CATERPILLAR®

99789-84100

Service Manual

GM4.3L Gasoline Engine

003103-up

For use with GC35K-GC70K; GP40, GPL40, GP45, GP50 Lift Trucks

Foreword

This service manual is a guide to servicing of Caterpillar ® lift trucks. The instructions are grouped by system.

The long, productive life of lift trucks depends upon correct servicing as described in this service manual. Carefully read the respective sections of this manual. Know all the components before attempting to test, repair or rebuild a part or system.

This manual's descriptions, illustrations and specifications are for trucks with these model numbers: Caterpillar GP40 and GPL40, GP45, GP50; GC35K-GC70K. Mitsubishi Caterpillar Forklift Inc. (MCFA) reserves the right to change specifications or design without notice and without incurring obligation.

Whenever a question arises regarding this engine, or this manual, consult your Caterpillar lift truck dealer for the latest available information.
For items petaining to the chasis, refer to the following manuals:
GC35K-70K – 99739-80100
GP40-50 – 99739-87100

Notes, Cautions, and Warnings

NOTES, CAUTIONS, and WARNINGS are used in this manual to emphasize important and critical instructions. They are used for the following conditions:

NOTE To highlight an essential operating procedure or condition.

⚠ CAUTION Operating procedures or practices that will result in damage to or destruction of the engine if not strictly observed.

⚠ WARNING Operating procedures or practices that will result in serious injury or loss of life if not correctly followed.

⚠ WARNING

The OPERATION & MAINTENANCE MANUAL outlines the proper and safe lubrication and maintenance for the machine, as recommended by Mitsubishi®.

Read and understand the OPERATION & MAINTENANCE MANUAL before performing any lubrication or maintenance. Improperly performed lubrication or maintenance procedures are dangerous and could result in injury or death.

Because the service mechanic may be unfamiliar with many of the systems on this machine it is important to use caution when performing service work. Knowledge of the system and/or components is important before the removal or disassembly of any component.

Because of the size of some of the machine components, the service mechanic should check the weights noted in this Manual. Use proper lifting procedures when removing any components.

Following is a list of basic precautions that should always be observed.

1. Read and understand all warning plates and decals on the machine before operating, lubricating or repairing the part or system.
2. Always wear protective glasses and protective shoes when working around machines. In particular, wear protective glasses when pounding on any part of the machine or its attachments with a hammer or sledge. Use welder's gloves, hood/goggles, apron and other protective clothing appropriate to the welding job being performed. Do not wear loose-fitting or torn clothing. Remove all rings from fingers when working on machinery.
3. Do not work on any machine that is supported only by lift jacks or a hoist. Always use blocks or jack stands to support the machine before performing any disassembly.
4. Lower the forks or other implements to the ground before performing any work on the machine. If this cannot be done, make sure the forks or other implements are blocked correctly to prevent them from dropping unexpectedly.

⚠ WARNING

Do not operate this machine unless you have read and understand the instructions in the OPERATOR'S MANUAL. Improper machine operation is dangerous and could result in injury or death.

5. Use steps and grab handles (if applicable) when mounting or dismounting a machine. Clean any mud or debris from steps, walkways or work platforms before using. Always face machine when using steps, ladders and walkways. When it is not possible to use the designed access system, use ladders, scaffolds, or work platforms to perform safe repair operations.
6. To reduce the risk of back injury, use hoist when lifting components which weigh 23 kg (50 lb.) or more. Make sure all chains, hooks, slings, etc., are in good condition and are of the correct capacity. Be sure hooks are positioned correctly. Lifting eyes are not to be side loaded during a lifting operation.
7. To reduce the risk of burns, be alert for hot parts on machines which have just been stopped and have hot fluids in lines, tubes and compartments.
8. Be careful when removing cover plates. Gradually back off the last two bolts or nuts located at opposite ends of the cover or device and pry cover loose to relieve any spring or other pressure before completely removing the last two bolts or nuts.
9. Be careful when removing filler caps, breathers and plugs on the machine. Hold a rag over the cap or plug to prevent being sprayed or splashed by liquids under pressure. The danger is even greater if the machine has just been stopped because fluids can be hot.
10. Always use tools that are in good condition and understand how to correctly use them before performing any service work.
11. Reinstall all fasteners with same part number. Do not use a lesser quality fastener if replacements are necessary. Do not mix metric fasteners with standard nuts and bolts.
12. If possible, make all repairs with the machine parked on a level, hard surface. Block the machine so it does not roll while working on or under it.
13. Disconnect battery and discharge any capacitors (electric trucks) before starting to work on the machine. Hang "Do Not Operate" tag in the Operator's Compartment.

14. Repairs which require welding should be performed only with the benefit of the appropriate reference information and by personnel adequately trained and knowledgeable in welding procedures. Determine the type of metal being welded and select correct welding procedure and electrodes, rods or wire to provide a weld metal strength equivalent at least to that of parent metal.
15. Do not damage wiring during removal operations. Do not reinstall damaged wiring. Reinstall the wiring so it will not be damaged in operation by contacting sharp corners, or by rubbing against an object or hot surface. Do not connect wiring to a line containing fluid.
16. Be sure all protective devices, including guards and shields, are properly installed and functioning correctly before starting a repair. If a guard or shield must be removed to perform the repair work, use extra caution.
17. When the mast needs to be in the raised position during maintanance and repairs, always support the mast and carriage to keep the carriage or attachments raised.
18. Loose or damaged fuel, lubricant and hydraulic lines, or tubes and hoses can cause fires. Do not bend or strike high pressure lines or install ones that are bent or damaged. Inspect lines, tubes and hoses carefully. Do not check for leaks with your hands. Pin hole (very small) leaks can result in a high velocity oil stream that will be invisible upon close inspection of the hose. This oil can penetrate the skin and cause serious injury. Use cardboard or paper to locate pin hole leaks.
19. Tighten connections to the correct torque. Make sure all heat shields, clamps and guards are installed correctly to avoid excessive heat, vibration or rubbing against other parts during operation. Shields must be correctly installed if they protect against oil spray onto hot exhaust components in the event of a line, tube, or seal failure.
20. Relieve all pressure in air, oil or water systems before any lines, fittings or related items are disconnected or removed. Always make sure all raised components are blocked correctly. Be alert for possible pressure when disconnecting any device from a system that uses pressure.
21. Do not operate a machine if any rotating part is damaged or contacts any other part during operation. Any high speed rotating component that has been damaged or altered should be checked for balance before reusing.
22. Caution should be used to avoid breathing dust that may be generated when handling components containing asbestos fibers. If this dust is inhaled, it can be hazardous to your health.

    If dust containing asbestos is present, there are several common sense guidelines that should be followed.

    a. Never use compressed air for cleaning.
    b. Avoid brushing or grinding asbestos containing materials.
    c. For clean up, use wet methods or a vacuum equipped with a high efficiency particulate air (HEPA) filter.
    d. Use exhaust ventilation on permanent machining jobs.
    e Wear an approved respirator if there is no other way to control the dust.
    f. Comply with applicable rules and regulations for the work place.
    g. Follow environmental rules and regulations for disposal of asbestos.
    h. Avoid areas where asbestos particles may be in the air.

