

Workshop Manual Volkswagen Taro 1989 ►

Engine	2L								
Code letters									
Booklet		2.4 ltr. Diesel engine							

Edition 02.89

V.A.G Service.

Repair Group Index to Workshop Manual

Volkswagen Taro 1989 ►

Engine
Code letters

2L

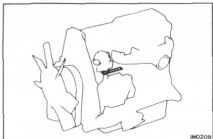
Booklet 2.4 ltr. Diesel engine Edition 02.89

When filing a technical instruction sheet, please enter the sheet number after the title of the instruction. This will enable you to see immediately which of the service bulletin topics have been published as technical instruction sheets.

Repair Group	Workshop Bulletins					
ENGINE MECHANICAL						
REMOVE AND FIT ENGINE						
TROUBLESHOOTING • ENGINE TUNE-UP						
COMPRESSION CHECK • TIMING BELT						
CYLINDER HEAD • CYLINDER BLOCK						
FUEL SYSTEM						
REPLACEMENT OF FUEL FILTER						
FUEL HEATER SYSTEM						
INJECTION NOZZLE • INJECTION PUMP						
FUEL TANK AND LINE						
COOLING SYSTEM						
CHECK AND REPLACEMENT OF ENGINE COOLANT						
WATER PUMP • THERMOSTAT • RADIATOR						
LUBRICATION SYSTEM						
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OIL PUMP • OIL COOLER AND RELIEF VALVES						
OIL NOZZLES AND RELIEF VALVES						
STARTING SYSTEM						
PRE-HEATING SYSTEM						

Technical Information should always be available to all foremen and mechanics, because compliance with the instructions given is essential to ensure vehicle roadworthiness and safety. In addition, the normal safety precautions to be observed when working on motor vehicles are also applicable.

The Workshop Manual is only intended for use within the V.A.G Organisation, and passing on to third parties is not permitted.



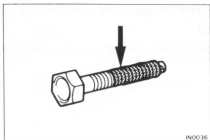
IDENTIFICATION INFORMATION

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. Non-reusable parts
 - (a) Always replace cotter pins gaskets, O-rings, oil seals, etc. with new ones.
 - (b) Non-reusable parts are indicated in the component illustrations by the "◆" symbol.



6. Precoated parts

Precoated parts are bolts and nuts, etc. that are coated with a seal lock adhesive (arrow) at the factory.

(a) If a precoated part is retightened, loosened or caused to move in any way, it must be recoated with the specified adhesive.

(b) Recoating of Precoated Parts

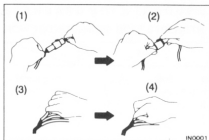
(1) Clean off the old adhesive from the part's threads.

(2) Dry with compressed air.

(3) Apply the specified seal lock adhesive to the part's threads.

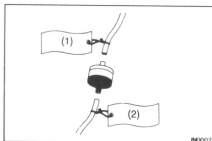
(c) Precoated parts are indicated in the component illustrations by the "★" symbol.

7. When necessary, use a sealer on gaskets to prevent leaks.
8. Carefully observe all specifications for bolt torques. Always use a torque wrench.
9. Use of special service tools (SST) and special service materials (SSM) may be required, depending on the nature of the repair. Be sure to use SST and SSM where specified and follow the proper work procedure. For a list of SST see SST catalogue. A list of SSM can be found at page IX.
10. When replacing fuses, be sure the new fuse is the correct amperage. DO NOT exceed the rating or use one of a lower rating.
11. 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 a jack alone, even for a small job that can be finished quickly.
12. Observe the following precautions to avoid damaging the parts:
 - (a) 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.



- (b) When separating electrical connectors, pull on the connector itself (2), not the wires (1).
- (c) When disconnecting vacuum hoses, pull on the end of the hose (4), not the middle (3).

- (d) When steam cleaning an engine, protect the distributor, coil, air filter, and injection pump from water.
- (e) Never use an impact wrench to remove or install temperature switches or temperature 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 adaptor instead. Once the hose has been stretched, it may leak.



13. Tag hoses before disconnecting them:










- (a) When disconnecting vacuum hoses, use tags to identify how they should be reconnected.
 - (1) VTV for TP, white side
 - (2) VTV for TP, black side
- (b) After completing a job, double check that the vacuum hoses are properly connected. A label under the hood shows the proper layout.

REMOVE AND FIT ENGINE

In the workshop the engine can be removed with an overhead crane. When replacing the engine, tighten the bolts securing the engine mountings, observing the torque values listed in the table on page VII. The torque values for the bolts between engine and drive line are listed in the sector on "Clutch and Gear Box". No other special procedures need to be observed. For that reason, no special instructions for removing and fitting the engine are included.

STANDARD BOLT TORQUE SPECIFICATIONS

HOW TO DETERMINE BOLT STRENGTH

	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		 Grooved	6T
Hexagon flange bolt w/washer hexagon bolt	 No mark	4T			
Hexagon head bolt	 Two protruding lines	5T	Welded bolt		4T
Hexagon flange bolt w/washer hexagon bolt	 Two protruding lines	6T			
Hexagon head bolt	 Three protruding lines	7T			

SPECIFIED TORQUE FOR STANDARD BOLTS

Class	Diameter mm	Pitch mm	Specified torque	
			Hexagon head bolt Nm	Hexagon flange bolt Nm
4T	6	1	5.4	5.9
	8	1.25	13	14
	10	1.25	25	28
	12	1.25	47	53
	14	1.5	75	83
	16	1.5	113	
5T	6	1	6.4	
	8	1.25	16	
	10	1.25	32	
	12	1.25	59	
	14	1.5	91	
	16	1.5	137	
6T	6	1	7.8	8.8
	8	1.25	19	21
	10	1.25	39	43
	12	1.25	72	79
	14	1.5		123
7T	6	1	11	12
	8	1.25	25	28
	10	1.25	52	58
	12	1.25	95	103
	14	1.5	147	167
	16	1.5	226	

SSM (SPECIAL SERVICE MATERIALS)

Part Name	Part No.	Use etc
Seal packing	AMV 188 200 03	Cylinder head cover Oil pan
Sealant	D 000 600	Flywheel or drive plate mount bolt Oil pump body cover
Sealant	D 000 600	Oil pressure switch or sender gauge

SPECIFICATIONS (Cont'd)

Compression pressure	at 250 rpm	Standard Limit	32.0 or more 20.0 5.0 or less
	Difference of pressure between each cylinder		
Cylinder head	Warp	Limit	0.20 mm
	Valve seat		20°, 45°, 75°
	Refacing angle		45°
	Contacting angle		1.8 - 2.2 mm
	Contacting width		11.800 - 12.000 mm
	Cylinder head bolt outer diameter	Standard Limit	11.60 mm
	Cylinder head gasket thickness	Mark B	1.40 - 1.50 mm
		Mark D	1.50 - 1.60 mm
		Mark F	1.60 - 1.70 mm
Valve guide bushing	Inside diameter		8.010 - 8.030 mm
	Outside diameter	Standard	13.040 - 13.051 mm
		Oversized 0.05	13.090 - 13.101 mm
Valve	Valve overall length	Standard	Intake 103.29 - 103.69 mm Exhaust 103.14 - 103.54 mm
		Limit	Intake 102.79 mm Exhaust 102.64 mm
	Valve face angle		44.5°
	Stem diameter		Intake 7.975 - 7.990 mm Exhaust 7.960 - 7.975 mm
	Stem oil clearance	Standard	Intake 0.020 - 0.055 mm Exhaust 0.035 - 0.070 mm
		Limit	Intake 0.08 mm Exhaust 0.10 mm
	Margin thickness	Standard	Intake 1.6 mm Exhaust 1.7 mm
		Limit	Intake 1.10 mm Exhaust 1.2 mm
Valve spring	Free length		46.20 mm
	Yellow painted mark		49.14 mm
	Blue painted mark		30.7 - 33.9 kg
	Installed tension at 37.0 mm		2.0 mm
	Squareness	Limit	
Valve filter	Lifter diameter		40.892 - 40.902 mm
	Cylinder head lifter bore diameter		40.960 - 40.980 mm
	Oil clearance	Standard Limit	0.058 - 0.088 mm 0.10 mm
Manifold	Warp	Limit	0.40 mm

SPECIFICATIONS (Cont'd)

Camshaft	Thrust clearance		Standard Limit	0.080 - 0.280 mm 0.35 mm
	Journal oil clearance		Standard Limit	0.022 - 0.074 mm 0.10 mm
	Journal diameter	Standard	No. 1	34.969 - 34.985 mm
			Others	27.969 - 27.985 mm
		Undersize 0.125	No. 1	34.844 - 34.860 mm
			Others	27.844 - 27.860 mm
		Undersize 0.250	No. 1	34.719 - 34.735 mm
			Others	27.719 - 27.735 mm
	Circle runout		Limit	0.10 mm
	Cam lobe height	Standard Intake		53.850 - 53.870 mm
Exhaust			54.990 - 55.010 mm	
Limit Intake			53.35 mm	
		Exhaust		53.49 mm
Combustion Chamber	Protrusion			Minus 0.03 - Plus 0.03 mm
	Shim thickness			0.03 mm 0.06 mm
Idler pulley tension spring	Free length			44.4 - 45.4 mm
	Installed load	at 52.1 mm		5.42 - 5.98 mm
Cylinder block	Cylinder head surface warpage		Limit	0.20 mm
	Cylinder bore diameter	Standard	Mark 1	92.000 - 92.010 mm
			Mark 2	92.010 - 92.020 mm
			Mark 3	92.020 - 92.030 mm
			Standard	92.23 mm
			Limit	Oversized 0.50
Piston and piston ring	Piston protrusion			0.68 - 0.97 mm
	Piston diameter		Mark 1	91.940 - 91.950 mm
			Mark 2	91.950 - 91.960 mm
			Mark 3	91.960 - 91.970 mm
			Oversized 0.50	92.440 - 92.470 mm
			Standard	0.050 - 0.070 mm
	Piston oil clearance		Limit	0.14 mm
	Piston ring groove clearance		No. 1	0.028 - 0.077 mm
			No. 2	0.060 - 0.105 mm
			Oil	0.030 - 0.070 mm
	Piston ring end gap	Standard	No. 1	0.350 - 0.650 mm
			No. 2	0.300 - 0.600 mm
			Oil	0.200 - 0.500 mm
		Limit	No. 1	1.50 mm
			No. 2	1.40 mm
			Oil	1.40 mm

SPECIFICATIONS (Cont'd)

Connecting rod	Thrust clearance		Standard	0.080 - 0.300 mm
			Limit	0.35 mm
	Connecting rod oil clearance			
	Standard	Standard		0.036 - 0.064 mm
		Undersize 0.25, Undersize 0.50		0.023 - 0.073 mm
	Limit			0.10 mm
	Connecting rod bearing center wall thickness			
	(Reference)	Standard	Mark 1	1.478 - 1.482 mm
			Mark 2	1.482 - 1.486 mm
			Mark 3	1.486 - 1.490 mm
Rod bending	Limit	per 100 mm	0.05 mm	
Twist	Limit	per 100 mm	0.15 mm	
Connecting rod bolt outer diameter		Standard	8.400 - 8.600 mm	
		Limit	8.20 mm	
Bush inside diameter			27.008 - 27.020 mm	
Piston pin diameter			27.000 - 27.012 mm	
Piston pin oil clearance		Standard	0.004 - 0.012 mm	
Limit		0.05 mm		
Crankshaft	Thrust clearance		Standard	0.040 - 0.250 mm
			Limit	0.30 mm
	Thrust washer thickness		Standard	2.430 - 2.480 mm
			Oversized 0.125	2.493 - 2.543 mm
			Oversized 0.250	2.555 - 2.605 mm
	Main journal oil clearance			
	Standard	Standard		0.034 - 0.065 mm
		Undersized 0.25, Undersized 0.50		0.033 - 0.079 mm
	Limit			0.10 mm
	Main journal diameter		Standard	61.985 - 62.000 mm
		Undersize 0.25	61.745 - 61.755 mm	
		Undersize 0.50	61.495 - 61.505 mm	
Main bearing center wall thickness				
(Reference)	Standard	Mark 1	1.979 - 1.983 mm	
		Mark 2	1.983 - 1.987 mm	
		Mark 3	1.987 - 1.991 mm	
Crank pin diameter		Standard	52.988 - 53.000 mm	
		Undersize 0.25	52.745 - 52.755 mm	
		Undersize 0.50	52.495 - 52.505 mm	
Circle runout		Limit	0.06 mm	
Main journal taper and out-of-round		Limit	0.02 mm	
Crank pin taper and out-of-round		Limit	0.02 mm	

TORQUE SPECIFICATIONS

Part tightened		Nm
No. 2 idler pulley - Cylinder block		33
Injection pump drive pulley - Injection pump		64
Camshaft timing pulley - Camshaft		98
No. 1 idler pulley bolt - Cylinder block	12 mm head bolt	19
	14 mm head bolt	44
Crankshaft pulley - Crankshaft		167
Glow plug - Cylinder head		13
Glow plug connector - Glow plug		1.0
Camshaft oil seal retainer - Cylinder head		18
Cylinder head - Cylinder block		78
	1st	90° turns
	2nd	90° turns
	3rd	5.0
No. 1 Cylinder head cover - Cylinder head		37
Right-hand engine hanger - Cylinder head		52
Exhaust manifold - Cylinder head		24
Intake manifold - Cylinder head		37
Left-hand hanger - Cylinder head		19
Water outlet housing - Cylinder head		18
No. 2 timing belt cover - Cylinder head		103
Main bearing cap - Cylinder head		54
	1st	90° turns
Connecting rod cap - Connecting rod		13
	2nd	12
Rear oil seal retainer - Cylinder head		123
Rear end plate - Cylinder head		98
Flywheel - Crankshaft		
Drive plate - Crankshaft		

TROUBLESHOOTING

DIESEL ENGINE DIAGNOSIS

GENERAL

1. Diesel engine problems are usually caused by the engine or fuel system. The injection pump is very rarely the cause of fuel system problems.
2. Before beginning fuel system tests, first check that the engine compression, valve timing and other major systems are within specification.

PRELIMINARY CHECKS

1. Before performing fuel system checks, ensure that the engine is in good running condition. If necessary, first check the compression, timing and major components or systems.
2. Check the air filter, and clean or replace it if necessary.
3. Check that there is sufficient fuel in the tank.
4. Check if the fuel is contaminated with gasoline or other foreign elements. Only good-quality diesel fuel should be used.
5. Bleed air from the system by pumping the priming (hand) pump 30 - 40 times.
6. Check for water in the fuel filter and fuel tank, and drain as necessary.
7. If the engine will not crank or if it cranks slowly, first troubleshoot the electrical system.

PRECAUTION:

- 1. The basic troubleshooting procedures for the diesel engine (valve clearance, compression, bearings, valves, pistons, etc.) are the same checks you would make for gasoline engine.
- 2. Repair of the injection pump requires consider 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 drive belt. Repair as necessary. (See page 151)
3. Inoperative starter	Check for battery voltage at starter terminals 30 and 50. If okay, see manual ELECTRICAL SYSTEM for repair procedure.

ENGINE CRANKS SLOWLY-WILL NOT START

Minimum cranking speed:	Cold	100 rpm
	Hot	150 rpm

(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 drive belt. Repair as necessary. (See page 151)
3. Improper engine oil	Check engine oil. If improper viscosity, drain and refill with oil of viscosity recommended by manufacturer. (See page 127)

ENGINE CRANKS NORMALLY BUT WILL NOT START

(Possible Cause)

(Check Procedure and Correction Method)

1. No fuel to nozzle

Loosen any one injection pipe union nut from its nozzle holder.
Crank engine for about 5 seconds while confirming that fuel is being discharged from 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 off solenoid operation noise (clicking sound) while repeatedly connecting and disconnecting fuel cut off solenoid.
If no noise, check if there is 12 V to solenoid when starter switch is ON.
If 12 V is confirmed, solenoid is faulty and should be replaced. If not 12 V, refer to DIESEL ELECTRICAL SYSTEM DIAGNOSIS and make necessary repairs.

3. No fuel into injection pump

Disconnect inlet hoses from fuel filter, and feed clean fuel from separate container directly into fuel pump.
Hint: When feeding fuel tank directly into pump, keep container at same level as vehicle fuel tank.
If engine starts, either 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.

4. Inoperative pre-heating operation

With starter switch turned ON and glow plug indicator light illuminated, check that 6 V is applied to glow plug.
If not, refer to DIESEL ELECTRICAL SYSTEM DIAGNOSIS and repair as necessary.

5. Faulty glow plug operation

Check glow plug for continuity.
If no continuity, a broken wire is indicated and glow plug should be replaced.

6. Fuel leakage from injection pipes

Check for loose unions or cracks.
If leaking, tighten to standard torque. If necessary, replace pipe(s).

ENGINE CRANKS NORMALLY BUT WILL NOT START (Cont'd)

(Possible Cause)

(Check Procedure and Correction Method)

7. Improper injection timing

Check injection timing. (See page 23)
Plunger stroke: 0.54 - 0.66 mm
If not as above, injection pump is improperly adjusted.
Hint: If crankshaft pulley is off more than 10°, it could indicate a jumped timing belt.

8. Improper cold start advance and fast idle

Check timer piston stroke and fast idle lever opening angle with an injection pump tester when cold start advance is operated.

9. Faulty injection nozzles

Check injection pressure with a nozzle tester. (See page 102)
Opening pressure: 1.45 - 155 bar
If not as above, nozzle adjustment is improper and pressure should be readjusted.
If pressure cannot be adjusted to specification, replace injection nozzle.

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 speed adjusting screw. Also check if accelerator cable or linkage 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 idle speed. (See page 25)
Idle speed: 700 rpm
Hint: If less than standard, idling would normally be rough.
If not as above, adjust with idle speed adjusting screw.

3. Fuel leakage

Check for leaks at injection pump connections, pump distribution head bolts, injection nozzle and delivery valve holders.
Tighten any loose connections to specified torque or replace parts as necessary.

ROUGH IDLE WITH WARM ENGINE (Cont'd)

(Possible Cause)

(Check Procedure and Correction Method)

4. Improper injection timing

Refer to step 7 of ENGINE CRANKS NORMALLY BUT WILL NOT START, above.

5. Improper operation of injection nozzles or delivery valves

With engine idling, loosen injection pipe to each cylinder in order, and check if idle speed changes. If no change, a faulty cylinder is indicated. Check according to following procedure.

- Faulty injection nozzle

Check injection nozzle with a nozzle tester.

(See page 102)

Opening pressure: 145 - 155 bar

If not as above, nozzle adjustment is improper and pressure should be readjusted.

If pressure cannot be adjusted to specification, replace injection nozzle.

- Faulty delivery valve

If injection pressure is as specified, 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

Refer to ROUGH IDLE WITH WARM ENGINE and repair accordingly.

3. Malfunction of fuel cut off solenoid

Refer to ENGINE CRANKS NORMALLY BUT WILL NOT START, above, and check accordingly.

Hint: No operation noise from fuel cut off solenoid may be due to loose electrical connections, so check connectors before proceeding with further repairs.

4. No fuel into injection pump

Refer to step 3 of ENGINE CRANKS NORMALLY BUT WILL NOT START, above.

LACK OF POWER

Hint:

- First check that the air cleaner is not clogged or the engine overheating.
- 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 adjustment of accelerator cable

With accelerator fully depressed, check that adjusting lever is in contact with maximum speed adjusting screw. Also check if accelerator cable or linkage is catching on something. If necessary, adjust so lever is in contact with screw, or make other required repairs.

2. Insufficient maximum speed

Check maximum speed. (See page 25)
Maximum speed: 5,150 rpm
If not as above, adjust with maximum speed adjusting screw.

3. Interchanged overflow screw (out) and inlet (no mark) fitting

Hint: Overflow screw is marked "OUT" and has a inner jet. Although both fittings are same size, they must not be interchanged.

4. Fuel leakage

Refer to step 3 of ROUGH WITH WARM ENGINE.

LACK OF POWER (Cont'd)

(Possible Cause)

(Check Procedure and Correction Method)

5. Clogged fuel filter

Disconnect inlet hose to fuel filter, and feed clean fuel directly into pump.
Hint: When feeding fuel directly into pump, keep container at same level as vehicle fuel tank.
If engine condition improves, fuel filter is clogged and should be replaced. (See page 95)
If no increase in engine condition after replacing fuel filter, check priming pump (hand pump) or perform other necessary repairs.

6. Improper injection timing

Refer to step 7 of ENGINE CRANKS NORMALLY BUT WILL NOT START.

7. Faulty injection nozzles

Refer to step 9 of ENGINE CRANKS NORMALLY BUT WILL NOT START.

EXCESSIVE EXHAUST SMOKE

Hint:

- Check that the air cleaner is not clogged.
- Check with the customer whether or not oil consumption has been excessive.

(Possible Cause)

(Check Procedure and Correction Method)

1. Improper injection timing

Refer to step 7 of ENGINE CRANKS NORMALLY BUT WILL NOT START.
Hint: Black smoke indicates advanced timing while white smoke indicates retarded timing. Adjustments should be produce accordingly.

2. Clogged fuel filter

Refer to step 5 of LACK OF POWER.
Hint: At high speed (2,000 - 3,000 rpm), a clogged filter tends to produce exhaust smoke white.

3. Faulty injection nozzles

Refer to step 9 of ENGINE CRANKS NORMALLY BUT WILL NOT START.
Hint: Excessive exhaust smoke is often caused by nozzle pressure being too low.

EXCESSIVE FUEL CONSUMPTION

Hint: Check whether clutch slipping, brakes grabbing, tires wrong size or air filter clogged.

(Possible Cause)

(Check Procedure and Correction Method)

1. Fuel leakage

Refer to step 3 of ROUGH IDLE WITH WARM ENGINE.

2. Idle speed too high

After sufficiently warming up engine, check idle speed. (See page 25)
Idle speed: 700 rpm
If not as above, adjust with idle speed adjusting screw.

3. Maximum speed too high

Check maximum speed. (See page 25)
Maximum speed: 5,150 rpm
If not as above, adjust with maximum speed adjusting screw.

4. Improper injection timing

Refer to step 7 of ENGINE CRANKS NORMALLY BUT WILL NOT START.

5. Faulty injection nozzles

Refer to step 9 of ENGINE CRANKS NORMALLY BUT WILL NOT START.

ENGINE NOISE WHEN WARM (CRANKING NOISE WITH EXCESSIVE VIBRATION)

(Possible Cause)

1. Engine coolant temperature too low

(Check Procedure and Correction Method)

Check coolant temperature with coolant temperature gauge.
If not sufficiently warm, thermostat is faulty and should be replaced.

