ENGINE TUNE-UP

ET

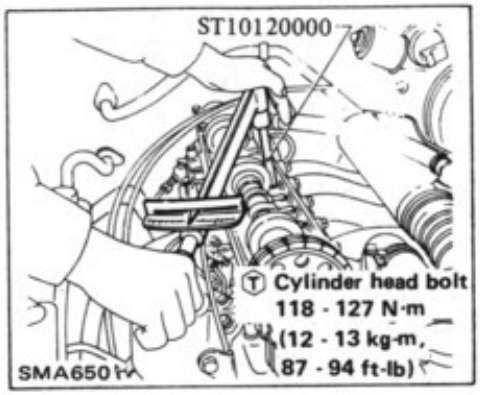
CONTENTS

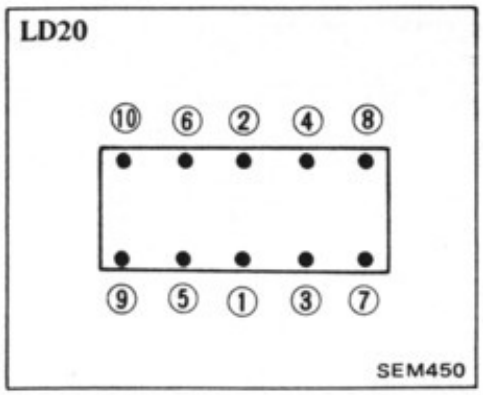
BASIC MECHANICAL SYSTEM

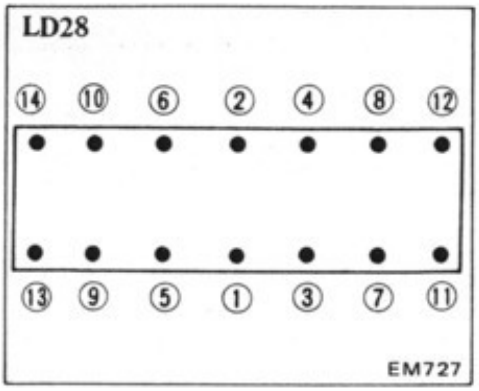
RETIGHTENING CYLINDER HEAD BOLTS, MANIFOLD NUTS

CYLINDER HEAD BOLTS

1. Run engine until coolant temperture indicator points to the middle of gauge, then stop engine.
2. Remove valve rocker cover.
3. Using Tool, tighten cylinder head bolts according to the order shown in figure, starting with the center and moving toward the ends.







4. Install valve rocker cover.

Ⓣ : **Valve rocker cover bolt**
6 - 9 N·m
(0.6 - 0.9 kg-m,
4.3 - 6.5 ft-lb)

MANIFOLD AND EXHAUST TUBE NUTS

WARNING:
Do not check the exhaust system until it has cooled off. Otherwise, you may burn yourself.

TIGHTENING TORQUE:

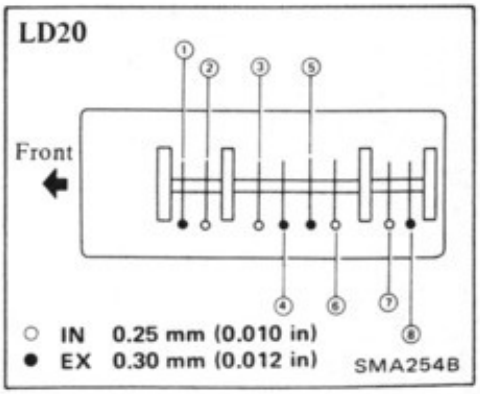
Unit			N·m	kg-m	ft-lb
Manifold	Bolt	(M10)	32 - 36	3.3 - 3.7	24 - 27
		(M8)	17 - 21	1.7 - 2.1	12 - 15
	Nut		17 - 21	1.7 - 2.1	12 - 15
Exhaust tube			26 - 36	2.7 - 3.7	20 - 27

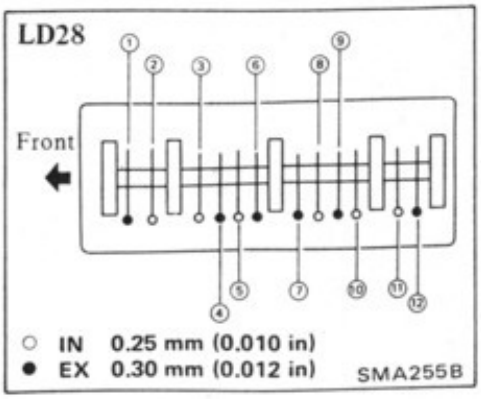
Never disassemble the intake manifold.

ADJUSTING INTAKE AND EXHAUST VALVE CLEARANCE

a. **Adjustment should be made while engine is hot.**
b. **Adustment cannot be made while engine is in operation.**
c. **When rocker cover is removed to adjust intake and exhaust valve clearance, check elongation of timing chain. For details, refer to INSTALLING TIMING CHAIN in EM section.**

To adjust, proceed as follows:
1. Remove valve rocker cover.
2. Set No. 1 cylinder at Top Dead Center on its compression stroke.
3. For LD20 engine, adjust clearance of half of the valves. Adjust ①, ②, ③ and ⑤ valves.
For LD28 engine, adjust ①, ②, ③, ⑥, ⑧ and ⑨ valves.
4. Set No. 4 (for LD20) or No. 6 (for LD28) cylinder at Top Dead Center on its compression stroke.
5. For LD20 engine, adjust ④, ⑥, ⑦ and ⑧ valves.

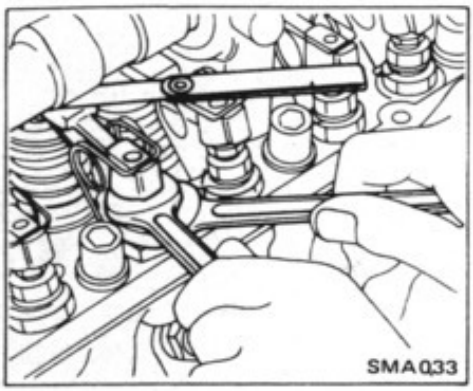




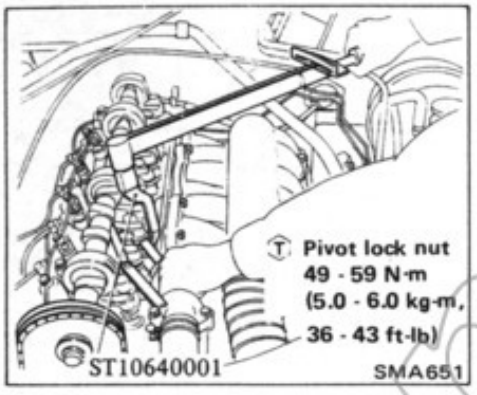
For LD28 engine, adjust ④, ⑤, ⑦, ⑩, ⑪ and ⑫ valves.

Valve clearance (Hot):
Intake
0.25 mm (0.010 in)
Exhaust
0.30 mm (0.012 in)

(1) If the clearance is not specified value, loosen pivot lock nut and turn valve rocker pivot to provide proper clearance.



(2) Hold valve rocker pivot and tighten pivot lock nut using Tool.



6. Install valve rocker cover.

Ⓣ : **Valve rocker cover bolt**
6 - 9 N·m
(0.6 - 0.9 kg-m,
4.3 - 6.5 ft-lb)

CHECKING AND ADJUSTING DRIVE BELT

1. Visually inspect for cracks or damage.

The belts should not touch the bottom of the pulley groove.

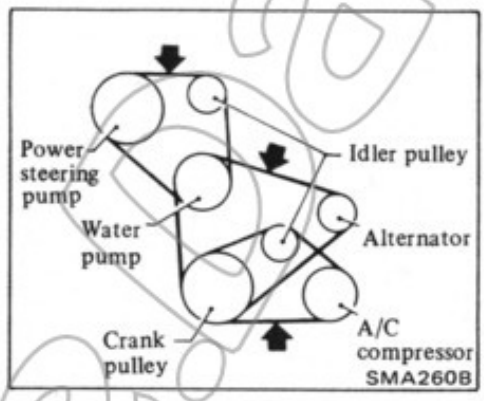
2. Check belt tension by pushing it.
The belts should deflect by the specified amount.

Drive belt deflection mm (in)

	Used belt deflection		Set deflection of new belt
	Limit	Adjust deflection	
Alternator	15 (0.59)	11 - 13* (0.43 - 0.51)	8 - 12 (0.31 - 0.47)
		12 - 14** (0.47 - 0.55)	10 - 12 (0.39 - 0.47)
A/C compressor	14 (0.55)	12 - 13 (0.47 - 0.51)	9 - 11 (0.35 - 0.43)
P/S oil pump	9 (0.35)	8 - 8.5 (0.315 - 0.335)	7 - 8 (0.28 - 0.31)

Pushing force: 98 N (10 kg, 22 lb)

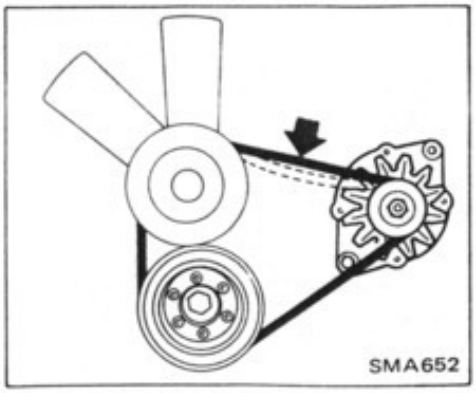
* For 430 and C31 models equipped with LD28
** For 910 and C120 models equipped with LD20



3. Adjust belt tension as follows:

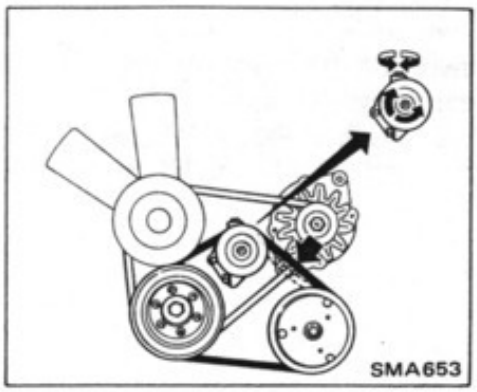
FAN BELT

1. Loosen alternator bracket bolts and adjusting bar bolt.
2. Move alternator until fan belt tension is within the specified range. Then tighten bracket bolts and adjusting bar bolt.



AIR CONDITIONER COMPRESSOR BELT

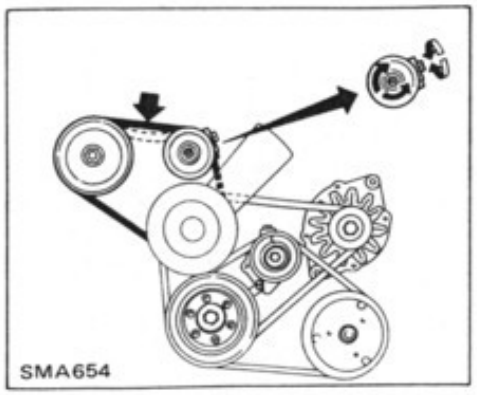
1. Loosen idler pulley lock nut.
2. Turn idler pulley adjusting bolt in either direction until air conditioner compressor belt's tension is within specified range.



3. Tighten idler pulley lock nut.

POWER STEERING PUMP BELT

1. Loosen idler pully lock nut.
2. Turn idler pulley adjusting bolt in either direction until power steering pump belt's tension is within specified range.



3. Tighten idler pulley lock nut.

CHECKING ENGINE COMPRESSION

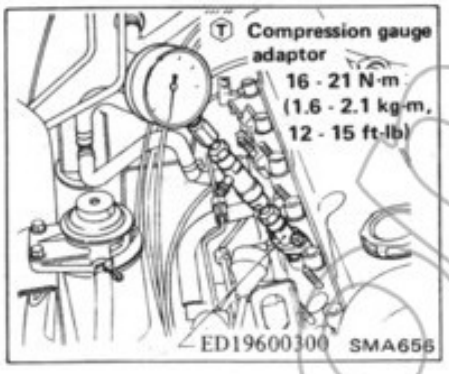
1. Run engine until water temperture indicator points to the middle of gauge, then stop engine.
2. Remove following parts:
- Spill tube assembly
- Injection tubes on nozzle side
- Nozzle assemblies


SMA655

CAUTION:
Remove nozzle washer with a pair of tweezers. Do not forget to remove this washer; otherwise, it may get lost when the engine is cranked.

3. Fit compression gauge adapter to cylinder head.

Make sure bleeder screw of gauge is closed.



