

ENGINE 4H SERIES

SECTION 00 SERVICE INFORMATION

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TROUBLESHOOTING

Hard Starting

1. Starter Inoperative

Checkpoint	Possible cause	Correction
Battery	Loose battery cable terminal Poor connections due to rusting	Clean and/or retighten the battery cable terminal
	Battery discharged or weak	Recharge or replace the battery
	Fan belt loose or broken	Adjust or replace the fan belt
Fusible link	Fusible link shorted	Replace the fusible link
Starter switch	Defective starter switch or starter relay	Replace the starter switch or the starter relay
Starter motor	Defective magnetic switch or starter relay	Repair or replace the magnetic switch
	Defective starter motor	Repair or replace the starter motor

2. Starter Motor Operates But Engine Does Not Turn Over

Checkpoint	Possible cause	Correction
Battery	Loose battery cable terminal Poor connections due to rusting	Clean and/or retighten the battery cable terminal
	Battery discharged or weak	Recharge or replace the battery
	Fan belt loose or broken	Adjust or replace the fan belt
Starter motor	Defective pinion gear	Replace the pinion gear
	Defective magnetic switch	Repair or replace the magnetic switch
	Brush wear, Weak brush spring	Replace the brush and/or the brush spring
Engine	Piston, crank bearing seizure, or other damage	Repair or replace the related parts

3. Engine Turns Over But Does Not Start

Checkpoint	Possible cause	Correction
Engine stop mechanism	Defective fuel cut solenoid valve	Replace the fuel cut solenoid valve

Fuel is Not Being Delivered to The Injection Pump

Fuel	Fuel tank is empty	Fill the fuel tank
Fuel piping	Clogged or damaged fuel lines Loose fuel line connection	Repair or replace the fuel lines Retighten the fuel line connection
Fuel filter	Fuel filter overflow valve does not close	Repair or replace the fuel filter overflow valve
	Clogged fuel filter element	Replace the fuel filter element or the filter cartridge
Fuel system	Air in the fuel system	Bleed the air from the fuel system
Fuel feed pump	Defective feed pump	Repair or replace the feed pump

Fuel is Being Delivered to The Injection Pump

Fuel	Use of the wrong fuel	Use the correct fuel
	Water particles in the fuel	Change the fuel
Fuel system	Air in the injection pump	Bleed the air from the fuel system

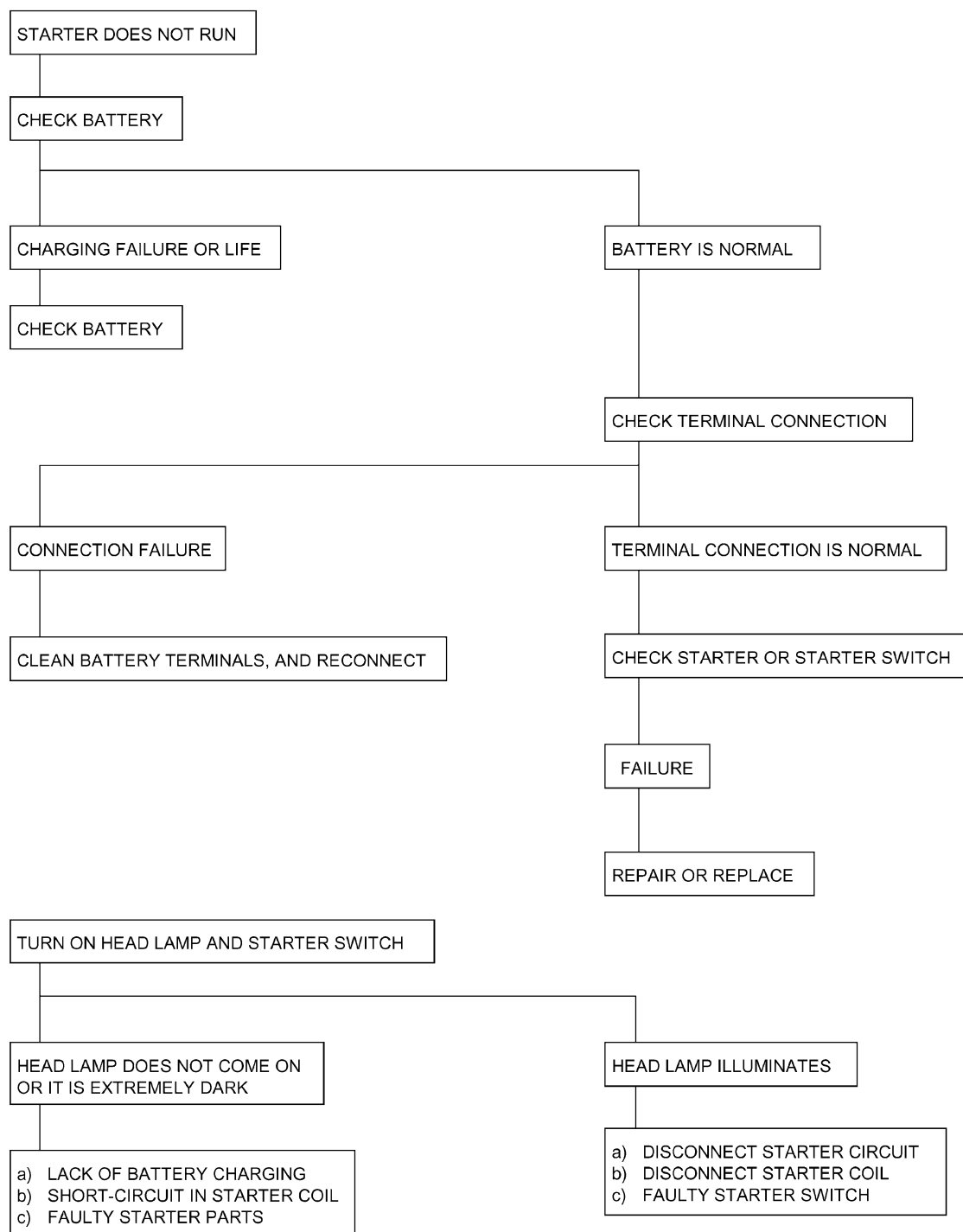
Checkpoint	Possible cause	Correction
Injection nozzle	Injection nozzle sticking	Replace the injection nozzle
	Injection nozzle injection starting pressure too low Improper spray condition	Adjust or replace the injection nozzle
Injection pump	Defective fuel injection nozzle resulting in the fuel drippage after fuel injection	Replace the delivery valve
	Defective injection pump control rack operation	Repair or replace the injection pump control rack
	Injection pump plunger worn or stuck	Replace the injection pump plunger assembly
	Injection pump drive shaft seizure or other damage	Replace the injection drive shaft
	Injection pump governor spring seizure	Replace the injection pump governor spring

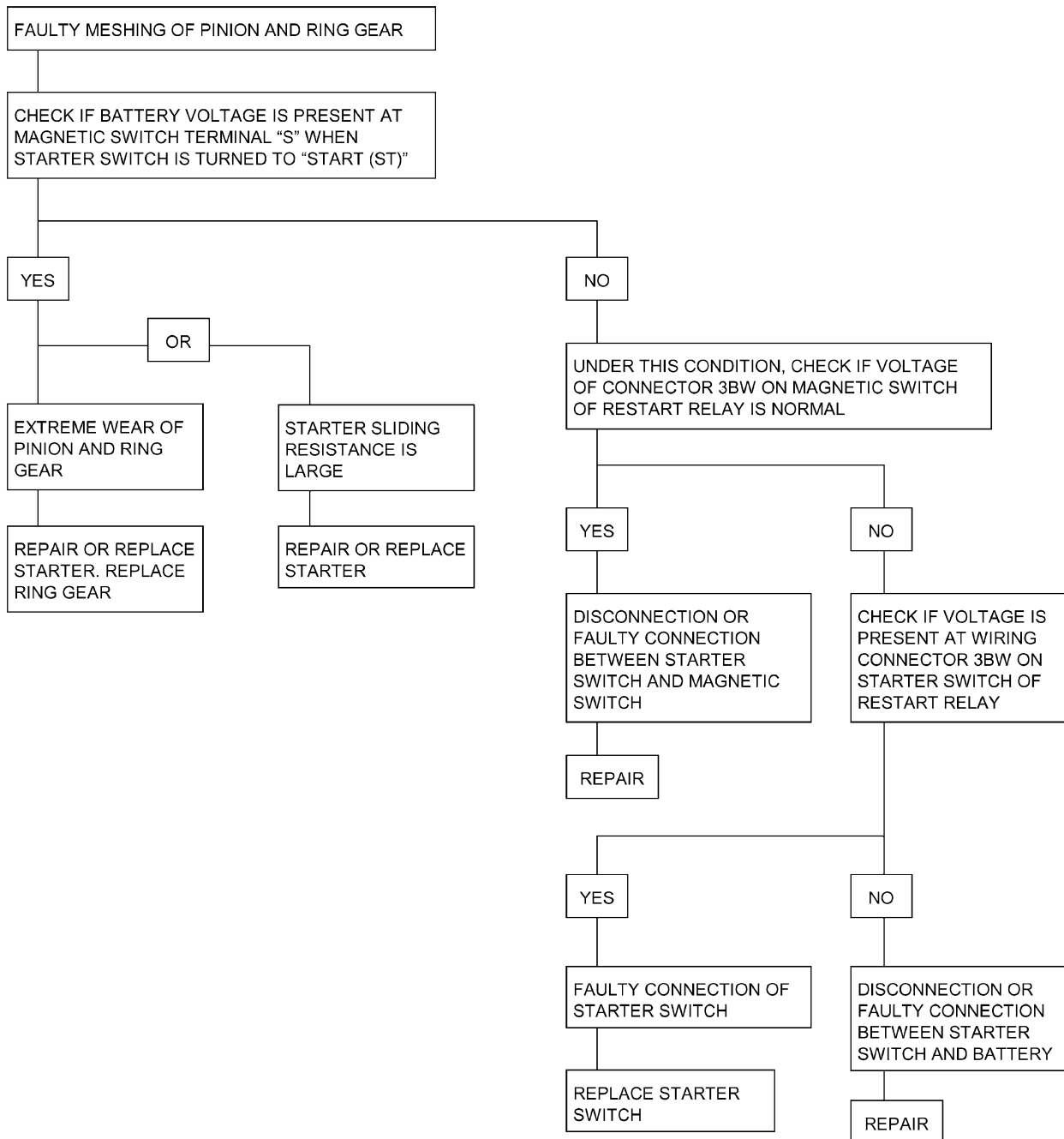
4. Quick-on Start System

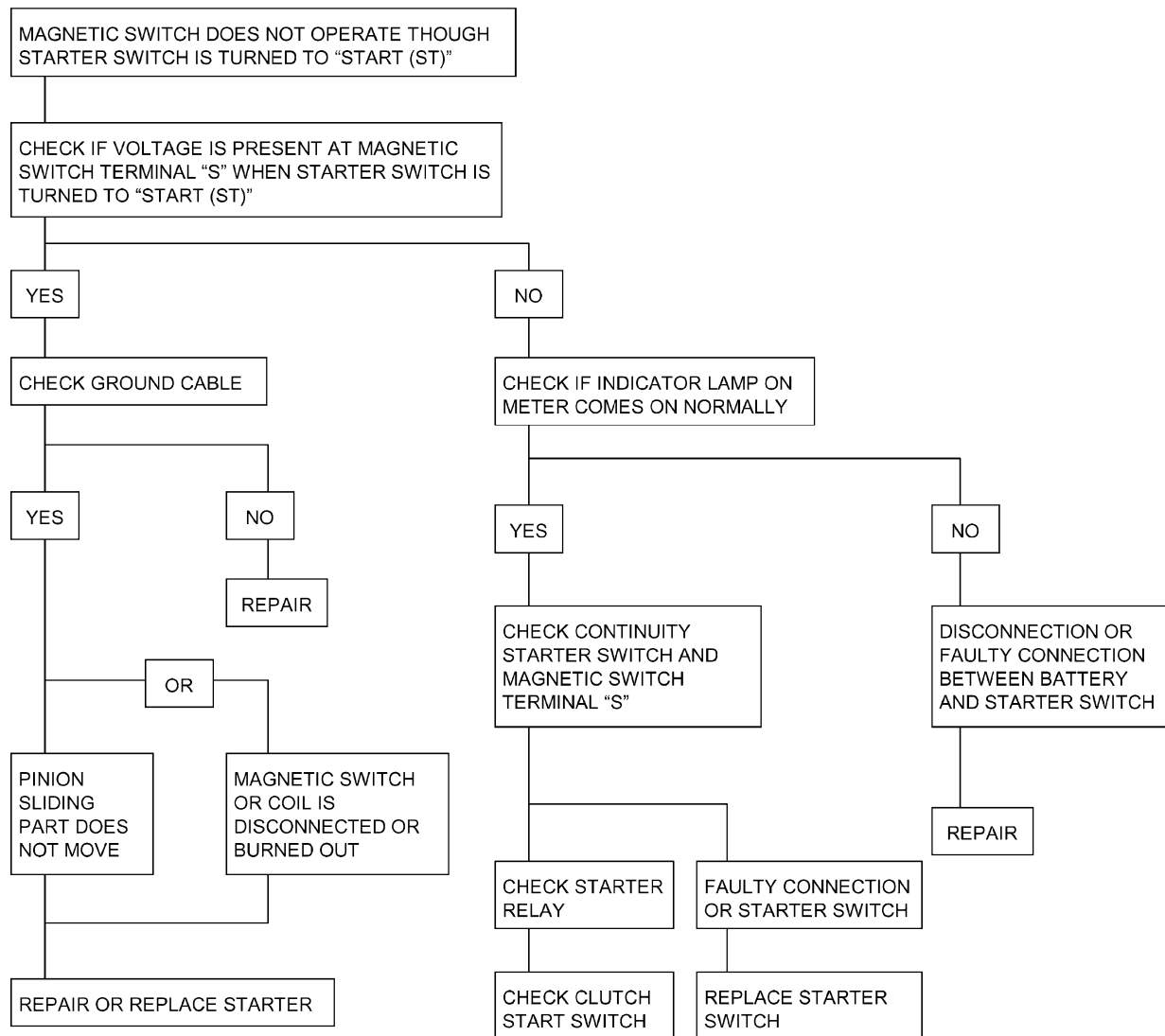
Check point	Possible cause	Correction
Glow plug indicator light does not turn on	1. Defective Fusible link wire 2. Broken indicator light fuse 3. Defective indicator bulb	Replace the fusible link wire Replace the indicator light fuse Replace the indicator light bulb
Preheating system dose not work	1. Defective fusible link wire shorted 2. Defective glow plug relay connector 3. Defective glow plug connector 4. Defective quick-on start timer connector	Replace the fusible link wire Replace or Repair glow plug relay connector Replace or Repair glow plug connector Replace or Repair quick-on start timer connector
Preheating time to long or to short	1. Defective thermo switch include defective wiring harness 2. Defective glow plug 3. Defective timer unit	Replace thermo switch Replace glow plug Replace timer unit

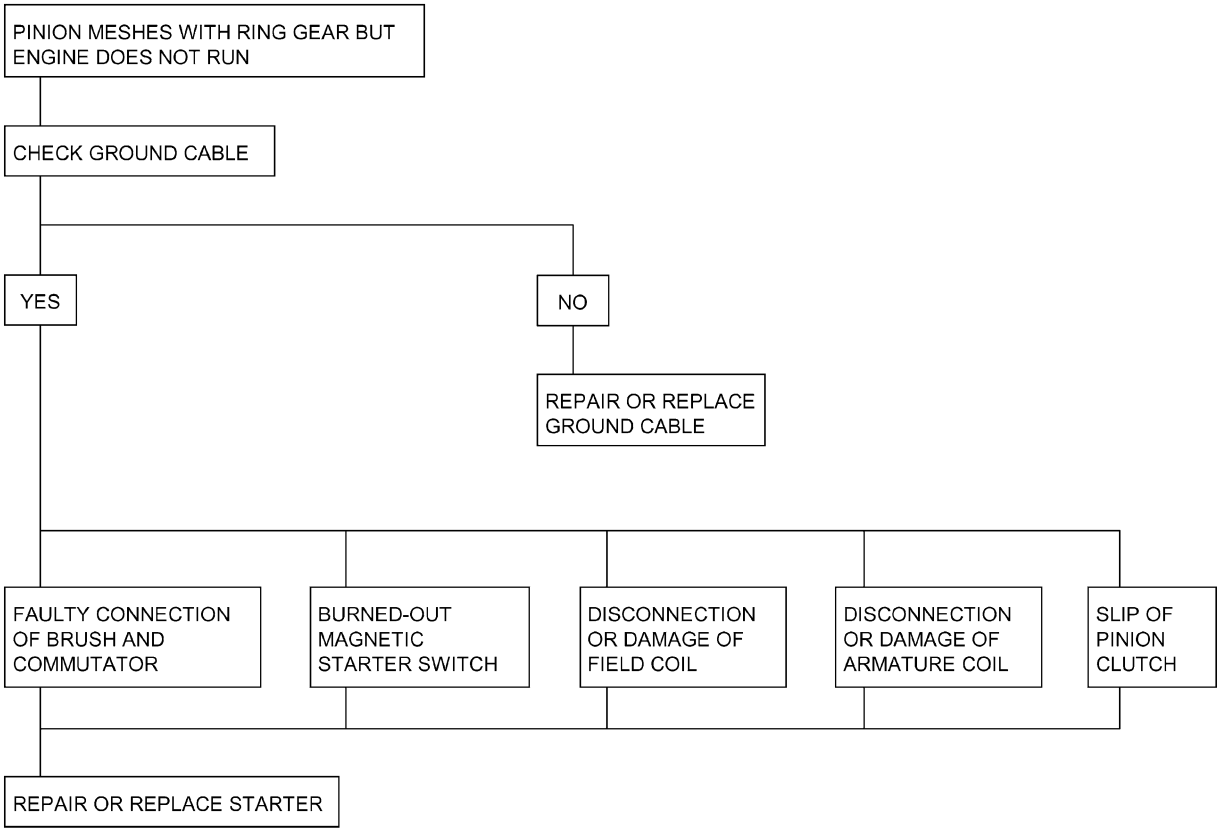
00-4 SERVICE INFORMATION

Check if battery is normal, then perform the following diagnosis.









Unstable Idling

Check point	Possible cause	Correction
Idling system	Idling improperly adjusted	Adjust the idling
Fast idling speed control device	Defective fast idling speed control device	Repair or replace the fast idling speed control device
Accelerator control system	Accelerator control system improperly adjusted	Adjust the accelerator control system
Fuel system	Fuel system leakage or blockage	Repair or replace the fuel system
	Air in the fuel system	Bleed the air from the fuel system
	Water particles in the fuel system	Change the fuel
Fuel filter	Clogged fuel filter element	Replace the fuel filter element or the fuel filter cartridge
Fuel feed pump	Defective fuel feed pump	Repair or replace the fuel feed pump
Injection nozzle	Injection nozzle sticking	Replace the injection nozzle
	Injection nozzle injection starting pressure too low	Adjust or replace the injection nozzle
	Improper spray condition	
Injection pump	Defective delivery valve resulting in fuel drippage after fuel injection	Replace the delivery valve
	Injection timing improperly adjusted	Adjust the injection timing
	Insufficient injection volume	Adjust the injection volume
	Defective idle spring	Replace the idle spring
	Defective governor lever operation	Repair or replace the governor lever
	Regulator valve improperly adjustment	Adjust or replace the regulator valve
	Broken plunger spring	Replace the plunger spring
	Worn plunger	Replace the plunger assembly
	Worn cam disc	Replace the cam disc
Valve clearance	Valve clearance improperly adjusted	Adjust the valve clearance
Compression pressure	Blown out cylinder head gasket Worn cylinder liner Piston ring sticking between the valve and the valve seat	Replace the related parts

Insufficient Power

Check point	Possible cause	Correction
Air cleaner	Clogged air cleaner element	Clean or replace the air cleaner element
Fuel	Water particle in the fuel	Replace fuel
Fuel filter	Clogged fuel filter element	Replace the fuel filter element or the fuel filter cartridge
Fuel feed pump	Defective fuel feed pump	Repair or replace the fuel feed pump
Injection nozzle	Injection nozzle sticking	Replace the injection nozzle
	Injection nozzle injection starting pressure too low	Adjust or replace the injection nozzle
	Improper spray condition	
Fuel injection pipes	Fuel injection pipes damaged or obstructed	Replace the fuel injection pipes
Injection pump	Defective regulating valve	Repair or replace the regulating valve
	Defective delivery valve	Replace the delivery valve
	Defective timer	Repair or replace the timer
	Worn cam disk	Replace the cam disk
	Improper control lever operation	Adjust or replace the control lever
	Defective injection timing	Adjust the injection timing Repair or replace the injection pump timer
	Weak governor spring	Replace the governor spring
	Worn plunger	Replace the plunger assembly
Compression pressure	Blown out cylinder head gasket Worn cylinder liner Piston ring sticking	Replace the related parts
Valve clearance	Valve clearance improperly adjusted	Adjust the valve clearance
Valve spring	Valve spring weak or broken	Replace the valve spring
Exhaust system	Exhaust pipe clogged	Clean the exhaust pipe
Full load adjusting screw seal	Open and improperly set adjusting screw seal	Adjust and reseal the adjusting screw

Excessive Fuel Consumption

Check point	Possible cause	Correction
Fuel system	Fuel leakage	Repair or replace the fuel system related parts
Air cleaner	Clogged air cleaner element	Clean or replace the air cleaner element
Idling speed	Poorly adjusted idling speed	Adjust the idling speed
Injection nozzle	Injection nozzle injection starting pressure too low Improper spray condition	Adjust or replace the injection nozzle
Fuel injection timing	Fuel injection timing improperly	Adjust the fuel injection timing
Injection pump	Defective delivery valve resulting in fuel drip after fuel injection	Replace the delivery valve
Valve clearance	Valve clearance improperly adjusted	Adjust the valve clearance
Compression pressure	Blown out cylinder head gasket Worn cylinder liner Piston ring sticking	Replace the related parts
Valve spring	Valve spring weak or broken	Replace the valve spring

Excessive Oil Consumption

Check point	Possible cause	Correction
Engine oil	Engine oil unsuitable Too much engine oil	Replace the engine oil Correct the engine oil level
Oil seal and gasket	Oil leakage from the oil seal and/or the gasket	Replace the oil seal and/or the gasket
Air breather	Clogged air breather	Clean the air breather
Intake and exhaust valve	Worn valve stems and valve guides	Replace the intake and exhaust valves and the valve guides

Overheating

Check point	Possible cause	Correction
Cooling water	Insufficient cooling water	Replenish the cooling water
Fan clutch	Oil leakage from the fan clutch	Replace the fan clutch
Fan belt	Fan belt loose or cracked causing slippage	Replace the fan belt
Radiator	Defective radiator cap or clogged radiator core	Replace the radiator cap or clean the radiator core
Water pump	Defective water pump	Repair or replace the water pump
Cylinder head and cylinder body sealing cap	Defective sealing cap resulting in water leakage	Replace the sealing cap
Thermostat	Defective thermostat	Replace the thermostat
Cooling system	Cooling system clogged by foreign material	Clean the foreign material from the cooling system
Fuel injection timing	Fuel injection timing improperly adjusted	Adjust the fuel injection timing

White Exhaust Smoke

Check point	Possible cause	Correction
Fuel	Water particles in the fuel	Replace the fuel
Fuel injection timing	Delayed fuel injection timing	Adjust the fuel injection timing
Compression pressure	Blown out cylinder head gasket Worn cylinder liner Piston ring sticking	Replace the related parts
Inlet and exhaust valves Valves seals	Defective valve seales Worn valves stems and valve guides	Replace the valve seales, the valves, and the valve guides

Dark Exhaust Smoke

Check point	Possible cause	Correction
Air cleaner	Clogged air cleaner element	Clean or replace the air cleaner element
Injection nozzle	Injection nozzle injection starting pressure too low Improper spray condition	Adjust or replace the injection nozzle
Fuel injection timing	Fuel injection timing improperly adjusted	Adjust the fuel injection timing
Injection pump	Defective delivery valve resulting in fuel drippage after fuel injection	Replace the delivery valve
	Excessive injection volume	Adjust the injection volume

Oil Pressure Does Not Rise

Check point	Possible cause	Correction
Engine oil	Improper viscosity engine oil	Replace the engine oil
	Insufficient engine oil	Correct the engine oil volume
Oil pressure gauge or unit Oil pressure indicator light	Defective oil pressure gauge or unit Defective indicator light	Repair or replace the oil pressure gauge or unit Replace the indicator light
Oil filter	Clogged oil filter element	Replace the oil filter element or the oil filter cartridge
Relief valve and by-pass valve	Relief valve sticking and/or weak by-pass valve spring	Replace the relief valve and/or the by-pass valve spring
Oil pump	Clogged oil pump strainer	Clean the oil pump strainer
	Worn oil pump related parts	Replace the oil pump related parts
Rocker arm shaft	Worn rocker arm bushing	Replace the rocker arm bushing
Camshaft	Worn camshaft and camshaft bearing	Replace the camshaft and the camshaft bearing
Crankshaft and bearings	Worn crankshaft and bearings	Replace the crankshaft and/or the bearings

Abnormal Engine Noise

1. Engine Knocking

Check to see that the engine has been thoroughly warmed up before beginning the troubleshooting procedure.

Check point	Possible cause	Correction
Fuel	Fuel unsuitable	Replace the fuel
Fuel injection timing	Fuel injection timing improperly adjusted	Adjust the fuel injection timing
Injection nozzle	Improper injection nozzle starting pressure and spray condition	Adjust or replace the injection nozzle
Compression pressure	Blown out head gasket	Broken piston ring Replace the head gasket or the piston ring

2. Gas Leakage Noise

Check point	Possible cause	Correction
Exhaust pipes	Loosely connected exhaust pipes Broken exhaust pipes	Tighten the exhaust pipe connections Replace the exhaust pipes
Injection nozzles and/or glow plugs	Loose injection nozzles and/or glow plugs	Replace the washers Tighten the injection nozzles and/or the glow plugs
Exhaust manifold	Loosely connected exhaust manifold and/or glow plugs	Tighten the exhaust manifold connections
Cylinder head gasket	Damaged cylinder head gasket	Replace the cylinder head gasket

3. Continuous Noise

Check point	Possible cause	Correction
Fan belt	Loose fan belt	Readjust the fan belt tension
Cooling fan	Loose cooling fan	Retighten the cooling fan
Water pump bearing	Worn or damaged water pump bearing	Replace the water pump bearing
Alternator or vacuum pump	Defective alternator or vacuum pump	Repair or replace the alternator or the vacuum pump
Valve clearance	Clearance improperly adjust	Adjust the valve clearance

4. Slapping Noise

Check point	Possible cause	Correction
Valve clearance	Valve clearance improperly adjusted	Adjust the valve clearance
Rocker arm	Damaged rocker arm	Replace the rocker arm
Flywheel	Loose flywheel bolts	Retighten the flywheel bolts
Crankshaft and thrust bearings	Worn or damaged crankshaft and/or thrust bearings	Replace the crankshaft and/or the thrust bearings
Crankshaft and connecting rod bearings	Worn or damaged crankshaft and/or connecting rod bearings	Replace the crankshaft and/or the connecting rod bearings
Connecting rod bushing and piston pin	Worn or damaged connecting rod bushing and piston pin	Replace the connecting rod bushing and/or the piston pin
Piston and cylinder liner	Worn or damaged piston and cylinder liner Foreign material in the cylinder	Replace the piston and the cylinder liner

Engine Cooling Trouble

Condition	Possible cause	Correction
Engine overheating	Low coolant level	Replenish
	Thermo unit faulty	Replace
	Faulty thermostat	Replace
	Faulty coolant unit	Repair or replace
	Clogged radiator	Clean or replace
	Faulty radiator cap	Replace
	Low engine oil level or use of improper engine oil	Replenish or change oil Replenish
	Damaged cylinder head gasket	Replace
	Clogged exhaust system	Clean exhaust system or replace faulty parts
	Loose fan belt	Adjust
	Excessive fuel injected	Adjust
	Improper injection timing	Adjust
Engine overcooling	Faulty thermostat	Replace
Too long engine warm-up time	Faulty thermostat	Replace
	Thermo unit faulty	Replace

Starter Motor Does Not Stop

STARTER DOES NOT STOP THOUGH STARTER SWITCH IS RETURNED TO "ON"

DISCONNECTED STARTER SWITCH WIRING CONNECTOR, AND CHECK STARTER SWITCH OPERATION.

