

SERVICE MANUAL

**MITSUBISHI
DIESEL ENGINE**

DO4EG-TAA

for KOBELCO CONSTRUCTION MACHINERY CO. , LTD



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Foreword

This service manual describes the maintenance and adjustment procedures, and specifications for Mitsubishi diesel engines.

To maintain the performance of the engine for many years and to ensure safe operation, it is important to use the engine correctly and conduct scheduled inspection and maintenance, and it may also be necessary to take appropriate measures which involve in disassembly, inspection, repair and assembly work of the engine and engine parts.

Read through this manual carefully and understand the work procedures fully before disassembling, inspecting, repairing or assembling the engine.

The contents of this manual are based on the engine model produced at the time of publication. Please note that the contents of this manual may change due to improvements made thereafter.

HOW TO USE THIS MANUAL

This service manual consists of several chapters, which will give you quick references to specifications, maintenance standards, adjustment and service procedures including practices to disassemble, inspect, repair and assemble the Mitsubishi diesel engines.

A short summary describing the contents of each chapter is given in the CHAPTER INDEX page, and there is also a detailed table of contents at the beginning of each chapter.

Regarding the procedures for operation and scheduled maintenance of the engine, refer to the Operation and Maintenance Manual. For information on the engine components and ordering of service parts, refer to the Parts Catalogue. Structure and function of the engine are described in the relevant training manuals.

If you have an inquiry, please check the engine model and serial number, and contact our service department.

Description format

- (1) Index numbers allotted to parts in exploded views are not only a call-out of part names listed in the text but also an indication of the sequence of disassembly.
- (2) Inspections to be conducted during disassembly process are indicated in boxes in the relevant exploded views.
- (3) Maintenance standards required for inspection and repair works are indicated in the appropriate positions in the text. They are also collectively indicated in the Chapter 2.
- (4) The tightening torque with engine oil applied on the thread, is specified [Wet]. Unless otherwise specified, the tightening torque is of dry condition.
- (5) In this manual, important safety or other cautionary instructions are emphasized with the following head marks.



Indicates an immediately hazardous situation which, if not avoided, will result in death or serious injury.



Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.



Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.



Indicates a potentially hazardous situation which, if not avoided, may result in property damage.

Note

Emphasizes important matter, or indicates information useful for operation or maintenance of the engine.

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Terms used in this manual

Nominal value

means the basic nominal size of a part to be measured.

Standard value

means the quantitative requirement for dimension of a part, clearance between parts and performance. The values are rounded off for the inspection job, and do not necessarily conform to the design values.

Limit value

means the value, which the measured value reaches, the part needs repair or replacement with a new one.

Abbreviations and Standards

- ♦BTDC : Before Top Dead Center
- ♦ATDC : After Top Dead Center
- ♦BBDC : Before Bottom Dead Center
- ♦ABDC : After Bottom Dead Center
- ♦TIR : Total Indicator Reading
- ♦API : American Petroleum Institute
- ♦ASTM : American Society for Testing and Materials
- ♦JIS : Japanese Industrial Standards
- ♦LLC : Long Life Coolant
- ♦MIL : Military Specifications and Standards (U.S.A.)
- ♦MSDS : Material Safety Data Sheet
- ♦SAE : Society of Automotive Engineers (U.S.A.)
- ♦P/N : Part Number

Unit of Measurement

Measurements are based on the International System of Units (SI), and their converted metric values are indicated in { } and U.S. customary values are in []. For the conversion, the following rates are used.

- ♦Pressure : 1 MPa = 10.197 kgf/cm²
- ♦Torque : 1 N•m = 0.10197 kgf•m
- ♦Force : 1 N = 0.10197 kgf
- ♦Output power : 1 kW = 1.341 HP = 1.3596 PS
- ♦Pressure (mercury column) : 1 kPa = 0.7 cmHg
- ♦Pressure (water column) : 1 kPa = 10.197 cmH₂O (cmAq)
- ♦Rotation speed: 1 min⁻¹ = 1 rpm

Safety Cautions

Fire and Explosion Precautions

WARNING

Keep Flames Away

Do not use flames near the engine (in the engine room). The flame is dangerous to ignite combustibles and cause a fire. Wipe off spilled fuel, oil and LLC immediately and thoroughly.



Spilled fuel, oil and LLC may ignite and cause a fire. Store the fuel and engine oil in a well ventilated area. Make sure that the fuel and engine oil container caps are tightly fastened.