4. Crank engine and read gauge indication.
- Run engine at about 200 rpm.
- Engine compression measurement should be made as quickly as possible.

Compression pressure:

Unit: kPa (bar, kg/cm², psi)/200 rpm

Standard	3,138 (31.4, 32, 455)
Minimum	2,452 (24.5, 25, 356)
Differential limit between cylinders	490 (4.9, 5, 71)

5. Cylinder compression in cylinders should not be less than 80% of the highest reading.

If cylinder compression in one or more cylinders is low, pour a small quantity of engine oil into cylinders through the nozzle holes and retest compression.

- **If adding oil helps the compression pressure,** chances are that piston rings are worn or damaged.
- **If pressure stays low,** valve may be sticking or seating improperly.
- **If cylinder compression in any two adjacent cylinders is low, and if adding oil does not help the compression,** there is leakage past the gasketed surface.

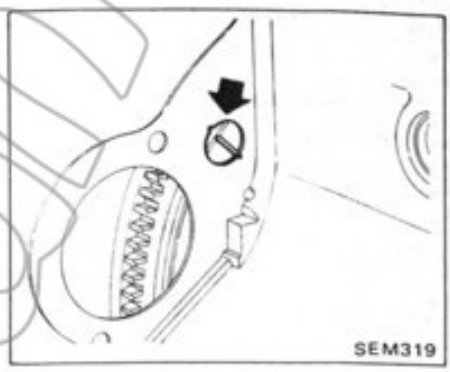
Oil and water in combustion chambers can result from this problem.

CHANGING TIMING BELT

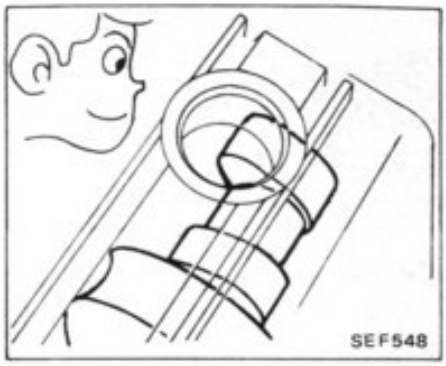
1. Remove fan shroud.
2. Remove the following belts.
- Alternator drive belt
- Air conditioner compressor drive belt
- Power steering oil pump drive belt

3. Set No. 1 cylinder at T.D.C. on its compression stroke.

Make sure that grooves in rear plate and drive plates are aligned with each other.

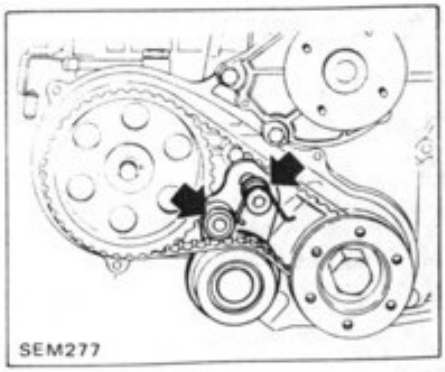

SEM319

Make sure that No. 1 cam of camshaft is in the position as shown.


SEF548

4. Remove front side engine parts.
- Fan, Tem-coupling and fan pulley
- Remove crank damper pulley by lightly tapping around it. **If it is difficult to remove, use a puller.**
- Front dust cover

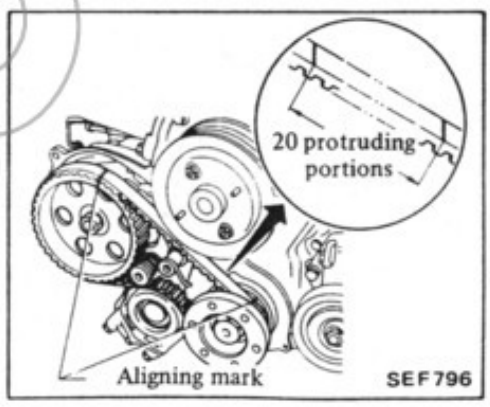
5. Remove tensioner shaft and spring set pin, then remove tensioner pulley. (Tensioner pulley is fastened with a tensioner shaft and spring pin.)


SEM277

6. Remove timing belt.
7. Visually check the condition of the timing belt. If any abnormalities are noted, check and correct.

Item to check	Problem	Cause
Belt is broken.	 SEM393A	• Improper handling • Poor belt cover sealing • Coolant leakage at water pump
Tooth is broken/ tooth root is cracked.	 SEM394A	• Injection pump jamming • Damaged crankshaft oil seal
Back surface is cracked/worn.	 SEM395A	• Tensioner jamming • Overheated engine • Interference with belt cover
Side surface is worn.	 • Side surface of belt is worn to such an extent that there is no trace of cutoff performed during manufacturing process. • Belt corners are worn and round. • Wicks are frayed and coming out. SEM396A	• Improper installation of belt • Malfunctioning crank pulley plate/ timing belt plate
Teeth are worn.	 • Canvas on tooth face is worn down. • Canvas on tooth is fluffy, rubber layer is worn down and faded white, or weft is worn down and invisible. SEM397A	• Poor belt cover sealing • Coolant leakage at water pump • Injection pump not functioning properly • Excessive belt tension
Oil/Coolant or water is stuck to belt.		• Poor oil sealing of each oil seal • Coolant leakage at water pump • Poor belt cover sealing

8. Confirm that No. 1 cylinder is set at T.D.C. on its compression stroke.
9. Confirm that tensioner pulley can be rotated smoothly.
10. Install the tensioner in "free" position.
11. Install timing belt.
(1) Align both timing marks of timing belt and crank pulley.
(2) Properly align timing mark of pump pulley with that of timing belt.



Ensure timing belt is clean and free from oil or water. Do not bend it.

12. Loosen spring set pin and tensioner so that belt is automatically set to "tension" position.
13. Tighten spring set pin.

Ⓣ: Tensioner shaft and spring set pin
30 - 40 N·m
(3.1 - 4.1 kg-m,
22 - 30 ft-lb)

INJECTION AND FUEL SYSTEM

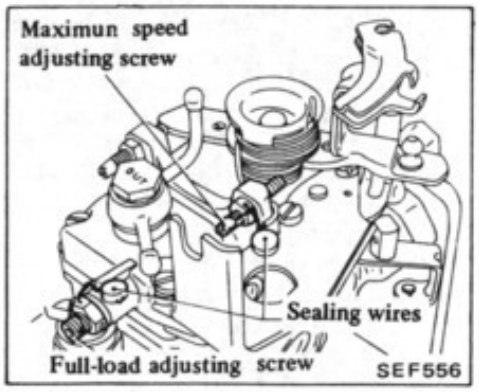
CHECKING AND ADJUSTING INJECTION TIMING

Refer to installation of injective pump in Section EF.

CHECKING AND ADJUSTING IDLE AND MAXIMUM SPEED

CAUTION:

a. Do not remove sealing wires unless absolutely necessary.

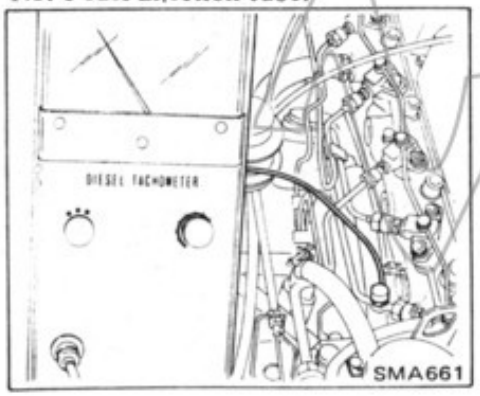


b. Disturbing full-load adjusting screw adjustment will change fuel flow characteristics, resulting in an improperly adjusted engine. Readjustment of fuel injection pump should be done using a pump tester.

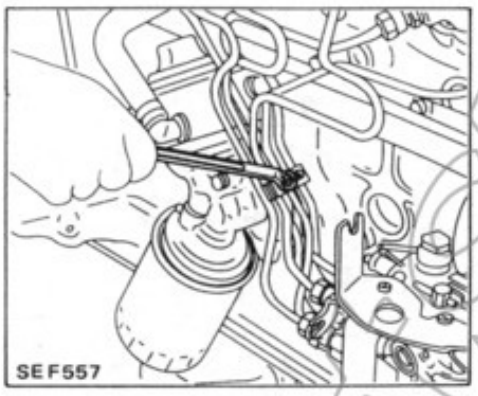
c. If maximum speed adjusting screw is turned in direction that increases control lever angle, engine damage may result.

IDLE ADJUSTMENT

1. Start engine and warm it up until coolant temperature indicator points to middle of gauge.
2. Attach tachometer's pickup to No. 1 fuel injection tube.



In order to take accurate reading of engine rpm, remove clamp that secures No. 1 fuel injection tube.

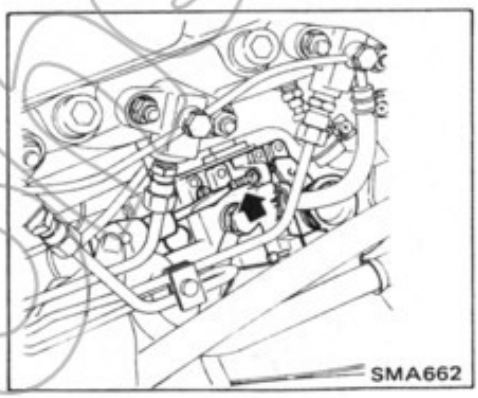


3. Start engine and check engine idle speed.

At this time, make sure the accelerator wire and throttle control wire are removed.

	Idle speed (rpm)
M/T	650
A/T	700

4. If engine idle speed is not within the specified value, proceed as follows.
(1) Loosen idle adjust screw lock nut.
(2) Turn idle adjust screw in either direction until the specified engine idle speed is obtained.



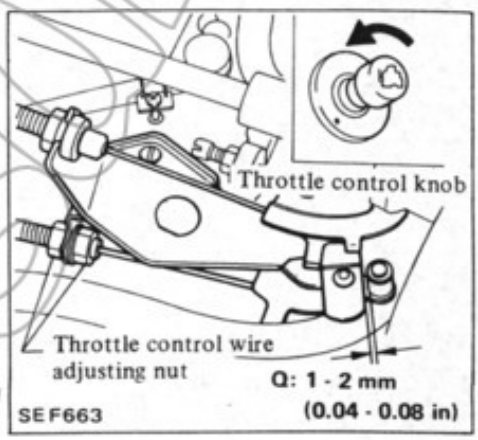
(3) Tighten idle adjust screw lock nut.
5. Fix the accelerator wire and throttle control wire.

Do not stretch wires too tightly.

THROTTLE CONTROL WIRE ADJUSTMENT

1. Turn throttle control knob fully counterclockwise.
2. Make sure that clearance between idle control lever pin and fuel injection pump control lever is within specified range.

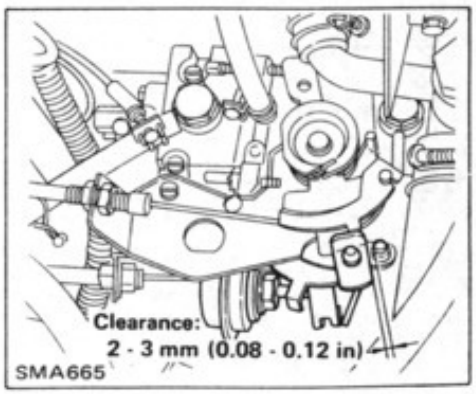
Clearance:
1 - 2 mm (0.04 - 0.08 in)



3. If not within specified range, adjust with throttle control wire adjusting nut.
4. After adjusting clearance properly, tighten lock nut.

F.I.C.D. ADJUSTMENT

1. Make certain that the clearance between the idle control lever pin and the injection pump control lever is within the specified limits.

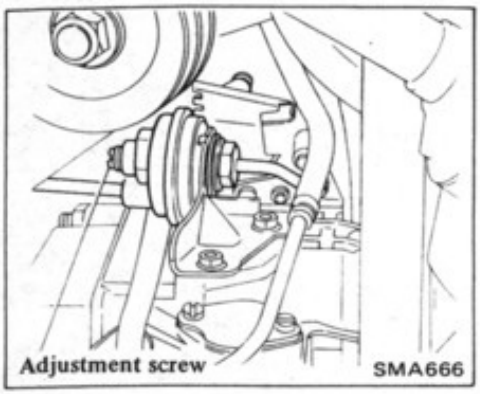


2. Adjust idle speed to specified rpm without the air conditioner operating.
3. Then check the idle speed when the air conditioner is operating and make sure it is correct.