STARTER SWITCH KEY POSITION		Connector No.	B-67				B-68				
		Terminal No.	1	2	3	4	1	2	4	5	6
		Terminal No.	ACC	B	ON	ST	B ₁	P ₁	P ₂	W	W
OFF		LOCK									
ON		ACC									
		ON									
		START									

THERE MUST BE NO CONTINUITY EXCEPT ABOVE LINES.

YES

MAGNETIC SWITCH CONTACTS ARE FUSED AND NOT MOVED, OR A RETURN SPRING IS BROKEN OR DETERIORATED

REPLACE MAGNETIC SWITCH

NO

REPLACE STARTER SWITCH

MAIN DATA AND SPECIFICATIONS

Main Data and Specifications

				Engine Model		
				4HF1	4HF1-2	
Item	Engine type			Four-cycle, overhead camshaft, water cooled		
	Combustion chamber type			Direct injection		
	Cylinder liner type			Dry liner, special compound metal		
	Timing drive system			Gear drive		
	No. of cylinders — Bore × stroke	mm (in)		4 — 112 × 110 (4 — 4.41 × 4.33)		
	No. of piston rings			Compression rings: 2, Oil ring: 1		
	Total piston displacement	cm ³ (in ³)		4334 (264.5)		
	Compression ratio	to : 1		19		
	Compression pressure			3,040 (31/441) — 200	3,226 (32.9/468) — 200	
		kPa (kg / cm ² / psi) — rpm				
	Fuel injection order			1 — 3 — 4 — 2		
	Fuel injection timing (BTDC)	deg		8	12	
	Specified fuel type			SAE No. 2 diesel fuel		
	Idling speed rpm			550 — 600	575 — 625	
	Valve system					
	Valve clearances (At cold):	Intake	mm (in)	0.4 (0.016)		
		Exhaust	mm (in)	0.4 (0.016)		
	Valve timing (At valve clearances 0.4 mm (0.016 in))					
	Intake valves	Open at (BTDC)	deg	18		
		Close at (ABDC)	deg	50		
	Exhaust valves	Open at (BBDC)	deg	51		
		Close at (ATDC)	deg	17		
	Fuel system					
	Injection pump type			Bosch in-line type with automatic timer	Bosch “VE” distributor with automatic timer	
	Plunger outside diameter			mm (in)	9.5 (0.374)	12 (0.472)
	Plunger lift			mm (in)	11.0 (0.433)	2.8 (0.110)
	Governor type			RLD-F mechanical (Variable speed)	Half all speed governor	
	Automatic timer type			SCDM, centrifugal, flyweight	Hydraulic speed sensing type	
Fuel feed pump type			Piston	Vane		

00-16 SERVICE INFORMATION

		Engine Model	
		4HF1	4HF1-2
Item	Injection nozzle type	Hole type (with 5 orifices)	
	Injection nozzle type		
	Pressure MPa (kg / cm ² / psi)	18.1 (185 / 2,631)	
	Pressure adjustment	Shim adjusted	
	Main fuel filter type	Disposal spin-on cartridge and remote mounted water separator	
	Lubricating system		
	Lubrication method	Full flow pressure circulation	
	Specified engine oil (API grade)	CD or above	
	Oil pressure kPa (kg / cm ² / psi) — rpm	147 (1.5 / 21) — 700 (SAE 10W-30 API CD grade engine oil at 80°C (176°F))	
	Oil pump type	Gear type	
	Oil filter type	Spin-on cartridge	
	Oil capacity lit (US / UK gal)	10.5 (2.77 / 2.31)	
	Oil cooler type	Water cooled	
	Cooling system		
	Radiator type	Corrugated fin with reserve tank	
	Coolant capacity lit (US / UK gal)	12 (3.17 / 2.64)	
	Water pump type	Centrifugal impeller, V-belt drive	
	Pump to crankshaft speed to : 1 ratio	1.16 (175 / 151)	
	Delivery volume lit (US / UK gal)/min	200 (52.8 / 44.0) (Pump speed at 3,300 rpm Water temperature at 82°C (180°F))	
	Pump bearing type	Double row shaft	
	Thermostat type	Wax pellet	
	Valve initial opening temperature °C (°F)	With jiggle valve: 85±1.5 (182 — 188) Without jiggle valve: 82±1.5 (177 — 182)	
	Valve lift mm (in)	With jiggle valve: 8 (0.3) or more at 100°C (212°F) Without jiggle valve: 8 (0.3) or more at 95°C (203°F)	
	Air cleaner type	Dry paper element	
	Battery type Volt-amp.hr.	55D23R / 12 — 60 : 2 pcs	
	Generator		
	Type	AC brush with IC regulator and vacuum pump	
	Voltage V	24	
	Drive and rotation	V-belt, clockwise viewed from the drive pulley	
	Ground polarity	Negative	
	Maximum output A	50 at 5,000 rpm (For Indonesian) 60 at 5,000 rpm 80 at 5,000 rpm	
	Maximum speed rpm	7,500 — 10,000	

		Engine Model	
		4HF1	4HF1-2
Item	Regulator		
	Type	IC	
	Regulating voltage	V	28 — 29
	Vacuum pump		
	-66.7 kPa (-500 mmHg / -9.67 psi) build-up time	13 seconds or less at 1,000 rpm 4 seconds or less at 5,000 rpm	
	Maximum vacuum	-90.7 kPa (-680 mmHg / -13.1 psi) or more at 5,000 rpm	
	Starter motor		
	Type	Magnetic solenoid-controlled	
	Model	S25-168	
	Rated voltage	V	24
	Rated output	kW	4.0
	Load characteristics		
	Terminal voltage	V	18.55
	Load current	A	250
	Torque	N·m (kg·m / lb·ft)	14.22 (1.45 / 10.49) at 1,500 rpm or more
	Preheating system	Quick-On-Start System II	
	Exhaust system		
	Pipe outside diameter × thickness		
	Front pipe	mm (in)	60.5 × 2.0 (2.38 × 0.079)
	Middle pipe	mm (in)	60.5 × 2.0 (2.38 × 0.079)
	Rear pipe	mm (in)	60.5 × 1.6 (2.38 × 0.063)
	Silencer Type	Circular section-shell construction of triple skin and end plates, internal construction of baffles and perforated tubes	
	Inside diameter	mm (in)	Approximately 200 (7.87)

				Engine Model	
				4HG1	4HG1-T
Item	Engine type			Four-cycle, overhead camshaft, water cooled	
	Combustion chamber type			Direct injection	
	Cylinder liner type			Dry liner, special compound metal	
	Timing drive system			Gear drive	
	No. of cylinders — Bore × stroke	mm (in)		4 — 115 × 110 (4 — 4.53 × 4.33)	
	No. of piston rings			Compression rings: 2, Oil ring: 1	
	Total piston displacement	cm ³ (in ³)		4570 (278.9)	
	Compression ratio			19	
	Compression pressure	kPa (kg / cm ² / psi)	— rpm	3,226 (32.9/468) — 200	
	Fuel injection order			1 — 3 — 4 — 2	
	Fuel injection timing (BTDC)	deg		9	7 (Except Colombia) 9 (For Colombia)
	Specified fuel type			SAE No. 2 diesel fuel	
	Idling speed rpm			550 — 600	600 — 650
	Valve system				
	Valve clearances (At cold):	Intake	mm (in)	0.4 (0.016)	
		Exhaust	mm (in)	0.4 (0.016)	
	Valve timing (At valve clearances 0.4 mm (0.016 in))				
	Intake valves	Open at (BTDC)	deg	18	
		Close at (ABDC)	deg	50	
	Exhaust valves	Open at (BBDC)	deg	51	
		Close at (ATDC)	deg	17	
	Fuel system				
	Injection pump type			Bosch in-line type with automatic timer	
	Plunger outside diameter	mm (in)		9.5 (0.374)	10.5 (0.413)
	Plunger lift	mm (in)		11.0 (0.433)	
	Governor type			RLD-F mechanical (Variable speed)	
	Automatic timer type			SCDM, centrifugal, flyweight	
	Fuel feed pump type			Piston	

		Engine Model	
		4HG1	4HG1-T
Item	Injection nozzle opening	Hole type (with 5 orifices)	
	Injection nozzle type		
	Pressure MPa (kg / cm ² / psi)	18.1 (185 / 2,631)	1st 18.1 (185 / 2,631) 2nd 21.1 (215 / 3,057)
	Pressure adjustment	Shim adjusted	
	Main fuel filter type	Disposal spin-on cartridge and remote mounted water separator	
	Lubricating system		
	Lubrication method	Full flow pressure circulation	
	Specified engine oil (API grade)	CD or above	
	Oil pressure kPa (kg /cm ² / psi) — rpm	147 (1.5 / 21) — 700 (SAE 10W-30 API CD grade engine oil at 80°C (176°F))	
	Oil pump type	Gear type	
	Oil filter type	Spin-on cartridge	
	Oil capacity lit (US / UK gal)	10.5 (2.77 / 2.31)	
	Oil cooler type	Water cooled	
	Cooling system		
	Radiator type	Corrugated fin with reserve tank	
	Coolant capacity lit (US / UK gal)	12 (3.17 / 2.64)	
	Water pump type	Centrifugal impeller, V-belt drive	
	Pump to crankshaft speed to : 1 ratio	1.19 (175 / 147)	
	Delivery volume lit (US / UK gal)/min	200 (52.8 / 44.0) (Pump speed at 3,300 rpm Water temperature at 82°C (180°F))	
	Pump bearing type	Double row shaft	
	Thermostat type	Wax pellet	
	Valve initial opening temperature °C (°F)	With jiggle valve: 85±1.5 (182 — 188) Without jiggle valve: 82±1.5 (177 — 182)	
	Valve lift mm (in)	With jiggle valve: 8 (0.3) or more at 100°C (212°F) Without jiggle valve: 8 (0.3) or more at 95°C (203°F)	
	Air cleaner type	Dry paper element or oil bath	
	Battery type Volt-amp.hr.	75D23R / 12-65 : 2 pcs	
	Generator		
	Type	AC brush with IC regulator and vacuum pump	
	Voltage V	24	12 or 24
	Drive and rotation	V-belt, clockwise viewed from the drive pulley	
	Ground polarity	Negative	
	Maximum output A	35 at 5,000 rpm 60 at 5,000 rpm	50 at 5,000 rpm 80 (12V) at 5,000 rpm
	Maximum speed rpm	7,500 — 10,000	

00-20 SERVICE INFORMATION

			Engine Model			
			4HG1		4HG1-T	
Item	Regulator					
	Type		IC			
	Regulating voltage		V	28 — 29	14.4±0.3	28 — 29
	Vacuum pump					
	-66.7kPa (-500 mmHg / -9.67 psi) build-up time		13 seconds or less at 1,000 rpm			
			4 seconds or less at 5,000 rpm			
	Maximum vacuum		-90.7 kPa (-680 mmHg / -13.1 psi) or more at 5,000 rpm			
	Starter motor					
	Type		Magnetic solenoid-controlled			
	Model		S25-168	R3.0	S25-168	
	Rated voltage		V	24	12	24
	Rated output		kW	4	3	4
	Load characteristics					
	Terminal voltage		V	18.55	14	18.55
	Load current		A	250	890 (MAX)	250
	Torque		N·m (kg·m / lb·ft)	14.22 (1.45 / 10.49) at 1,500 rpm or more	29.4 (2.99 / 21.63) at 860 rpm or more	14.22 (1.45 / 10.49) at 1,500 rpm or more
	Preheating system		Quick-On-Start System II			
	Exhaust system					
	Pipe outside diameter × thickness					
	Front pipe		mm (in)	60.5 × 2.0 (2.38 × 0.079)		
	Middle pipe		mm (in)	60.5 × 2.0 (2.38 × 0.079)		
	Rear pipe		mm (in)	60.5 × 1.6 (2.38 × 0.063)		
	Silencer type		Circular section-shell construction of triple skin and end plates, internal construction of baffles and perforated tubes			
	Inside diameter		mm (in)	Approximately 200 (7.87)		

				Engine Model	
				4HE1-TC (4HE1-XS, XN) 98EPA	4HE1-TC (4HE1-XS) SPEC. EURO3
Item	Engine type			Four-cycle, overhead camshaft, water cooled	
	Combustion chamber type			Direct injection	
	Cylinder liner type			Dry liner, special compound metal	
	Timing drive system			Gear drive	
	No. of cylinders — Bore × stroke		mm (in)	4 — 110 × 125 (4 — 4.33 × 4.92)	
	No. of piston rings			Compression rings 3, oil ring 1	
	Total piston displacement		cm ³ (in ³)	4751(289.9)	
	Compression ratio		to : 1	17.3	
	Compression pressure		kPa (kg / cm ² / psi) — rpm	3,040 (31/441) — 200	
	Fuel injection order			1— 3 — 4 — 2	
	Fuel injection timing (BTDC)		deg	8	9
	Specified fuel type			SAE No. 2 diesel fuel	
	Idling speed		rpm	775 — 825	
	Valve system				
	Valve clearances (At cold):		Intake mm (in) Exhaust mm (in)	0.4 (0.016) 0.4 (0.016)	
	Valve timing (At valve clearances 0.4 mm (0.016 in))				
	Intake valves		Open at (BTDC)	deg	14
			Close at (ABDC)	deg	51
	Exhaust valves		Open at (BBDC)	deg	49
			Close at (ATDC)	deg	16

00-22 SERVICE INFORMATION

		Engine Model	
		4HE1-TC (4HE1-XS, XN) 98EPA	4HE1-TC (4HE1-XS) SPEC. EURO3
Item	Fuel system		
	Injection pump type	Bosch in-line MI-TICS Different injection fuel quantity between 98EPA and EURO3, or XS and XN	
	Plunger outside diameter mm (in)	11 (0.433)	
	Plunger lift mm (in)	12 (0.472)	
	Governor type	RLD-M mechanical (Variable speed)	
	Automatic timer type	Electronic control	
	Fuel feed pump type	Piston	
	Injection nozzle opening		
	Injection nozzle type	Hole type (with 6 × 0.22φ orifices) (with 6 × 0.21φ orifices)	
	Pressure MPa (kg / cm ² / psi)	21.6 (220 / 3,128)	
	Pressure adjustment	Shim adjusted	
	Main fuel filter type	Disposal spin-on cartridge and remote mounted water separator	
	Lubricating system		
	Lubrication method	Full flow pressure circulation	
	Specified engine oil (API grade)	CD or above	
	Oil pressure kPa (kg / cm ² / psi) — rpm	147 (1.5 / 21) — 700 (SAE 10W-30 API CD grade engine oil at 80°C (176°F))	
	Oil pump type	Gear type	
	Oil filter type	Spin-on cartridge	
	Oil capacity lit (US / UK gal)	13 (3.43 / 2.86)	
	Oil cooler type	Water cooled	
	Cooling system		
	Radiator type	Corrugated fin with reserve tank	
	Coolant capacity lit (US / UK gal)	11 (3.70 / 3.08)	
	Water pump type	Centrifugal impeller, V-belt drive	
	Pump to crankshaft speed to : 1 ratio	1.19	
	Delivery volume lit (US / UK gal)/min	200 (52.8 / 44.0) (Pump speed at 3,300 rpm Water temperature at 82°C (180°F))	
	Pump bearing type	Double row shaft	
	Thermostat type	Wax pellet	
	Valve initial opening tem- °C (°F) perature	With jiggle valve: 85 ± 1.5 (182 — 188) Without jiggle valve Primary: 82 ± 2 (176 — 183) Secondary: 85 ± 2 (181 — 189)	
	Valve lift mm (in)	With jiggle valve: 8 (0.3) or more at 100°C (212°F) Without jiggle valve: 8 (0.3) or more at 95°C (203°F)	

		Engine Model	
		4HE1-TC (4HE1-XS, XN) 98EPA	4HE1-TC (4HE1-XS) SPEC. EURO3
Item	Air cleaner type	Dry paper element or wet paper element	
	Battery type Model / Volt-amp.hr.	80D26R / 12-65 : 2 pcs	
	Generator		
	Type	AC brush with IC regulator and vacuum pump	
	Voltage	12 (For Venezuela) 24 (Except Venezuela)	
	Drive and rotation	V-belt, clockwise viewed from the drive pulley	
	Ground polarity	Negative	
	Maximum output V / A / rpm	12 / 80 at 5,000 (Hitachi) (For Venezuela) 24 / 50 at 5,000, 24 / 60 at 5,000 (Hitachi) 24 / 80 at 5,000 (Hitachi) (Except Venezuela)	
	Maximum speed rpm	7,500 — 10,000	
	Regulator		
	Type	IC	
	Regulating voltage V	28 — 29 (Except Venezuela)	
	Vacuum pump		
	-66.7 kPa (-500 mmHg / -9.67 psi) build-up time	13 seconds or less at 1,000 rpm 4 seconds or less at 5,000 rpm	
	Maximum vac- kPa (mmHg / psi) uum	-90.7 (-680 / -13.1) or more at 5,000 rpm	
	Starter motor		
	Type	Magnetic solenoid-controlled	
	Model	R3.0 (For Venezuela) S25-505D (Except Venezuela)	
	Rated voltage V	12 (For Venezuela) 24 (Except Venezuela)	
	Rated output kW	3 (For Venezuela) 4.5 (Except Venezuela)	
	Load characteristics		
	Terminal voltage V	14.3 (Except Venezuela)	
	Load current A	890 (MAX) (For Venezuela) 400 (Except Venezuela)	
	Torque N·m (kg·m / lb·ft)	29.4 (2.99 / 21.63) at 860 rpm or more (For Venezuela) 25.0 (2.55 / 18.4) at 1,000 rpm or more (Except Venezuela)	

00-24 SERVICE INFORMATION

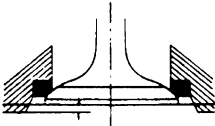
		Engine Model	
		4HE1-TC (4HE1-XS, XN) 98EPA	4HE1-TC (4HE1-XS) SPEC. EURO3
	Preheating system	Quick-On-Start System II	
	Exhaust system		
	Pipe outside diameter × Thickness		
	Front pipe mm (in)	60.5×2.0 (2.38×0.079)	
	Middle pipe mm (in)	60.5×2.0 (2.38×0.079)	
	Rear pipe mm (in)	60.5×1.6 (2.38×0.063)	
	Silencer type	Silencer with built-in catalytic converter (platinum)	Silencer with built-in catalytic converter (iron oxide)
	Inside diameter mm (in)	Approximately 200 (7.87)	
	Exhaust gas recirculation system (EGR)	Equipped	Equipped (cooled)

SERVICE STANDARD

Engine

Item	Service Standard	Service Limit
Compression Pressure KPa (kg / cm ² / psi) / rpm	3040 (31 / 441) or more Variance in pressure between the cylinders: less than 294 (3 / 43) / 200	2,157 (22 / 312)

Cylinder Head

Item	Service Standard	Service Limit
Inlet and Exhaust Valve Seat Depression mm (in)  N6A1400E	0.7 — 1.2 (0.028 — 0.047) Measurement should be taken by using a new valve.	2.5 (0.098)
Cylinder Head Lower Face Warpage mm (in)	0.05 (0.002) or less Do not regrind the cylinder head lower face.	0.2 (0.008)
Manifold Fitting Face Warpage mm (in)	0.05 (0.002) or less	0.2 (0.008)
Water Leak Test kPa (kg / cm ² / psi)	490 (5 / 71) — 3 minutes	Repair or replace those having water leak.

Cylinder Head Gasket Selection

Remarks:

The grade mark of the cylinder head gasket is shown by semicircular notches on the left side of the front portion of the gasket.

4HF1/4HF1-2/4HG1-T

Cylinder Head Gasket Selection

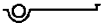
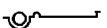
		mm (in)	
Gasket Grade	Ti max	Gasket Thickness (Reference)	
A 	0.579 - 0.659 (0.0228 - 0.0259)	1.70 (0.0669)	
B 	0.659 - 0.739 (0.0259 - 0.0291)	1.75 (0.0689)	
C 	0.739 - 0.819 (0.0291 - 0.0322)	1.80 (0.0708)	

N6A1401E

00-26 SERVICE INFORMATION

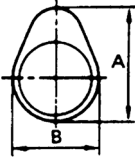
4HE1-TC

Cylinder Head Gasket Selection

		mm (in)	
Gasket Grade		Ti max	Gasket Thickness (Reference)
A		0.529 - 0.609 (0.0208 - 0.0240)	1.70 (0.0669)
B		0.609 - 0.679 (0.0240 - 0.0267)	1.75 (0.0689)
C		0.679 - 0.759 (0.0267 - 0.0300)	1.80 (0.0708)

N6A1404E

Camshaft

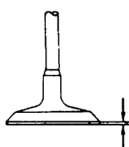
Item		Service Standard	Service Limit
Cam Height	mm (in)	52.75 — 52.91 (2.076 — 2.083)	51.8 (2.039)
			
Camshaft Journal Uneven Wear	mm (in)	0.015 (0.0006) or less	0.05 (0.002)
Camshaft Journal Wear	mm (in)	39.950 — 39.975 (1.5728 — 1.5738)	39.850 (1.569)
Camshaft Journal and Bearing Clearance	mm (in)	0.025 — 0.087 (0.00098 — 0.00343)	0.15 (0.0059)
Camshaft Run-Out	mm (in)	0.04 (0.0016) or less against the adjacent journal	0.05 (0.002)

Rocker Arm and Rocker Arm Shaft

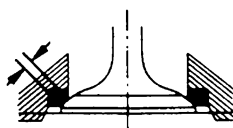
Item		Service Standard	Service Limit
Rocker Arm Shaft Wear	mm (in)	21.979 — 22.000 (0.8653 — 0.8661)	21.85 (0.860)
Rocker Arm Bushing Wear	mm (in)	22.010 — 22.035 (0.8665 — 0.8675)	22.15 (0.872)
Rocker Arm and Rocker Arm Shaft Clearance	mm (in)	0.010 — 0.056 (0.0004 — 0.0022)	0.2 (0.008)
Rocker Arm Shaft Run-Out	mm (in)		0.3 (0.012)
Rocker Arm Roller and Pin Clearance	mm (in)	0.040 — 0.084 (0.0016 — 0.0033)	0.5 (0.020)
Roller Surface			When there is an excessive wear or deformation found, replace it. When it is damaged only slightly, correct it with an oil stone.

Valve

Item		Service Standard	Service Limit
Valve Stem Wear	mm (in)	Inlet 8.946 — 8.961 (0.3522 — 0.3528)	8.88 (0.35)
		Exhaust 8.921 — 8.936 (0.3512 — 0.3529)	8.80 (0.34)
Valve Stem and Valve Guide Clearance	mm (in)	Inlet 0.038 — 0.071 (0.0015 — 0.0028)	0.20 (0.0079)
		Exhaust 0.064 — 0.096 (0.0025 — 0.0038)	0.25 (0.0098)
Valve Guide and Cylinder Head Interference	mm (in)	0.005 — 0.040 (0.0002 — 0.0016) Press it in with the valve guide applied with engine oil.	
Valve Thickness	mm (in)	Inlet Nominal size 1.80 (0.071)	1.3 (0.051)
		Exhaust Nominal size 1.75 (0.069)	1.3 (0.051)
Valve Contact Width	mm (in)	Inlet Nominal size 2.5 (0.098)	3.0 (0.118)
		Exhaust Nominal size 2.0 (0.079)	2.5 (0.098)

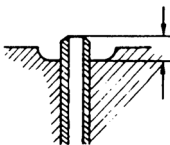
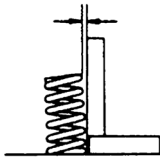
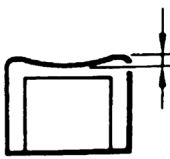


N6A1408E

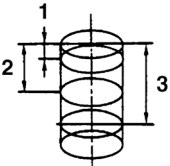


N6A1409E

00-28 SERVICE INFORMATION

Item		Service Standard	Service Limit
Valve Guide Upper End Height	mm (in)	14.1±0.2 (0.555±0.008)	
	N6A1410E		
Valve Stem Seal Lip Wear	mm (in)	8.3 — 8.7 (0.3268 — 0.3425)	8.8 (0.346)
Valve Spring Tension	N (kg / lb)	414 — 477 (42.2 — 48.6 / 93 — 107) Set length 47.0 mm (1.85 in)	40.9 (98 / 401)
Valve Spring Free Height	mm (in)	Nominal size 62.5 (2.46)	59.4 (2.34)
Valve Spring Squareness	mm (in)		1.0 (0.04)
	N6A1411E		
Valve Clearance (At cold)	mm (in)	0.4 (0.016)	
Valve Stem Cap Wear	mm (in)		0.5 (0.02) Replace it when worn or deformed excessively.
	N6A1412E		

Cylinder Body

Item		Service Standard	Service Limit
Cylinder Liner Bore Wear	mm (in)	4HF1: 112.021 — 112.050 4HF12: (4.4103 — 4.4114) 4HG1: 115.021 — 115.050 4HG1-T: (4.5284 — 4.5295) 4HE1-TC: 110.041 — 110.080 (4.3323 — 4.3338)	112.20 (4.417) 115.20 (4.535) 115.20 (4.535)
	N6A1413E		
1. 20 mm (0.79 in) 2. 90 mm (3.54 in) 3. 160 mm (6.30 in)			
Cylinder Liner Projection	mm (in)	0.10 — 0.14 (0.0039 — 0.0055) The difference in the cylinder liner projection height between any two adjacent cylinders must not exceed 0.03 (0.0012)	There must be a projection on the cylinder liner.
Cylinder Body Upper Face Warpage	mm (in)	0.05 (0.002) or less Do not regrind the cylinder body upper face.	0.02 (0.008)

Item		Service Standard	Service Limit
Water Leak Test	kPa (kg / cm ² / psi)	490 (5 / 71) — 3 minutes	Repair or replace those having water leak.

