

Foreword

This booklet has been prepared to provide the necessary information for the operation, inspection and maintenance of the ZPP Engine.

We urge you to follow the recommendations contained in this booklet so that the ZPP Engine will remain free of trouble throughout its working life. Please familiarize yourself with the booklet and refer to it when necessary.

If you encounter any problems with your Nissan Engine contact the authorized ZPP dealer in your area.

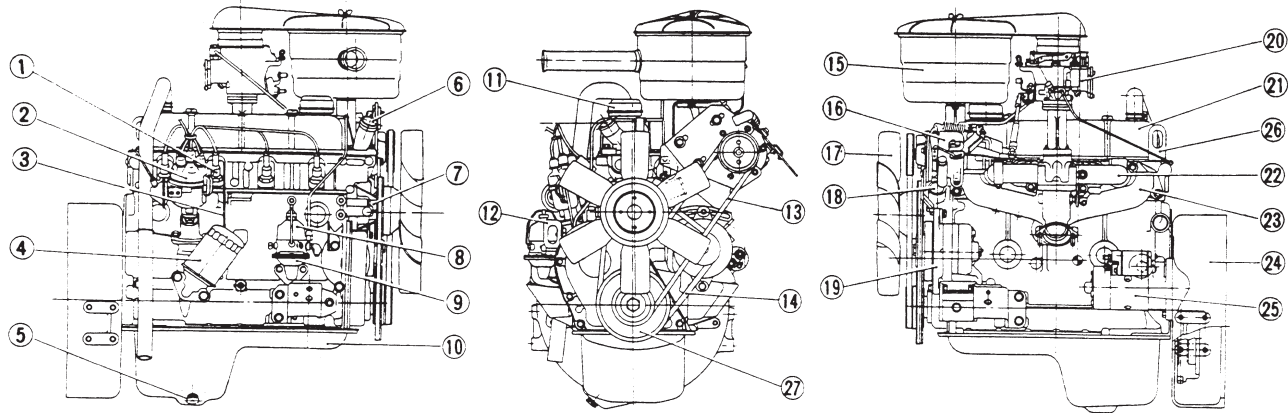
All information, specifications and illustrations in this manual are on a basis of the latest data obtainable at the time of the publication. ZPP reserves the right to make changes or improvements at any time without notice.

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Names of Parts

ENGINES



- 1 Spark plug
- 2 Distributor
- 3 Oil level gauge
- 4 Oil filter
- 5 Oil drain plug
- 6 Water outlet
- 7 Water pump

- 8 Fuel filter
- 9 Fuel pump
- 10 Oil pan
- 11 Oil filter cap
- 12 Front engine slinger
- 13 V Belt (for governor)
- 14 V Belt (for fan & alternator)

- 15 Air cleaner
- 16 Governor
- 17 Cooling fan
- 18 Water inlet
- 19 Alternator
- 20 EFI
- 21 Rocker cover

- 22 Intake manifold
- 23 Exhaust manifold
- 24 Flywheel housing
- 25 Starter motor
- 26 Rear engine slinger
- 27 Crank pulley

Operation

HANDLING OF NEW ENGINE

The life and performance of an engine are greatly influenced by how it is handled and serviced during the initial period.

Operate the engine by observing the following precautions during the initial 100 hours of operation.

Cautions in operation

1. After starting, warm the engine thoroughly by means of warming-up operation until the cooling water temperature rises above 50°C (122°F)
2. Never attempt to race the engine under non-loaded conditions
3. Always maintain the operation speed of the engine below 70% of the maximum engine rpm.
4. Avoid overloading.

ENGINE HANDLING PRECAUTIONS

When handling the engine, be sure to observe the following precautions.

When Starting the engine

1. Check the engine oil and coolant level and refill if necessary.
2. After the engine starts, make sure that the oil and charge warning lamps are off.
3. Warm up the engine until it runs smoothly, emitting normal exhaust gases.
4. During this warming up operation or when the cooling water the cooling water temperature is still low, never attempt to race the engine.

During engine operation

1. During operation, always make sure that the cooling water temperature and lubricating oil pressure are both normal. Normal cooling water temperature is 75 to 85°C (167 to 185°F)
Oil pressure is normal if the "OIL" warning lamp remains OFF during engine operation.
2. Always be aware of the condition of the engine, paying attention to any abnormal vibration, noise or other unusual circum-

stances. If any abnormality is found, immediately stop the operation, examine the cause, and make the necessary correction.

When Stopping the engine

Upon completion of operation, idle the engine for some time to lower its temperature before stopping this procedure will help to extend the engine life.

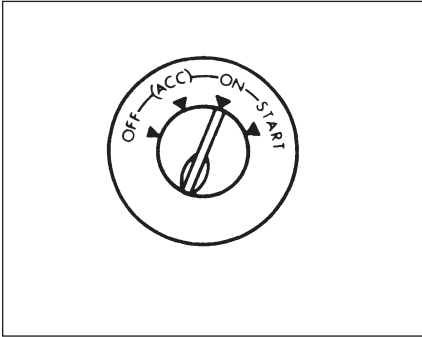
Note that stopping the engine immediately after heavily loaded operation will deteriorate the engine because it is still in a very hot state.

Others

Perform periodical inspection and replacement of the following items:

Engine, oil, oil filter, air cleaner element, fuel filter element.

STARTING AND OPERATING



Starting

1. Turn the ignition key to the extreme right. Release the key as soon as the engine starts.

Do not turn the starting motor for more than 10 seconds at any time. It is not good for starter motor to run for long time.

2. Never race the engine during this warming-up period.

Stopping

To stop the engine, idle the engine, turn the ignition key to the "OFF" position, then the engine will stop.

Except in an emergency, be sure to turn the ignition key off only after the engine speed has returned to idle.

CAUTIONS DURING OPERATION

During engine operation, the warning light should remain OFF. If it comes ON immediately stop operation, and take the actions that are described below.

If any other abnormalities such as unusual noise vibration or shocks are observed again, stop the operation, and make the necessary inspection and repair.

At completion of the day's operations

1. Make sure that there is no oil leak, water leak, or any other defects.
2. Clean the exterior of the engine so that any oil leak, water leak, fuel leak or other defect may be easily detected.
3. If antifreeze is not used in the cooling system in cold weather, be sure to discharge the cooling water to prevent damage to the engine and/or radiator due to freezing water.
4. Repair any faulty parts detected during operation.

Other Handling and Operations

AGAINST COLD AND HOT WEATHER

In cold weather

- Oil

Use engine oil suitable for ambient temperature (Refer to RECOMMENDED LUBRICANTS)

- Coolant

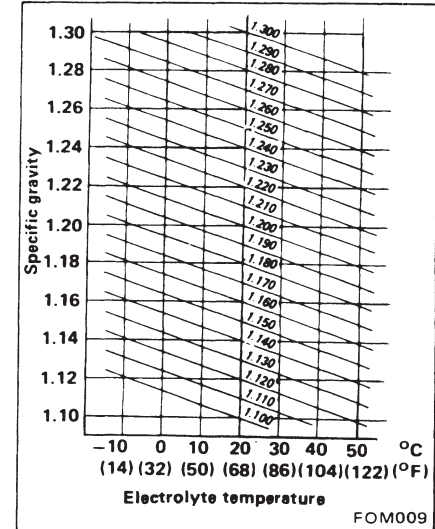
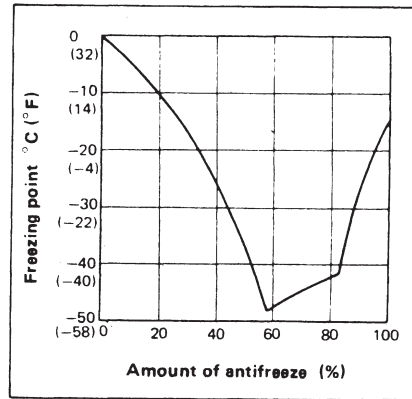
When coolant might freeze under low ambient temperature, drain out the coolant completely.

