = 1.65 – 2.55 (0.10 – 0.16)	0.34 (0.02)	Adjust
			375		More than q Plus 0.5 (0.03)	–	–
			475		q Minus [1.2 – 2.2 (0.07 – 0.13)]		
	CM CR	Minus 30 – 40°	400	200	q = 1.65 – 2.55 (0.10 – 0.16)	0.34 (0.02)	Adjust
			375		More than q Plus 0.5 (0.03)	–	–
			475		q Minus [1.2 – 2.2 (0.07 – 0.13)]		

*1 w/ HAC Apply 730 ± 1.5 mm Hg (28.74 ± 0.06 in. Hg, 97.3 ± 0.2 kPa) absolute pressure

COOLING SYSTEM

Coolant capacity (w/heater)	CE70	6.3 liters	6.7 US qts	5.5 Imp. qts
	CE80	7.3 liters	7.7 US qts	6.4 Imp. qts
	CV, CT	7.5 liters	7.9 US qts	6.6 Imp. qts
	CM	7.0 liters	7.4 US qts	6.2 Imp. qts
	CR	7.1 liters	7.5 US qts	6.2 Imp. qts

Radiator	Relief valve opening pressure	STD	0.75 – 1.05 kg/cm² (10.7 – 14.9 psi, 74 – 103 kPa)		
		Limit	0.6 kg/cm²	8.5 psi	59 kPa
Thermostat	Valve opening temperature				
	Starts to open at		80 – 84°C		176 – 183°F
	Fully opens at		95°C		203°F
	Valve opening travel		More than 8 mm (0.31 in.)		

LUBRICATION SYSTEM

Oil pressure	Oil pressure at Idle		More than 0.3 kg/cm² (4.3 psi, 29 kPa)	
	at 3,000 rpm		2.5 – 6.0 kg/cm² (36 – 85 psi, 245 – 588 kPa)	
Oil pump	Body clearance	STD	0.10 – 0.17 mm	0.0039 – 0.0067 in.
		Limit	0.20 mm	0.0079 in.
	Tip clearance	STD	0.05 – 0.15 mm	0.0020 – 0.0059 in.
		Limit	0.20 mm	0.0079 in.
	Side clearance	STD	0.03 – 0.09 mm	0.0012 – 0.0035 in.
		Limit	0.15 mm	0.0059 in.

STARTING SYSTEM

Pre-heating system	Type Light lighting time at 20°C (68°F)		Super glow About 2 – 4 seconds		Variable delay About 9 – 13 seconds
Starter	Rated voltage and output	Power	12V, 1.4 kW	12V, 2.0 kW	12V, 2.5 kW
	No-load characteristic	Ampere	Less than 90A at 11.5V	Less than 120A at 11.5V	Less than 180A at 11.0V
		rpm	More than 3,500 rpm	More than 4,000 rpm	More than 3,500 rpm
	Brush Length	STD	15.0 mm (0.591 in.)	14.5 mm (0.571 in.)	20.5 mm (0.807 in.)
		Limit	10.0 mm (0.394 in.)	9.5 mm (0.374 in.)	12.0 mm (0.472 in.)
	Commutator Outer diameter	STD	30 mm (1.18 in.)	35 mm (1.38 in.)	36 mm (1.42 in.)
		Limit	29 mm (1.14 in.)	34 mm (1.34 in.)	35 mm (1.38 in.)
	Undercut depth	STD	0.5 – 0.8 mm (0.020 – 0.032 in.)	0.7 – 0.9 mm (0.028 – 0.035 in.)	←
		Limit	0.2 mm (0.008 in.)	←	←
	Circle runout	Limit	0.05 mm (0.0020 in.)	←	←
	Spring installed load	STD	1.8 – 2.4 kg (4.0 – 5.3 lb) (18 – 24 N)	2.4 – 3.6 kg (5.3 – 7.9 lb) (24 – 35 N)	3.2 – 4.0 kg (7.1 – 8.8 lb) (31 – 39 N)
		Limit	1.44 kg (3.2 lb, 14 N)	2.0 kg (4.4 lb, 20 N)	2.2 kg (4.9 lb, 22 N)

CHARGING SYSTEM

Battery specific gravity when fully charged at 20°C (68°F)			1.27 – 1.29	NT80–S6(S), NX110–5, NX110–5L, NX110–5L–MF, NX120–7, NX120–7L, NX120–7L–MF
Drive belt deflection with 10 kg (22.0 lb, 98N)				
FR Vehicles (CM, CR)		New belt	4.5 – 6.0 mm	0.177 – 0.236 in.
		Used belt	6.5 – 8.5 mm	0.256 – 0.335 in.
	(Others)	New belt	6 – 7.5 mm	0.236 – 0.295 in.
		Used belt	7.5 – 10.5 mm	0.295 – 0.413 in.
FF Vehicles		New belt	9 – 11 mm	0.35 – 0.43 in.
		Used belt	12 – 14 mm	0.47 – 0.55 in.
Drive belt tension (Reference) w/SST				
FR Vehicles (CM, CR)		New belt	70 – 80 kg	
		Used belt	30 – 45 kg	
	(Others)	New belt	45 – 55 kg	
		Used belt	20 – 35 kg	
FF Vehicles		New belt	45 – 55 kg	
		Used belt	20 – 35 kg	
Alternator	Rated output		12V 40A, 12V 45A, 12V 50A, 12V 55A, 12V 60A	
	Rotor coil resistance	w/ IC regulator	Approx. 2.9Ω	
		w/o IC regulator	Approx. 4.0Ω	
	Brush exposed length	STD	20 mm	0.79 in.
		Limit	5.5 mm	0.217 in.
Alternator regulator	Regulator voltage	w/ IC regulator	13.8 – 14.4V	
		w/o IC regulator	13.8 – 14.8V	
		CE OPT: Cold area of the Europe	13.8 – 14.4V	
	Voltage relay actuating voltage		4.0 – 5.8V	

