Chrysler Engine Operator Manual

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100 Power Drive Mankato, MN 56001
Phone 507.625.7973 Fax 507.625.2968 Toll Free 800.325.5450 www.mtu-online.com

Chrysler_Manual_11-06

Forward

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

We urge you to follow the recommendations contained in this booklet so that the Chrysler 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 Chrysler Engine contact the authorized MTU Onsite Energy service 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. MTU Onsite Energy reserves the right to make changes or improvements at any time without notice.

Contents

Part Descriptions

ENGINE

The 2.8 liter four-cylinder engine is an in-line, lightweight, overhead valve engine. The engine cylinder head has dual quench-type combustion chambers that create turbulence and fast burning of the air/fuel mixture.

LUBRICATION SYSTEM

A gear—type positive displacement pump is mounted at the underside of the block opposite the No. 4 main bearing.

CYLINDER BLOCK

The cylinder block is a cast iron inline four cylinder design. The cylinder block is drilled forming galleries for both oil and coolant.

CYLINDER HEAD

The cylinder head is made of cast iron containing eight valves made of chrome plated heat resistant steel, valve stem seals, springs, retainers and keepers. The cylinder head, valve seats and guides can be resurfaced for service purposes. The cylinder head uses dual quench-type design combustion chambers which cause turbulence in the cylinders allowing faster burning of the air/fuel mixture. The valve guides are integral to the cylinder head. They are not replaceable. However, they are serviceable.

CRANKSHAFT

The crankshaft is constructed of nodular cast iron.

PISTON AND CONNECTING ROD

The pistons are made of a high strength aluminum alloy, the piston skirts are coated with a solid lubricant (Molykote) to reduce friction and provide scuff resistance. The connecting rods are made of cast iron.

CAMSHAFT

The camshaft is made of cast iron with eight machined lobes and four bearing journals.

ROCKER ARM

The rocker arms are made of stamped steel and have an operational ratio of 1.6:1.

VALVES

The valves are made of heat resistant steel and have chrome plated stems to prevent scuffing. All valves use three bead lock keepers to retain the valve spring and promote valve rotation.

VALVE SPRING

The valve springs are made of high strength chrome silicon steel. The springs are common for both intake and exhaust valves.

CYLINDER HEAD COVER

The cylinder head cover is made of die cast aluminum and incorporates the Crankcase Ventilation (CCV) Hoses and the oil fill opening.

HYDRAULIC TAPPET

Valve lash is controlled by hydraulic tappets located inside the cylinder block, in tappet bores above the camshaft.

VALVE GUIDE

The valve guides are integral to the cylinder head. They are not replaceable. However, they are serviceable.

OIL PAN

The oil pan is made of stamped steel. The oil pan gasket is a one piece steel backbone silicone coated gasket.

VALVE STEM SEAL

The valve stem seals are made of rubber and incorporate a garter spring to maintain consistent lubrication control.

INTAKE MANIFOLD

The intake manifold is made of cast aluminum and uses seven bolts to mount to the cylinder head. This mounting style improves sealing and reduces the chance of leaks.

EXHAUST MANIFOLD

The exhaust manifold is log style and is made of high silicon molybdenum cast iron. The exhaust manifold shares a common gasket with the intake manifold. The exhaust manifold also incorporates a ball flange outlet for improved sealing and strain free Connections

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. It is important that the engine is operating to its optimum performance level to maintain fuel economy and the lowest emission levels.

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

CAUTIONS IN OPERATION

1. Prior to starting, engine block heaters need to be on and working properly.
2. Always maintain the operation speed of 1800 rpm.
3. Do not overload the engine.

STARTING THE ENGINE

1. Before starting, check the engine oil and coolant level and fill or add if necessary.
2. Visually check the engine for leaks, loose belt or foreign objects that may interfere with operation.
3. Check instrumentation for proper oil pressure (above 30 psi).

DURING ENGINE OPERATION

1. During operation, always make sure that the cooling water temperature and

lubricating oil pressure are both within normal operating range. Normal cooling water temperature is 167 to 210°F and oil pressure is 30-75 psi.

2. Always be aware of the condition of the engine, paying attention to any abnormal vibration, noise or other unusual circumstances. If any abnormality is found, immediately stop the operation, examine the cause, and make the necessary correction.

STOPPING THE ENGINE

Stopping the engine immediately after heavily loaded operation will deteriorate the engine and/or may cause high engine temperature alarm to activate because it is still in a very hot state. If high engine temperature alarm activates, the unit will not restart until alarm is manually cleared.

Upon completion of operation, allow engine to cool down; recommended cool down time is 5 minutes.

PERIODIC INSPECTIONS

Perform periodical inspection and replacement of the following items: engine oil, oil filter, air cleaner element, fuel filter element, radiator, coolant level, and coolant quality. Follow maintenance schedule found later in this manual.

Other Handling and Operations

COLD AND HOT WEATHER OPERATION

IN COLD WEATHER:

- **Oil**

Use engine oil suitable for ambient temperature.

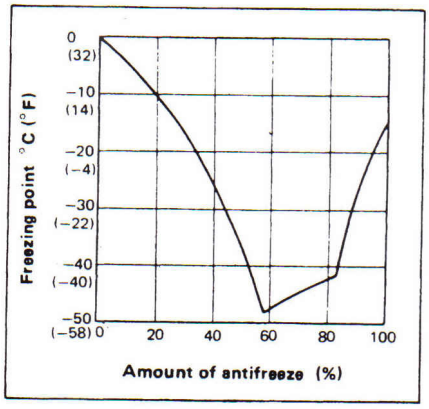
- **Coolant**

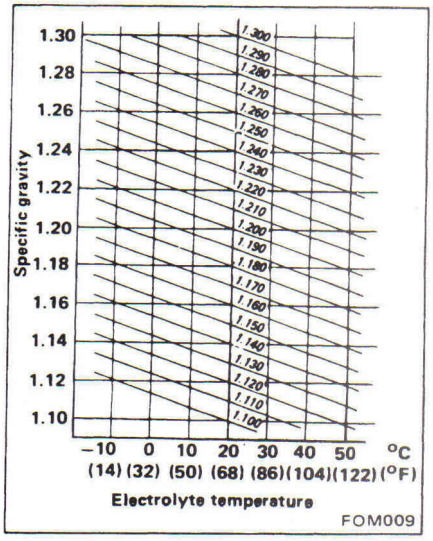
Mix coolant to a 50/50 mixture for proper and safe operation of the cooling system. Refer to chart for proper freezing point of mixture.