2. Improper injection timing

Refer to step 7 of ENGINE CRANKS NORMALLY BUT WILL NOT START.

3. Faulty injection nozzles

Refer to step 9 of ENGINE CRANKS NORMALLY BUT WILL NOT START.

ENGINE WILL NOT RETURN TO IDLE

(Possible Cause)

- Binding accelerator cable

(Check Procedure and Correction Method)

Operate adjusting lever on top of injection pump, and check if engine returns to idle. (See page 25)
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)

- Improper fuel cut solenoid operation

(Check Procedure and Correction Method)

Disconnect connector 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.

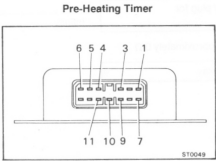
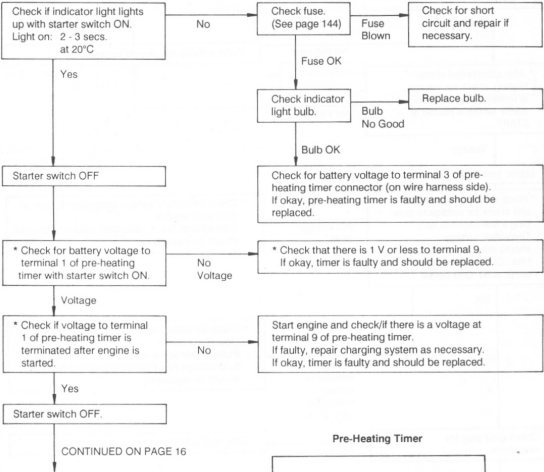
DIESEL ELECTRICAL SYSTEM DIAGNOSIS

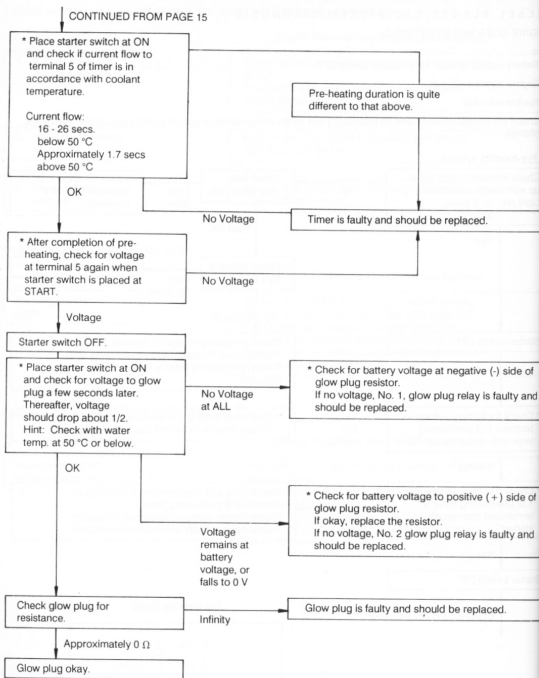
ENGINE DOES NOT START COLD

Hint:

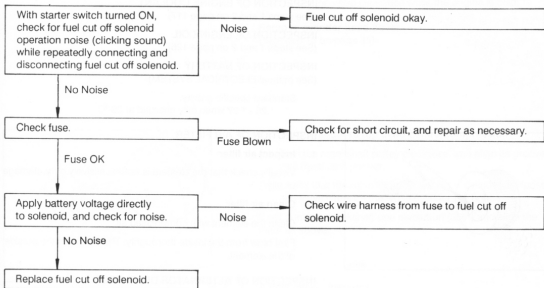
- Battery voltage at least 12 V - starter switch OFF.
- Engine chanks normally.
- Fusible link okay.
- Check the voltage marked with an asterisk (*) just as the starter switch is placed at ON because the voltage will change.

1. Pre-heating system





2. Fuel Cut Off Solenoid



ENGINE TUNE-UP

INSPECTION OF ENGINE COOLANT

(See steps 1 and 2 on page 117)

INSPECTION OF ENGINE OIL

(See steps 1 and 2 on page 126)

INSPECTION OF BATTERY

(See manual ELECTRICAL SYSTEM)

Standard specific gravity:

1.25 - 1.27 when fully charged at 20 °C

INSPECTION OF AIR FILTER

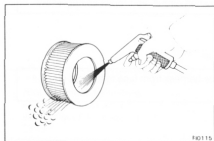
1. Inspect air filter

Visually check that the element is not excessively dirty, damaged or oily.

2. Clean air filter

Clean the element with compressed air.

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



INSPECTION OF ALTERNATOR DRIVE BELT

(See manual ELECTRICAL SYSTEM)

Drive belt deflection:

New belt 7 - 10 mm

Used belt 10 - 15 mm

Drive belt tension (Reference)

New belt 45 - 55 kg

Used belt 20 - 35 kg

INSPECTION OF GLOW PLUGS

(See page 147)

INSPECTION OF INJECTION NOZZLES

(See page 102)

Opening pressure:

New nozzle 151 - 159 bar

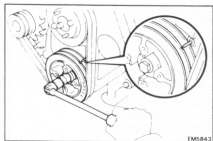
Reused nozzle 145 - 155 bar

ADJUSTMENT OF VALVE CLEARANCE

Hint: Adjust the valve clearance while the engine is cold.

1. Remove cylinder head cover

(See step 13 on page 45)



2. Set No. 1 cylinder to top dead centre/compression

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

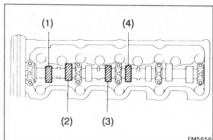
If not, turn the crankshaft one revolution (360°) and align the mark as above.

3. Adjust valve clearance

- Check only those valves indicated in the figure.

- | | |
|--------------|--------------|
| (1) No. 1 EX | (3) No. 2 IN |
| (2) No. 1 IN | (4) No. 3 EX |

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



Valve clearance (Cold):

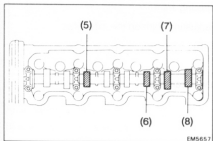
Intake	0.20 - 0.30 mm
Exhaust	0.40 - 0.50 mm

- Turn the crankshaft one revolution (360°), and align the mark as above (See procedure step 3).

- Check only the valves indicated in the figure.

- | | |
|--------------|--------------|
| (5) No. 2 EX | (7) No. 4 EX |
| (6) No. 3 IN | (8) No. 4 IN |

Measure the valve clearance.
(See procedure step (a))

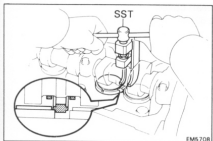


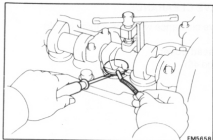
- Remove the adjusting shim.

- Turn the crankshaft to position the cam lobe of the camshaft on the adjusting valve upward.
- Using SST, press down the valve lifter.

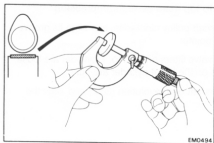
SST 09248-64010

Hint: Before pressing down the valve lifter, position the notch the exhaust manifold side.





- Remove the adjusting shim with small screwdriver and magnetic finger.



- (e) Determine the replacement adjusting shim size following Formula or Charts:

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

T Thickness of used shim

A Measured valve clearance

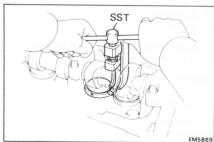
N Thickness of new shim

Intake $N = T + (A - 0.25 \text{ mm})$

Exhaust $N = T + (A - 0.45 \text{ mm})$

- Select a new shim with a thickness as close as possible to the calculated values.

Hint: Shims are available in seventeen sizes of 0.05 mm, from 2.50 mm to 3.30 mm.



- (f) Install a new adjusting shim.

- Place a new adjusting shim on the valve lifter.
- Remove SST (B).

SST 09248-64010

- (g) Recheck the valve clearance.

4. **Reinstall cylinder head cover**
(See step 4 on page 63)

ADJUSTING SHIM SELECTION USING CHART EXHAUST

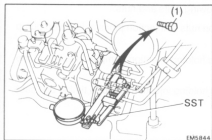
(A)	mm	(B)		mm
		Shim No.	Shim No.	
0.000 - 0.020	2.550	1	2	2.550
0.021 - 0.040	2.550	1	2	2.550
0.041 - 0.060	2.550	1	2	2.550
0.061 - 0.080	2.550	1	2	2.550
0.081 - 0.100	2.550	1	2	2.550
0.101 - 0.120	2.550	1	2	2.550
0.121 - 0.140	2.550	1	2	2.550
0.141 - 0.160	2.550	1	2	2.550
0.161 - 0.180	2.550	1	2	2.550
0.181 - 0.200	2.550	1	2	2.550
0.201 - 0.220	2.550	1	2	2.550
0.221 - 0.240	2.550	1	2	2.550
0.241 - 0.260	2.550	1	2	2.550
0.261 - 0.280	2.550	1	2	2.550
0.281 - 0.300	2.550	1	2	2.550
0.301 - 0.320	2.550	1	2	2.550
0.321 - 0.340	2.550	1	2	2.550
0.341 - 0.360	2.550	1	2	2.550
0.361 - 0.380	2.550	1	2	2.550
0.381 - 0.399	2.550	1	2	2.550
0.400 - 0.500	2.550	1	2	2.550
0.501 - 0.520	2.550	1	2	2.550
0.521 - 0.540	2.550	1	2	2.550
0.541 - 0.560	2.550	1	2	2.550
0.561 - 0.580	2.550	1	2	2.550
0.581 - 0.600	2.550	1	2	2.550
0.601 - 0.620	2.550	1	2	2.550
0.621 - 0.640	2.550	1	2	2.550
0.641 - 0.660	2.550	1	2	2.550
0.661 - 0.680	2.550	1	2	2.550
0.681 - 0.700	2.550	1	2	2.550
0.701 - 0.720	2.550	1	2	2.550
0.721 - 0.740	2.550	1	2	2.550
0.741 - 0.760	2.550	1	2	2.550
0.761 - 0.780	2.550	1	2	2.550
0.781 - 0.800	2.550	1	2	2.550
0.801 - 0.820	2.550	1	2	2.550
0.821 - 0.840	2.550	1	2	2.550
0.841 - 0.860	2.550	1	2	2.550
0.861 - 0.880	2.550	1	2	2.550
0.881 - 0.900	2.550	1	2	2.550
0.901 - 0.920	2.550	1	2	2.550
0.921 - 0.940	2.550	1	2	2.550
0.941 - 0.960	2.550	1	2	2.550
0.961 - 0.980	2.550	1	2	2.550
0.981 - 1.000	2.550	1	2	2.550
1.001 - 1.020	2.550	1	2	2.550
1.021 - 1.040	2.550	1	2	2.550
1.041 - 1.060	2.550	1	2	2.550
1.061 - 1.080	2.550	1	2	2.550
1.081 - 1.100	2.550	1	2	2.550
1.101 - 1.120	2.550	1	2	2.550
1.121 - 1.140	2.550	1	2	2.550
1.141 - 1.160	2.550	1	2	2.550
1.161 - 1.180	2.550	1	2	2.550
1.181 - 1.200	2.550	1	2	2.550
1.201 - 1.220	2.550	1	2	2.550
1.221 - 1.240	2.550	1	2	2.550
1.241 - 1.260	2.550	1	2	2.550
1.261 - 1.280	2.550	1	2	2.550
1.281 - 1.300	2.550	1	2	2.550

- (A) Measured clearance
(B) Installed shim thickness

New shim thickness		mm	
Shim No.	Thickness	Shim No.	Thickness
01	2.50	46	2.95
42	2.55	26	3.00
06	2.60	47	3.05
43	2.65	31	3.10
11	2.70	48	3.15
44	2.75	36	3.20
16	2.80	49	3.25
45	2.85	41	3.30
21	2.90		

Exhaust valve clearance:
0.40 - 0.50 mm

Example: The 2.800 mm shim is installed and the measured clearance is 0.350 mm. Replace the 2.800 mm shim with a No. 11 shim.

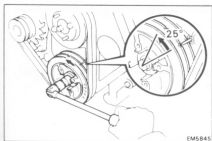


ADJUSTMENT OF INJECTION TIMING

1. Install SST and dial indicator

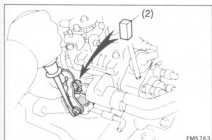
- Remove the plug bolt (1) from the distributive head plug of the injection pump.
- Install SST (plunger stroke measuring tool) and a dial indicator to the plug bolt hole of distributive head plug.

SST 09275-54010



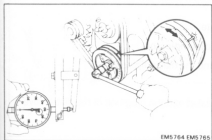
2. Set No. 1 or No. 4 cylinder to 25° or more before top dead center/compression

Turn the crankshaft pulley clockwise so the pulley groove is 25° or more from the timing pointer.



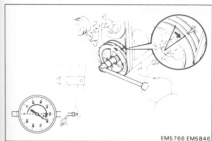
3. Release automatic cold start device advance

- Using a screwdriver, turn the cold starting lever counter-clockwise approx. 20°.
- Put a metal plate (2) (thickness of 8.5 - 10 mm) between the cold starting lever and thermo wax plunger.



4. Adjust injection timing

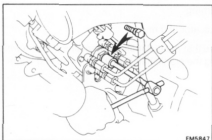
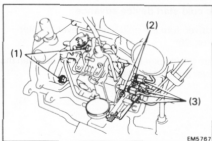
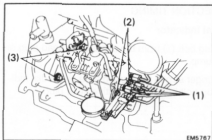
- Set the dial indicator at 0 mm.
- Recheck to see that the dial indicator remains at 0 mm while slightly rotating the crankshaft pulley clockwise and counterclockwise.



- Slowly rotate the crankshaft pulley clockwise until pulley groove is aligned with the timing pointer.

- Measure the plunger stroke.

Plunger stroke: 0.54 - 0.66 mm



(e) Loosen the following bolts and nuts:

- (1) Four union nuts of injection pipes at injection pump side.
- (2) Two bolts holding injection pump to injection pump stay.
- (3) Two nuts holding injection pump to timing belt case.

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

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

If the stroke is greater than specified, tilt the pump away from the engine.

(g) Tighten the following bolts and nuts:

- (1) Two nuts holding injection pump to timing belt case.

Torque: 21 Nm

- Recheck the plunger stroke.

- (2) Two bolts holding injection pump to injection pump stay.

Torque: 18 Nm

- (3) Four union nuts of injection pipes.

Torque: 25 Nm

5. Remove metal plate

6. Remove SST and dial indicator

(a) Remove SST and the dial indicator.

SST 09275-54010

(b) Install a new gasket and the plug bolt of the distributive head plug.

Torque: 17 Nm

7. Start engine and check for leaks

ADJUSTMENT OF IDLE SPEED AND MAXIMUM SPEED

1. Initial conditions

- (a) Engine at reach normal operating temperature
- (b) Air cleaner installed
- (c) All accessories switched OFF
- (d) All vacuum lines properly connected
- (e) Valve clearance set correctly
- (f) Injection timing set correctly

2. Connect tachometer

3. Adjust idle speed

- (a) Check that the adjusting lever touches the idle speed adjusting screw (1) when the accelerator pedal is released.

If not, adjust the accelerator linkage.

- (b) Start the engine.

- (c) Check the idle speed.

Idle speed: 700 rpm

- (d) Adjust the idle speed.

- Disconnect the accelerator linkage.
- Loosen the lock nut of the idle speed adjusting screw (2).
- Adjust the idle speed by turning the IDLE SPEED ADJUSTING SCREW.
- Securely tighten the lock nut, and recheck the idle speed.
- Reconnect the accelerator linkage.
- After adjustment, adjust the accelerator linkage.

4. Adjust maximum speed

- (a) Check that the adjusting lever touches the maximum speed adjusting screw (3) when the accelerator pedal is depressed all the way.

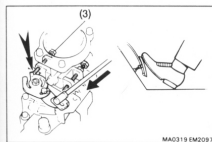
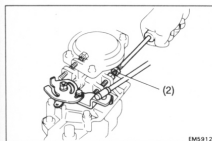
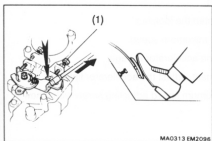
If not, adjust the accelerator linkage.

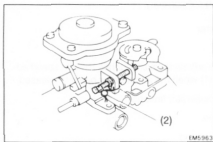
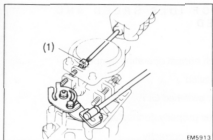
- (b) Start the engine.

- (c) Depress the accelerator pedal all the way.

- (d) Check the maximum speed.

Maximum speed: 5,150 rpm





(e) Adjust the maximum speed.

- Disconnect the accelerator linkage.
- Cut out the seal wire of the maximum speed adjusting screw (1).
- Loosen the lock nut of the maximum speed adjusting screw.
- Adjust the maximum speed by turning the MAXIMUM SPEED ADJUSTING SCREW (1).

Hint: Adjust at idle speed. Then, raise engine speed and recheck the maximum speed.

- Securely tighten the lock nut.
- Recheck the maximum speed.
- Reconnect the accelerator linkage.
- After adjustment, adjust the accelerator linkage.
- Seal the maximum speed adjusting screw with a new seal wire (2).



COMPRESSION CHECK

Hint: If there is lack of power, excessive oil consumption or poor fuel economy, measure the compression pressure.

1. Warm up and stop engine

Allow the engine to reach normal operating temperature.

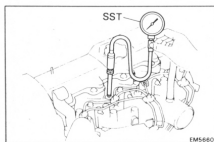
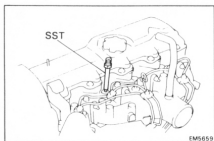
2. Disconnect injection pump (fuel cut solenoid) connector

3. Remove glow plugs (See step 3 on page 30)

4. Check cylinder compression pressure

(a) Install SST (attachment) to the glow plug hole.

SST 09992-00024 (09992-00121) or V.A.G 1381 and Adapter 1381/11



(b) Connect SST (compression gauge) to SST (attachment).

SST 09992-00024 (09992-00121) or V.A.G 1381 and Adapter 1381/11

(c) Fully open the throttle valve.

(d) While cranking the engine, measure the compression pressure.

Hint: Always use a fully charged battery to obtain engine revolution of 250 rpm or more.

(e) Repeat steps (a) through (d) for each cylinder.

Notice: This measurement must be done in as short a time as possible.

Compression pressure: 32.0 or more

Minimum pressure: 20.0

Difference between each cylinder: 5.0 or less

(f) 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) through (d) 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.

5. Reinstall glow plugs

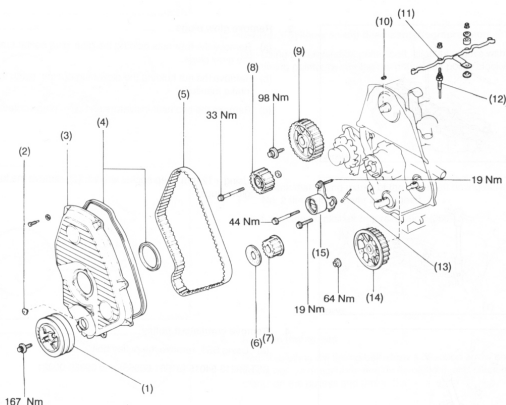
(See step 12 on page 40)

6. Reconnect injection pump (fuel cut solenoid) connector

TIMING BELT

Hint: If replacement the timing belt before the timing belt warning light comes on, (light comes on after 100.000 km of driving), be sure to reset the timing belt counter of the speedometer to zero.

COMPONENTS



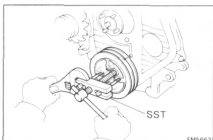
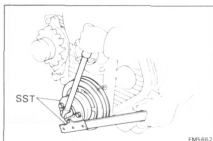
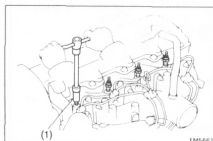
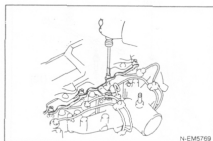
EMS 786

- (1) Crankshaft Pulley
- (2) Timing Pointer Grommet
- (3) No. 2 Timing Belt Cover
- (4) Gasket
- (5) Timing Belt
- (6) Timing Belt Guide
- (7) Crankshaft Timing Pulley
- (8) No. 2 Idler Pulley

- (9) Camshaft Timing Pulley
- (10) Set Key
- (11) Glow plug contact rail
- (12) Glow Plug
- (13) Tension Spring
- (14) Injection Pump Drive Pulley
- (15) No. 1 Idler Pulley

REMOVAL OF TIMING BELT

1. Remove alternator drive belts
2. Remove water pump pulley
(See steps 2 and 3 on page 119)



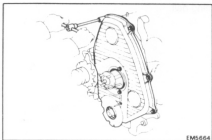
3. Remove glow plugs

- (a) Remove the four nuts holding the glow plug contact rail to the glow plugs.
- (b) Remove the nut holding the glow plug contact rail to the intake manifold.
- (c) Remove the two heat insulators and glow plug contact rail.
- (d) Using a 12 mm deep socket wrench (1), remove the four glow plugs.

4. Remove crankshaft pulley

- (a) Using SST, remove the pulley bolt.
SST 09213-54015 (91651-60855) and 09330-00021

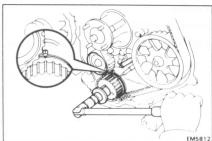
- (b) Using SST, remove the pulley.
SST 09213-60017 (09213-00060)



5. Remove No. 1 timing belt cover

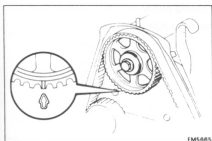
Remove the eleven bolts, washers, timing belt cover, two gas-kets and grommet (for timing pointer).

6. Remove timing belt guide



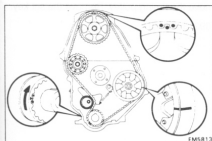
7. Set No. 1 cylinder to top dead center/compression

- Using the crankshaft pulley bolt, align its groove with the timing pointer by turning the crankshaft pulley clockwise.



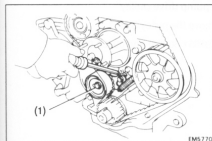
- Check that timing marks of the camshaft timing pulley and No. 2 timing belt cover are aligned.

If not, turn the crankshaft one revolution (360°).

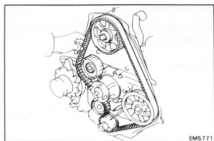


8. Remove timing belt

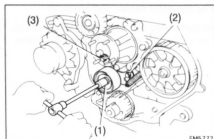
Hint: If re-using the timing belt, draw a direction arrow on the timing belt (in direction of engine revolution), and place match-marks on the pulleys and timing belt.