Tidy up Around the Engine

Do not place combustible or explosive material, such as fuel, engine oil, LLC or explosive powder near the engine. Such substances can cause a fire or explosion. Thoroughly remove dust, dirt and other foreign material collected on the engine and the area around the engine. Such material can cause a fire or the engine to overheat. In particular, clean the top surface of the battery thoroughly. Dust can cause a short circuit. Always place the engine at a position at least 1 m [3.28 ft.] apart from buildings and other equipment to prevent a possible fire caused by engine heat.

Pay Attention to Fuel, Oil and Exhaust Gas Leak

If any fuel, oil or exhaust gas leakage is found, immediately take corrective measures to stop it. Such leakages, if left uncorrected, can cause fuel or engine oil to reach hot engine surfaces or hot exhaust gas to contact flammable material, may results in a fire, personal injury and damage to the equipment.

Use Explosion-Proof Light

When inspecting fuel, engine oil, coolant, battery electrolyte, etc., use an explosion-proof light. If the lighting is not an explosion-proof type, it may ignite and cause an explosion.

Prevent Electrical Wires from Short Circuit

Avoid inspecting or servicing the electrical system with the battery cable connected to the battery. Otherwise, a fire could result from short circuit. Be sure to disconnect the battery cable from the negative (-) terminal before starting work. A loose terminal and a damaged cable or wire may result in a short circuit and a fire. Inspect, and if any defect is found, repair or replace it before starting work.

Keep Fire Extinguishers and First-Aid Kit Handy

Keep fire extinguishers handy, and become familiar with their usage. Keep a first-aid kit at the designated place to be ready for use in an emergency. Make counteract procedures against a fire or an accident. Provide the contact person and means of communication in case of emergency.

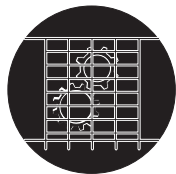


Stay Away From Rotating and Moving Parts



Install Protective Covers Over Rotating Parts After Inspection and Maintenance Work

Check the covers over engine rotating parts for correct installation. Repair any damaged or loosed covers. Never remove the protective covers over rotating parts during operation. When the engine is coupled to a radiator or other equipment, install protective covers over the exposed connecting belt and coupling.



Check Work Area for Safety Before Starting

Before starting the engine, make sure that no one is near the engine and that tools are not left on or near the engine. Verbally notify persons within the immediate area when starting the engine. When the starter device is tagged with the warning sign saying DO NOT RUN, never start the engine.

Stay Away From Moving Parts While Engine Operates

Keep away from the rotating parts during operation. Do not leave any objects that may get caught in rotating parts. If clothes or a tool gets caught in rotating parts, serious injury will result.



Lockout and Tagout

Be sure to lockout and tagout before starting inspection and maintenance. Lockout and tagout are effective methods of cutting off machines and equipment from energy sources. To accomplish the lockout/tagout, remove the starter switch key, set the battery switch to OFF position and attach a DO NOT RUN or equivalent caution tag to the starter switch. The starter switch key must be kept by the person who performs inspection and maintenance work.

Be Sure to Stop the Engine Before Inspection and Maintenance

Be sure to stop the engine before proceeding to inspection and maintenance work. Never try to make adjustments on the engine parts while the engine is running. Rotating parts such as belt can reel in your body and cause serious injuries.

Always Put Back Engine Turning Tool After Use

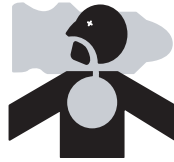
Be sure to remove the turning tool used for inspection and maintenance work. If the engine is started with a turning tool inserted, it can not only cause a damage to the engine, but also lead to a personal injury.

Be Careful of Exhaust Gas Poisoning

WARNING

Be Careful of Ventilation to Operate Engine

If the engine is installed in an enclosed area, and the exhaust gas is ducted outside, make sure that duct joints are free from gas leak. Exhaust gas from the engine sometimes contains harmful components. Operating the engine in an ill-ventilated area can cause gas poisoning.



Be Careful of Hearing Loss

WARNING

Wear Ear Plugs

Wear ear plugs to check the engine room while the engine is running. Combustion sound and mechanical noise of engine can cause hearing loss.



Be Careful of Falling

WARNING

Lift Engine Carefully

Use slings or wire ropes strong enough to lift the load considering the engine weight. To lift the engine, hitch the proper slings to the lifting hangers prepared on the engine. To lift the engine, keep the engine in a well-balanced position, thinking carefully of the engine center of gravity.



The hangers prepared on the engine are designed for lifting the weight of engine only. In the case where the generator, marine gear, and others are installed to the engine, consider that the additional weight will not affect the hangers of the engine.