COOLANT CAPACITY (ENGINE PROPER):

2.5 gallons

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 belt tension, as well as battery charger for proper operation.

The normal specific gravity is 1.260 as corrected at 20℃ (68℉). It changes approximately 0.0007 for every 1℃ (1.8℉). If the specific gravity for electrolyte does not reach the desirable value, charge the battery soon. Be sure to disconnect the battery charger before removing battery cables.

PROCEDURES FOR PLACING THE ENGINE IN LONG-TERM STORAGE

Before storing the engine for a long period of time (more than six 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 1800 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.

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 1800 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℃ (32℉). 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 carburetor and spray or pour rust preventing oil into the combustion chamber. Next, disconnect cables and crank the engine five to ten times, and then reinstall the spark plug cables.

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 belt grooves of pulleys, etc.). Spray or apply anti-rust agent to the cleaned surfaced. Do not apply any antirust agent to the fan and belt grooves of pulleys.

OTHERS

1. Loosen fan belt.
2. Seal the air intake hole of the air cleaner and air outlet hole of the exhaust tube with adhesive tape.
3. When storing the engine as a complete assembly outdoors, cover it fully with a porous water-proof bag. Do not use a vinyl bag 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.
    a. Lubricating system:

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

b. Cooling system:
   If antifreeze is used, drain cooling water from the drain valves on the radiator and cylinder block and flush the cooling system. If an anti-rust agent is used, flush the cooling system. Refill 50/50 with coolant and distilled water. Plug in block heater and allow coolant to warm up.
c. Exterior of engine:
   Clean the exterior surfaces of the engine with a petroleum solvent (Trichlene).

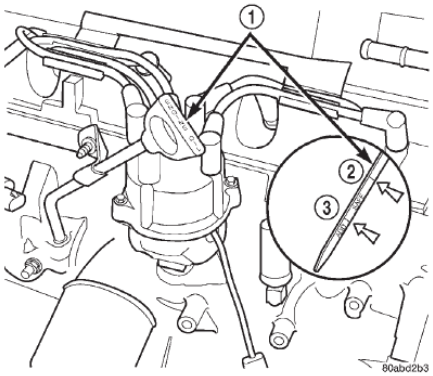
3. Replace oil filter and air cleaner.
4. Adjust the fan belt for proper tension.
5. Check and adjust valve clearance. Apply engine oil to the rocker arm and other valve mechanism.
6. Check the battery electrolyte level and specific gravity. Refill and/or recharge if it is necessary.
7. Before the engine starts, disconnect the spark plug cables from spark plugs.
8. 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 spark plug cables.
9. Start the engine unloaded and run at 1800 rpm for about 15 minutes.
10. Make sure that the oil pressure is operating in the safe range and coolant temperature is normal, and that the engine does not produce any abnormal vibration or noise.

Engine Inspection

In order to prevent trouble during operation, it is necessary that the operator be aware of the condition of the engine. To achieve this awareness, the operator must inspect the engine during routine maintenance.

If you note any defects, notify your authorized MTU Onsite Energy dealer.

CHECK ENGINE OIL LEVEL



1 – DIPSTICK
2 – SAFE
3 – ADD

The engine oil level indicator (dipstick) is located at the right rear of the engine. Unless the engine has exhibited loss of oil pressure, run the engine for about five minutes before checking oil level. Checking engine oil level on a cold engine is not accurate. To ensure proper lubrication of an engine, the engine oil must be maintained at an acceptable level. The acceptable levels are indicated between the ADD and SAFE marks on the engine oil dipstick.

1. With engine OFF, allow approximately ten minutes for oil to settle to bottom of crankcase. Remove engine oil dipstick.
2. Wipe dipstick clean.
3. Install dipstick and verify it is seated in the tube.
4. Remove dipstick, with handle held above the tip, note oil level reading.
5. Add oil only if level is below the ADD mark on dipstick.

CAUTION
Do not overfill crankcase with engine oil. Oil foaming and pressure loss can result.

CHECK COOLING LEVEL

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

CHECKING THE ENGINE FOR LEAKAGE

INTAKE MANIFOLD LEAKAGE DIAGNOSIS

An intake manifold air leak is characterized by lower than normal manifold vacuum. Also, one or more cylinders may not be functioning.

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH THE FAN. DO NOT PUT YOUR HANDS NEAR THE PULLEYS, BELTS OR THE FAN. DO NOT WEAR LOOSE CLOTHING.

1. Start the engine.
2. Spray a small stream of water at the suspected leak area.
3. If a change in RPM is observed the area of the suspected leak has been found.
4. Repair as required.

CYLINDER-TO-CYLINDER LEAKAGE TEST

To determine if an engine cylinder head gasket is leaking between adjacent cylinders; follow the procedures outlined in Cylinder Compression Pressure Test. An engine cylinder head gasket leaking between adjacent cylinders will result in approximately a 50-70% reduction in compression pressure.

CYLINDER-TO-WATER JACKET LEAKAGE TEST

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH THE FAN. DO NOT PUT YOUR HANDS NEAR THE PULLEYS, BELTS OR THE FAN. DO NOT WEAR LOOSE CLOTHING.

1. Remove the radiator cap.
2. Start the engine and allow it to warm up until the engine thermostat opens.
3. If a large combustion/compression pressure leak exists, bubbles will be visible in the coolant.
4. If bubbles are not visible, install a radiator pressure tester and pressurize the coolant system.
5. If a cylinder is leaking combustion pressure into the water jacket, the tester pointer will pulsate with every combustion stroke of the cylinder.

CYLINDER COMBUSTION PRESSURE LEAKAGE TEST

The combustion pressure leakage test provides an accurate means for determining engine condition. Combustion pressure leakage testing will detect:
- Exhaust and intake valve leaks (improper seating).
- Leaks between adjacent cylinders or into water jacket.
- Any causes for combustion/compression pressure loss.

1. Check the coolant level and fill as required. DO NOT install the radiator cap.
2. Start and operate the engine until it attains normal operating temperature, then turn the engine OFF.
3. Remove the spark plugs.
4. Remove the oil filler cap.
5. Remove the air cleaner.
6. Calibrate the tester according to the manufacturer's instructions. The shop air source for testing should maintain 483 kPa (70 psi) minimum, 1,379 kPa (200

psi) maximum and 552 kPa (80 psi) recommended.
7. Perform the test procedures on each cylinder according to the tester manufacturer's instructions.

While testing, listen for pressurized air escaping through the throttle body, tailpipe and oil filler cap opening. Check for bubbles in the radiator coolant.