- Loosen the No. 1 idler pulley bolt (1), and shift left as far as it will go.
- Temporarily tighten the pulley bolt (1), and then relieve the timing belt tension.

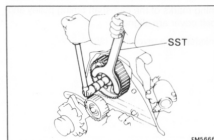


(c) Remove the timing belt.



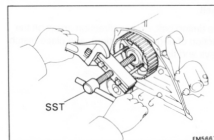
9. Remove No. 1 idler pulley

- (a) Remove the two bolts (1 and 2).
- (b) Loosen the bolt (3), and remove it, the idler pulley and tension spring.

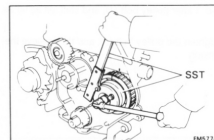


10. Remove camshaft timing pulley

- (a) Using SST, remove the pulley bolt.
SST 09278-54012

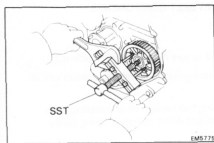


- (b) Using SST, remove the timing pulley. Remove the set key.
SST 09213-60017 (09213-00060)



11. Remove injection pump drive pulley

- (a) Using SST, remove the pulley bolt.
SST 09213-54015 (91651-60855) and 09330-00021



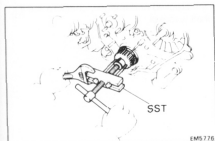
(b) Using SST, remove the drive pulley.

SST 09213-60017 (09213-00060)



12. Remove No. 2 idler pulley

Remove the bolt, idler pulley and spacer.



13. Remove crankshaft timing pulley

Using SST, remove the timing pulley.

SST 09213-60017 (09213-00050)

INSPECTION OF TIMING BELT COMPONENTS

1. Inspect timing belt

Notice:

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

If there are any defects as shown in the figures, check the following points:

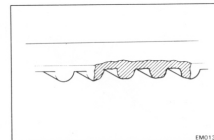
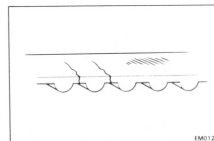
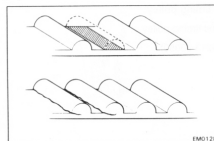
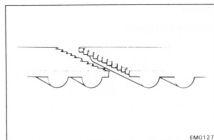
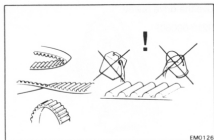
(a) Premature parting

- 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 either the camshaft is locked.

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

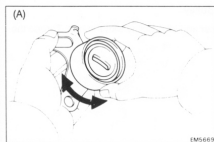
(d) If there is wear or damage on only one side of the belt, check the belt guide and the alignment of the each pulley.





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

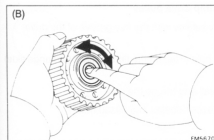
If necessary, replace the timing belt.



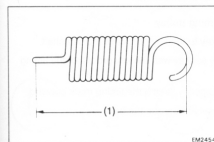
2. Inspect idler pulleys

Check the turning smoothness of the idler pulley. If necessary, replace the idler pulley.

- (a) No. 1 idler pulley



- (b) No. 2 idler pulley



3. Inspect tension spring

- (a) Measure the free length of the tension spring (1).

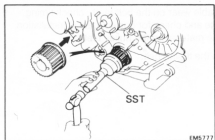
Free length (1): 44.4 - 45.4 mm

If the free length is not as specified, replace the tension spring.

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

Installed tension: 59 Nm at 52.1 mm

If the installed tension is not as specified, replace the tension spring.



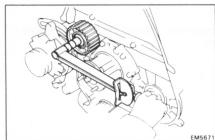
INSTALLATION OF TIMING BELT

(See page 29)

1. Install crankshaft timing pulley

- Align the pulley set key with the key groove of the timing pulley.
- Using SST and a hammer, tap in the timing pulley, facing the flange side inward.

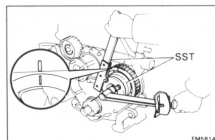
SST 09223-46011



2. Install No. 2 idler pulley

- Install the spacer and idler pulley with the bolt. Torque the bolt.

Torque: 33 Nm



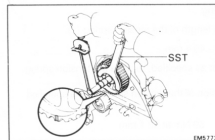
3. Install injection pump drive pulley

- Align the pulley set key with the key groove of the drive pulley.
- Slide the drive pulley, facing the timing mark (or flange side) outward.
- Using SST, install and torque the bolt.

SST 09213-54015 (91651-60855) and 09330-00021

Torque: 64 Nm

Notice: Do not use an impact wrench

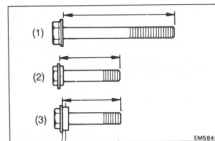


4. Install camshaft timing pulley

- Install the set key to the key groove of the camshaft.
- Align the pulley set key with the key groove of the timing pulley.
- Slide the timing pulley, facing the timing mark outward.
- Using SST, install and torque the bolt.

SST 09278-54012

Torque: 98 Nm



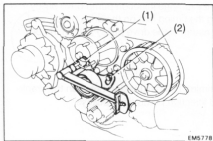
5. Temporarily install No. 1 idler pulley and tension spring

Hint:

- The bolt lengths for bolt types (1), (2), and (3) shown in the illustration are:

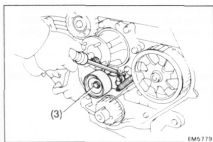
- 76.5 mm
- 42.9 mm Color: Yellow
- 41.3 mm Color: Silver

- Bolt (3) is combined with the idler pulley.

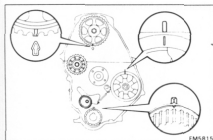


- (a) Install the idler pulley with the three bolts. Torque the two bolts (1 and 2).

Torque: 19 Nm



- (b) Install the tension spring.
(c) Pry the bracket of the idler pulley toward the left as far as it will go and tighten the bolt (3).
(d) Check that the idler pulley moves smoothly.

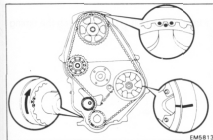


6. Set No. 1 cylinder to top dead centre/compression

Set the timing and drive pulleys at each position.

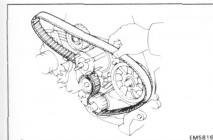
Notice:

- The engine should be cold.
- When turning the crankshaft or camshaft, the valve heads will hit against the piston top so do not turn them more than necessary.

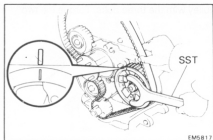


7. Install timing belt

Hint: If re-using the timing belt, align the points marked during removal, and install the timing belt with the arrow pointing in the direction of engine revolution.

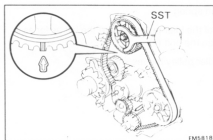


- (a) Remove any oil or water from each pulleys, and keep them clean.
(b) Install the timing belt on the crankshaft timing and No. 1 idler pulleys.



- (c) Using SST, slightly turn the injection pump drive pulley clockwise. Hang the timing belt on the drive pulley, and align the timing marks of the drive pulley and timing belt case.

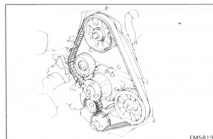
SST 09278-54012



- (d) Check that the timing belt has tension between the crankshaft timing and injection pump drive pulleys.

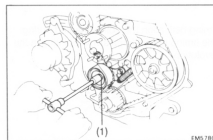
- (e) Using SST, slightly turn the camshaft timing pulley clockwise. Hang the timing belt on the timing pulley, and align the timing marks of the timing pulley and timing belt case.

SST 09278-54012



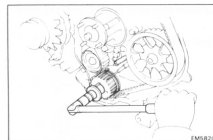
- (f) Check that the timing belt has tension between the injection pump drive and camshaft timing pulleys.

- (g) Install the timing belt on the No. 2 idler pulley.



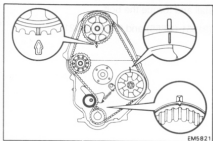
8. Check valve timing

- (a) Loosen the No. 1 idler pulley bolt (1), and stretch the timing belt.



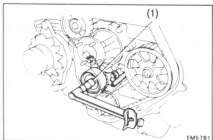
- (b) Turn the crankshaft pulley four revolutions from top dead centre to top dead centre.

Hint: Always turn the crankshaft clockwise.



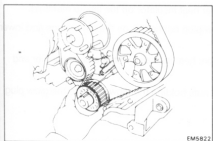
- (c) Check that each pulley aligns with the timing marks as shown in the figure.

If the marks do not align, remove the timing belt and reinstall it.



- (d) Torque the No. 1 idler pulley bolt (1).

Torque: 44 Nm



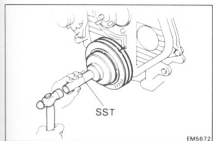
9. Install timing belt guide

Install the belt guide, facing the cup side outward.



10. Install No. 1 timing belt cover

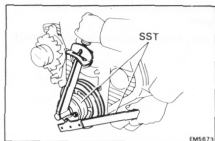
- Install the two gaskets and grommet to the timing belt cover.
- Install the timing belt cover with the eleven bolts.



11. Install crankshaft pulley

- Align the pulley set key with the key groove of the pulley.
- Using SST, tap in the pulley.

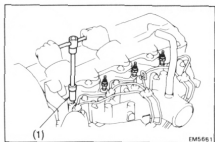
SST 09223-63010



(c) Using SST, install and torque the bolt.

SST 09213-54015 (91651-60855) and 09330-00021

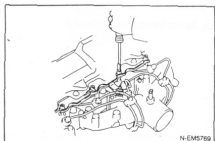
Torque: 167 Nm



12. Install glow plugs

(a) Using a 12 mm deep socket wrench (1), install and torque the four glow plugs.

Torque: 13 Nm



(b) Place the lower heat insulator on the intake manifold.

(c) Place the glow plug connector on the glow plugs and lower heat insulator.

(d) Install the upper heat insulator with the plate washer and nut.

(e) Install the five nuts holding the glow plugs to the glow plug connector.

Torque: 1 Nm

13. Install water pump pulley

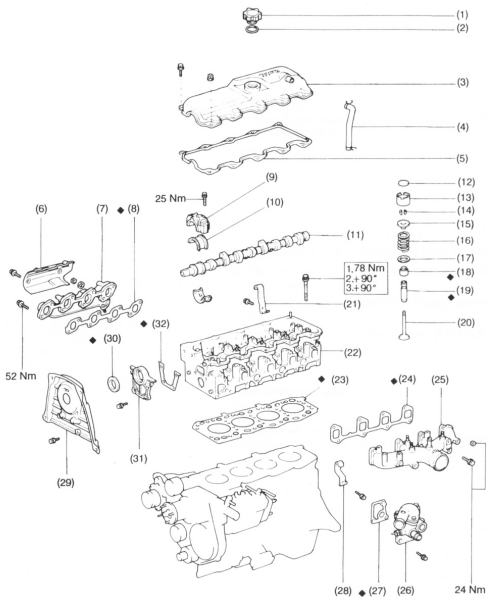
(See steps 4 and 5 on page 121)

14. Install alternator drive belts

Adjust the drive belt. (See manual ELECTRICAL SYSTEM)



CYLINDER HEAD COMPONENTS



N-EM6209

- (1) Oil Filler Cap
- (2) Gasket
- (3) Cylinder Head Cover
- (4) Engine breather (PVC)-hose
- (5) Gasket
- (6) Heat Insulator
- (7) Exhaust Manifold
- (8) Gasket
- (9) Camshaft Bearing Cap
- (10) Camshaft Bearing
- (11) Camshaft
- (12) Adjusting Shim
- (13) Valve Lifter
- (14) Keeper
- (15) Spring Retainer
- (16) Valve Spring
- (17) Spring Seat
- (18) Oil Seal
- (19) Valve Guide Bush
- (20) Valve
- (21) Right-hand Engine Hanger
- (22) Cylinder Head
- (23) Cylinder Head Gasket
- (24) Gasket
- (25) Intake Manifold
- (26) Water Outlet and Outlet Housing Assembly
- (27) Gasket
- (28) Left-hand Engine Hanger
- (29) No. 2 Timing Belt Cover
- (30) Oil Seal
- (31) Camshaft Oil Seal Retainer
- (32) Gasket

◆ Non-reusable part

REMOVAL OF CYLINDER HEAD

(See page 42)

1. **Drain engine coolant** (See page 117)
2. **Remove timing belt**
(See steps 1 to 8 on pages 29 to 32)
3. **Remove camshaft timing pulley**
(See step 10 on page 32)
4. **Remove injection pipes**
(See step 2 on page 100)
5. **Remove injection nozzles**
(See steps 3 and 4 on page 101)
6. **Engine breather (PVC)-hose**

7. **Remove No. 2 timing belt cover**

Remove the four bolts and belt cover.

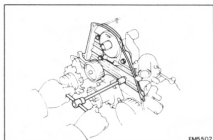
8. **Remove water outlet and outlet housing assembly**

- (a) Disconnect the by-pass hose from the thermo wax of the injection pump.
- (b) Remove the four bolts, the water outlet, outlet housing assembly and gasket.

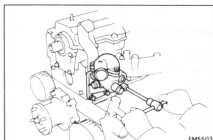
9. **Remove left-hand engine mounting**

10. **Remove intake manifold**

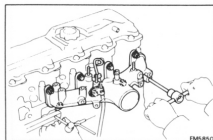
Remove the six bolts, two nuts, intake manifold and gasket.



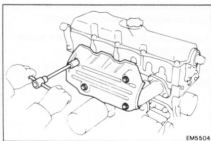
EM5502



EM5503

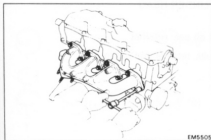


EM5850



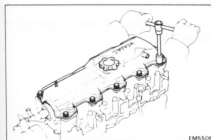
11. Remove exhaust manifold

- (a) Remove the four bolts and heat insulator.



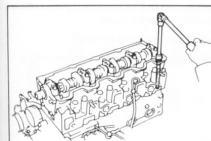
- (b) Remove the six bolts, two nuts, two plate washers, exhaust manifold and gasket.

12. Remove right-hand engine mounting



13. Remove cylinder head cover

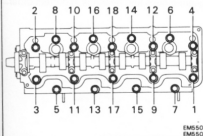
Remove the eight bolts, two nuts, cylinder head cover and gasket.

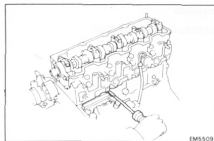


14. Remove cylinder head

- (a) Uniformly loosen and remove the eighteen cylinder head bolts in several passes in the sequence shown.

Notice: Head warp or cracking could result from removing bolts in incorrect order.





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

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

Notice: Be careful not to damage the cylinder head and cylinder block surfaces of cylinder head gasket side.

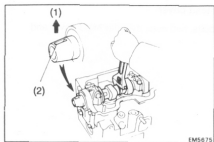


DISASSEMBLY OF CYLINDER HEAD

(See page 42)

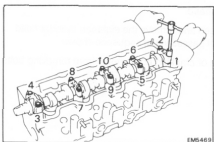
1. Remove camshaft oil seal retainer

Remove the four bolts, retainer and gasket.

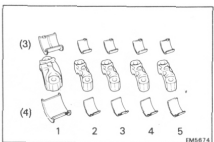


2. Remove camshaft

- (a) Set the key groove of the camshaft (2) facing upward (1) by turning the camshaft with a wrench.

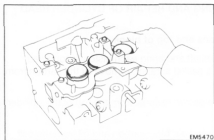


- (b) Uniformly loosen and remove the ten bearing cap bolts in several passes in the sequence shown.
- (c) Remove the five bearing caps and camshaft.
- (d) Remove the ten bearings from the bearing caps and cylinder head.



Hint: Arrange the bearing caps and bearings in correct order.

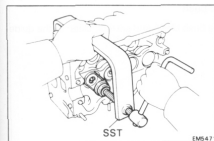
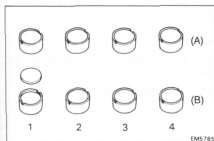
- (3) Upper
(4) Lower



3. Remove valve lifters and shims

Hint: Arrange the valve lifters and shims in correct order.

- (A) Inlet
- (B) Exhaust



4. Remove valves

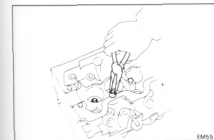
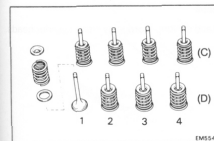
- (a) Using SST, compress the valve spring and remove the two keepers.

SST 09202-43013

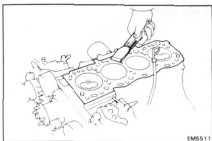
- (b) Remove the spring retainer, valve spring, valve and spring seat.

Hint: Arrange the valves, valve springs, spring seats and spring retainers in correct order.

- (C) Inlet
- (D) Exhaust



- (c) Using needle-nose pliers, remove the oil seal.

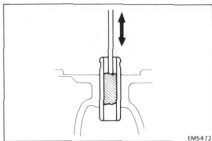


INSPECTION, CLEANING AND REPAIR OF CYLINDER HEAD COMPONENTS

1. Clean top of pistons and top of block

- (a) Turn the crankshaft and bring each piston to top dead centre. Using a gasket scraper, remove all the carbon from the piston top.
- (b) Remove all the gasket material from the top of the cylinder block.
- (c) Using compressed air, blow carbon and oil from the bolt holes.

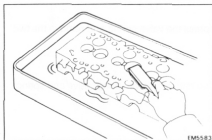
Caution: Protect your eyes when using high pressure air.



2. Remove gasket material

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

Notice: Be careful not scratch the surfaces.

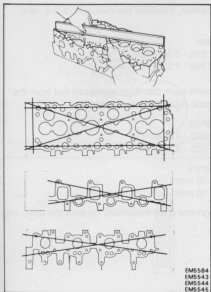


3. Clean valve guide bush

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

4. Clean cylinder heads

Using a soft brush and solvent, thoroughly clean cylinder heads.

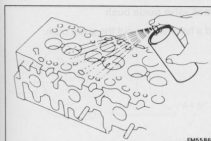


5. Inspect cylinder head for flatness

Using a precision straight edge and thickness gauge, measure the surfaces contacting the cylinder block manifolds for warp.

Maximum warp: 0.20 mm

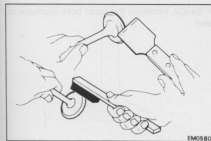
If warp is greater than maximum, replace the cylinder head.



6. Inspect cylinder head for cracks

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

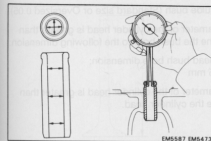
If cracket replace the cylinder head.



7. Clean valves

(a) Using a gasket scraper, chip any carbon from the valve head.

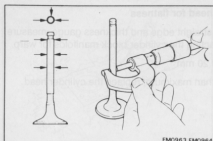
(b) Using a wire brush, thoroughly clean the valve.



8. Inspect valve stems and guide bush

(a) Using a caliper gauge, measure the inside diameter of the guide bush.

Bush inside diameter: 8.010 - 8.030 mm



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

Valve stem diameter:

Intake 7.975 - 7.990 mm

Exhaust 7.960 - 7.975 mm

- (c) Subtract the valve stem diameter measurement from the guide bush inside diameter measurement.

Standard oil clearance:

Intake 0.020 - 0.055 mm

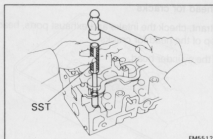
Exhaust 0.035 - 0.070 mm

Maximum oil clearance:

Intake 0.08 mm

Exhaust 0.10 mm

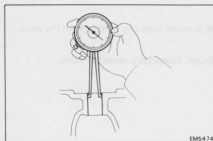
If the clearance is greater than maximum, replace the valve and guide bush.



9. If necessary, replace valve guide bush

- (a) Using SST and a hammer, tap out the guide bush.

SST 09201-60011



- (b) Using a caliper gauge, measure the bush bore diameter of the cylinder head.

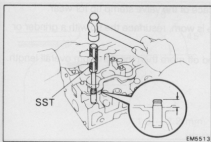
Bush bore diameter mm	Bush size
13.004 - 13.025	Use Standard
13.054 - 13.075	Use Oversized 0.05

- (c) Select a new guide bush (Standard size or Oversized 0.05).

If the bush bore diameter of the cylinder head is greater than 13.025 mm, machine the bush bore to the following dimension:

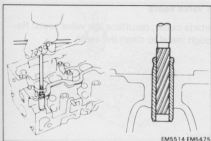
Rebored cylinder head bush bore dimension:
13.054 - 13.075 mm

If the bush bore diameter of the cylinder head is greater than 13.075 mm, replace the cylinder head.

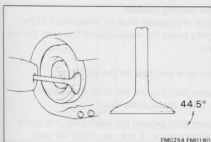


- (d) Using SST and a hammer, tap in a new guide bush to where there is 10.8 - 11.2 mm protruding from the cylinder head.

SST 09201-60011



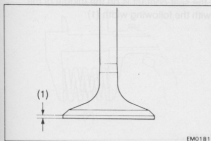
- (e) Using a sharp 8 mm reamer, ream the guide bush to obtain the standard specified clearance (See page 50) between the guide bush and valve stem.



10. Inspect and grind valves

- Grind the valve enough to remove pits and carbon.
- Check that the valve is ground to the correct valve face angle.

Valve face angle: 44.5°



- Check the valve head margin thickness (1).

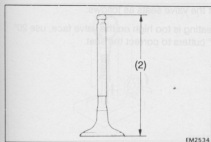
Standard margin thickness:

Intake	1.6 mm
Exhaust	1.7 mm

Minimum margin thickness:

Intake	1.1 mm
Exhaust	1.2 mm

If the margin thickness (1) is less than minimum, replace the valve.



- Check the valve overall length (2).

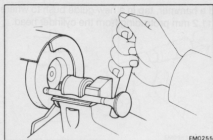
Standard overall length:

Intake	103.29 - 103.69 mm
Exhaust	103.14 - 103.54 mm

Minimum overall length:

Intake	102.79 mm
Exhaust	102.64 mm

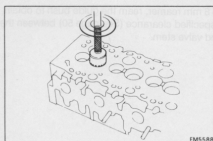
If the overall length (2) is less than minimum, replace the valve.



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

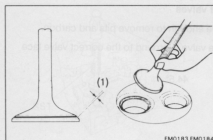
If the valve stem tip is worn, resurface the tip with a grinder or replace the valve.

Notice: Do not grind off more than the minimum overall length.