In such a cold weather, it is recommended to mix anti-freeze solution into cooling system because it makes you free from draining coolant.

Coolant capacity (Engine proper):

2.7 l (2-7/8 US qt. 2-3/8 Imp qt)

Coolant mixture ratio



- Battery

Battery should not be left in discharged state. When battery performance becomes questionable, check the specific gravity of the electrolyte, terminals of battery and alternator for looseness.

The normal specific gravity is 1,260 as

corrected at 20°C (68°F). It changes about 0.0007 for every 1°C (1.8°F). If the specific gravity for electrolyte does not reach the desirable value, charge the battery soon.

In hot weather

● Oil

Engine oil should be changed to summer type oil (Refer to RECOMMENDED LUBRICANTS)

● Coolant

Because the engine is more likely to overheat in hot weather, the engine should be placed in the shade. Overheating sometimes comes from defective hoses, connections, loosened radiator cap, or defective fan belt. So check carefully the cooling system to maintain the best cooling effect.

It is recommended to add antifreeze solution into the cooling system because it increases the coolant boiling point.

● Battery

Since the battery electrolyte evaporates much in hot weather, it is necessary to top up distilled water frequently.

WHEN USING THE ENGINE ONLY DURING A PARTICULAR PERIOD OF THE YEAR

When the engine is to be used only in a particular period of the year, such as summer or winter, the service life of the engine will be determined by how it is maintained during the out-of-use period. Follow the procedures below when preparing the engine.

During in-use period

Follow the normal handling procedures during this period. However, it will be necessary to shorten the oil replacement interval and other service intervals, because the engine will often be operated for a longer than normal period of time during a single day and the load applied will often be greater than usual.

During out-of-use period

During the out-of-use period, perform the following maintenance procedures for the engine. If it is impossible to perform these operations, refer to "Long Term Storage".

1. Perform loaded operation once a month.

- Run the engine and perform checks set forth in item 1 above.

- Apply a load in excess of 50% of the rated load to the engine, and operate it for more than 10 minutes. Make sure that no abnormal

noise or vibration is produced.

2. Perform the following inspection and adjustment before placing the engine in use period.

- Drain sediment from the fuel system (fuel filter and fuel tank).
- Change engine oil and oil filter element.
- Check and adjust valve clearance.
- Check and adjust fan belt tension.
- Check battery electrolyte level and specific gravity.
- Change air cleaner element.
- Check cooling water
- Check exhaust leakage

PROCEDURES FOR PLACING THE ENGINE IN LONG-TERM STORAGE

Before storing the engine for a long period of time (more than 3 months), perform the following procedures to prevent formation of rust. If the storage period is short, follow the maintenance procedures for the engine as described in the previous paragraph.

Lubricating system

Drain the engine oil, pour the specified amount of rust preventive oil into the oil pan, and then run the engine under no load at approximately 1,500 rpm for about 10 minutes. Stop the engine, and seal all the openings of the lubricating system with sealing tape.

For a greater rust preventing effect, perform this operation in combination with the rust preventing procedure for the fuel system and cooling system.

Fuel system

Drain fuel from the fuel system, and pour the mixed fuel (the ratio of fuel to rust preventing oil should be 1 : 1) into the fuel tank. Operate the engine under no load at 1,500 rpm for about 10 minutes. Stop the engine, drain the mixed fuel, and then seal all of the openings in the fuel system (such as the breather of the fuel tank) with sealing tape.

Cooling system

Flush the cooling system, and pour antifreeze or an anti-rust agent into the cooling water. Run the engine under no load at 1,500 rpm for about 10 minutes. Stop the engine, and seal all of the openings in the cooling system (such as overflow pipe, etc.) with sealing tape. If antifreeze is used, keep the cooling water in the system. If an anti-rust agent is used, thoroughly drain the cooling water before sealing.

When using antifreeze, pay attention to the freezing point of coolant and choose a mixing ratio of at least 30%, a mixing ratio of less than 30% provides only a limited rust preventing effect. Note that the anti-rust agent will freeze when the temperature falls below 0°C (32°F). In such event, either thoroughly drain the cooling water or use antifreeze.

Combustion chamber

After completing the rust preventive procedure, allow the engine temperature to drop to room temperature. Then disconnect the air cleaner from the EFI, and spray or pour rust preventing oil into the combustion chamber. Next, disconnect the high tension cable from the spark plugs, turn the ignition switch to the "START" position, and crank the engine five to ten times, and then install the

high tension cables and air cleaner.

Engine exterior

Using a petroleum solvent, remove dirt and oil from the uncoated metal surfaces of the engine (intake manifold, exhaust manifold, rocker cover, fan and governor belt grooves of pulleys, etc.). Spray or apply anti-rust agent to the cleaned surfaced. Do not apply any type mineral or vegetable oil to the fan and governor belt grooves of pulleys.

Others

1. Remove the fan belt and keep it loosened.
2. Seal the air intake hole of the air cleaner and air outlet hole of the exhaust tube with adhesive tape.
3. Wrap the open type generator with a porous bag, and fasten the bag with a rubber band or similar item.
4. If the engine is equipped with a clutch. Spray an evaporative anti-rust agent into the clutch housing, and seal the opening with adhesive tape.
5. When storing the engine as a complete assembly outdoors, cover it fully with a porous water-proof sheet.
Do not use a vinyl sheet, because it lacks porosity and retains water inside.

Preparations for operation after long-term storage

1. Remove all adhesive sealing tapes from the openings of the engine.
2. Drain the rust preventing oil and anti-rust agent by using the following procedure, and replace it with the specified amount of engine oil, fuel and cooling water.

Lubricating system:

Drain oil through the drain plug of oil pan and oil filter.

Fuel system:

First operate the engine with the mixed fuel that is used in the rust preventing operation, and then drain the fuel.

Cooling system:

If antifreeze is used, drain cooling water from the drain valves on each of the radiator and cylinder block, and flush the cooling system.

If an anti-rust agent is used, flush the cooling system.

Exterior of engine:

Clean the exterior surfaces of the engine with a petroleum solvent (Trichlene).

3. Replace the elements of the oil filter, the air cleaner and the fuel filter with new ones.
4. Adjust the fan and governor belt for proper tension.

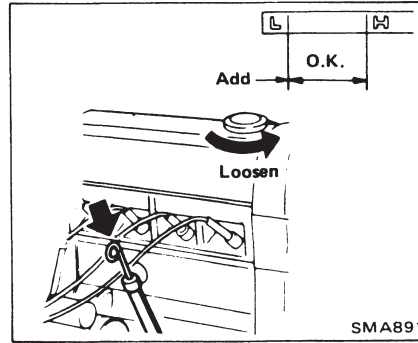
5. Check and adjust valve clearance. Apply engine oil to the rocker arm and other valve mechanism.
6. Check the battery electrolyte level and specific gravity. Refill and/or recharge if it is necessary.
7. Before the engine starts, disconnect the high tension cables from the spark plugs.
8. Set the ignition switch at the "START" position, and crank the engine for about 10 seconds. Repeat this cranking operation two or three times in order to disperse engine oil to every portion of the engine, and then install the high tension cable.
9. Start the engine, and let it idle for about 5 minutes.
10. Gradually increase the engine speed to the rated rpm, and run the engine for about 10 minutes under no load. Make sure that the charge warning lamp and oil warning lamp are off and cooling water temperature are normal, and that the engine does not produced any abnormal vibration or noise.