All gauge pressure indications should be equal, with no more than 25% leakage.

FOR EXAMPLE: At 552 kPa (80 psi) input pressure, a minimum of 414 kPa (60 psi) should be maintained in the cylinder.

CYLINDER COMBUSTION PRESSURE LEAKAGE DIAGNOSIS CHART

CONDITION	POSSIBLE CAUSE	CORRECTION
AIR ESCAPES THROUGH THROTTLE BODY	Intake valve bent, burnt, or not seated properly	Inspect valve and valve seat. Reface or replace, as necessary
AIR ESCAPES THROUGH TAILPIPE	Exhaust valve bent, burnt, or not seated properly	Inspect valve and valve seat. Reface or replace, as necessary
AIR ESCAPES THROUGH RADIATOR	Head gasket leaking or cracked cylinder head or block	Remove cylinder head and inspect. Replace defective part
MORE THAN 50% LEAKAGE FROM ADJACENT CYLINDERS	Head gasket leaking or crack in cylinder head or block between adjacent cylinders	Remove cylinder head and inspect. Replace gasket, head, or block as necessary
MORE THAN 25% LEAKAGE AND AIR ESCAPES THROUGH OIL FILLER CAP OPENING ONLY	Stuck or broken piston rings; cracked piston; worn rings and/or cylinder wall	Inspect for broken rings or piston. Measure ring gap and cylinder diameter, taper and out-of-round. Replace defective part as necessary

ENGINE OIL LEAK INSPECTION

Begin with a thorough visual inspection of the engine, particularly at the area of the suspected leak. If an oil leak source is not readily identifiable, the following steps should be followed:

1. Do not clean or degrease the engine at this time because some solvents may cause rubber to swell, temporarily stopping the leak.
2. Add an oil soluble dye (use as recommended by manufacturer). Start the engine and let idle for approximately 15 minutes. Check the oil dipstick to make sure the dye is thoroughly mixed as indicated with a bright yellow color under a black light.
3. Using a black light, inspect the entire engine for fluorescent dye, particularly at the suspected area of oil leak. If the oil leak is found and identified, repair per service manual instructions.
4. If dye is not observed, drive the vehicle at various speeds for approximately 24km (15 miles), and repeat inspection.
5. If the oil leak source is not positively identified at this time, proceed with the air leak detection test method.

AIR LEAK DETECTION TEST METHOD

1. Disconnect the breather cap to air cleaner hose at the breather cap end. Cap or plug breather cap nipple.
2. Remove the PCV valve from the cylinder head cover. Cap or plug the PCV valve grommet.

3. Attach an air hose with pressure gauge and regulator to the dipstick tube.

CAUTION: Do not subject the engine assembly to more than 20.6 kpa (3 PSI) of test pressure.

4. Gradually apply air pressure from 1 psi to 2.5 psi maximum while applying soapy water at the suspected source. Adjust the regulator to the suitable test pressure that provide the best bubbles which will pinpoint the leak source. If the oil leak is detected and identified, repair per service manual procedures.
5. If the leakage occurs at the rear oil seal area, refer to the section, Inspection for Rear Seal Area Leak.
6. If no leaks are detected, turn off the air supply and remove the air hose and all plugs and caps. Install the PCV valve and breather cap hose.
7. Clean the oil off the suspect oil leak area using a suitable solvent. Drive the vehicle at various speeds approximately 24 km (15 miles). Inspect the engine for signs of an oil leak by using a black light.

INSPECTION FOR REAR SEAL AREA LEAKS

Since it is sometimes difficult to determine the source of an oil leak in the rear seal area of the engine, a more involved inspection is necessary. The following steps should be followed to help pinpoint the source of the leak.

If the leakage occurs at the crankshaft rear oil seal area:

1. Disconnect the battery.

2. Remove torque converter or clutch housing cover and inspect rear of block for evidence of oil. Use a black light to check for the oil leak:
   (a) Circular spray pattern generally indicates seal leakage or crankshaft damage.
   (b) Where leakage tends to run straight down, possible causes are a porous block, distributor seal, camshaft bore cup plugs oil galley pipe plugs, oil filter runoff, and main bearing cap to cylinder block mating surfaces.

3. If no leaks are detected, pressurize the crankcase as outlined in the, Inspection (Engine oil Leaks in general)

CAUTION: Do not exceed 20.6 kPa (3 psi).

4. If the leak is not detected, very slowly turn the crankshaft and watch for leakage. If a leak is detected between the crankshaft and seal while slowly turning the crankshaft, it is possible the crankshaft seal surface is damaged. The seal area on the crankshaft could have minor nicks or scratches that can be polished out with emery cloth.

CAUTION: Use extreme caution when crankshaft polishing is necessary to remove minor nicks and scratches. The crankshaft seal flange is especially machined to complement the function of the rear oil seal.

5. For bubbles that remain steady with shaft rotation, no further inspection can be done until disassembled.

ENGINE MAINTENANCE SCHEDULE											
The following table lists the periodic maintenance required to ensure quality performance and good mechanical conditions of the Engine and Fuel Systems for your generator set.											
MAINTENANCE OPERATION											
Periodic maintenance should be performed after specified intervals have elapsed in hours or annually, whichever comes first.	**250 hrs.**	**500 hrs.**	**750 hrs.**	**1000 hrs.**	**1250 hrs.**	**1500 hrs.**	**1750 hrs.**	**2000 hrs.**	**2250 hrs.**	**2500 hrs.**	**Annual**
1. Intake & exhaust valve clearances (operating temperature)	I	I	I	I	I	I	I	I	I	I	I
2. Drive belt tension	I	I	I	I	I	I	I	I	I	I	I
3. Cylinder head bolts & manifold nuts	T	I	I	I	I	I	I	I/T	I	I	I/T
4. Radiator	I/C	I/C	I/C	I/C	I/C	I/C	I/C	I/C	I/C	I/C	I/C
5. Engine oil	R	R	R	R	R	R	R	R	R	R	R
6. Oil filter	R	R	R	R	R	R	R	R	R	R	R
7. Air cleaner element	I	I/R	I	I/R	I	I/R	I	I/R	I	I/R	I
8. Ignition timing (LPG & NG)	I	I	I	I	I	I	I	I	I	I	I
9. Spark plugs	I	I/R	I	I/R	I	I/R	I	I/R	I	I/R	I
10. Distributor inside (IC ignition system)	I	I	I	I	I/C	I	I	I	I	I/C	I
11. Charging system – engine alternator	I	I	I	I	I	I	I	I	I	I	I
12. Battery	I	I	I	I	I	I	I	I	I	I	R
13. Fuel line supply and connectors portion for LPG and NG leakage	I	I	I	I	I	I	I	I	I	I	I
14. Fuel line supply and connectors for damage	I	I	I	I	I	I	I	I	I	I	I
15. Strainer (optional)	I/C	I/C	I/C	I/C	I/C	I/C	I/C	I/C	I/C	I/C	I/C
16. LPG/NG manual shutoff lock off (optional)	I	I	I	I	I	I	I	I	I	I	I

Abbreviations:

I = Inspection
R = Replace
C = Clean
D = Drain
T = Retighten

MAINTENANCE OPERATION

MTU Onsite Energy recommends the following maintenance be performed by trained and certified representatives.