Unit: rpm

Idle speed (Air conditioner "ON")	800

If not, adjust it by turning F.I.C.D. actuator stroke adjusting screw.



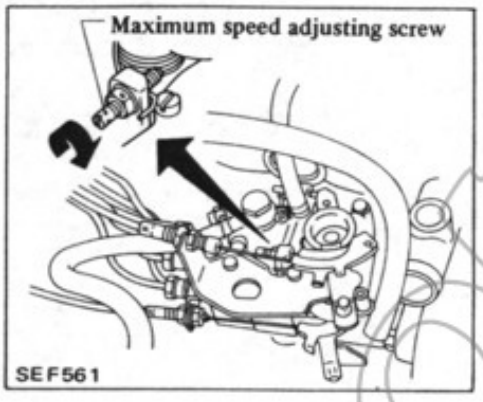
MAXIMUM SPEED ADJUSTMENT

Maximum speed adjusting wire is retained by sealing wire and need not be adjusted under normal circumstances. However, if it should become necessary to adjust it, the following procedure should be followed:

1. Start engine and warm it up until coolant temperature indicator points to middle of gauge.
2. Connect tachometer's pickup to No. 1 fuel injection tube.

To obtain accurate reading of engine rpm, remove clamp that secures No. 1 fuel injection tube.

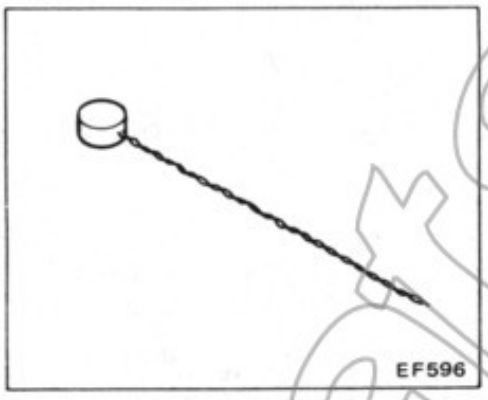
3. Turn maximum speed adjusting screw fully clockwise.



4. Depress the accelerator pedal fully under no load and, at this point, read engine speed indication.

Specified maximum engine speed (Under no-load):
5,300 rpm

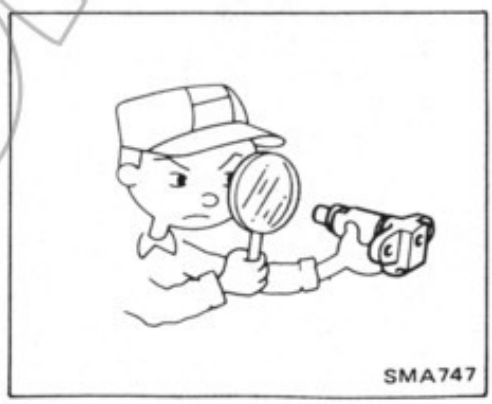
5. If indication is lower than specified maximum engine speed, turn maximum speed adjusting screw counterclockwise 1 or 2 rotations. Then depress accelerator pedal to floor under no load and, at this point, read indication.
6. If indication is still lower than specified speed, repeat step 5 above until specified engine speed is reached.
7. After adjustment, tighten lock nut securely.
8. Slide a sealing sleeve over max. speed adjusting screw, and wind up with a wire.



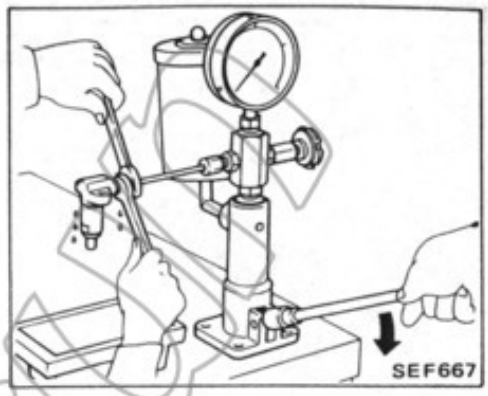
TESTING AND ADJUSTING INJECTION NOZZLES

WARNING:
When using nozzle tester, be careful not to allow diesel fuel sprayed from nozzle to come into contact with your hand or body, and make sure that your eyes are properly protected.

1. Clean and check nozzles.



2. Install nozzle to injection nozzle tester and **bleed air from flare nut.**

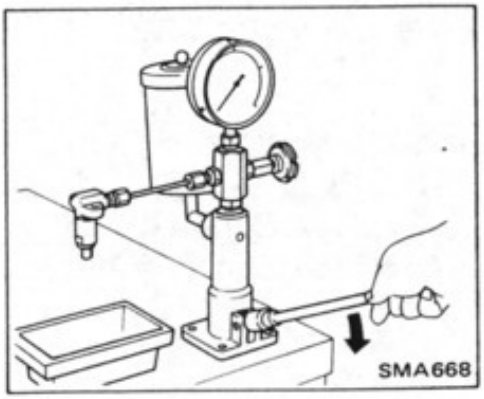


3. Check initial injection pressure by pumping tester handle one time per second.

Initial injection pressure:
12,259 - 13,239 kPa
(122.6 - 132.4 bar,
125 - 135 kg/cm^2,
1,778 - 1,920 psi)

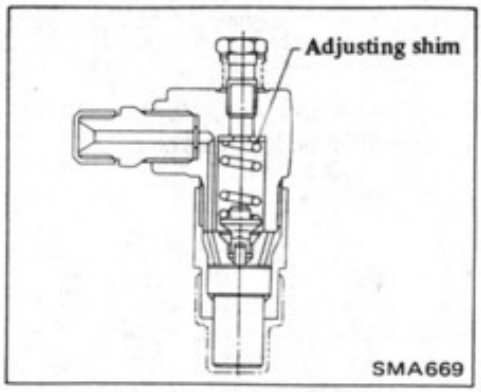
New nozzle initial injection pressure:
13,239 - 14,024 kPa
(132.4 - 140.2 bar,
135 - 143 kg/cm^2,
1,920 - 2,033 psi)

The new nozzle is not required to adjust initial injection pressure.

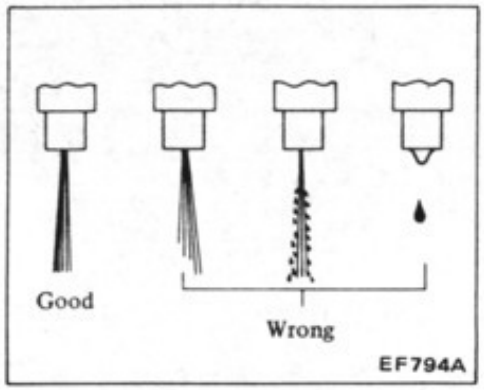


4. To adjust injection pressure, change adjusting shims.

a. **Increasing the thickness of adjusting shims increases initial injection pressure. Decreasing shim thickness reduces initial injection pressure.**
b. **A shim thickness of 0.04 mm (0.0016 in) corresponds approximately to a difference of 471 kPa (4.71 bar, 4.8 kg/cm^2, 68 psi) in initial injection pressure.**



5. Check spray pattern by pumping tester handle one time per second.

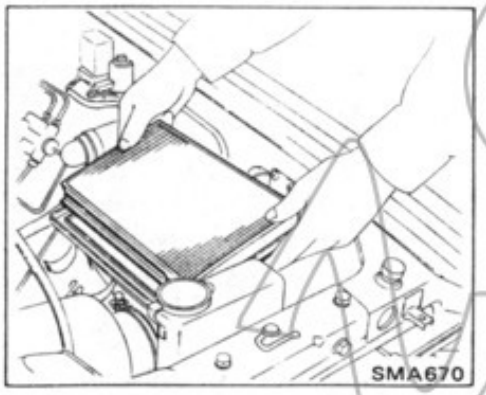


6. Inadequate fuel spray pattern or drips from nozzle and is often due to improper contact of needle with seat. If such a failure is experienced, service injection nozzle. **When servicing nozzle, refer to Injection Nozzle Assembly in section EF.**

CLEANING AND REPLACING AIR CLEANER FILTER AND RESONATOR

AIR CLEANER

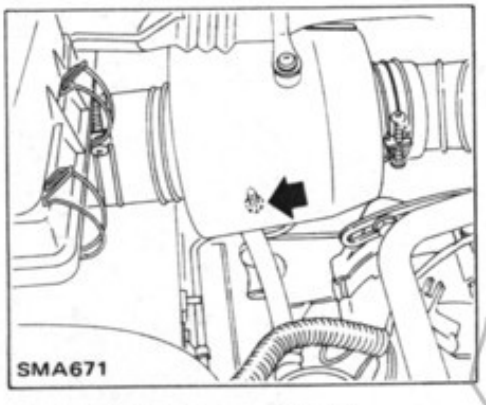
1. Remove air cleaner cover and filter element.



2. Wipe inside of air cleaner housing and cover with a damp cloth.
3. Install filter element and air cleaner cover.

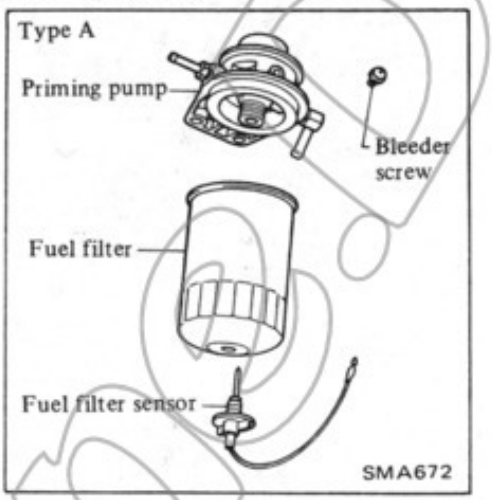
RESONATOR (For LD28)

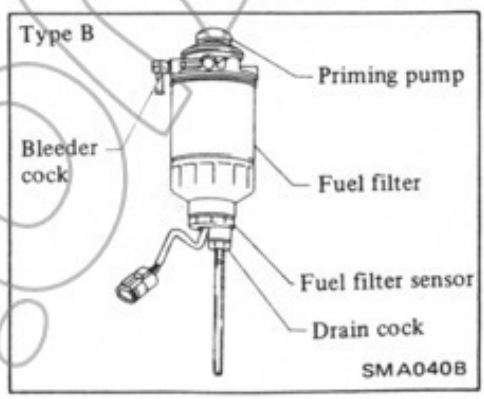
If resonator makes noise, drain water by loosening resonator bottom screw.



CHECKING FUEL FILTER, DRAIN WATER AND REPLACING FILTER

This filter includes priming pump and fuel filter sensor.

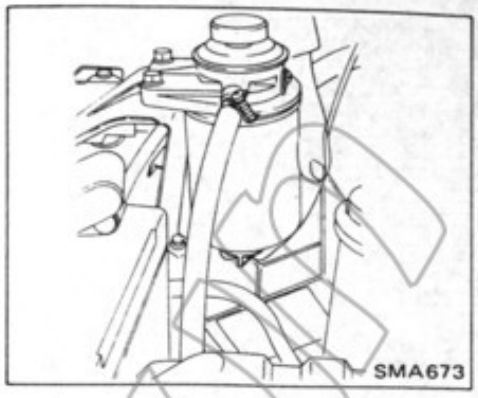




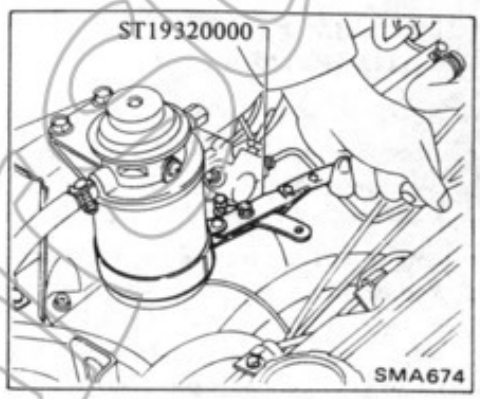
Reuse the fuel filter sensor.

Replacing fuel filter

1. Remove fuel filter sensor and drain fuel.



2. Remove fuel filter, using Tool.



3. Install fuel filter sensor to new fuel filter.
4. Install fuel filter to priming pump.
5. Bleed air.

Refer to Section EF for fuel system bleeding instructions.

Start engine and check for leaks.

Drain water

1. Set a container under fuel filter.
2. For type A, loosen bleeder screw and remove fuel detector senosor and drain water.
3. For type B, loosen drain cock and drain water.
4. Bleed air.

Refer to section EF for bleeding fuel system.

For type B, bleeder screw or cock does not need to be loosened because air automatically enters from the drain passage. Loosening drain cock 4 to 5 turns causes water to start draining. Do not remove drain cock by loosening it excessively.