Daily Care

In order to prevent trouble in daily operation, it is necessary that the operator be constantly aware of the condition of the engine. To achieve this awareness, the operator must personally inspect the engine before starting the day's activities.

If you note any defects, notify your authorized ZPP dealer.

CHECK ENGINE OIL LEVEL



To check the oil level, pull out the level gauge, wipe it clean and reinsert it; remove it again to read the oil level. The level should be between the "L" and "H" marks.

CHECK COOLING WATER LEVEL

Remove the radiator cap, and check the cooling water level. Also check the cap and determine if it functions correctly. The cooling water level is correct if it is near the filler neck of radiator. Insufficient water level may be caused by leakage from the engine or radiator. Check carefully for any sign of leakage; if no leaks are discovered, add water to the filler neck portion.

If cooling water is dirty, flush the cooling system.

When replacing the radiator cap, be sure to fit it securely. If replaced loosely or improperly, the cooling water will quickly evaporate, causing the engine to overheat.

CHECKING THE ENGINE FOR LEAKAGE

1. Insure that the engine, radiator and hoses are not leaking.
2. Check each portion of the engine, and make sure that there is no sign of an oil leak.
3. Check the fuel system to make sure that there is no sign of fuel leaking from the fuel pipe and hose.

CHECKING THE ENGINE OPERATION DURING BOTH IDLING AND ACCELERATION

Make sure that the engine runs normally at idling speed, and that engine rpm increases smoothly as it is accelerated.

OTHERS

Correct all of the faults and problems that were observed during the previous day's operation.

If any faults are discovered during the daily inspection, contact an authorized ZPP dealer for additional inspection, adjustment or repair. Always maintain the engine in its top condition.

ENGINE AND EFI MAINTENANCE SCHEDULE - ZPP MODEL: CG13, A15, H20 II AND H25

The following table lists the periodic maintenance required to ensure quality performance and good mechanical conditions of the Engine, Fuel systems and Catalytic converter in your application unit.

MAINTENANCE OPERATION

Periodic maintenance should be performed after specified intervals have elapsed in months or hours, whichever comes first	Months	1	2	3	4	5	6	7	8	9	10
	Hours	250	500	750	1000	1250	1500	1750	2000	2250	2500

ENGINE MAINTENANCE (LPG Fuel System Includes Items below)

1. Intake & exhaust valve clearances (operating temp)		I					I				I
2. Drive Belt Tension		I	I	I	I	I	I	I	I	I	I
3. Cylinder head bolts & manifold nuts		T							T		
4. Radiator outside	(A)			C			C			C	
5. Engine oil	(A)	R	R	R	R	R	R	R	R	R	R
6. Oil Filter	(A)		R		R		R		R		R
7. Engine coolant (L.L.C.)											R
8. Fuel Filter gasoline							R				
9. Air cleaner element	(A)	I	I/R	I	I/R	I	I/R	I	I/R	I	I/R
10. Ignition timing (Gasoline & LPG)		I	I	I	I	I	I	I	I	I	I
11. Spark Plugs		I	I/R	I	I/R	I	I/R	I	I/R	I	I/R
12. Distributor inside (IC ignition system)						C					C
13. P.C.V. valve (Gasoline)	(A)			I			I			I	
14. P.C.V. hoses (Gasoline)				I			I			I	
15. Fuel supply & return lines for leaks				I			I			I	

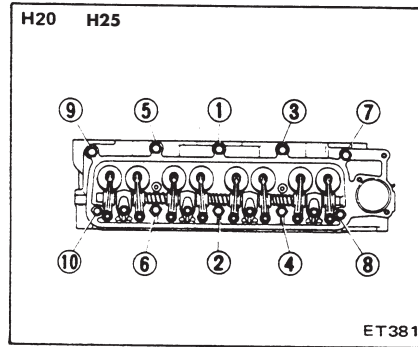
ENGINE MAINTENANCE (LPG Fuel System)

1. Fuel line supply and connectors portion for gas leakage	(B)	I	I	I	I	I	I	I	I	I	I
2. Fuel line supply and connectors for damage	(B)	I	I	I	I	I	I	I	I	I	I
3. Filter LPG				I/R			I/R			R	
4. Primary Vaporize/Regulator Plug (oil contamination)				I/D					I/D		
5. LPG lock off				I					I		

Notes: A) Under heavy duty operating condition, more frequent maintenance might be necessary
 B) At time of LPG cylinder replacement, inspect tank connections for leakage with soapy water

Abbreviations: I = Inspection
 R = Replace
 A = Adjust
 C = Clean
 D = Drain
 T = Retighten

MAINTENANCE OPERATION



Retightening cylinder head nuts, manifold bolts and nuts and carburetor securing nuts

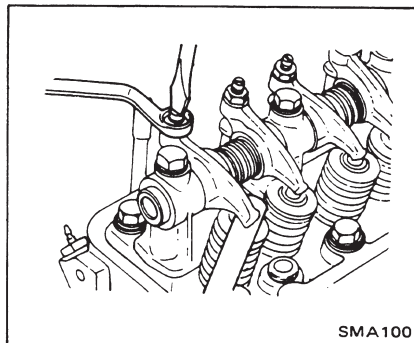
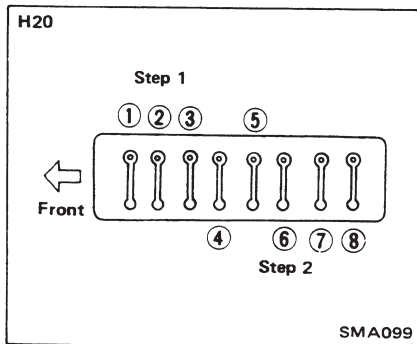
Cylinder head bolts

When the engine is cold, retightening should be made in the sequence shown.

- ⌚ : **Cylinder head bolt**
H20 & H25
78 to 93 N•m
(8.0 to 9.5 kg-m,
58 to 69 ft-lb)

Manifold and exhaust tube nut and carburetor attaching nut

- ⌚ : **Carburetor nuts**
8 to 12 N•m
(0.8 to 1.2 kg-m,
5.8 to 8.7 ft-lb)
- Manifold nuts**
14 to 18 N•m
(1.4 to 1.8 kg-m,
10 to 13 ft-lb)



Adjusting intake and exhaust valve clearance

Adjustment should be made while engine is warm but not running.

1. Start engine and warm it up, sufficiently. Then turn off engine.
 2. Remove valve rocker cover.
 3. Rotate crankshaft.
- (1) Set No. 1 cylinder in top dead center on its compression stroke, and adjust valve clearance.

H20:

①, ②, ③, and ⑤.

(2) Set No. 4 cylinder in top dead center on its compression stroke and adjust valve clearance.

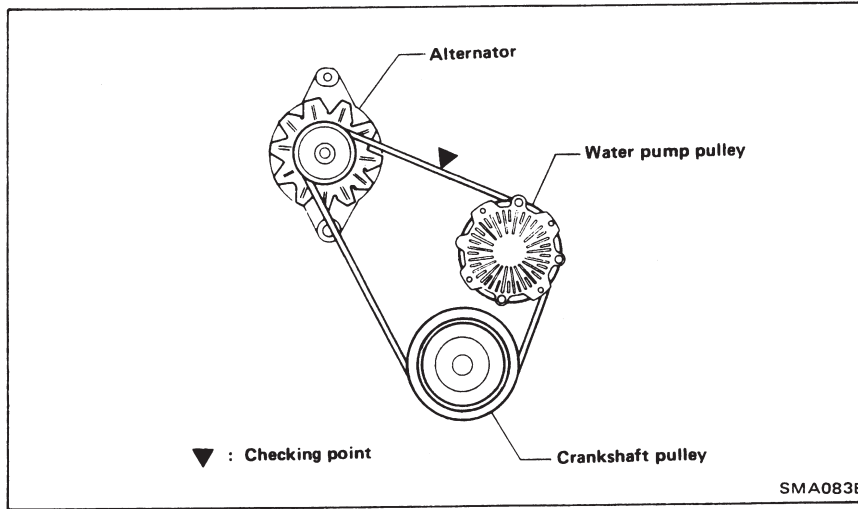
H20:

④, ⑥, ⑦, and ⑧.