11. Inspect and clean valve seats

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



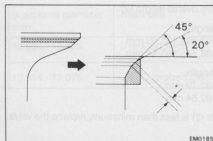
(b) Check the valve seating position.

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

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

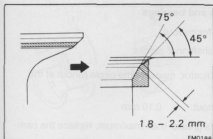
- If blue appears 360° around the face, the valve is concentric. If not, replace the valve.
- If blue appears 360° around the valve seat, the guide and face are concentric. If not, resurface the seat.
- Check that the seat contact is on the middle of the valve face with the following width (1):

1.8 - 2.2 mm

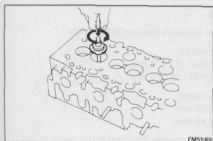


If not, correct the valve seats as follows:

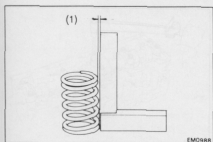
- (1) If the seating is too high on the valve face, use 20° and 45° cutters to correct the seat.



- (2) If the seating is too low on the valve face, use 75° and 45° cutters to correct the seat.



- (d) Hand-lap the valve and valve seat with an abrasive compound.
(e) After hand-lapping, clean the valve and valve seat.

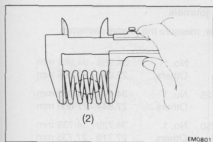


12. Inspect valve springs

- (a) Using a steel square, measure the squareness of the valve spring (1).

Maximum squareness: 2.0 mm

If squareness (1) is greater than maximum, replace the valve spring.



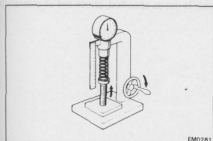
- (b) Using calipers, measure the free length of the valve spring.

(2) Painted mark

Free length:

Yellow painted mark	46.20 mm
Blue painted mark	49.14 mm

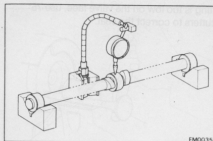
If the free length is not as specified, replace the valve spring.



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

Installed tension: 301 - 332 N at 37.0 mm

If the installed tension is not as specified, replace the valve spring.



EM0035

13. Inspect camshafts and bearings

A. Inspect camshaft for runout

- Place the camshaft on V-blocks.
- Using a dial indicator, measure the circle runout at the centre journal.

Maximum circle runout: 0.10 mm

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

B. Inspect cam lobes

Using a micrometer, measure the cam lobe height.

Standard cam lobe height:

Intake 53.850 - 53.870 mm

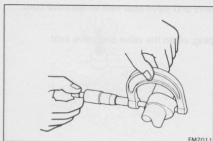
Exhaust 54.990 - 55.010 mm

Minimum cam lobe height:

Intake 53.35 mm

Exhaust 54.49 mm

If the cam lobe height is greater than maximum, replace the camshaft.



EM2011

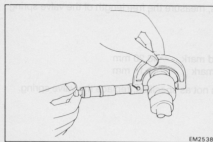
C. Inspect camshaft journals

Using a micrometer, measure the journal diameter.

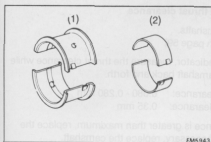
Journal diameter

Standard	No. 1	34.969 - 34.985 mm
	Others	27.969 - 27.985 mm
Undersize 0.125	No. 1	34.844 - 34.860 mm
	Others	27.844 - 27.860 mm
Undersize 0.250	No. 1	34.729 - 34.735 mm
	Others	27.719 - 27.735 mm

If the journal diameter is not as specified, check the oil clearance.



EM2538

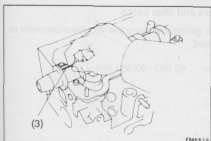


D. Inspect camshaft bearings

Check the bearings for crazing and scoring.

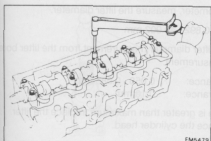
If the bearings are damaged, replace the bearings.

- (1) No. 1
- (2) Others



E. Inspect camshaft journal oil clearance

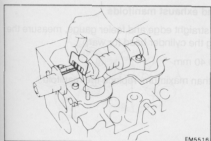
- (a) Install the bearings to the bearing caps and cylinder head.
- (b) Clean the bearings and camshaft journals.
- (c) Place the camshafts on the cylinder head.
- (d) Lay a strip of Plastigage (3) across each of the camshaft journals.



- (e) Install the bearing caps.
(See step 3 (c) to (e) on page 59)

Torque: 25 Nm

Hint: Do not rotate the camshaft.



- (f) Remove the bearing caps.
- (g) Measure the Plastigage at its widest point.

Standard oil clearance: 0.022 - 0.074 mm

Maximum oil clearance: 0.10 mm

If the oil clearance is greater than maximum, replace the bearings. If necessary, grind or replace the camshaft.

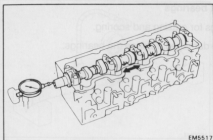
- (h) Completely remove the Plastigage.

F. If necessary, grind an hone camshaft journals

Grind and hone the journals to Undersize diameter.

(See procedure step 13 (A))

Install new journal Undersize bearings.



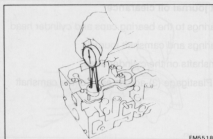
G. Inspect camshaft thrust clearance

- (a) Install the camshafts.
(See step 3 on page 59)
- (b) Using a dial indicator, measure the thrust clearance while moving the camshaft back and forth.

Standard thrust clearance: 0.080 - 0.280 mm

Maximum thrust clearance: 0.35 mm

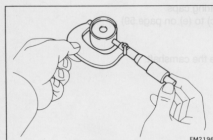
If the thrust clearance is greater than maximum, replace the No. 1 bearings. If necessary, replace the camshaft.



14. Inspect valve lifters and lifter bores

- (a) Using a caliper gauge, measure the lifter bore diameter of the cylinder head.

Lifter bore diameter: 40.960 - 40.980 mm



- (b) Using a micrometer, measure the lifter diameter.

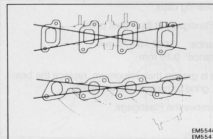
Lifter diameter: 40.892 - 40.902 mm

- (c) Subtract the lifter diameter measurement from the lifter bore diameter measurement.

Standard oil clearance: 0.058 - 0.088 mm

Maximum oil clearance: 0.10 mm

If the oil clearance is greater than maximum, replace the lifter. If necessary, replace the cylinder head.

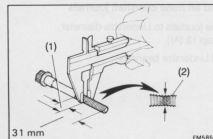


15. Inspect intake and exhaust manifolds

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

Maximum warp: 0.40 mm

If warp is greater than maximum, replace the manifold.



16. Inspect cylinder head bolts

Using calipers, measure the outer diameter of the compressed thread (2) at point (1).

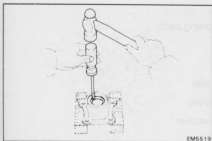
Standard outer diameter: 11.800 - 12.000 mm

Minimum outer diameter: 11.60 mm

If the outer diameter is less than minimum, replace the bolt.

REPLACEMENT OF CAMSHAFT OIL SEAL

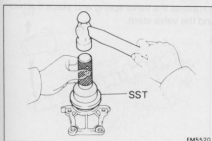
Hint: There are two methods (A and B) to replace the oil seal as follows:



REPLACE CAMSHAFT OIL SEAL

A. If camshaft oil seal retainer is removed from cylinder head:

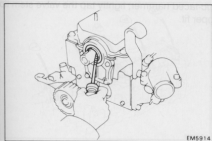
- (a) Using a screwdriver and hammer, tap out the oil seal.



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

SST 09223-46011

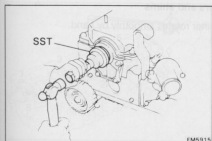
- (c) Apply MP grease to the oil seal lip.



B. If camshaft oil seal retainer is installed to the cylinder head:

- (a) Using a knife, cut off the oil seal lip.
(b) Using a screwdriver, pry out the oil seal.

Notice: Be careful not to damage the camshaft. Tape the screwdriver tip.



- (c) Apply multipurpose grease to a new oil seal lip.
(d) Using SST and a hammer, tap in the oil seal until its surface is flush with the oil seal retainer edge.

SST 09223-46011

ASSEMBLY OF CYLINDER HEAD

(See page 42)

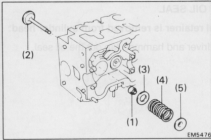
Hint:

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

1. Install valves

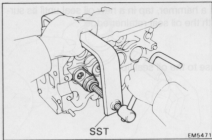
(a) Install the following parts:

- (1) Oil seal
- (2) Valve
- (3) Spring seat
- (4) Valve spring
- (5) Spring retainer

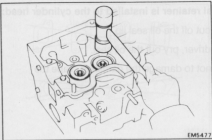


(b) Using SST, compress the valve spring and place the two keepers around the valve stem.

SST 09202-43013

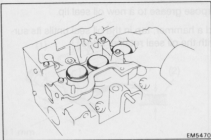


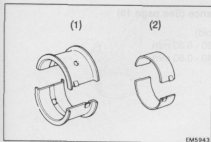
(c) Using a plastic-faced hammer, lightly tap the valve stem tip to assure proper fit.



2. Install valve lifters and shims

Check the valve lifter rotates smoothly by hand.

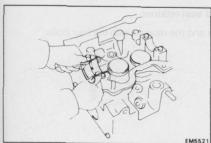




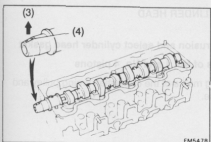
3. Install camshafts

Hint: Different the bearing are used for the No. 1 and others.

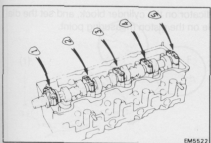
- (1) No. 1
- (2) Others



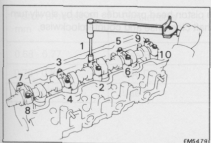
- (a) Install the ten bearings to the bearing caps and cylinder head.



- (b) Place the camshaft on the cylinder head, facing the key groove (4) upward (3).



- (c) Install the five bearing caps in their proper locations.



- (d) Apply a light coat of engine oil on the threads and under the heads of the bearing cap bolts.
- (e) Install and uniformly tighten the ten bearing cap bolts carefully in the sequence shown.

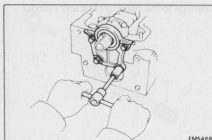
Torque: 25 Nm.

4. Adjust valve clearance (See page 19)

Valve clearance (Cold):

Intake 0.20 - 0.30 mm

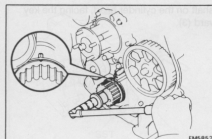
Exhaust 0.40 - 0.50 mm



5. Install camshaft oil seal retainer

Install a new gasket and the retainer with the four bolts.

Torque: 18 Nm



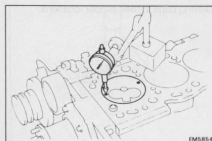
INSTALLATION OF CYLINDER HEAD

(See page 42)

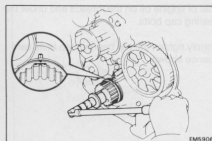
1. Check piston protrusion and select cylinder head gasket

A. Check protrusions of No. 1 and No. 4 pistons

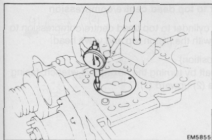
(a) Align the timing marks of the crankshaft timing pulley and timing belt case.



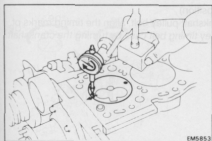
(b) Place a dial indicator on the cylinder block, and set the dial indicator needle on the piston measuring point.



(c) Find where the piston head protrudes most by slowly turning the crankshaft clockwise and counterclockwise.



(d) Set the dial indicator at 0 mm.



(e) Measure the piston protrusion from the cylinder block by sliding the dial indicator.

Protrusion: 0.68 - 0.97 mm

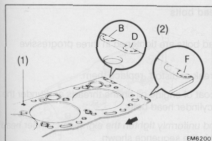
Hint: For each piston, measure the piston protrusion at two measuring points.

(When removing piston and connecting rod assembly)
If the protrusion is not as specified, remove the piston and connecting rod assembly (See page 68) and reinstall it (See page 89).

B. Check protrusions of No. 2 and No. 3 pistons

(a) Turn the crankshaft 1/2 of a revolution (180°).

(b) Measure the piston protrusions.
(See procedure steps A (b) to (e))



C. Select new cylinder head gasket

Hint: There are three sizes of new cylinder head gasket, marked either "B", "D" or "F", or indicated by a cutout mark.

(1) Mark B, D or F

(2) Cutout mark

Arrow indicates front

New cylinder head gasket thickness:

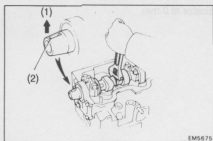
Mark B 1.40 - 1.50 mm

Mark D 1.50 - 1.60 mm

Mark F 1.60 - 1.70 mm

Piston protrusion mm	Gasket size
0.68 - 0.77	Use B
0.78 - 0.87	Use D
0.88 - 0.97	Use F

When selecting a new cylinder head gasket, use the largest value from the eight measurements made of the piston protrusion.



EM5675

2. Set No. 1 cylinder to top dead centre/compression

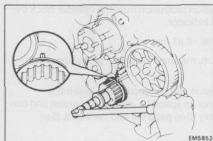
Hint: Set the No. 1 cylinder to top dead centre/compression to avoid interference with the piston top and valve head.

(a) (Camshaft Position)

Set the camshaft by turning the hexagonal wrench, facing the key groove (2) upward (1).

(b) (Crankshaft Position)

Using the crankshaft pulley bolt, align the timing marks of the timing pulley timing belt case by turning the crankshaft.



EM5682

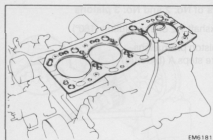
3. Install cylinder head

A. Place cylinder head on cylinder block

- (a) Place a new cylinder head gasket in position on the cylinder block.

Notice: Be careful of the installation direction.

- (b) Place the cylinder head in position on the cylinder head gasket.



EM6181

B. Install cylinder head bolts

Hint:

- The cylinder head bolts are tightened in three progressive steps.
- If any of bolts break or distort, replace them.

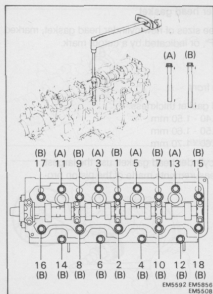
- (a) Apply a light coat of engine oil on the threads and under the heads of the cylinder head bolts.
- (b) First, install and uniformly tighten the eighteen cylinder head bolts carefully in the sequence shown.

Torque: 78 Nm

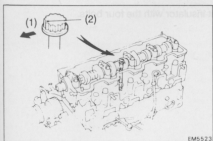
Hint: The bolt lengths for bolt types (A) and (B) shown in the illustration are:

- (A) 107 mm
- (B) 127 mm

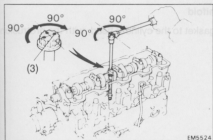
If any one of the bolts does not meet the torque specification, replace the bolt.



EM5592 EM5596
EM5598



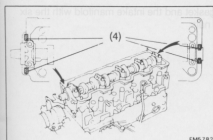
- (c) Mark the front (1) of the cylinder head bolt head with paint (2).



- (d) 2nd, retighten the cylinder head bolts 90° in the numerical order shown.

- (e) 3rd, retighten cylinder head bolts by an additional 90° .

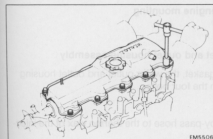
- (f) Check that the painted mark (3) is now facing rearward.



4. Install cylinder head cover

- (a) Apply seal packing (4) to the cylinder heads as shown in the figure.

Seal packing: Part No. AMV 188 200 03



- (b) Install the gasket to the cylinder head cover.

- (c) Install the cylinder head cover with the eight bolts and two nuts.

Torque: 5 Nm



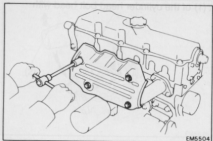
5. Install right-hand engine mounting

Torque: 37 Nm

6. Install exhaust manifold

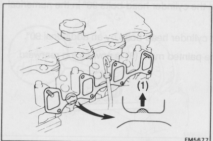
- (a) Install a new gasket and the exhaust manifold with the six bolts and two nuts.

Torque: 52 Nm



EM5504

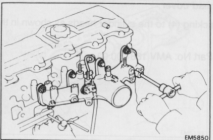
- (b) Install the heat insulator with the four bolts.



EM5677

7. Install intake manifold

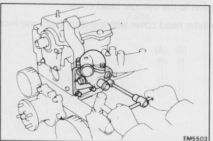
- (a) Install a new gasket to the cylinder head, with the protrusion upward (1).



EM5850

- (b) Install a new gasket and the intake manifold with the six bolts and two nuts.

Torque: 24 Nm



EM5503

8. Install left-hand engine mounting

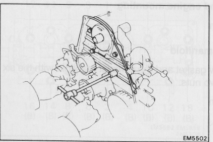
Torque: 37 Nm

9. Install water outlet and outlet housing assembly

- (a) Install a new gasket, the water outlet and outlet housing assembly with the four bolts.

Torque: 19 Nm

- (b) Connect the by-pass hose to the thermo wax of the injection pump.



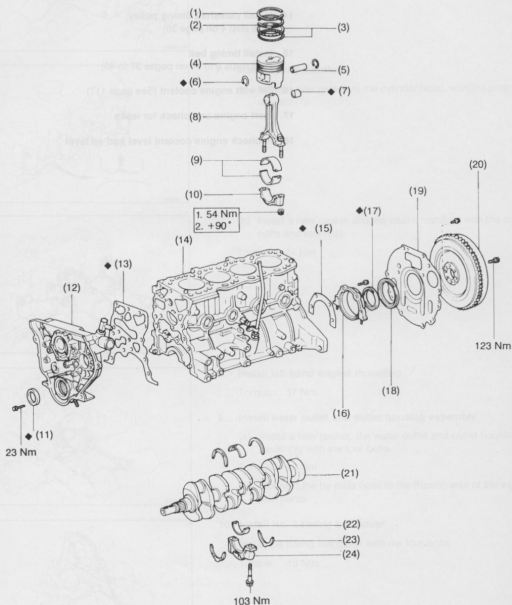
EM5502

10. Install No. 2 timing belt cover

Install the timing belt cover with the four bolts.

Torque: 18 Nm

CYLINDER BLOCK COMPONENTS

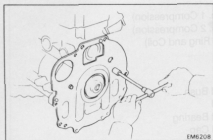


- (1) Piston Ring (No. 1 Compression)
- (2) Piston Ring (No. 2 Compression)
- (3) Piston Ring (Oil Ring and Coil)
- (4) Piston
- (5) Piston Pin
- (6) Snap Ring
- (7) Connecting Rod Bush
- (8) Connecting Rod
- (9) Connecting Rod Bearing
- (10) Connecting Rod Cap
- (11) Crankshaft Front Oil Seal
- (12) Oil Pump (Timing Belt Case)
- (13) Gasket
- (14) Cylinder Block
- (15) Gasket
- (16) Rear Oil Seal Retainer
- (17) Crankshaft Rear Oil Seal
- (18) Dust Cover
- (19) Rear End Plate
- (20) Flywheel
- (21) Crankshaft
- (22) Main Bearing
- (23) Crankshaft Thrust Washer
- (24) Main Bearing Cap

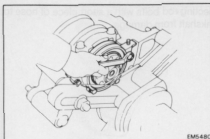
◆ Non-reusable part

PREPARATION FOR DISASSEMBLY

1. Remove clutch cover and disc
2. Remove flywheel



3. Remove rear end plate
Remove the two bolts, end plate and dust cover.
4. Install engine to engine stand for disassembly
5. Remove alternator
6. Remove timing belt and pulleys
(See page 29)
7. Remove cylinder head (See page 44)
8. Remove injection pump (See page 110)
9. Remove water pump (See page 119)
10. Remove oil pan and oil pump
(See page 130)
11. Remove oil cooler (See page 138)



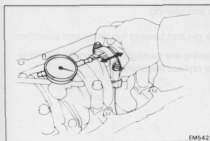
EM5480

DISASSEMBLY OF CYLINDER BLOCK

(See page 66)

1. Remove rear oil seal retainer

Remove the four bolts, retainer and gasket.



EM5423

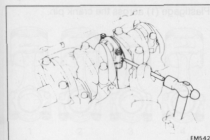
2. Check connecting rod thrust clearance

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

Standard thrust clearance: 0.080 - 0.300 mm

Maximum thrust clearance: 0.35 mm

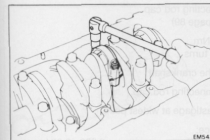
If the thrust clearance is greater than maximum, replace the connecting rod assembly. If necessary, replace the crankshaft.



EM5424

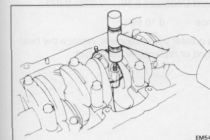
3. Remove connecting rod caps and check oil clearance

(a) Using a punch, place the matchmarks on the connecting rod and cap to ensure correct reassembly.



EM5425

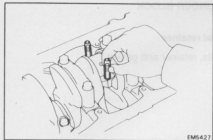
(b) Remove the connecting rod cap nuts.



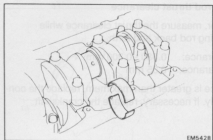
EM5426

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

Hint: Keep the lower bearing inserted in the connecting cap.



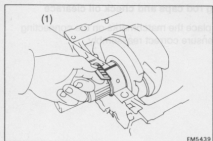
- (d) Cover the connecting rod bolts with a short piece of hose to protect the crankshaft from damage.



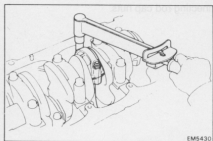
- (e) Clean crank pin and bearing.

- (f) Check the crank pin and bearing for pitting and scratches.

If the crank pin or bearing are damaged, replace the bearings.
If necessary, grind or replace the crankshaft.



- (g) Place a strip of Plastigage (1) across the crank pin.



- (h) Install the connecting rod cap.
(See step 7 on page 89)

Torque: 1st 54 Nm
2nd 90° turns

Hint: Do not rotate the crankshaft

- (i) Remove the connecting rod cap.

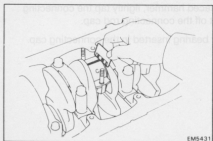
- (j) Measure the Plastigage at widest point.

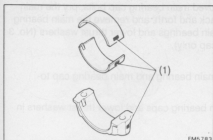
Standard oil clearance:

Standard 0.036 - 0.064
Undersize 0.25 and Undersize 0.50 0.023 - 0.073

Maximum oil clearance: 0.10 mm

If the oil clearance is greater than maximum, replace the bearings. If necessary, grind or replace the crankshaft.