Cylinder Liner Grade Selection

Remarks:

Cylinder Bore Grade Mark Position

The grade mark (1, 2 or 3) of the cylinder bore is stamped on the position just beside each cylinder on the upper left side (the upper portion of the oil cooler installation face) of the cylinder body.

Cylinder Liner Grade Mark Position

The outside diameter grade mark (1, 2 or 3) of the cylinder liner is stamped on the position approximately 160mm from the top face of the liner.

4HF1/4HF1-2

Line Grade	Cylinder Bore Diameter mm (in)	Service Grade	Liner Outside Diameter mm (in)
1	115.001 — 115.010 (4.5276 — 4.5279)	1X	114.991 — 115.000 (4.5272 — 4.5276)
2	115.011 — 115.020 (4.5280 — 4.5283)	3X	115.001 — 115.010 (4.5276 — 4.5279)
3	115.021 — 115.030 (4.5284 — 4.5287)		

4HG1 / 4HG1-T

Line Grade	Cylinder Bore Diameter mm (in)	Service Grade	Liner Outside Diameter mm (in)
1	118.001 — 118.010 (4.6457 — 4.6461)	1X	117.991 — 118.000 (4.6453 — 4.6457)
2	118.011 — 118.020 (4.6461 — 4.6464)	3X	118.001 — 118.010 (4.6457 — 4.6461)
3	118.021 — 118.030 (4.6465 — 4.6468)		

4HE1-TC

Line Grade	Cylinder Bore Diameter mm (in)	Service Grade	Liner Outside Diameter mm (in)
1	115.001 — 115.010 (4.5276 — 4.5279)	1X	115.021 — 115.030 (4.5284 — 4.5287)
2	115.011 — 115.020 (4.5280 — 4.5283)	3X	115.031 — 115.040 (4.5289 — 4.5291)
3	115.021 — 115.030 (4.5284 — 4.5287)		

Crankshaft

Item		Service Standard	Service Limit
Crankshaft Journal and Crankpin Uneven Wear		mm (in)	0.05 (0.002)
Crankshaft Journal Wear	No. 1, 2, 4 and 5	81.905 — 81.925 (3.2246 — 3.2254)	81.85 (3.2224)
	mm (in) No. 3	81.890 — 81.910 (3.2240 — 3.2248)	81.85 (3.2224)
Crankshaft Journal and Bearing Clearance	No. 1, 2, 4 and 5	0.037 — 0.072 (0.0015 — 0.0028)	0.11 (0.0043)
	mm (in) No. 3	0.051 — 0.086 (0.0020 — 0.0034)	0.11 (0.0043)
Crankpin Wear		4HF1, 4HG1, 4HG1-T: 65.902 — 65.992 (2.5946 — 2.5954)	65.85 (2.5925)
		4HE1-TC: 72.920 — 72.922 (2.8709 — 2.8433)	72.850 (2.8681)
Crankshaft Journal Bearing Spread		mm (in)	87 (3.43)
Crankshaft End Play		mm (in)	0.104 — 0.205 (0.0041 — 0.0081)
Crankshaft Run-Out		mm (in)	0.05 (0.002) or less
Crankshaft Front and Rear Oil Seal and Slinger Wear			When there is an oil leak found, the oil seal and slinger must be replaced as a set. Insert it securely with a special tool.

Crankshaft Journal Bearing Selection

Remarks:

Crankshaft Bearing Housing Grade Mark Position

The crankshaft bearing housing grade marks (1 or 2) are stamped collectively for all cylinders on the underside of the left front portion of the cylinder body.

Crankshaft Journal Grade Mark Position

The crankshaft journal grade marks (1 or 2) are stamped collectively for all cylinders on the front side of the crankshaft No. 1 balancer

Crankshaft Bearing Grade Mark Position

The identification color code (black, brown or blue) of the crankshaft journal bearing grade mark is applied on the side of each bearing.

Crankshaft Journal No. 1, 2, 4 and 5

Bearing Housing		Crankshaft Journal		Crankshaft Bearing Color Code
Grade Mark	(Reference) Inside Diameter mm (in)	Grade Mark	(Reference) Outside Diameter mm (in)	
1	87.000 — 87.009 (3.4252 — 3.4255)	1	81.905 — 81.915 (3.2246 — 3.2250)	Black
		2	81.916 — 81.925 (3.2250 — 3.2254)	Brown
2	87.010 — 87.019 (3.4256 — 3.4259)	1	81.905 — 81.915 (3.2246 — 3.2250)	Blue
		2	81.916 — 81.925 (3.2250 — 3.2254)	Black

Crankshaft Journal No. 3

Bearing Housing		Crankshaft Journal		Crankshaft Bearing Color Code
Grade Mark	(Reference) Inside Diameter mm (in)	Grade Mark	(Reference) Outside Diameter mm (in)	
1	87.000 — 87.009 (3.4252 — 3.4255)	1	81.890 — 81.900 (3.2240 — 3.2244)	Black
		2	81.901 — 81.910 (3.2244 — 3.2248)	Brown
2	87.010 — 87.019 (3.4256 — 3.4259)	1	81.890 — 81.900 (3.2240 — 3.2244)	Blue
		2	81.901 — 81.910 (3.2244 — 3.2248)	Black

Piston

Item	Service Standard	Service Limit
Piston and Cylinder Liner Clearance mm (in)	4HG1: 0.081 — 0.116 (0.0032 — 0.0044)	
	4HF1: 0.081 — 0.113 (0.0032 — 0.0044)	
	4HE1-TC: 0.091 — 0.131 (0.0036 — 0.0052)	

Piston Grade Selection

Remarks:

Piston Grade Mark Position

The piston grade marks (i.e. A, B, C) are stamped on the piston upper face.

Piston Outside Diameter Measuring Position

Take measurement of the Piston at the position 82mm (3.23 in) from the top in the direction of the longer diameter.

Piston Grade

Engine model	Cylinder Liner Bore Diameter mm (in)	Piston Service Grade	Piston Outside Diameter mm (in)
4HF1 4HF1-2	112.041 — 112.060 (4.4111 — 4.4118)	—	111.947 — 111.960 (4.4074 — 4.4079)
4HG1 4HG1-T	115.040 — 115.060 (4.5291 — 4.5299)	—	114.944 — 114.959 (4.5253 — 4.5259)
4HE1-TC	110.066 — 110.075 (4.3333 — 4.3337)	AX	109.944 — 109.959 (4.3285 — 4.3291)
	110.076 — 110.085 (4.3337 — 4.3340)	CX	109.960 — 109.975 (4.3291 — 4.3297)

Piston Pin

Item	Service Standard	Service Limit
Piston Pin Wear mm (in)	4HF1 4HF1-2 4HG1 4HG1-T 35.995 — 36.000 (1.4171 — 1.4173)	35.970 (1.4161)
	4HE1-TC 39.995 — 40.000 (1.5746 — 1.5748)	39.970 (1.5736)

00-32 SERVICE INFORMATION

Item		Service Standard	Service Limit
Piston and Piston Pin Clearance	mm (in)	0.004 — 0.017 (0.0002 — 0.0007)	0.04 (0.0016)
		Clearance should be wide enough for the piston pin to be inserted under the condition where the piston is heated to the temperature of 80°C to 100°C (176°F to 212°F).	When an abnormal striking sound is heard, replace the piston and the piston pin.

Piston Ring

Item			Service Standard	Service Limit
Piston Ring Gap (Inside the cylinder) mm (in)	4HF1 4HF1-2	1st Compression Ring	0.24 — 0.39 (0.0094 — 0.0153)	1.50 (0.0591)
		2nd Compression Ring	0.35 — 0.50 (0.0138 — 0.0197)	1.50 (0.0591)
		Oil Ring	0.02 — 0.40 (0.0008 — 0.0157)	1.50 (0.0591)
	4HG1 4HG1-T	1st Compression Ring	0.24 — 0.39 (0.0094 — 0.0153)	1.50 (0.0591)
		2nd Compression Ring	0.35 — 0.50 (0.0138 — 0.0197)	1.50 (0.0591)
		Oil Ring	0.15 — 0.35 (0.00591 — 0.0138)	1.50 (0.0591)
	4HE1-TC	1st Compression Ring	0.24 — 0.40 (0.0094 — 0.0157)	1.50 (0.0591)
		2nd Compression Ring	0.30 — 0.40 (0.0118 — 0.0157)	1.50 (0.0591)
		3rd Compression Ring	0.30 — 0.40 (0.0118 — 0.0157)	1.50 (0.0591)
		Oil Ring	0.02 — 0.40 (0.0008 — 0.0157)	1.50 (0.0591)
Piston Ring & Piston Ring Groove Clearance mm (in)	4HF1 4HF1-2	1st Compression Ring	0.062 — 0.092 (0.0024 — 0.0036)	0.2 (0.0078)
		2nd Compression Ring	0.04 — 0.08 (0.0015 — 0.0031)	0.15 (0.0059)
		Oil Ring	0.02 — 0.06 (0.0008 — 0.0024)	0.15 (0.0059)
	4HG1 4HG1-T	1st Compression Ring	0.062 — 0.092 (0.0024 — 0.0036)	0.2 (0.0078)
		2nd Compression Ring	0.04 — 0.08 (0.0015 — 0.0031)	0.15 (0.0059)
		Oil Ring	0.02 — 0.06 (0.0008 — 0.0024)	0.15 (0.0059)
	4HE1-TC	1st Compression Ring	0.09 — 0.13 (0.0035 — 0.0051)	0.2 (0.0078)
		2nd Compression Ring	0.09 — 0.13 (0.0035 — 0.0051)	0.2 (0.0078)
		3rd Compression Ring	0.09 — 0.13 (0.0035 — 0.0051)	0.2 (0.0078)
		Oil Ring	0.03 — 0.07 (0.0012 — 0.0028)	0.15 (0.0059)
The direction of the piston ring connecting end			Alternately at 180°. Don't position the connecting end in the side pressure direction. Place the connecting end of the oil ring and that of the expander coil at 180° alternately.	

Connecting Rod

Item		Service Standard	Service Limit
Connecting Rod Alignment	mm (in)	Distortion	0.05 (0.002) or less
		Parallelism	0.05 (0.002) or less
Connecting Rod Small End Bushing and Piston Pin Clearance		mm (in)	0.012 — 0.027 (0.0005 — 0.0011)
			There must be clearance enough to rotate the piston pin while holding it lightly with its large end fixed.
Connecting Rod Bearing Spread		mm (in)	70 (2.77) or more

Item		Service Standard	Service Limit
Connecting Rod Bearing and Crankpin Clearance	mm (in)	0.036 — 0.077 (0.0014 — 0.0030)	0.10 (0.004)
The difference in weight between the connecting rod and the piston when assembled.	N (gr / lb)		0.2 (20 / 0.28)

Connecting Rod Bearing Selection

Remarks:

The connecting rod big end inside diameter grade marks (A or B) are stamped on top of the cylinder number align marks of the big end.

4HF1 / 4HF1-2 / 4HG1 / 4HG1-T

Connecting Rod Big End		Crankpin	Big End Bearing Color Code
Grade Mark	(Reference) Inside Diameter mm (in)	(Reference) Outside Diameter mm (in)	
A	69.985 — 69.992 (2.7553 — 2.7556)	65.902 — 65.922 (2.5946 — 2.5954)	Green
B	69.993 — 70.000 (2.7556 — 2.7559)	65.902 — 65.922 (2.5946 — 2.5954)	Yellow

4HE1-TC

Connecting Rod Big End		Crankpin	Big End Bearing Color Code
Grade Mark	(Reference) Inside Diameter mm (in)	(Reference) Outside Diameter mm (in)	
A	77.985 — 77.992 (3.0702 — 3.0705)	72.902 — 72.922 (2.8702 — 2.8709)	Green
B	77.993 — 78.000 (3.0706 — 3.0709)	72.902 — 72.922 (2.8702 — 2.8709)	Yellow

Flywheel

Item		Service Standard	Service Limit
Flywheel Thickness	mm (in)	31.4 — 31.6 (1.236 — 1.244) (Flywheel friction surface — crankshaft setting face)	31.0 (1.22)
Friction Surface Run-Out	mm (in)		0.2 (0.008)
Friction Surface Roughness	mm (in)	0.006 (0.0002) or less	
Ring Gear			The tooth face burr must be chamfered. Replace ones when damaged excessively.

Gear Train

Item		Service Standard	Service Limit
Timing Gear Backlash Gear to Gear (In the direction of a normal line)	mm (in)	0.10 — 0.17 (0.0039 — 0.0067) Hold both the gear to be checked and the adjoining gear stationary.	0.30 (0.012)
Crankshaft Gear and Crankshaft Interference	mm (in)	0.03 — 0.093 (0.0012 — 0.0037)	
Camshaft Gear and Camshaft Inter- ference	mm (in)	0.015 — 0.023 (0.0006 — 0.0009)	
Idle Gear Shaft Wear	mm (in)	29.959 — 29.980 (1.1795 — 1.1803)	29.80 (1.1732)
Idle Gear Bushing Wear	mm (in)	30.000 — 30.021 (1.1811 — 1.1819)	30.1 (1.185)
Idle Gear Bushing and Idle Gear Shaft Clearance	mm (in)	0.020 — 0.062 (0.0008 — 0.0024)	0.2 (0.008)
Idle Gear End Play	mm (in)	0.058 — 0.115 (0.0002 — 0.005)	0.2 (0.008)

Lubrication System

Item			Service Standard	Service Limit
Oil Pump	Gear Teeth and Inner Wall Clearance	mm (in)	0.125 — 0.220 (0.0049 — 0.0087)	0.3 (0.012)
	Gear and Pump Cover Clearance	mm (in)	0.064 — 0.109 (0.0018 — 0.0043)	0.2 (0.008)
	Gear Shaft Wear	mm (in)	15.989 — 16.000 (0.6295 — 0.6299)	15.9 (0.626)
	Gear Shaft and Bush- ing Clearance	mm (in)	0.04 — 0.07 (0.0016 — 0.0028)	0.2 (0.012)
	Delivery Volume	cc (cu-in)/rev	16.54 (1.0) Delivery Pressure: 392kPa (4 kg/cm ² / 56.9 psi) Oil Temperature: 50 ± 2°C (122 ± 3.6°F) Oil Viscosity: SAE 30	
Relief Valve Opening Pressure		Oil Gallery	441.3 (4.5 / 64.0)	(Reference)
kPa (kg/cm ² / psi)		Oil Pump	784.5 (8.0 / 113.8)	(Reference)

Cooling System

Item			Service Standard	Service Limit
Water Pump	External appearance		Check the following: • Cracks and damages of the pump body • Cracks and corrosion of the impeller • Water leak from the seal unit When an abnormal condition is found, replace the water pump as an assembly.	
	Seal Unit		Push the fan center in the radial direction while rotating it and check the seal unit for any excessive play or abnormal sound. When there is any abnormal condition found, replace the water pump as an assembly.	
	Delivery Volume lit (US / UK gal) / min		200 or more Water Pump Speed: 3,300 rpm Water Temperature: 80 ± 2°C (176 ± 3.6°F)	
Fan Drive Belt Tension	mm (in)	8 — 12 (0.31 — 0.47) ... New belt 10 — 14 (0.39 — 0.55) ... Reuse belt Depress the drive belt mid-portion with a 98N (10kg / 22lb) force		
Thermostat With Jiggle Valve	Valve Initial Opening Temperature	°C (°F)	85 ± 1.5 (185 ± 2.7)	
	Valve Lift At 100°C (212°F)	mm (in)	8 (0.31) or more	
Thermostat With-Out Jiggle Valve	Valve Initial Opening Temperature	°C (°F)	82 ± 1.5 (177 — 182)	
	Valve Lift At 95°C (203°F)	mm (in)	8 (0.31) or more	
Radiator	External appearance		• Check the radiator for any corrosion, water leak, fin damage, or clogging. When there is any abnormal condition found, correct the radiator or replace it. • When deterioration, cracking or water leak is found in the rubber hose, replace the rubber hose.	
	Pressure Valve Opening Pressure	kPa (kg/cm ² /psi)	103.0 ± 14.7 (1.05 ± 0.15 / 14.9 ± 2.1)	
	Vacuum Valve Opening Pressure	kPa (kg/cm ² /psi)	1.0 — 4.9 (0.01 — 0.05 / 0.14 — 0.71)	
Cooling Fan	Cooling Fan Pulley Speed	rpm	3,900	Rotate the fan by hand, and when it doesn't rotate smoothly, or when there is oil leak from the fan clutch, replace the fan clutch.
	Cold Condition (Bi-metal lower than 40°C (104°F))	rpm	900 or lower	
	Hot Condition (Bi-metal higher than 70°C (158°F))	rpm	3,300 ± 150	
	Pulley Ratio (Crankshaft/Fan)		175 / 151	

Fuel System

Item		Service Standard	Service Limit
Fuel Feed Pump	Suction capacity	The suction must be completed in 25 times or less. Priming Pump Speed: 60 — 100 times/minute Pipe Inside Diameter: 8mm (0.31in) Suction Pipe Length: 2,000mm (78.7 in) Suction Height: 1,000mm (39.4in)	
Injection Nozzle	Spray Condition	- The spray must be fine and uniform. - The injection must be directed in the center direction with no stray spray. - The spray from each nozzle hole must be uniform	

Engine Electrical

Item		Service Standard	Service Limit
Generator	Ball bearing		When it doesn't rotate smoothly or is giving out an abnormal sound, or when there is an oil leak from the seal, replace it.
	Slip Ring Diameter mm (in)	Nominal size 31.6 (1.244)	30.6
	Rotor	Coil Resistance Ω	Nominal resistance 12.6
		Coil Insulation Resistance $M\Omega$	1 or more (500 volt megger tester)
	Stator	Coil Resistance Ω	Nominal resistance 0.17 (Between coil end and each coil end)
		Coil Insulation Resistance $M\Omega$	1 or more (500 volt megger tester)
	Brush Length mm (in)	Nominal size 20 (0.79)	6 (0.24)
IC Voltage Regulator	Rectifier	The rectifier is normal when there is continuity with the tester - terminal connected to "B" (battery) terminal and the + terminal to the rectifier holder, and when there is no continuity with their connections reversed.	When there is continuity in both directions, or when there is no continuity in both directions, replace the rectifier.
	Battery Power V	<4HF1 / 4HF1-2 / 4HG1 / 4HG1-T> LR 250 — 504 (24V - 60A) LR 250 — 508B (24V - 50A) DENSO (12V - 35A)	28 — 29 28 — 29 27.8 — 28.8
		<4HE1-TC> LR 250 — 510 (24V - 50A) LR 180 — 510 (12V - 80A)	28 — 29 14.1 — 14.7

Item			Service Standard			Service Limit
IC Voltage Regulator	Output Current	A	1300 rpm	2000 rpm	4000 rpm	
			<4HF1 / 4HF1-2 / 4HG1 / 4HG1-T> LR 250 — 504 18 35 53 LR 250 — 508B 15 32 46 DENSO 12 18 37 <4HE1-TC> LR 250 — 510 15 32 43 LR 180 — 510 25 58 82			
	Pulley Ratio (Crankshaft/Generator)		175 / 82			
Vacuum Pump	Pump Housing Inside Diameter	mm (in)	60.0 — 60.1 (2.362)			(Reference)
	Vane Length	mm (in)	14.2 — 15.2 (0.559 — 0.598)			(Reference)
	Performances Time required for the pressure to get to -66.7kPa (-500mmHg / -9.7psi).		1,000 rpm 13 sec or less 1,000 rpm 35 sec or less (LR 180 — 510 only) 5,000 rpm 4 sec or less 5,000 rpm 10 sec or less (LR 180 — 510 only) Oil Viscosity: SAE 30 Oil Temperature: $70 \pm 5^{\circ}\text{C}$ ($158 \pm 9^{\circ}\text{F}$) Oil Pressure: 441kPa (4.5 kg / cm^2 / 64psi) Tank Capacity: 7,000cc (427 cu-in)			
	Check Valve		• Apply 98 — 490 kPa (1 — 5 kg/cm^2 14-71 psi) compressed air to pump side of the check valve. • Check for air leakage from the check valve. • If there is air leakage, the check valve must be replaced.			
Starter	Commutator Run-Out	mm (in)	0.05 (0.002) or less			0.2 (0.008)
	Commutator Outside Diameter	mm (in)	36.5 (1.437)			35.5 (1.398)
	Mica Segment Depth	mm (in)	0.5 — 0.8 (0.020 — 0.031)			0.2 (0.008)
	Brush Length	mm (in)	15.0 (0.591)			10.5 (0.413)
	Brush Spring Tension	N (kg / lb)	24.5 — 34.3 (2.5 — 3.5 / 5.5 — 7.7)			

00-38 SERVICE INFORMATION

Item			Service Standard	Service Limit																																																													
Starter	Load Characteristics																																																																
	Terminal Voltage	V	18.55																																																														
	Load Current	A	250																																																														
	Torque	N·m (kg·m / lb·ft)	14.2 (1.45 / 10.5) or more																																																														
	Speed	rpm	860																																																														
			<table><tr><td></td><td colspan="10">Terminal</td></tr><tr><td></td><td>ACC</td><td>B</td><td>ON</td><td>ST</td><td>B1</td><td>P1</td><td>P2</td><td>W</td><td>W</td></tr><tr><td>LOCK</td><td></td><td></td><td></td><td></td><td>○—○</td><td>○</td><td></td><td></td><td></td></tr><tr><td>ACC</td><td>○—○</td><td>○</td><td></td><td></td><td>○—○</td><td>○</td><td></td><td>○—○</td><td>○</td></tr><tr><td>ON</td><td>○—○</td><td>○—○</td><td>○</td><td></td><td>○—○</td><td>○</td><td>○</td><td></td><td></td></tr><tr><td>START</td><td></td><td>○—○</td><td>○—○</td><td>○</td><td>○—○</td><td>○</td><td>○</td><td></td><td></td></tr></table>		Terminal											ACC	B	ON	ST	B1	P1	P2	W	W	LOCK					○—○	○				ACC	○—○	○			○—○	○		○—○	○	ON	○—○	○—○	○		○—○	○	○			START		○—○	○—○	○	○—○	○	○			
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				N6A1414E																																																													
Preheating system (QOSII)	Time required for the glow indicator to light up	sec	3.5 After the key switch is turned to ON position without engine turned.																																																														
	Time required for the source voltage to be supplied to the glow plug	sec	18 After the key switch is turned to ON position without engine turned.																																																														
	Glow Relay Coil Resistance	Ω	Nominal resistance 51.5																																																														
	Thermo Switch Operating Temperature	°C (°F)	OFF → ON: 7 — 13 (44.6 — 55.4) ON → OFF: Less 3 (37.4)																																																														
	Glow Plug Continuity			If no continuity exists, must be replaced.																																																													

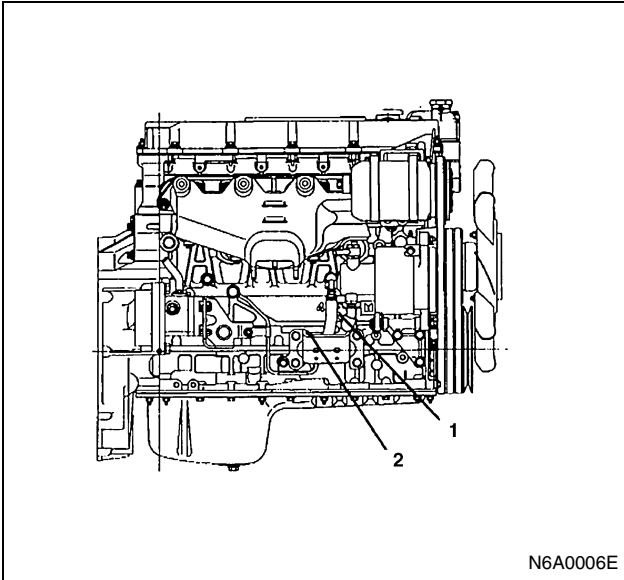
SERVICING

Servicing refers to general maintenance procedures to be performed by qualified service personnel.

Model Identification

Engine Serial Number

The engine number is stamped on the front left hand side of the cylinder body.



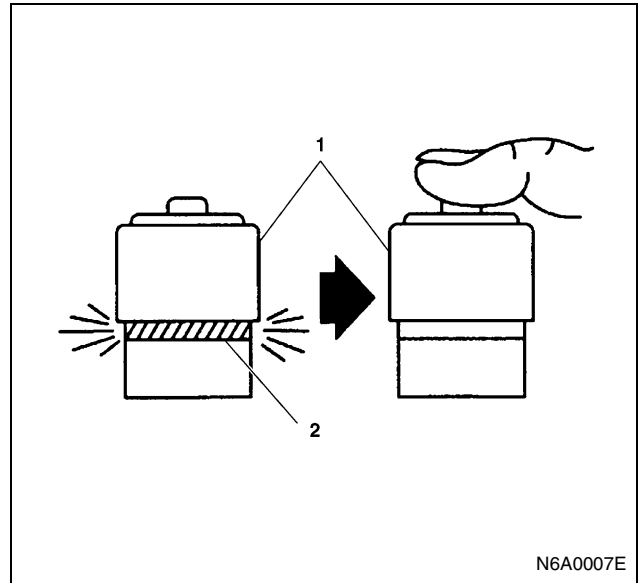
Legend

1. Engine type
2. Engine number

Air Cleaner

Dust Indicator

1. The dust indicator is installed to the air cleaner. (for Australia and GCC)
Inspect the dust indicator. If the indicator plate is red, the air cleaner element must be cleaned or replaced.
2. Clean the air cleaner element once and reinstall it. Press the dust indicator button to clear the dust indicator.

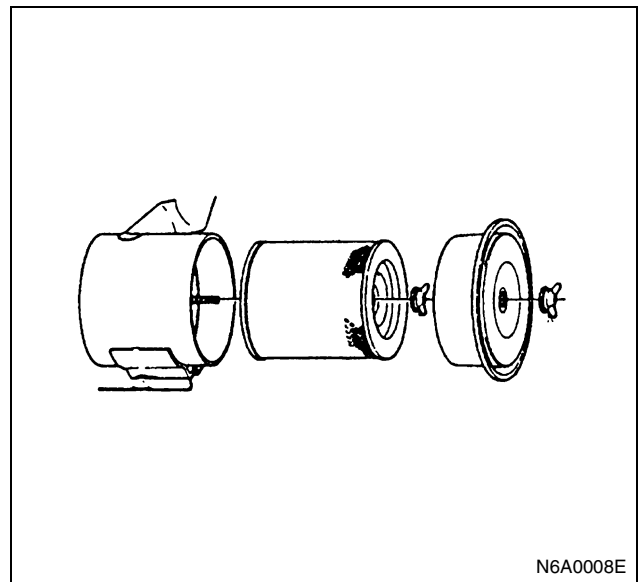


Legend

1. Dust indicator
2. Red color

Dry Type Washable Paper Element

Element cleaning procedures will vary according to the condition of the element.