STANDARD BOLT TORQUE SPECIFICATIONS

STANDARD BOLT TORQUE SPECIFICATIONS

HOW TO DETERMINE BOLT STRENGTHS

	Mark	Class		Mark	Class
Hexagon head bolt	 Bolt head No. 4– 5– 6– 7–	4T 5T 6T 7T	Stud bolt	 No mark	4T
	 No mark	4T			
Hexagon flange bolt w/washer hexagon bolt	 No mark	4T		 Grooved	6T
Hexagon head bolt	 Two protruding lines	5T			
Hexagon flange bolt w/washer haxagon bolt	 Two protruding lines	6T	Welded bolt		4T
Hexagon head bolt	 Three protruding lines	7T			

SPECIFIED TORQUE FOR STANDARD BOLTS

Class	Diameter mm	Pitch mm	Hexagon head bolt			Hexagon flange bolt		
			kg-cm	ft-lb	N·m	kg-cm	ft-lb	N·m
4T	6	1	55	48 in.-lb	5.4	60	52 in.-lb	5.9
	8	1.25	130	9	13	145	10	14
	10	1.25	260	19	25	290	21	28
	12	1.25	480	35	47	540	39	53
	14	1.5	760	55	75	850	61	83
	16	1.5	1,150	83	113		—	
5T	6	1	65	56 in.-lb	6.4		—	
	8	1.25	160	12	16		—	
	10	1.25	330	24	32		—	
	12	1.25	600	43	59		—	
	14	1.5	930	67	91		—	
	16	1.5	1,400	101	137		—	
6T	6	1	80	69 in.-lb	7.8	90	78 in.-lb	8.8
	8	1.25	195	14	19	215	16	21
	10	1.25	400	29	39	440	32	43
	12	1.25	730	53	72	810	59	79
	14	1.5		—		1,250	90	123
7T	6	1	110	8	11	120	9	12
	8	1.25	260	19	25	290	21	28
	10	1.25	530	38	52	590	43	58
	12	1.25	970	70	95	1,050	76	103
	14	1.5	1,500	108	147	1,700	123	167
	16	1.5	2,300	166	226		—	

SST (SPECIAL SERVICE TOOLS)

NOTE: Classification

A = SST required for vehicle inspections and minor repairs and multipurpose SST.

B = SST required for major repairs involving disassembly of components.

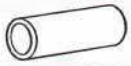
C = SST required for rather special, less frequent work not of classifiable as either A or B.

Section / Classification / Part Name / Part No. / Illustration				EM	FU	CO	LU	ST	CH
	09032-00100	(Oil Pan Seal Cutter)	A	●			●		
	09201-60011	(Valve Stem Guide Remover & Replacer)	A	●					
	09202-43013	(Valve Spring Compressor)	A	●					
	09213-14010	(Crankshaft Pulley Holding Tool)	A	●	●	●	●		
	09213-31021	(Crankshaft Pulley Puller)	A	●	●	●	●		
	09213-60017	(Crankshaft Pulley Puller)	A	●	●		●		
	09214-60010	(Crankshaft Pulley & Gear Replacer)	B	●	●	●	●		
	09216-00020	(Belt Tension Gauge)	A	●	●	●	●		●
	09216-00030	(Belt Tension Cable)	A	●	●	●	●		●

SST (SPECIAL SERVICE TOOLS) (Cont'd)

Section / Classification / Part Name / Part No. / Illustration				EM	FU	CO	LU	ST	CH
	09222-64010	Connecting Rod Bushing Remover & Replacer	B	●					
	(09222-02020)	(Remover & Replacer)		●					
	(09222-02030)	(Guide)		●					
	(09222-02040)	(Base)		●					
	09223-56010	Crankshaft Rear Oil Seal Replacer	B	●					
	09228-44010	(Oil Filter Wrench)	A				●		
	09228-64010	(Fuel Filter Wrench)	A		●				
	09230-00010	Radiator Service Tool Set	B			●			
	09241-76022	Injection Pump Stand Set	C		●				
	09245-54010	Injection Pump Stand Arm	C		●				
	09248-64010	Valve Clearance Adjusting Tool	A	●					
	09260-54012	Injection Pump Tool Set	C		●				
	09268-64010	Injection Nozzle Wrench Set	A	●	●				
	09275-54010	Plunger Stroke Measuring Tool	A	●	●	●			

SST (SPECIAL SERVICE TOOLS) (Cont'd)

Section / Classification / Part Name / Part No. / Illustration				EM	FU	CO	LU	ST	CH
	09278-54012	(Drive Shaft Holding Tool)	A	●	●	●			
	09286-46011	(Injection Pump Spline Shaft Puller)	C					●	●
	09330-00021	(Companion Flange Holding Tool)	A	●	●	●	●		
	09612-24013	(Steering Gear Housing Overhaul Tool Set)	B	●					
	09820-00021	(Alternator Rear Bearing Puller)	B						●
	09820-00030	(Alternator Rear Bearing Replacer)	B						●
	09992-00023	(Cylinder Compression Check Gauge Set)	A	●					
	09992-00160	(Compression Gauge No. 5 Attachment)	A	●					
	09992-00240	(Turbocharger Pressure Gauge)	C	●	●				