EM5783

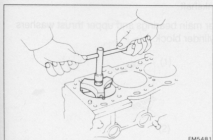
Hint: If using a standard bearing, replace with one having the same number marked on the connecting rod cap. There are three sizes of standard bearings, marked "1", "2" and "3" accordingly.

(1) Mark 1, 2 or 3

(Reference)

Standard sized bearing centre wall thickness:

Mark "1"	1.478 - 1.482 mm
Mark "2"	1.482 - 1.486 mm
Mark "3"	1.486 - 1.490 mm

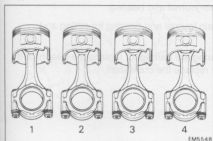


EM5481

(k) Completely remove the Plastigage.

4. Remove piston and connecting rod assemblies

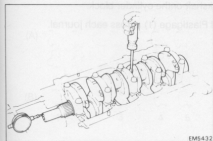
- Remove the all carbon from the piston ring ridge.
- Cover the connecting rod bolts.
(See page 70).
- Push the piston, connecting rod assembly and upper bearing through the top of the cylinder block.



EM5548

Hint:

- Keep the bearings, connecting rod and cap together.
- Arrange the piston and connecting rod assemblies in correct order.



EM5432

5. Check crankshaft thrust clearance

Using a dial indicator, measure the thrust clearance while prying the crankshaft back and forth with a screwdriver.

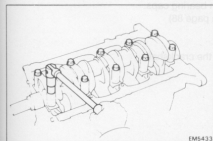
Standard thrust clearance: 0.040 - 0.250 mm

Maximum thrust clearance: 0.30 mm

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

Thrust washer thickness:

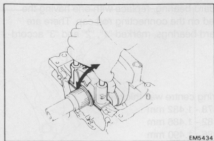
Standard	2.430 - 2.480 mm
Oversized 0.125	2.493 - 2.543 mm
Oversized 0.250	2.555 - 2.605 mm



EM5433

6. Remove main bearing caps and check oil clearance

- Remove the ten main bearing cap bolts.



EM5434

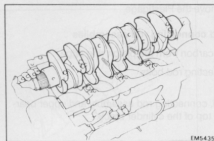
- (b) Using the removed main bearing cap bolts, pry the main bearing cap back and forth, and remove the main bearing caps, lower main bearings and lower thrust washers (No. 3 main bearing cap only).

Hint:

- Keep the lower main bearing and main bearing cap together.
- Arrange the main bearing caps and lower thrust washers in correct order.

- (c) Lift out the crankshaft.

Hint: Keep the upper main bearings and upper thrust washers together with the cylinder block.

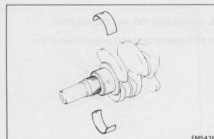


EM5435

- (d) Clean each main journal and bearing.

- (e) Check each main journal and bearing for pitting and scratches.

If the journal or bearing are damaged, replace the bearings. If necessary, grind or replace the crankshaft.



EM5436

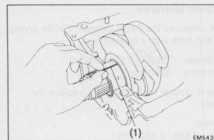
- (f) Place the crankshaft on the cylinder block.

- (g) Place a strip of Plastigage (1) across each journal.

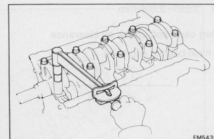
- (h) Install the main bearing caps.
(See step 5 on page 88)

Torque: 103 Nm

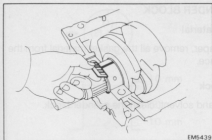
Hint: Do not rotate the crankshaft.



EM5437



EM5438



- (i) Remove the main bearing caps.
- (j) Measure the Plastigage at its widest point.

Standard clearance:

Standard	0.034 - 0.065 mm
Undersize 0.25 and Undersize 0.50	0.033 - 0.079 mm

Maximum clearance: 0.10 mm

If the oil clearance is greater than maximum, replace the bearings. If necessary, grind or replace the crankshaft.

Hint: If using a standard bearing, replace with one having the same number marked on the lower right rear of the cylinder block. There are three sizes of standard bearings, marked "1", "2" and "3" accordingly.

(1) Mark 1, 2 or 3

(2) Bearing No.

Arrow indicates front

(Reference)

Standard sized bearing centre wall thickness:

Mark "1"	1.979 - 1.983 mm
Mark "2"	1.983 - 1.987 mm
Mark "3"	1.987 - 1.991 mm

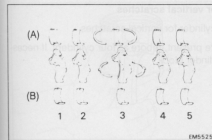
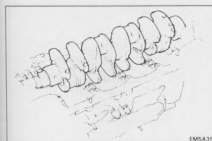
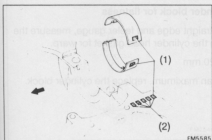
- (k) Completely remove the Plastigage.

7. Remove crankshaft

- (a) Lift out the crankshaft
- (b) Remove the upper main bearings and upper thrust washers from cylinder block.

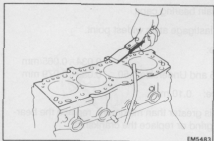
Hint: Arrange the main bearing caps, bearings and thrust washers in correct order.

- (A) Upper bearing cups
- (B) Lower bearing cups



8. Remove check valves and oil nozzles

(See page 141)



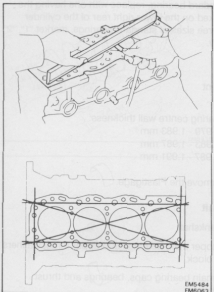
INSPECTION OF CYLINDER BLOCK

1. Remove gasket material

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

2. Clean cylinder block

Using a soft brush and solvent, clean the cylinder block.

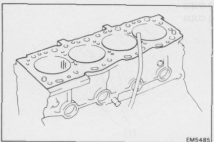


3. Inspect top of cylinder block for flatness

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

Maximum warp: 0.20 mm

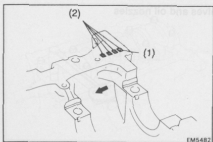
If warp is greater than maximum, replace the cylinder block.



4. Inspect cylinder for vertical scratches

Visually check the cylinder for vertical scratches.

If deep scratches are present, rebore all four cylinders. If necessary, replace the cylinder block.



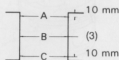
5. Inspect cylinder bore diameter

Hint: There are three sizes of the standard cylinder bore diameter, marked "1", "2" and "3" accordingly. The marked is stamped on the lower left rear of the cylinder block.

(1) Mark 1, 2 or 3

(2) Cylinder No.

Arrow indicates front



EM2548
EM0086

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

- (1) Thrust Direction
- (2) Axial Direction
- (3) Middle

Arrow indicates front

Standard diameter:

Standard	Mark "1"	92.000 - 92.010 mm
Standard	Mark "2"	92.010 - 92.020 mm
Standard	Mark "3"	92.020 - 92.030 mm

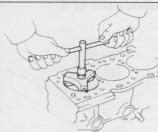
Maximum diameter:

Standard	92.23 mm
Oversize 0.50	92.73 mm

If the diameter is greater than maximum, rebore all four cylinders. If necessary, replace the cylinder block.

6. Remove burrs in cylinder surface

If the wear is less than 0,2 mm, grinding of the cylinder will not be necessary. However, a ridge below the piston ring at the top of the cylinder, in the cylinder wall, must be removed with a ridge reamer.



EM5481

DISASSEMBLY OF PISTON AND CONNECTING ROD ASSEMBLIES

1. Check fit between piston and piston pin

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

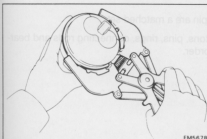
If any movement is felt, replace the piston and pin as a set.



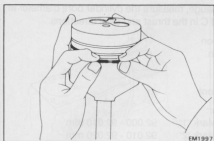
EM5549

2. Remove piston rings

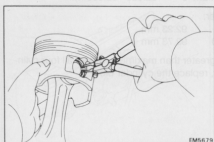
- (a) Using a piston ring expander, remove the two compression rings.



EM5678

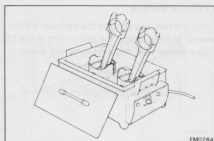


- (b) Remove the oil ring and coil by hand.
Hint: Arrange the rings in correct order only.

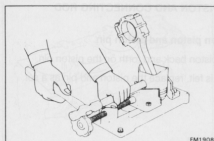


3. Disconnect connecting rod from piston

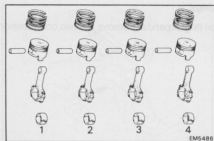
- (a) Using needle-nose pliers, remove the snap rings.



- (b) Gradually heat the piston to approx. 60 °C.

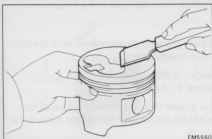


- (c) Using a plastic-faced hammer and brass bar, lightly tap out the piston pin and remove the connecting rod.



Hint:

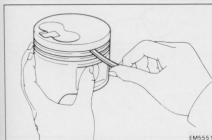
- The piston and pin are a matched set.
- Arrange the pistons, pins, rings, connecting rods and bearings in correct order.



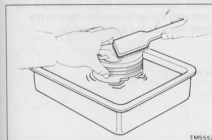
INSPECTION OF PISTON AND CONNECTING ROD ASSEMBLIES

1. Clean piston

- (a) Using a gasket scraper, remove the carbon from the piston top.

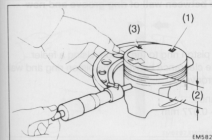


- (b) Using a groove cleaning or broken ring, clean the piston ring grooves.



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

Notice: Do not use a wire brush.



2. Inspect piston diameter and oil clearance

Hint: There are three sizes of the standard piston diameter, marked "1", "2" and "3" accordingly. The mark is stamped on the top of the piston (1).

The arrow (3) indicates the front

- (a) Using a micrometer, measure the piston diameter at right angles to the piston pin centre line, the indicated distance (2) from the piston head.

Distance: 58.27 - 58.33 mm

Piston diameter:

Standard	Mark "1"	91.940 - 91.950 mm
Standard	Mark "2"	91.950 - 91.960 mm
Standard	Mark "3"	91.960 - 91.970 mm
Oversized	0.50	92.440 - 92.470 mm

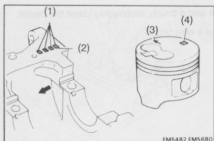
(b) Measure the cylinder bore diameter in the thrust directions.
(See page 75)

(c) Subtract the piston diameter measurement from the cylinder bore diameter measurement.

Standard oil clearance: 0.050 - 0.070 mm

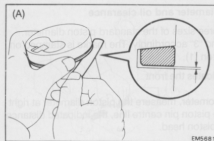
Maximum oil clearance: 0.14 mm

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



Hint (Use cylinder block subassembly): When installing a standard piston, install one with the same number mark as the standard bore diameter mark on the cylinder block.

- (1) Cylinder No.
- (2) Mark 1, 2 or 3
- (3) Arrow indicates front
- (4) Mark 1, 2 or 3



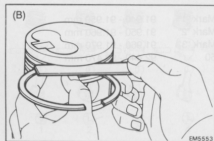
3. Inspect clearance between wall of ring groove and new piston ring

No. 1 ring (A)

Install a new No. 1 piston ring to the piston. Using a feeler gauge, measure the clearance between the piston ring and wall of the piston ring groove.

Ring groove clearance:

No. 1 0.028 - 0.077 mm



No. 2 and oil rings (B)

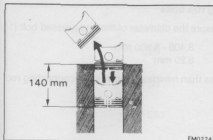
Using a feeler gauge, measure the clearance between new piston ring and the wall of the piston ring groove.

Ring groove clearance:

No. 2 0.060 - 0.105 mm

Oil 0.030 - 0.070 mm

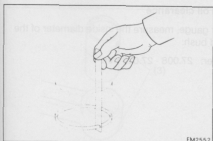
If the clearance is greater than maximum, replace the piston.



EM0224

4. Inspect piston ring end gap

- Insert the piston ring into the cylinder bore.
- Using a piston, push the piston ring a little beyond the bottom of the ring travel, 140 mm from the top of the cylinder block.



EM2552

- Using a feeler gauge, measure the end gap.

Standard end gap:

No. 1 0.350 - 0.650 mm

No. 2 0.300 - 0.600 mm

Oil 0.200 - 0.500 mm

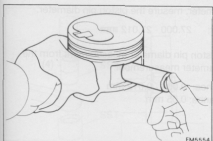
Maximum end gap:

No. 1 1.50 mm

No. 2 1.40 mm

Oil 1.40 mm

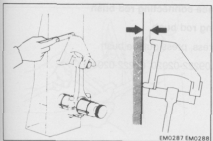
If the end gap is greater than maximum, replace the piston ring.
If the end gap is greater than maximum, even with a new piston ring, rebore all four cylinders or replace the cylinder block.



EM5554

5. Inspect piston pin fit

At 60 °C, you should be able to push the piston pin into the piston pin hole with your thumb.



EM0287 EM0288

6. Inspect connecting rod

A. Inspect connecting rod alignment

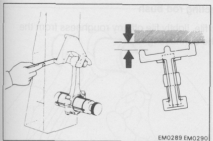
Using a rod aligner, check the connecting rod alignment.

- Check for bending.

Maximum bending:

0.05 mm per 100 mm

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



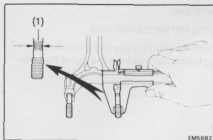
EM0289 EM0290

- Check for twist.

Maximum twist:

0.15 mm per 100 mm

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



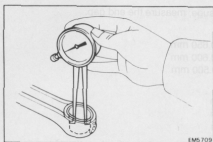
B. Inspect connecting rod bolts

Using callipers, measure the diameter of the compressed bolt (1).

Standard diameter: 8.400 - 8.600 mm

Minimum diameter: 8.20 mm

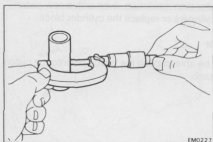
If the diameter is less than minimum, replace the connecting rod bolt.



C. Inspect piston pin oil clearance

(a) Using a caliper gauge, measure the inside diameter of the connecting rod bush.

Bush inside diameter: 27.008 - 27.020 mm



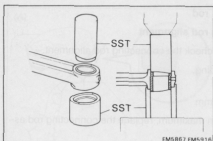
(b) Using a micrometer, measure the piston pin diameter.

Piston pin diameter: 27.000 - 27.012 mm

(c) Subtract the piston pin diameter measurement from the bush inside diameter measurement.

Standard oil clearance: 0.004 - 0.012 mm

Maximum oil clearance: 0.05 mm

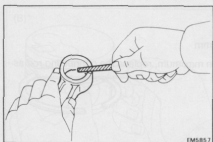


7. If necessary, replace connecting rod bush

A. Remove connecting rod bush

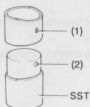
Using SST and a press, press out the bush

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



B. Install new connecting rod bush

(a) Using a round file, lightly file off any roughness from the small end of the connecting rod.



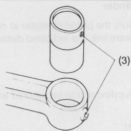
EM5858

- (b) Attach the bush to SST with the ball (2) of SST inside the oil hole (1) of the bush.

SST 09222-64010



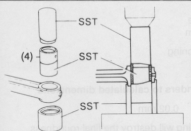
- (c) Align the oil holes (3) of the bush and connecting rod.



EM5859

- (d) Using SST and a press, press in the bush (4).

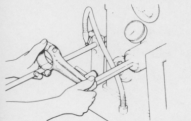
SST 09222-64010



EM5868 EM5917

C. Hone connecting rod bush and check piston pin fit

- (a) Using a pin hole grinder, hone the bush to obtain the standard specified clearance (see page 80) between the bush and piston pin.

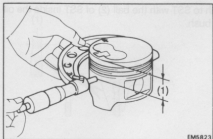


EM5291

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



EM5824



BORING OF CYLINDERS

Hint:

- Bore all four cylinders for the oversized piston outside diameter.
- Replace the piston rings with ones to match the oversized pistons.

1. Kepp oversized pistons

Oversized (0.50) piston diameter:
92.440 - 92.470 mm

2. Calculate amount to bore cylinder

- (a) Using a micrometer, measure the piston diameter at right angles to the piston pin centre line, the indicated distance (1) from the piston head.

Distance: 58.27 - 58.33 mm

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

Size to be rebored = $P + C - H$

P = Piston diameter

C = Piston clearance

0.050 - 0.070 mm

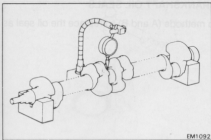
H = Allowance for honing

0.02 mm or less

3. Bore and hone cylinders to calculated dimensions

Maximum honing: 0.02 mm

Caution: Excess honing will destroy the final roundness.



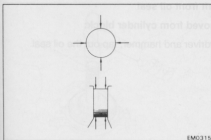
INSPECTION AND REPAIR OF CRANKSHAFT

1. Inspect crankshaft for runout

- Place the crankshaft on V-blocks.
- Using a dial indicator, measure the circle runout at the centre journal.

Maximum circle runout: 0.06 mm

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



2. Inspect main journals and crank pins

- Using a micrometer, measure the diameter of each main journal and crank pin.

Main journal diameter:

Standard	61.985 - 62.000 mm
Undersize 0.25	61.745 - 61.755 mm
Undersize 0.50	61.495 - 61.505 mm

Crank pin diameter:

Standard	52.988 - 53.000 mm
Undersize 0.25	52.745 - 52.755 mm
Undersize 0.50	52.495 - 52.505 mm

If the diameter is not as specified, check the oil clearance (See pages 69 to 73).

- Check each main journal and crank pin for taper and out-of-round as shown.

Maximum taper and out-of-round: 0.02 mm

If the taper or out-of-round is greater than maximum, grind or replace the crankshaft.

3. If necessary, grind and hone main journals and/or crank pins

Grind and hone the main journals and/or crank pins to the finished undersized diameter (See procedure step 2).

Install new main journal and/or crank pin undersized bearings.

REPLACEMENT OF CRANKSHAFT OIL SEALS

Hint: There are two methods (A and B) to replace the oil seal as follows:

1. Replace crankshaft front oil seal

A. If oil pump is removed from cylinder block:

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

(b) Using SST and a hammer, tap in a new oil seal to the depth of 0.5 mm from the oil pump case edge.

SST 09214-60010

(c) Apply Multipurpose grease to the oil seal lip.

B. If oil pump is installed to the cylinder block:

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

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

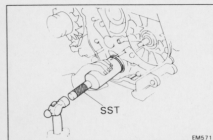
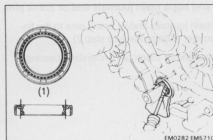
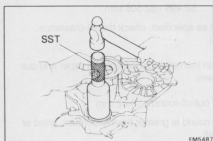
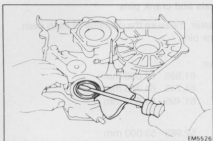
Notice: Be careful not to damage the crankshaft. Tape the screwdriver tip.

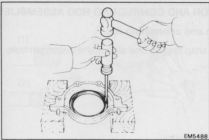
(1) Cut Position

(c) Apply Multipurpose grease to a new oil seal lip.

(d) Using SST and a hammer, tap in the oil seal to the depth of 0.5 mm from the oil pump case edge.

SST 09214-60010

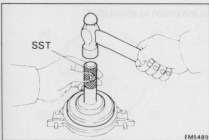




2. REPLACE CRANKSHAFT REAR OIL SEAL

A. If rear oil seal retainer is removed from cylinder block:

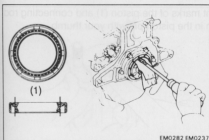
- (a) Using a screwdriver and hammer, tap out the oil seal.



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

SST 09223-63010

- (c) Apply Multipurpose grease to the oil seal lip.

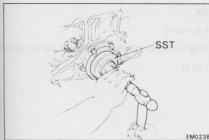


B. If rear oil seal retainer is installed to cylinder block:

- (a) Using a knife, cut off the oil seal lip.
- (b) Using a screwdriver, pry out the oil seal.

Notice: Be careful not to damage the crankshaft. Tape the screwdriver tip.

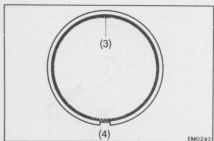
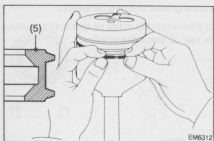
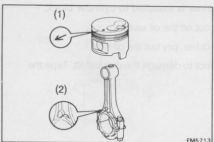
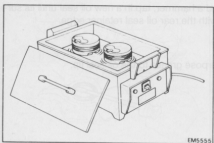
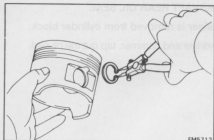
- (1) Cut Position



- (c) Apply Multipurpose grease to a new oil seal lip.

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

SST 09223-63010



ASSEMBLY OF PISTON AND CONNECTING ROD ASSEMBLIES

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 60 °C.

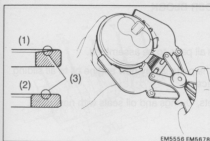
- (c) Align the front marks of the piston (1) and connecting rod (2), and push in the piston pin with your thumb.

2. Install piston rings

- (a) Install the coil by hand.
- (b) Install the oil ring by hand with the code mark facing upward.

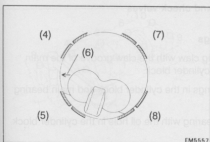
Code mark: T or N

Hint: Face the end gap of the oil ring (4) in the opposite direction of coil joint (3).



- (c) Using a piston ring expander, install the two compression rings with the code mark (3) facing upward.

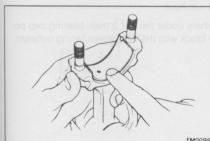
Code mark: No. 1 1T or 1N
No. 2 T2 or 2N



- (d) Position the piston rings so that the ring ends are as shown.

Notice: Do not align the ring ends.

- (4) Oil ring
(5) No. 1 ring
(6) Front mark (arrow)
(7) No. 2 ring
(8) Coil



3. Install bearings

- (a) Align the bearing claw with the groove of the connecting rod or connecting cap.
(b) Install the bearings in the connecting rod and connecting rod cap.

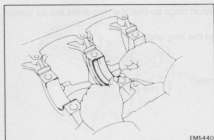
Notice: Install the bearing with the oil hole in the connecting rod.

ASSEMBLY OF CYLINDER BLOCK

(See page 66)

Hint:

- 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 and check valves**
(See page 142)

2. **Install main bearings**

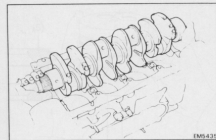
- (a) Align the bearing claw with the claw groove of the main bearing cap or cylinder block.
- (b) Install the bearings in the cylinder block and main bearing cap.