Dust Fouled Element

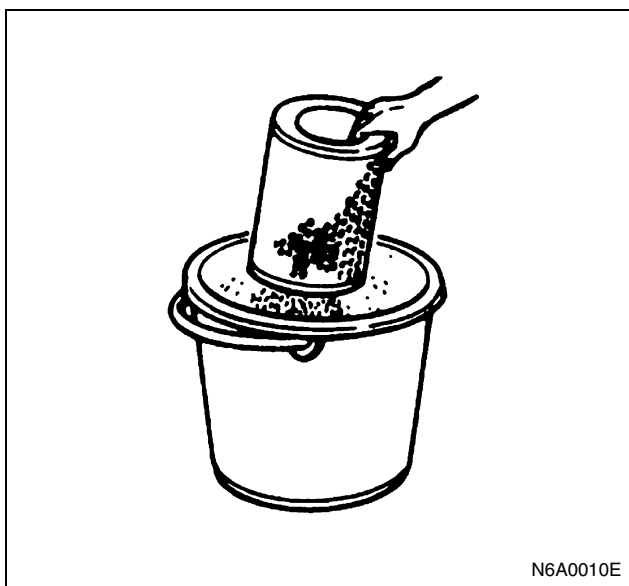
Rotate the element with your hand while applying compressed air to the inside of the element. This will blow the dust free.

Compressed air pressure must not exceed 686 kPa (7 kg/cm² / 99.6 psi).



Carbon and Dust Fouled Element

1. Prepare a cleaning solution of Isuzu Genuine Element Cleaner (Donaldson D1400) diluted with water.
2. Immerse the element in the solution for twenty minutes.



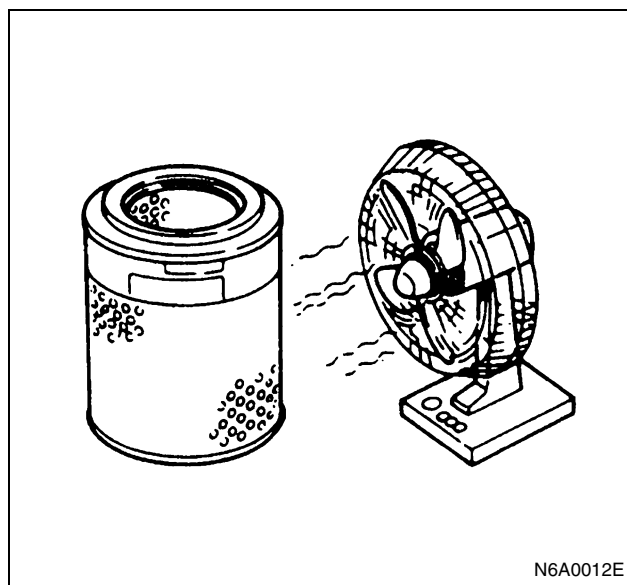
3. Remove the element from the solution and rinse it well with running water.
Water pressure must not exceed 274 kPa (2.8 kg/cm² / 39.8 psi).



4. Dry the element in a well ventilated area.
An electric fan will hasten drying.

Caution:

Do not use compressed air or an open flame to dry the element quickly. Damage to the element will result. It will usually take two or three days for the element to dry completely. Therefore, it is a good idea to have a spare on hand to use in the interim.

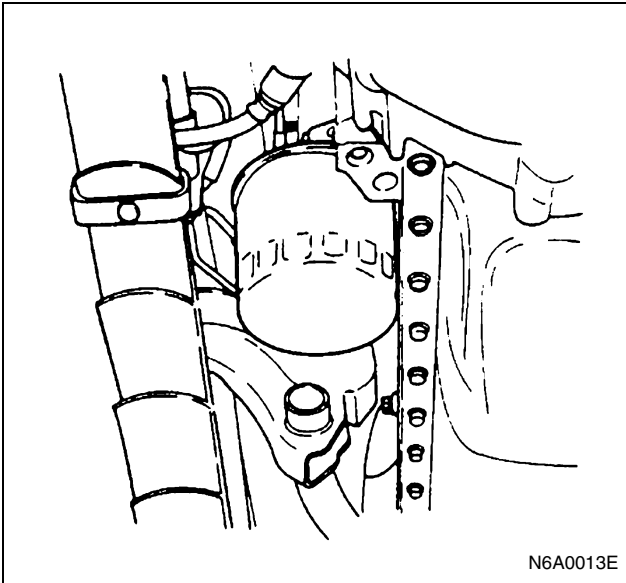


Lubricating System

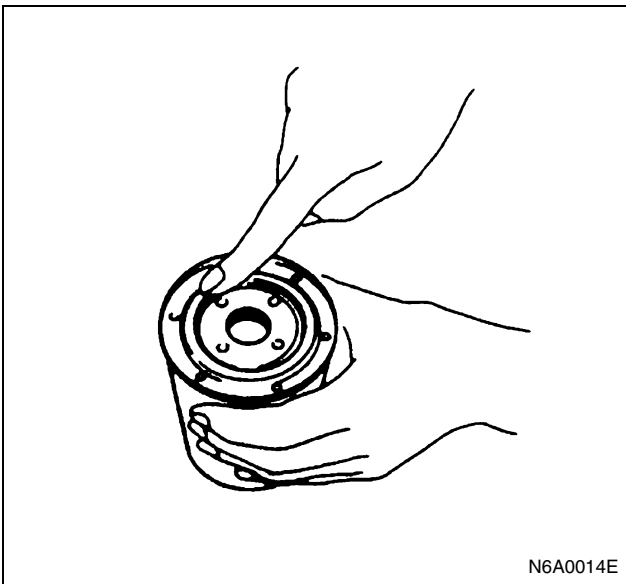
Main Oil Filter (Disposable Spin-On Cartridge Element)

Replacement Procedure

1. Loosen the used oil filter by turning it counterclockwise with the filter wrench.
Filter Wrench: 1-85221-097-0



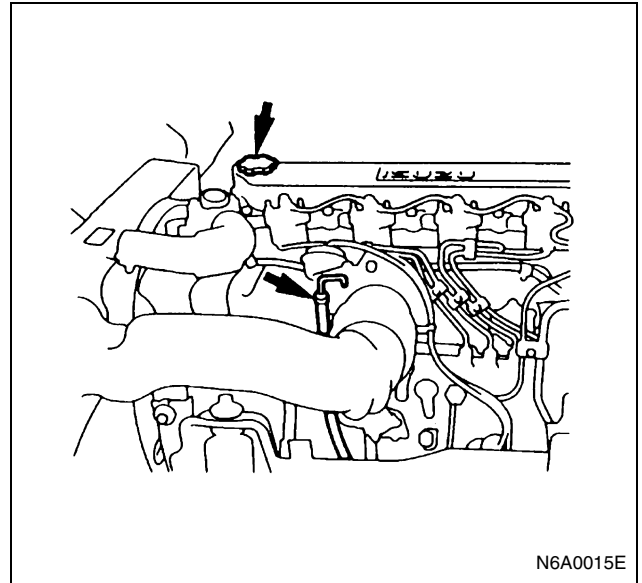
2. Clean the oil filter fitting face.
This will allow the new oil filter to seat properly.
3. Apply a light coat of engine oil to the O-ring.



4. Turn in the new oil filter until the filter O-ring is fitted against the sealing face.
5. Use the filter wrench to turn in the filter an additional one full turn.
6. Check the engine oil level and replenish to the specified level if required.

Engine Oil Replenishment	lit (US/UK gal)
0.7 (0.19/0.15)	

7. Start the engine and check for oil leakage from the main oil filter.



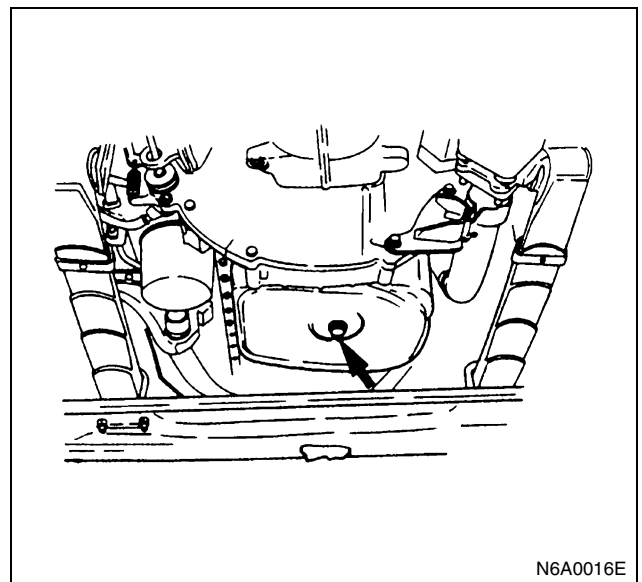
Engine Oil Replacement

Draining

1. Remove the drain plug to completely drain the engine oil.
Do this while the engine is hot.
2. Replace the drain plug.
3. Tighten the drain plug to the specified torque.

Tighten:

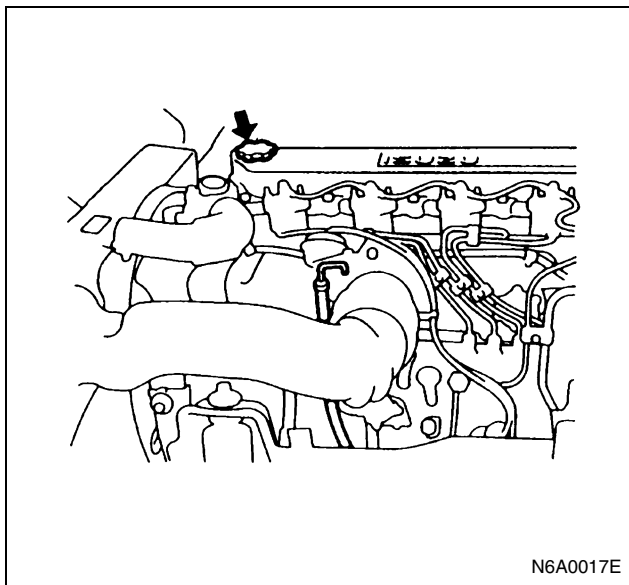
Drain plug to 78 N·m (8.0 kg·m/58 lb·ft)



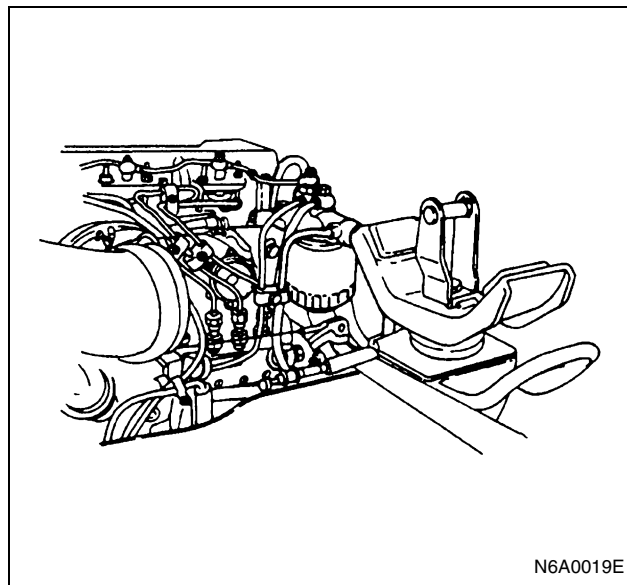
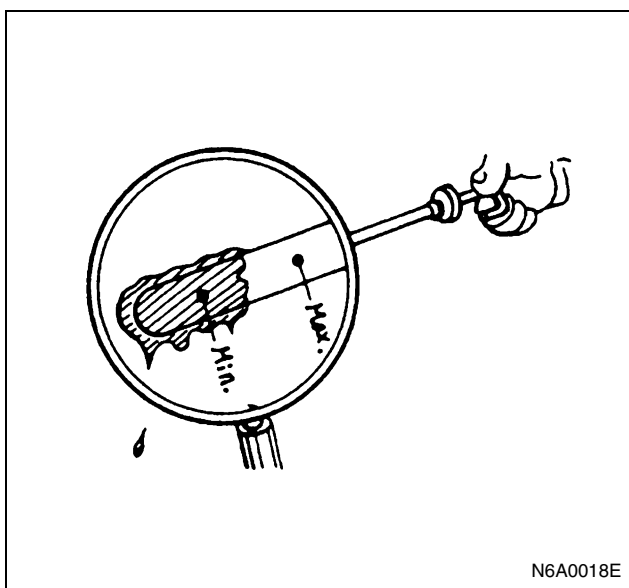
Replenishment

1. Remove the filler cap.
2. Pour the specified engine oil into the crankcase through the oil filler.
3. Replace the filler cap.

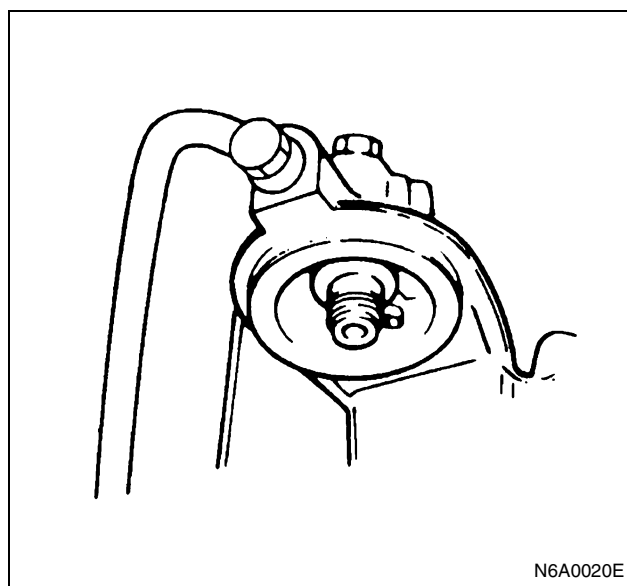
Crankcase and Filter Oil Capacity	lit (US/UK gal)
10.5 (2.8/2.3)	



4. Start the engine and allow it to idle for a few minutes.
5. Stop the engine.
6. Use the dipstick to check the oil level.
If the oil level is below the "MIN" line, add oil through the oil filler.
If the oil level is above the "MAX" line, drain off the excess oil through the drain plug.



2. Clean the upper cover fitting face.
This will allow the new fuel filter to seat properly.



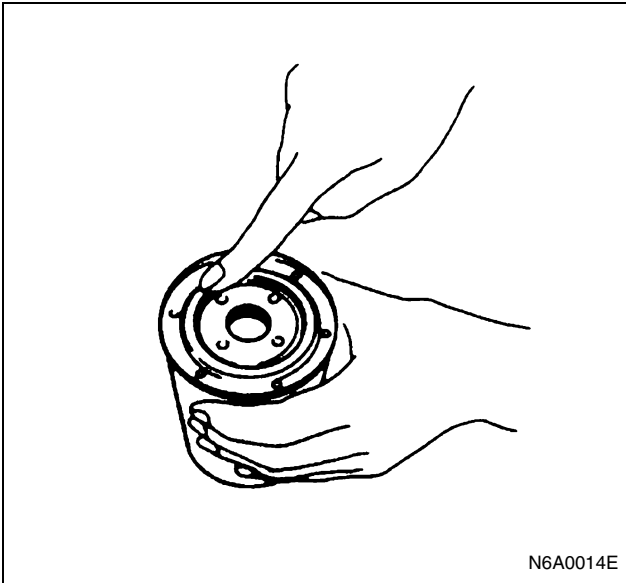
3. Apply a light coat of engine oil to the O-ring.

Fuel System

Fuel Filter

Replacement Procedure

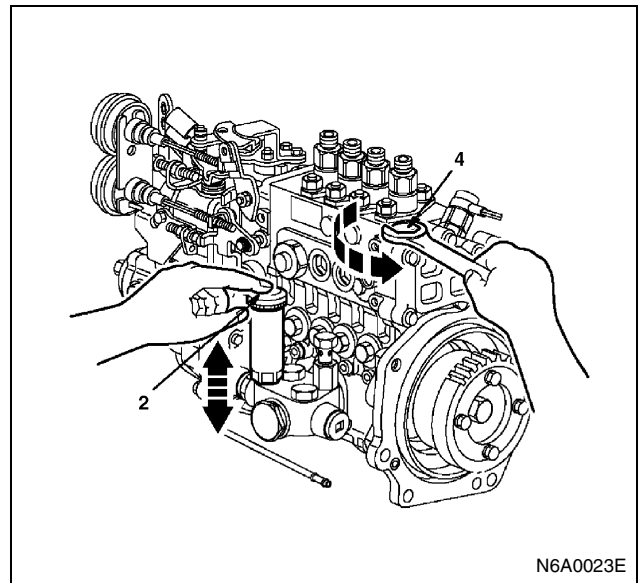
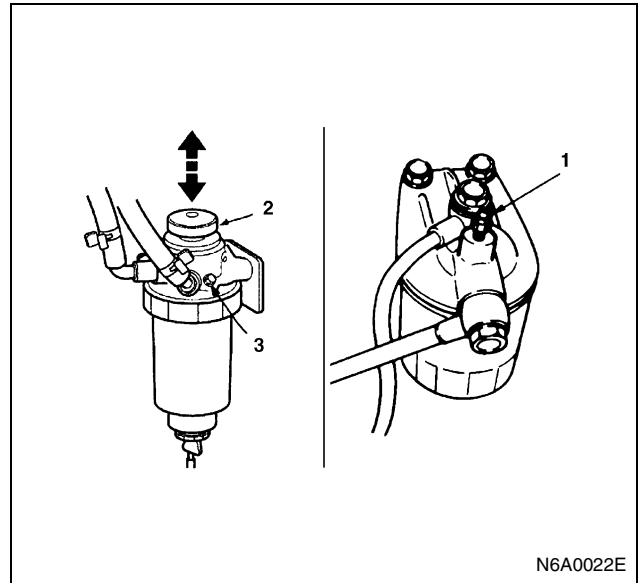
1. Loosen the used fuel filter by turning it counter-clockwise with the universal filter wrench.



4. Supply fuel to the new fuel filter to facilitate bleeding.
5. Turn in the new fuel filter until the filter O-ring is fitted against the sealing face.
Be very careful to avoid fuel spillage.
6. Use the filter wrench to turn in the fuel filter an additional 1/3 to 2/3 of a turn.
7. Operate the priming pump to bleed the air from the fuel line in the following procedures.
 - Loosen the priming pump cap (2).
 - Loosen the air bleeding plug (3). (4HG1-T model only)
 - Operate the priming pump. Pump the primer pump until fuel flow is free of air bubbles. (Except 4HG1-T model)
 - Tighten the air bleeding plug (3). (4HG1-T model only)
 - Loosen the bleeding plug (1).
 - Operate the priming pump. Pump the primer pump until fuel flow is free of air bubbles.
 - Tighten the bleeder plug (1).
 - Operate the priming pump. Pump the primer pump until fuel flow is free of air bubbles. (Except 4HE1-TC model)
 - Loosen the bleeding plug on the injection pump (4). (4HE1-TC model only)
 - Operate the priming pump. Pump the primer pump until fuel flow is free of air bubbles. (4HE1-TC model only)
 - Tighten the bleeding plug on the injection pump (4). (4HE1-TC model only)
 - Lock the priming pump cap (2).

Notice:

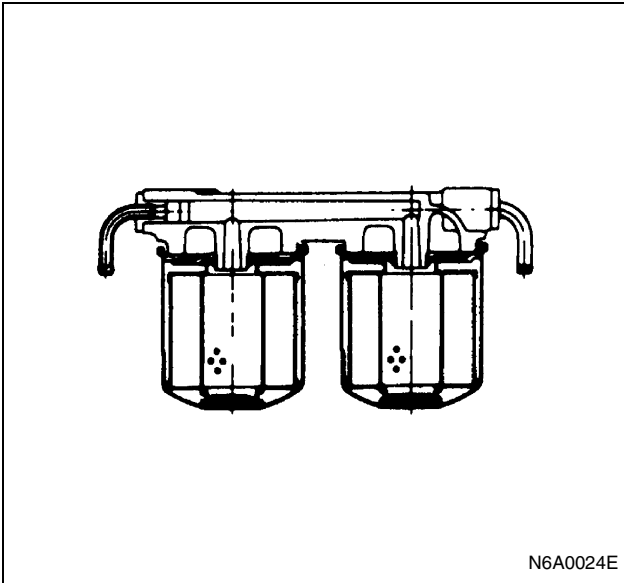
Check for fuel leakage from around the injection pump and the fuel filter.



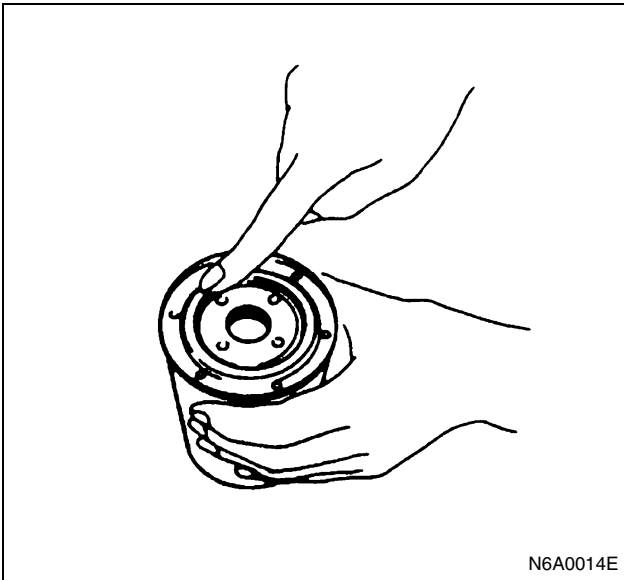
8. Start the engine.
Crank the engine for ten seconds or until it starts.
If the engine does not start after ten seconds, repeat Step 7.

Sub Fuel Filter (Dual Type)**Replacement Procedure**

1. Loosen the fuel filters by turning them counter-clockwise with the universal filter wrench.
2. Clean the upper cover fitting faces.
This will allow the new fuel filters to seat properly.



3. Apply a thin coat of engine oil to the O-rings.

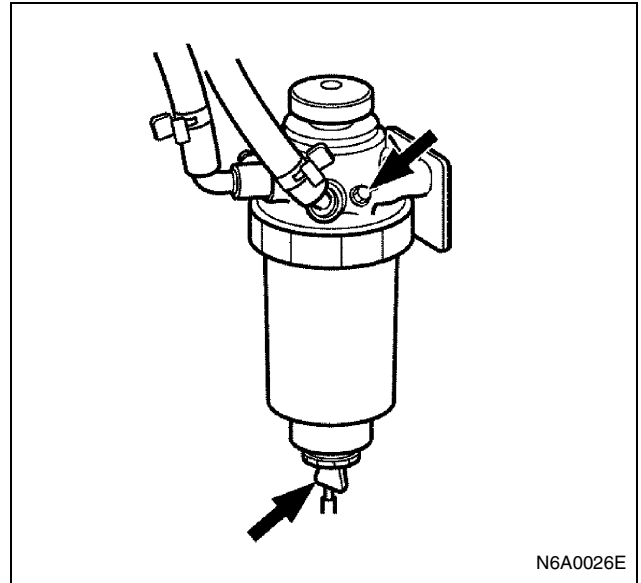


4. Install the filter assemblies.
Carefully turn each assembly clockwise until the O-ring is fitted against the filter cover sealing face.
5. Use the filter wrench to turn in each filter assembly an additional 1/3 to 2/3 of turn.
6. Operate the priming pump on the fuel filter to bleed the fuel system.
Refer to "AIR BLEEDING" for more detailed information.

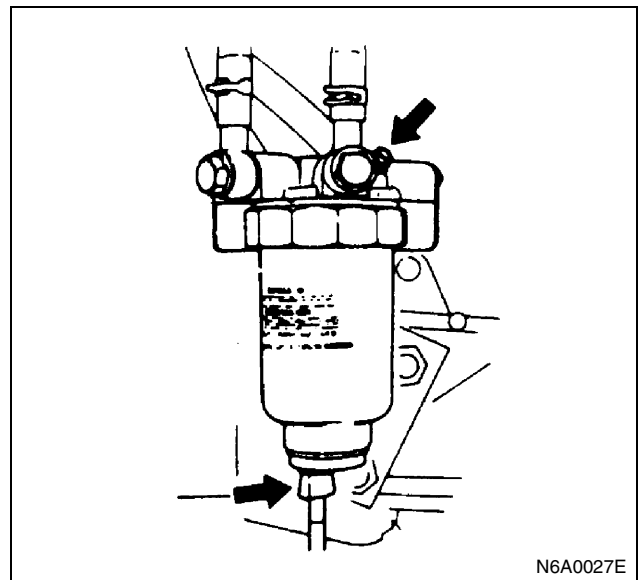
Pre-fuel Filter Water Draining Procedure

The indicator light will come on when the water level in the water separator exceeds the specified level. Drain the water and foreign material from the water separator with the following procedure.

1. Place the end of a vinyl hose (beneath the drain plug) in a container.
2. Loosen the air intake plug and drain plug, then drain water.



3. After draining, securely tighten the drain plug and air intake plug.



4. Then, operate the priming pump on the injection pump to bleed the fuel system.
5. After starting the engine, check to see that no fuel leaks from the drain plug.

Injection Nozzle

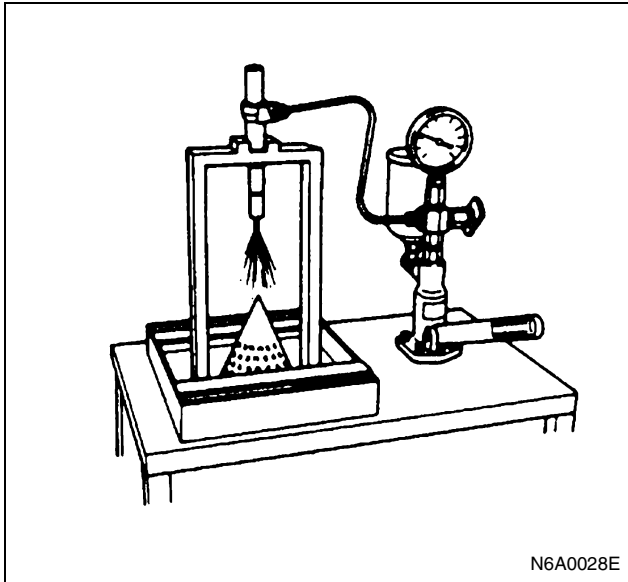
Pressure and Spray Condition Check

1. Use a nozzle tester to check the injection nozzle opening pressure.
If the opening pressure is above or below the specified value, the injection nozzle must be replaced or adjusted.
Refer to "Adjustment."