CYLINDER HEAD BOLTS

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

Required Torque: **Cylinder head bolt**
2.8L Chrysler

a) Tighten all bolts in sequence (1 through 10) to 30 N·m (22 ft. lbs.) torque
b) Tighten all bolts in sequence (1 through 10) to 60 N·m (45 ft. lbs.) torque
c) Check all bolts to verify they are set to 60 N·m (45 ft. lbs.) torque
d) Tighten bolts (in sequence):
    a. Bolts 1 through 6 to 149 N·m (110 ft. lbs.) torque
    b. Bolt 7 to 136 N·m (100 ft. lbs.) torque
    c. Bolts 8 through 10 to 149 N·m (110 ft. lbs.) torque

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 clearances.

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

See ‘Specification’ section at the back of this manual for more detail.

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

Change engine oil at mileage and time intervals described in Maintenance Schedules. Do not use non-detergent or straight mineral oil when adding or changing crankcase lubricant. Engine failure can result. Use an engine oil that is API Service Grade Certified.

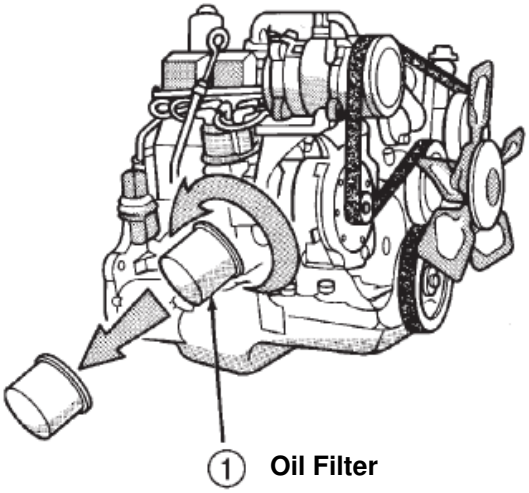
WARNING:
Be careful not to burn yourself, as the engine oil may be hot.

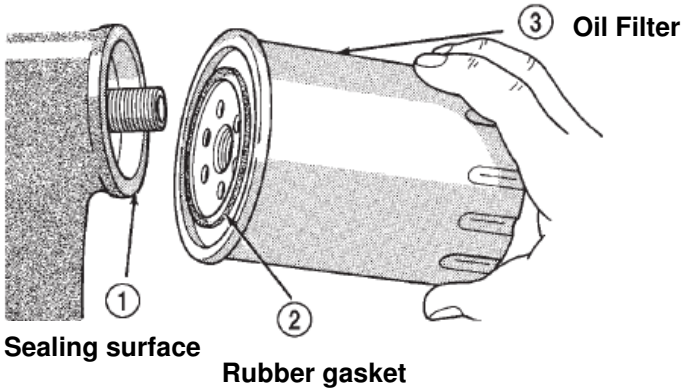
- **A milky oil indicates the presence of cooling water; isolate the cause and take corrective measure.**
- **An oil with extremely low viscosity indicates dilution with fuel.**

1. Start engine and warm up engine sufficiently, then stop engine.
2. Remove oil fill cap.
3. Place a suitable drain pan under crankcase drain.
4. Remove drain plug from crankcase and allow oil to drain into pan. Inspect drain plug threads for stretching or other damage. Replace drain plug if damaged.
5. Install drain plug in crankcase.
6. Fill crankcase with specified type and amount of engine oil.
7. Install oil fill cap.
8. Start engine and inspect for leaks.
9. Stop engine and inspect oil level.

CHANGING ENGINE OIL FILTER

1. Position a drain pan under the oil filter.
2. Using a suitable oil filter wrench loosen filter.
3. Rotate the oil filter counterclockwise to remove it from the cylinder block oil filter boss
4. When filter separates from adapter nipple, tip gasket end upward to minimize oil spill. Remove filter.
5. With a wiping cloth, clean the gasket sealing surface of oil and grime.
6. Lightly lubricate oil filter gasket with engine oil or chassis grease.
7. Thread filter onto adapter nipple. When gasket makes contact with sealing surface, hand tighten filter one full turn, do not over tighten.
8. Add oil, verify crankcase oil level and start engine. Inspect for oil leaks. If any leakage is evident, these parts have not been properly installed.





CAUTION:
Do not use oil filter with metric threads. The proper oil filter has SAE type 3/4 X 16 threads. An oil filter with metric threads can result in oil leaks and engine failure.

CHANGING ENGINE COOLANT

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

WARNING:
The coolant in a recently operated engine is hot and pressurized. Release the pressure before removing the drain cock, cap and drain plugs.

CLEANING RADIATOR

Clean inside of radiator with dry compressed air.

CHECKING COOLING SYSTEM, HOSES AND CONNECTIONS.

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

MTU Onsite Energy recommends that the following service be performed by a trained and certified technician.

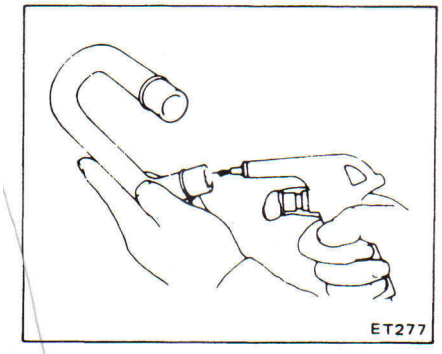
CHECKING ENGINE COMPRESSION PRESSURE

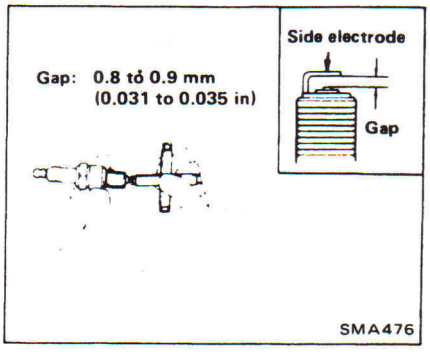
Ensure the battery is completely charged and the engine starter motor is in good operating condition. Otherwise the indicated compression pressures may not be valid for diagnosis purposes.