Keep the angle formed by slings attached to hangers within 60°. If the angle exceeds this limit, excessive load may be applied to the hangers and damage the hangers. If the wire rope contacts the engine directly, place a cloth or other soft pad to avoid damage to the engine and wire rope. Remove the engine part if necessary.

Do not Climb Onto the Engine

Do not climb onto the engine, nor step on any engine parts on the engine sides. To work on parts located high on the engine, use a ladder, footing, and others to prevent from slipping and falling. Climbing onto the engine may result in engine part damage and your injury by falling down.

Always Prepare a Stable Footing

When working on the upper part of the engine and other hard-to-reach places, use a stable footing. Standing on an old footstool or parts box may result in personal injury. Do not put any unnecessary objects on a footing.



Be Careful When Handling Fuel, Engine Oil or Coolant

WARNING

Use Specified Fuel, Engine Oil and Coolant Only

Use the fuel, oil and coolant specified in this manual only, and handle them carefully. Use of material other than specified one, or improper handling may cause various engine defects and malfunctions. Get the MSDS issued from the fuel, oil and coolant suppliers, and follow the directions in the MSDS for proper handling.

Be Careful with Coolant

When handling coolant, wear rubber gloves and a protective face mask. If the coolant contacts your skin, or get into your eyes or mouth, it may cause injury of skin or eyes, or poisoning. If coolant is accidentally swallowed, induce vomiting immediately and seek medical attention. If coolant enters your eyes, flush them immediately with plenty of water and seek medical attention. If coolant contacts your skin or clothing, wash it away immediately with plenty of water. Keep flames away from coolant. Coolant can catch flames and cause a fire. Drained coolant is a hazardous material. Do not discard it in an unauthorized procedure. Practice the applicable law and regulations when discard drained coolant.

Proper Procedure to Discard Waste Oil and Coolant

Do not discard waste engine oil or coolant in an unauthorized procedure. Such a way of disposal is strictly prohibited by laws and regulations. Discard waste oil, coolant and other environmentally hazardous waste in accordance with the applicable laws and regulations.

Be Careful of Burns

WARNING

Do Not Touch the Engine During or Immediately After Operation

Do not touch any parts of the engine and exhaust system (especially DPF system) during or immediately after the operation. You can get burned.



Before starting the maintenance and inspection work, check the water temperature meter to make sure that the engine is cooled down.

Be Careful to Open and Close the Radiator Cap

Never open the radiator cap while the engine is running or immediately after the engine stops. Stop the engine and give a sufficient time to allow the coolant to cool down before opening the cap. When opening the radiator cap, slowly open the cap so as to release internal pressure. To prevent hot steam scalds, wear thick rubber gloves, or cover the cap with a cloth. When closing the radiator cap, tightly close the cap. Do not open the radiator cap during engine running or immediately after engine stop. Otherwise hot steam and coolant gush out and can cause burns.

Refill Coolant Only After the Coolant Temperature Dropped

Refill the coolant after the coolant temperature drops to a room temperature. Replacement job immediately after the engine stop may cause burns.

Battery

CAUTION

Be Careful with Battery

- Never use flames or generate sparks near the battery. The battery gives off highly flammable hydrogen gas and oxygen gas. Any flame or spark near a battery may cause an explosion.
- Do not use the battery if its fluid level is below the lower limit line. Wrong use of the battery may result in an explosion.
- Do not short the battery terminals with a tool or other metal object.
- When disconnecting battery cables, always remove first from negative (-) terminal first. When reconnecting the cables, always connect first to the positive (+) terminal.
- Charge the battery in a well-ventilated area, with all battery cables removed.
- Make sure the cable clamps are securely fastened to the battery terminals. A loose terminal can cause sparks that may result in an explosion.
- Before servicing electrical components or conducting electric welding, set the battery switch to the [Open/OFF] position or disconnect the cable from the negative (-) battery terminal to cut off the electrical current.
- Electrolyte (battery fluid) contains dilute sulfuric acid. Careless handling of the battery may lead to the loss of sight and/or skin burns. Also, do not swallow battery fluid.
- Wear protective goggles and rubber gloves when working with the battery (such as adding water or charging).
- If battery electrolyte is spilled onto the skin or clothing, immediately wash it away with lots of water. Use soap to clean thoroughly.
- Battery fluid can make you blind if splash into your eyes. Immediately flush it away with plenty of clean water, and seek immediate medical attention.
- If battery fluid is accidentally swallowed, gargle with plenty of water, then drink lots of water, and seek immediate medical attention.



