Operation and Maintenance Manual
PowerKit 6M21 Series Diesel Engine

6M21(CR)

6M21(MP)

OMMBV2001

Foreword

Please be advised, do not operate or perform any operation, maintenance, or repair on this PowerKit engine until you have read and understood the information in this Manual in its entirety. This Manual must be read in full before operating your PowerKit in order to gain the maximum operational performance of the engine and to safely operate and maintain the engine. The operation and maintenance instructions are given as a guide for engines operating at the rating as sold.

Documentation

Baudouin uses English as the primary business language for all publications. Other languages may be available, please consult with your local Baudouin representative.

The photos and illustrations in this manual are for reference only. Some illustrations may have been modified to ensure clarity (for example guards and covers may be removed), and some equipment shown in this manual may be different to your engine. For the latest information, please contact your local Baudouin representative.

The 'DT' technical documents ('documentation technique') quoted in this Manual are available from the Baudouin Network for reference.

The information contained in this Manual is correct at the time of publication. Baudouin reserves the right to modify these specifications without notice.

Safety

The Safety section of this manual covers basic safety precautions and shows warnings and potentially hazardous situations. This Manual must be read in full before operating your PowerKit in order to operate and maintain the engine safely.

Maintenance & Spare Parts

Maintenance should be carried out at the appropriate intervals as shown in the Maintenance Table. The inspection and maintenance intervals are given as a guide, for engines operating under normal conditions. Consult with your Baudouin representative for operation under severe conditions.

We recommend that a copy of the Maintenance Schedule be displayed near the engine and that a service record be kept and stored with the engine.

The use of Baudouin Genuine Spare Parts is imperative to the optimal operation, performance and longevity of your PowerKit engine. The use of alternatives or counterfeit parts can lead to voiding engine warranty, damage, failures, and personal injury or death.

Overhaul

This Manual does not include detailed instructions for overhaul of your engine. Contact your local Baudouin representative who can help you to proceed with an overhaul program for your engine. All major repairs should be carried out by an authorized Baudouin partner.

1. Safety

1.1 Safety Information

Failure to comply with the preventive measures and safety instructions included in this manual and with warnings indicated on the engine may lead to injury or death. This Operation and Maintenance Manual must be kept on or near the engine and must be easily accessible and ready to be consulted at any time. Furthermore, this manual must stay with the engine at all times.

Most accidents can be prevented by following basic safety precautions, recognizing hazardous situations and acting accordingly, but these safety instructions alone are not sufficient to avoid every hazard. Baudouin cannot anticipate or identify every possible hazard in your operating environment. Persons operating or maintaining the engine must be able to recognize hazardous situations, and they must have the necessary skills, training and tools to perform operation and maintenance activities properly.

1.2 Symbols Used

Please take note of the warnings and precautions indicated throughout this Manual in order to avoid unsafe practices and conditions. In this Manual, the following symbols are used to highlight specific information.

HAZARD WARNING

This warning symbol is recognized across the world. In this Manual this symbol is used to highlight the importance of the information that follows. Make sure that you understand the consequences of a dangerous situation and the ways in which to avoid danger. Failure to comply with warnings can result in material damage, serious injury or even death.

WARNING

This type of warning indicates a potentially dangerous situation, which if not avoided, may result in serious injury, death, or considerable material damage.

CAUTION

This type of warning indicates a potentially dangerous situation, which if not avoided, may result in minor injury or material damage. It can also warn against dangerous practices.

The warnings in this guide cannot cover every situation imaginable. Please only use procedures, methods, tools, and parts specially recommended by the engine manufacturer.

Safety symbols

Symbol	Definition
	Wear hand protection
	Wear ear protection
	Wear eye protection
	Wear head protection
	Wear foot protection
	Wear a protective mask
	Wear overalls
	Avoid naked flames
	Do not smoke
	Do not use a mobile phone
	Keep an extinguisher close by
	Danger: battery acid
	Danger: live cables, electrical risks
	Highly flammable products
	Keep away from hanging loads
	Risk of thermal burns
	Risk of mechanical drive / rotating parts
	Lifting is forbidden
	Risk of steam burns
	Water drain valve

Universal Warning

The location of the Universal Warning label is illustrated below.

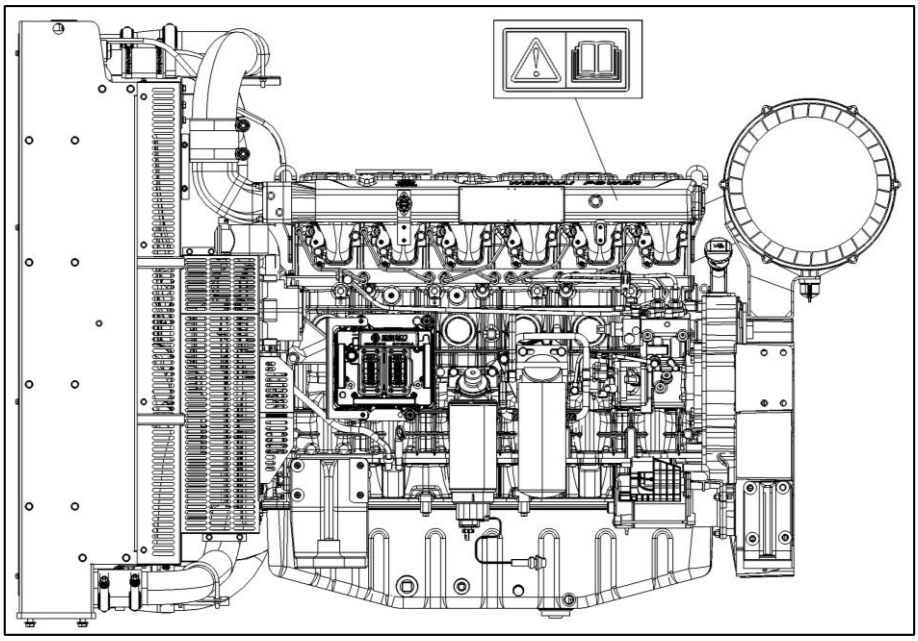
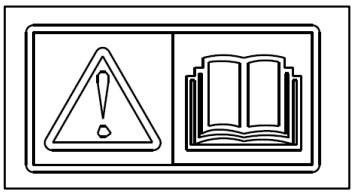


Figure 1.2A-6M21 Illustration

	Do not operate or perform maintenance on this engine unless you have read and understand the instructions and warnings in this Operation and Maintenance Manual. Failure to follow the instructions or heed the warnings could result in serious injury or death.

1.3 Personal Safety

These Personal Safety precautions are designed to reduce the risk of contamination, serious injury or death.