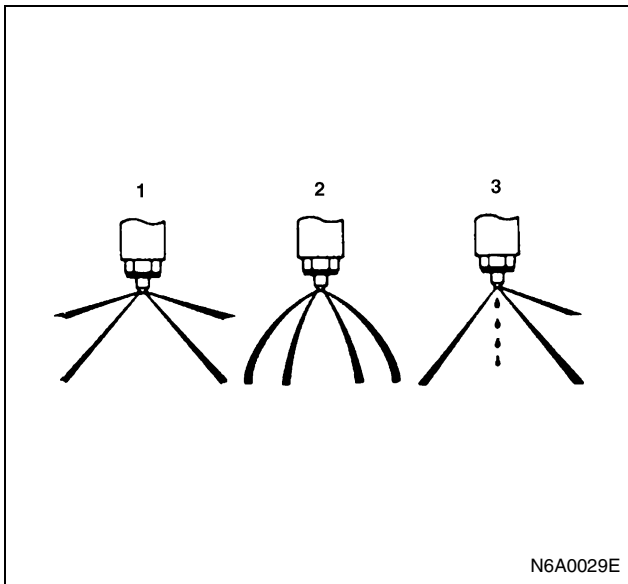
Injection Nozzle Opening Pressure

Mpa (kg/cm²/psi)

4HF1/4HF1-2/4HG1	18.14 (185/2,631)
4HE1-TC	21.57 (220/3,128)
4HG1-T	1st: 18.1 (185/2,631) 2nd: 21.1 (215/3,057)



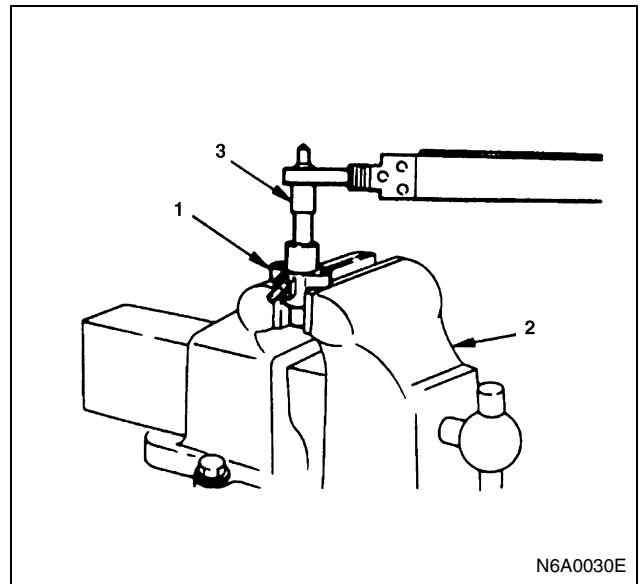
2. Check the spray condition.
Refer to the illustration.
Spray Condition



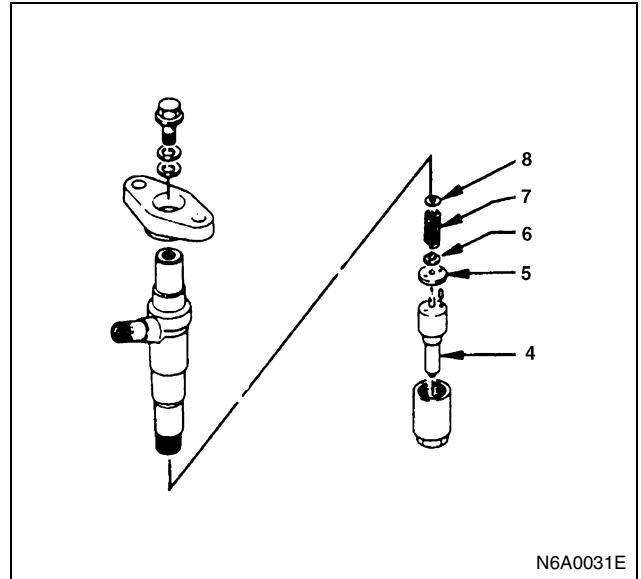
- 1) Correct
 - 2) Incorrect (Restrictions in orifice)
 - 3) Incorrect (Dripping)
- If the spray condition is bad, the injection nozzle must be replaced or adjusted.
Refer to "6C FUEL SYSTEM".

Adjustment

1. Clamp the injection nozzle holder (1) in a vise (2).
2. Use a wrench to remove the injection nozzle retaining nut (3).



3. Remove the injection nozzle holder from the vise.
4. Remove the injection nozzle (4), the spacer (5), the spring seat (6) the spring (7) and the adjusting shim (8).



5. Install the new adjusting shim, the spring, the spring seat, the spacer, the injection nozzle, and the retaining nut.
6. Clamp the injection nozzle holder in the vise.
7. Tighten the injection nozzle holder retaining nut to the specified torque.

Tighten:

Injection nozzle holder retaining nut to 34 N·m (3.5 kg·m/ 25 lb·ft)

8. Remove the injection nozzle holder from the vise.

9. Attach the injection nozzle holder to the injection nozzle tester.
10. Apply pressure to the nozzle tester to check that the injection nozzle opens at the specified pressure.

If the injection nozzle does not open at the specified pressure, install or remove the appropriate number or adjusting shims to adjust it.

Removing or installing one shim will increase or decrease the nozzle opening pressure approximately 370 kPa (3.77 kg/cm² / 53.6 psi).

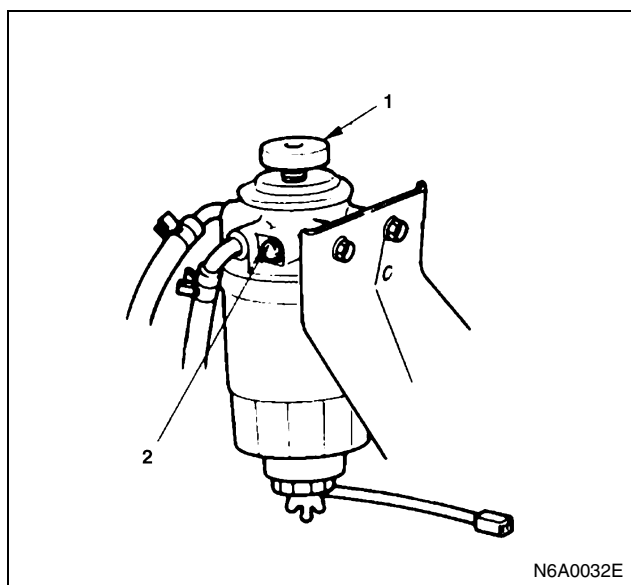
Adjust Shim Availability		mm (in)
Range	0.5 — 1.5	(0.02 — 0.06)
Increment	0.025	(0.001)
Total Number of Shims	41	

Air Bleeding (Except 4HF1-2 model only)

Above works refer to "FUEL SYSTEM" in this section.

Air Bleeding (4HF1-2 model only)

1. Actuate the priming pump (1) to send the air in the fuel system to the injection pump.
2. Loosen the sedimenter air bleeding plug (2) and operate the priming pump until no bubbles appear.
3. Tighten the air bleeding plug (2) completely.



4. Try to start the engine. If the engine is not started within 10 seconds, air bleeding should be conducted once again.
5. Check that there is no fuel leak, and then tighten the priming pump completely.

Water Drain

If more water than specified has collected, the warning light is lit. Under this condition, follow the following water drain procedure:

1. Place a container (Approximately 0.2 liters capacity) beneath the drain plug on the separator.
2. Loosen the drain plug and air bleeding plug.
3. After draining, tighten the drain plug.

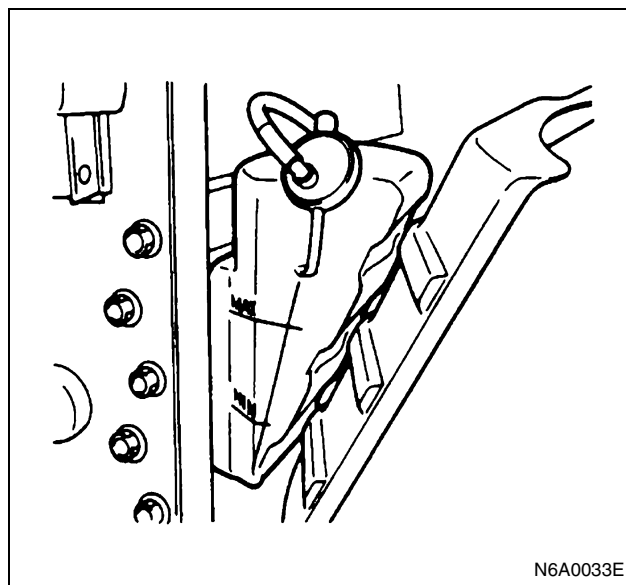
4. Operate the priming pump several times again and check for fuel leak.
5. Tighten the air bleeding plug.
6. Make sure that the warning light in the instrument panel is off. (Except 4HE1-TC model)

Cooling System

Coolant Level

Check the coolant level and replenish the radiator reserve tank if necessary.

If the coolant level falls below the "MIN" line, carefully check the cooling system for leakage. Then add enough coolant to bring the level up to the "MAX" line.

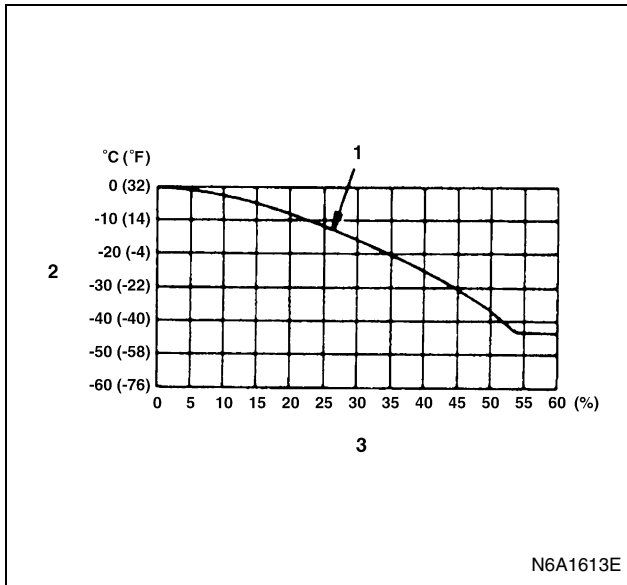


Notice:

Do not overfill the reserve tank.

Remove the radiator filler cap only when absolutely necessary.

Always check the coolant level when the engine is cold. Always refer to the chart at the left to determine the correct cooling water to antifreeze solution mixing ratio.

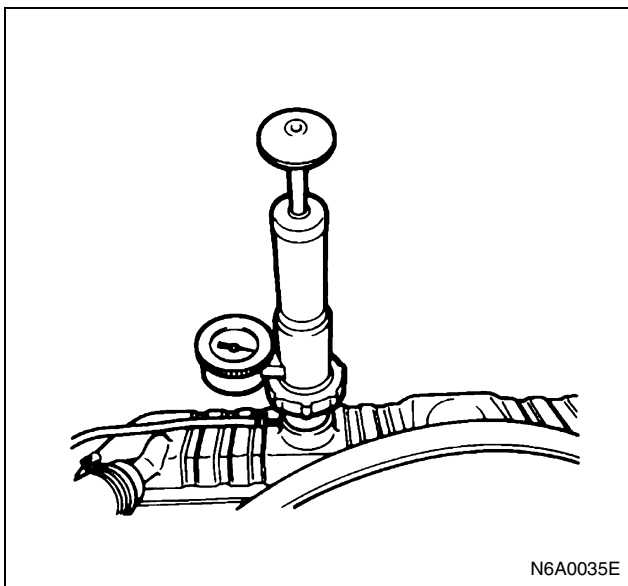
**Legend**

1. Good quality ethylene glycol anti-freeze
2. Freezing point
3. Mixing ratio

Cooling System Leakage Inspection

Clog up the reservoir tank hose carefully and check the cooling system for leakage with a radiator cap tester by applying an air pressure of 196 kPa (2 kg/cm²/28 psi) from filler neck to inside the radiator.

As the radiator upper tank is provided with a valve, the pressure fails to rise higher than the valve opening pressure unless the hose is clogged up.

**Radiator Valve Inspection**

Apply air pressure from filler neck using radiator cap tester and check the opening pressure of radiator valve. If the valve opening pressure is out of the standard value range, replace with a new radiator valve.

Radiator valve opening pressure	kPa (kg/cm ² /psi)
93 — 123	(0.95 — 1.25/13.5 — 17.8)

Remove the radiator valve and check a negative pressure valve as the center of the valve seat side. If the negative pressure valve does not work smoothly, clean or replace the radiator valve.

Tighten:

Radiator valve fixing to 6 N·m (0.6 kg·m/4 lb·ft)

Conduct cooling system leakage check after reinstalling the radiator valve.

Thermostat Operating Test

1. Completely submerge the thermostat in water.
2. Heat the water.

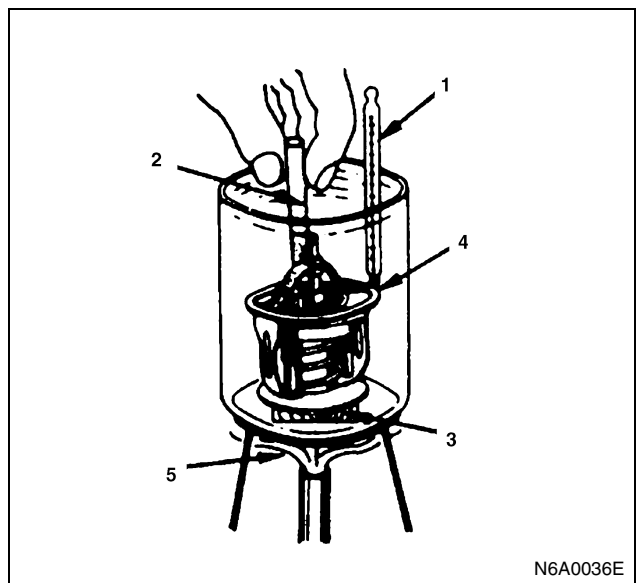
Stir the water constantly to avoid direct heat being applied to the thermostat.

3. Check the valve initial opening temperature.

Valve Initial Opening Temperature			°C (°F)
			Standard
without jiggle valve	Primary valve	83 — 87	(181 — 189)
	Secondary valve	80 — 84	(176 — 183)
with jiggle valve		83.5 — 86.5	(182 — 188)

4. Check the valve lift full opening temperature.

Valve Lift Full Opening Temperature		°C (°F)
		Standard
without jiggle valve		95 (203)
with jiggle valve		100 (212)



Legend

1. Thermometer
2. Aditating rod
3. Wooden piece
4. Thermostat
5. Heat

Fan Belt

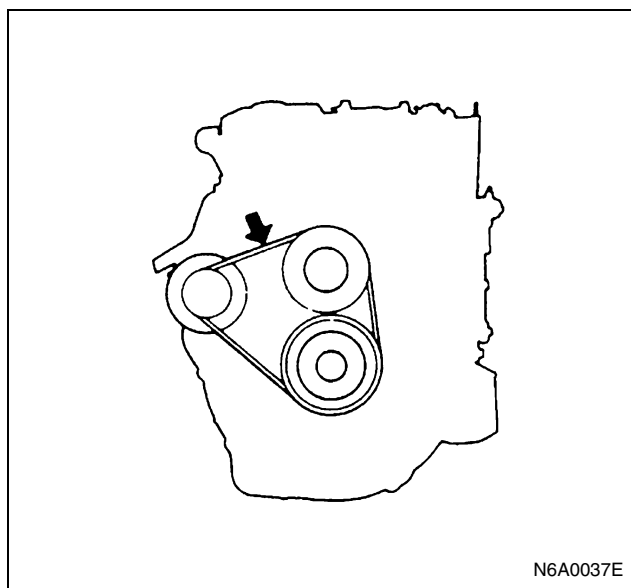
Check the drive belt tension.

Depress the drive belt mid-portion with a 98 N (10 kg/22 lb) force.

Drive Belt Deflection	mm (in)
8 — 12 (0.31 — 0.47) ... New belt	
10 — 14 (0.39 — 0.55) ... Reuse belt	

Check the drive belt for cracking and other damage.

- Crankshaft damper pulley
- Generator pulley
- Cooling fan pulley

**Fan Belt Adjustment**

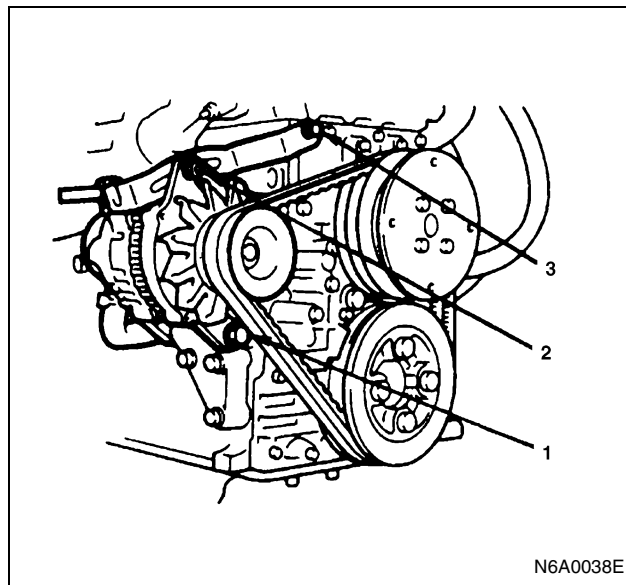
Fan belt tension is adjusted by moving the generator.

Tighten:

Bolt 1 to 40 N·m (4.1 kg·m/30 lb·ft)

Bolt 2 to 24 N·m (2.4 kg·m/17 lb·ft)

Bolt 3 to 46 N·m (4.7 kg·m/34 lb·ft)



If equipped with A/C compressor, loosen the A/C drive belt tension pulley adjust bolt and lock nut. Then free the A/C drive belt. When finishing the fan belt adjustment, adjust the A/C drive belt and check the belt tension.

Air Conditioning (A/C) Compressor Drive Belt

Check the drive belt tension.

- Depress the drive belt mid-portion with a 98 N (10 kg/22 lb) force.

Drive Belt Deflection	mm (in)
16 — 20 (0.63 — 0.79) ... New belt	
18 — 22 (0.71 — 0.87) ... Reuse belt	

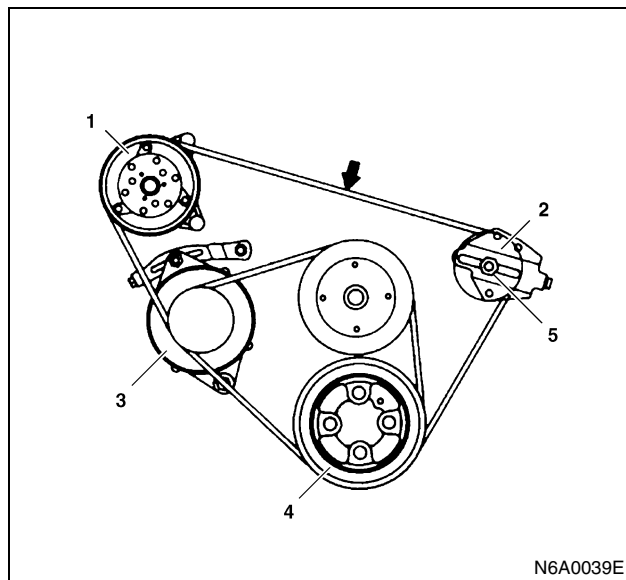
Check the drive belt for cracking and other damage.

A/C compressor drive belt tension is adjusted by moving the tension pulley.

When finishing the fan drive belt, then adjust the A/C drive belt.

Tighten:

Locking nut to 27 N·m (2.8 kg·m/20 lb·ft)



Legend

1. A/C compressor pulley
2. Tension pulley
3. Generator pulley
4. Crankshaft damper pulley
5. Tension pulley lock nut

Engine Control**Idling Speed Inspection**

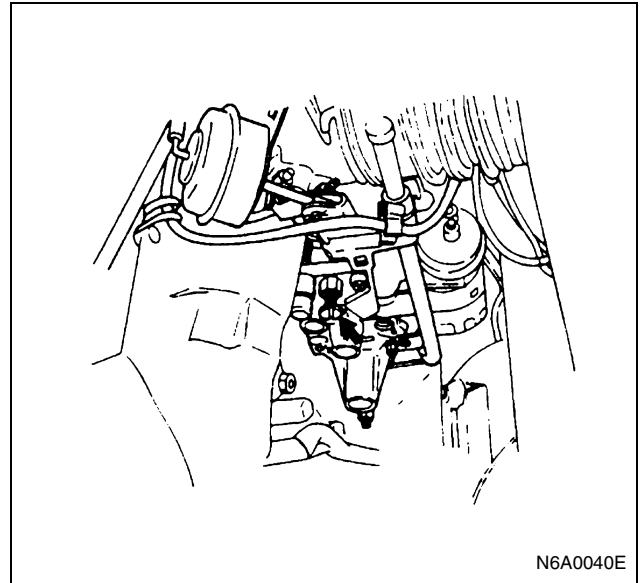
1. Set the vehicle parking brake and chock the drive wheels.
2. Place the transmission in neutral.
3. Start the engine and allow it to warm up.
4. Check that the idling control knob is in the engine idling position.
5. Set a tachometer to the engine.
6. Check the engine idling speed.
Engine idling speed should be as below.

Engine Idling Speed		rpm
4HF1	M/T	550 — 625
4HF1-2	M/T	575 — 625
4HG1	M/T	550 — 600
4HG1-T	M/T	600 — 650
4HE1-TC (4HE1-TC-XS, XN) 98EPA	M/T	775 — 825
4HE1-TC (4HE1-TC-XS, XN) SPEC. EURO3	M/T	775 — 825

If the engine idling speed is outside the specified range, it must be adjusted.

Idling Speed Adjustment

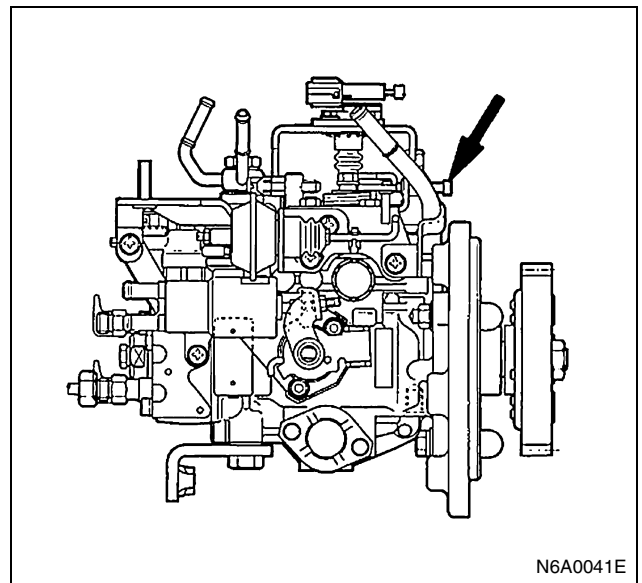
1. Loosen the idling set bolt lock nut on the injection pump.
2. Adjust the idling speed with the idling set bolt.
3. Tighten the lock nut.



N6A0040E

Idling Speed Check & Adjustment (4HF1-2 model only)

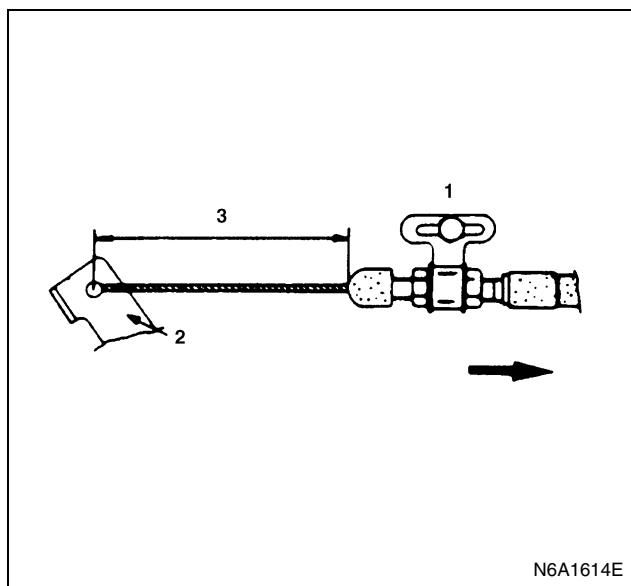
1. Warm up the engine.
2. Measure idling speed by means of tachometer.
3. If idling speed is out of the standard, adjust with an idling adjust bolt (indicated by an arrow mark).
Idling speed: 575 — 625 rpm



N6A0041E

Accelerator Control**Accelerator Control Cable Adjustment**

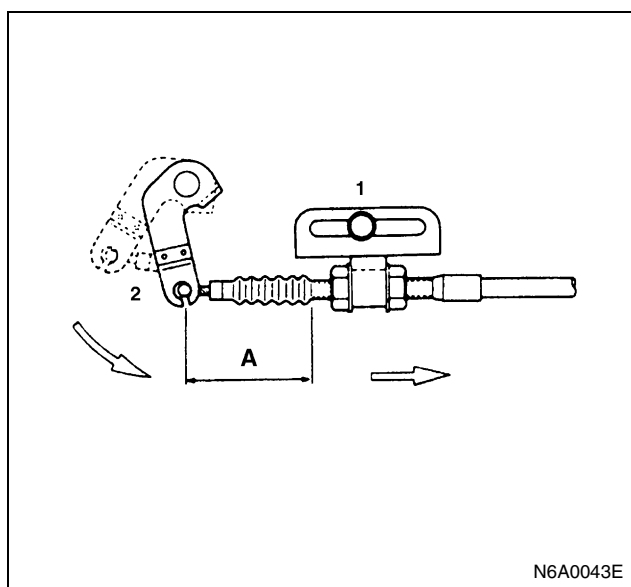
1. Loosen the accelerator cable clamp bolt (1).
2. Check that the idling control knob is in the engine idling position.
3. Hold the accelerator lever (2) in the fully closed position and stretch the control cable (3) in the direction indicated by the arrow to remove any slack.



Engine Stop Control

Adjustment

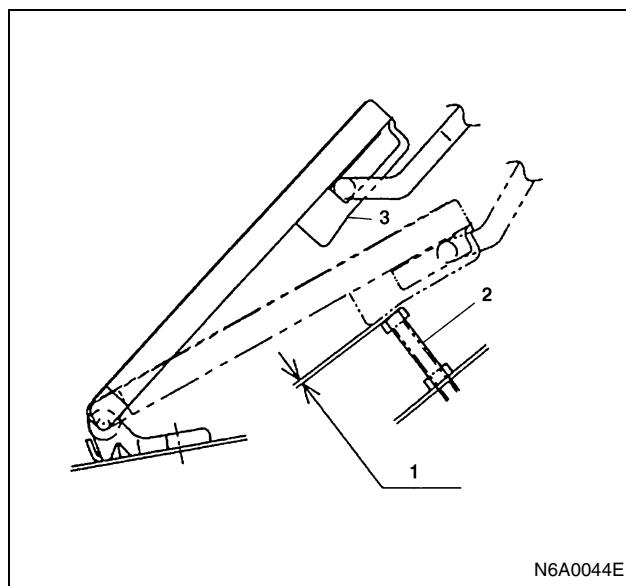
1. Check that the key switch is either in the "LOCK" position or removed from the engine.
2. Loosen the bolt (1).
3. Pull the fuel cut lever (2) as far as possible and hold it.
4. Remove cable slackness (A) by pulling the cable in the direction of the arrow in the illustration.
5. Tighten the bolt (1).