When Abnormality Occurs

CAUTION

Stop Overheated Engine After Cooling Run

Even if the engine is about to overheat, do not stop the engine immediately. Abrupt stopping of an overheated engine can cause the coolant temperature to rise, resulting in seized engine parts. If the engine is about to overheat, run the engine at low idling speed (cooling operation), and stop the engine after the coolant temperature lowers sufficiently.

Do Not Add Coolant Immediately After a Sudden Stop Due to Overheating.

If the engine stops suddenly due to overheating, or you suddenly stop the engine by any reason, do not add coolant immediately. If coolant is added immediately, parts such as cylinder heads can be damaged due to the sudden drop of temperature. Add coolant slowly after the engine becomes cool.

Be Careful to Restart After an Abnormal Stop

If the engine stops abnormally, do not restart the engine immediately after the stopping. If the engine stops or is stopped, inspect the engine to clarify the cause of the defect and correct the cause before restarting. If the engine is kept operating in such a condition, it can result in serious engine failure.

Immediately Stop the Engine When Engine Oil Pressure Drops.

If the engine oil pressure drops significantly, stop the engine immediately, and inspect the lubrication system to find the cause. Continuous engine operation with low oil pressure may cause bearings and other parts to seize.

Stop the Engine Immediately When the Belt Break

If the belt breaks, stop the engine immediately. Continuous engine operation with the broken belt can cause the engine to overheat. Steam of boiled coolant may gush out from the reserve tank or radiator, and results in burns.

Other Cautions



Do Not Tamper

If tampered, the warranty is totally void even in the warranty period. Tampering with the engine can not only damage the engine but also may lead to personal injury.

Perform All Specified Pre-operation Inspections and Scheduled Inspections

Conduct the daily inspection and scheduled inspection/maintenance as described in this manual.

Failure to conduct the specified inspections may cause various engine problems, damage to parts, and a serious accident.

Wear Proper Work Clothing and Protective Gears

Wear a hard hat, face shield, safety shoes, dust mask, gloves, ear plugs, and other protective gears as needed. When using compressed air, wear ear plugs, safety goggles, a hard hat, gloves, and other necessary protective gears. Works without wearing proper protective gears may result in serious injury.

Break-in the Engine

To break-in a new engine or overhauled engine, operate the engine at a speed lower than the rated speed in a light load condition during the first 50 hours of operation. Operating a new engine or overhauled engine in a severe condition during the break-in period shortens the service life of the engine.

Warm-up the Engine Before Use

After starting the engine, run the engine at a low idling speed for warming-up. Start the work after the coolant temperature is raised. Warm-up operation circulates lubricant in the engine, and works for the longer service life and economical operation. Do not continue the warm-up operation for a longer time than necessary. Carbon build-up in the cylinders and incomplete combustion may result. Sometimes, white smoke may exhausted when the engine speed and load are increased after a prolonge time warming-up operation. This is not a trouble.

Do Not Operate the Engine in an Overloaded Condition

If the engine shows an overloaded condition such as black exhaust smoke, reduce the load immediately to an appropriate load condition. Overloading causes not only high fuel consumption but also excessive carbon deposits inside the engine. Carbon deposits cause various problems and will shorten the service life of the engine.

Cool Down the Engine Before Stop

Cool down the engine at a low idling for five to six minutes before stopping it. Stopping the engine immediately after high-load operation will cause local heat up of engine parts and shorten the service life of the engine. During the cooling operation, check the engine for abnormalities.

Do Not Continue Low Load Operation

Low load continuous operation (less than 30%) must be limited within one hour. Long warm-up operation causes carbon deposits in the cylinders, and may lead to incomplete combustion. Also, after low load operation for approx. one hour, run the engine at a 30% or higher load for five minutes or more.

Avoid continuous low-idling operation as it may cause the soot accumulation in the DPF, and shorten the manual regeneration interval. Also, conduct the manual regeneration immediately after the (vehicle monitor) alarm expediting the manual regeneration is activated.

Use Care to Protect Engine from Water

Use care to protect engine from water such as rain entering through the air inlet or exhaust openings. Do not wash the engine while it is running. Cleaning fluid or water can be sucked into the engine. Starting the engine with water inside the combustion chambers can cause the water hammering, and may result in engine inner parts damage and serious accident. Do not use a high-pressure or hoe washing. Water will enter the sensor or harness, and a serious accident may be the result.

Properly Maintain the Air Cleaner

The major cause of abnormal wear on engine parts is foreign materials from intake air. Worn parts produce many problems such as increase of oil consumption, decrease of output and starting difficulties. For effective removal of dust from intake air, maintain the air cleaner according to the following instructions.