- Wear personal protective equipment (PPE) as required.
- Avoid prolonged and repeated contact with oil and diesel fuel.
- Do not put oily rags in pockets.
- Avoid contaminating clothing with oil.
- Wash overalls regularly. Throw away unwashable clothing and shoes impregnated with oil.
- Emergency treatment must be immediately sought in the event of any injury.
- Always wear protective mechanic's gloves before working in order to avoid prolonged and repeated contact with oil and diesel fuel.
- Wash with soap and hot water or, alternatively, use hand detergent and a nailbrush to make sure that all oil is removed. Products containing lanolin can help replace the skin's natural oils that may have been removed.
- DO NOT use petrol, kerosene, fuel, thinners or solvents to clean the skin.
- If skin problems occur, immediately consult a doctor.
- If possible, degrease components before handling them.
- When there are risks for the eyes, use safety glasses or a face shield. An eye-rinsing solution must be kept close at hand.
- Do not spill oil or other fluids on the ground when repairing the engine. In the event of an accidental spillage of hydrocarbon or other fluid, take all the necessary measures to section off the area, clean up and protect people and the environment.
- The handling, storage and recycling of hydrocarbons, ethylene, glycol and oil must comply with the safety and environmental standards applicable in the country where these operations take place.
- Ensure that all guards and covers are secured in place on the engine.
- Make sure adequate, non-expired extinguishers are available and that personal are adaquately trained in extinguisher operation.

1.4 Environmental Safety

- There are laws regarding environmental protection and the disposal of waste of hydrocarbons. To ensure compliance with environmental protection laws, consult your local authorities who will advise you. Obey all local regulations for the handling and disposal of liquids.
- The products and spare parts supplied by Baudouin do not contain asbestos.

1.5 Fluid Safety

- All oil, fuel, and some coolant liquids are flammable. If these liquids are leaking onto hot surfaces they can cause a fire which can cause injury and/or damage.
- Do not check for leaks using any body part. Use a cardboard section or other appropriate tool to check for a leak.
- Store all fuels and lubricants in closed, clearly labelled containers in a safe place.
- When draining liquids from the engine, ensure that the correct tools are used and that liquids are collected in a suitable container and disposed of following all local regulations.
- Oily rags and other flammable materials must not be stored in close proximity to engine, genset, or system.
- Do not smoke near the fuel tank or while in the filling area. Ensure there are no open flames or sparks. Always stop the engine before refuelling.

- Mobile phones (in particular their batteries) may give off sparks that could cause an explosion in certain high-risk areas. Switch off all mobile phones when filling the fuel tank or while in the filling area.

1.6 Batteries

- Wear personal protective equipment (PPE) as required.
- Do not smoke in areas where batteries are charged or near fuel circuits.

- The batteries release flammable fumes that can explode. Ensure there are no open flames or sparks near the battery.

- If the batteries are in a closed area, make sure there is sufficient ventilation.

- The battery cables must be fitted with a battery switch and fuse or circuit breaker to isolate the circuit.
- Sulphuric acid contained in batteries is toxic and corrosive; it can burn clothes and skin or even cause blindness in case of contact with the eyes.
- Disconnect the batteries before any operation involving the electrical system.
- Never disconnect any battery cable while the engine is operating.
- Never check battery charge by short circuiting it.
- Do not charge a frozen battery; heat it up 16°C (61°F) beforehand.
- In the event of corrosive material contact with a body part:
  - Rinse the affected part with plenty of water.
  - Apply bicarbonate of soda or lime to neutralise the acid.
  - Rinse your eyes for 10 to 15 minutes.
  - See a doctor immediately.
- In the event of ingestion see a doctor immediately.
- Make sure the batteries are clean and fitted with the recommended covers, cables and connections.
- Electric wiring must be kept in good condition, properly positioned and attached.

1.7 Welding

- Do not weld or flame cut pipes, hoses or tanks that contain flammable fluids. Components containing flammable fluids must be drained and cleaned appropriately with a non-flammable solvent before conducting any welding of flame cutting.
- Disconnect the engine wiring harness

before welding (control cabinets, electrical cabinets etc.).

- Comply with all legal provisions in force before conducting welding work.
- Do not use open fires.
- Make sure that the work will not affect the on-board electrical and electronic equipment.
- Make sure that the automatic fire suppression system is deactivated before any welding or grinding work.
- Make sure that there is sufficient ventilation in the premises where welding is to be carried out.

1.8 Electrical Risks

- Electrical checks must be carried out regularly.
- Electric wiring must be kept in good condition, properly positioned and soundly attached.
- All wires should be of the recommended size.
- Wires and cables must be protected by a fuse or calibrated circuit breaker.
- Do not short-circuit fuses and/or circuit breakers.
- The electrical circuit of the engine must be isolated from the engine and generator.
- Ensure that the engine is grounded correctly to prevent uncontrolled electrical circuit paths which can cause damage.
- Insulation problems can cause short-circuits or stray current. Stray current can damage electrical and electronic components, bushing or crankshaft seating and may also cause radio-frequency disturbance.
- The engine earth must be properly connected to the chassis, as well as all the flexible hoses.

- Flexible connections for cooling
- Flexible circuit connections fuel
- Electrical control systems and electronic fuel injection

- Earth faults can cause corrosion in the pipes and engine or genset unit components.

1.9 Lines, Tubes and Hoses

- Ensure that all high pressure lines are not bent, worn or damaged. High pressure lines must be positioned, supported and firmly fastened. Do not attach any other components to the high pressure lines. Tighten all connections to the recommended torque.
- Do not check for leaks using your hand. Use a cardboard to check for a leak.
- Tighten all connections and filter housings to the recommended torque.
- Release the lubrication, fuel and pressure cooling circuits before disconnecting or removing hoses or associated parts.

1.10 Coolant Safety

- At operating temperature, the coolant is hot and pressurized. When pressure is released sharply, this hot liquid may be transformed into fumes. Any contact with this hot liquid or these fumes may cause serious burns.

- The cooling system also contains alkali which can cause injury. Do not allow alkali to contact your skin, eyes or mouth.
- Let the components of the coolant circuit cool down before draining the circuit.
- Only check the coolant level when the engine has stopped.

- Slowly unscrew the coolant filler plug to release pressure.

1.11 Cleaning the Engine

- Use personal protective equipment when cleaning an engine.
- Regularly clean the engine surface to remove any greasy deposits that may be flammable.
- Do not wash an engine in operation or which has just stopped.
- Use the safety equipment required by your local codes and standards.
- Make sure high-pressure water cannot damage the equipment being washed. Do not get electrical equipment or seals wet.
- Take necessary precautions when using a high-pressure cleaner. Comply with the safety instructions indicated for the cleaning equipment used as well as local codes and standards.
- High pressure cleaning can blow out high-speed debris from the engine which can cause injury.

1.12 General Precautions for Operation

1.12.1 Before any operation or maintenance on any Baudouin product

- Wear personal protective equipment (PPE) where required.
- For maintenance, place a “Do Not Use” or similar sign on the starter switches.
- Access to the equipment is only for authorized and qualified personnel.
- Ensure that all guards and covers are secured in place on the engine.
- Make sure that the repair premises and surrounding area are suitable for safe working.
- Inspect the engine for potential hazards. Ensure there are no personnel on, under or around the engine.
- Ensure that the pipes and hoses are not worn or damaged. Pipes must be positioned, supported and firmly fastened.
- Ensure that the electrical wiring is not worn or damaged. Wiring must be positioned, supported and firmly fastened
- Remove all wiring that is obstructive to repair/maintenance or unattached.
- Use the proper tools for the operation being performed.
- Report all necessary repairs promptly.
- Remove any rings, chains and watches before starting work. Wear suitable and properly-fitting work clothes.
- Remove and isolate the control panel key.
- Do not perform any operation or maintenance operations which are not fully understood.
- Clear the engine of any flammable materials such as fuel, oil or debris.
- Do not smoke near the engine or where flammable materials are stored.
- Exhaust shields (if equipped) must be fitted correctly.
- Do not expose the engine or components to flames.
- Do not touch hot parts of an engine in operation or which has just been stopped.
- Ensure the starter battery insulation switch is in open position.
- Switch off the circuit breaker located in engine connection box (if equipped).
- Switch off engine room lock switch or emergency stop (if equipped).
- For maintenance, for engines fitted with a pneumatic starter system, isolate the tanks and evacuate the pipe linking the tanks to the starter.
- For engines installed on automatic start genset select the lock position on the selection mode of the control panel, to avoid the engine start.
- Use caution when cover plates or other components are removed. Gradually loosen and remove bolts/nuts but do not remove the last two bolts which are located on opposite ends of the plate. Before removing the last two bolts, pry open the plate and gradually release the pressure.
- Do not remove any hydraulic components or parts until the pressure in the system has been relieved. Contact Baudouin for procedures required to remove hydraulic components.