1. Clean the spark plug recesses with compressed air.
2. Remove the spark plugs.
3. Secure the throttle in the wide-open position.
4. Disable the fuel system.
5. Disconnect the ignition coil.
6. Insert a compression pressure gauge and rotate the engine with the engine starter motor for three revolutions.
7. Record the compression pressure on the 3rd revolution.
8. Continue the test for the remaining cylinders.
9. Refer to Engine Specifications for the correct engine compression pressures.

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 and blow dust off inner side of element with dry compressed air. **Be careful not to drop dirt into carburetor.**
2. Install air cleaner.

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 (See diagram ET277). 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 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 (see above diagram SMA476).

Spark plug type: Champion Resistor Type RC-12ECC

BATTERY MAINTENANCE

CAUTION: Repeated contact with battery electrolyte fluid may cause drying of the skin that may result in irritation, dermatitis, and skin burns. Repeated exposure to sulfuric acid mist may cause erosion of teeth, chronic eye irritation and/or chronic inflammation of the nose, throat and lungs.

California Proposition 65 Warning: During charging of a battery, strong inorganic acid mists containing sulfuric acid are evolved, a chemical Known to the State of California to cause cancer. Wear protective equipment when handling.

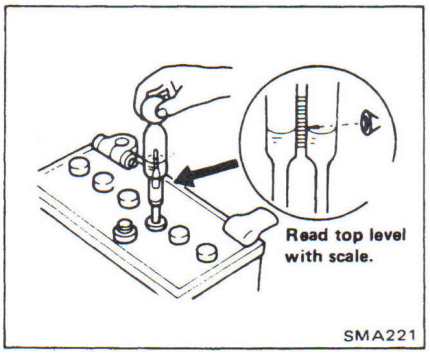
CHECKING ELECTROLYTE LEVEL

Check the fluid level in each filler. If necessary, add only distilled water. Replace battery annually.

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.



Battery:
MTU Onsite Energy Part Number: 82903

	Permissible value	Fully charged value [at 20ºC (68ºF)]
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	Probable 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
	Blown fuse	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.	Check spark plug firstly by following procedure.
	Ignition system in trouble	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.
	Fuel system in trouble (low fuel, low fuel psi, low fuel volume)	Fill fuel, check fuel psi with gauge, check fuel volume.
	Valve mechanism does not work properly	
	Low compression	
Ignition system out of order	Disconnection of high tension cable	Replace
	Loose connection or disconnection in primary circuit	Repair or replace
Fuel system out of order	Faulty governor	Must be 7” to 11” WC 4-6 oz.
	Faulty or dirty magnetic pickup unit (mpu)	Check resistance
Low compression	Incorrect spark plug tightening or faulty gasket	Tighten to normal torque or replace gasket
	Improper grade engine oil or low viscosity	Replace with proper grade oil
	Incorrect valve clearance	Adjust
	Compression leak from valve seat	Remove cylinder head and lap valves
	Sticky valve stem	Correct or replace valve and valve guide
	Weak or damaged valve springs	Replace
	Compression leak at cylinder head gasket	Replace gasket

Condition	Probable cause	Corrective Action
	Sticking damaged piston ring	Replace piston rings
	Warm piston ring or cylinder	Overhaul engine
	(Trouble-shooting procedure) Inject a small quantity of engine oil in spark plug hole, and then measure cylinder compression	
	Compression increases	Malfunctioning cylinder or piston ring
	Compression does not change	Compression leaks from valve, cylinder head or head gasket
Others	Incorrect valve clearance	Adjust
	Extremely low revolution	Adjust
	Malfunctioning of the ignition system (spark plug, high tension cable, ignition coil, etc.)	Replace
	Incorrect basic ignition timing	Adjust
	Faulty P.C.V. valve	Replace
	Clogged air cleaner filter	Replace air cleaner filter
	Loose manifold and cylinder head bolts	Retighten bolts
Improper Engine Speed (Low)	Fuel pressure	Check 7-11” WC 4-6 oz
	Low volume	NG = 270 cfh, LP = 173 cfh
	Bent butterfly	Replace
	Stuck fuel solenoid	Replace
Improper Engine Speed (High)	Fuel pressure	Check 7-11” WC 4-6 oz.
	Faulty L Series Governor	Refer to governor manual
	Faulty magnetic pickup unit or control setting	Check resistance
	Bent butterfly	Replace
Others	Incorrect valve clearance	Adjust
	Extremely low revolution	Adjust
	Malfunction of the ignition system (spark plug, high tension cable, ignition coil, etc.	Replace
	Incorrect basic ignition timing	Adjust
	Faulty P.C.V. valve	Replace
	Clogged air cleaner filter	Replace air cleaner filter

Condition	Probable cause	Corrective Action
	Loose manifold and cylinder head bolts	Retighten bolts
Engine Power Not Up To Normal	Low compression	Previously mentioned.
	Incorrect ignition timing	Adjust
Ignition system out of order	Damaged spark plugs	Clean, adjust or replace plugs
Fuel system out of order	Clogged fuel pipe or strainer, fuel psi switch, manual shut off valve (optional)	Clean
Air intake system out of order	Clogged air cleaner	Clean or replace filter
	Air inhaling from manifold gasket or throttle body gasket	Replace gasket
	Faulty P.C.V. valve	Replace
Overheating	Insufficient coolant	Replenish
Intake louver blocked recirculating hot air	Loose fan belt	Adjust fan belt
	Worn or oiled fan belt	Replace
Exhaust air opening blocked	Inoperative thermostat	Replace
	Worn water pump	Replace
	Clogged or leaky radiator	Flush, repair or replace
	Faulty radiator filter cap	Replace
	Air in cooling system	Retighten each part of cooling system
	Improper engine oil grade	Replace with proper grade oil
	Incorrect ignition timing	Adjust
Overcooling	Inoperative thermostat	Replace
Noisy Engine Engine knocking	Carbon knocking	Disassemble cylinder head and remove carbon
	Timing knocking	Adjust ignition timing
	Fuel knocking	Use specified octane fuel
	Pre-ignition (misusing of spark plug)	Use specified spark plug
Mechanical knocking Crankshaft bearing	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.	This is caused by worn or damaged bearings, or unevenly worn crankshaft. Renew bearings and adjust or change crankshaft. Check lubrication system.
Connecting rod bearing knocking	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	Same as the case of crankshaft bearings