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Sealers, Adhesives, and Lubricants

Application	Type of Material	GM Part Number	MCFA Part Number
Balancer Shaft Driven Gear Bolt Threads	Threadlock	12345382	2I4264
Coolant Sealing Pellets	Sealant	3634621	
Crankshaft Balancer Keyway	Adhesive	12346141	A000000165
Cylinder Head Bolt Threads	Sealant	12346004	2I4256
Engine Block to Crankshaft Rear Oil Seal Housing	Adhesive	12346141	A000000165
Junction at the Oil Pan Sealing Surfaces			
Engine Block to Engine Front Cover Junction at the Oil Pan Sealing Surfaces	Adhesive	12346141	A000000165
Engine Block at the Lower Intake Manifold Sealing Surfaces	Adhesive	12346141	A000000165
Engine Block Coolant Drain Hole Plug Threads	Sealant	12346004	2I4263
Engine Block Oil Gallery Plug	Sealant	12346004	2I4263
Engine Coolant Temperature (ECT) Gauge Sensor Threads	Sealant	12346004	2I4263
Engine Oil	SAE 10W30 Oil	12345610 5QT	A000000806
Engine Oil Pressure Sensor Threads	Sealant	12346004	2I4263
Engine Oil Pressure Sensor Fitting Threads	Sealant	12346004	2I4263
Engine Oil Supplement	Lubricant	1052367	
Exhaust Manifold Bolt/ Stud Threads	Threadlock	12345493	2I4256
Expansion Cup Plug (Balance Shaft Rear Bearing Hole)	Sealant	12346004	2I4263
Expansion Cup Plug (Camshaft Rear Bearing Hole)	Sealant	12346004	2I4263
Distributor Module	Heat Sink Compound		5P8937
Lower Intake Manifold Bolt Threads	Threadlock	12345382	2I4264
Oil Level Indicator Tube	Sealant	12346004	2I4263
Oil Pump Screen Tube	Sealant	12346004	2I4263
Valve Rocker Arm Stud Threads	Threadlock	12345493	2I4256
Valve Train Component Prelube	Lubricant	12345501	
Water Pump Bolt Threads	Sealant	12346004	2I4263

Form-In-Place Gasket (FIPG)

The engine has several places where the form-in-place gasket (FIPG) is in use. To ensure the gasket is fully sealed, use the following precautions when applying the FIPG:

1. It is absolutely necessary to apply the sealant in the right amount, evenly and without a break.
2. Bead size, continuity, and location are crucial to a good seal. Too thin a bead causes leakage. Too thick a bead can be squeezed out of location and cause blockage or narrowing in the fluid feed line.

NOTE Since the FIPG used in the engine hardens as it reacts with moisture in the air, it is normally used in the metallic flange area.

Disassembly

The parts assembled with the FIPG can be easily disassembled. Break the seal by striking it with a mallet or by inserting a flat, thin gasket scraper and hammering it through the joint. Use caution to prevent damage to the joined parts.

Surface Preparation

Use a gasket scraper or wire brush to thoroughly remove all surface oil and dirt from all gasket application surfaces. Completely remove any old FIPG still remaining in the bolt holes. All application surfaces must be flat.

Form-In-Place Gasket Application

Apply the FIPG in a smooth, continuous bead without any breaks. Also cover the bolt hole circumference with an even, continuous bead. Wipe away any excess and mount the parts while the FIPG is still wet (15 minutes or less). Check the mounted parts and wipe away any excess sealant.

How to Read This Manual

Scope of Explanation

This book describes the service procedures for the engine removed from a vehicle.
For procedures concerning the removal of the engine from the vehicle and on-vehicle inspection and servicing, refer to the appropriate service manuals separately prepared for the individual models.

Maintenance and Servicing Procedures

(1) A diagram of the component parts is provided near the front of each section in order to give the reader a better understanding of the installed condition of component parts.

(2) The numbers provided within the diagram indicate the sequence for maintenance and servicing procedures; the symbol N indicates a non- reusable part; the tightening tongue is provided where applicable.

- Removal Steps:
  The part designation number corresponds to the number in the illustration to indicate removal steps.
- Installation Steps:
  Specified in case installation is impossible in reverse order of removal steps. Omitted if installation is possible in reverse order of removal steps.
- Disassembly Steps:
  The part designation number corresponds to the number in the illustration to indicate disassembly steps.
- Reassembly Steps:
  Specified in case reassembly is impossible in reverse order of disassembly steps. Omitted if reassembly is possible in reverse order of disassembly steps.

Classification of Major Maintenance/Service Points

When there are major points relative to maintenance and servicing procedures (such as essential maintenance and service points, maintenance and service standard values, information regarding the use of special tools, etc.), these are arranged together as major maintenance and service points and explained in detail.

Indicates there are essential points for removal or disassembly.

Indicates there are essential points for installation or reassembly.

Symbols for Lubrication, Sealants and Adhesives

Information concerning the locations for lubrication and application of sealants and adhesives is provided, by using symbols, in the diagram of component parts, or on the page following the component parts page, and explained.


Grease
(multi-purpose grease unless there is a brand or type specified)

Sealant or adhesive

Brake fluid, automatic transmission fluid or air conditioner compressor oil


Engine oil or gear oil

Inspecting

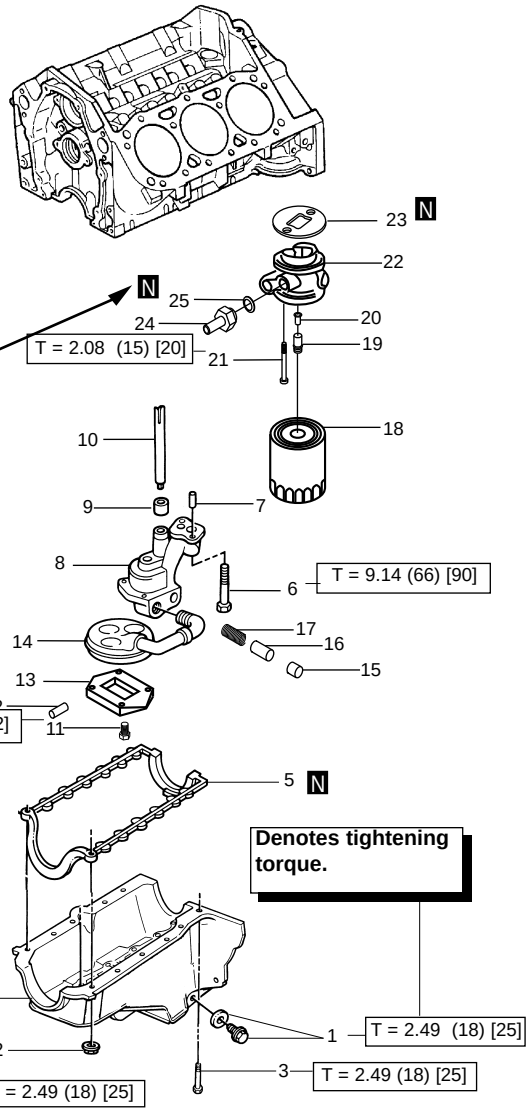
Only the inspections to be performed by using special tools or measuring instruments are covered. General service procedures not covered in this manual, such as visual inspections and cleaning of parts should always be performed during actual service operations.