- ♦ Do not maintain the air cleaner during operation. Foreign material enters the engine and may result in a serious failure.
- ♦ Remove the air cleaner slowly to prevent dust accumulated on the element from falling off. After removing the air cleaner, immediately cover the opening (inlet port of air cleaner) with plastic sheet or similar means to prevent dust from entering the engine.
- ♦ An air cleaner with a dust indicator gives an alarm when it is clogged. Conduct maintenance when the alarm is given.

Observe Safety Rules at Work Site

Observe the safety rules established at the workplace when operating and maintaining the engine. Do not operate the engine if you are in bad health. Consult your supervisor about your condition. Operation of the engine with decreased attention may cause improper operation and results in an accident. When working in a team of two or more people, use specified hand signals to communicate among workers.

Use Proper Tools for Maintenance Work

Always keep in mind to select most appropriate tools for the work and use them correctly. If a tool is damaged, replace with new tool.

Do Not Operate Starter for a Long Time

Do not use the starter for more than 10 seconds at a time. If the engine does not start, wait for at least 1 minute before starting again. Continuous operation of the starter to start a stubborn engine may lead to a flat battery or starter burning out.

Do Not Turn Off the Battery Switch During Operation

Do not turn off the battery switch during operation. If the battery switch is turned OFF when the engine is running, not only various indicators will stop working but also the diodes and transistors in the starter can be damaged.

Cautions for Engine Transportation

To road-transport the engine, consider the engine weight, width and height, and obey applicable laws and regulations such as road traffic laws, vehicle road acts and vehicle restriction ordinances.

Be Careful of Engine Room Ventilation

Always keep the engine room well-ventilated. Insufficient intake air amount of the engine can cause an increase in the engine temperature, and could result in a decrease in the output power and poor performance. It is highly recommended to calculate the required amount of air supply to the engine and install an adequate ventilation system before installing the engine.

Do Not Touch High Pressure Fuel Jet.

Do not touch fuel jet leaked or sprayed from the high pressure injection pipe. Fuel in the fuel injection pipe has a high pressure and if the fuel impinges your skin, it goes through the skin and can cause serious injury.

Warning Labels



Maintenance of Warning Labels

Make sure all warning/caution labels are legible.

Clean or replace the warning or caution label when the description or illustration is not clear to read.

For cleaning the warning/caution labels, use a cloth, water and soap. Do not use cleaning solvent, gasoline or other chemicals to prevent the label from fading and peering.

Replace a damaged or missing label with a new one.

If any engine part stuck with a warning label is replaced with a new one, attach a new identical warning label to the new part.

To get new warning labels, contact our approved dealer.



Warning Labels

Points on Disassembling and Assembling

This service manual contains the recommended practices to service the engine. The manual also contains dedicated special tools made for the work, and the basic safety cautions to obey when working. Note that this manual does not cover all potential hazards that could occur during maintenance, inspection and service works of the engine.

When working on the engine, follow the related instructions in this manual and also be careful of the following:

Points on Disassembling

- ♦ Use correct tools and instruments. Or serious damage or accident may result.
- ♦ Do not use jack bolts having sharp edge, as they may cause damage to the surface.
- ♦ Use a footing and workbench to place disassembled parts if necessary, and obey the disassembling procedures described in this manual. Do not place the parts on the floor directly. Place them on a workbench or the like.
- ♦ Place the engine parts in the order of removal to prevent from missing. Place the parts in the serial order for reassembling.
- ♦ When reusing the engine parts, unless there are special reasons, install them to their original positions.
- ♦ Pay attention to assembling marks. Put your marks on the parts, if necessary, to ensure correct assembling.
- ♦ Carefully check each part for defects during disassembling or cleaning. Do not miss symptoms which can not be found after disassembling or cleaning.
- ♦ Pay attention to the safety, especially for the balancing of disassembled parts and carrying of heavy parts. (Get the help, and use jacks, chain blocks and guide bolts as necessary.)
- ♦ Use protective gloves when you touch overheated or frozen parts. Touching the part with a bare hand can cause burns.

Points on Assembling

- ♦ Wash all engine parts, except such parts as oil seals, O-rings and rubber seats, in cleaning oil and dry them with compressed air.
- ♦ Use correct tools and instruments.
- ♦ Use only high-quality lubricating oil and grease of the appropriate type. Be sure to apply oil, grease or adhesive to specified surfaces.
- ♦ Use a torque wrench to tighten parts correctly when their tightening torques are specified. Refer to "Tightening torque table."
- ♦ Replace Gaskets, packings and O-rings with new ones.
- ♦ Use protective gloves when you touch overheated or frozen parts. Touching the part with a bare hand can cause burns.



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