Accelerator Pedal Adjustment

1. Press the accelerator pedal to the floorboard and hold it.
2. Use the stopper bolt (2) to adjust the clearance between the stopper bolt end and the accelerator pedal (3) lower face.

Accelerator Pedal Clearance	mm (in)
0 — 2 (0 — 0.079)	



Legend

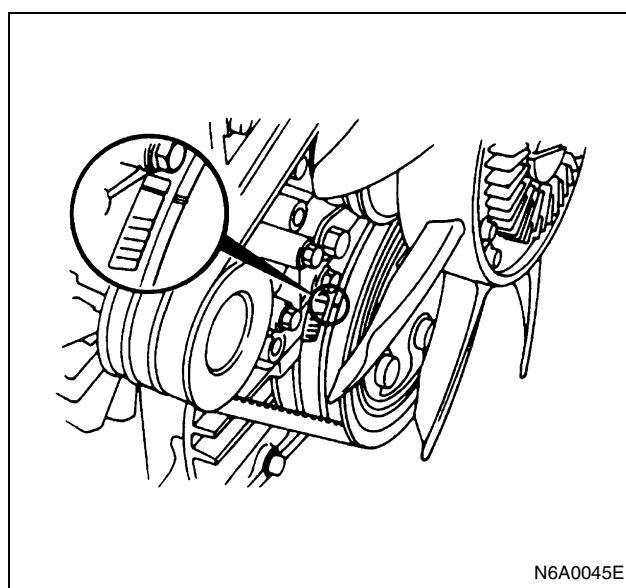
1. Full stroke 0 — 2 mm (0 — 0.079 in)
2. Stopper bolt
3. Accelerator pedal

Valve Clearance Adjustment

1. Bring the piston in either the No.1 cylinder or the No.4 cylinder to TDC on the compression stroke by turning the crankshaft until the crankshaft damper pulley timing mark is aligned with the TDC notched line.

Notice:

If there are two marks on the crank pulley, the front side of mark is for setting BTDC 49° and the rear side of mark is for setting TDC.

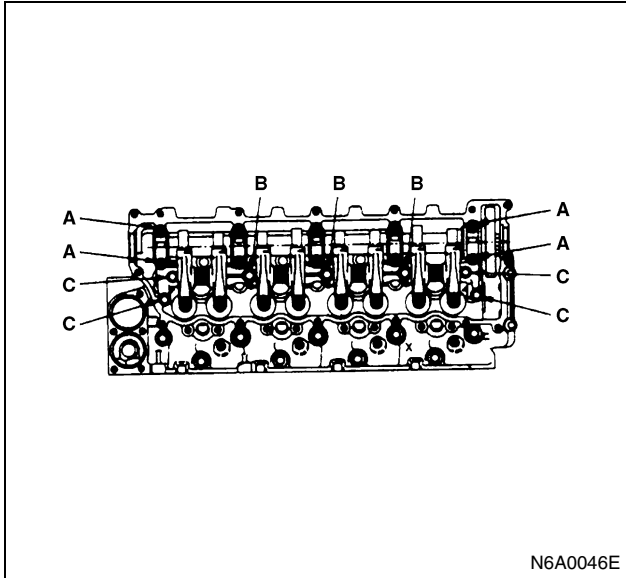


2. Tighten the rocker arm shaft bracket nuts and bolts to the specified torque in numerical order a little at a time as shown in the illustration.

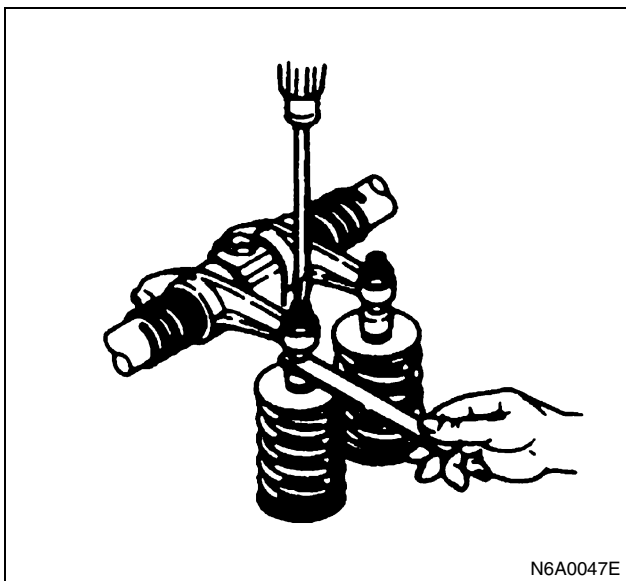
Tighten:

Rocker arm shaft bracket nut and bolt to

- Nut (A) 27 N·m (2.8 kg·m/20 lb·ft)
- Bolt (B) 56 N·m (5.7 kg·m/41 lb·ft)
- Bolt (C) 27 N·m (2.8 kg·m/20 lb·ft)



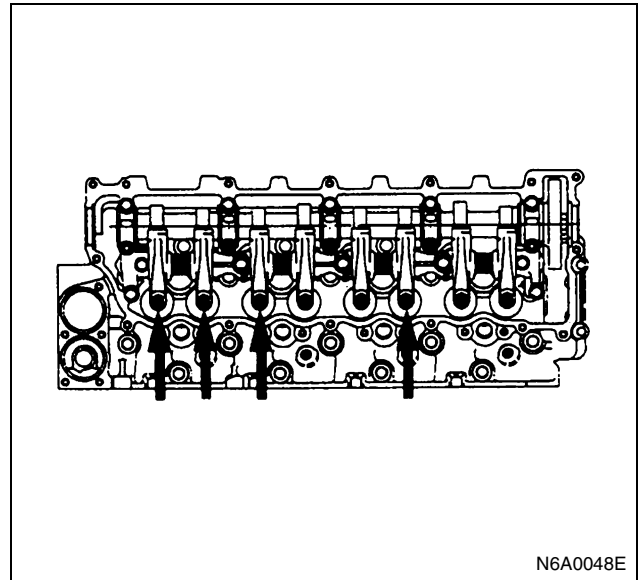
- Apply engine oil to the threaded portion of the nuts marked with "A" and the bolts with "B" shown in the illustration, and then tighten them to the specified torque.
3. Check for play in the No.1 intake and exhaust valve rocker arms.
If the No.1 cylinder intake and exhaust valve rocker arms have play, the No.1 piston is at TDC on the compression stroke.
If the No.1 cylinder intake and exhaust valve rocker arms are depressed, the No.4 piston is at TDC on the compression stroke.



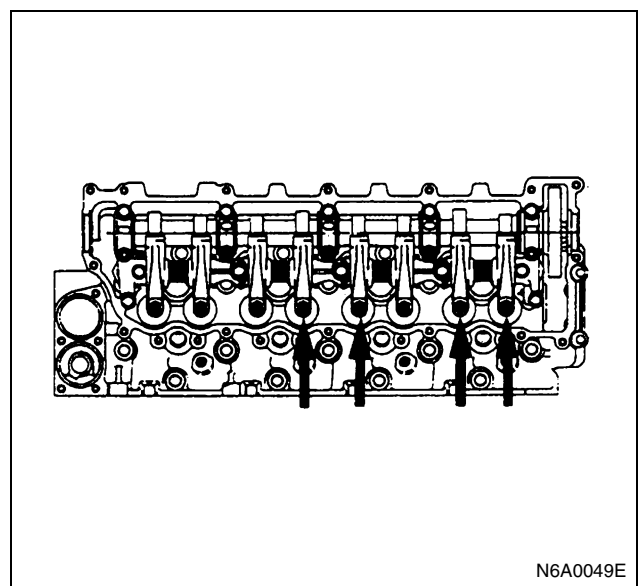
Adjust the No.1 or the No.4 cylinder valve clearance while their respective cylinders are at TDC on the compression stroke.

Valve Clearance		mm (in)
At cold		0.40 (0.016)

4. Loosen each valve clearance adjusting screw as shown in the illustration.



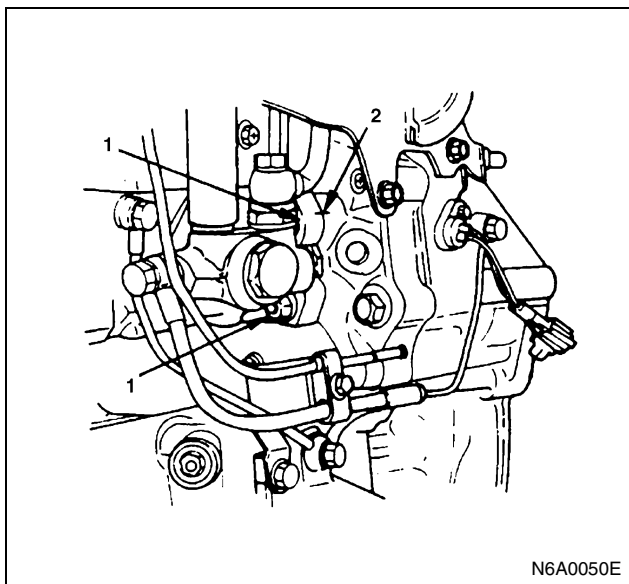
5. Insert a feeler gauge of the appropriate thickness between the rocker arm and the valve stem end.
6. Turn the valve clearance adjusting screw until a slight drag can be felt on the feeler gauge.
7. Tighten the lock nut securely.
8. Rotate the crankshaft 360 degrees.
9. Realign the crankshaft damper pulley timing mark with the TDC notched line.
10. Adjust the clearance for the remaining valves as shown in the illustration.



Injection Timing Adjustment

Injection Pump Notched Line Inspection

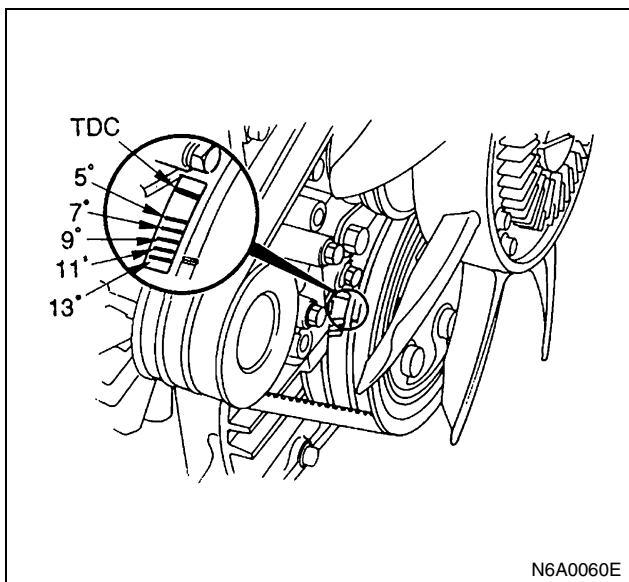
1. Check the injection pump bracket nuts (1) for looseness.
Tighten as required.
2. Check that the notched lines (2) on the injection pump bracket and the timing gear case are aligned.
If the notched lines are not aligned, the injection timing must be checked.



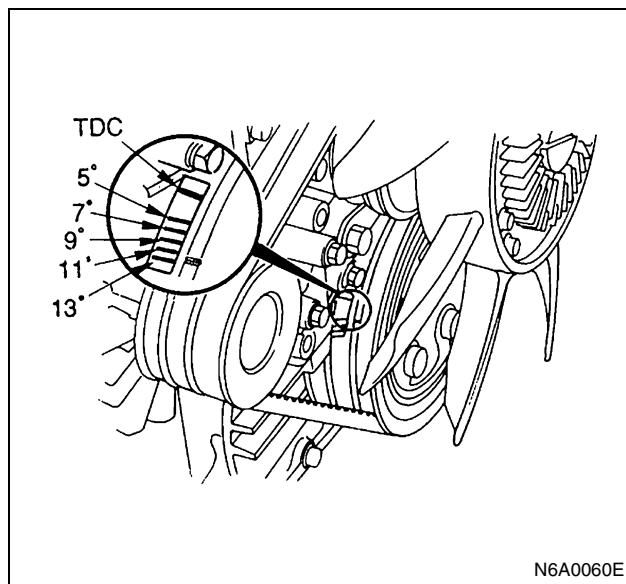
3. Some time, check injection timing on the crank damper pulley.
If the injection timing aligned with in correct, the injection timing must be readjusted.

Injection Timing Adjustment

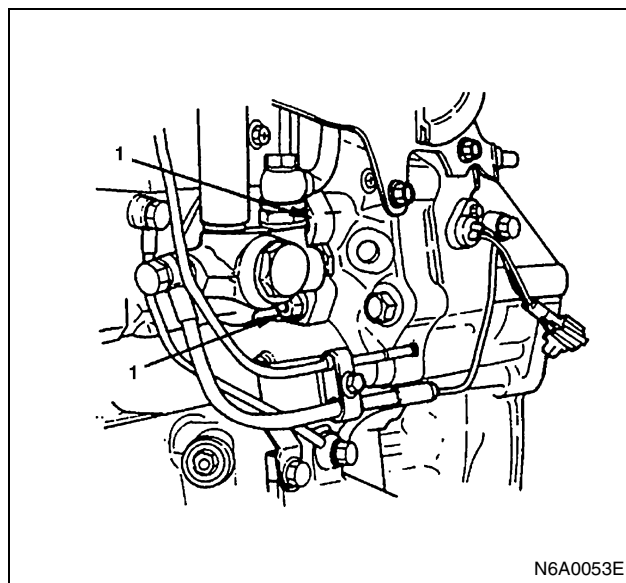
1. Turn the crankshaft until the timing mark on the crankshaft damper pulley is aligned with the BTDC (injection timing of each engine model) mark in the illustration.



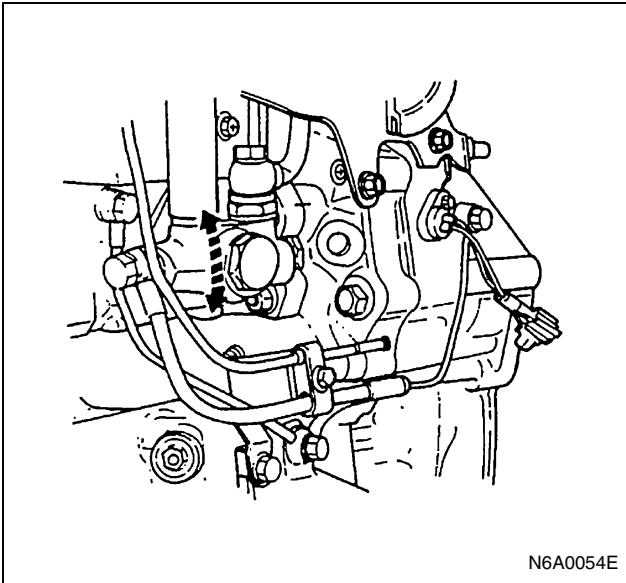
Injection Timing	deg
4HF1 4HE1-TC (4HE1-XS, XN)	BTDC 8
4HG1	BTDC 9
4HEI-T	BTDC 7
4HE1-TC (4HE1-XS)	BTDC 9 (Spec EURO3)



2. Remove the two foam rubbers.
3. Loosen the four injection pump fixing nuts (1).
This will allow the pump to pivot.
Do not bend or scratch the fuel pipe.

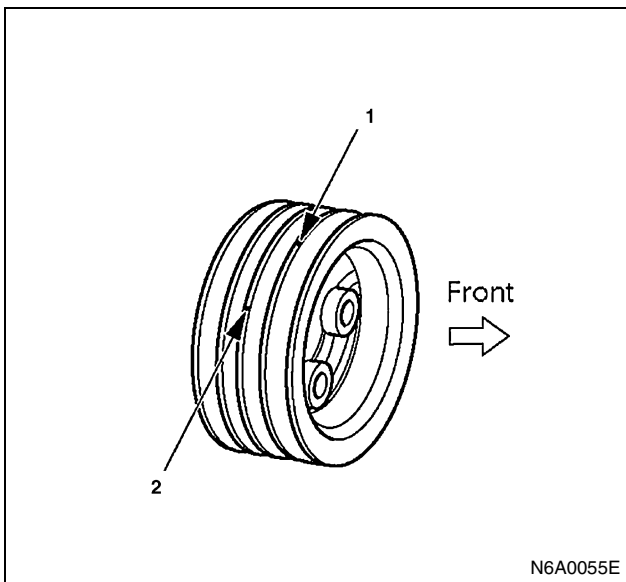


4. Align the notched line between the injection pump bracket and the timing gear case.
Make sure that the timing mark on the crank damper pulley is aligned with correct injection timing.

**Notice:**

In case the crank pulley has two marks as illustrated, (1) BTDC 49° mark on the second crest and (2) TDC mark on the third crest (as viewed from the front side), be sure to set at the mark (2). (If there are two different marks on one and same crest, set at the mark which comes second when rotated in the normal direction.)

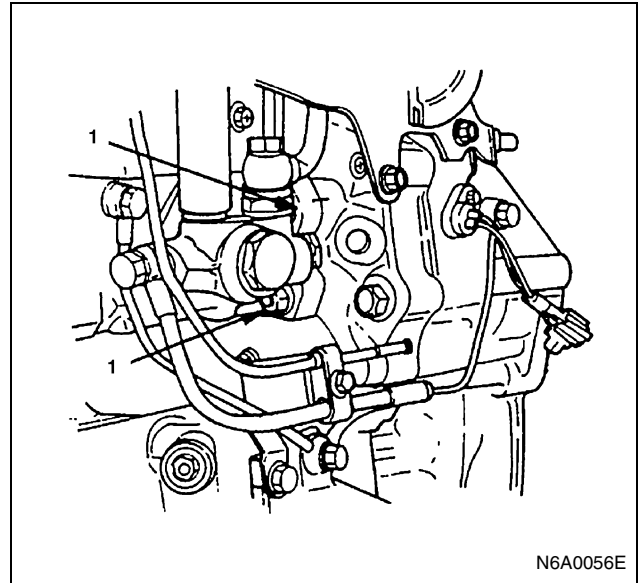
The mark (1) is used when installing the injection pump for 4HF1-2.



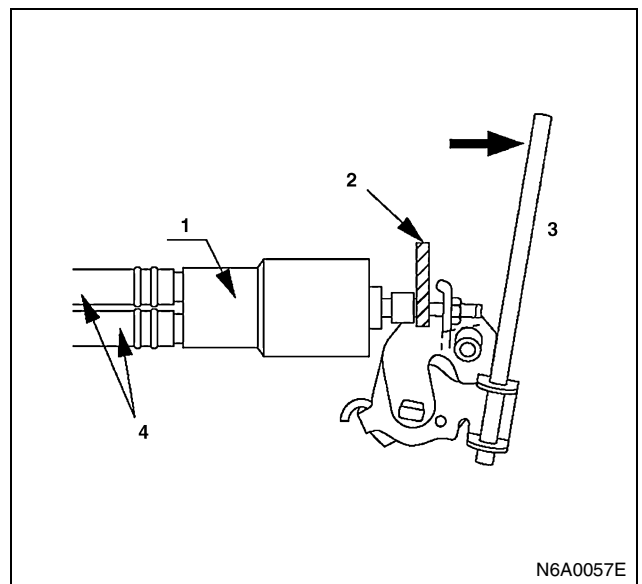
5. Tighten the injection pump fixing nuts (1) to the specified torque.

Tighten:

Injection pump fixing nut to 25 N·m (2.6 kg·m/19 lb·ft)

**Injection Timing Check (4HF1-2 model only)**

1. Set No. 1 Cylinder to the TDC in the compression stroke.
2. Disconnect Injection Pipe.
3. Put down Wax CSD lever, insert a spacer 10 — 20 mm (0.39 — 0.47 in) thick between the plunger and adjust bolt, and cancel the Wax CSD.

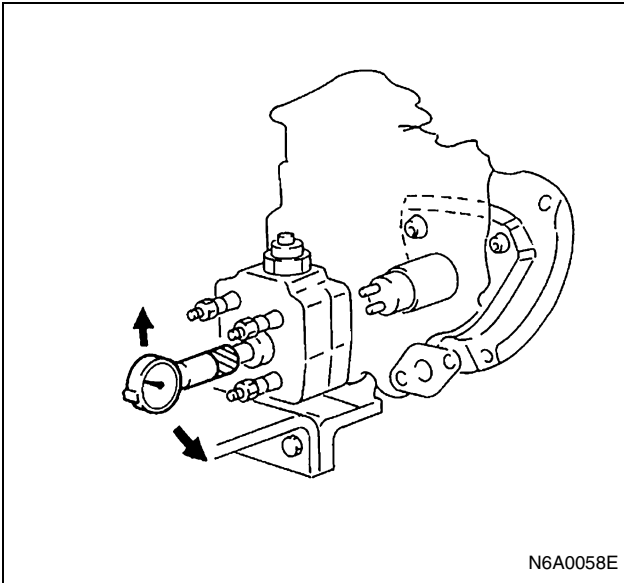
**Legend**

1. Wax CSD
2. Spacer
3. Lever
4. Water hose

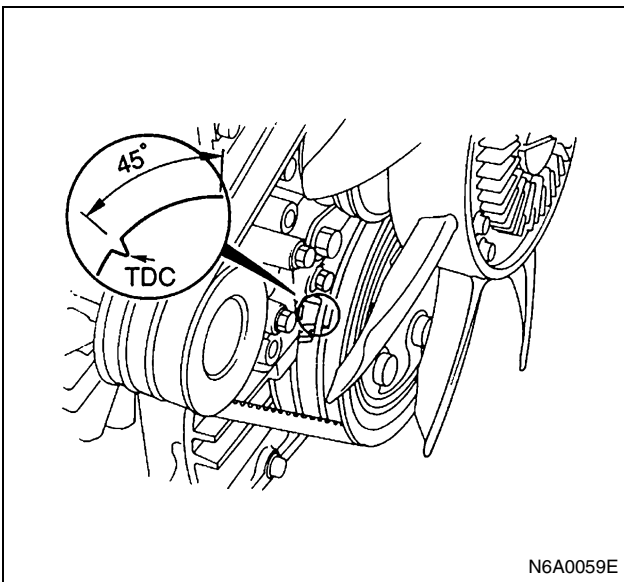
4. Remove the pump rear plug, connect a dial gage and set the lift at 1 mm (0.039 in).

Special Tool

Measuring device: 5-8840-0145-0



5. Set the crankshaft damper pulley TDC mark to the pointer or 45° before TDC.

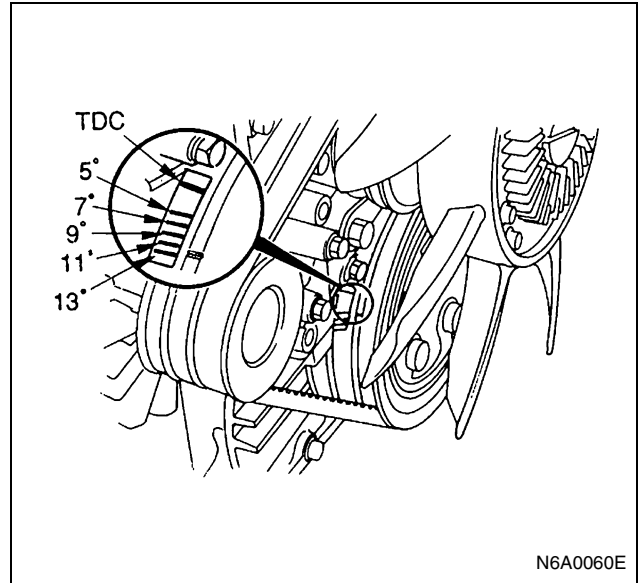


6. Set the dial gage to the "0" position.
7. Turn the crankshaft leftwise and rightwise a little and make sure that the needle stays in the "0" position.
8. Turn the crankshaft in the normal direction and read the measuring device's indication at the 12° before TDC position.

Notice:

As there is no 12° mark, set midway between the 11° and 13° marks.

Standard value: 0.5 mm (0.0197 in)



Injection Timing Adjustment (4HF1-2 model only)

If injection timing is out of the specified range, follow the following procedure for adjustment:

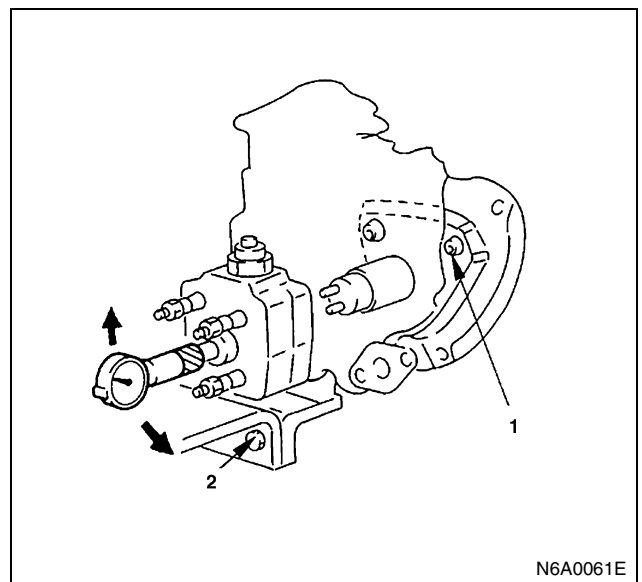
1. Loosen injection pump fixing nuts (1) and bracket bolt (2).
2. Adjust the mounting angle of injection pump:
 - If injection timing is too fast, bring the injection pump closer to the engine.
 - If injection timing is too slow, put the injection pump more distant from the engine.
3. When the dial gage has indicated the specified value, tighten the fixing nuts (1) and bolt (2) to specified torque:

Tighten:

Fixing nut to 24 N·m (2.4 kg·m/17 lb·ft)

Tighten:

Bracket bolt to 48 N·m (4.9 kg·m/35 lb·ft)



4. Disconnect the dial gage, install and tighten the plug to specified torque. (Make sure of a copper washer being attached to the plug)

Tighten:

Pump rear plug to 17 N·m (1.7 kg·m/12 lb·ft)

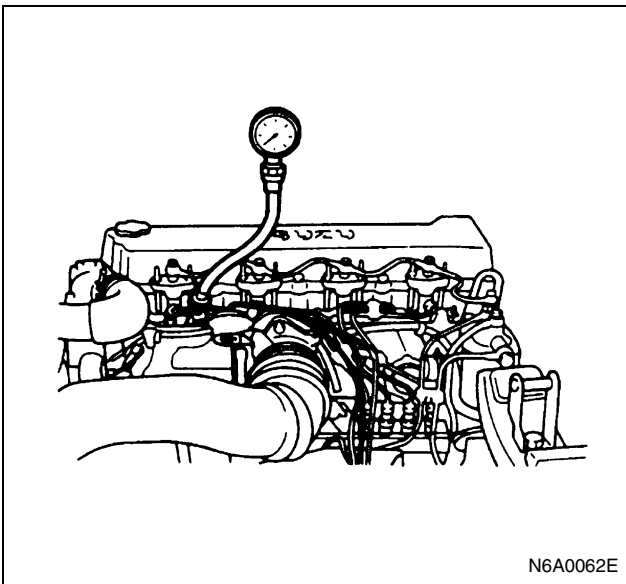
5. Release the wax CSD and connect the injection pipe.