Valve clearance (Hot):

Intake & exhaust:

0.35 mm (0.015 in)



Checking and adjusting drive belts

1. Visually inspect for cracks, fraying, wear or oiliness.

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

2. Check belt tension by pushing midway between pulleys.

Drive belt deflection:

8 to 12 mm (0.31 to 0.47 in)

Pushing force:

98 N (10 kg. 22 lb)


Changing engine oil and oil filter

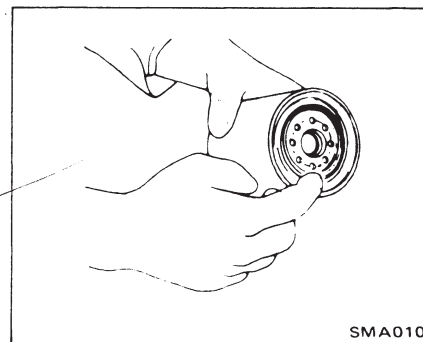
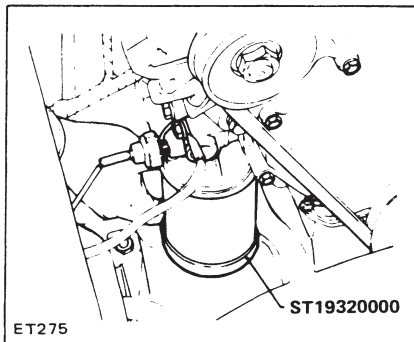
1. Start engine and warm up engine sufficiently, then stop engine.
2. Remove oil filter cap and oil pan drain plug, and allow oil to drain.

WARNING:

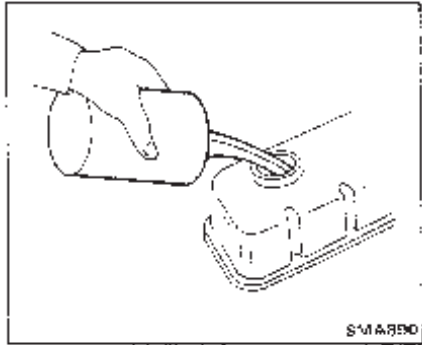
Be careful not to burn yourself, as the engine oil may be hot.

- **A milky oil indicates the presence of cooling water, isolate the cause and take corrective measure.**
 - **An oil with extremely low viscosity indicates dilution with fuel.**
3. Clean and install oil pan drain plug with washer.

 : **Oil pan drain plug**
20 to 28 N•m
(2.0 to 3.0 kg-m, 14 to 22 ft-lb)



4. Using Tool, remove oil filter.
5. Wipe oil filter mounting surface with a clean rag.
6. Smear a little engine oil on rubber gasket of new oil filter.
7. Install new oil filter. Handtighten ONLY. DO NOT use a wrench to tighten the filter.



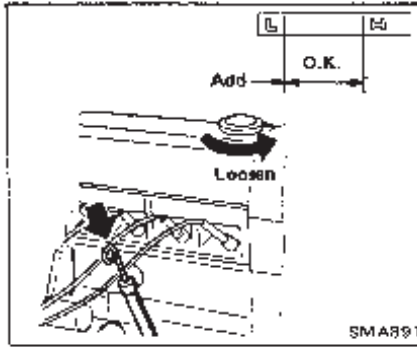
- Refill engine with new recommended engine oil, referring to Recommended Lubricants.

Check oil level with dipstick.

Oil capacity:

Unit: liter (US qt. Imp qt)

	H2O
With oil filter	4.2 (4-1/2, 3-3/4)
Without oil filter	3.7 (3.7/8, 3-1/4)



- Start engine. Check area around drain plug and oil filter for any sign of oil leakage.

If any leakage is evident, these parts have not been properly installed.

- Warm up engine sufficiently. Then stop engine and wait a few minutes. Check oil level. If necessary, add engine oil.

When checking oil level, set engine at level.

Changing engine coolant

WARNING:

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

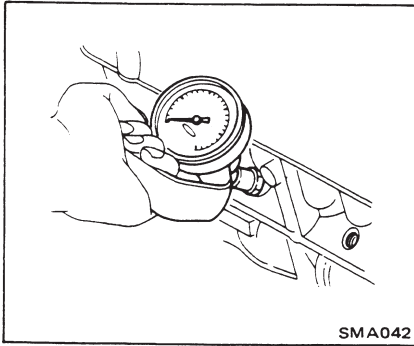
When using antifreeze coolant, mix the antifreeze coolant with water, observing instructions attached to antifreeze container.

Cleaning radiator outside

Clean outside of radiator with dry compressed air.

Checking cooling system, hoses and connections.

Check hoses and fittings for loose connections or deterioration. Retighten or replace if necessary.



Checking engine compression pressure

1. Warm up engine sufficiently, then stop engine.
 2. Remove all spark plugs.
 3. Properly attach a compression tester to spark plug hole in cylinder being tested.
 4. Set carburetor throttle valve at fully-open position.
 5. Crank engine and read gauge indication.
- Engine compression measurement should be made as quickly as possible.

Compression pressure:

Standard

**1,275 kPa (12.75 bar,
13.0 kg/cm²,
185 psi)/300 rpm**

Minimum

**1,079 kPa (10.79 bar,
110.0 kg/cm²,
158 psi)/300 rpm**

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

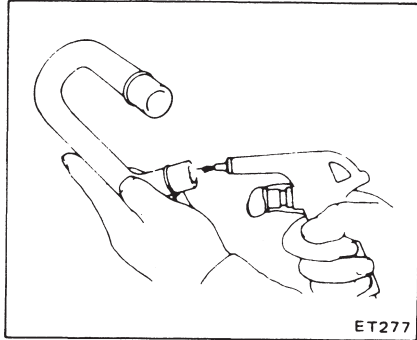
If cylinder compression in one or more cylinders is low, pour a small quantity of engine oil into cylinders through the spark plug holes and retest compression.

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

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

Checking fuel lines (Hoses, piping, connections, etc.)

Check fuel lines for proper attachment, leaks, cracks, damage, loose connections, chaffing and deterioration. If necessary, replace any damaged or defective parts.

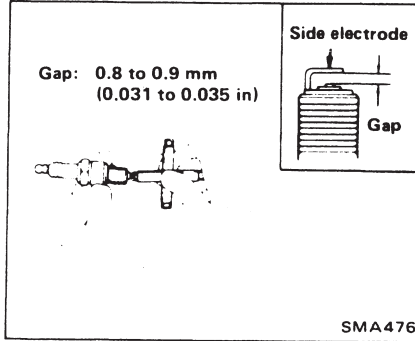


Cleaning and replacing air cleaner element (Dry paper type)

1. Remove air cleaner cover and filter element.
2. Blow dust off inner side of element with dry compressed air.
3. Wipe inside of air cleaner housing and cover with damp cloth.

Be careful not to drop into carburetor.