Condition	Probable cause	Corrective Action
	crankshaft bearing generates the noise.	
Mechanical knocking Piston cylinder noise	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.	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. Overhaul engine.
Piston pin noise	This noise is heard at each highest and lowest dead end of piston. To locate the place, cause a misfire in each cylinder.	This may cause a wear on piston pin, or piston pin hole. Renew piston and piston pin assembly.
Water pump noise	This noise may be caused by worn or damaged bearings, or by the uneven surface of sliding parts	Replace water pump with a new one
Others	An improper adjustment of valve clearance	Adjust
	Noise of timing chain	Adjust the tension of chain
	An excessive end play on crankshaft	Disassemble engine and renew main bearing
Abnormal combustion (Backfire, afterfire, run-on, etc.)		
Improper ignition timing	Improper ignition timing	Adjust
Fuel system out of order	Improper heat range of spark plugs	Use specified spark plugs
	Damaged throttle body or manifold gasket (backfire afterfire)	Replace them with new parts
Faulty cylinder head, etc.	Improperly adjusted valve clearance	Adjust
	Excess carbon in combustion chamber	Remove head and get rid of carbon
	Damaged valve spring (backfire, afterfire)	Replace it with a new one
Excessive oil consumption		
Oil leakage	Loose oil drain plug	Tighten it
	Loose or damaged oil pan gasket	Renew gasket or tighten it
	Loose or damaged chain cover gasket	Renew gasket or tighten it
	Worn oil seal in front and rear of crankshaft	Renew oil seal
Excessive oil consumption	Loose or damaged rocker cover gasket	Renew gasket or tighten it (but not too much)
	Improper tightening of oil filter	Renew gasket and tighten it with

Condition	Probable cause	Corrective Action
		the proper torque
	Loose or damaged oil pressure switch	Renew oil pressure switch or tighten it
	Cylinder and piston wear	Overhaul cylinder and renew piston
	Improper location of piston ring gap or reversely assembled piston ring	Remount piston rings
	Damaged piston rings	Renew rings. Repair or renew piston and cylinder
	Worn piston ring groove and ring	Renew piston and piston ring
	Fatigue of valve oil seal lip	Replace seal lip with a new one
	Work valve stem	Renew valve or guide
Others	Inadequate quality of engine oil	Use the designated oil
	Engine overheat	Previously mentioned
	Malfunction of P.C.V. system	Check or replace
Trouble in other functions		
Decreased oil pressure	Improper grade oil	Replace with proper grade oil
	Overheat	Previously mentioned
	Malfunctioning oil pump regulator valve	Disassemble oil pump and repair or replace it
Decreased oil pressure	Functional deterioration of oil pump	Repair or replace it with a new one
	Blocked oil filter	Replace with a new one
Excessive wear on the sliding parts	Increased clearance in various sliding parts	Disassemble and replace the worn parts with new ones
	Blocked oil strainer	Clean it
	Malfunctioning oil gauge pressure switch	Replace it with a new one
Scuffing of sliding parts	Oil pressure decreases	Previously mentioned
	Damaged quality or contamination of oil	Exchange the oil with proper one and change oil filter
	Clogged air cleaner filter	Clean or replace filter
	Overheat or overcool	Previously mentioned
	Improper fuel mixture	Check the fuel system
	Decrease of oil pressure	Previously mentioned

Condition	Probable cause	Corrective Action
	Insufficient clearances	Adjust to the sufficient clearances
	Overheat	Previously mentioned
	Improper fuel mixture	Check the fuel system
	Improper ignition timing	Adjust

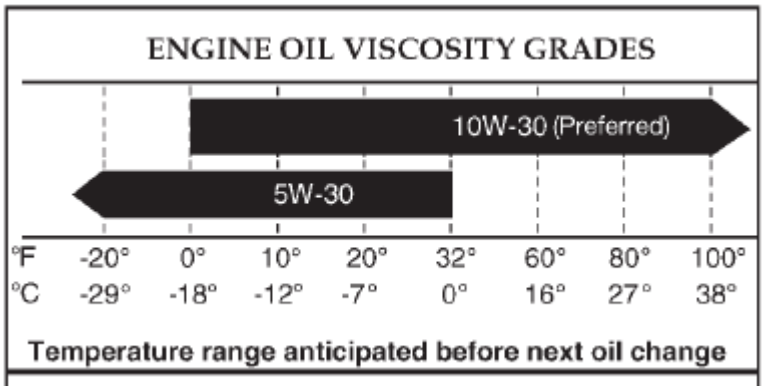
Recommended Lubricant

LUBRICANT

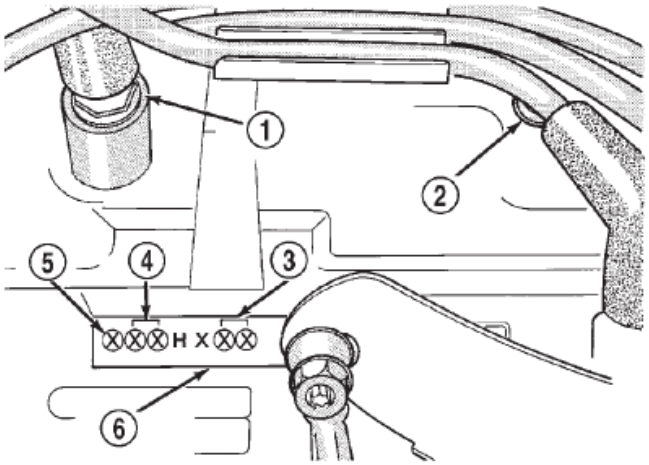
In dry gaseous fueled engines, use an engine oil that is API Service Grade Certified. Standard engine oil identification notations have been adopted to aid in the proper selection of engine oil. The identifying notations are located on the label of engine oil plastic bottles and the top of engine oil cans.

SAE VISCOSITY

An SAE viscosity grade is used to specify the viscosity of engine oil. SAE 10W-30 specifies a multiple viscosity engine oil. When choosing an engine oil, consider the range of temperatures the vehicle will be operated in before the next oil change. Select an engine oil that is best suited to your area's particular ambient temperature range and variation.



Engine Build Date Code



1 – NO. 4 CYLINDER
2 – NO. 3 CYLINDER
3 – DAY
4 – MONTH
5 – YEAR
6 – MACHINED SURFACE

The Engine Build Date Code is located on a machined surface on the right side of the cylinder block between the No.3 and No.4 cylinders.