1.12.2 Starting the Engine

- For initial start-up of a new engine, or the first start after a service, make provisions to be able to stop the engine if a fault occurs. This can be done by shutting off the fuel or air supply to the engine.
- Never use any engine starting agents (for example, ether) to facilitate start-up due to a risk of explosion or injury.
- Never start an engine without checking that this operation can be carried out without danger to people or equipment. If there is a warning tag attached to the control panel or start switch do not start the engine or touch the controls.
- Start the engine from the control panel or operator's booth.
- Ensure that the jacket water heater and/or lube oil heater (if equipped) are working properly by checking the temperature gauges during the heating operation.
- Never short across the starting motor terminals or the batteries as this could damage the electrical system.
- Never bypass or disable the automatic shutoff circuit – these are provided to help prevent injury and engine damage.
- Engine exhaust could be harmful to your health, therefore always start and operate the engine in a well ventilated area. If in an enclosed area, ensure the engine exhaust is vented properly to the outside.

1.12.3 Stopping the Engine

- Stop the engine from the control panel or operator's booth.
- Use the Emergency Stop Button (if equipped) only in the event of an emergency. Do not use the Emergency Stop Button for normal engine stopping. Do not start the engine after using the Emergency Stop Button until the problem that caused the emergency stop has been corrected.
- Let the engine cool down before carrying out any maintenance operation.
- Do not perform any operations on the engine for at least 15 minutes after an emergency shut down.

1.13 Recommendations for Engines Equipped with Common Rail System

- Wear personal protective equipment (PPE) where required.
- High-pressure fuel spray can cause irreversible body damage. Wear required protection when conducting operations on the entire circuit.
- Make sure that the lines are depressurized before any dismantling operations.
- Release the high pressure before handling the feed and injection circuit of a common rail engine.
- When checking the injectors, make sure that the high-pressure jet does not touch the skin.
- All investigations of leaking fuel, oil or other high pressure liquids must be conducted using a screen and never with bare hands.
- Use a spray fumes extracting device.
- If fuel comes into contact with the skin, it can cause injury. Consult a doctor immediately.
- Fuel, oil and coolant contain harmful chemicals. Avoid any contact with skin and hands.

2. Product

2.1 Rating Definitions

Rating definitions	Running conditions
COP Continuous power	■ Annual running time is unlimited. ■ Continuous rated power is allowed. ■ No overload ability.
PRP Unlimited Prime Rated Power	■ Annual running time is unlimited. ■ The average load rate is no more than 70% during a range of 24 hours. ■ Maximum time range with overload 10% within 12h is 1 hour.
ESP Emergency Standby Power	■ The annual running time shall not exceed 200h. ■ The average load rate shall not exceed 70% in 24h cycle. ■ No overload. ■ The acceleration requirement is in accordance with Q/WCG136.13. Acceleration from starting to rated power should be within 10s without engine warm stage. ■ For natural aspirate diesel engine, when the environment temperature is below 5 degrees Celsius, it is need to use preheat facilities to warm coolant temperature higher than 30 degrees Celsius. When environment temperature is higher than 5degrees Celsius, no preheating facilities are required. ■ For diesel engine with turbocharger, when the environment temperature is below 10 degrees Celsius, it is need to use preheat facilities to warm engine coolant temperature higher than 30 degree Celsius. When environment temperature is higher than 10 degree Celsius, no preheating facilities are required.

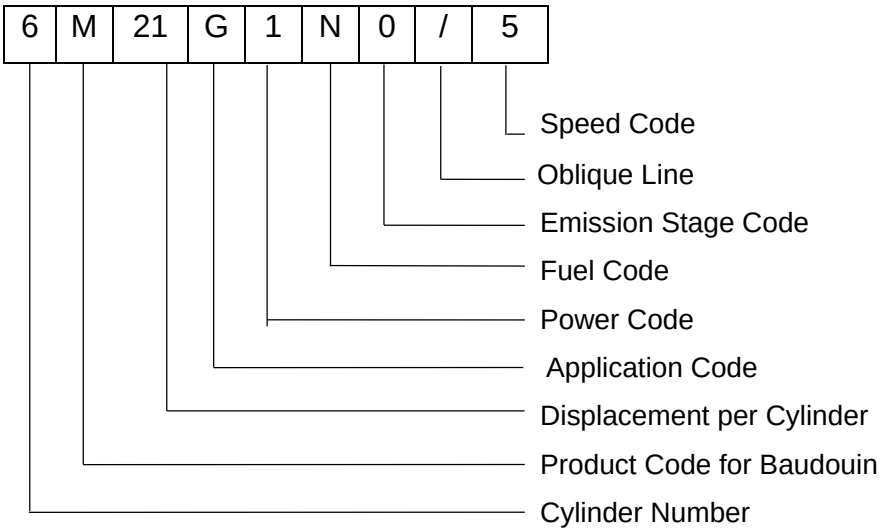
2.2 Engine Model

2.2.1 Abbreviations

6M21MP: 6M21 with Mechanical Injection Pump
6M21CR: 6M21 with Common Rail Injection Pump

2.2.2 Model Definition

The product model of Baudouin Industrial engines.



2.2.3 Product Series Code

Product series Code is comprised by Cylinder Number、Product Code for Baudouin (M) and Displacement per Cylinder.

2.2.4 Application Code

Code	Application
G	Land Power Generation
GT	Land Power Generation for Tele com
V	Variable speed models (Pump, Air pressure…)

2.2.5 Power Code

- Common rules

  Use number 2, 4, 6…..as the different power lever for the models, choose 2 as the lowest power and increase the power with the order of the number, 1, 3, 5, 7…..as the alternate power code and will be used according to market demands.

- For the single speed engines that without emission (can only be used for PRP or ESP)

  Power code for 50Hz correspond Standby Power (kVA) of generating set.

  Power code for 60Hz correspond Standby Power (kW) of generating set.

  Contents of emission phase code and fuel code will not be used.

2.2.6 Speed Code

RPM	1500	1800	1500 & 1800	3000
Code	5	6	S	3
Engine speed is only used for gen-set application using, and is shown as table, the speed code for other application will not be used.				