4. Install element and air cleaner cover.



Checking crankcase ventilation hose

1. Check hoses and hose connections for leaks.
2. Check each hose for cracks or distortion.
3. Disconnect all hoses and blow them out with dry compressed air.

If any hose cannot be made free of obstructions, replace with a new one.

Checking and replacing spark plugs

1. Disconnect the high tension cables from the spark plugs.

Do not pull on the cable.

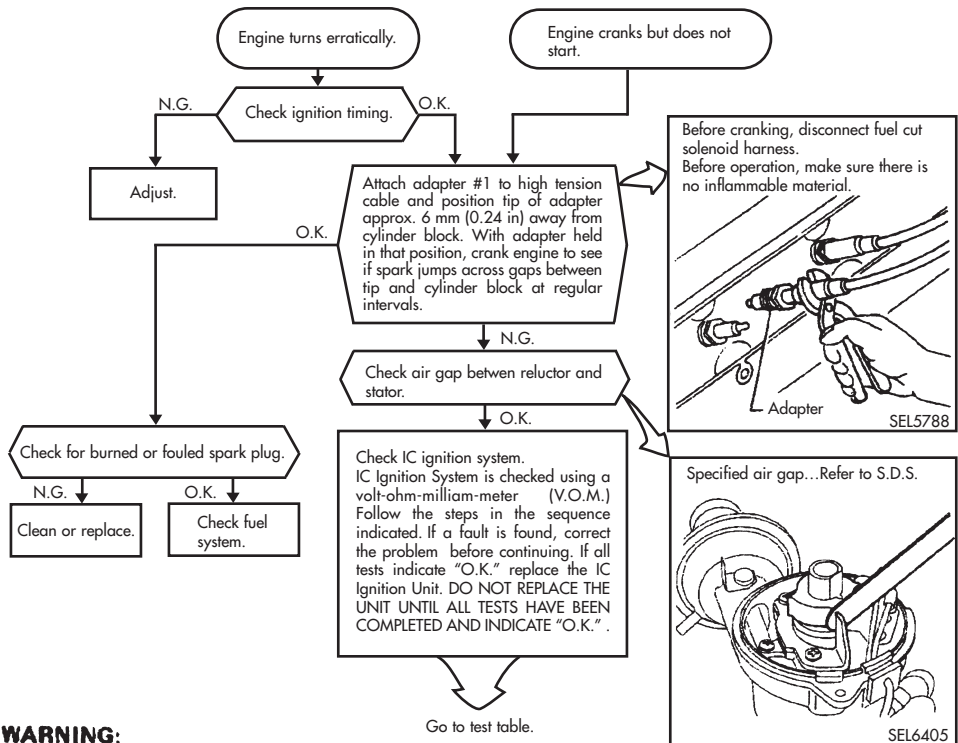
2. Remove spark plugs with spark plug wrench.
3. Clean plugs in sand blast cleaner
4. Inspect insulator for cracks or chips, gasket or damage or deterioration and electrode for wear or burning. If they are excessively worn, replace with new ones.
5. Check spark plug gap.

Spark plug type:

Reference Parts Manual

IC IGNITION SYSTEM

IC IGNITION SYSTEM TROUBLE-SHOOTING



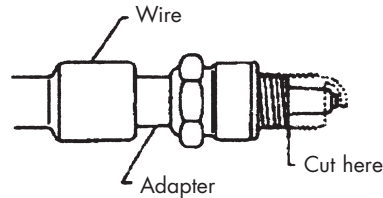
WARNING:

When current is flowing, never touch with bare hand high tension cables or any other parts with high voltage. If parts are moist, touching them could cause an electric shock, even if they are insulated. Always wear dry, well-insulated gloves or wrap affected parts with dry cloth before handling.

***1:**

Preparation of spark plug for checking

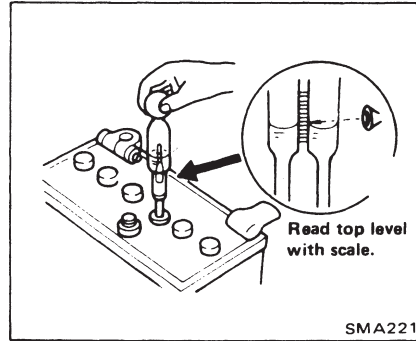
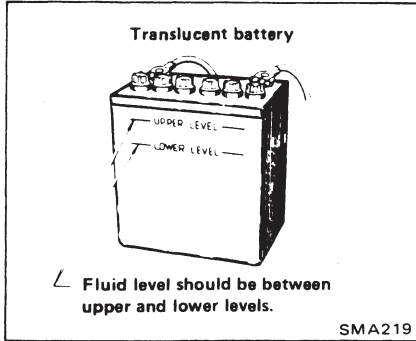
Many things can be utilized as an adapter. However, it is recommended that a used spark plug whose threaded portion has been half cut off as shown in the figure.



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NOTE:

1. When performing the following tests, use a multimeter which can measure accurately in the following ranges; 0 to 20V D.C.; 0 to 1,000 Ω ; 0 to 10V A.C.; 0 to 50,000 Ω .
2. If possible, start the vehicles and let it run for 5 to 15 minutes with the hood closed. This will bring all components to normal operating temperature, and will make it easier to diagnose intermittent problems.
3. It is not necessary to disconnect the harness connectors when performing the tests which follow. Simply insert the motor probes into the back of appropriate connector cavity.



Checking electrolyte level

Check the fluid level in each filler. If necessary add only distilled water. Do not overfill.

Checking electrolyte gravity

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

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

Trouble Diagnosis and Corrections

Condition	Probably cause	Corrective action
CANNOT CRANK ENGINE OR SLOW CRANKING	Improper grade oil.	Replace with proper grade oil.
	Partially discharged battery.	Charge battery
	Malfunctioning battery.	Replace.
	Loose alternator belt.	Adjust.
	Trouble in charging system.	Inspect.
	Wiring connection trouble in starting circuit.	Correct.
	Malfunctioning ignition switch.	Repair or replace.
Malfunctioning starting motor.	Repair or replace.	

ENGINE WILL CRANK NORMALLY BUT WILL NOT START

In this case, the following trouble causes may exist, but in many cases ignition system or fuel system is in trouble.

- Ignition system in trouble
- Fuel system in trouble
- Valve mechanism does not work properly
- Low compression

(Trouble-shooting procedure)

- Check spark plug firstly by following procedure.
- Disconnect high tension cable from one spark plug and hold it about 10 mm (0.39 in) from the engine metal part and crank the engine.

Condition	Probably cause	Corrective action
	<p>Good spark occurs.</p> <ul style="list-style-type: none"> a. Check spark plug. b. Check ignition timing. c. Check fuel system. d. Check cylinder compression <p>No spark occurs. Very high current.</p> <p>Low or no current.</p>	<p>Check the current flow in primary circuit. Inspect primary circuit for short. Check breaker point operation.</p> <p>Check for loose terminal or disconnection in primary circuit.</p>
<p>Ignition system out of order</p>	<p>Faulty pickup. Leak at rotor cap and rotor. Faulty spark plug. Improper ignition timing. Faulty ignition coil.</p>	<p>Repair or replace. Adjust. Replace. Clean or replace. Clean, adjust plug gap or replace. Adjust. Replace.</p>

Condition	Probably cause	Corrective action
Ignition system out of order	Disconnection of high tension cable. Loose connection or disconnection in primary circuit.	Replace. Repair or replace.
Fuel system out of order	Lack of fuel Dirty fuel filter. Dirty or clogged fuel pipe. Improper idling Dirty or clogged injector. Clogged breather pipe of fuel tank.	Supply. Replace. Clean. Adjust. Replace or clean injector. Repair and clean.
Low compression	Incorrect spark plug tightening or faulty gasket. Improper grade engine oil or low viscosity. Incorrect valve clearance. Compression leak from valve seat. Sticky valve stem.	Tighten to normal torque or replace gasket. Replace with proper grade oil. Adjust. Remove cylinder head and lap valves. Correct or replace valve and valve guide.