Notice: Install the bearing with the oil hole in the cylinder block.

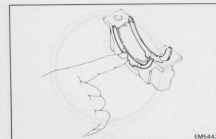


3. **Install upper thrust washers**

Install the thrust washers under the No. 3 main bearing cap position of the cylinder block with the oil grooves facing outward.

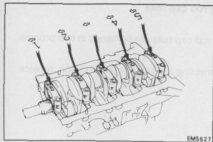


4. **Place crankshaft on cylinder block**

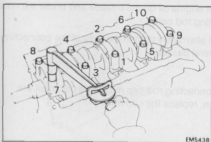


5. **Install main bearing cap and lower thrust washers**

- (a) Install the thrust washers on the No. 3 main bearing cap with the grooves facing outward.



- (b) Install the main bearing caps in their proper locations.



- (c) Apply a light coat of engine oil on the threads and under the heads of the main bearing cap bolts.
- (d) Install and uniformly tighten the ten main bearing cap bolts in several passes in the sequence shown.

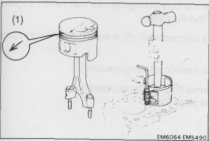
Torque: 103 Nm

- (e) Check that the crankshaft turns smoothly.
- (f) Check the crankshaft thrust clearance.
(See step 5 on page 71)

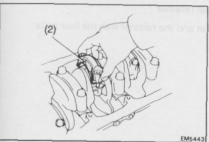


6. Install piston and connecting rod assemblies

- (a) Cover the connecting rod bolts with a short piece of hose to protect the crankshaft from damage.



- (b) Using a piston ring compressor, push the correctly numbered piston and connecting rod assemblies into each cylinder with the front mark (1) of the piston facing forward.



7. Install connecting rod caps

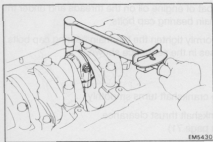
A. Place connecting rod cap on connecting rod

- (a) Match the numbered connecting rod cap with the connecting rod.
- (b) Install the connecting rod cap with the front mark (2) facing forward.

B. Install connecting rod cap nuts

Hint:

- The connecting rod cap nuts are tightened in two progressive steps.
- If any of the connecting rod bolts break or distort, replace them.

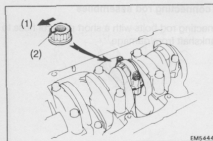


(a) Apply a light of engine oil on the threads and under the nuts of the connecting rod cap.

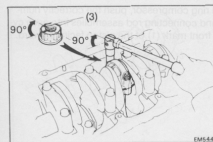
(b) 1st, install and alternately tighten the nuts of the connecting rod cap in several passes.

Torque: 54 Nm

If any one of the connecting rod cap nuts does not meet the torque specification, replace the cap nut.



(c) Mark the front (1) of the connecting rod cap nut with paint (2).



(d) Next, retighten the connecting rod cap nuts ninety degrees, as indicated in the illustration.

(e) Check that the painted mark (3) is now at a 90° angle to the front.

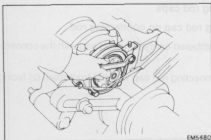
(f) Check that the crankshaft turns smoothly.

(g) Check the connecting rod thrust clearance.
(See step 2 on page 69)

8. Install rear oil seal retainer

Install a new gasket and the retainer with the four bolts.

Torque: 13 Nm



POST ASSEMBLY

1. **Install oil cooler**
(See page 139)
2. **Install oil pump and oil pan**
(See page 135 and 136)
3. **Install water pump**
(See page 121)
4. **Install injection pump**
(See page 111)
5. **Install cylinder head**
(See page 60)
6. **Install pulleys and timing belt**
(See page 36)
7. **Install alternator**
8. **Remove engine stand**
9. **Install rear end plate**

Install the end plate with the bolt.

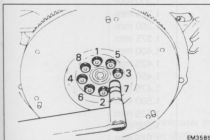
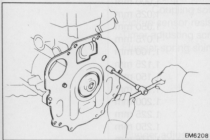
Torque: 12 Nm

10. Install flywheel

- (a) Apply a light coat of engine oil on the threads and under the heads of the bolts.
- (b) Install the flywheel on the crankshaft
- (c) Install and uniformly tighten the eight mount bolts in several passes, in the sequence shown.

Torque: 123 Nm

11. Install clutch disc and cover



FUEL SYSTEM

SPECIFICATIONS

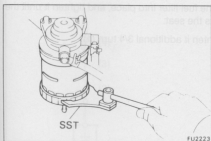
Fuel heater	Resistance at 20 °C	Approximately 0.7 Ω
Injection nozzles	Nozzle type Nozzle opening pressure Adjusting shim thickness	DN4PD57 See page 1 0.900 mm 0.925 mm 0.950 mm 0.975 mm 1.000 mm 1.025 mm 1.050 mm 1.075 mm 1.100 mm 1.125 mm 1.150 mm 1.175 mm 1.200 mm 1.225 mm 1.250 mm 1.275 mm 1.300 mm 1.325 mm 1.350 mm 1.375 mm 1.400 mm 1.425 mm 1.450 mm 1.475 mm 1.500 mm 1.525 mm 1.550 mm 1.575 mm 1.600 mm 1.625 mm 1.650 mm 1.675 mm 1.700 mm 1.725 mm 1.750 mm 1.775 mm 1.800 mm 1.825 mm 1.850 mm 1.875 mm 1.900 mm 1.925 mm 1.950 mm

REPLACEMENT OF FUEL FILTER

1. Disconnect fuel filter warning switch connector

2. Drain fuel from fuel filter

- Connect a vinyl hose to the drain cock, and insert other end of the vinyl hose in a container.
- Loosen the drain plug, and drain the fuel.

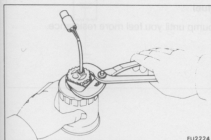


3. Replace fuel filter

A. Remove fuel filter

Using SST, remove the fuel filter.

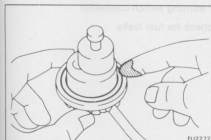
SST 09228-64010



B. Remove fuel filter warning switch from fuel filter

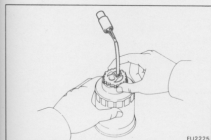
Using pliers, remove the warning switch and O-ring.

Notice: Be careful not to damage the warning switch.

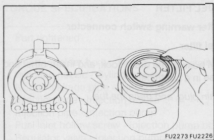


C. Install fuel filter warning switch to new fuel filter

- Install a new O-ring to the warning switch.
- Apply fuel to the O-ring of the warning switch.

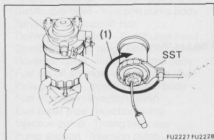


- Install the warning switch to a new fuel filter by hand.



D. Install new fuel filter

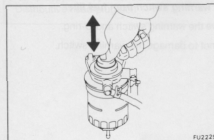
- (a) Check and clean the fuel filter installation surface.
- (b) Apply fuel to the gasket of a new fuel filter.



- (c) Lightly screw the fuel filter into place, and tighten it until the gasket contacts the seat.

- (d) Using SST, tighten it additional 3/4 turn (1).

SST 09228-64010



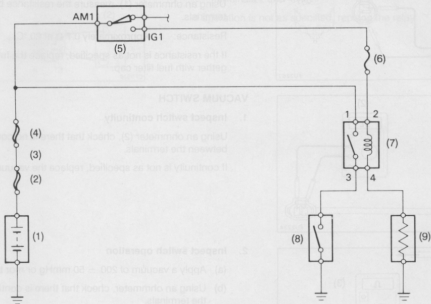
4. Fill fuel filter with fuel

Operate the hand pump until you feel more resistance.

5. Connect fuel filter warning switch connector

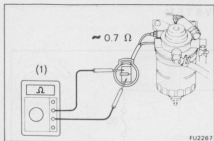
6. Start engine and check for fuel leaks

FUEL HEATER SYSTEM SYSTEM CIRCUIT



FU2231

- (1) Battery
- (2) Main fuse
- (3) Line fuse
- (4) ALT 80A
- (5) Starter Switch
- (6) Fuse IGN 7.5A
- (7) Fuel Heater Relay
- (8) Vacuum Switch
- (9) Fuel Heater



INSPECTION OF COMPONENTS

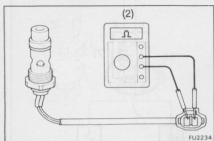
FUEL HEATER

Inspect fuel heater

Using an ohmmeter (1), measure the resistance between the terminals.

Resistance: Approximately 0.7Ω at 20°C

If the resistance is not as specified, replace the fuel heater together with fuel filter cap.

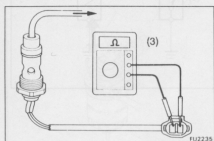


VACUUM SWITCH

1. Inspect switch continuity

Using an ohmmeter (2), check that there is no continuity between the terminals.

If continuity is not as specified, replace the vacuum switch.

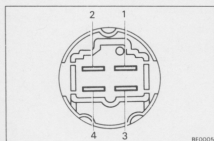


2. Inspect switch operation

(a) Apply a vacuum of 200 ± 50 mmHg or more to the port.

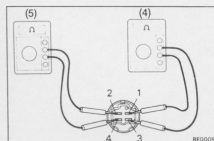
(b) Using an ohmmeter, check that there is continuity between the terminals.

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



FUEL HEATER RELAY

Location: In the engine compartment relay box.

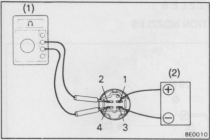


1. Inspect relay continuity

(a) Using an ohmmeter, check that there is continuity between terminals 1 and 3 (4).

(b) Check that there is no continuity between terminals 2 and 4 (5).

If continuity is not as specified, replace the relay.



2. Inspect relay operation

- Apply battery voltage (2) across terminals 1 and 3.
- Using an ohmmeter, check that there is continuity between terminals 2 and 4 (1).

If operation is not as specified, replace the relay.

- Fuel Hose
- Nozzle Leakage Pipe
- Gasket
- Injection Nozzle
- Injection Seat
- Gasket
- Clamp
- Injection Pipe
- Non-reusable part

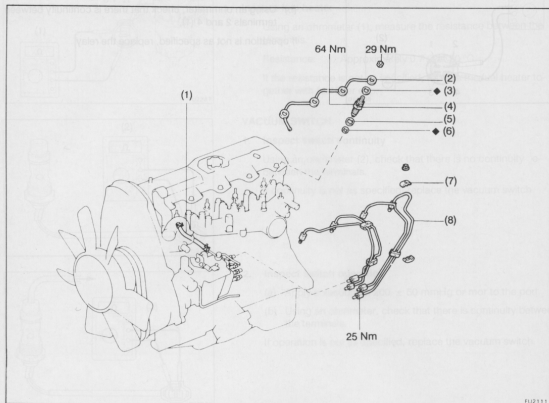
- Remove glow plug connector
(See step 8 on page 30)
- Remove injection pipes

- Loosen the union nuts of the four injection pipes
- Loosen the nuts of the two upper clamps. Remove the injection pipes including the upper and lower clamps.



INJECTION NOZZLES

REMOVAL OF INJECTION NOZZLES

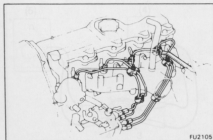


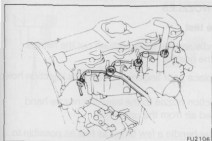
- (1) Fuel Hose
- (2) Nozzle Leakage Pipe
- (3) Gasket
- (4) Injection Nozzle
- (5) Nozzle Seat
- (6) Gasket
- (7) Clamp
- (8) Injection Pipe
- ◆ Non-reusable part

1. **Remove glow plug connector**
(See step 3 on page 30)

2. **Remove injection pipes**

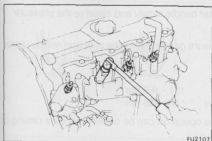
- (a) Loosen the union nuts of the four injection pipes.
- (b) Loosen the nuts of the two upper clamps. Remove the injection pipes including the upper and lower clamps.





3. Remove nozzle leakage pipe

- Disconnect the fuel hose from the nozzle leakage pipe.
- Remove the four nuts, leakage pipe and four gaskets.

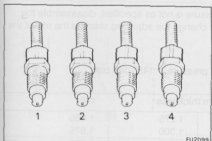


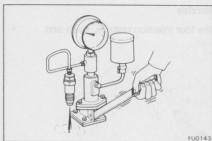
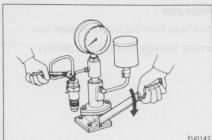
4. Remove injection nozzles.

Using SST, remove the four injection nozzles, seats and gaskets.

SST 09268-64010

Hint: Arrange the injection nozzles in correct order.





TEST OF INJECTION NOZZLES

1. Injection pressure test

- Pump the handle several times to flush out the fittings. Then tighten the nozzle.

Caution: Do not place your fingers of the nozzle injection hole.

- Install the injection nozzle to the injection nozzle hand tester and bleed air from the union nut.
- Pump the tester handle a few times as fast as possible to discharge the carbon from the injection hole.
- Pump the tester handle slowly and observe the pressure gauge.
- Read the pressure gauge just as the injection nozzle starts to spray.

Opening pressure:

New nozzle 151 - 159 bar

Reused nozzle 145 - 155 bar

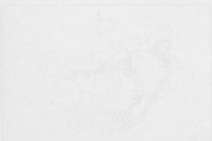
Hint: Proper nozzle operation can be determined by a rattling or creaking sound.

If the opening pressure is not as specified, disassemble the nozzle holder and change the adjusting shim on the top of the pressure spring.

(See page 104).

Adjusted opening pressure: 145 - 155 bar

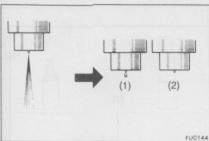
Adjusting shim thickness		mm
0.900	1.275	1.650
0.925	1.300	1.675
0.950	1.325	1.700
0.975	1.350	1.725
1.000	1.375	1.750
1.025	1.400	1.775
1.050	1.425	1.800
1.075	1.450	1.825
1.100	1.475	1.850
1.125	1.500	1.875
1.150	1.525	1.900
1.175	1.550	1.925
1.200	1.575	1.950
1.225	1.600	
1.250	1.625	



Remove the upper clamp.
(See step 4 on page 90).

2. Remove injection pipes

- Loosen the green nuts of the two injection pipes.
- Loosen the nuts of the two upper clamps. Remove the injection pipes including the upper and lower clamps.

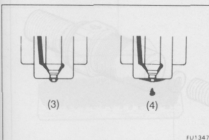


Hint:

- Varying the adjusting shim thickness by 0.025 mm changes the injection pressure by about 3.5 bar.
- Only one adjusting shim should be used.

(f) There should be no dripping after injection.

- (1) Faulty
(2) Good

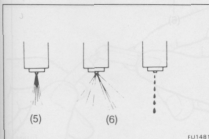


2. Leakage test

While maintaining pressure at about 10 - 20 bar 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) Good
(4) Faulty



3. Spray pattern test

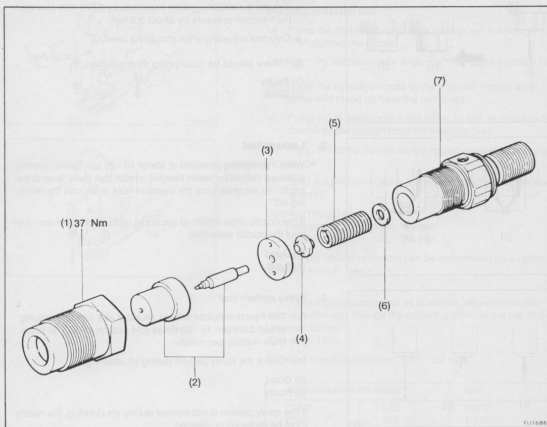
(a) The injection nozzle should shudder at a certain pumping speed between 15 - 60 times (old nozzle) or 30 - 60 times (new nozzle) per minute.

(b) Check the spray pattern during shuddering.

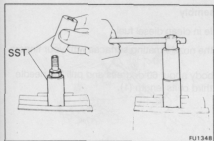
- (5) Good
(6) Faulty

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

COMPONENTS



- (1) Nozzle Holder Retaining Nut
- (2) Nozzle Assembly
- (3) Distance Piece
- (4) Pressure Pin
- (5) Pressure Spring
- (6) Adjusting Shim
- (7) Nozzle Holder Body



DISASSEMBLY OF INJECTION NOZZLES

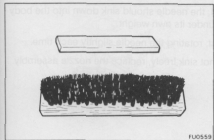
Disassemble injection nozzles

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

SST 09268-64010

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

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

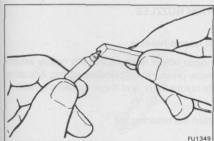


CLEANING AND INSPECTION OF INJECTION NOZZLES

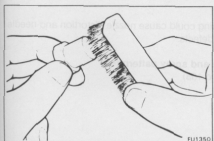
1. Nozzle cleaning

- (a) To wash the nozzles. Use wooden stick and brass brush, wash in clean diesel fuel.

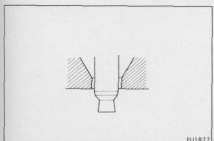
Hint: Do not touch the nozzle mating surfaces with your fingers.



- (b) Using a wooden stick, remove the carbon adhering to the nozzle needle tip.

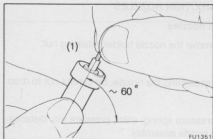


- (c) Using a brass brush, remove the carbon from the exterior of the nozzle body (except lapped surface).

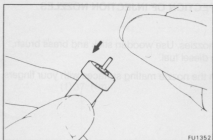


- (d) Check the seat of the nozzle body for burns or corrosion.
(e) Check the nozzle needle tip for damage or corrosion.

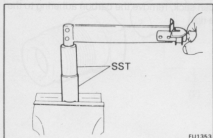
If any of these conditions are present, replace the nozzle assembly.



FU1351



FU1352



FU1353

2. Inspect nozzle assembly

- (a) Wash the nozzle in clean diesel fuel.

Hint: 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 (1).

- (c) When released, the needle should sink down into the body slot smoothly under 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 OF INJECTION NOZZLES

(See page 104)

1. Assemble injection nozzle holders

- (a) Assemble the nozzle holder retaining nut, the nozzle assembly, distance piece, pressure pin, pressure spring, adjusting shim and nozzle holder body, and finger tighten the retaining nut.

- (b) Using SST, tighten the retaining nut.

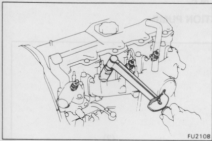
SST 09268-64010

Torque: 37 Nm

Notice: Over torquing could cause nozzle distortion and needle adhesion or other defects.

2. Perform pressure and spray pattern test

(See pages 102 and 103)



INSTALLATION OF INJECTION NOZZLES

(See page 100)

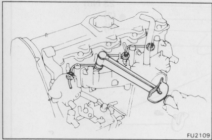
1. Install injection nozzles

- Place new four gaskets and the four nozzle seats into the injection nozzle holes of the cylinder head.
- Using SST, install the four injection nozzles.

SST 09268-64010

Torque: 64 Nm

Notice: Over torquing could cause nozzle distortion and needle adhesion or other defects.

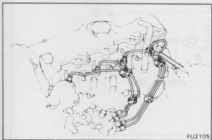


2. Install nozzle leakage pipe

- Install new four gaskets and the leakage pipe with the nuts.

Torque: 29 Nm

- Connect the fuel hose to the return pipe.



3. Install injection pipes

- Place the two upper clamps on the intake manifold.
- Install the four injection pipes.

Torque: 25 Nm

- Secure the injection pipes with the two upper clamps and bolts.

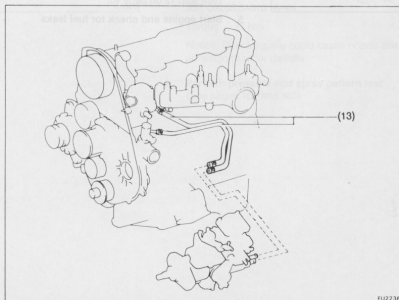
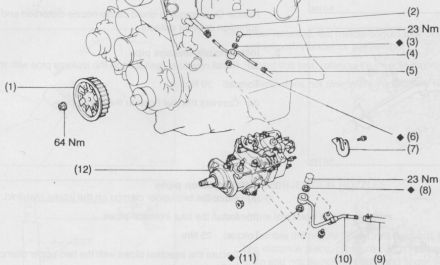
4. Install glow plug connector

(See step 12 on page 40)

5. Start engine and check for fuel leaks

INJECTION PUMP

REMOVAL OF INJECTION PUMP

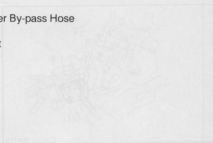


FU2236

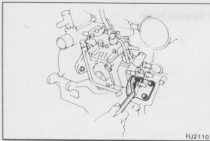
N-FU2300

- (1) Injection Pump Drive Pulley
- (2) Fuel Hose
- (3) Gasket
- (4) Fuel Outlet Pipe
- (5) Fuel Hose
- (6) Gasket
- (7) Injection Pump Support
- (8) Gasket
- (9) Fuel Hose
- (10) Fuel Inlet Pipe
- (11) Gasket
- (12) Injection Pump
- (13) Thermo Wax Water By-pass Hose

◆ Non-reusable part

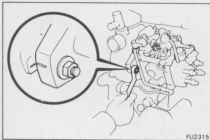


1. **Drain coolant**
(See page 117)
2. **Disconnect accelerator linkage**
3. **Remove timing belt**
(See steps 1 to 8 on pages 29 to 32)
4. **Remove injection pump drive pulley**
(See step 11 on pages 32 and 33)
5. **Disconnect water by-pass hoses from thermo wax**
6. **Disconnect injection pump connector**
7. **Disconnect fuel hoses from injection pump**
8. **Remove injection pipes**
(See step 2 on page 100)



9. **Remove injection pump**

- (a) Remove the four bolts and pump support.



- (b) Before removing the injection pump, check if the period lines are aligned.

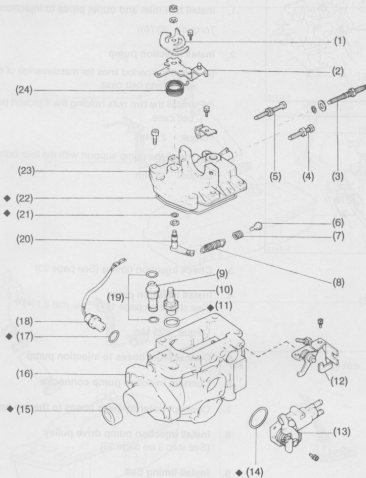
If not, place new matchmarks for reinstallation.