2.2.7 Emission Stage Codes

Emission Stage Code	Non-road
0	No emission certification
1	U.S. EPA 40 CFR 60 JJJJ U.S. EPA Tier 1 India CPCB I
2	U.S. EPA Tier 2 India CPCB Ⅱ
3	U.S. EPA Tier 3 EU Stage ⅢA/B China stage Ⅲ
4	U.S. EPA Tier 4 India CPCB Ⅳ EU Stage Ⅳ China stage Ⅳ
5	EU stage Ⅴ
6	EU stage Ⅵ
Note1: New product model should be compiled on the basis of the most stringent Emission legislation； Note2: Current model name can still be used when applying for another emission certification with existing product.	

2.2.8 Fuel Code

The fuel code of diesel oil is indicated by “D”， natural gas is indicated by “N”, and LPG is indicated by “L”.

2.2.9 Engine Nameplate

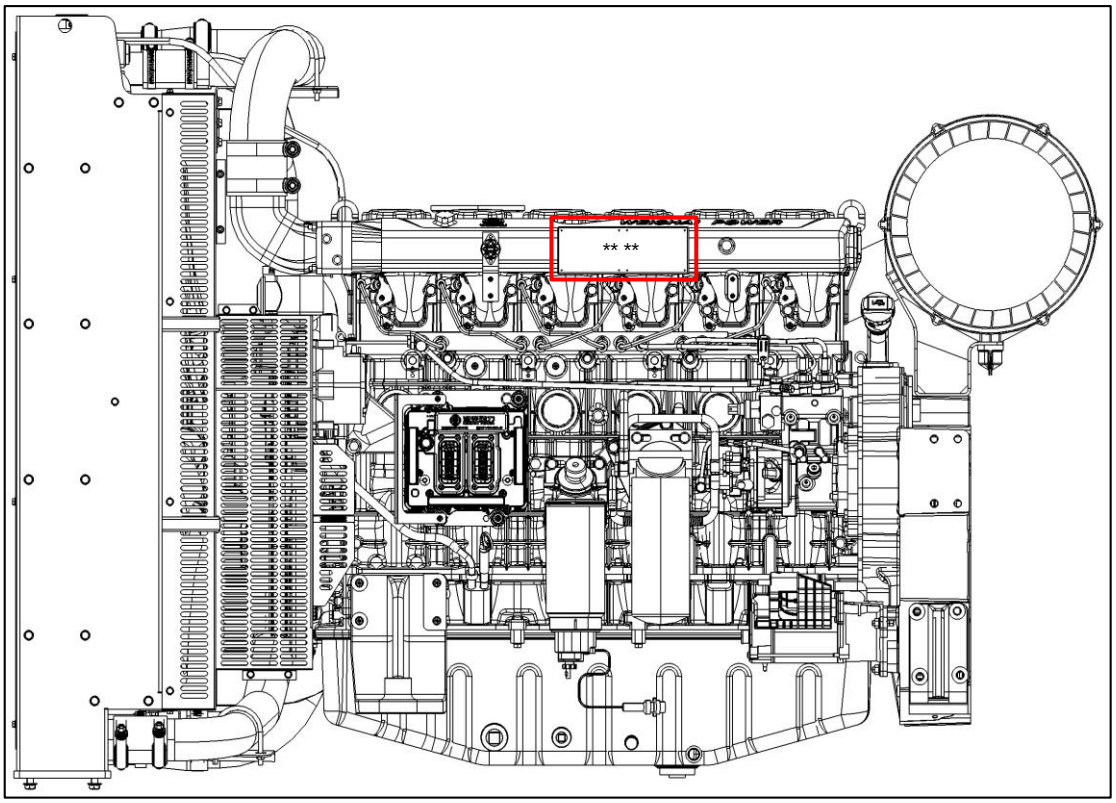
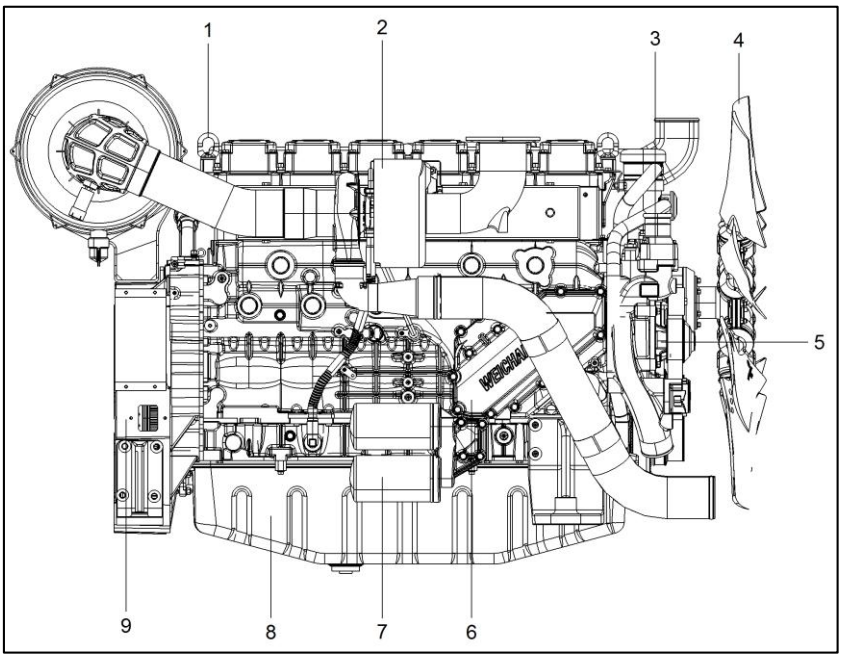


Figure 2.2.9A-6M21 Series Diesel Engine

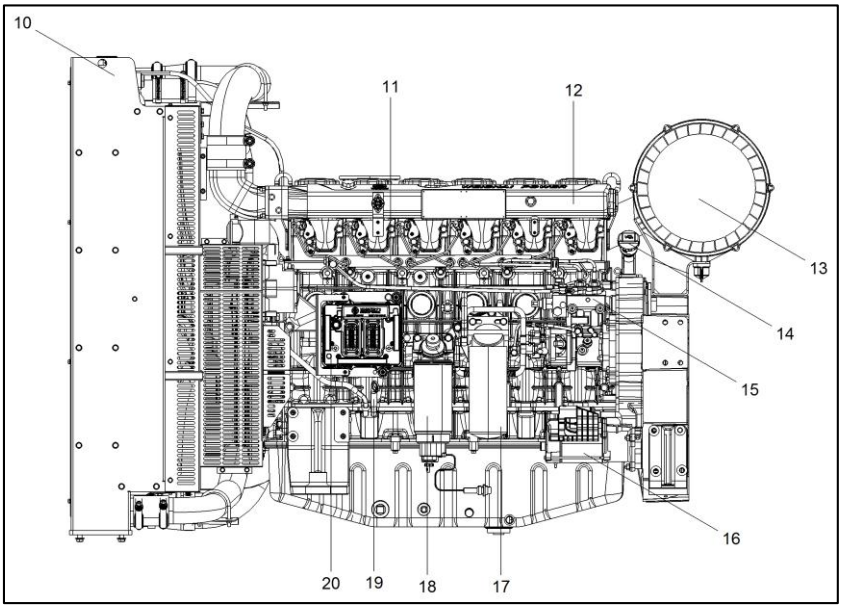
2.3 Engine Overview

2.3.1 Schematic Diagrams of 6M21CR



1-Lifting Rings
2-Turbocharger
3-Thermostat
4-Fan
5-Water Pump
6-Oil Cooler
7-Oil Filters
8-Oil Sump
9-Flywheel Housing