CHECKING FUEL LINES (Hoses, piping, connectors, etc.) FOR LEAKS

Check fuel lines for loose connections, cracks and deterioration. Retighten loose connections; if necessary, replace any damaged or faulty parts.

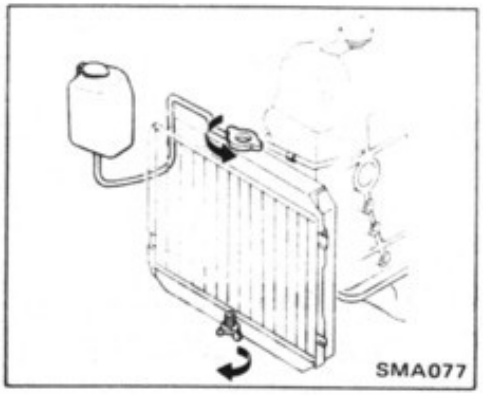
COOLING AND LUBRICATION SYSTEM

CHANGING ENGINE COOLANT

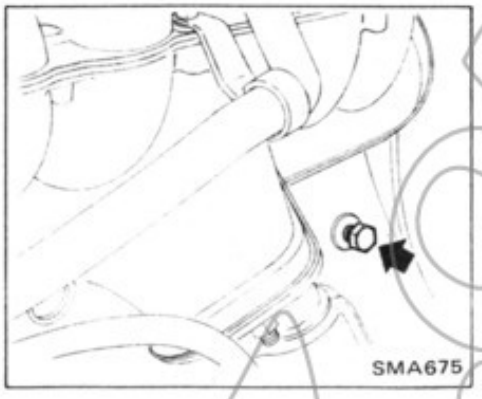
WARNING:
To avoid being scalded, never attempt to change the coolant when engine is hot.

When changing engine coolant, on heater-equipped models, set heater "TEMP" control lever at fully "HOT" position.

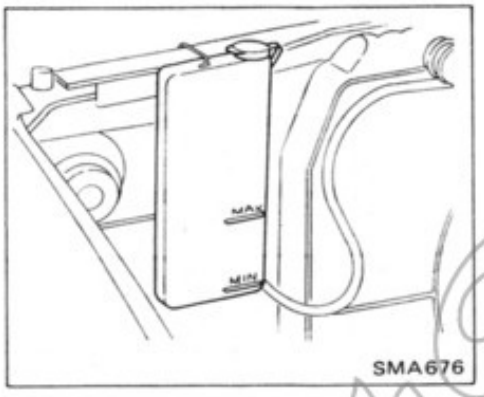
1. Open drain cock at bottom of radiator, and remove radiator cap.


SMA077

2. Remove cylinder block drain plug located at left rear of cylinder block.


SMA675

3. Drain coolant completely. Then flush cooling system.
4. Close drain cock and plug.
5. Fill radiator and reservoir tank with coolant to the specified level. When using anti-freeze coolant, mix the anti-freeze coolant with water, observing instructions attached to anti-freeze container.


SMA676

6. Run engine for a few minutes. Then stop engine, and check coolant level. If necessary, add coolant.

Check for coolant leaks.

CHECKING COOLING SYSTEM HOSES AND CONNECTIONS FOR LEAKS

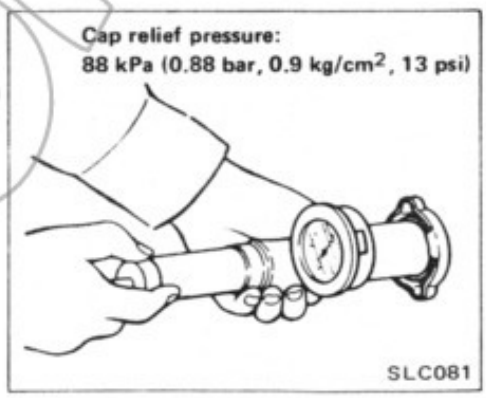
Check hoses and fittings for loose connections or deterioration.

Retighten or replace if necessary.

CHECKING RADIATOR CAP

Using cap tester, check the radiator cap relief pressure.

If the pressure gauge drops rapidly and excessively, replace the radiator cap.

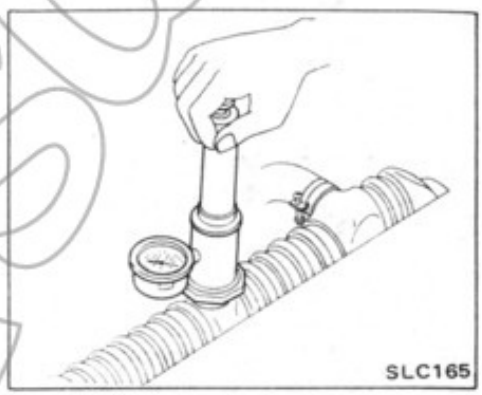


SLC081

CHECKING COOLING SYSTEM FOR LEAKS

Attach pressure tester and pump tester, and apply specified pressure. Check for drop in pressure.

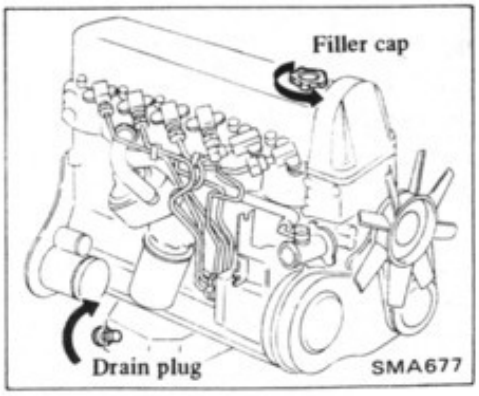
If pressure drops, check for leaks from hoses, radiator, or water pump. If no external leaks are found, check heater core, block and head.


SLC165

CHANGING ENGINE OIL AND FILTER

1. Run engine until water temperature indicator points to the middle of gauge, then stop engine.
2. Remove oil filler cap and oil pan drain plug, and allow oil to drain.

WARNING:
Be careful not to burn yourself, as the engine oil may still be hot.



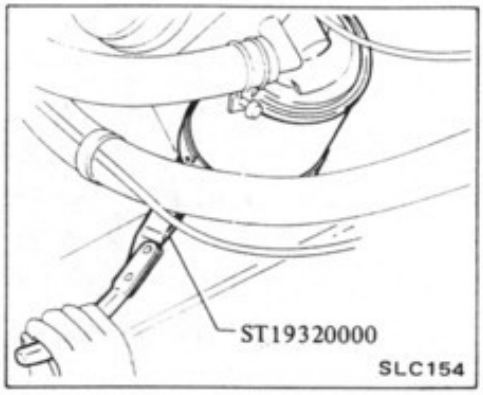
SMA677

- **A milky oil indicates the presence of cooling water. Isolate the cause and take corrective measures.**
- **An oil with extremely low viscosity indicates the presence of gasoline.**

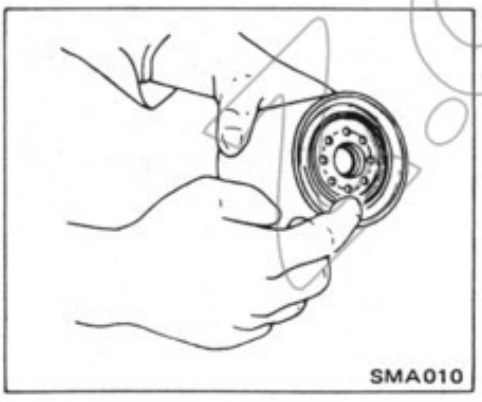
3. Clean and install oil pan drain plug with washer.

Ⓣ : **Oil pan drain plug**
20 - 29 N·m
(2.0 - 3.0 kg-m,
14 - 22 ft-lb)

4. Using Tool, remove oil filter.



5. Wipe oil filter mounting surface with a clean rag.
6. Smear a little engine oil on rubber lip of new oil filter.



7. Install new oil filter.

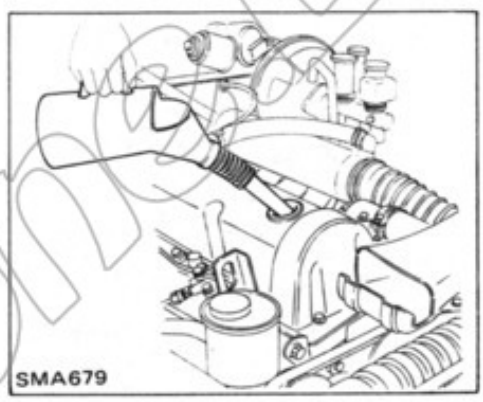
Screw in oil filter until a slight resistance is felt, then tighten additional 2/3 of a turn.

8. Refill engine with new engine oil, referring to Recommended Lubricants.

Approximate oil refill capacity

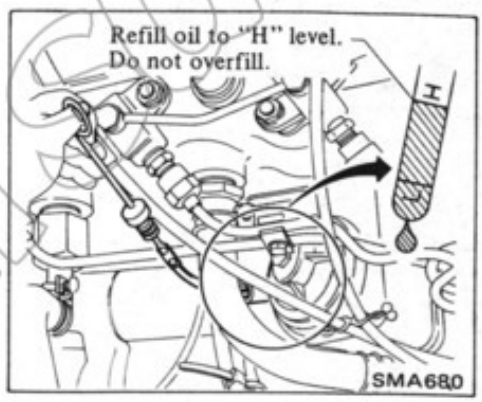
Unit: liter (Imp qt)

		Without oil filter chage	With oil filter change
LD20	910	3.8 (3-3/8)	4.5 (4)
	C120	3.6 (3-1/8)	4.3 (3-3/4)
LD28	430	4.3 (3-3/4)	5.0 (4-3/8)
	C31	4.3 (3-3/4)	5.0 (4-3/8)



a. Start engine. Check area around drain plug and oil filter for any sign of oil leakage.
If any leakage is evident, these parts have not been properly installed.

b. Run engine until water temperature indicator points to the middle of gauge. Then stop engine and check oil level with dipstick. If necessary, add engine oil.
c. When checking oil level, park the car on a level surface.



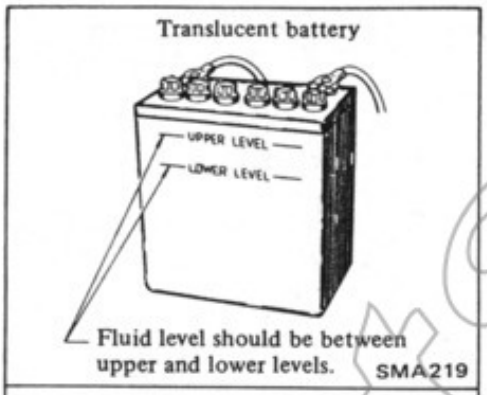
CHECKING ENGINE OIL FOR LEAKS

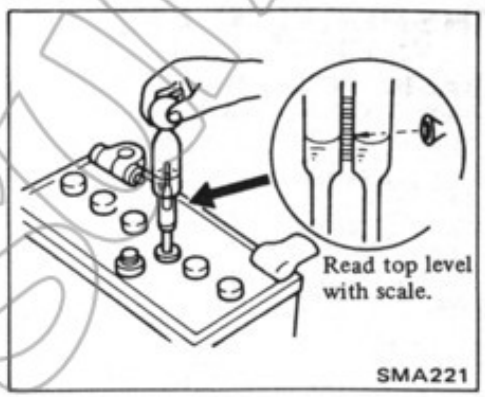
Check cylinder head, front engine cover, oil pan, oil pump, oil filter gasket, etc. or other parts for sign of leaks past their gasketed surfaces. If necessary, replace gaskets or faulty parts. After maintenance has been done, check replaced parts to see if any leaks occur.

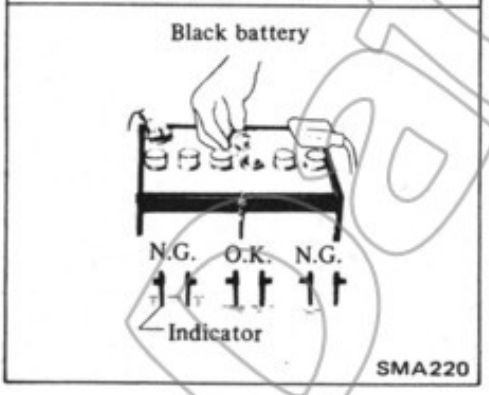
ELECTRICAL SYSTEM

CHECKING BATTERY

WARNING:
Do not expose the battery to flames or electrical sparks. Hydrogen gas generated by battery action is explosive. Do not allow battety fluid to come in contact with skin, eyes, fabrics, or painted surfaces. If the acid contacts the eyes, skin or clothing, immediately flush with water for 15 minutes and seek medical attention. In freezing weather, run the engine for while after adding distilled water, to make sure that the water mixes properly with the fluid. Otherwise the water may freeze and damage the battery.