- (c) Remove the two nuts and injection pump.

Notice: Do not hold or carry the pump by the adjusting lever.

10. **Remove fuel inlet and outlet pipes from injection pump**

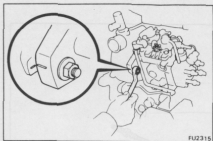
COMPONENTS



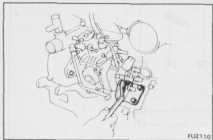
FU2257

- | | |
|-----------------------------------|--------------------------|
| (1) No. 2 Adjusting Lever | (13) Thermo Wax |
| (2) No. 1 Adjusting Lever | (14) O-Ring |
| (3) Full Load Set Screw | (15) Oil Seal |
| (4) Idle Speed Adjusting Screw | (16) Pump Body |
| (5) Maximum Speed Adjusting Screw | (17) O-Ring |
| (6) Spring Seat | (18) Pickup Sensor |
| (7) Damper Spring | (19) O-Ring |
| (8) Speed Control Spring | (20) Adjusting Lever |
| (9) Regulator Valve | (21) O-Ring |
| (10) Fuel Inlet Hollow Screw | (22) Gasket |
| (11) Gasket | (23) Governor Cover |
| (12) Idle-up Lever | (24) Lever Return Spring |

◆ Non-reusable part



FU2315



FU2110

INSTALLATION OF INJECTION PUMP

(See page 108)

1. Install fuel inlet and outlet pipes to injection pump

Torque: 23 Nm

2. Install injection pump

(a) Align the period lines (or matchmarks) of the injection pump and timing belt case.

(b) Install the two nuts holding the injection pump to the timing belt case.

Torque: 21 Nm

(c) Install the pump support with the four bolts.

Torque: 18 Nm

3. Check injection timing (See page 23)

4. Install injection pipes

(See step 3 on page 107)

Torque: 25 Nm

5. Connect fuel hoses to injection pump

6. Connect injection pump connector

7. Connect water by-pass hoses to thermo wax

8. Install injection pump drive pulley

(See step 3 on page 36)

9. Install timing belt

(See steps 6 to 14 on pages 37 to 40)

10. Connect accelerator linkage

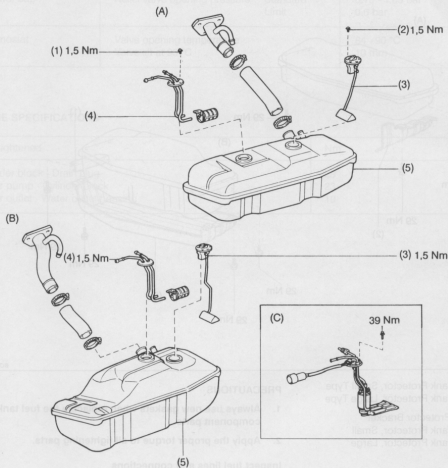
11. Fill with engine coolant (See page 117)

12. Start engine and check for fuel leaks

13. Check idle speed and maximum speed

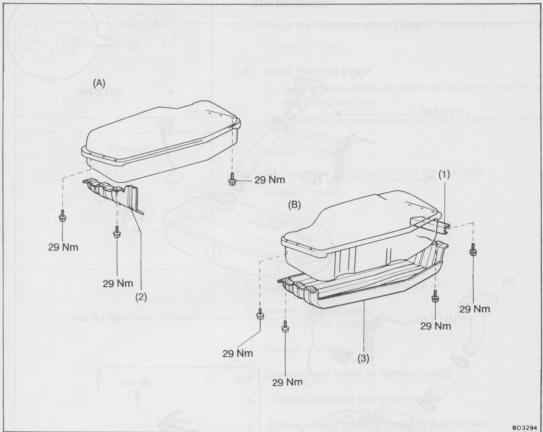
(See page 25)

FUEL TANK AND LINE COMPONENTS



N-BO3293

- (A) 56 Liter Tank
- (B) 65 Liter Tank
- (C) Fuel Pump
- (1) Bolt, 5 pieces
- (2) Bolt, 5 pieces
- (3) Fuel Sender Gauge
- (4) Fuel Suction Tube
- (5) Fuel Tank
- (6) Fuel Suction Tube
- (7) Fuel Tank
- (8) Fuel Tank



- (A) Fuel Tank Protector, Small Type
 (B) Fuel Tank Protector, Large Type
 (1) Tank Protector Bracket
 (2) Fuel Tank Protector, Small
 (3) Fuel Tank Protector, Large

PRECAUTIONS

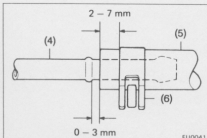
1. Always use new gaskets when replacing the fuel tank or component parts.
2. Apply the proper torque to all tightening parts.

Inspect fuel lines and connections

- (a) Insert the fuel lines and connections for cracks, leakage or deformation.
- (b) Inspect the fuel tank vapour vent system hoses and connections for looseness, kinks or damage.
- (c) Inspect the fuel tank for distortion, cracks, fuel leakage or tank mount bolts looseness.
- (d) Inspect the filler neck for damage or fuel leakage.
- (e) Hose and tube connections are as shown in the illustration.

If problem is found, repair or replace the parts as necessary.

- (4) Pipe
 (5) Hose
 (6) Clip



FU0041

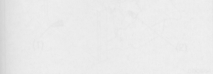
COOLING SYSTEM

SPECIFICATIONS

Engine coolant capacity		9,2 liters
Radiator cap	Relief valve opening pressure Standard Limit	0.75 - 1.05 bar 0.6 bar
Thermostat	Valve opening temperature Valve lift at 95 °C	84 - 90 °C 10 mm

TORQUE SPECIFICATIONS

Part tightened	Nm
Cylinder block - Drain plug	29
Water pump - Cylinder block	23
Water outlet - Water outlet housing	19



(a) Close the drain cock.

Torque (Engine drain cock) : 35 Nm

(b) Fill the system with coolant.

Use a good brand of ethylene glycol base coolant, mixed according to the manufacturer's instructions.

Capacity (with Haldex 5.5 liter)

(c) Reinstall the radiator cap.

(d) Warm up the engine and check for leaks.

(e) Recheck the coolant level and refill as necessary.

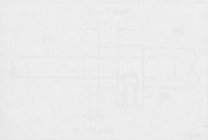
TROUBLESHOOTING

Problem	Possible cause	Remedy	Page
Engine overheats	Fan belt loose or missing	Adjust or replace belt	*
	Dirt, leaves or insects on radiator	Clean radiator or condenser	123
	Hoses, water pump, thermostat housing, radiator, heater, core plugs or head gasket leakage	Repair as necessary	
	Thermostat faulty	Check thermostat	122
	Injection timing retarded	Adjust timing	23
	Fluid coupling faulty	Replace fluid coupling	119
	Radiator hose plugged or rotted	Replace hose	
	Water pump faulty	Replace water pump	119
	Radiator plugged or cap faulty	Check radiator	123
	Cylinder head or block cracked or blocked	Repair as necessary	

* See manual ELECTRICAL SYSTEM

Hint: If the engine tends to overheat, removal of the thermostat will adversely effect cooling efficiency.

- (4) Fuel Tank Protector, Small Tank
(5) Fuel Tank Protector, Large Tank
(1) Tank Protector, Small
(2) Fuel Tank Protector, Small
(3) Fuel Tank Protector, Large



PRECAUTIONS

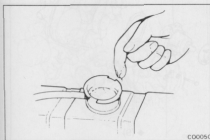
1. Always use new gaskets when replacing the fuel tank or component parts.
2. Apply the proper torque to all tightening parts.
- Inspect fuel lines and connections
- (4) Insult the fuel lines and connector for cracks, leakage or deterioration.
(5) Inspect the fuel tank vapour vent system hoses and connections for looseness, kinks or damage.
(6) Inspect the fuel tank for distortion, cracks, fuel leakage or tank mount bolts looseness.
(7) Inspect the filler neck for damage or fuel leakage.
(8) Hose and tube connections are as shown in the illustration.
- If problem is found, repair or replace the parts as necessary.
- (4) Pipe
(5) Hose
(6) Cap



CHECK AND REPLACEMENT OF ENGINE COOLANT

1. Check engine coolant level at reverse tank

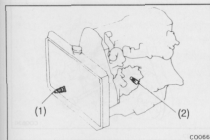
The coolant level should be between the "LOW" and "FULL" lines.
If low, check for leaks and add coolant up to the "FULL" line.



2. Check engine coolant quality

There should not be any excessive deposits of rust or scales around the radiator cap or radiator filler hole, and the coolant should be free from oil.

If excessively dirty, replace the coolant.



3. Replace engine coolant

- Remove the radiator cap.
- Drain the coolant from the radiator (1) and engine (2) drain cocks. (Engine drain cock is at left rear of engine block.)

- Close the drain cocks.

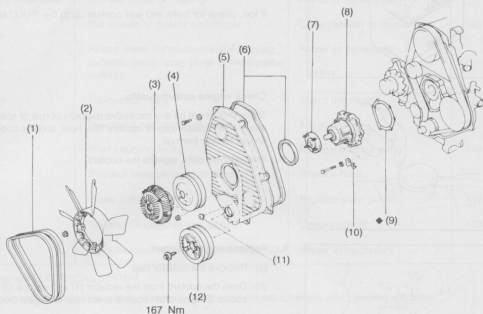
Torque (Engine drain cock): 29 Nm

- Fill the system with coolant.
Use a good brand of ethylene-glycol base coolant, mixed according to the manufacturer's directions.

Capacity (with Heater): 9.2 liters

- Reinstall the radiator cap.
- Warm up the engine and check for leaks.
- Recheck the coolant level and refill as necessary.

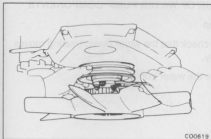
WATER PUMP COMPONENTS



C00630

- (1) Drive Belt
- (2) Fan
- (3) Fluid Coupling
- (4) Water Pump Pulley
- (5) No. 1 Timing Belt Cover
- (6) Gasket
- (7) Pulley Seat
- (8) Water Pump
- (9) Gasket
- (10) Tension Spring Bracket
- (11) Timing Pointer Grommet
- (12) Crankshaft Pulley

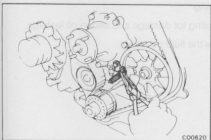
◆ Non-reusable part



REMOVAL OF WATER PUMP

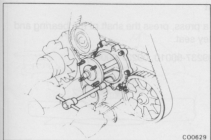
1. Drain engine coolant (See page 117)
2. Remove drive belts
3. Remove fan, fluid coupling and water pump pulley

Remove the four nuts holding the fluid coupling to the pulley seat, and remove the fan, fluid coupling assembly and pulley.



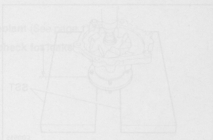
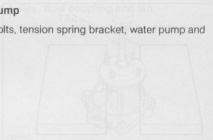
4. Remove crankshaft pulley and No. 1 timing belt cover (See steps 4 and 5 on pages 30 and 31)
5. Remove timing belt tension spring

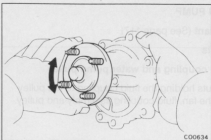
Using needle nose pliers, remove the tension spring.



6. Remove water pump

Remove the six bolts, tension spring bracket, water pump and gasket.





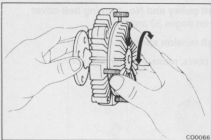
C00634

INSPECTION AND REPAIR OF WATER PUMP COMPONENTS

1. Inspect water pump

Turn the pulley and check that the water pump bearing moves smoothly and quietly.

If necessary, replace the water pump.

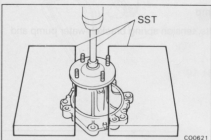


C00666

2. Inspect fluid coupling

Check the fluid coupling for damage and silicon oil leakage.

If necessary, replace the fluid coupling.

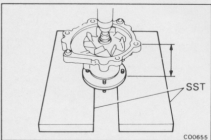


C00621

3. Replace pulley seat

(a) Using SST and a press, press the shaft of the bearing and remove the pulley seat.

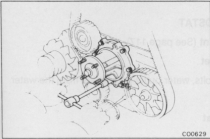
SST 09236-00101 (09237-00010, 09237-00050)



C00655

(b) Using SST and a press, press the shaft of the bearing and install a new pulley seat to a distance of 76.5 - 77.5 mm between the pulley seat and pump body.

SST 09236-00101 (09237-00010)



CD0629

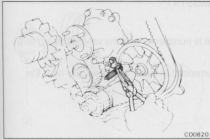
INSTALLATION OF WATER PUMP

(See page 118)

1. Install water pump

Install a new gasket, the water pump and tension spring bracket with the six bolts.

Torque: 23 Nm



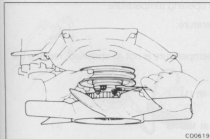
CD0620

2. Install timing belt tension spring

Using needle nose pliers, install the tension spring.

3. Install No. 1 timing belt cover and crankshaft pulley

(See steps 10 and 11 on pages 39 and 40)



CD0619

4. Install water pump pulley, fluid coupling and fan

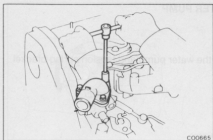
Install the pulley seat, the fluid coupling and fan assembly with the four nuts.

5. Install drive belts

6. Fill with engine coolant (See page 117)

7. Start engine and check for leaks





C00665

THERMOSTAT

REMOVAL OF THERMOSTAT

1. Drain engine coolant (See page 117)
2. Remove water outlet

Remove the three bolts, water outlet and gasket from the water outlet housing.

3. Remove Thermostat



C00681

INSPECTION OF THERMOSTAT

Inspect thermostat

Note: The thermostat is numbered with the valve opening temperature.

- (a) Immerse the thermostat in water and gradually heat the water.

- (b) Check the valve opening temperature.

Valve opening temperature:
86 - 90 °C

If the valve opening temperature is not as specified, replace the thermostat.

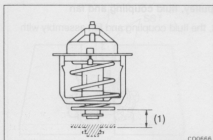
- (c) Check the valve lift (1).

Valve lift:
10 mm or more at 100 °C

If the valve lift is not as specified, replace the thermostat.

- (d) Check that valve spring is tight when the thermostat is fully closed.

If necessary, replace the thermostat.



C00666

INSTALLATION OF THERMOSTAT

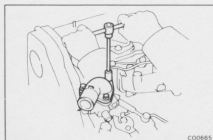
1. Place thermostat in water outlet housing

2. Install water outlet to water inlet housing

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

Torque: 19 Nm

3. Fill with engine coolant (See page 117)
4. Start engine and check for leaks



C00665

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 distort the fins of the radiator core. If the cleaner nozzle pressure is 30 - 35 bar, keep a distance of at least 40 - 50 cm between the radiator core and cleaner nozzle.

INSPECTION OF RADIATOR

1. Inspect radiator cap (2)

Using a radiator cap tester (1) V.A.G 1274, pump the tester and measure the relief valve opening pressure.

Standard opening pressure:

0.75 - 1.05 bar

Minimum opening pressure:

0.6 bar

If the opening pressure is less than minimum, replace the radiator cap.

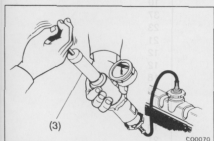
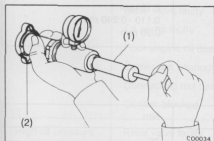
2. Inspect cooling system for leaks

(a) Fill the radiator with coolant and attach a radiator cap tester (3) V.A.G 1274.

(b) Warm up the engine.

(c) Pump it to 1.2 bar, check that pressure does not drop.

If the pressure drops, check for leaks the hoses, radiator or water pump. If no external leaks are found, check the heater core, cylinder block and head. If no external leaks can be found, check the heat exchanger, cylinder block and cylinder head.



LUBRICATION SYSTEM

SPECIFICATIONS

Engine oil capacity		See page 1	
Oil pressure	at idling at 3000 rpm	0.3 bar or more 3.0 - 5.5 bar	
Oil pump	Body clearance	Standard	0.144 - 0.219 mm
		Limit	0.40 mm
	Side clearance	Standard	0.035 - 0.085 mm
		Limit	0.15 mm
	Tip clearance	Standard	0.110 - 0.240 mm
		Limit	0.30 mm

TORQUE SPECIFICATIONS

Part tightened	Nm
Engine oil drain plug	39
Oil pump body cover - Timing belt case	10
Relief valve plug - Timing belt case	37
Oil pump (timing belt case) - Cylinder block	23
Oil pump (timing belt case) - Injection pump	21
Oil strainer - Oil pump (timing belt case)	12
Oil strainer - Cylinder block	12
Oil pan - Cylinder block	18
Oil pan - Oil pump (timing belt case)	18
Oil pan - Rear oil seal retainer	18
Oil cooler - Oil filter bracket	14
Oil cooler bracket - Cylinder block	Bolt 19
Oil cooler bracket - Cylinder block	Nut 21
Relief valve plug - Oil filter bracket	36
Oil nozzle check valve - Cylinder block	25

Necessary, replace the thermostat.

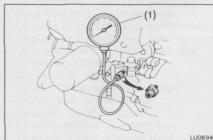
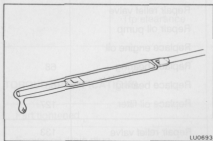
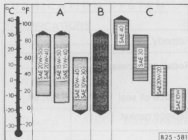
INSTALLATION OF THERMOSTAT

Place thermostat in water outlet housing.

1. Install water outlet to water inlet housing.
Install a new gasket and the water outlet with the three bolts.
Torque: 19 Nm
2. Fill with engine coolant (See page 117).
3. Start engine and check for leaks.

TROUBLESHOOTING

Problem	Possible cause	Remedy	Page
Oil leakage	Cylinder head, cylinder block or oil pump body damaged or cracked	Repair as necessary	57, 84
	Oil seal faulty	Replace oil seal	
	Gasket faulty	Replace gasket	
Low oil pressure	Oil leakage	Repair as necessary	68 68 127
	Relief valve faulty	Repair relief valve	
	Oil pump faulty	Repair oil pump	
	Poor engine oil quality	Replace engine oil	
	Crankshaft bearing faulty	Replace bearing	
	Connecting rod bearing faulty	Replace bearing	
High oil pressure	Oil filter blocked	Replace oil filter	133
	Relief valve faulty	Repair relief valve	



OIL PRESSURE CHECK

1. Check engine oil quality

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

If the quality is poor, replace the oil.

Only use engine oil, grade API.

(A) Use Multigrade of a good brand, grade VW 505 00.

Use Multigrade of a good brand, grade API-CD.

Use Multigrade of a good brand, grade VW 501 01.

(B) Use a special oil for the running-in period of the engine, grade VW 500 00.

(C) Use a type of oil of a good brand, grade API-CD.

Take account of ambient temperatures expected in the period until the next oil change.

2. Check engine oil level

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

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

3. Remove oil pressure switch or sender gauge

4. Install oil pressure gauge (1) V.A.G 1342

5. Warm up engine

Allow the engine to reach normal operating temperature.

6. Check oil pressure

Oil pressure:

At idling 0.3 bar or more

At 3,000 rpm 0.3 - 5.5 bar

7. Reinstall oil pressure switch or sender gauge

Apply adhesive to two or three threads.

Adhesive: Part No. AMV 188 200 03 or equivalent

8. Start engine and check for leaks

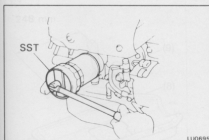
REPLACEMENT OF ENGINE OIL AND OIL FILTER

Notice:

- Prolonged and repeated contact with mineral oil will result in the removal of natural fats from the skin, leading to dryness, irritation and dermatitis. In addition, used engine oil contains potentially harmful contaminants which may cause skin cancer.
- Care should be taken, therefore, when changing engine oil, to minimize the frequency and length of time your skin is exposed to used engine oil. Protective clothing and gloves, that cannot be penetrated by oil, should be worn. The skin should be thoroughly washed with soap and water, or use waterless hand cleaner, to remove any used engine oil. Do not use gasoline, thinners, or solvents.
- In order to preserve the environment, used oil must be disposed of only at designated disposal sites.

1. Drain engine oil

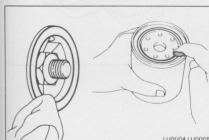
- (a) Remove the oil filler cap.
- (b) Remove the oil drain plug, and drain the oil into a container.



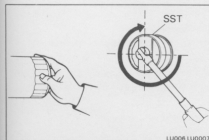
2. Replace oil filter

- (a) Using SST, remove the oil filter.

SST 09228-10001



- (b) Check and clean the oil filter installation surface.
- (c) Apply clean engine oil to the gasket of a new oil filter.



- (d) Lightly screw the oil filter into place, and tighten it until the gasket contacts the seat.
- (e) Using SST, tighten it additional 3/4 turn.

SST 09228-10001

3. Fill with engine oil

- (a) Clean and install the oil drain plug with a new gasket.

Torque: 39 Nm

- (b) Fill with new engine oil (specification see page 126).

Capacity:

Drain and refill

with oil filter change

5.9 liters

without oil filter change

5.0 liters

Dry fill 6.4 liters

- (c) Reinstall the oil filler cap.

4. Start engine and check for leaks

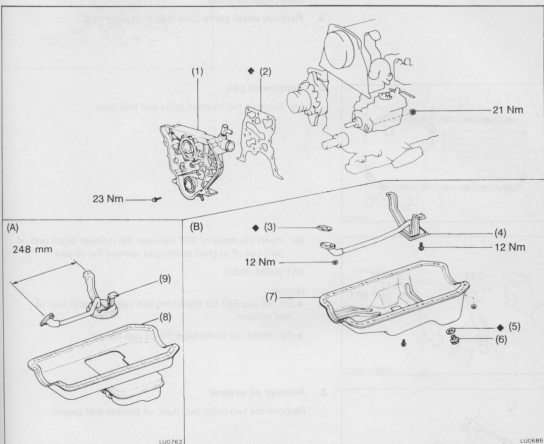
5. Recheck engine oil level (See page 126)



OIL PUMP

REMOVAL

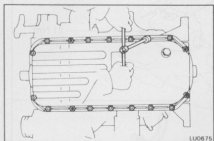
Hint: When repairing the oil pump, the oil pan and strainer should be removed and cleaned.