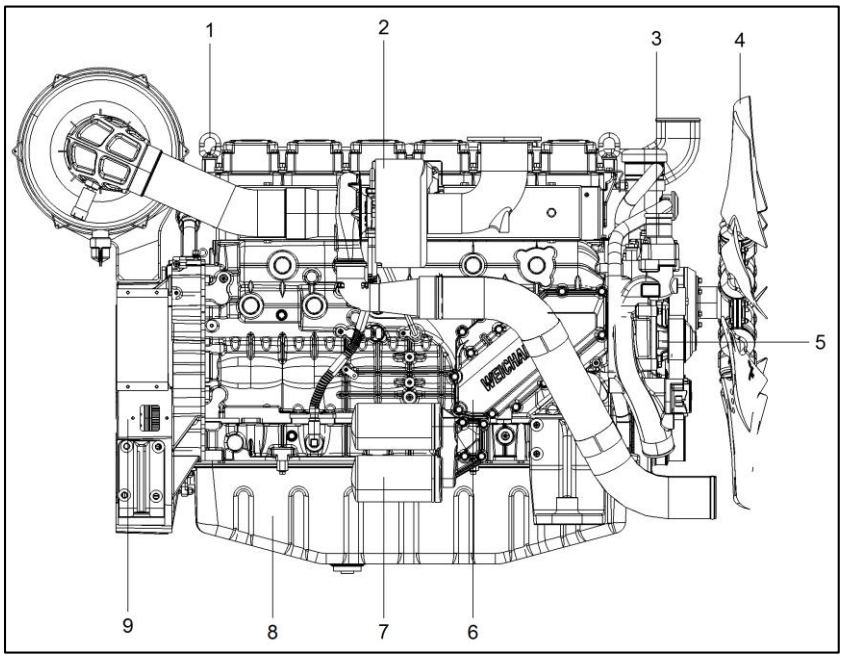
Figure 2.3.1A-Right Side



10-Radiator
11-Common Rail
12-Air Intake Manifold
13-Air Filter
14-Oil Filler
15-Fuel Pump
16-Starter
17-Fuel Filter
18-Fuel Coarse Filter
19-Dipstick
20-ECU

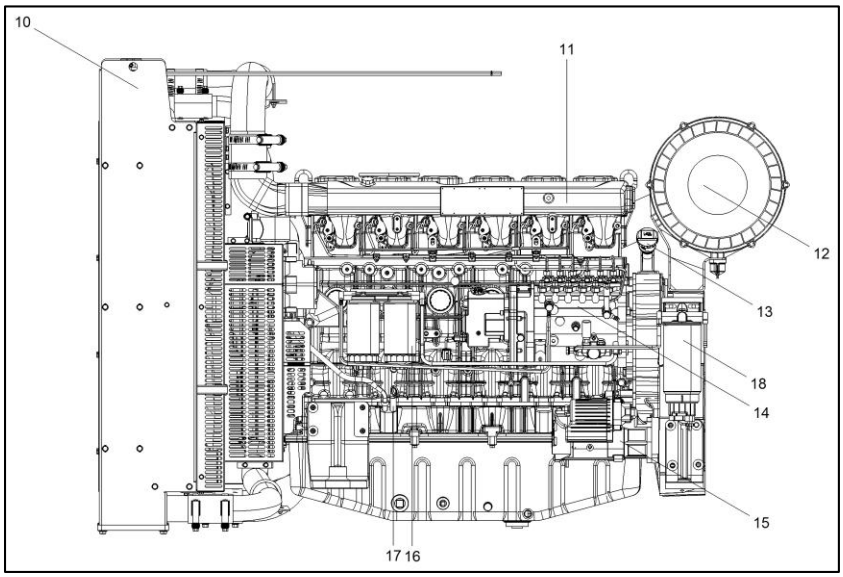
Figure 2.3.1B-Left Side

2.3.2 Schematic Diagrams of 6M21MP



1-Lifting Rings
2-Turbocharger
3-Thermostat
4-Fan
5-Water Pump
6-Oil Cooler
7-Oil Filters
8-Oil Sump
9-Flywheel Housing

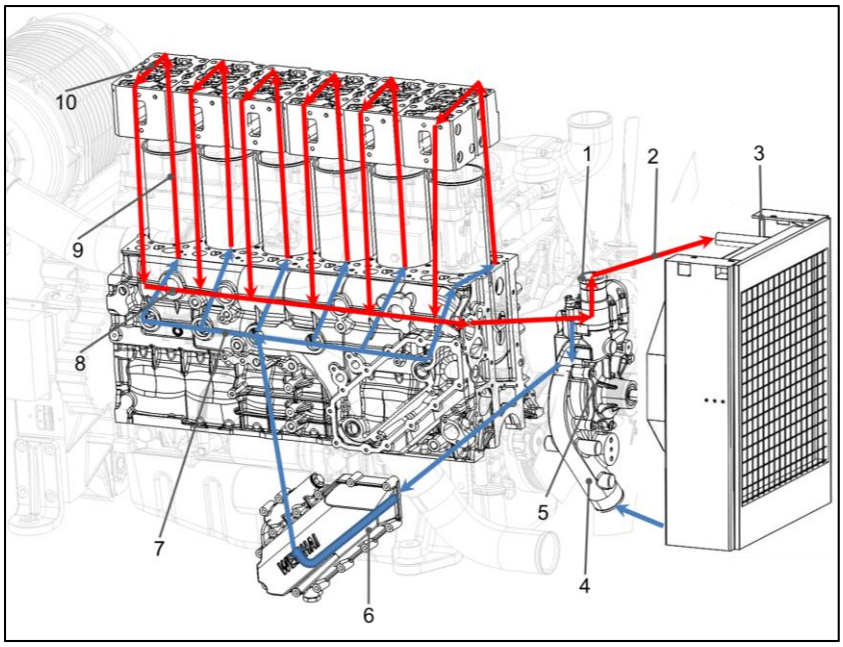
Figure 2.3.2A-Right Side



10-Radiator
11-Air Intake Manifold
12-Air Filter
13-Oil Filler
14-Fuel Pump
15-Starter
16-Fuel Filter
17-Dipstick
18-Fuel Coarse Filter

Figure 2.3.2B-Left Side

2.4 Cooling Circuits



1-Thermostat assembly
2-Hot Coolant Outlet Pipe
3-Radiator
4-Cooled Coolant Inlet Pipe
5-Water Pump
6-Lube Oil Cooler
7-Water Gallery
8-Outlet Pipe from Engine
9-Cylinder Block Cooling
10-Cylinder Head Cooling

Figure 2.4-Overall Layout of cooling circuits

6M21 series diesel engine cooling circuits:

The water pump draws coolant from the radiator. Coolant circulates through oil cooler, cylinder liners and cylinder heads. Finally, all the coolant is driven to the thermostat through the return pipe. The water out-let pipe is integrated into the cylinder block.

a) If the coolant temperature is low, the thermostat is not opened, and the coolant will directly enter the water pump through the thermostat, thus entering the cooling circuit.