Condition	Probably cause	Corrective action
<p>Low compression</p>	<p>Weak or damaged valve springs. Compression leak at cylinder head gasket. Sticking damaged piston ring. Worn piston ring or cylinder.</p> <p>(Trouble-shooting procedure) Inject a small quantity of engine oil in spark plug hole, and then measure cylinder compression. Compression increases. Compression does not change.</p>	<p>Replace. Replace gasket. Replace piston rings. Overhaul engine.</p> <p>Malfunctioning cylinder or piston ring. Compression leaks from valve, cylinder head or head gasket.</p>
<p>IMPROPER ENGINE IDLING</p>	<p>Loose or cracked vacuum hoses or air hoses from intake manifold.</p>	<p>Check for loose connections or cracks.</p>

Condition	Probably cause	Corrective action
Others	<p>Incorrect valve clearance.</p> <p>Malfunction of the ignition system (spark plug, high tension cable, ignition coil, etc.</p> <p>Incorrect basic ignition timing.</p> <p>Faulty P.C.V. valve.</p> <p>Clogged air cleaner filter.</p> <p>Loose manifold and cylinder head bolts.</p>	<p>Adjust.</p> <p>Replace.</p> <p>Adjust.</p> <p>Replace.</p> <p>Replace air cleaner filter.</p> <p>Retighten bolts.</p>

Condition	Probably cause	Corrective action
<p>ENGINE POWER NOT UP TO NORMAL</p> <p>Low compression</p> <p>Ignition system out of order</p> <p>Fuel system out of order</p> <p>Air intake system out of order</p>	<p>Incorrect ignition timing</p> <p>Damaged spark plugs.</p> <p>Damaged spark plugs.</p> <p>Clogged fuel pipe or needle valve.</p> <p>Dirty or clogged fuel filter.</p> <p>Fuel pump will not work properly.</p> <p>Clogged air cleaner.</p> <p>Air inhaling from manifold gasket or throttle body gasket.</p> <p>Faulty P.C.V. valve.</p>	<p>Previously mentioned.</p> <p>Adjust.</p> <p>Clean, adjust or replace plugs.</p> <p>Clean, adjust are replace plugs.</p> <p>Clean.</p> <p>Replace.</p> <p>Repair or replace.</p> <p>Clean or replace filer.</p> <p>Replace gasket.</p> <p>Replace.</p>

Condition	Probably cause	Corrective action
Overheating	Insufficient coolant. Loose fan belt. Worn or oiled fan belt. Inoperative thermostat. Worn water pump. Clogged or leaky radiator. Faulty radiator filter cap. Air in cooling system. Improper engine oil grade. Incorrect ignition timing. Clogged injector (lean mixture).	Replenish. Adjust fan belt. Replace. Replace. Replace. Flush, repair or replace. Replace. Retighten each part of cooling system. Replace with proper grade oil. Adjust. Clean/Replace
Overcooling	Inoperative thermostat.	Replace.

Condition	Probably cause	Corrective action
<p>NOISY ENGINE</p> <p>Engine knocking</p> <p>Mechanical knocking</p> <p>Crankshaft bearing</p> <p>Connecting rod bearing knocking</p>	<p>Overloaded engine.</p> <p>Carbon knocking</p> <p>Timing knocking.</p> <p>Fuel knocking</p> <p>Preignition (misusing of spark plug).</p> <p>This strong dull noise increases when engine is accelerated. To locate the place, cause a misfire in each cylinder. If the noise stops by the misfire, this cylinder generates the noise.</p> <p>This is a little higher-pitched noise than the crankshaft knocking, and also increases when engine is accelerated. Cause a misfire in each cylinder and if the noise diminishes almost completely, this crankshaft bearing generates the noise.</p>	<p>Use right gear in driving.</p> <p>Disassemble cylinder head and remove carbon.</p> <p>Adjust ignition timing.</p> <p>Use specified octane fuel.</p> <p>Use specified spark plug/Adjust Timing</p> <p>This caused by worn or damaged bearings, or unevenly worn crankshaft. Renew bearings and adjust or change crankshaft. Check lubrication system.</p> <p>Same as the case of crankshaft bearings.</p>

Condition	Probably cause	Corrective action
<p>Mechanical knocking</p> <p>Piston cylinder noise</p> <p>Piston pin noise</p> <p>Water pump noise</p> <p>Others</p>	<p>When you hear an overlapping metallic noise which increases its magnitude with the revolution of engine and which decreases as engine is warmed up, this noise is caused by piston and cylinder. To locate the place, cause a misfire in each cylinder.</p> <p>This noise is heard at each highest and lowest dead end of piston. To locate the place, cause a misfire in each cylinder.</p> <p>This noise may be caused by worn or damaged bearings, or by the uneven surface of sliding parts.</p> <p>An improper adjustment of valve clearance. Noise of timing chain. An excessive end play on crankshaft.</p>	<p>This may cause an abnormal wearing of cylinder and lower compression which in turn will cause a lower out-put power and excessive consumption of oil.</p> <p>Overhaul engine.</p> <p>This may cause a wear on piston pin, or piston pin hole. Renew piston and piston pin assembly.</p> <p>Replace water pump with a new one.</p> <p>Adjust. Adjust the tension of chain. Disassemble engine and renew main bearing.</p>

Condition	Probably cause	Corrective action
<p>ABNORMAL COMBUSTION (Backfire, afterfire, run-on,etc.)</p> <p>Improper ignition timing</p> <p>Fuel system out of order</p> <p>Faulty cylinder head, etc.</p>	<p>Improper ignition timing.</p> <p>Improper heat range of spark plugs.</p> <p>Damaged throttle body or manifold gasket (backfire afterfire).</p> <p>Leaky Injector or o-ring</p> <p>Clogged injector.</p> <p>Improperly adjusted valve clearance</p> <p>Excess carbon in combustion chamber.</p> <p>Damaged valve spring (backfire, afterfire).</p>	<p>Adjust.</p> <p>Use specified spark plugs.</p> <p>Replace damaged parts.</p> <p>Replace faulty o-ring or injector</p> <p>Clean or replace.</p> <p>Adjust.</p> <p>Remove head and clean of carbon.</p> <p>Replace damaged part.</p>

Condition	Probably cause	Corrective action
<p>EXCESSIVE OIL CONSUMPTION</p> <p>Oil leakage</p> <p>Excessive oil consumption</p>	<p>Loose oil drain plug.</p> <p>Loose or damaged oil pan gasket.</p> <p>Loose or damaged chain cover gasket.</p> <p>Worn oil seal in front or rear of crankshaft.</p> <p>Loose or damaged rocker cover gasket.</p> <p>Improper tightening of oil filter.</p> <p>Loose or damaged oil pressure switch.</p> <p>Cylinder and piston wear.</p> <p>Improper location of piston ring gap or reversely assembled piston ring.</p> <p>Damaged piston rings.</p> <p>Worn piston ring groove and ring.</p> <p>Fatigue of valve oil seal lip.</p> <p>Worn valve stem.</p>	<p>Tighten it.</p> <p>Renew gasket or tighten it.</p> <p>Renew gasket or tighten it.</p> <p>Replace oil seal.</p> <p>Renew gasket or tighten it to specification.</p> <p>Renew gasket and tighten it with the proper torque.</p> <p>Replace oil pressure switch or tighten it.</p> <p>Overhaul cylinder and renew piston.</p> <p>Remount piston rings.</p> <p>Replace rings.</p> <p>Repair or renew piston and cylinder.</p> <p>Replace piston and piston ring.</p> <p>Replace seal lip.</p> <p>Replace valve or guide.</p>

Condition	Probably cause	Corrective action
Others	Inadequate quality of engine oil. Engine overheat. Malfunction of P.C.V. system.	Use the designated oil. Previously mentioned. Check or replace.
POOR FUEL ECONOMY See the explanation of the power decrease Others	Improper idle adjustment (Idle speed, ignition timing, mixture ratio). Fuel leakage.	Adjust it to the designated rpm. Repair or tighten the connection of fuel pipes.
TROUBLE IN OTHER FUNCTIONS Decreased oil pressure	Improper grade oil. Overheat. Malfunctioning oil pump regulator valve.	Replace with proper grade oil. Previously mentioned. Disassemble oil pump and repair or replace it.