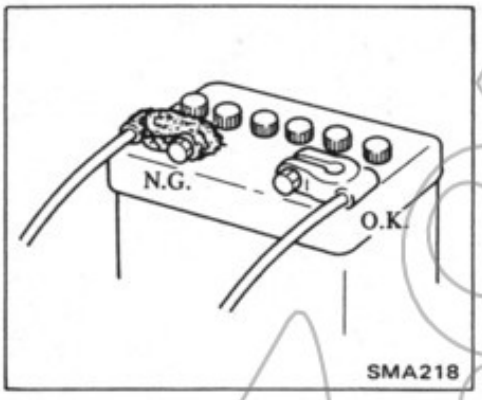






VISUAL CHECK

1. Rusted battery support.
2. Loose terminal connections.
3. Rusted or deteriorated terminals.
4. Damaged or leaking battery.



CHECK ELECTROLYTE LEVEL

Check the fluid level in each cell. If necessary, add only distilled water.

CHECK ELECTROLYTE GRAVITY

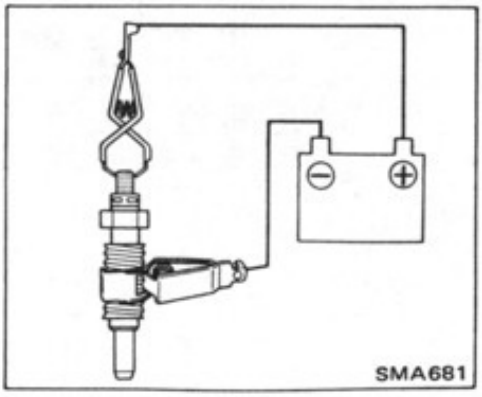
1. Place the hydrometer in the cell. Be sure the float is not in contact with the cylinder wall.
2. Take enough electrolyte into the hydrometer to allow the float to suspend freely between the top and bottom of the cylinder.
3. Read indication.

	Permissible value	Fully charged value [at 20°C (68°F)]
Frigid climate	Over 1.22	1.28
Tropical climate	Over 1.18	1.24
Other climates	Over 1.20	1.26

CHECKING GLOW PLUGS

1. Remove glow plugs from cylinder head.
2. Apply battery voltage (over 10V) to glow plug and see if it will turn red within 15 seconds.

If it takes too much time to turn red, replace it.



SERVICE DATA AND SPECIFICATIONS

INSPECTION AND ADJUSTMENT

BASIC MECHANICAL SYSTEM

Valve clearance Hot mm (in)	Intake	0.25 (0.010)
	Exhaust	0.30 (0.012)
Compression pressure kPa (bar, kg/cm^2, psi)	Standard	3,138 (31.4, 32, 455)
	Minimum	2,452 (24.5, 25, 356)
	Differential limit	490 (4.9, 5, 71)

Drive belt deflection

mm (in)

	Used belt deflection		Set deflection of new belt
	Limit	Adjust deflection	
Alternator	15 (0.59)	11 - 13* (0.43 - 0.51)	8 - 12 (0.31 - 0.47)
		12 - 14** (0.47 - 0.55)	10 - 12 (0.39 - 0.47)
A/C compressor	14 (0.55)	12 - 13 (0.47 - 0.51)	9 - 11 (0.35 - 0.43)
P/S oil pump	9 (0.35)	8 - 8.5 (0.315 - 0.335)	7 - 8 (0.28 - 0.31)

Pushing force: 98 N (10 kg, 22 lb)

* For 430 and C31 models equipped with LD28
** For 910 and C120 models equipped with LD20

INJECTION AND FUEL SYSTEM

Item	Trans-mission	LD28	LD20
Injection timing and idle speed degree/rpm	M/T	B.T.D.C. 5°/650	B.T.D.C. 7°/650
	A/T	B.T.D.C. 5°/700	B.T.D.C. 7°/700
Idle speed of air conditioner "ON" rpm	M/T A/T	800	
Initial injection pressure kPa (bar, kg/cm^2, psi) New		13,239 - 14,024 (132.4 - 140.2, 135 - 143, 1,920 - 2,033)	
Used		12,259 - 13,239 (122.6 - 132.4, 125 - 135, 1,778 - 1,920)	

COOLING SYSTEM AND LUBRICATION SYSTEM

Radiator cap relief pressure kPa (bar, kg/cm^2, psi)	88 (0.88, 0.9, 13)
Cooling system leakage testing pressure kPa (bar, kg/cm^2, psi)	157 (1.57, 1.6, 23)

Approximate oil refill capacity Unit: liter (Imp qt)

		Without oil filter change	With oil filter change
LD20	910	3.8 (3-3/8)	4.5 (4)
	C120	3.6 (3-1/8)	4.3 (3-3/4)
LD28	430	4.3 (3-3/4)	5.0 (4-3/8)
	C31	4.3 (3-3/4)	5.0 (4-3/8)

ELECTRICAL SYSTEM

Item \ Climate		Frigid climate	Tropical climate	Other climate
BATTERY	Permissible valve	Over 1.22	Over 1.18	Over 1.20
	Fully charged value [at 20°C (68°F)]	1.28	1.24	1.26

TIGHTENING TORQUE

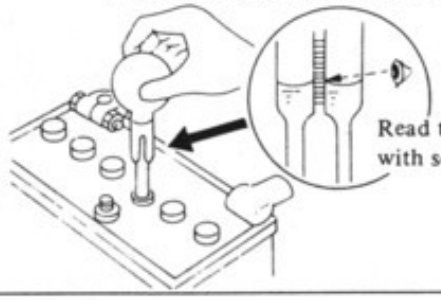
Unit		N·m	kg-m	ft-lb
Cylinder head bolt		118 - 127	12 - 13	87 - 94
Rocker cover		6 - 9	0.6 - 0.9	4.3 - 6.5
Manifold	M10	32 - 36	3.3 - 3.7	24 - 27
	M8	17 - 21	1.7 - 2.1	12 - 15
Alternator		43 - 58	4.4 - 5.9	32 - 43
Injection pump fixing nut and bolt		16 - 21	1.6 - 2.1	12 - 15
Injection tube		22 - 25	2.2 - 2.5	16 - 18
Spill tube		15 - 18	1.5 - 1.8	11 - 13
Nozzle fixing nut		16 - 21	1.6 - 2.1	12 - 15
Oil pan drain plug		20 - 29	2.0 - 3.0	14 - 22
Glow plug		20 - 25	2.0 - 2.5	14 - 18
Glow plug connecting plate		1.0 - 1.5	0.1 - 0.15	0.7 - 1.1
Tensioner shaft		30 - 40	3.1 - 4.1	22 - 30
Spring set pin		30 - 40	3.1 - 4.1	22 - 30

TROUBLE DIAGNOSES AND CORRECTIONS

: Condition
: Check points
: Action
: Probable cause system

Engine fails or is difficult to start.

Are battery electrolyte and fuel levels O.K.?



O.K.

ELECTRICAL SYSTEM

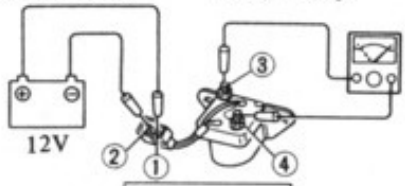
Will starter motor rotate?

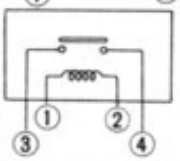
Check points.
- Connections.
- Ignition switch.
- Starting circuit.
- Starter motor.

O.K. / NOT O.K. → Repair or replace.

Check glow system.

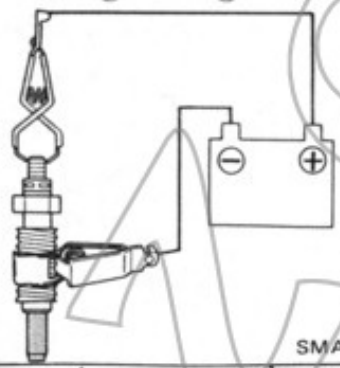
Check points.
- Connections.
- Glow circuit.
- Glow relay.





- Glow timer.
- Glow plug.

SMA729

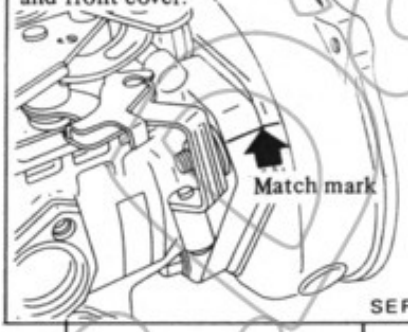


NOT O.K. → Repair or replace.

O.K. → (A)

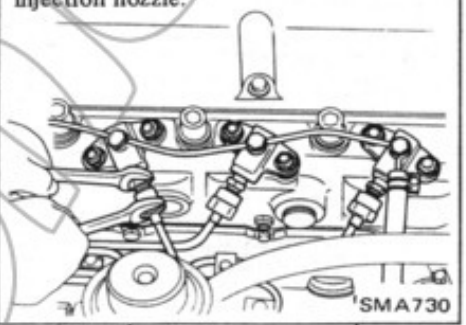
FUEL SYSTEM

Check timing mark of injection pump and front cover.



O.K. / NOT O.K. → Adjust.

Crank engine to make sure fuel reaches injection nozzle.

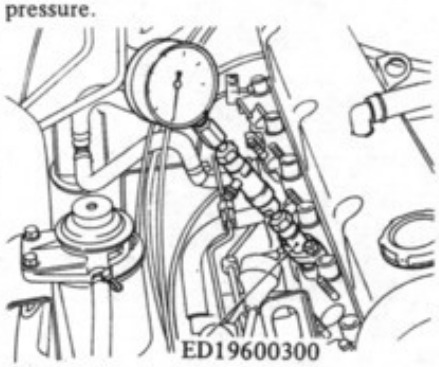


NOT O.K. → (A)

O.K. → (B)

MECHANICAL SYSTEM

Crank engine and check compression pressure.



Check points.
- Valve lip seal worn.
- Piston or piston ring worn.
- Valve stem or valve seat worn.
- Cylinder gasket damaged.

O.K. → (B)

NOT O.K. → Repair or replace.

Ⓐ

Is fuel delivered to injection pump?

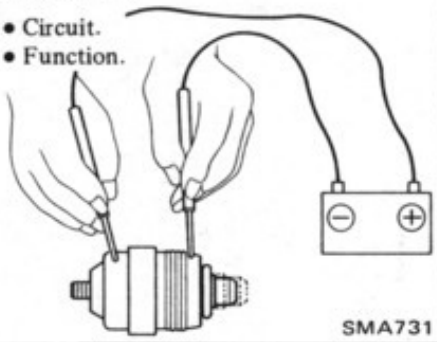
Check points.
- Fuel line twisted or clogged.
- Fuel filter clogged.

O.K. → Check fuel cut solenoid valve.

NOT O.K. → Repair or replace.

Check fuel cut solenoid valve.

Check points.
- Circuit.
- Function.



O.K. → Does delivery valve stick?

NOT O.K. → Replace.

Does delivery valve stick?

O.K. → Overhaul injection pump.

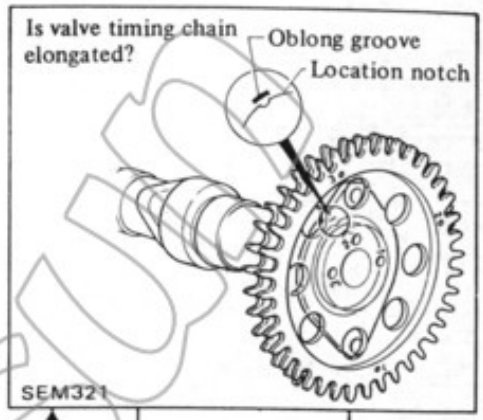
NOT O.K. → Replace.

Overhaul injection pump.

Inspection points.
- Rusted or tardy movement of feed pump vane.
- Weak, broken, worn or rusted plunger spring.
- Abnormal wear on cam disc.

Ⓑ

Is valve timing chain elongated?



NO. → Check valve clearance.

YES. → Adjust or replace chain.

Check valve clearance.