Removal and Installation

Removal steps

1. Plug
2. Nut
3. Bolt
4. Pan
5. Gasket
6. Bolt
7. Pin
8. Pump
9. Retainer
10. Shaft
11. Bolt
12. Pin
13. Cover
- ◗ A ◖ 14. Screen
15. Plug
16. Valve
17. Spring
18. Filter
19. Fitting
20. Valve
21. Bolt
22. Adapter - Oil Filter
23. Gasket
24. Connector
25. Gasket

Unit: kgf-m (lbf-ft) [N-m]
***kgf-m (lbf-in.) [N-m]**



Denotes nonreusable part.

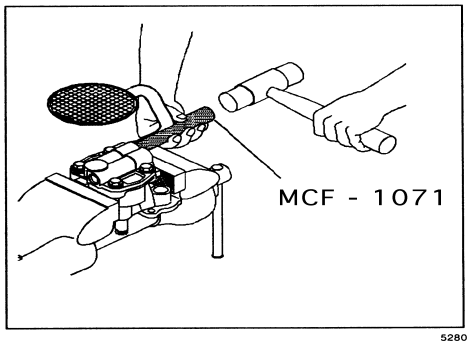
Lubricate all internal parts with engine oil during reassembly

Denotes tightening torque.

INSTALLATION OR REMOVAL SERVICE POINTS

◗ **A** ◖ Install the oil pump screen.

- If removed, replace the oil pump screen. The oil pump screen must have a good press fit into the oil pump body.
- Mount the oil pump in a soft jawed vise.
- Apply sealer to the end of the pipe.
- Use the MCF-1071 and a soft-faced hammer to tap the oil pump screen into the pump body. The screen must align parallel with the bottom of the oil pan when it is installed.



Operating procedures, cautions, etc., on removal, installation, disassembly and reassembly are described.

This alphabetical letter corresponds to a part that is indentified in the drawing on the first page of each section. The letter appears during an explanation of removal, installation, disassembly or reassembly steps.

Special Tools and Equipment

NOTE

All special service tool part numbers beginning with MCF- can be found in the new dealer SERVICE TOOL AND EQUIPMENT CATALOG/MANUAL MCF-5000. The catalog contains a wide assortment of tools and equipment used to service the lift truck. Information on ordering, warranty, and repair will be covered in the SERVICE TOOL AND EQUIPMENT CATALOG/MANUAL. Contact SPX/OTC Service tool department at 1-800-533-0492

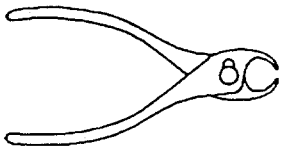
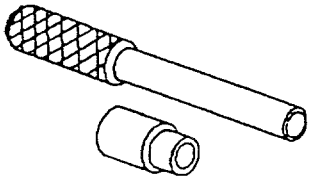
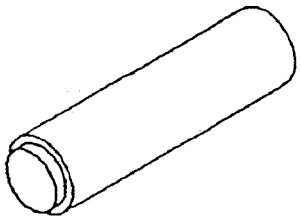
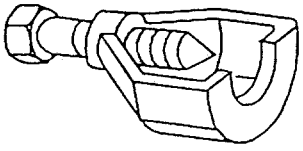
Illustration	Tool Number/ Description
 14487	MCF - 1078 or J 3049 - A Valve Lifter Remover
 3404	MCF - 1064 or J 5239 Connecting Rod Bolt Guide Set
 3407	MCF - 1065 or J 5590 Installer
 3406	MCF - 1066 or J 5825 - A Crankshaft Gear Remover

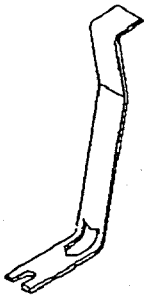
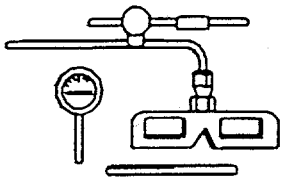
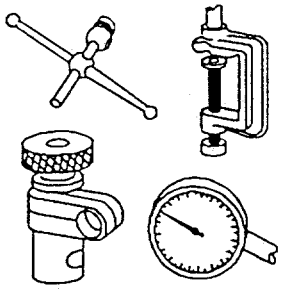
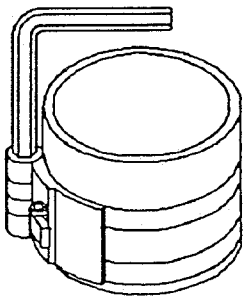
Illustration	Tool Number/ Description
 3399	MCF - 1089 or J 5892 - D Valve Spring Compressor
 35463	MCF - 1091 or J 7872 Magnetic Base Dial Indicator
 2014	MCF - 1067 or J 8001 Dial Indicator Set
 3403	MCF - 1068 or J 8037 Ring Compressor

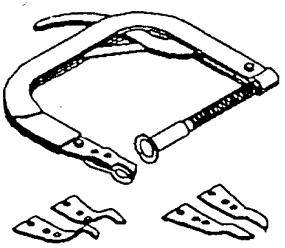
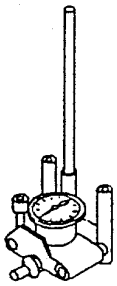
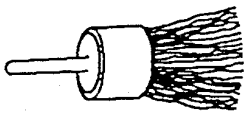
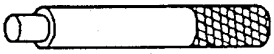
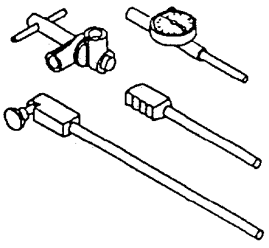
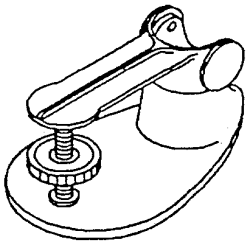
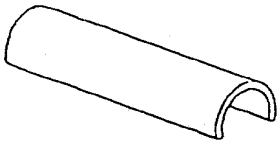
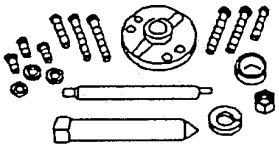
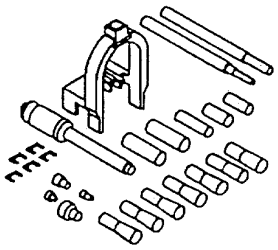
Illustration	Tool Number/ Description
 3414	MCF - 1069 or J 8062 Valve Spring Compressor
 5110	MCF - 1079 or J 8087 Cylinder Bore Gauge
 35464	MCF - 1092 or J 8089 Carbon Removing Brush
 2015	MCF - 1070 or J 8092 Universal Driver Handle
 3408	MCF - 1080 or J 8520 Cam Lobe Lift Indicator

Illustration	Tool Number/ Description
 5112	MCF - 1082 or J 9666 Valve Spring Tester
 3416	MCF - 1071 or J 21882 Oil Suction Pipe Installer
 66168	MCF - 1086 or J 23523 - F Balancer Remover and Installer
 14495	MCF - 1083 or J 24086 - C Piston Pin Remover/Installer