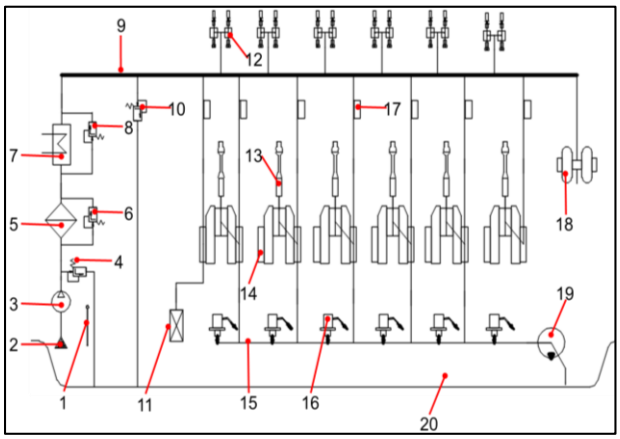
b) If the coolant temperature is high enough to reach the thermostat opening temperature, the coolant enters the radiator through the thermostat. The coolant will be cooled by the fan and the radiator. Then the coolant enters the water pump through the water inlet pipe and enters the cooling circuit.

The charged air is also cooled through the radiator.

2.5 Lubrication System

6M21 Series engines are equipped with a lubrication system including an oil cooler.
The gear driving oil pump is located at the low front of the engine.
Many engine parts are lubricated by pressurized oil through piping and crankcase hoses.

■ **Oil circuit**



1-Oil Dipstick
2-Suction strainer
3-Oil pump
4-Safety Valve
5-Oil Filter
6-Filter Bypass Valve
7-Oil Cooler
8-Cooler Bypass Valve
9-Main Oil Gallery
10-Pressure Limiting Valve
11-Intermediate Gear
12-Rocker Arm Set
13-Conrod
14-Main Bearings
15-Auxiliary Oil Gallery
16-Piston Spray Nozzle
17-Camshaft Bearings
18-Turbocharger
19-Fuel Injection Pump
20-Oil Pan

Figure2.5-Overall Layout of oil circuits

The engine oil from the oil pan passes through the oil suction strainer and then is pumped into the oil filters and oil cooler by the oil pump, and finally arrives at the positions needed to be lubricated through the oil line system. Most of the oil will come to the main bearings and then to the connecting rod bearings via the oil gallery of crankshaft. The lubrication of cylinder liner surface and piston pin is achieved through the lubricating oil injected by the piston cooling nozzle. The valve control system, turbocharger, fuel injection pump and intermediate gear bearing are also provided with forced lubrication via the oil pipe and oil gallery. The piston head is cooled through injecting lubricating oil to the inner chamber of piston by the piston cooling nozzle; and the lubricating oil is cooled by the cooling coolant in oil cooler. The pressure of lubricating oil in the circulation system is regulated by the pressure limiting valves in the oil pump body and main oil gallery.

■ **Oil filters**

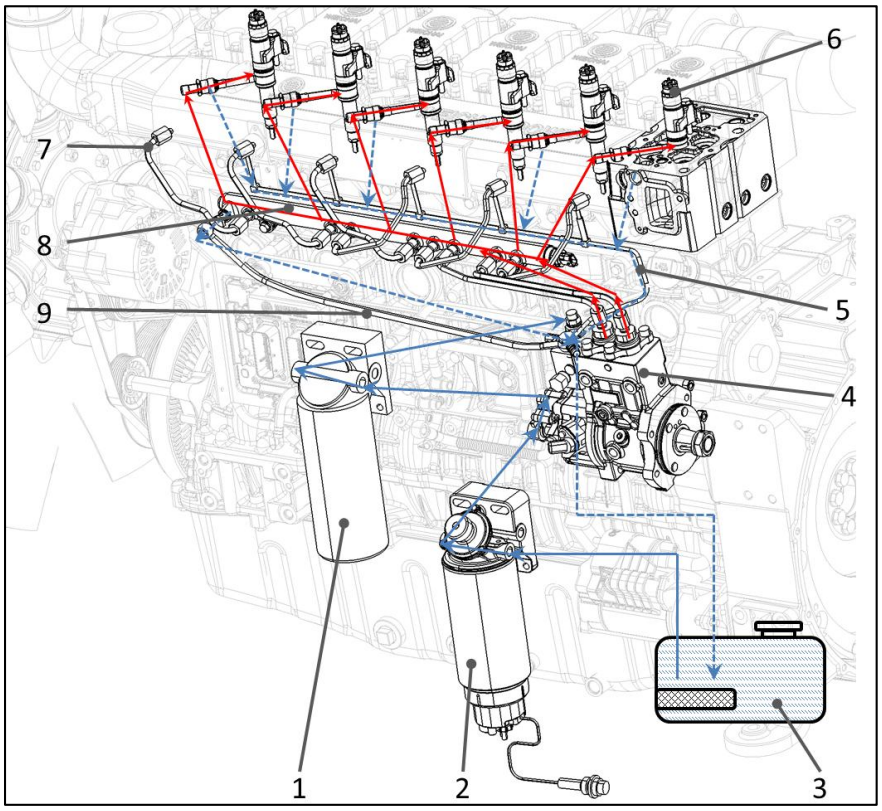
6M21 Engine range is equipped with a lubricating system including 2 full flow oil filters. These filters are equipped with a by-pass valve allowing the continuity of the engine lubrication even in case of a sudden clogging.

2.6 Fuel System

2.6.1 Fuel circuit diagram of 6M21CR

The fuel pump draws the fuel from the fuel tank through fuel coarse filter and through full flow filter to the injection pump.
Injection pump delivers fuel under high pressure through the common rail and high pressure line to the injectors.
Excess fuel not injected is returned to the fuel tank.
Injector holder leakages return to fuel tank.

■ **Overall Layout of Fuel System**



1-Fuel Filter
2-Fuel Coarse Filter
3-Fuel Tank
4-Injection Pump
5-Injector Fuel Return Line
6-Injector
7-High Pressure Fuel Line
8-Common Rail Pipe
9-Fuel Return Line