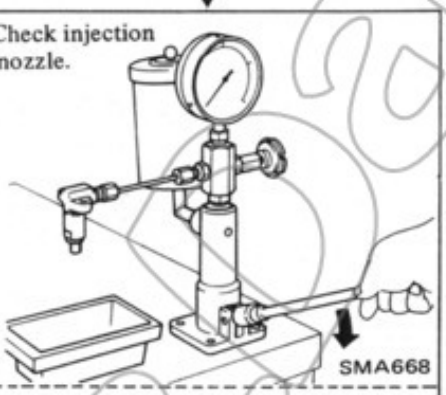
O.K. → Overhaul injection pump.

NOT O.K. → Adjust.

Overhaul injection pump.

Inspection points.
- Rusted or tardy movement of feed pump vane.
- Weak, broken, or rusted regulating valve spring.
- Low setting pressure of regulating valve.
- Weak or broken delivery valve spring.
- Poor seating at delivery valve seat
- Weak, broken, worn, or rusted plunger spring.
- Malfunction of governor lever.
- Broken or weak timer spring.
- Rusted or tardy movement of timer piston.
- Weak or broken governor spring.
- Maladjusted injection quantity..
- Abnormal wear on cam disc.

O.K. → Check injection nozzle.



Check points.
- Fuel injection pattern.
- Clogging.
- Sticking
- Injection pressure.

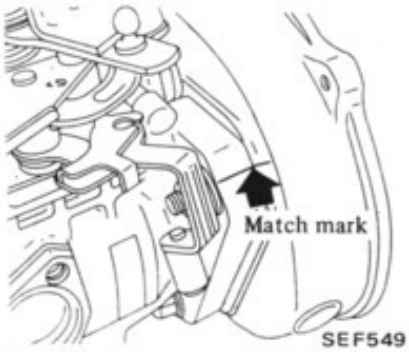
NOT O.K. → Adjust, repair or replace.

O.K. → Check valve clearance.

UNSTABLE IDLING SPEED

FUEL SYSTEM

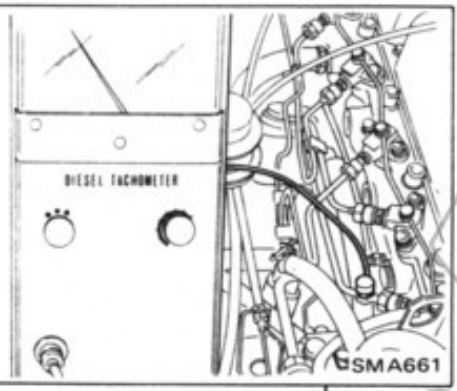
Check timing mark of injection pump and front cover.



O.K. → Check idle speed.

NOT O.K. → Adjust.

Check idle speed.



O.K. → Check fuel line.

NOT O.K. → Adjust.

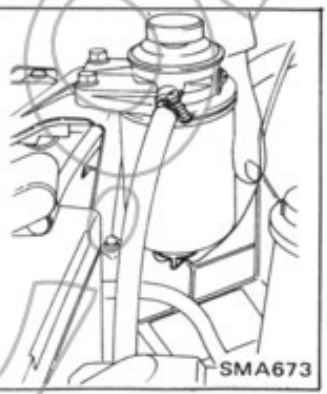
Check fuel line.

Check points.
- Fuel line twisted or clogged.
- Fuel filter clogged.
- Leaks or loose.

O.K. → Purge air and drain water.

NOT O.K. → Repair, retighten or replace.

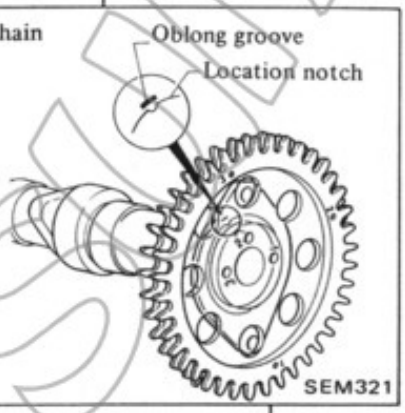
Purge air and drain water.



O.K. → (A)

MECHANICAL SYSTEM

Is valve timing chain elongated?



NO. → Check valve clearance.

YES. → Adjust or replace chain.

Check valve clearance.

O.K. → Check engine mounting.

NOT O.K. → Adjust.

Check engine mounting.

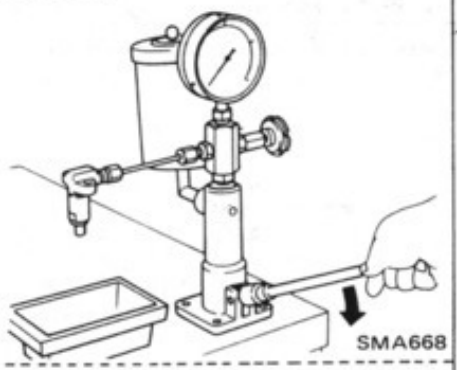
Check points.
- Cracked.
- Loose.

O.K. → (A)

NOT O.K. → Replace or retighten.

Ⓐ

Check injection nozzle.

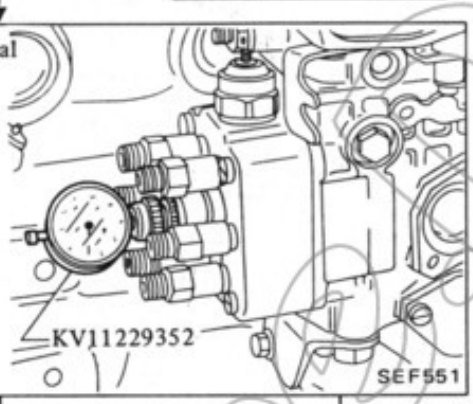


Check points.
- Fuel injection pattern.
- Clogging.
- Sticking.

O.K. / NOT O.K.

Adjust, repair or replace.

Check initial timing.



O.K. / NOT O.K.

Adjust or replace.

Does delivery valve stick?

NO. / YES.

Replace.

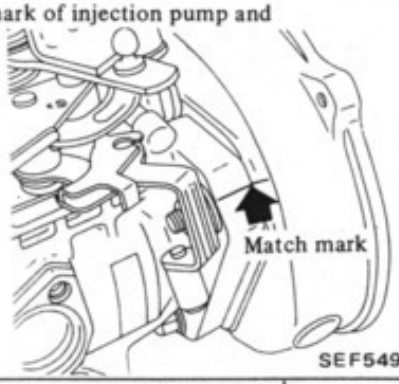
Overhaul injection pump.

Inspection points.
- Rusted or tardy movement of feed pump vane.
- Weak, broken, or rusted regulating valve spring.
- Low setting pressure of regulating valve.
- Weak or broken delivery valve spring.
- Poor seating at delivery valve seat.
- Weak, broken, worn, or rusted plunger spring.
- Malfunction of governor lever.
- Broken or weak timer spring.
- Rusted or tardy movement of timer piston.
- Weak or broken governor spring.
- Maladjusted injection quantity.
- Abnormal wear on cam disc.

EXCESSIVE WHITE or BLACK SMOKE

FUEL SYSTEM

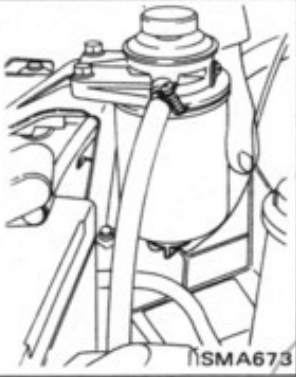
Check timing mark of injection pump and front cover.



NOT O.K. → Adjust.

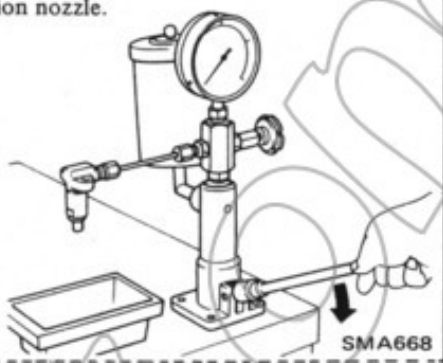
O.K. (White smoke)

Purge air and drain water.



O.K. (Black smoke)

Check injection nozzle.



Check points
- Nozzle worn.
- Spring worn.
- Injection pressure.

NOT O.K. → Adjust, repair or replace.

Does delivery valve stick?

YES. → Replace.

→ Ⓐ

MECHANICAL SYSTEM

Black smoke or white smoke?

(Black smoke) / (White smoke)

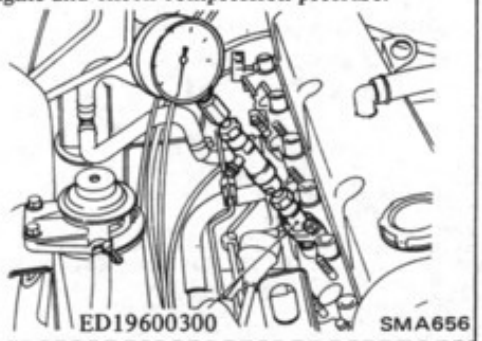
NO. Is air cleaner element clogged?

YES. → Replace.

O.K. NO. Check for oil or similar material in or on tail pipe.

YES.

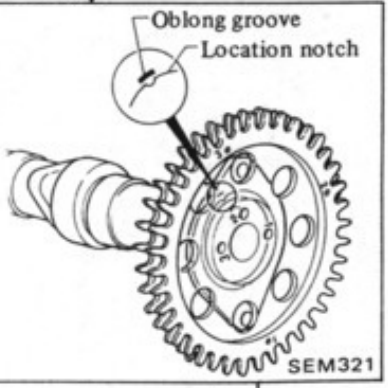
Crank engine and check compression pressure.



Check points.
- Cylinder head gasket damaged.
- Piston or piston ring worn.
- Valve stem or valve seat worn.
- Valve lip seal worn.

O.K. (Black smoke) → Check injection nozzle.

O.K. (White smoke) → Is valve timing chain elongated?