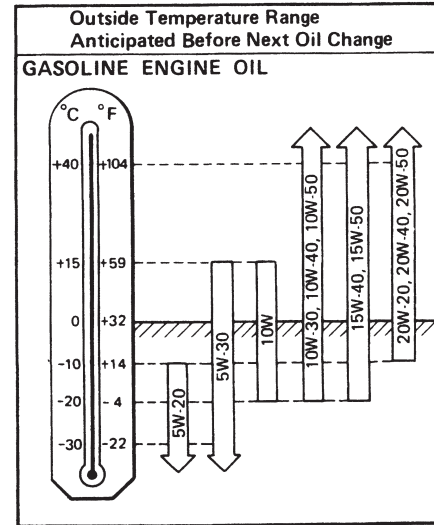
Condition	Probably cause	Corrective action
Decreased oil pressure	Functional deterioration of oil pump. Blocked oil filter. Increased clearance in various sliding parts.	Repair or replace it with a new one. Replace with a new one. Disassemble and replace the worn parts with new ones.
Excessive wear on the sliding parts	Blocked oil strainer. Malfunctioning oil gauge pressure switch. Oil pressure decreases. Damaged quality or contamination of oil.	Clean it., Replace it with a new one. Previously mentioned. Exchange the oil with proper one and change oil filter.
Scuffing of sliding parts	Clogged air cleaner filter. Overheat or overcool. Improper fuel mixture. Decrease of oil pressure. Insufficient clearances. Overheat. Improper fuel mixture. Improper ignition timing.	Clean or replace filter. Previously mentioned. Check the fuel system. Previously mentioned. Adjust to the sufficient clearances. Previously mentioned. Check the fuel system. Adjust.

Recommended Lubricant

LUBRICANT

Lubricant	Specifications	Remarks
Gasoline engine oil	API SD or SE	For further details, refer to the recommended SAE viscosity chart.
Antifreeze	—	Ethylene glycol base

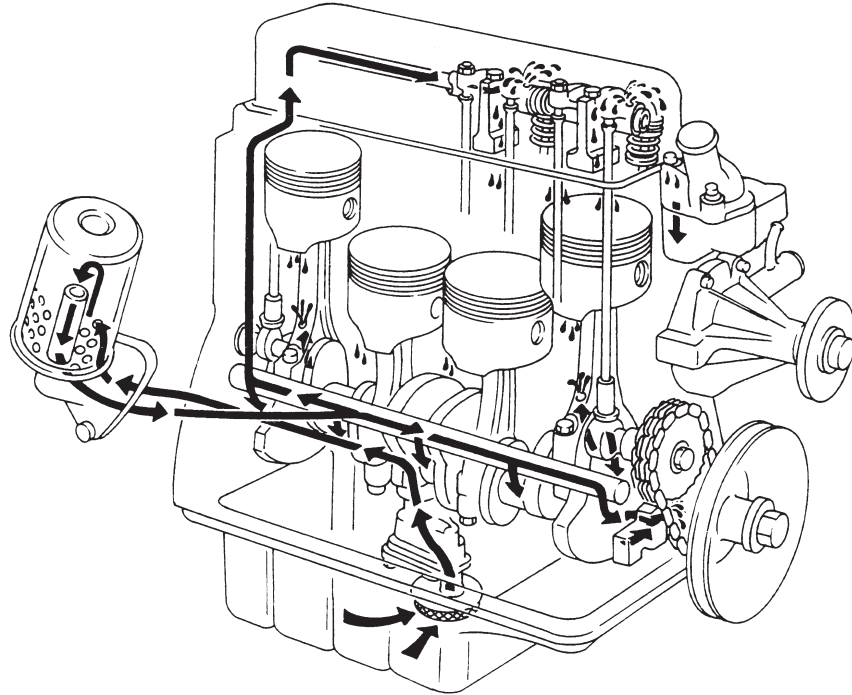
SAE VISCOSITY NUMBER



T10005

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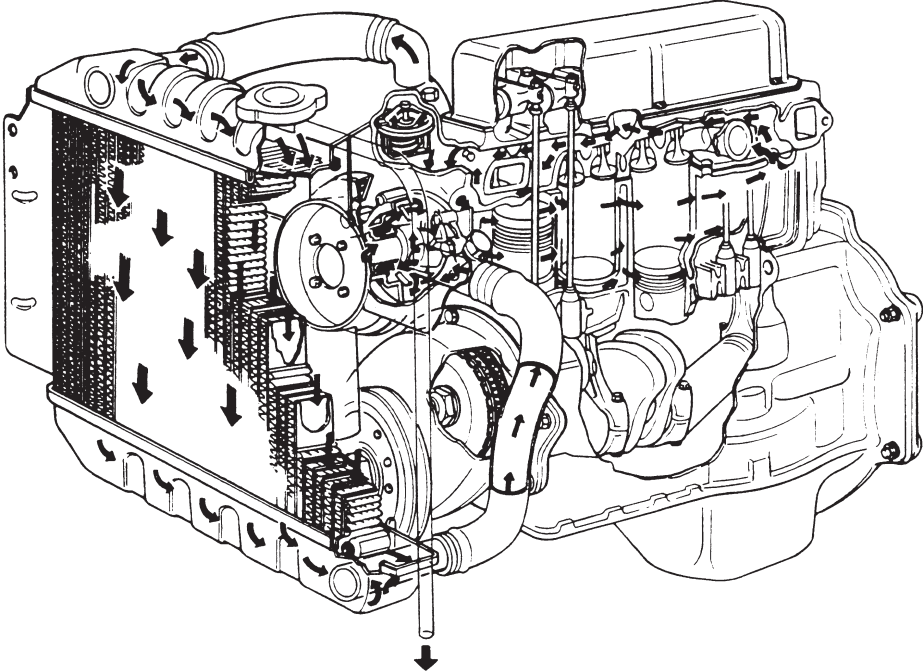
LUBRICATION SYSTEM DIAGRAM