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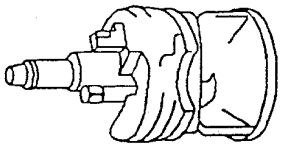
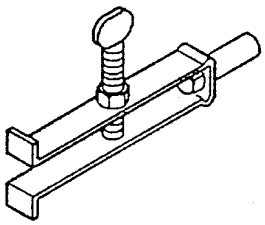
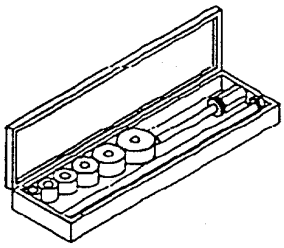
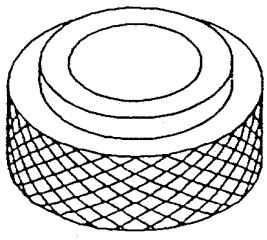
 3412	MCF - 1084 or J 24270 Cylinder Bore Ridge Reamer
 4862	MCF - 1096 or J 26941 Bushing/Bearing Remover
 5118	MCF - 1093 or J 33049 Camshaft Bearing Service Kit
 3401	MCF - 1085 or J 35468 Cover Aligner/Seal Installer

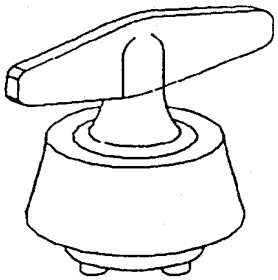
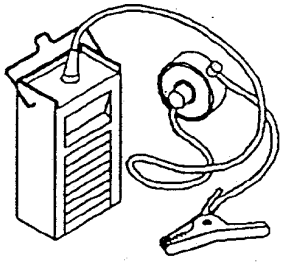
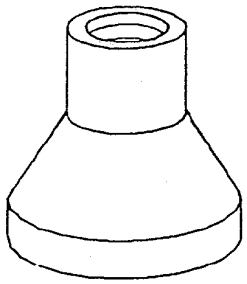
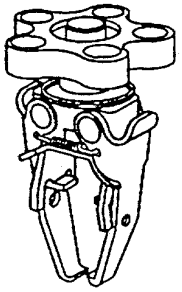
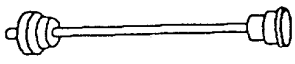
Illustration	Tool Number/ Description
 350498	MCF - 1073 or J 35621 - B Rear Main Seal Installer
 3413	MCF - 1074 or J 36660 Electronic Torque Angle Meter
 3411	MCF - 1075 or J 36996 Balance Shaft Installer
 33658	MCF - 1090 or J 38606 Valve Spring Compressor
 3410	MCF - 1076 or J 38834 Balance Shaft Service Kit

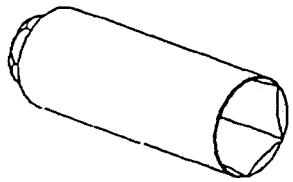
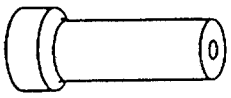
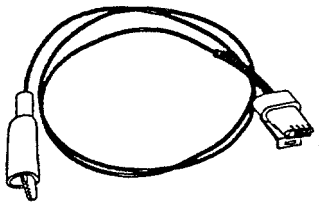
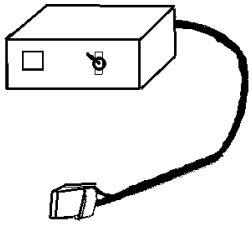
Illustration	Tool Number/ Description
 67136	MCF - 1097 or J 41712 Oil Pressure Switch Socket
 38509	MCF - 1087 or J 42073 Valve Stem Seal Installer

Illustration	Tool Number/ Description
	MCF - 1094 Timing Shunt
	MCF - 1101 or 91868-02300 ECU Diagnostic Tester

Use of RTV and Anaerobic Sealer (Gasket Eliminator)

1. Apply RTV to one of the clean surfaces. Use a bead size as specified in the procedure. Run the bead to the inside of any bolt holes. Do not allow the sealer in any bolt holes. Do not allow the sealer in any blind threaded holes, as it may prevent the bolt from seating properly or cause damage when the bolt is tightened.
2. Assemble components while RTV is still wet (within 3 minutes). Do not wait for RTV to skin over.
3. Tighten bolts to specifications. Do not overtighten.
4. Apply a continuous bead of gasket eliminator to one flange. Surfaces to be resealed must be clean and dry.

NOTE

Important: Incorrect shimming of anaerobic sealed joints may occur when joints are partially torqued and allowed to cure more than five minutes.

5. Spread the bead evenly with a finger to get a uniform coating on the complete flange.

Determining When to Overhaul the Engine

Deciding when to overhaul the engine is determined by considering the following factors:

A drop in compression pressure as well as an increase in lube oil consumption and excessive blowby.

Lack of power, increase in fuel consumption, drop in lube oil pressure, hard starting and abnormal sound are also engine troubles. These troubles, however, are not always the result of low compression pressure and give no valid reason for overhauling the engine.

The engine develops troubles of widely different varieties when its compression pressure drops. Following are the list of typical troubles caused by this compression pressure fault.

1. Lack of power
2. Increase in fuel consumption
3. Increase in lube oil consumption
4. Excessive blowby through breather due to worn cylinders, pistons, etc.
5. Excessive blowby due to poor seating of worn inlet and exhaust valves
6. Hard starting
7. Abnormal sound

In most cases, these troubles occur concurrently. Some of them are directly caused by low compression pressure, but others are not. Among the troubles listed above, 1, 2, and 6 could be caused by low compression pressure.

The most valid reason for overhauling the engine is (4). To determine when to overhaul the engine, it is reasonable to take this trouble into consideration in conjunction with the other troubles.

Precautions

Precautions for Disassembly and Assembly

This section contains basic safety precautions and outlines basic recommended procedures, some of which require special tools, devices or work methods.

However, the safety precautions contained herein are not for all service work. It is the responsibility of service personnel to know that specific requirements, precautions and work hazards exist and to discuss these with a foreman or supervisor.

Disassembly

1. Always use tools that are in good condition. Understand how to use them before performing any service work.
2. Use an overhaul stand or a work bench, if necessary. Also, use bins to keep engine parts in order of removal.
3. Lay down the disassembled and cleaned parts in the order in which they were removed to save time for assembly.
4. Pay attention to marks on assemblies, components and parts for their positions or directions. If necessary, add marks to aid in assembly.
5. During removal or cleaning, carefully check each part for any sign of faulty condition. Signs of wear or abnormalities that caused the engine to work abnormally are more easily and accurately spotted during removal or cleaning.
6. Get help when lifting or carrying a part that is too heavy or awkward for one person to handle. If necessary, use a jack or a hoist.