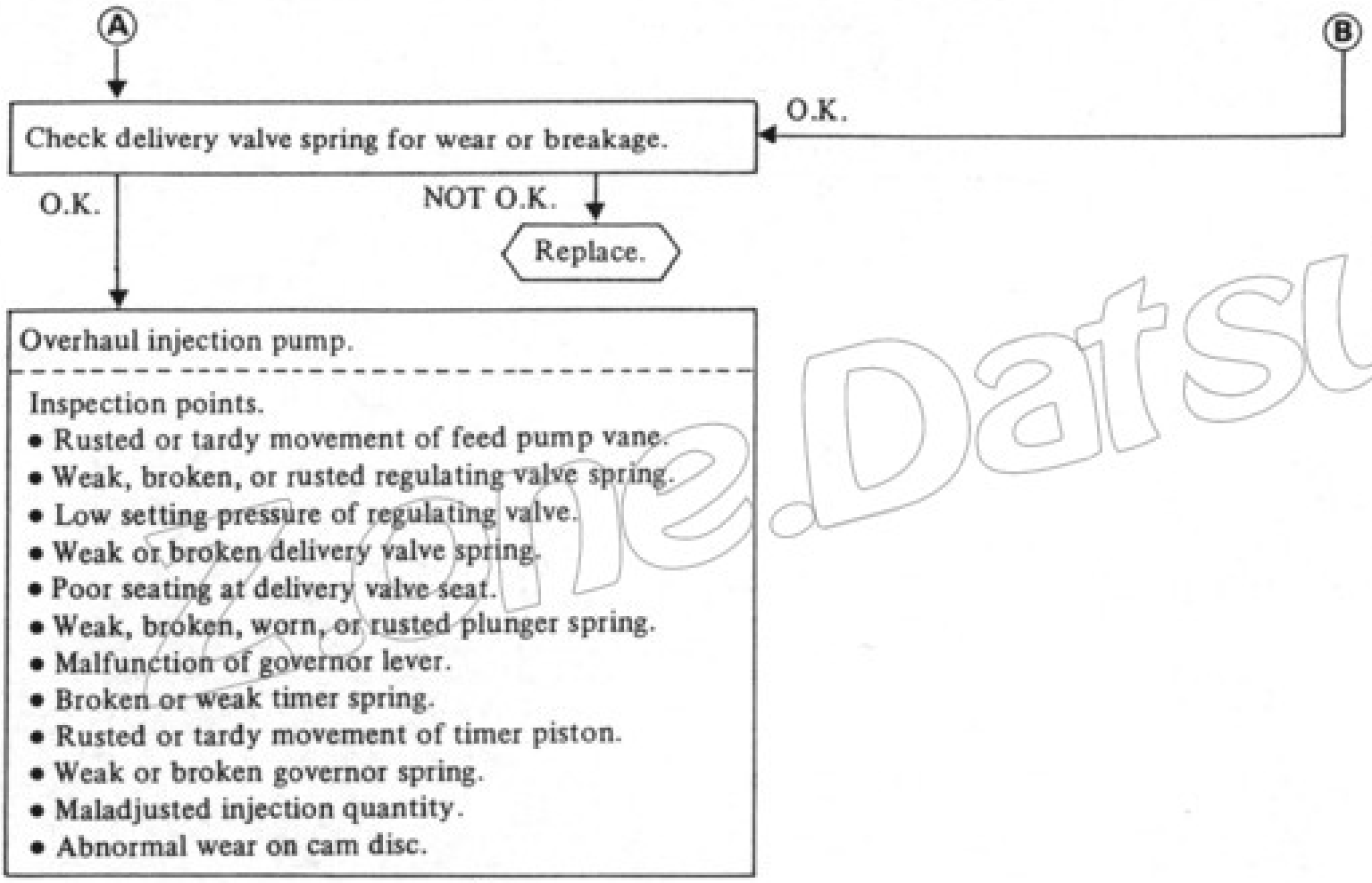


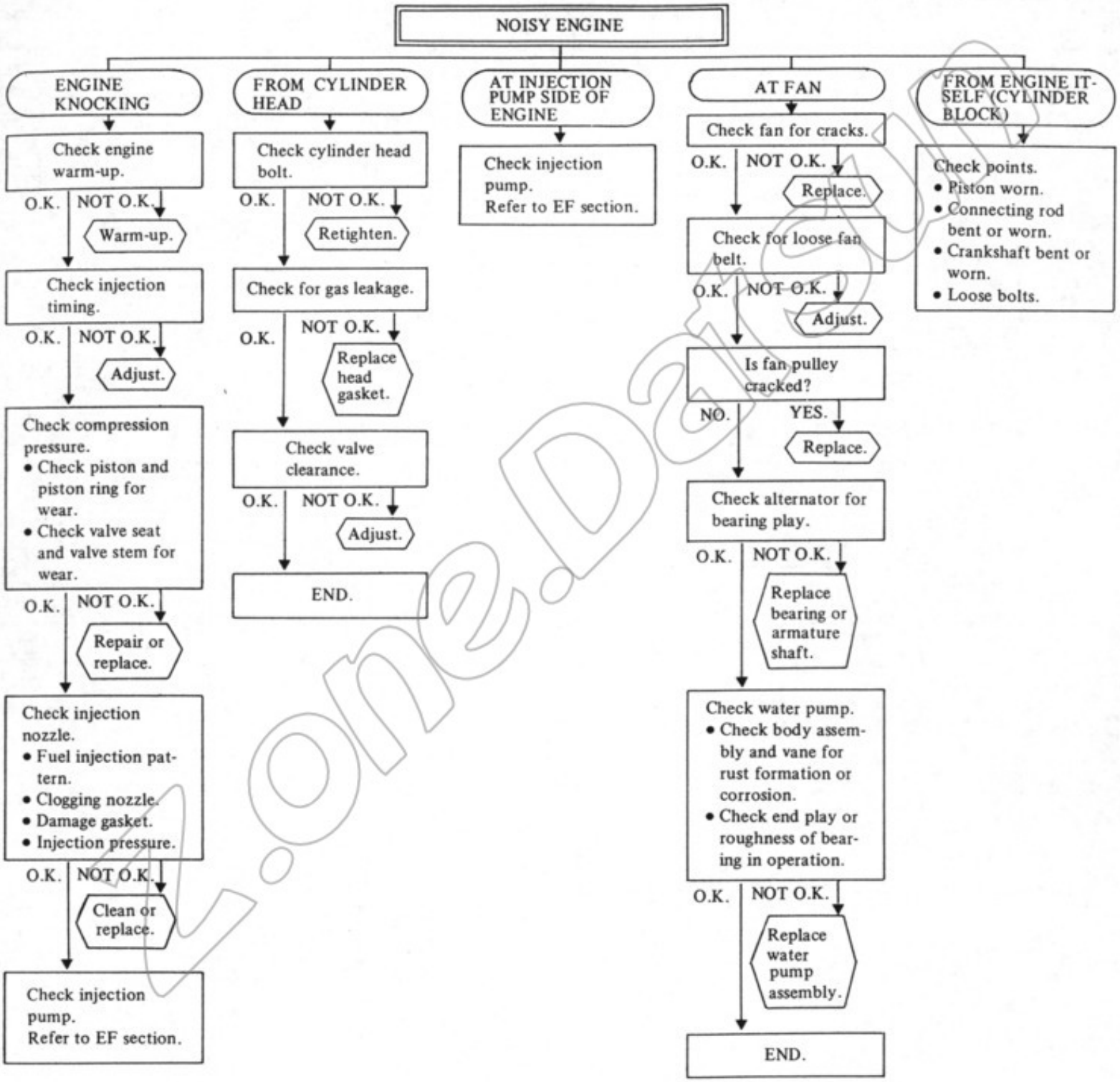
NO. → Ⓑ

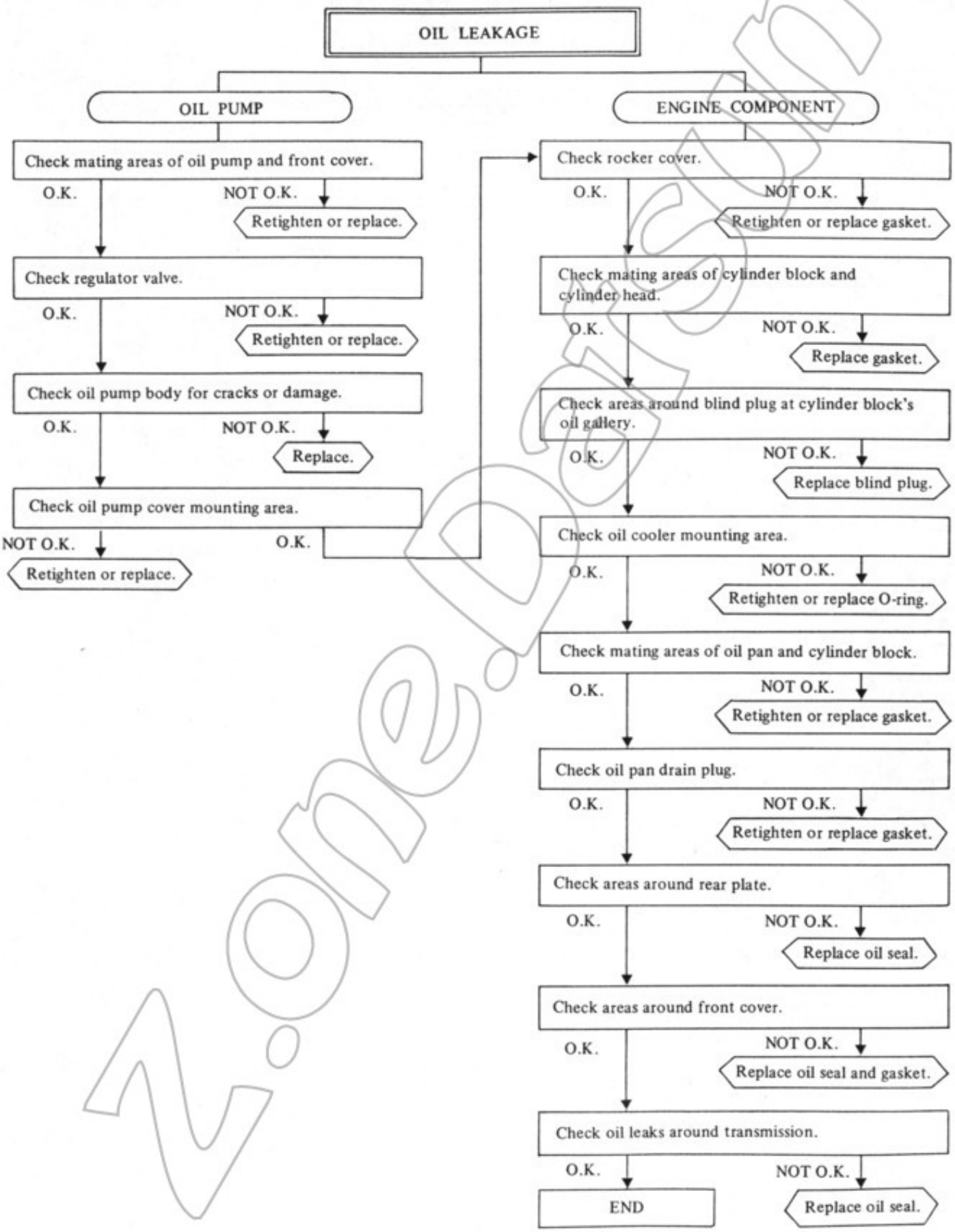
YES. → Adjust or replace chain.

NOT O.K. → Repair or replace.

(White smoke) → Does delivery valve stick?




NOISY ENGINE
ENGINE KNOCKING
Check engine warm-up.
O.K.
NOT O.K.
Warm-up.
Check injection timing.
O.K.
NOT O.K.
Adjust.
Check compression pressure.
• Check piston and piston ring for wear.
• Check valve seat and valve stem for wear.
O.K.
NOT O.K.
Repair or replace.
Check injection nozzle.
• Fuel injection pattern.
• Clogging nozzle.
• Damage gasket.
• Injection pressure.
O.K.
NOT O.K.
Clean or replace.
Check injection pump.
Refer to EF section.
FROM CYLINDER HEAD
Check cylinder head bolt.
O.K.
NOT O.K.
Retighten.
Check for gas leakage.
O.K.
NOT O.K.
Replace head gasket.
Check valve clearance.
O.K.
NOT O.K.
Adjust.
END.
AT INJECTION PUMP SIDE OF ENGINE
Check injection pump.
Refer to EF section.
AT FAN
Check fan for cracks.
O.K.
NOT O.K.
Replace.
Check for loose fan belt.
O.K.
NOT O.K.
Adjust.
Is fan pulley cracked?
NO.
YES.
Replace.
Check alternator for bearing play.
O.K.
NOT O.K.
Replace bearing or armature shaft.
Check water pump.
• Check body assembly and vane for rust formation or corrosion.
• Check end play or roughness of bearing in operation.
O.K.
NOT O.K.
Replace water pump assembly.
END.
FROM ENGINE ITSELF (CYLINDER BLOCK)
Check points.
• Piston worn.
• Connecting rod bent or worn.
• Crankshaft bent or worn.
• Loose bolts.


OIL LEAKAGE
OIL PUMP
Check mating areas of oil pump and front cover.
O.K.
NOT O.K.
Retighten or replace.
Check regulator valve.
O.K.
NOT O.K.
Retighten or replace.
Check oil pump body for cracks or damage.
O.K.
NOT O.K.
Replace.
Check oil pump cover mounting area.
NOT O.K.
O.K.
Retighten or replace.
ENGINE COMPONENT
Check rocker cover.
O.K.
NOT O.K.
Retighten or replace gasket.
Check mating areas of cylinder block and cylinder head.
O.K.
NOT O.K.
Replace gasket.
Check areas around blind plug at cylinder block's oil gallery.
O.K.
NOT O.K.
Replace blind plug.
Check oil cooler mounting area.
O.K.
NOT O.K.
Retighten or replace O-ring.
Check mating areas of oil pan and cylinder block.
O.K.
NOT O.K.
Retighten or replace gasket.
Check oil pan drain plug.
O.K.
NOT O.K.
Retighten or replace gasket.
Check areas around rear plate.
O.K.
NOT O.K.
Replace oil seal.
Check areas around front cover.
O.K.
NOT O.K.
Replace oil seal and gasket.
Check oil leaks around transmission.
O.K.
NOT O.K.
END
Replace oil seal.

WATER LEAKAGE

RADIATOR

Check drain cock.

- O.K. → Check radiator for cracks.
- NOT O.K. → Replace packing or retighten.

Check radiator for cracks.

- O.K. → Radiator hoses for cracks.
- NOT O.K. → Repair or replace.

Radiator hoses for cracks.

- NOT O.K. → Retighten or replace.
- O.K. → Oil cooler for cracks.

OIL COOLER

Oil cooler for cracks.

- O.K. → Check oil cooler hoses for cracks and loose joints.
- NOT O.K. → Repair or replace.

Check oil cooler hoses for cracks and loose joints.

- NOT O.K. → Retighten or replace.
- O.K. → Check mating areas of cylinder block and head.

ENGINE COMPONENT

Check mating areas of cylinder block and head.

- O.K. → Check areas around blind plug at cylinder block's water gallery.
- NOT O.K. → Retighten or replace gasket.