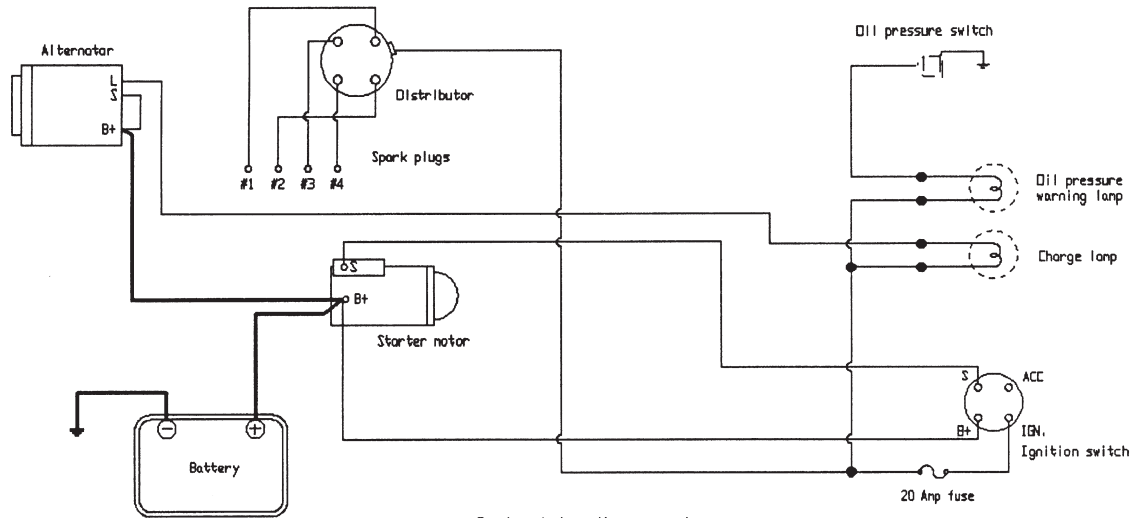
FOM253

COOLING SYSTEM DIAGRAM

Cooling circuit

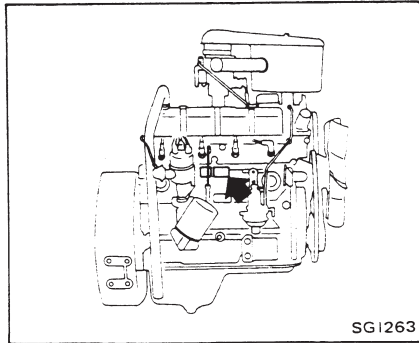


SIC522



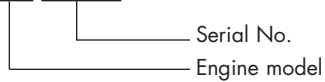
Basic wiring diagram only.
Not application specific.

Engine Serial Number



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

H20-Sxxxxx



Service Data and Specifications

INSPECTION AND ADJUSTMENT

Item	Engine model	H15	H20-II	H25
Valve clearance (Hot) mm (in)	Intake Exhaust	0.38 (0.015)		
Fan belt deflection	mm (in)	1 - 13 (0.43 - 0.51)		
Applied pushing force	N (kg, lb)	98 (10, 22)		
Engine oil capacity (US qt. Imp qt)		3.8 94, 3-3/8)		
With oil filter		3.5 (3-3/4, 3-1/8)		
Without oil filter				
Engine compression pressure kPa (bar, kg/cm ² , psi) rpm Standard		1,275(12.75, 13.0, 185)/300	1,226 (12.26, 12.5, 178)/300	1,275 (12.75,13.0, 185)/300
Minimum		1.079 (10.79, 11.0, 156)/300	1.030 (10.30, 10.5, 149)/300	1.079(10.79, 11.0, 156)/300
Spark plug Type		BP4WES, BP4ES		
Gap	mm (in)	0.8 - 0.9 (0.031 - 0.035)		
Distributor Air gap	mm (in)	0.35 - 0.45 (0.0138 - 0.0177)		
High tension cable resistance		Less than 30,000		
Ignition timing idle speed B.T.D.C. degree/rpm		4° /650 See valve cover label		
Max. engine speed under no load rpm		3,100 - 3,300		2,800 - 3,000
Max/ engine speed under load rpm		2,500 - 2,900	2,600 - 3,000	2,300 - 2,600

TIGHTENING TORQUE

UNIT	N•m	kg-m	ft-lb
Cylinder head bolt	74 - 83	7.5 - 8.5	54 - 61
Rocker cover nuts	1.8 - 2.7	0.18 - 0.28	1.3 - 2.0
Rocker shaft	49 - 59	5.0 - 6.0	36 - 43
Connecting rod cap bolts			
H15, H20-11	31 - 37	3.2 - 3.8	23 - 27
H25	38 - 44	3.9 - 4.5	28 - 33
Main bearing cap bolt	83 - 93	8.5 - 9.5	61 - 69
Flywheel housing fixing bolts	43 - 58	4.4 - 5.9	32 - 43
Flywheel fixing bolts or driving plate	132 - 142	13.5 - 14.5	98 - 105
Camshaft sprocket bolt	29 - 39	3.0 - 4.0	22 - 29
Oil pan bolts	6.4 - 7.5	0.65 - 0.76	4.7 - 5.5
Oil pan pump bolts	21 - 34	2.1 - 3.5	15 - 25
Oil pan drain plug	20 - 39	2.0 - 4.0	14 - 29
Carburetor nuts	14 - 18	1.4 - 1.8	10 - 13
Manifold nuts	16 - 19	1.6 - 1.9	12 - 14
Fuel pump nuts	14 - 18	1.4 - 1.8	10 - 13
Crank pulley bolt	142 - 152	14.5 - 15.5	105 - 112
Cover for hydraulic pump chain	3.7 - 5.0	0.38 - 0.51	2.7 - 3.7
Engine front cover bolts	16 - 19	1.6 - 1.9	12 - 14
Alternator bolts	44 - 59	4.5 - 6.0	33 - 43

EFI General Description

Operating principal: The system operates under the speed density principal i.e. the system reads RPM, MAP, coolant and air temperatures to make the fuel calculations.

MAP & Air Temperature Sensors: The MAP and Air Temperature Sensor are integrated into the throttle body.

Coolant Temperature Sensor: Zenith provides the Coolant Temperature Sensor and if required an adapter bushing. Zenith recommends that the sensor be installed as close as possible to the thermostat.

RPM Inputs: RPM inputs are taken from the negative side of the ignition coil, or distributor.

Hot /Cold Start: The ECU reads both air and coolant temperatures and will calculate the correct fuel requirements for gasoline or LPG for superior starting.

Governor:

Full Authority: The governor is a full authority governor i.e.. It will seek to maintain the RPM commanded regardless of engine load conditions.

Tamper Proof Speed Settings: Engine speed settings are factory programmed and non field adjustable

Idle Self Learn: The governor contains an adaptive self learning feature which electronically provides the proper throttle stop reference for optimum governing and consistent idle for each production unit.

Speed inputs: Selector switch (up to 3 speeds plus idle)

Accelerator pedal position sensor (PPS) for infinitely variable speeds.

Electrical

Ground: The ECU must be grounded directly to the engine block.

The ground must be a clean and unpainted surface.

Supply:

ECU:	12 volts, key on and crank.
Actuator power:	12 volts, key on and crank.
Injector:	12 volts, key on and crank.
Fuel pump / LPG lock-off:	12 volts, key on and crank.

Wire Spec: SAE J1128

Wire size: Minimum wire size: 18 awg

Wire Loom: Temp rated to 135 deg. C

Battery voltage: The system is designed for optimum function at 13.5 . 14.7 volts.

Voltage surges caused by a defective battery or charging system may cause erratic governor function. Minimum operating voltage is 9 volts.

Component temperature range: - 40 deg. C. + 105 Deg. C

ECU Design Features: Sealed unit for harsh environments.

On-Board Flash Programming.

ECU Design Standards: The ZEEMS system is designed to meet and has been tested to the following standards.

SAE J1113/11 . Immunity to Conducted Transients on Power leads. .

SAE J 1113/13 . Immunity to Electrostatic discharge..

ASE EP455 . Mutual Coupling of Signal/Input/Output lines. .

IEC 1000-4-2 . Electrostatic Discharge Immunity Test. .

EN 12895 . Industrial Truck Electromagnetic Compatibility.

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