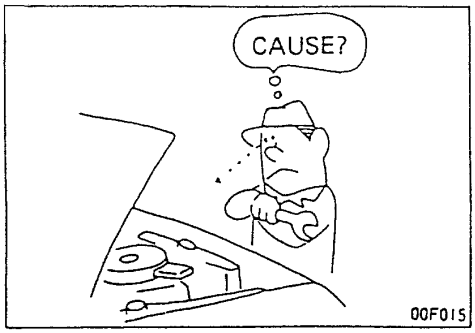
Assembly

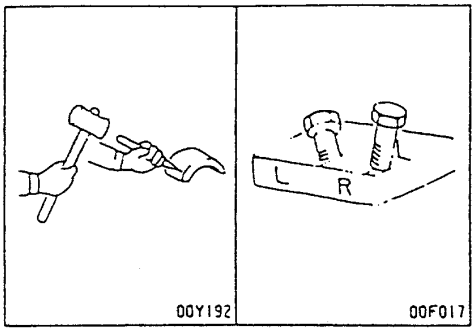
Cleanliness and Care

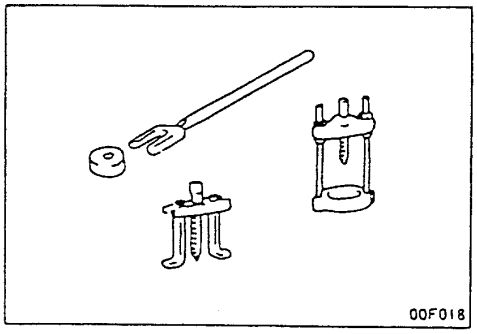
This engine is a combination of many machined, honed, polished and lapped surfaces with tolerances that are measured in ten thousandths of an inch. Care and cleanliness are important when any internal engine parts are serviced. During assembly, a liberal coating of engine oil should be applied to friction areas to project and lubricate the surfaces on initial operation. Throughout this section, it should be understood that proper cleaning and protection of machined surfaces and friction areas are part of the repair procedure. This is considered standard shop practice, even if not specifically stated.

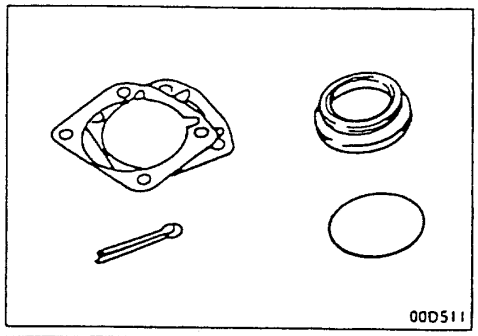
When valve train components are removed for service, they should be retained in order. At the time of installation, they should be installed in the same locations and with the same mating surfaced as when removed.

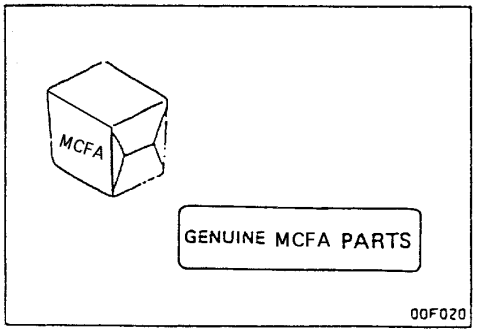
1. Wash all parts, except for oil seals, O-rings, rubber sheets, etc., with cleaning solvent and dry them with pressure air.
2. Always use tools that are in good condition and be sure you understand how to use them before performing any service work.
3. Use only good-quality lubricants. Be sure to apply a coat of oil, grease or sealant to parts as specified.
4. Be sure to use a torque wrench to tighten parts for which torques are specified.
5. Replace gaskets and packings with new ones.











General Precautions

Removal and Disassembly

Confirm the location of the faulty part and find the probable cause of the trouble. Then decide whether removal or disassembly is required. If so, carry out the removal or disassembly according to the steps shown in this service manual.

To prevent erroneous installation and to facilitate installation work, punch or draw alignment marks in places where neither function nor appearance is affected.

Make a distinction between the items removed from one assembly and those removed from another assembly, especially when disassembling a unit having a large number of component parts or when disassembling two or more similar parts. Always do the following:

1. Keep the removed parts in order.
2. Make a distinction between the parts to be replaced and the parts to be reused.
3. When replacing bolts and nuts, use only ones of the specified size.

Special Tools

When specified, be sure to use the special tools for the specific service work. Using other tools may cause damage to parts and/or injury to workers.

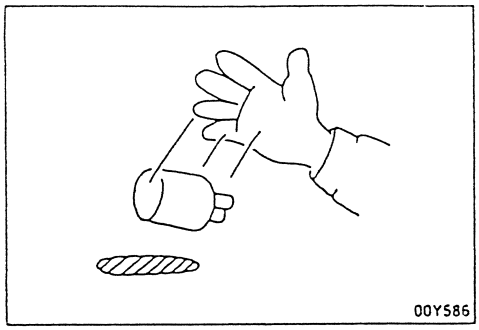
Non-reusable Parts

Whenever any of the following parts are removed, be sure to replace them with new ones.

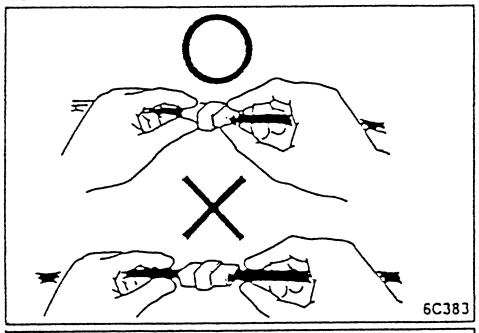
1. Oil seals
2. Gaskets (except rocker cover gasket)
3. Packings
4. O-rings
5. Lock washers
6. Split pins

Recommended Replacement Parts

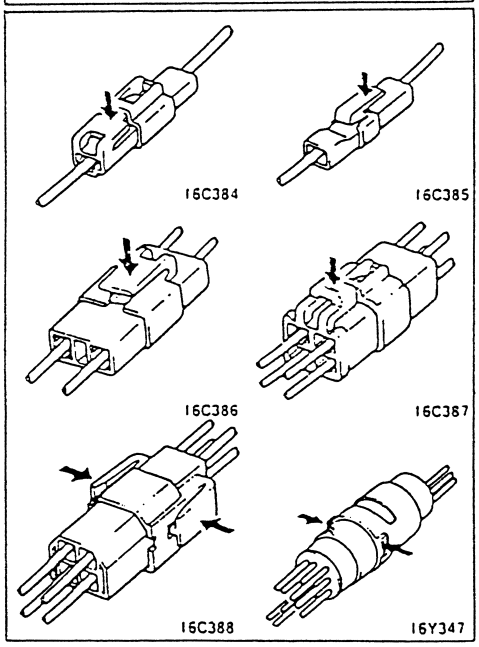
1. For replacement parts, use only genuine Mitsubishi parts.
2. Use of the available sets and kits of service parts is recommended.
3. To unify parts, or for other reasons, service parts are subject to change. When replacing parts in the engine, carefully check for possible modifications by referring to the updated parts catalog for the specific engine.



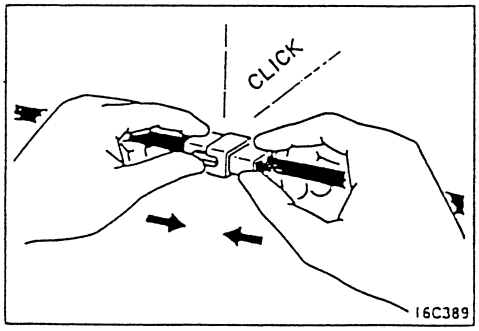
Handling of Electrical System
Shocks are harmful to sensors and relays. Never drop or throw them.