Check areas around blind plug at cylinder block's water gallery.

- O.K. → Check water pumps.
- NOT O.K. → Replace blind plug.

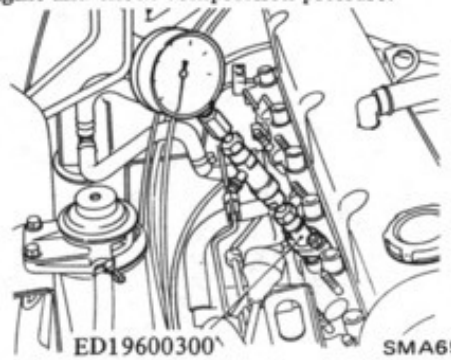
Check water pumps.

- NOT O.K. → Retighten or replace gasket.
- → END

HIGH OIL CONSUMPTION

Oil leakage.
Refer to OIL LEAKAGE.

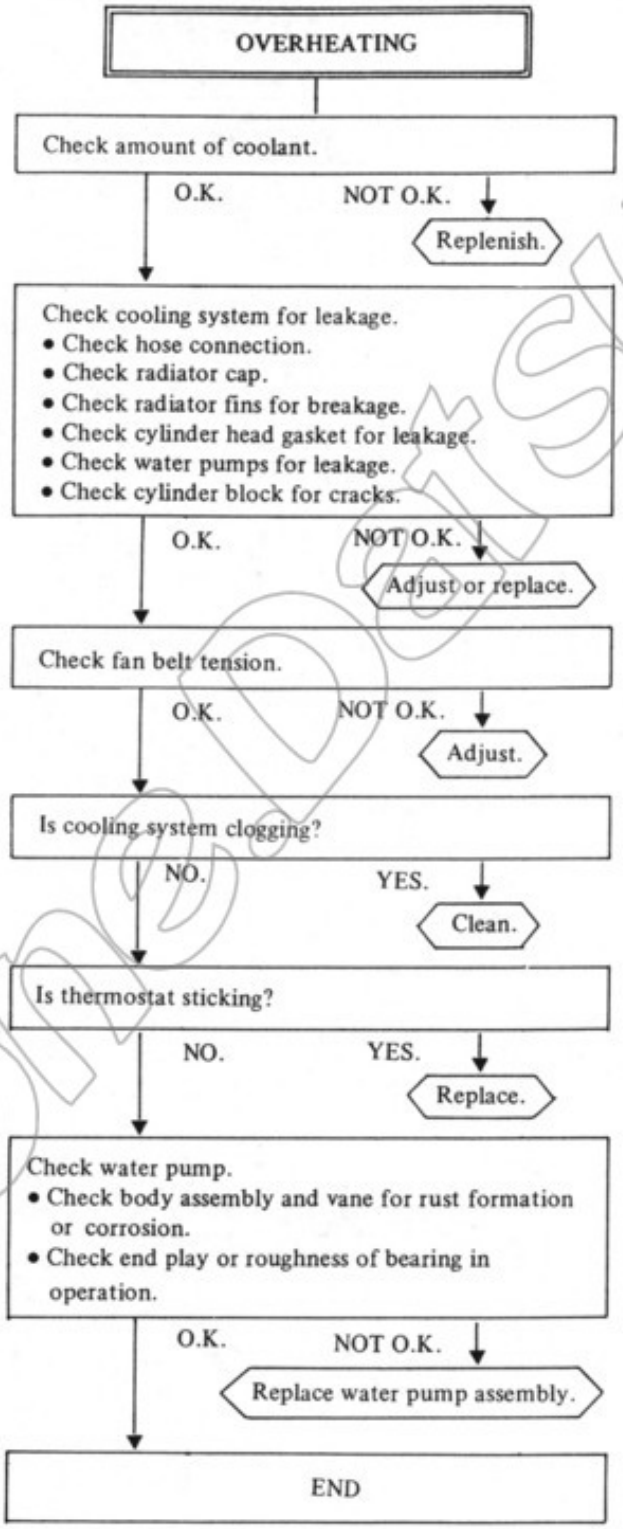
Crank engine and check compression pressure.



Check points.

- Cylinder gasket damaged.
- Piston or piston ring worn.
- Valve stem or valve seat worn.
- Valve lip seal worn.

- O.K. → END
- NOT O.K. → Repair or replace.


OVERHEATING
Check amount of coolant.
O.K.
NOT O.K.
Replenish.
Check cooling system for leakage.
• Check hose connection.
• Check radiator cap.
• Check radiator fins for breakage.
• Check cylinder head gasket for leakage.
• Check water pumps for leakage.
• Check cylinder block for cracks.
O.K.
NOT O.K.
Adjust or replace.
Check fan belt tension.
O.K.
NOT O.K.
Adjust.
Is cooling system clogging?
NO.
YES.
Clean.
Is thermostat sticking?
NO.
YES.
Replace.
Check water pump.
• Check body assembly and vane for rust formation or corrosion.
• Check end play or roughness of bearing in operation.
O.K.
NOT O.K.
Replace water pump assembly.
END

INSUFFICIENT OUTPUT

FUEL SYSTEM

Fuel quality is normal.

O.K.

NOT O.K. → Replace.

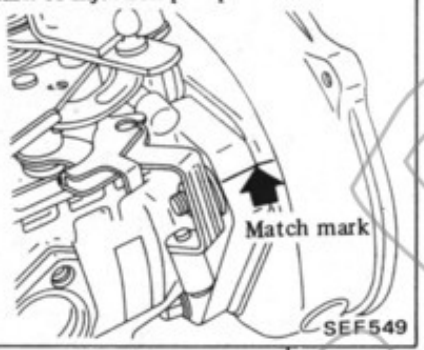
Does control lever contact maximum speed adjusting screw?

Check points.
- Accelerator pedal stroke.
- Accelerator wire elongated.
- Accelerator linkage stuck.

O.K.

NOT O.K. → Adjust or repair.

Check timing mark of injection pump and front cover.



O.K.

NOT O.K. → Adjust.

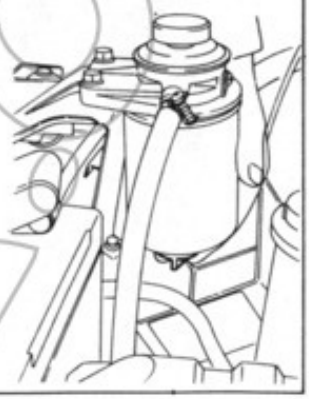
Check fuel line.

Check points.
- Fuel line twisted or clogged.
- Fuel filter clogged.
- Leaks or loose.

O.K.

NOT O.K. → Repair, retighten or replace.

Purge air and drain water.



O.K.

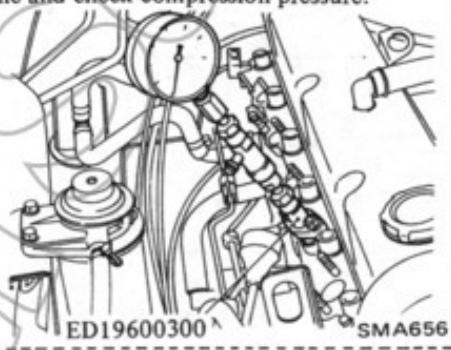
MECHANICAL SYSTEM

Check air cleaner element for clogs.

O.K.

NOT O.K. → Replace.

Crank engine and check compression pressure.

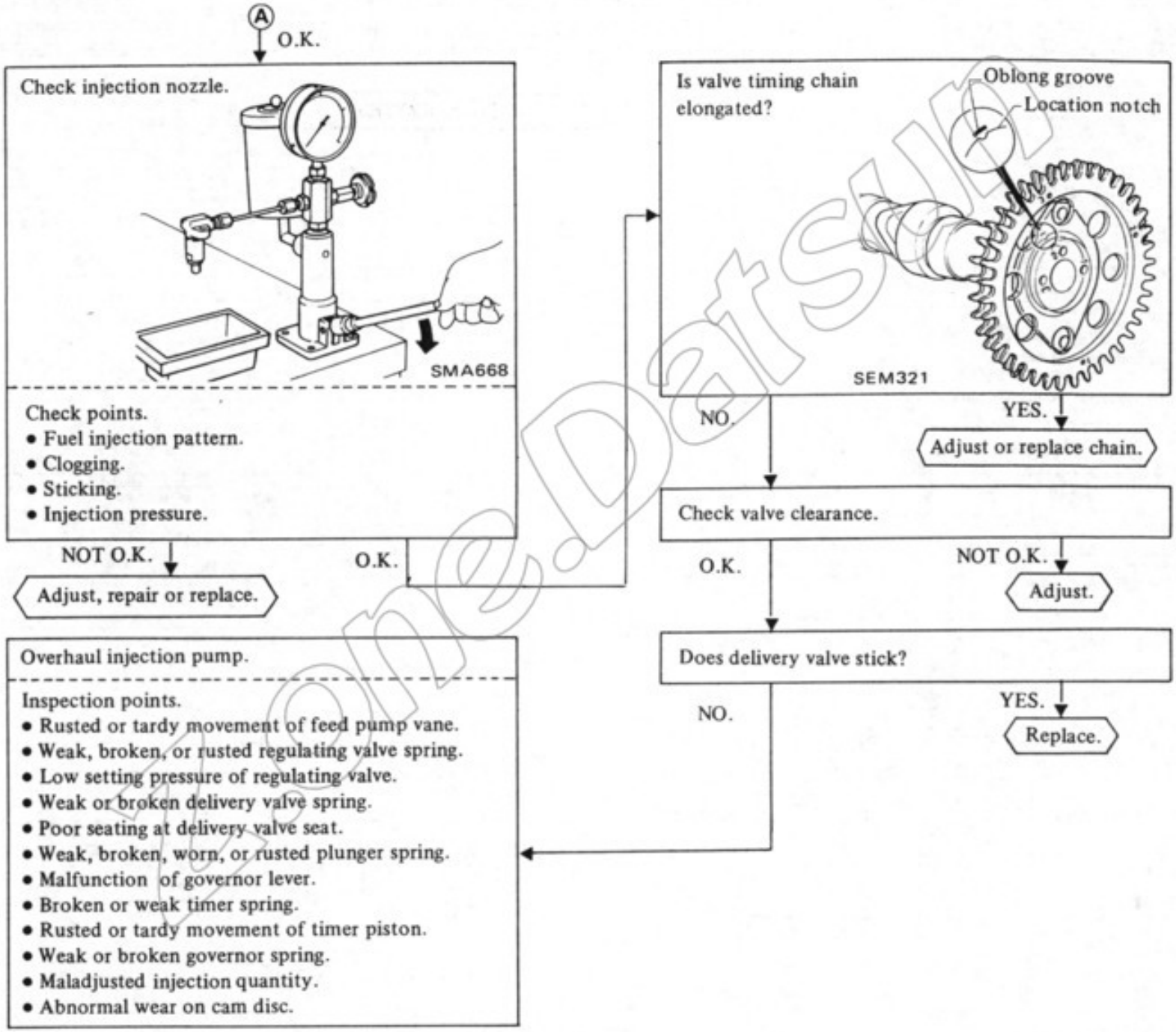


Check points.
- Valve lip seal worn.
- Piston or piston ring worn.
- Valve stem or valve seal worn.
- Cylinder gasket damaged.

O.K.

NOT O.K. → Repair or replace.

Ⓐ


A
O.K.
Check injection nozzle.
SMA668
Check points.
• Fuel injection pattern.
• Clogging.
• Sticking.
• Injection pressure.
NOT O.K.
Adjust, repair or replace.
O.K.
Overhaul injection pump.
Inspection points.
• Rusted or tardy movement of feed pump vane.
• Weak, broken, or rusted regulating valve spring.
• Low setting pressure of regulating valve.
• Weak or broken delivery valve spring.
• Poor seating at delivery valve seat.
• Weak, broken, worn, or rusted plunger spring.
• Malfunction of governor lever.
• Broken or weak timer spring.
• Rusted or tardy movement of timer piston.
• Weak or broken governor spring.
• Maladjusted injection quantity.
• Abnormal wear on cam disc.
Is valve timing chain elongated?
Oblong groove
Location notch
SEM321
NO.
YES.
Adjust or replace chain.
Check valve clearance.
O.K.
NOT O.K.
Adjust.
Does delivery valve stick?
NO.
YES.
Replace.

SPECIAL SERVICE TOOLS

Tool number	Tool name
ST10120000	Cylinder head bolt wrench 
ST10640001	Pivot adjuster 
ST19320000	Oil filter wrench 
ED19600000	Compression gauge set 
ED19600300	Compression gauge adapter