- (A) Oil Pan and Oil Strainer, 2WD
- (B) Oil Pan and Oil Strainer, 4WD
- (1) Oil Pump (Timing Belt Case)
- (2) Gasket
- (3) Gasket
- (4) Oil Strainer, 4WD
- (5) Gasket
- (6) Drain Plug
- (7) Oil Pan, 4WD
- (8) Oil Pan, 2WD
- (9) Oil Strainer, 2WD

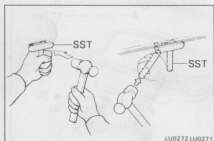
◆ Non-reusable part

1. **Drain engine coolant** (See page 117)
2. **Drain engine oil** (See page 127)
3. **Remove timing belt and pulleys without camshaft timing pulley**
(See pages 29 to 33)
4. **Remove water pump** (See step 6 on page 113)



5. **Remove oil pan**

- (a) Remove the fourteen bolts and four nuts.

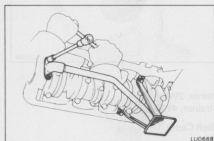


- (b) Insert the blade of SST between the cylinder block and oil pan, cut off applied sealer and remove the oil pan.

SST 09032-00100

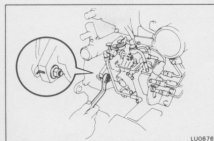
Notice:

- Do not use SST for the timing belt case side and rear oil seal retainer.
- Be careful not to damage the oil pan flange.



6. **Remove oil strainer**

Remove the two bolts, two nuts, oil strainer and gasket.

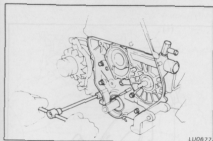


7. **Remove oil pump (timing belt case)**

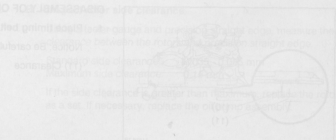
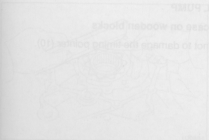
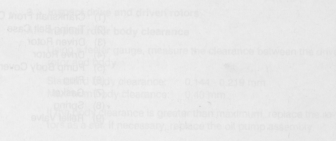
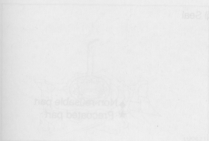
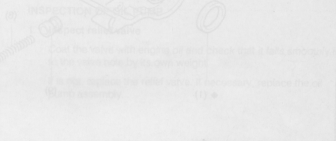
- (a) (with Automatic Cold Start Device)
Disconnect the thermo wax water by-pass hose from the timing belt case.
- (b) Before removing the two nuts holding the timing belt case to the injection pump, check if the injection pump period lines are aligned.

If not, place new matchmarks for reinstallation.

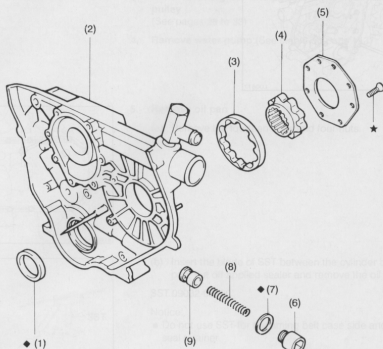
- (c) Remove the two nuts.



(d) Remove the five bolts, timing belt case and gasket.



COMPONENTS



LU0678

- (1) Crankshaft Front Oil Seal
- (2) Timing Belt Case
- (3) Driven Rotor
- (4) Drive Rotor
- (5) Pump Body Cover
- (6) Plug
- (7) Gasket
- (8) Spring
- (9) Relief Valve

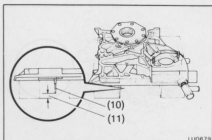
◆ Non-reusable part
★ Precoated part

DISASSEMBLY OF OIL PUMP

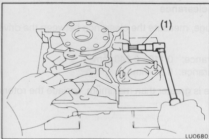
1. Place timing belt case on wooden blocks

Notice: Be careful not to damage the timing pointer (10).

(11) Clearance

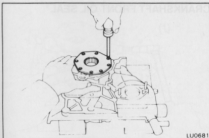


LU0679



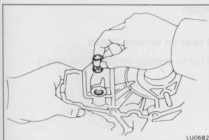
2. Remove relief valve

Using a 12 mm hexagon wrench (1), remove the plug, gasket, spring and relief valve.



3. Remove drive and driven rotors

Remove the six screws, pump body cover, the drive and driven rotors.

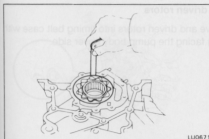


INSPECTION OF OIL PUMP

1. Inspect relief valve

Coat the valve with engine oil and check that it falls smoothly into the valve hole by its own weight.

If not, replace the relief valve. If necessary, replace the oil pump assembly.



2. Inspect drive and driven rotors

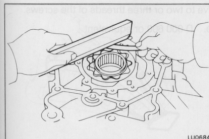
A. Inspect rotor body clearance

Using a feeler gauge, measure the clearance between the driven rotor and body.

Standard body clearance: 0.144 - 0.219 mm

Maximum body clearance: 0.40 mm

If the body clearance is greater than maximum, replace the rotors as a set. If necessary, replace the oil pump assembly.



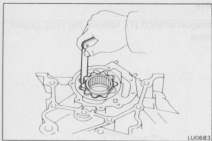
B. Inspect rotor side clearance

Using a feeler gauge and precision straight edge, measure the clearance between the rotors and precision straight edge.

Standard side clearance: 0.035 - 0.085 mm

Maximum side clearance: 0.15 mm

If the side clearance is greater than maximum, replace the rotors as a set. If necessary, replace the oil pump assembly.



C. Inspect rotor tip clearance

Using a feeler gauge, measure the clearance between the drive and driven rotors.

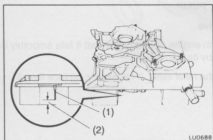
Standard tip clearance: 0.110 - 0.240 mm

Maximum tip clearance: 0.30 mm

If the tip clearance is greater than maximum, replace the rotors as a set.

REPLACEMENT OF CRANKSHAFT FRONT OIL SEAL

(See page 84)



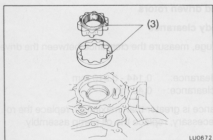
ASSEMBLY OF OIL PUMP

(See page 132)

1. Place timing belt case on wooden blocks

Notice: Be careful not to damage the timing pointer (1).

(2) Clearance

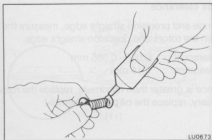


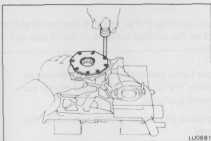
2. Install drive and driven rotors

(a) Place the drive and driven rotors into timing belt case with the marks (3) facing the pump body cover side.

(b) Apply adhesive to two or three threads of the screws.

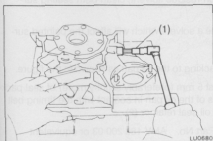
Sealant: Part No. D 000 600 or equivalent





(c) Install the pump body cover with the six screws.

Torque: 10 Nm

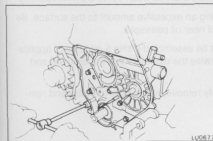


2. Install relief valve

(a) Insert the relief valve and spring into the installation hole of the timing belt case.

(b) Using a 12 mm hexagon wrench (1), install a new gasket and the plug.

Torque: 37 Nm



INSTALLATION OF OIL PUMP

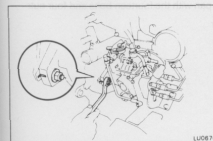
(See page 129)

1. Install oil pump (timing belt case)

(a) Place a new gasket on the cylinder block.

(b) Install the timing belt case with the five bolts.

Torque: 23 Nm



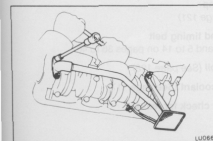
(c) Install the two nuts holding the injection pump to the timing belt case.

Torque: 21 Nm

(d) Check that the injection pump period lines (or matchmarks) are aligned.

If not correct, align the period lines (or matchmarks) by tilting the injection pump.

(e) Connect the thermo wax water by-pass hose to the timing belt case.



2. Install oil strainer

Install a new gasket and the oil strainer with the two bolts and two nuts.

Torque: 12 Nm

3. Install oil pan

- (a) Remove any old packing (FIPG) material and be careful not to drop any oil on the contact surfaces of the 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.
- Using a non-residue solvent, clean both sealing surfaces.

Notice: Do not use a solvent which will affect the painted surfaces.

- (b) Apply seal packing to the oil pan as shown in the figure.

Hint: Apply at least 5 mm (preferably slightly more) of seal packing to the portions of the oil pan in contact with the timing belt case (1) and rear oil seal retainer (2).

Seal packing: Part No. AMV 188 200 03 or equivalent

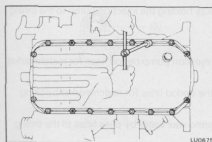
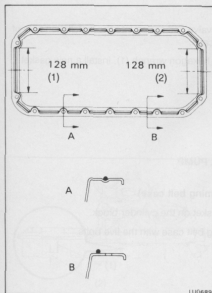
- Install a nozzle that has been cut to a 5 mm opening.

Hint: Avoid applying an excessive amount to the surface. Be particularly careful near oil passages.

- Parts must be assembled within 5 minutes of application. Otherwise the material must be removed and reapplied.
- Immediately remove nozzle from the tube and reinstall cap.

- (c) Install the oil pan with the fourteen bolts and four nuts

Torque: 180 bar



4. Install water pump

(See step 1 on page 121)

5. Install pulleys and timing belt

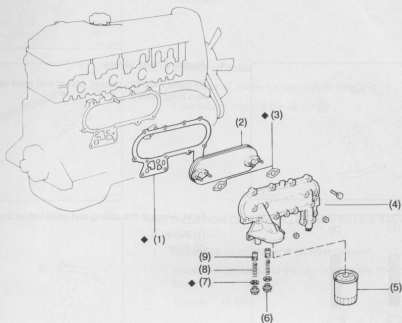
(See steps 1 to 3 and 5 to 14 on pages 36 to 40)

6. Fill with engine oil (See page 128)

7. Fill with engine coolant (See page 117)

8. Start engine and check for leaks

OIL COOLER AND RELIEF VALVES COMPONENTS



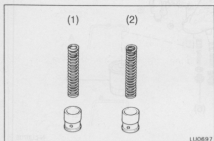
N-LU6705

- (1) Gasket
- (2) Oil Cooler
- (3) Gasket
- (4) Oil Filter Bracket
- (5) Oil Filter
- (6) Valve, Used as dummy-plug,
to prevent oil to flow to main hole
- (7) Gasket
- (8) Spring
- (9) Relief Valve

◆ Non-reusable part

REMOVAL OF OIL COOLER AND RELIEF VALVES

1. Drain engine coolant (See page 117)
2. Remove exhaust manifold
(See step 12 on page 45)
3. Remove oil filter (See page 127)



4. Remove relief valves

Remove the plug, gasket, spring and relief valve. Remove the two relief valves.

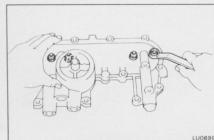
Note: Arrange the spring and relief valves in correct order.

- (1) Front
- (2) Rear



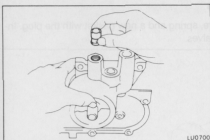
5. Remove oil cooler and oil filter bracket assembly

Remove the eleven bolts, two nuts, the oil cooler, filter bracket assembly and gasket.



6. Separate oil cooler and oil filter bracket

Remove the four nuts, the oil cooler and two gasket from the filter bracket.



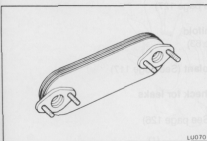
LU0700

INSPECTION OF OIL COOLER AND RELIEF VALVES

1. Inspect relief valve

Coat the valve with engine oil and check that it falls smoothly into the oil filter bracket by its own weight.

If it is not, replace the relief valve. If necessary, replace the oil filter bracket.

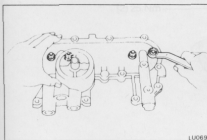


LU0701

2. Inspect oil cooler

Check the oil cooler for damage or clogging.

If necessary, replace the oil cooler.



LU0699

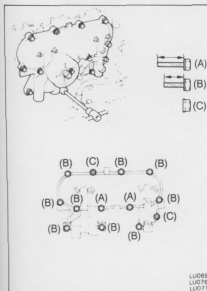
INSTALLATION OF OIL COLLER AND RELIEF VALVES

(See page 137)

1. Assemble oil cooler and oil filter bracket

Install new gaskets and the oil cooler to the filter bracket with the four nuts.

Torque: 14 Nm



LU0698
LU0767
LU0719

2. Install oil cooler and oil filter bracket assembly

Install a new gasket, the oil cooler and filter bracket assembly with the eleven bolts and two nuts.

Torque: Bolt 19 Nm
Nut (C) 21 Nm

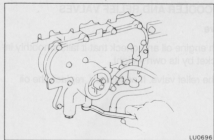
Hint: The bolt lengths for bolt types A and B shown in the illustration are:

A 35 mm
B 25 mm

REMOVAL OF OIL NOZZLES AND RELIEF VALVES

1. Drain engine oil (See page 137)

2. Remove oil pan
(See step 4 on page 137)



3. Install relief valves

Install the relief valve, spring and a new gasket with the plug. Install the two relief valves.

Torque: 36 Nm

4. Install oil filter (See page 127)

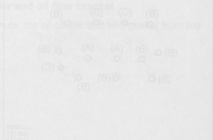
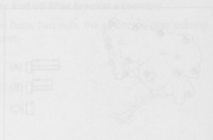
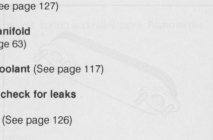
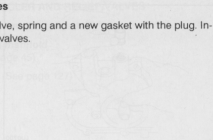
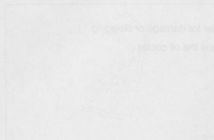
5. Install exhaust manifold

(See step 6 on page 63)

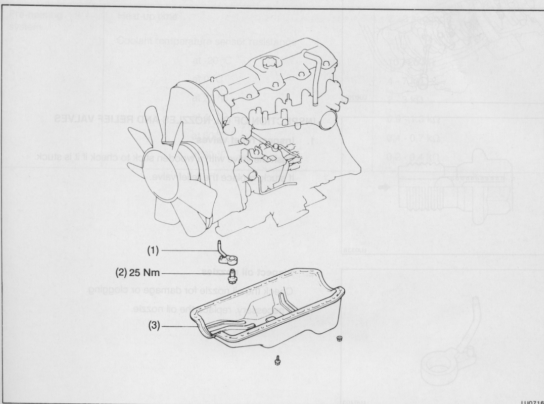
6. Fill with engine coolant (See page 117)

7. Start engine and check for leaks

8. Check engine oil (See page 126)



OIL NOZZLES AND RELIEF VALVES COMPONENTS

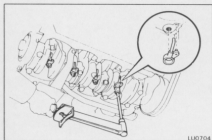
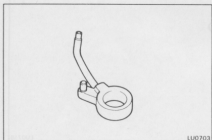
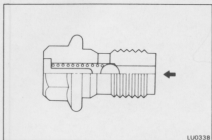
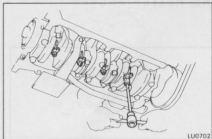


LU0716

- (1) Oil Nozzle
- (2) Relief Valve
- (3) Oil pan

REMOVAL OF OIL NOZZLES AND RELIEF VALVES

1. **Drain engine oil** (See page 127)
2. **Remove oil pan**
(See step 5 on page 130)



3. Remove relief valves and oil nozzles

Remove the four relief valves and oil nozzles.

INSPECTION OF OIL NOZZLES AND RELIEF VALVES

1. Inspect relief valves

Push the valve with a wooden stick to check if it is stuck.

If stuck, replace the relief valve.

2. Inspect oil nozzles

Check the oil nozzle for damage or clogging.

If necessary, replace the oil nozzle.

INSTALLATION OF OIL NOZZLES AND RELIEF VALVES

(See page 141)

1. Install oil nozzles and relief valves

- Align the pin of the oil nozzle with the pin hole of the cylinder block.
- Install the oil nozzle with the relief valve. Install the four oil nozzles and relief valves.

Torque: 25 Nm

2. Install oil pan

(See step 3 on page 136)

3. Fill with engine oil (See page 128)

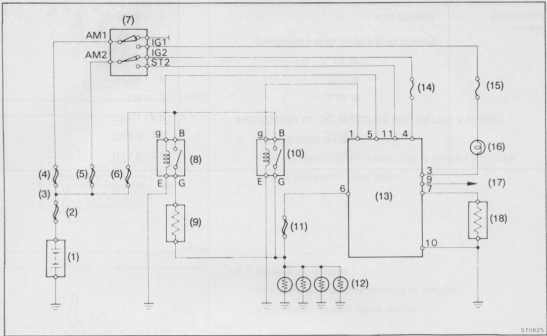
4. Start engine and check for leaks

STARTING SYSTEM

SPECIFICATIONS

Pre-heating system	Heat-up time	2 - 3 seconds
	Coolant temperature sensor resistance	
	at -20 °C	10 - 20 kΩ
	at 0 °C	4 - 7 kΩ
	at 20 °C	2 - 3 kΩ
	at 40 °C	0.9 - 1.3 kΩ
	at 60 °C	0.4 - 0.7 kΩ
	at 80 °C	0.2 - 0.4 kΩ

PRE-HEATING SYSTEM SYSTEM CIRCUIT



- (1) Battery
- (2) Main fuse (MAIN 2.0L)
- (3) Cables
- (4) AM1 60 A
- (5) AM2 30 A
- (6) Glow 80 A
- (7) Starter switch
- (8) No. 2 Glow Plug Relais
- (9) Glow Plug Resistor
- (10) No. 1 Glow Plug Relay
- (11) Line fuse
- (12) Glow Plugs
- (13) Pre-Heating Timer
- (14) Fuse IGN 7.5A
- (15) Fuse GAUGE 10A
- (16) Glow Plug Indicator Light
- (17) To Discharge Warning Light
- (18) Coolant temperature sensor

INSPECTION OF PRE-HEATING SYSTEM

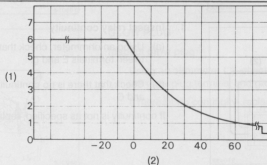
Hint: Refer to Diesel Electrical System Diagnosis for inspection procedures. (See page 15)

Heat-up time of glow indicator light

Turn the starter switch ON, measure the heat-up time.

For heat-up time: see diagram.

- (1) Heat-up time in seconds
- (2) Coolant temperature in °C



ST0552

(A)



K-13-5

INSPECTION OF HEATING SYSTEM

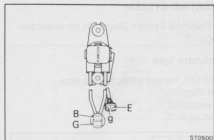
PRE-HEATING TIMER

Inspect pre-heating timer circuit

Location: In the foot well at the passenger side.

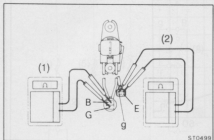
Disconnect the connector from the pre-heating timer, and check the connector on the wire harness side (A) as shown in the following chart.

Check for	Tester connection	Condition	Specified value
Continuity	1 - Ground	-	Continuity
Voltage	3 - Ground	Turn starter switch OFF Turn starter switch ON	No voltage Battery voltage
Voltage	4 - Ground	Turn starter switch OFF Turn starter switch ON	No voltage Battery voltage
Continuity	5 - Ground	-	Continuity
Continuity	6 - Ground	-	Continuity
Continuity	7 - Ground	-	Continuity
Continuity	10 - Ground	-	Continuity
Voltage	11 - Ground	Turn starter switch OFF Turn starter switch START	No voltage Battery voltage



NO. 1 GLOW PLUG RELAY

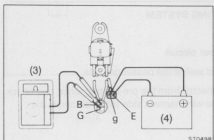
Location: In the engine compartment on the left side.



1. Inspect relay continuity

- Using an ohmmeter, check that there is continuity (2) between terminals E and g.
- Check that there is no continuity (1) between terminals B and G.

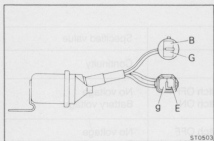
If continuity is not as specified, replace the relay.



2. Inspect relay operation

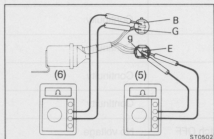
- Apply battery voltage (4) across terminals E and g.
- Using an ohmmeter, check that there is continuity (3) between terminals B and G.

If operation is not as specified, replace the relay.



NO. 2 GLOW PLUG RELAY

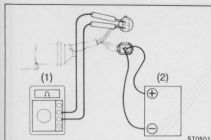
Location: In the engine compartment on the left side.



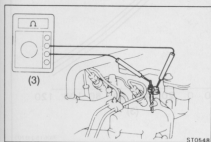
1. Inspect relay continuity

- Using an ohmmeter, check that there is continuity (5) between terminals E and g.
- Check that there is no continuity (6) between terminals B and G.

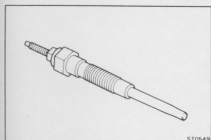
If continuity is not as specified, replace the relay.



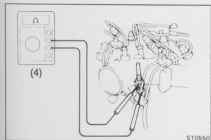
ST0501



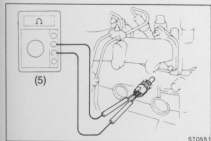
ST0549



ST0549



ST0550



ST0551

2. Insert relay operation

- Apply battery voltage (2) across terminals E and G.
- Using an ohmmeter, check that there is continuity (1) between terminals B and G.

If operation is not as specified, replace the relay.



GLOW PLUG

Inspect glow plug

Using an ohmmeter (3), check that there is continuity between the glow plug terminal and ground.

If there is no continuity, replace the glow plug.

Hint:

- 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 plug when cleaning.
- During inspection, be sure to wipe any oil off the glow plug terminal and bakelite washer with a dry cloth.
- Be careful apply more than 7 volts to the glow plug as it could cause an open circuit.

GLOW PLUG RESISTOR

Inspect glow plug resistor

Using an ohmmeter (4), check that there is continuity between the resistor terminals.

If there is no continuity, replace the resistor.

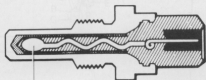
COOLANT TEMPERATURE SENSOR

Inspect temperature sensor

Using an ohmmeter (5), measure the resistance between the sensor terminals.

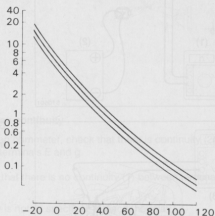
Resistance: Refer to chart

If the resistance is not as specified, replace the sensor.



(1)

(2)



(3)

F0515 F0709

- (1) Thermistor
- (2) Resistance $k\Omega$
- (3) Temperature in $^{\circ}\text{C}$