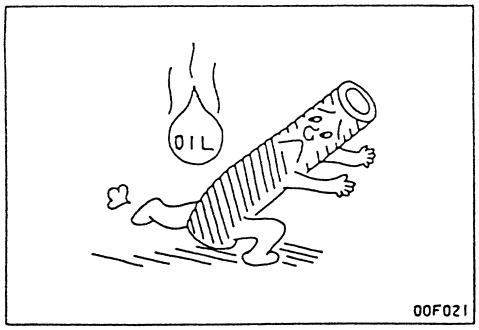
When disconnecting a connector, do not pull the harness. Hold the halves of the connector to separate them from each other.



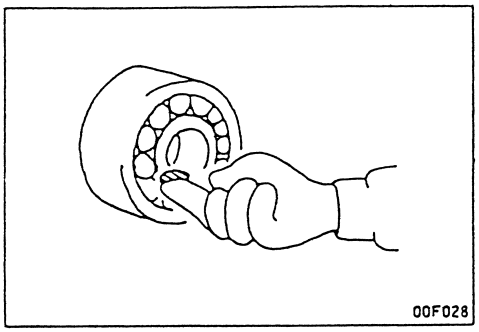
When disconnecting a lock type connector, push the lock lever(s) in the direction(s) shown by the arrow(s).



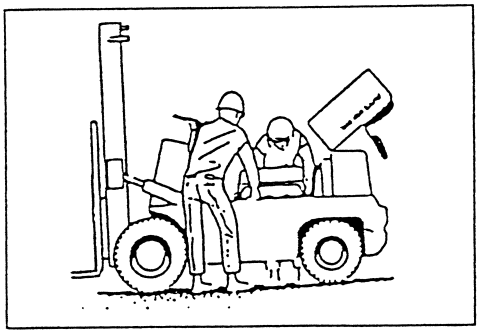
When connecting a lock type connector, put the plug into the socket until it clicks.



Handling of Rubber Hoses and Tubes
Take care not to spill gasoline or oil on rubber hoses or tubes, otherwise the rubber is likely to deteriorate.



Greasing
During assembly or installation, coat the designated surfaces with the specified grease or oil.



Cooperation
When two or more persons work together, each worker should pay attention to the safety of the other(s).

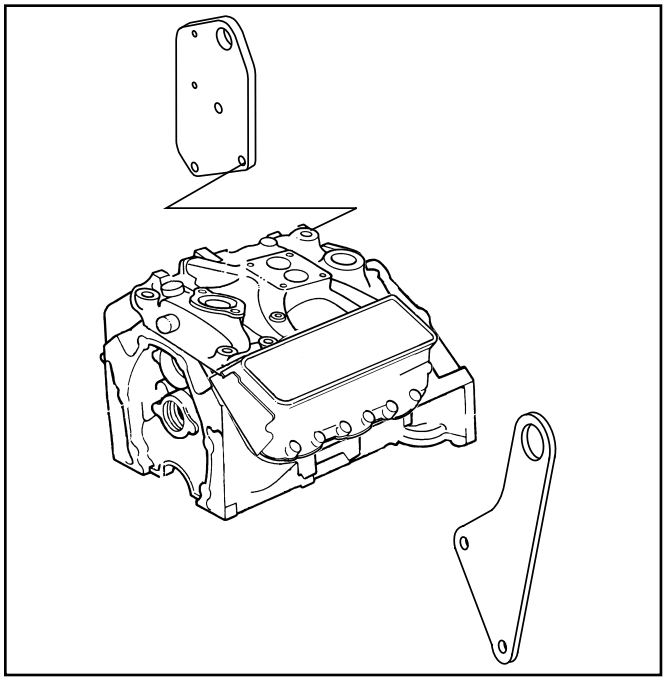
Engine Replacement

Removal Procedure

NOTE

If the engine is damaged internally and a new engine assembly is installed in the machine, ensure that all foreign material is flushed out of the cooling system. It is necessary to flush out the oil cooler system. Failure to rid the oil cooler system of debris can result in engine damage.

1. Disconnect battery.
2. Raise the machine and support with stands.
3. Drain fluids and oil filter removal
   a. Remove the oil pan drain plug, and allow oil to drain.
   b. Remove the oil filter.
   c. Remove both coolant drain plugs and allow coolant to drain.
4. Disconnect the exhaust pipe from the exhaust manifolds.
5. Disconnect the following items:
   • The wiring harnesses
   • The throttle cable
   • The fuel lines



6. Support engine using appropriate sling and hoist. Use existing lift eyes.
7. Disconnect the fuel line and fuel line clamp.
8. Remove the starter. Refer to *Engine Electrical*.
9. Disconnect the torque convertor bolts from the flywheel.
10. Remove the oil filter.
11. Support the transmission with a jack.
12. Remove the transmission engine bolts.
13. Remove the front engine mount bolts.
14. Remove the distributor.
15. Use the engine lifting device to remove the engine from the machine.

Installation Procedure

NOTE

If the engine is damaged internally and a new engine assembly is installed in the machine, ensure that all foreign material is flushed out of the cooling system. It is necessary to flush out the oil cooler system. Failure to rid the oil cooler system of debris can result in engine damage.

1. Raise the machine.
2. Install the engine into the machine.
3. Install the left upper transmission to engine bolt.
4. Install the front engine mounts.
5. Install the distributor.
6. Install the following items:
   • The wiring harnesses
   • The vacuum lines
   • The throttle cable
   • The fuel lines
7. Install torque convertor to flywheel bolts.
8. Install the remaining transmission to engine bolts.
9. Install the oil filter.
10. Install the pump drive shaft.
11. Install the starter. Refer to *Engine Electrical*.
12. Connect the fuel line and fuel line clamp.
13. Connect the exhaust pipe to the exhaust manifolds.
14. Lower the machine.
15. Fill the crankcase with oil.
16. Fill radiator with coolant.
17. Connect battery.

Specifications

Engine Specifications - Gas and LP

Application	Specification
Engine	
Engine Model	GM 4.3L
Manufacturer	General Motors
Type	Gasoline
Cooling System	Water Cooled
No. of Cylinders - Arrangement	6 - 90° V
No. of Stroke	4
Type of Combustion Chamber	Semi - Spherical
Valve Arrangement	Overhead
Type of Cylinder Liner	Integral
Cylinder Bore x Stroke, mm (in)	101.6x88.39 (4.00x3.48)
Displacement, cc (cu in)	4293 (262)
Compression Ratio	9.2:1
Rated Output, PS/rpm	94/ 2450
Rated Torque, kgf -m/rpm	31.0/1200
Min. rpm	750 ± 50
Max. rpm	2650-2700
Dimensions (LxWxH), mm	710x620x740 (28x24.5x29)
Weight, kg (lbs)	260 (572)
Installation Position	Rear
Ignition	Spark
Firing Order	1-6-5-4-3-2
Initial Ignition Timing BTDC deg	0° Gasoline, 8° L.P.G.
Rotation (View From Pulley)	CW
Voltage for Electric System	12 V