Tighten:

Pipe sleeve nut to 29 N·m (3.0 kg·m/22 lb·ft)

Compression Pressure Measurement

1. Start the engine and allow it to warm up.
Engine Coolant Temperature: Above 80°C (176°F)
2. Stop the engine.
3. Remove the following parts.
 - Glow plugs.
 - In case VE pump;
Fuel cut solenoid connector.
 - In case line pump;
F-9 fuse in fuse box.
4. Set the adapter and the compression gauge to the No.1 cylinder glow plug hole.
Compression Gauge: 5-8840-2675-0
Adapter; Compression Gauge: 5-8531-7001-0



5. Connect a tachometer and check that engine cranking speed is 200 rpm or higher.
6. Turn the engine over with the starter motor and take the compression gauge reading.
7. Repeat the procedure (steps 4,5 and 6) for the remaining cylinders.

Compression Pressure

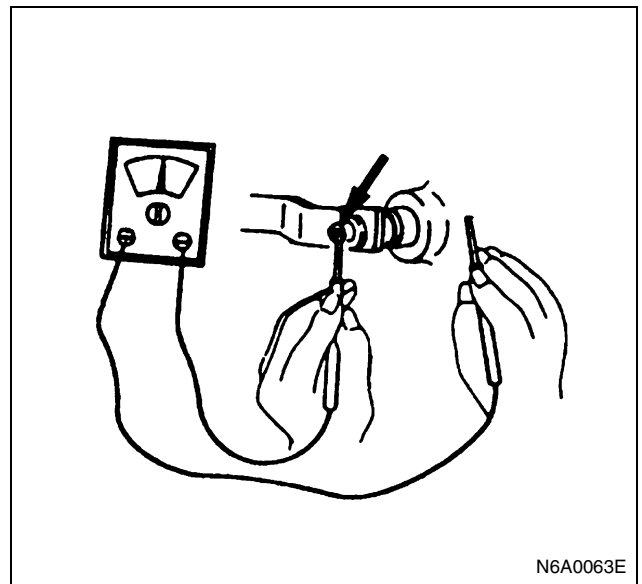
kPa (kg/cm²/psi) at 200 rpm

Standard	More than 2,942 (30/426)
Limit for use	2,157 (22/312)
Variance in pressure between cylinders	Less than 294 (3/43)

If the measured value is less than the specified limit, above works refer to "TROUBLESHOOTING" Section in this manual.

Quick-On-Start II System**Inspection Procedure**

1. Disconnect the thermoswitch connection on the thermostat outlet pipe.
2. Turn the key switch to the "ON" position.
If the Quick-ON-Start II system is operating properly, the flow relay will make a clicking sound within three seconds.
3. Measure the glow plug terminal voltage with a circuit tester as soon as possible after turning the key switch to the "ON" position.



4. Check the glow plug heating time.

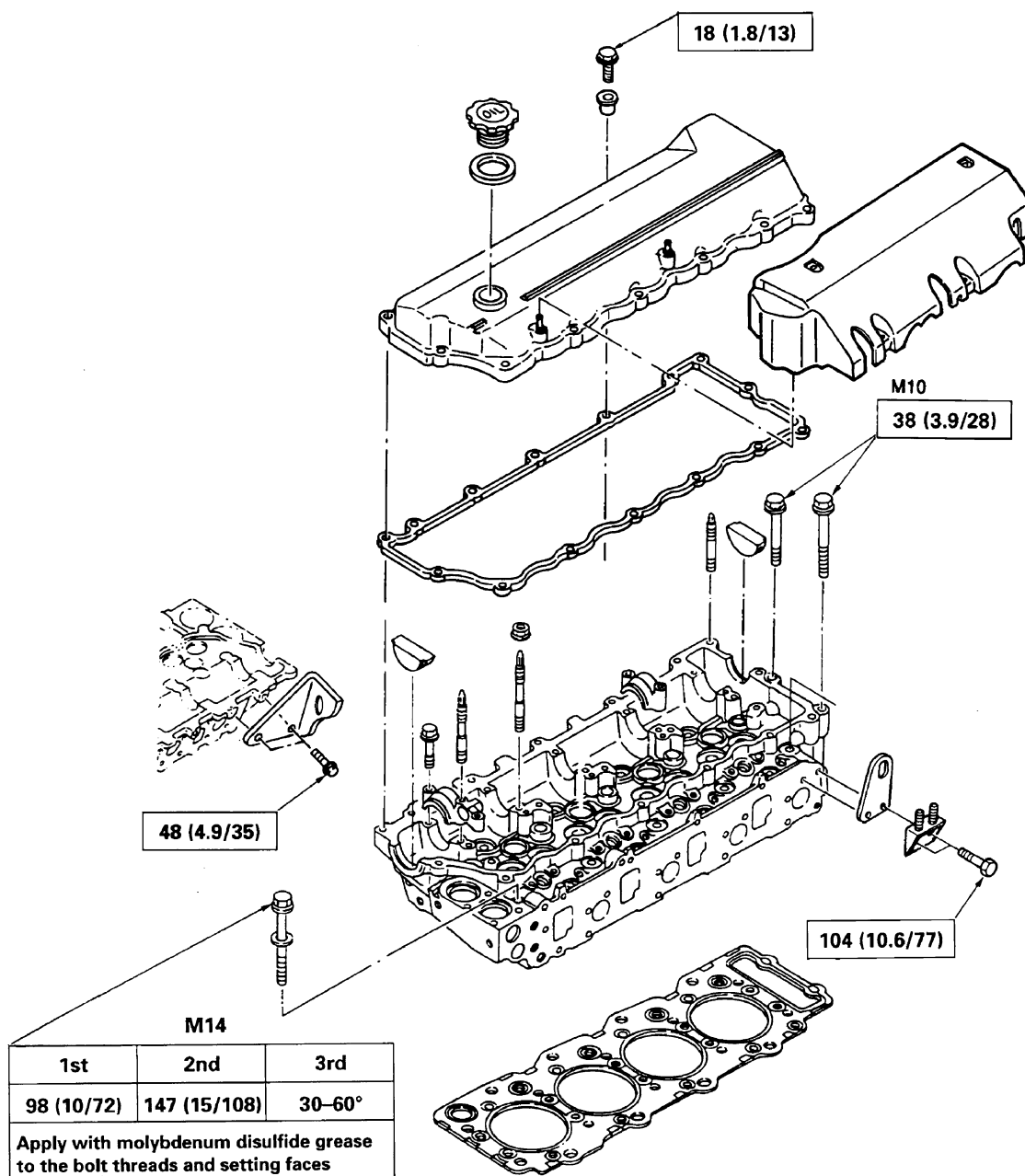
Approximate Glow Plug Heating Time	sec
18	

FIXING TORQUE

Cylinder Head, Head Gasket and Head Cover

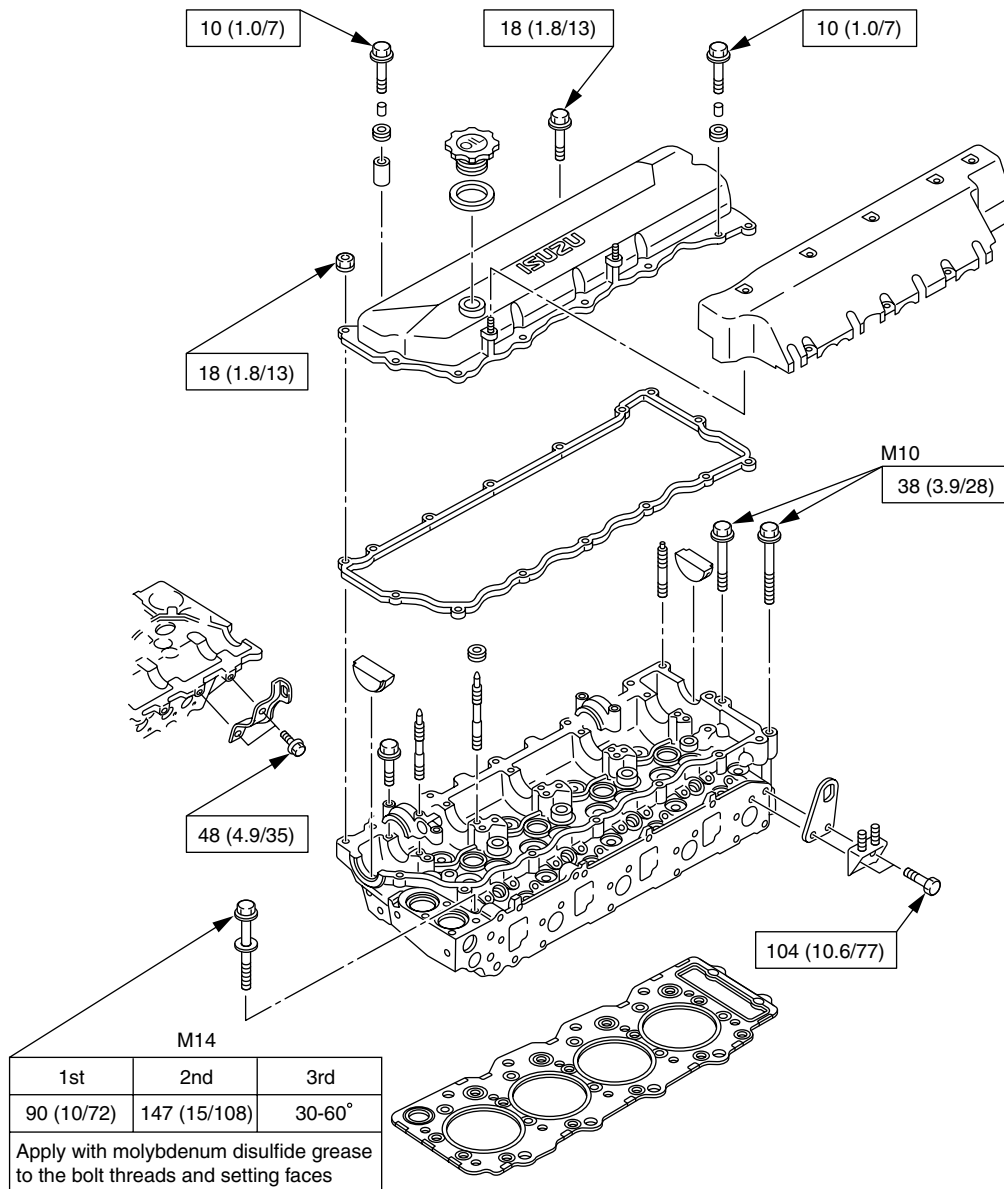
Except for 4HE1-TC (Engine)

N·m (kg·m / lb·ft)



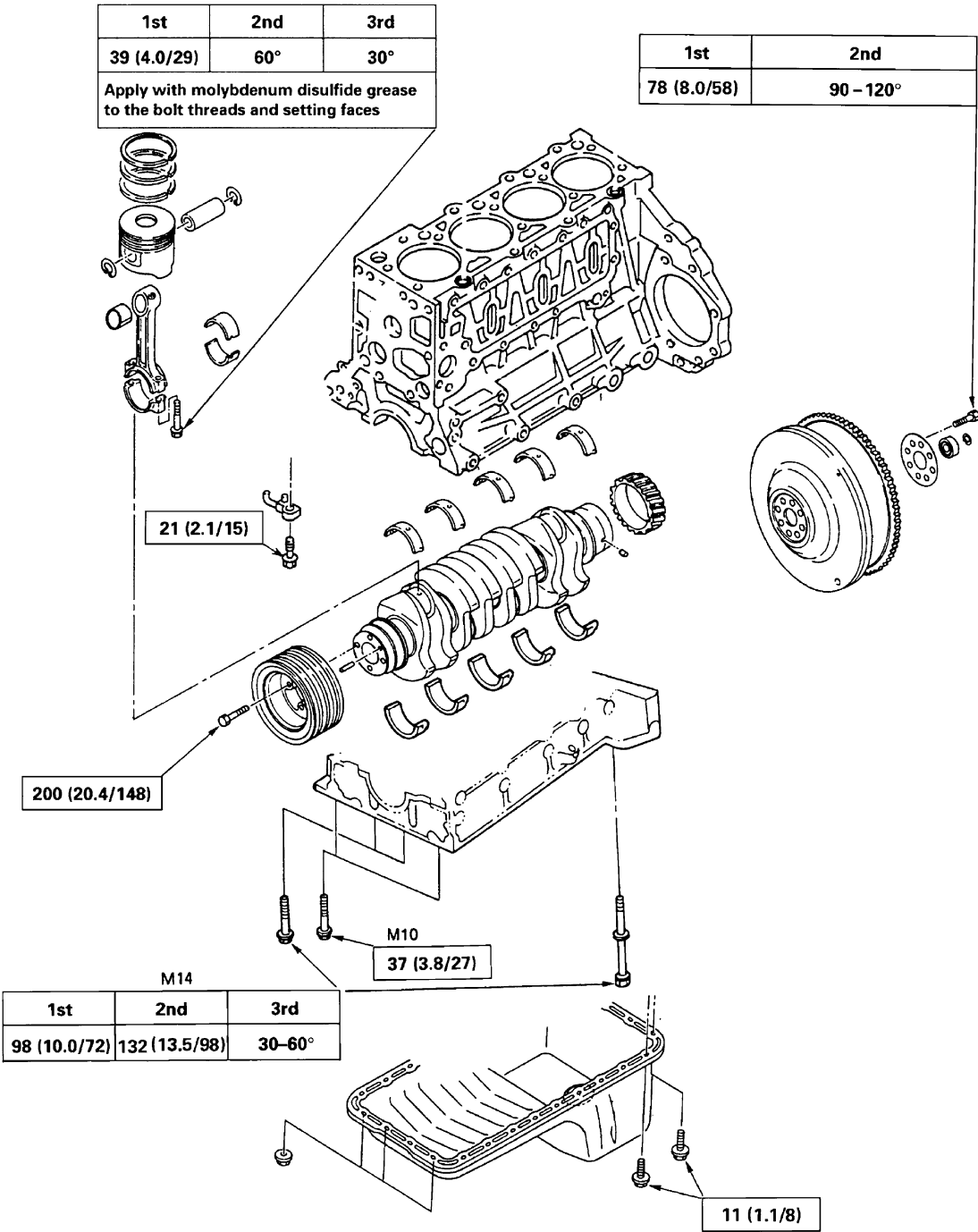
4HE1-TC (Engine)

N·m (kg·m / lb·ft)

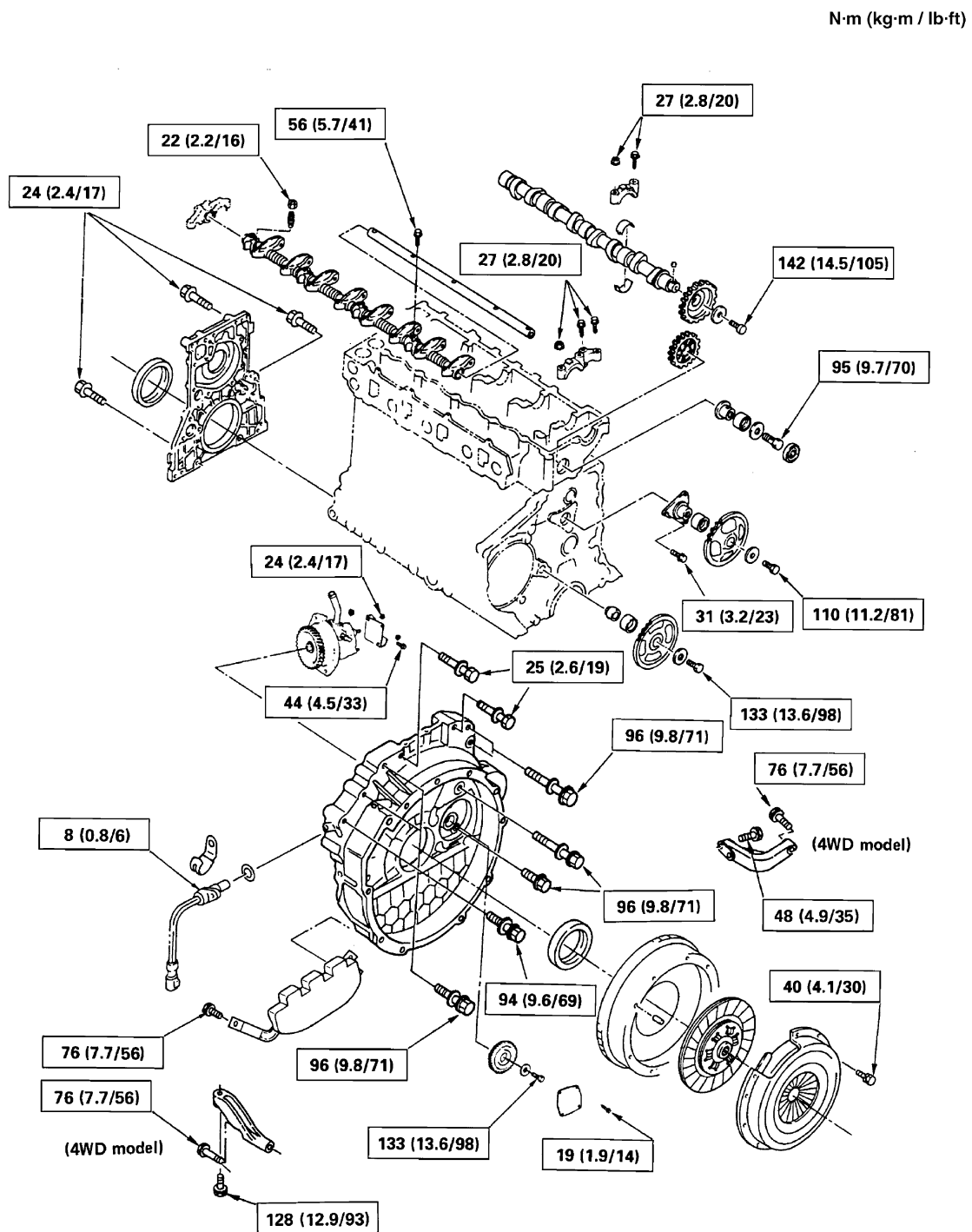


Crankshaft, Flywheel, Damper Pulley, Connecting Rod and Oil Pan

N·m (kg·m / lb·ft)

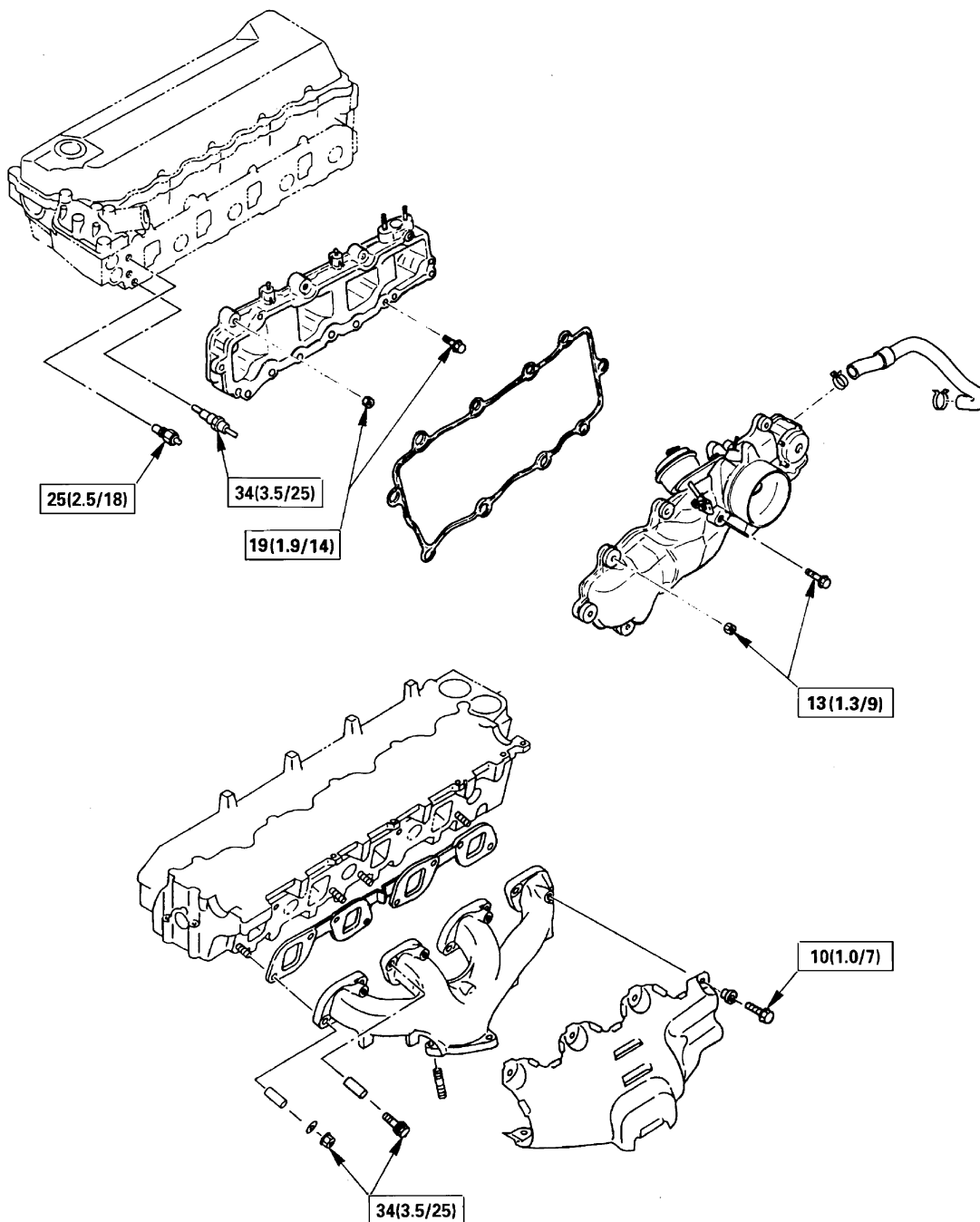


Gear Train, Camshaft, Rocker Arm Shaft, Front Retainer, Flywheel Housing



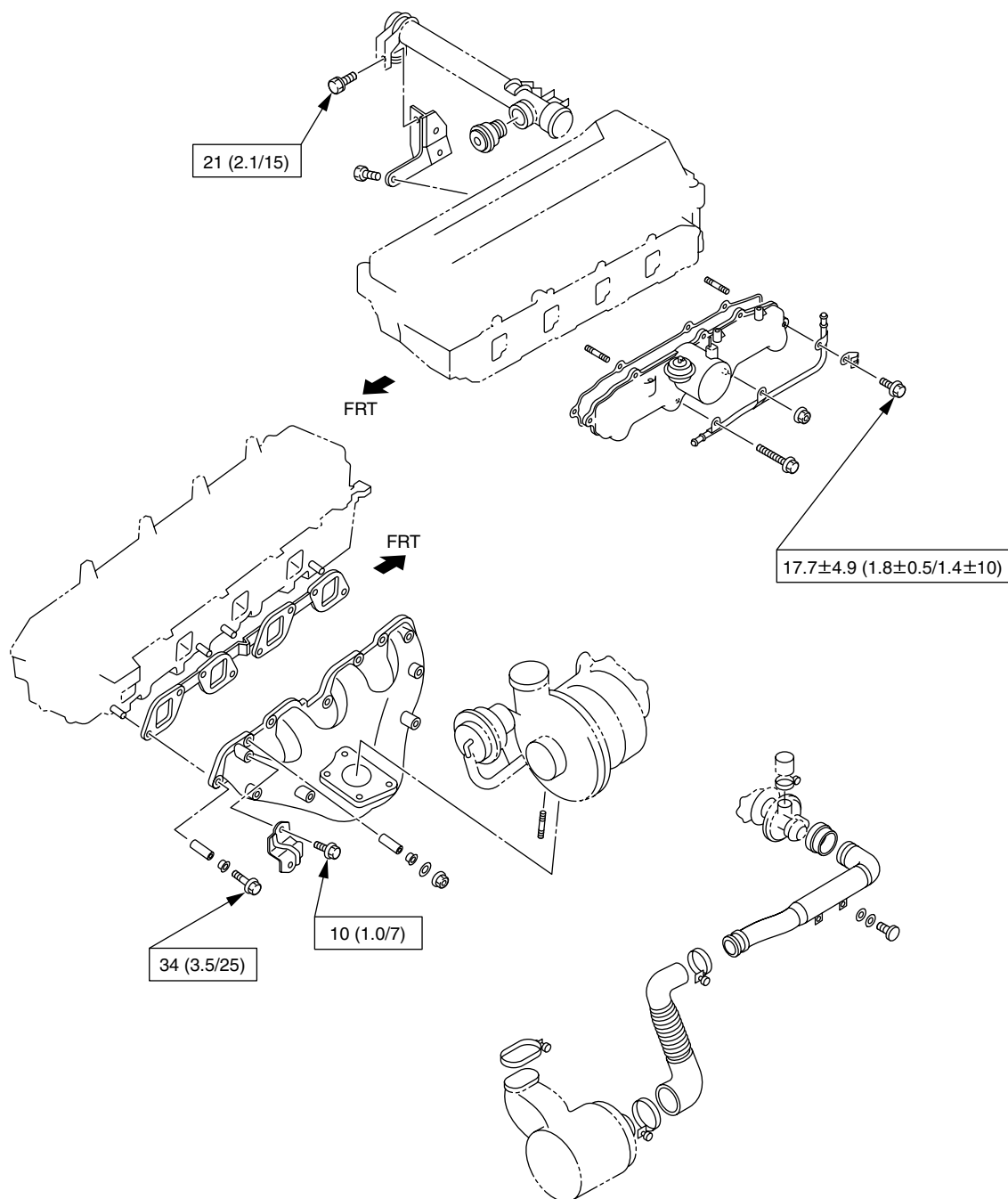
Inlet Cover and Exhaust Manifold

N·m (kg·m / lb·ft)