The digits of the code identify:

1st Digit	The year (8 = 1998).
2nd & 3rd Digits	The month (01 - 12).
4th & 5th Digits	The engine type/fuel system/compression ratio (HX = A 2.8 liter (169 CID) 9.5:1 compression ratio engine with a multi-point fuel injection system).
6th & 7th Digits	The day of engine build (01 - 31).

FOR EXAMPLE: Code * 801HX23 * identifies a 2.8 liter (169 CID) engine with a multi-point fuel injection system, 9.5:1 compression ratio and built on January 23, 1998.

Specifications

DESCRIPTION	SPECIFICATION
Engine Type	In-line 4 Cylinder
Bore and Stroke	98.4 x 91.0 mm (3.88 x 3.58 in.)
Displacement	2.8L (169 cu in.)
Compression Ratio	9:5:1
Compression Pressure Range	116 to 965 kPa (110 to 14 psi)
Max. Variation Between Cylinders	206 kPa (30 psi)
Firing Order	1–3–4–2
Lubrication	Pressure Feed–Full Flow Filtration
Cooling System	Liquid Cooled–Forced Circulation
Cylinder Block	Cast Iron
Crankshaft	Cast Nodular Iron
Cylinder Head	Cast Iron
Camshaft	Cast Iron
Pistons	Aluminum Alloy
Cylinder Combustion Cavity	Double Quench
Connecting Rods	Cast Iron
CAMSHAFT	
Hydraulic Tappet Clearance	Zero Lash
Bearing Clearance	0.025 - 0.076 mm (0.001 - 0.003 in.)

DESCRIPTION	SPECIFICATION
Bearing Journal Diameter	
No. 1	51.54 - 51.56 mm (2.029 - 2.030 in.)
No. 2	51.28 - 51.31 mm (2.019 - 2.020 in.)
No. 3	51.03 - 51.05 mm (2.009 - 2.010 in.)
No. 4	50.78 - 50.80 mm (1.999 - 2.000 in.)
Base Circle Runout (Max)	0.03 mm (0.001 in.)
Camshaft Lobe Lift	
Exhaust	6.579 mm (0.259 in.)
Intake	6.477 mm (0.255 in.)
Camshaft Duration	
Intake	253.3°
Exhaust	259°
VALVES	
Valve Lift	
Exhaust	10.528 mm (0.4145 in.)
Intake	10.350 mm (0.4075 in.)
Intake Valve Timing	
Opens	15.4° (BTDC)
Closes	58° (ABDC)
Duration	253.3°
Exhaust Valve Timing	
Opens	52.8° (BBDC)
Closes	26.2° (ATDC)
Duration	259°
Valve Overlap	41.6°
Valve Lenght (Overall)	
Intake	124.435 - 125.070 mm (4.899 - 4.924 in.)
Exhaust	125.120 - 125.755 mm (4.927 - 4.952 in.)
Valve Stem Diameter	7.899 - 7.925 mm (0.311 - 0.312 in.)

DESCRIPTION	SPECIFICATION
Stem to Guide Clearance	0.025 - 0.076 mm (0.001 - 0.003 in.)
ValveFace Angle Intake Exhaust	 46.5° 46.5°
Valve Head Diameter Intake Exhaust	 48.387 - 48.641 mm (1.905 - 1.915 in.) 37.973 - 38.227 mm (1.495 - 1.505 in.)
Tip Refinishing (Max Alowable)	0.25 mm (0.010 in.)
VALVE SPRINGS	
Free Length (Approx.)	47.65 mm (1.876 in.)
Spring Load Valve Closed Valve Open	 316 to 351 N @ 41.656 mm (71 to 79 Lbs. @ 1.64 in.) 898.6 to 969.7 N @ 30.89 mm (202 to 218 Lbs. @ 1.216 in.)
Inside Diameter (Top)	21.0 mm to 21.51 mm (0.827 to 0.847 in.)
Installed Height	41.656 mm (1.640 in.)
CRANKSHAFT	
End Play	0.038 to 0.165 mm (0.0015 to 0.0065 in.)
Main Bearing Journal Diameter	63.489 to 63.502 mm (2.4996 to 2.5001 in.)

DESCRIPTION	SPECIFICATION
Main Bearing Journal Width No. 1 No. 2 No. 3-4-5	 27.58 to 27.89 mm (1.086 to 1.098 in.) 32.28 to 32.33 mm (1.271 to 1.273 in.) 30.02 to 30.18 mm (1.182 to 1.188 in.)
Main Bearing Clearance	0.03 to 0.06 mm (0.001 to 0.0025 in.)
Main Bearing Clearance (Preferred)	0.051 mm (0.002 in.)
Connecting Rod Journal Diameter	53.17 to 53.23 mm (2.0934 to 2.0955 in.)
Connecting Rod Journal Width	27.18 to 27.33 mm (1.070 to 1.076 in.)
Out of Round - Max	0.013 mm (0.0005 in.)
Taper - Max	0.013 mm (0.0005 in.)
CYLINDER BLOCK	
Deck Height	236.73 mm (9.320 in.)
Deck Clearance	0.000 mm (0.000 in.)
Cylinder Bore Diameter—Standard	98.45 to 98.48 mm (3.8759 to 3.8775 in.)
Cylinder Bore Diameter— Taper (Max) Out of Round (Max)	 0.025 mm (0.001 in.) 0.025 mm (0.001 in.)
Tappet Bore Diameter	23.000 to 23.025 mm (0.9055 to 0.9065 in.)
Flatness	0.03 mm per 25 mm (0.001 in. per 1 in.) 0.05 mm per 152 mm (0.002 in. per 6 in.)

DESCRIPTION	SPECIFICATION
Flatness Max	0.20 mm for total length (0.008 in. for total length)
Main Bearing Bore Diameter	68.3514 to 68.3768 mm (2.691 to 2.692 in.)
CONNECTING RODS	
Total Weight (Less Bearing)	663 to 671 grams (23.39 to 23.67 oz.)
Length (Center to Center)	155.52 to 155.62 mm (6.123 to 6.127 in.)
Piston Pin Bore Diameter	23.59 to 23.62 mm (0.9288 to 0.9298 in.)
Bore (Less Bearings)	56.08 to 56.09 mm (2.2080 to 2.2085 in.)
Bearing Clearance	0.025 to 0.076 mm (0.001 to 0.003 in.)
Bearing Clearance (Preferred)	0.044 to 0.050 mm (0.0015 to 0.0020 in.)
Side Clearance	0.25 to 0.48 mm (0.010 to 0.019 in.)
Twist (Max)	0.002 mm per mm (0.002 in. per in.)
Bend (Max)	0.006 mm per mm (0.006 in. per inch.)
CYLINDER HEAD	
Combustion Chamber	49.9 to 52.9 cc (3.04 to 3.23 cu. in.)
Valve Guide I. D. (Integral)	7.95 to 7.97 mm (0.313 to 0.314 in.)
Valve Seat Angle Intake Exhaust	 44.5° 44.5°
Valve Seat Width	1.01 to 1.52 mm (0.040 to 0.060 in.)