Engine Specifications - Gas and LP, continued

Application		Specification	
Ignition System		HEI or EST	
Ignition Coil -	Type	Mold	
	Manufacturer	AC Delco	
Distributor -	Type	Pointless	
	Manufacturer	AC Delco	
	Type of Spark Advance Control	Internal Solid State Circuit	
Spark Plug -	Model	AC #41 - 932	
	Manufacturer	AC Delco	
	Size, mm	14 (0.55)	
	Gap, mm (in)	1.52 (.060)	
Fuel System		GAS	LP
Carburetor/ Mixer-Type		IFZ	CA100
	Manufacturer	AISAN Kogyo Co.	IMPCO
Governor -	Type	Electronic	Pneumatic
	Manufacturer	Mitsubishi Heavy Industries	AISAN Kogyo Co.
Fuel Pump -	Type	Electromagnetic	–
	Manufacturer	Jidosha Kiki	–
Engine Lubrication System			
	Type	Pressure Feed	
	Oil Pump	Gear Pump	
	Oil Filter	Paper Element	
	Oil Cooler	Oil to Water Type	
	Refill Capacity, Liter (Quart) Oil Pan	4.0 (4.2)	
	Oil Filter and Cooler	0.7 (0.8)	
	Total	4.7 (5.0)	

Engine Specifications - Gas and LP, continued

Application	Specification
Cooling System	
Type	Forced Circulation
Complete Engine Refill Capacity, Liter (Quarts)	18.2 (4.84)
Water Pump	Centrifugal Type, V - Belt Driven
Thermostat Type/ Opening Temp° F	Wax Type / 180
Alternator	
Type	3 - Phase AC
Manufacturer	MANDO
Rated Output, V - A	12 - 50
Regulator	Built in IC Type
Starter	
Type	Electromagnetic
Manufacturer	Delco Remy
Voltage - Output, V - kW	12 V - 0.75

General Specifications

Application	Specification	
Engine type	90 Degree V6	
RPO VIN Code	L35(W), LF6 (X)	
Displacement	4.3L	262 CID
Bore	101.6 (4.000)	
Stroke	88.39 (3.480)	
Compression Ratio	9.2:1	
Firing Order	1-6-5-4-3-2	
Spark Plug Gap	1.52 (060)	
Oil Pressure (Minimum Hot)	41.4 at 1000 min. (6.0 at 1000)	
- kPa at engine RPM (psi at engine RPM)	124.1 at 2000 (18.0 at 2000)	
Service Weight (KG) [LB]	(185) [408]	
Ignition Timing BTDC (LP) [Gasoline]	(8°) [0°]	
Lubrication System		
Oil Capacity Without Filter Change - liters(qts.)	3.75 (4)	
Oil Capacity With Filter Change Add - liters(qts.)	0.398 (0.42)	
Pan		
Engine Block Clearance Tolerance	0.254 (0.010) max.	
Cylinder Head		
Surface Flatness	0.1016 (0.004) max.	
Exhaust Manifold		
Surface Flatness	0.254 (0.010) max.	
Intake Manifold		
Surface Flatness	0.254 (0.010) max.	
Cylinder Bore		
Diameter	101.618-101.643 (4.0007-4.0017)	
Out-of-Round Production	0.02 (0.0001) max.	
Out-of Round Service Limit	0.05 (0.002) max.	
Taper Production Thrust Side	0.012 (0.0005) max.	

NOTE **Important:** All measurements are in millimeters (inches) unless otherwise noted.

General Specifications, continued

Application	Specification
Taper Production Relief Side	0.025 (0.001) max.
Taper Service Limit	0.025 (0.001) max.
Piston	
Piston Bore Clearance-Production	0.0001-0.005 (0.0007-0.002)
Piston Bore Clearance-Service Limit	0.070 (0.0024) max.
Piston Rings (End Gap Measured in Cylinder Bore)	
Piston Compression Ring Groove Clearance-Production Top	0.050-0.15 (0.02-0.06)
Piston Compression Ring Groove Clearance-Production 2nd	0.10-0.20 (0.04-0.08)
Piston Compression Ring Groove Clearance-Service Limit	0.050-0.107 (0.0127-0.0042) max.
Piston Compression Ring Gap-Production Top	0.25-0.40 (0.010-0.016)
Piston Compression Ring Gap-Production 2nd	0.46-0.66 (0.018-0.026) max.
Piston Compression Ring Gap-Service Limit	.25 - .88 (0.06 - .035) max.
Piston Oil Ring Groove Clearance-Production	0.051-0.17 (0.002-0.007)
Piston Oil Ring Groove Clearance-Service Limit	0.051-0.20 (0.002-0.008) max.
Piston Oil Ring Gap-Production	0.003-0.0127 (0.015-0.050)
Piston Oil Ring Gap-Service Limit	0.25-1.65 (0.009-0.065) max.
Piston Pin	
Diameter	23.545-23.548 (0.9267-0.9271)
Clearance in Piston-Production	0.009-0.0024 (0.0002-0.0007)
Clearance in Piston-Service Limit	0.0025 (max.) (0.001) max.
Fit in Connecting Rod	0.021-0.040 (0.0008-0.0016) Interference
Crankshaft	
Crankshaft Journal-Diameter #1	62.199-62.217 (2.4488-2.4495)
Crankshaft Journal-Diameter #2, #3	62.191-62.215 (2.4485-2.4494)

NOTE **Important:** All measurements are in millimeters (inches) unless otherwise noted.

General Specifications, continued

Application	Specification
Crankshaft Journal-Diameter #4	62.179-62.203 (2.4479 - 2.4489)
Crankshaft Journal Taper-Production	0.0076 (0.0003) max.
Crankshaft Journal Out-of-Round-Production	0.005 (0.0002) max.
Crankshaft Journal Out-of-Round-Service Limit	0.025 (0.001) max.
Crankshaft Bearing Clearance-Production #1	0.020-0.050 (0.0008-0.0020)
Crankshaft Bearing Clearance-Production #2, #3, #4	0.22-0.061 (0.0009-0.0024)
Crankshaft Bearing Clearance-Service Limit #1	0.025-0.05 (0.0010-0.0020)
Crankshaft Bearing Clearance-Service Limit #2, #3, #4	0.025-0.06 (0.0010-0.025)
Crankshaft End Play	0.050-0.20 (0.002-0.008)
Crankshaft Runout	0.025 (0.001) max.
Connecting Rod	
Connecting Rod Journal Diameter	57.116-57.148 (2.2487-2.2497)
Connecting Rod Journal Taper-Production	0.007 (0.0003)
Connecting Rod Journal Taper-Service Limit	0.025 (0.001)
Connecting Rod Journal Out-of-Round-Production	0.007 (0.0002)
Connecting Rod Journal Out-of-Round-Service Limit	0.025 (0.001)
Rod Bearing Clearance-Production	0.038-0.078 (0.0015-0.0031)
Rod Bearing Clearance-Service Limit	0.025-0.076 (0.0010-0.0030)
Rod Side Clearance	0.15-0.44 (0.006-0.017)
Camshaft	
Journal Diameter	47.452-47.478 (1.8682-1.8692)
End Play	0.0254-0.2286 (0.001-0.009)
Lobe Lift Intake	0.0726-0.0736 (0.286-0.290)
Lobe Lift Exhaust	0.0741-0.0751 (0.292-0.296)
Balance Shaft	
Front Bearing Journal Diameter	55.985-55.001(2.1648-2.1654)
Rear Bearing Journal Diameter	38.084-38.100 (1.4994-1.500)
Rear Bearing Journal Clearance	0.0254-0.09144 (0.001-0.0036)

NOTE **Important:** All measurements are in millimeters (inches) unless otherwise noted.