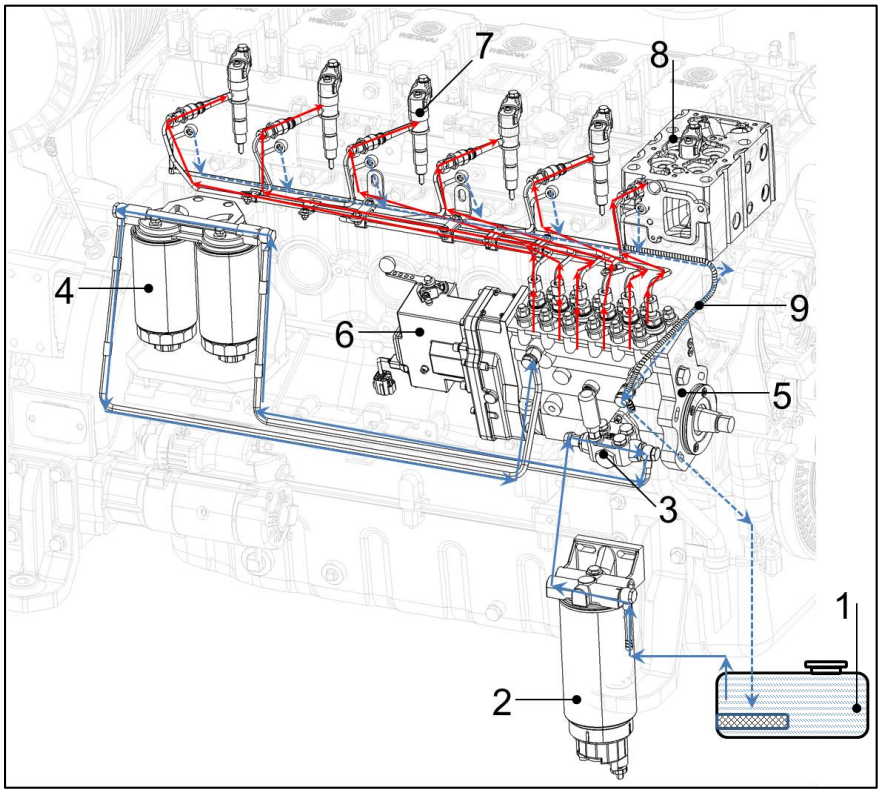
Figure2.6.1-Overall Layout of Fuel System

Low Pressure Circuit High Pressure Circuit Fuel Return Circuit

2.6.2 Fuel circuit diagrams of 6M21MP

The feed pump draws the fuel from the fuel tank through pre-filter and through full flow filter to the injection pump.
Injection pump delivers fuel under high pressure to the injectors.
Excess fuel not sprayed is returned to the fuel tank.
Injector holder leakages return to fuel tank.

■ **Overall Layout of Fuel System**



1-Fuel Tank
2-Pre-fuel Filter
3-Fuel Feed Pump
4-Fuel Filter
5-Injection Pump
6-Electronic Governor
7-Injector
8-Cylinder Head
9-Fuel Return Line

Figure2.6.2-Overall Layout of Fuel System

Low Pressure Circuit High Pressure Circuit Fuel Return Circuit

2.7 Electronic Control Unit (ECU)

2.7.1 ECU for 6M21CR

The WISE15 ECU has two wire harness slots, in which the gray stands for the engine side and the black stands for the genset control panel, each with 76 pins.

The engine wire harness includes engine sensors, fuel injectors and electrically controlled fan pins, which have been installed before delivery.

The genset wire harness includes the functional pins of the genset, and OEM fabricates the wire harness according to the functional needs of the genset.

Terminal diagram

WISE15-P160 Genset Terminal Diagram

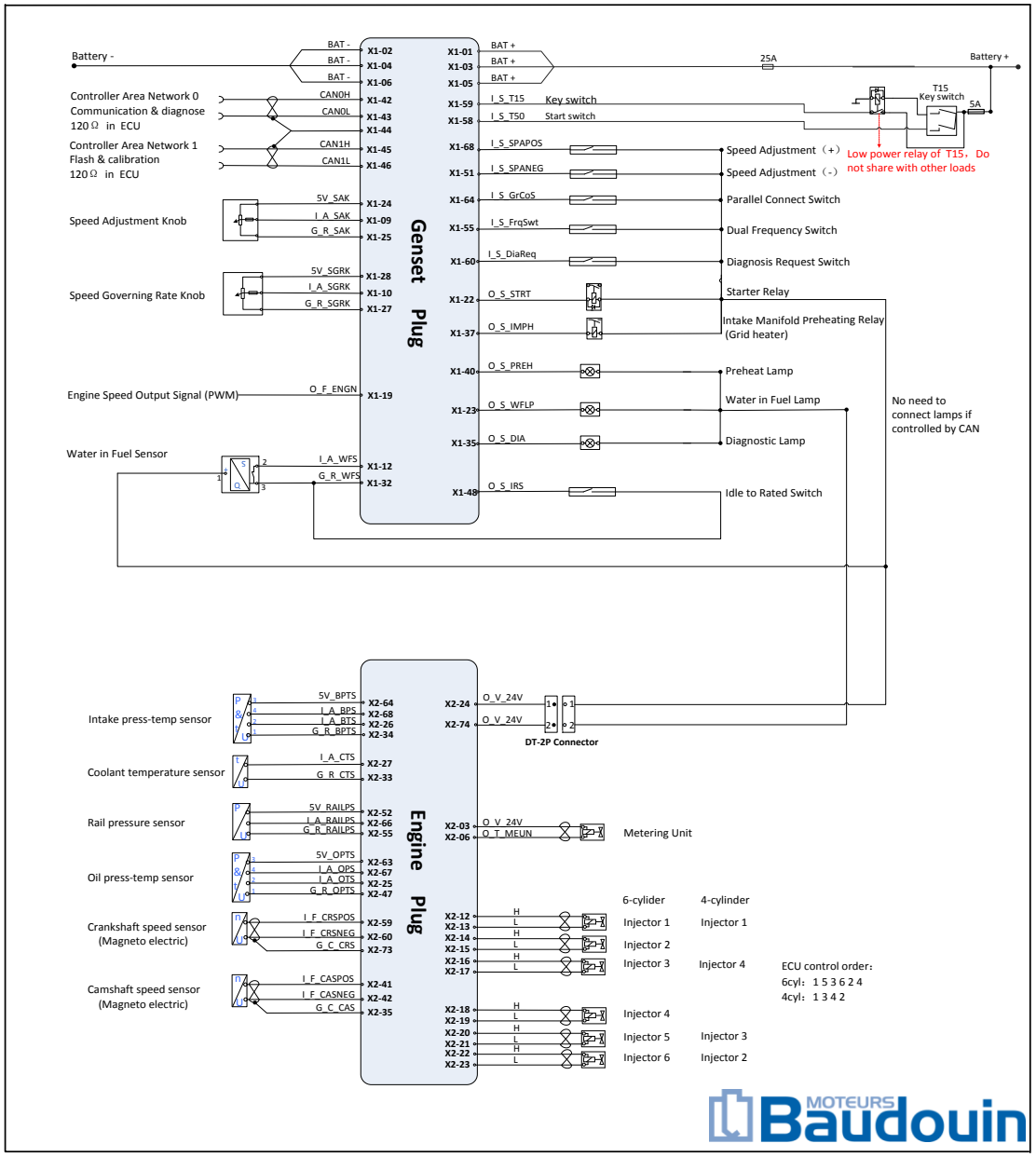


Figure2.7.1A-Terminal Diagram for 6M21CR ECU

To prevent any damage to ECU, it is forbidden to carry out hot plugging operation on ECU.