DESCRIPTION	SPECIFICATION
Valve Seat Runout	0.064 mm (0.0025 in.)
Flatness	0.03 mm per 25 mm (0.001 in. per 1 in.) 0.05 mm per 152 mm (0.002 in. per 6 in.)
Flatness (Max)	0.20 mm for total length (0.008 in. for total length)
ROCKER ARMS, PUSH RODS & TAPPETS	
Rocker Arm Ratio	1.6:1
Push Rod Length (Blue)	241.300 to 241.808 mm (9.500 to 9.520 in.)
Push Rod Diameter	7.92 to 8.00 mm (0.312 to 0.315 in.)
Hydraulic Tappet Diameter	22.962 to 22.974 mm (0.904 to 0.9045 in.)
Tappet to Bore Clearance	0.025 to 0.063 mm (0.001 to 0.0025 in.)
PISTON	
Weight (Less Pin)	417 to 429 grams (14.7 to 15.1 oz.)
Compression Height	40.61 to 40.72 mm (1.599 to 1.603 in.)
Piston to Bore Clearance	0.018 to 0.038 mm (0.0008 to 0.0015 in.)
Piston Ring Groove Height Compression Rings Oil Control Ring	 1.530 to 1.555 mm (0.0602 to 0.0612 in.) 4.035 to 4.060 mm (0.1589 to 0.1598 in.)
Piston Ring Groove Diameter Compression Ring #1 Compression Ring #2	 88.39 to 88.65 mm (3.48 to 3.49 in.) 87.63 to 87.88 mm (89.66 to 89.92 in.)

DESCRIPTION	SPECIFICATION
Oil Control Ring	89.66 to 89.92 mm (3.53 to 3.54 in.)
Piston Pin Bore Diameter	23.650 to 23.658 mm (0.9312 to 0.9315 in.)
Piston Pin Diameter	23.637 to 23.640 mm (0.9306 to 0.9307 in.)
Piston to Pin Clearance	0.0102 to 0.0208 mm (0.0005 to 0.0009 in.)
PISTON RINGS	
Ring Gap Clearance	
Top Compression Ring	0.229 to 0.610 mm (0.0090 to 0.0240 in.)
2nd Compression Ring	0.483 to 0.965 mm (0.0190 to 0.0380 in.)
Oil Control Steel Rails	0.254 to 1.500 mm (0.010 to 0.060 in.)
Ring Side Clearance	
Compression Rings	0.042 to 0.084 mm (0.0017 to 0.0033 in.)
Oil Control Rings	0.06 to 0.21 mm (0.0024 to 0.0083 in.)

DESCRIPTION	SPECIFICATION
OIL PUMP AND OIL PRESSURE	
Gear to Body Clearance	
(Radial)	0.051 to 0.102 mm (0.002 to 0.004 in.)
(Radial Preferred)	0.051 mm (0.002 in.)
Gear End Clearance—	
Plastigage	0.051 to 0.152 mm (0.002 to 0.006 in.)
Plastigage Preferred	0.051 mm (0.002 in.)
Feeler Gauge	0.1016 to 0.2032 mm (0.004 to 0.008 in.)
Feeler Gauge Preferred	0.1778 mm (0.007 in.)
Min. Pressure (600 rpm)	89.6 kPa (13 psi)
Min. Pressure at Idle (800 rpm)	172 to 241 kPa (25 to 35 psi)
Min. Pressure at 1600 rpm and Higher	255 to 517 kPa (37 to 75 psi)
Oil Pressure Relief	517 kPa (75 psi)

TIGHTENING TORQUE

DESCRIPTION	N·m	Ft. Lbs.	In. Lbs
[redacted]			
Camshaft Sprocket Bolt	108	80	—
[redacted]			
Connecting Rod Cap Nuts	45	33	—
Cylinder Block Drain Plugs	41	30	—
Cylinder Head Bolts #1–10 & #12–14	149	110	—
Cylinder Head Bolt #11	135	100	—
Cylinder Head Cover Bolts	13	—	115
Dipstick Tube Bracket to Cylinder Block—Bolt	19	—	168
Distributor Hold-Down Clamp Bolt	23	—	204
[redacted]			
Insulator Bracket—Nuts	47	35	—
Insulator—Through Bolt	81	60	—
[redacted]			
Exhaust Manifold/Pipe Nuts	27	20	—

DESCRIPTION	N·m	Ft. Lbs.	In. Lbs
Exhaust Manifold			
Bolt #1	41	30	—
Bolts #2-5	31	23	—
Nuts 6 and 7	14	—	126
Flywheel/Converter Housing Bolts	38	28	—
Flywheel to Crankshaft Bolts	143	105	—
Front Cover to Block Bolts 1/4-20	7	—	60
Front Cover to Block 5/16-18	22	—	192
Generator Mounting—Bolts	57	42	—
Generator Mounting Bracket to Engine—Bolts	47	35	—
Main Bearing Cap Bolts	108	80	—
Oil Filter Adaptor Bolt	102	75	—
Oil Filter Connector	68	50	—
Oil Filter	18	13	—
Oil Galley Plug	41	30	—
Oil Pan 1/4-20 Bolts	9.5	—	84
Oil Pan 5/16-18 Bolts	15	—	132
Oil Pan Drain Plug	34	25	—
Oil Pressure Sending Unit	15	—	130
Oil Pump Short Attaching Bolts	23	—	204
Oil Pump Long Attaching Bolts	23	—	204
Oil Pump Cover Bolts	8	—	70
Rocker Arm—Bolts	28	21	—
Spark Plugs	37	27	—
Starter Motor Mounting Bolts	45	33	—
Thermostat Housing Bolts	18	—	156
Throttle Body Bolts	10	—	90
Vibration Damper Bolt	108	80	—
Water Pump to Block Bolts	31	23	—