General Specifications, continued

Application	Specification
Valve System	
Valve Lifter	Hydraulic Roller Type
Valve Rocker Arm Ratio	1.50:1
Valve Lash	Net Lash No Adjustment
Face Angle	45 Degrees
Seat Angle	46 Degrees
Seat Runout	0.05 (0.002) max.
Seat Width Intake	0.76-1.27 (0.030-0.050)
Seat Width Exhaust	1.651-2.489 (0.065-0.098)
Stem Clearance Production Intake	0.025-0.069 (0.0011-0.0027)
Stem Clearance Production Exhaust	0.025-0.069 (0.0011-0.0027)
Stem Clearance Service Limit Intake	0.0257 (0.001) max.
Stem Clearance Service Limit Exhaust	0.0508 (0.002) max.
Valve Spring Free Length	52 (2.03)
Valve Spring Pressure Closed - N at mm / (Lb at in.)	338-374 at 43 (76-84 at 1.78)
Valve Spring Pressure Open - N at mm / (Lb at in.)	832-903 at 32 (187-203 at 1.27)
Valve Spring Installed Height Intake	45.2 (1.78)
Valve Spring Installed Height Exhaust	45.2-43.43 (1.690-1.710)
Valve Lift Intake	10.51 (0.414)
Valve Lift Exhaust	10.87 (0.428)

NOTE **Important:** All measurements are in millimeters (inches) unless otherwise noted.

Major Nuts and Bolts Tightening Torque

Item	Torque				Remarks
	kgf-m	N-m	lbf•ft	lbf•in	
Balance Shaft Retainer Plate Bolts	1.22	12	–	106	
Balance Shaft Driven Gear Bolt (First Pass)	2.08	20	15	–	
Balance Shaft Driven Gear Bolt (Final Pass)	35 degrees				
Camshaft Retainer Bolt	1.22	12	–	106	
Camshaft Sprocket Bolt	2.49	25	18	–	
Connecting Rod Nut (First Pass)	2.77	27	20	–	
Connecting Rod Nut (Final Pass)	70 degrees				
Crankshaft Balancer Bolt	10.25	100	74	–	
Crankshaft Bearing Cap Bolt	10.66	105	77	–	
Crankshaft Position Sensor Bolt	.92	9	–	80	
Crankshaft Rear Oil Seal Housing Nut and Bolt	1.52	15	11	–	
Crankshaft Rear Oil Seal Housing Stud	.61	6	–	53	
Cylinder Head Bolts (First Pass in Sequence)	3.05	30	22	–	
Cylinder Head Bolts (Long Bolts Final Pass in Sequence)	75 degrees				
Cylinder Head Bolts (Medium Bolts Final Pass in Sequence)	65 degrees				
Cylinder Head Bolts (Short Bolts Final Pass in Sequence)	55 degrees				
Cylinder Head Core Head Plugs	2.08	20	15	–	
Distributor Clamp Bolt	2.49	25	18	–	
Engine Block Oil Gallery Plugs	2.08	20	15	–	
Engine Front Cover Bolt	1.22	12	–	106	
Exhaust Manifold Bolts and Stud (First Pass)	1.52	15	11	–	
Exhaust Manifold Bolts and Stud (Final Pass)	3.05	30	22	–	
Engine Flywheel Bolt	10.25	10	74	–	
Front Lift Bracket Stud	4.16	40	30	–	
Ignition	1.22	12	–	106	
Intake Manifold Bolt (First Pass)	.31	3	–	27	
Intake Manifold Bolt (Second Pass)	1.22	12	–	106	
Intake Manifold Bolt (Final Pass)	1.52	15	11	–	
Oil Filter Adapter Bolts	2.08	20	15	–	
Oil Level Indicator Tube Bolt	1.22	12	–	106	
Oil Pan Nuts (Tighten in Sequence)	2.49	25	18	–	
Oil Pan Bolts (Tighten in Sequence)	2.49	25	18	–	

NOTE **Important:** Unless otherwise noted all torques are dry.

Major Nuts and Bolts Tightening Torque, continued

Item	Torque				Remarks
	kgf-m	N-m	lbf/ft	lbf/in	
Oil Pan Drain Plug	2.49	25	18	–	
Oil Pressure Fittings (Plus Necessary Alignment)	1.52	15	11	–	
Oil Pressure Sensor and Switch	3.05	30	22	–	
Oil Pump Bolt-to-Rear Crankshaft Bearing Cap	9.14	90	66	–	
Oil Pump Cover Bolts	1.22	12	–	106	
Spark Plugs (New Cylinder Head)	3.05	30	22	–	
Spark Plugs (All Subsequent Installations)	2.08	20	15	–	
Valve Lifter Guide Retainer Bolt	1.66	16	12	–	
Valve Rocker Arm Ball Stud	4.85	47	35	–	
Valve Rocker Arm Cover Bolts	1.22	12	–	106	
Valve Rocker Arm Nut	2.49	25	18	–	
Water Pump Bolts	4.85	45	35	–	

NOTE **Important:** Unless otherwise noted all torques are dry.

Base Engine Misfire Diagnosis

The following diagnosis information covers common problems and possible causes. When the proper diagnosis is made, the problem should be corrected by adjustment, repair or part replacement, as required. Refer to the appropriate section of the manual for these procedures.
This diagnostic table will assist in engine misfire diagnosis due to a mechanical problem such as a faulty camshaft or leaking headgasket. It is assumed that the base engine timing is correct and the acceptable fuel is being used. The Gasoline engine is equipped with an ECU Diagnostics tester. See page 113.

Step	Action	Value(s)	Yes	No
1	Are there any obvious mechanical noises?	–	Go to Base Engine Misfire Diagnosis	Go to Step 2
2	Visually inspect valve train components, spark plugs, wires, and hose for proper hook up or damage. Are there any damaged components or improperly connected wires or hoses?	–	Go to Step 3	Go to Step 4
3	Repair or replace the parts as necessary. Do the symptoms still exist?	–	Go to Step 4	System OK
4	Remove and inspect the spark plugs. Are any spark plugs contaminated with engine coolant?	–	Go to Step 8	Go to Step 5
5	Are the spark plugs contaminated with engine oil?	–	Go to Step 9	Go to Step 12
6	Check valve stem oil seals and valve guides for wear. Are the components damaged?	–	Go to Step 7	Go to Step 8
7	Repair or replace valve stem oil seals and valve guides as necessary. Do the symptoms still exist?	–	Go to Step 8	System OK
8	1. Remove and inspect the intake manifold and the intake maifold gasket. Refer to *Intake Manifold Removal.* 2. Replace the parts as necessary. Do the symptoms still exist?	–	Go to Step 13	System OK
9	Remove and inspect the intake manifold and the intake manifold gasket. Refer to *Intake Manifold Removal.* Are the components damaged?	–	Go to Step 10	Go to Step 11
10	Replace the parts as necessary. Do the symptoms still exist ?	–	Go to Step 13	System OK
11	Remove and inspect the cylinder head. Refer to *Cylinder Head Clean and Inspect.* Are the valve guides or the seals damaged?	–	Go to Step 11	Go to Step 12
12	Remove and inspect the piston, the piston rings, and the cylinder for wear. Are the piston components damaged?	–	Go to Step 10	Go to Step 13