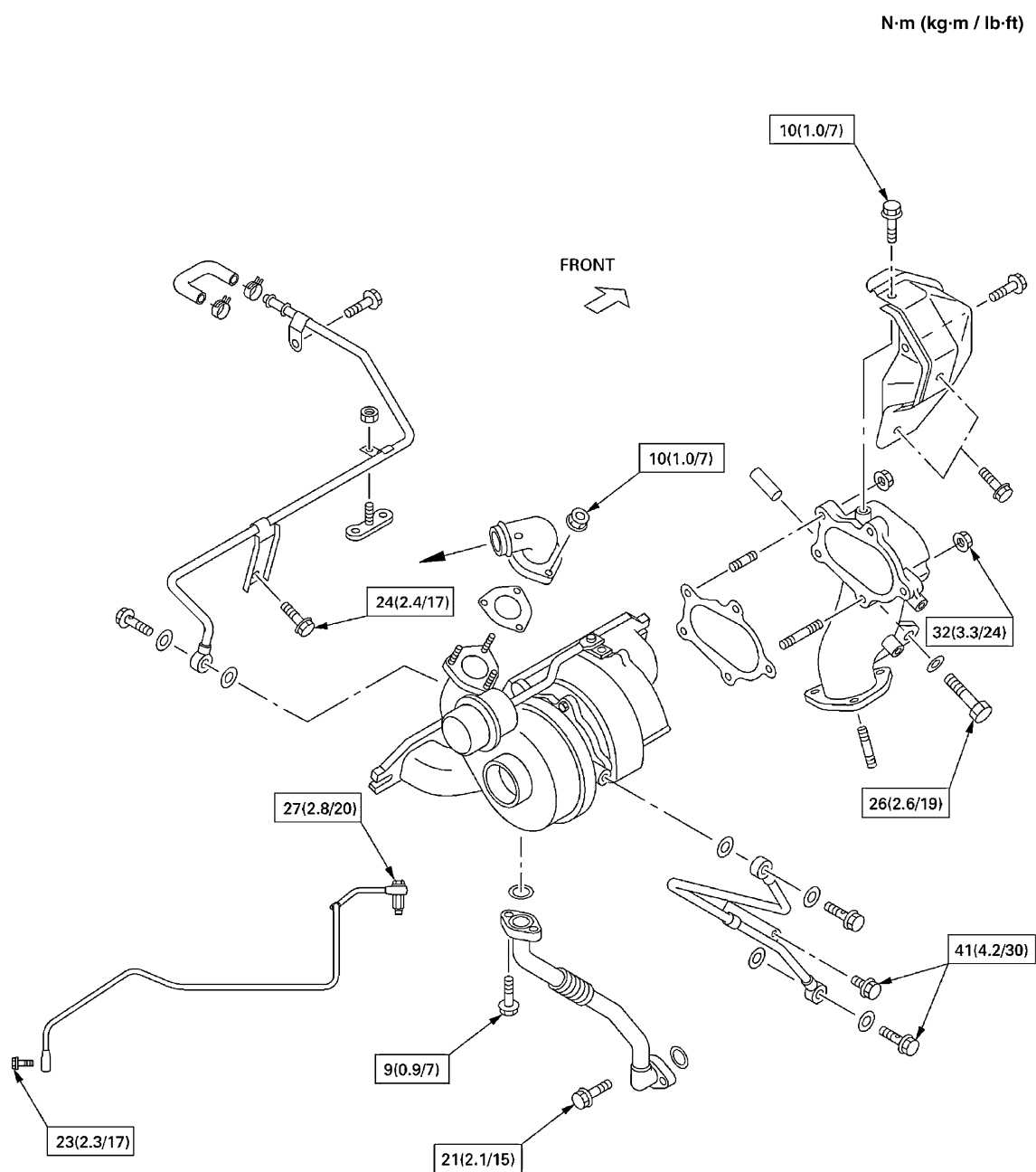


4HE1-TC Engine

N·m (kg·m / lb·ft)

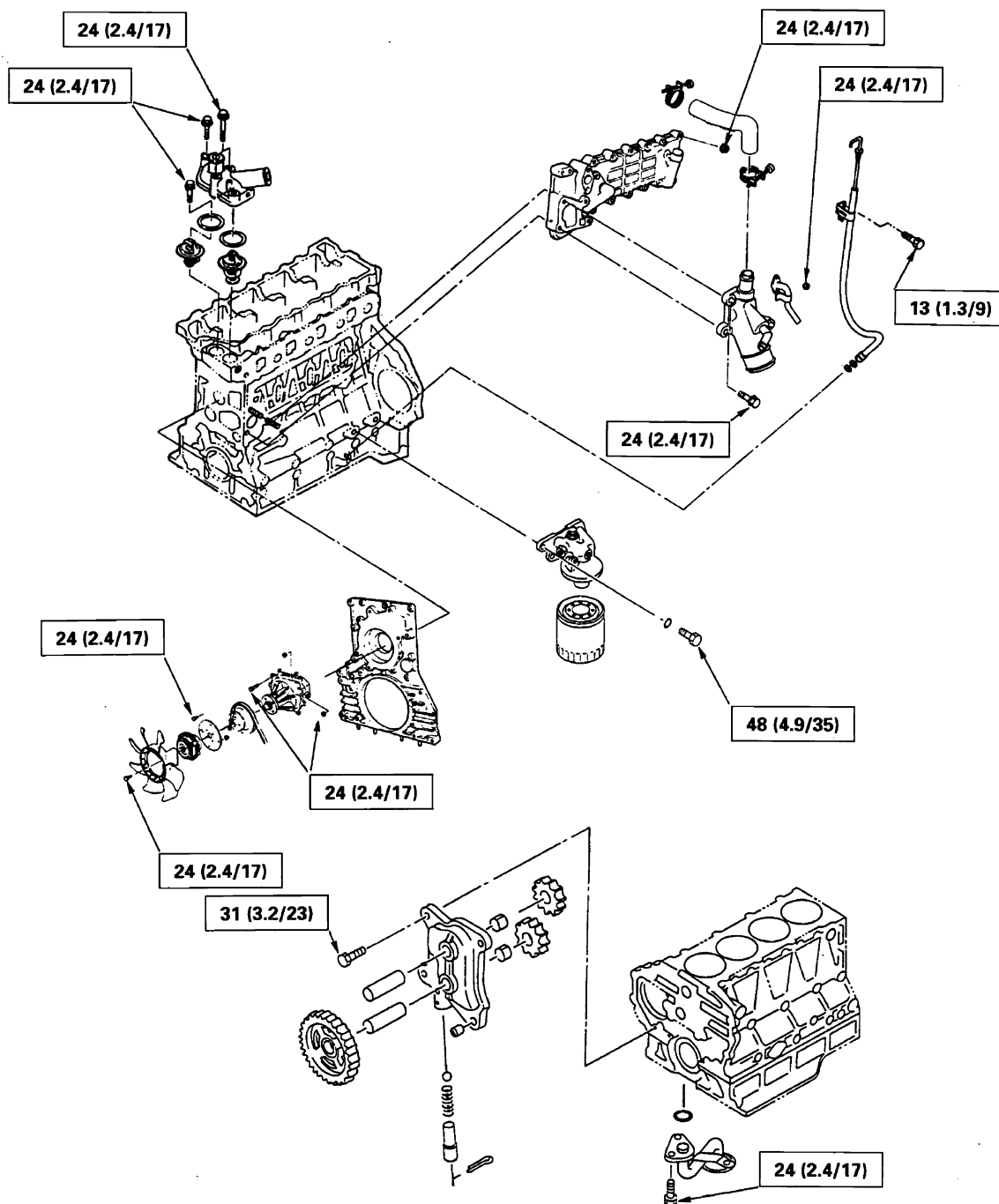


Turbocharger, Water Pipe and Oil Pipe

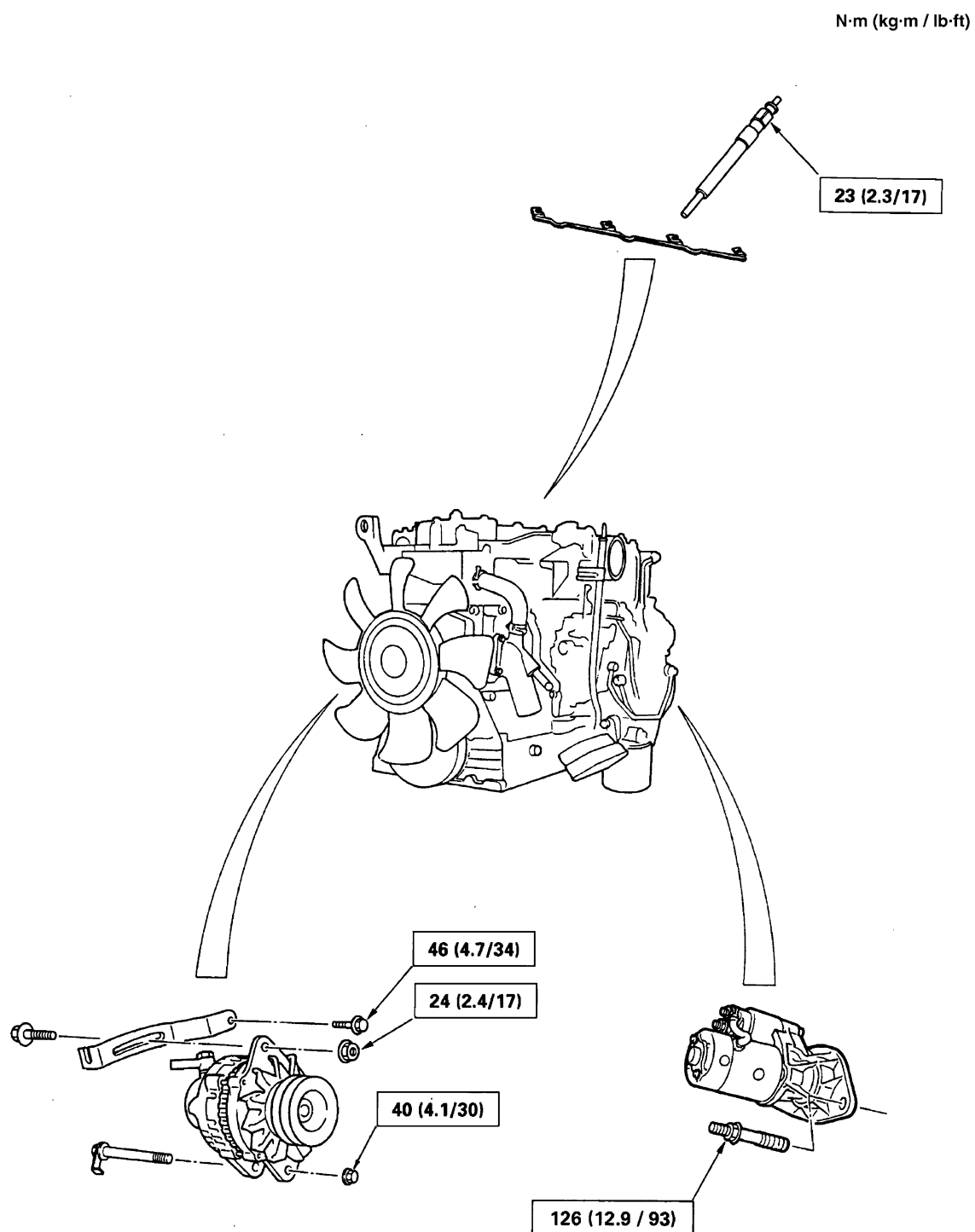


Water Pump, Water Outlet Pipe, Oil Pump, Oil Cooler and Oil Filter

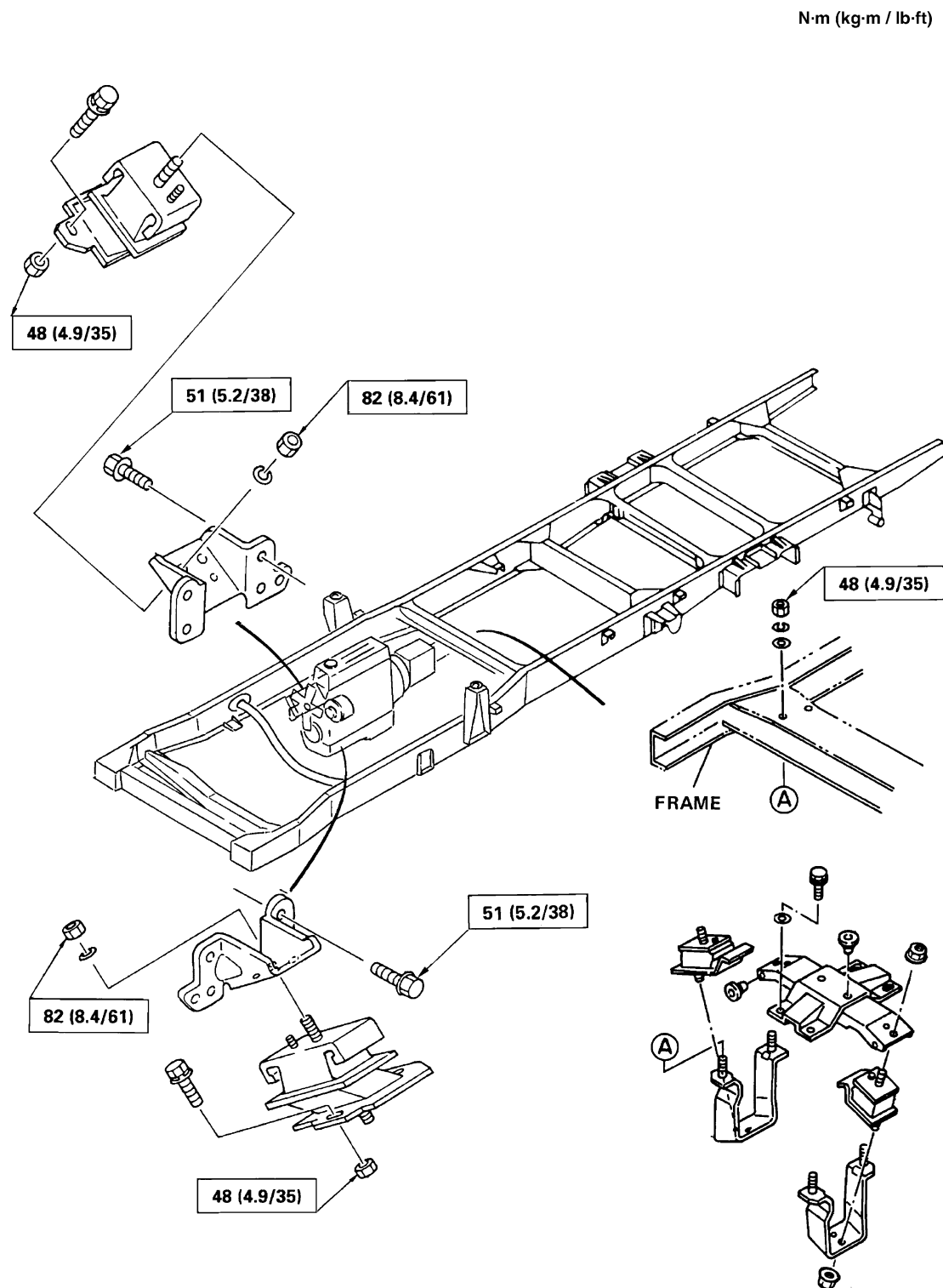
N·m (kg·m / lb·ft)



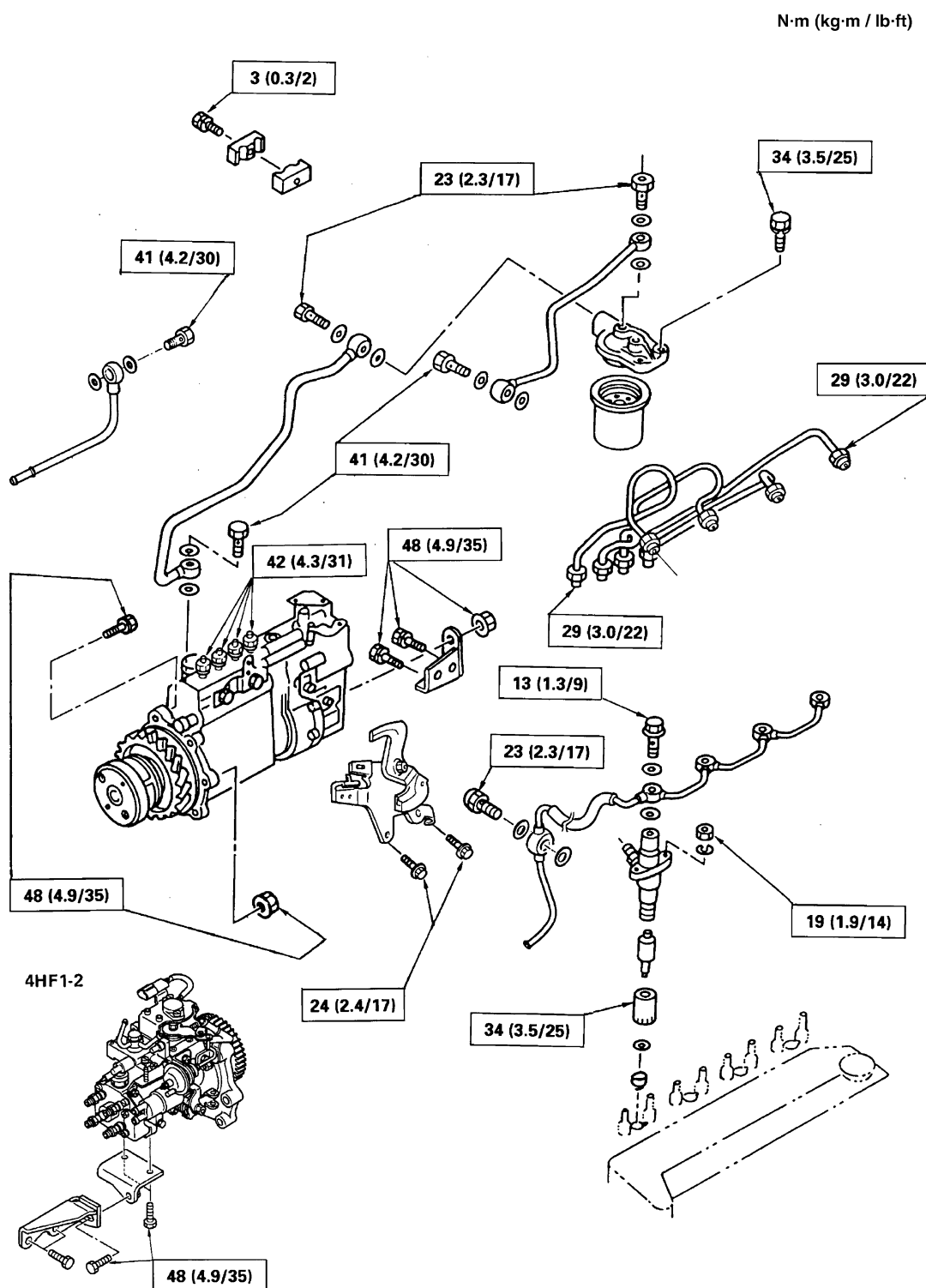
Generator, Starter and Glow Plug



Engine Mounting



Injection Pump, Injection Pipe and Fuel Pipe



SPECIAL TOOLS

Special Tools

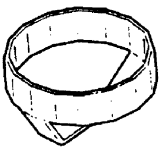
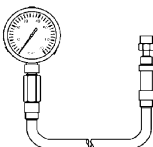
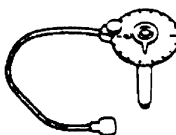
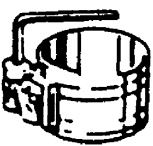
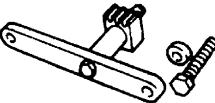
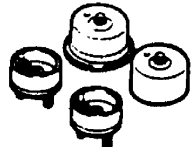
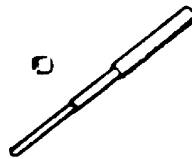
Illustration	Tool Number / Description / Remarks
 1852210970	1-8522-1097-0 / Oil filter wrench
 5884026750	5-8840-2675-0 / Compression gauge
 5853170010	5-8531-7001-0 / Adapter; Compression gauge
 5884002660	5-8840-0266-0 / Angle gauge / For angular bolt and nut tightening
 5884090180	5-8840-9018-0 / Piston installer
 5884022300	5-8840-2230-0 / Crankshaft stopper

Illustration	Tool Number / Description / Remarks
 5884023600	5-8840-2360-0 / Slinger puller / For crankshaft front and rear slinger remove
 5884024310	5-8840-2431-0 / Oil seal setting tool kit / For crankshaft front and rear oil seal and slinger install
 5884022400	5-8840-2240-0 / Clutch pilot aligner
 5884022280	5-8840-2228-0 / Valve spring compressor
 5884022270	5-8840-2227-0 / Valve guide replacer
 8943968150	8-9439-6815-0 / Valve guide seal installer

00-68 SERVICE INFORMATION

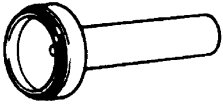
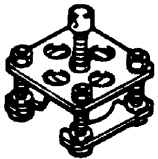
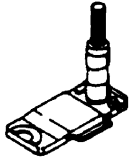
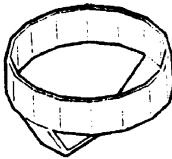
Illustration	Tool Number / Description / Remarks
 5884022220	5-8840-2222-0 / Sealing cup installer
 9852311690	9-8523-1169-0 / Cylinder liner remover
 5884022200 5884023970	5-8840-2220-0 5-8840-2397-0 (4HG1) / Cylinder liner remover ankle
 5884023370	5-8840-2337-0 / Cylin- der Liner Installer (4HE1- TC only)
 8943968180	8-9439-6818-0 / Crank- shaft gear remover
 8943968190	8-9439-6819-0 / Crank- shaft gear installer
 5884023400	5-8840-2340-0 / Conrod bush replacer

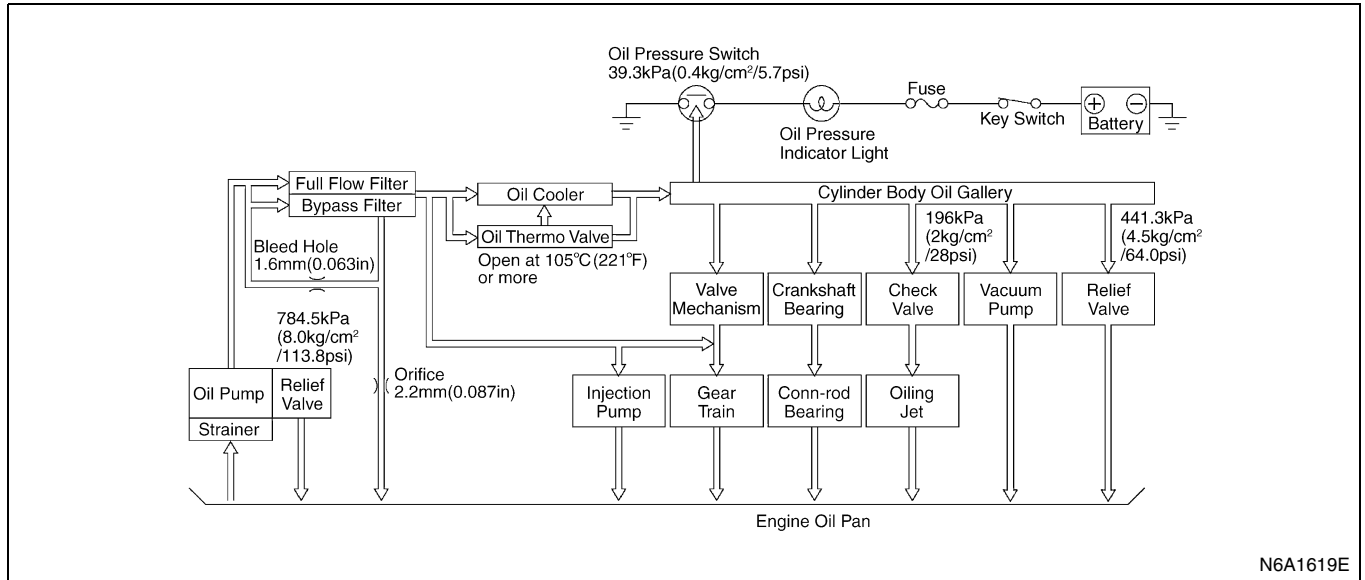
Illustration	Tool Number / Description / Remarks
 5884020940	5-8840-2094-0 / Oil filter wrench / 4WD model

LUBRICATING SYSTEM

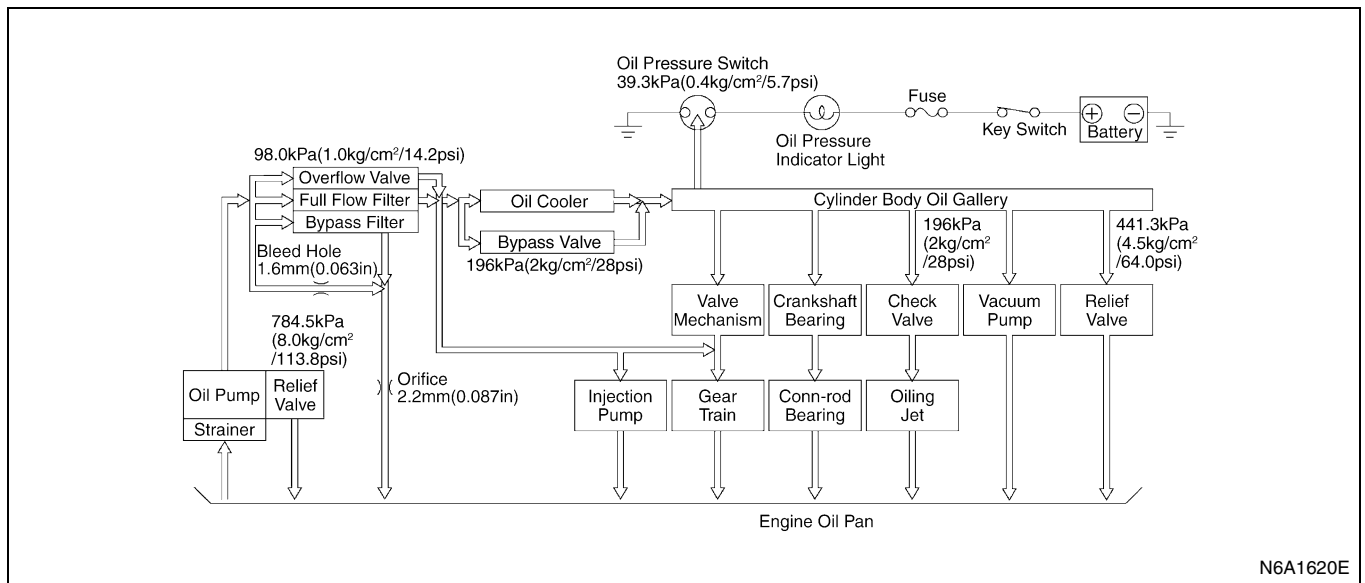
General Description

Lubricating Oil Flow

4HF1, 4HF1-2, 4HG1-T Model



4HE1-TC Model



The engine lubricating system is a full flow type.

Lubricating oil is pumped from the oil pump to the cylinder body oil gallery through the oil filter and the oil cooler. It is then delivered to the vital parts of the engine from the cylinder body oil gallery.

Oil jets installed on the cylinder body spray engine oil to the piston inside faces to achieve maximum cooling effect.