Electrical connection to the ECU

- ECU power line
  - Pin No.: X1-01, X1-03, X1-05 (positive), X1-02, X1-04, X1-06 (negative)
  - Functional description: ECU main power (24V DC)
  - Operating voltage range: 9-32V

  A 25 Ampere fuse is to be included in the positive line to the ECU

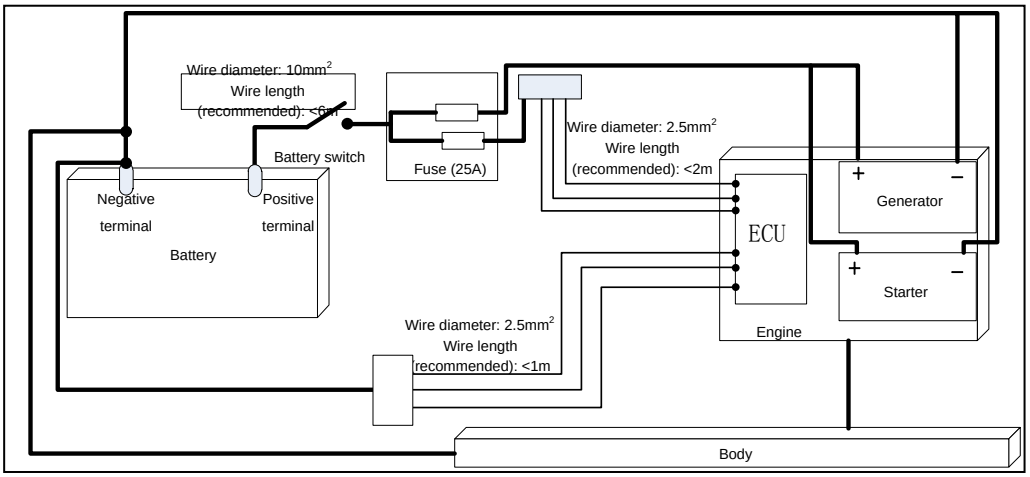


Figure 2.7.1B-ECU and Battery Connection Diagram

- Ignition switch (T15)
  - Pin No.: X1-59
  - Functional description:
    - The switch is ECU power switch. After the switch is on, ECU will be in the working condition, and after the switch is off, the engine will be stopped.
    - Any interference on the T15 switch from other electrical devices should be avoided, otherwise the switch may be off, but the engine cannot be stopped.

  When the T15 switch is opened in order to shut off the engine, the main battery shall continue supplying power to the ECU for 120 seconds via the main battery switch in order to ensure all engine data is written to memory.

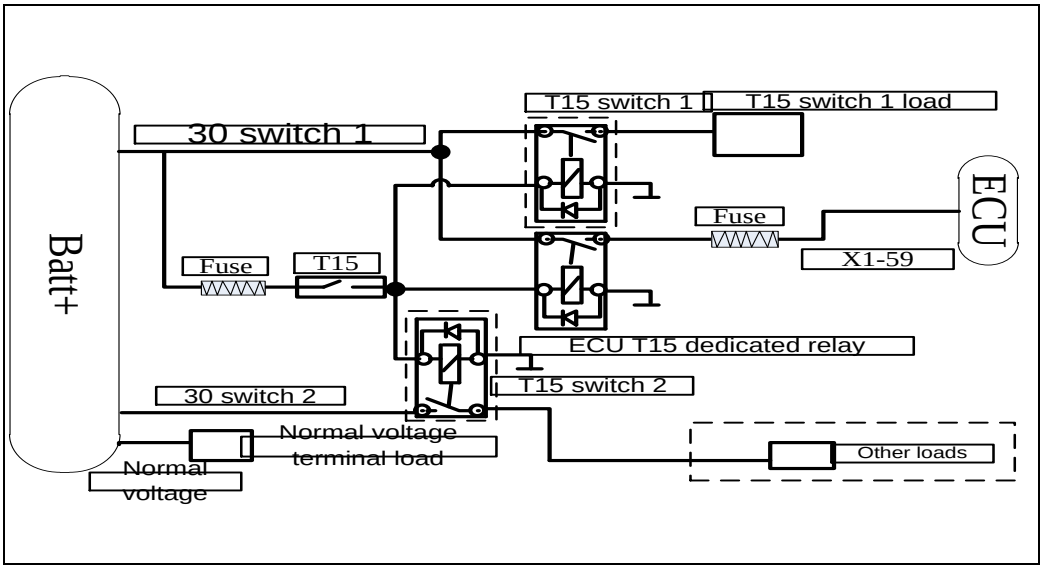


Figure 2.7.1C-Key Switch T15

- Starter switch (T50)
  - Pin No.: X1-58
  - Functional description: The engine starter is controlled by ECU; the switch will be onto control the start relay output. Benefits of the ECU-controlled start are as following:
    - With the help of the second start protection, the starter will not respond after the start switch is pressed again when the engine has been started
    - For example, the engine is started, but the key is seized in the state in which T50 is on. At this time, the starter relay will not respond.
    - Controls start time and prevent battery damage. In case of difficult start, start circuit will be powered off when the engine is not started after a certain time (12s by default).
    - Prevent blind meshing. When the starter fails to drive the crankshaft to a certain speed within a certain period of time, ECU will think that the starter and the flywheel are not engaged, and the relay will be disconnected. At present, the calibrated value is 12 s and 52 r/min.
    - Control preheating. If the engine is started before the intake air heating is not completed, the intake air heating will be terminated, otherwise the battery cannot withstand.

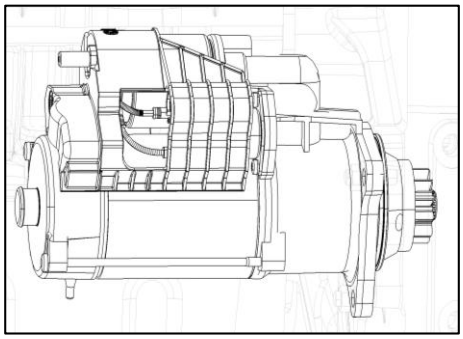


Figure 2.7.1D-Starter

- Speed adjustment knob
  - Pin No.: X1-24, X1-09, X1-25
  - Functional description: It is used to adjust the engine speed, and cannot be used together with the speed fine-tuning switch.

- Speed governing rate knob
  - Pin No.: X1-28, X1-10, X1-27
  - Functional description: It is used to set the engine steady speed.

- Speed adjustment (+)
  - Pin No.: X1-68
  - Functional description: It is used to increase the engine speed slightly or continuously. Press it to increase the speed by a fixed amount (optional), press and hold it to increase the speed by N fixed amounts continuously.

- Speed adjustment (-)
  - Pin No.: X1-51
  - Functional description: It is used to decrease the engine speed slightly or continuously. Press it to decrease the speed by a fixed amount (optional), press and hold it to decrease the speed by N fixed amounts continuously.

- Parallel connection switch
  - Pin No.: X1-64
  - Functional description: It is the conversion switch between stand-alone power generation state and two or more grid-connected power generation state.

- Dual frequency switch
  - Pin No.: X1-55
  - Functional description: It is a changeover switch between 50 Hz power generation mode and 60 Hz power generation mode.

- Idle to rated switch
  - Pin No.: X1-48
  - Functional description: The engine switches from the idle running state to the power generation state at the rated speed.

- Fault Diagnosis

Figure 2.7.1E-Fault Diagnosis

  - Diagnostic request switch Pin No.: X1-60
  - Diagnostic lamp Pin No.: X1-35
  - Functional description: Once the diagnostic request switch is pressed, ECU will flash and the read number of lights will be the flash code. The switch is required to be self-resetting.

Note:

When the diagnosis switch is off, the diagnostic lamp will stay on. If the switch fails to

reset automatically, the diagnostic lamp may stay on due to the diagnostic switch off.
Each flash code consists of 3 bits, for example: 3-2-1, the flashing diagram is as follows:

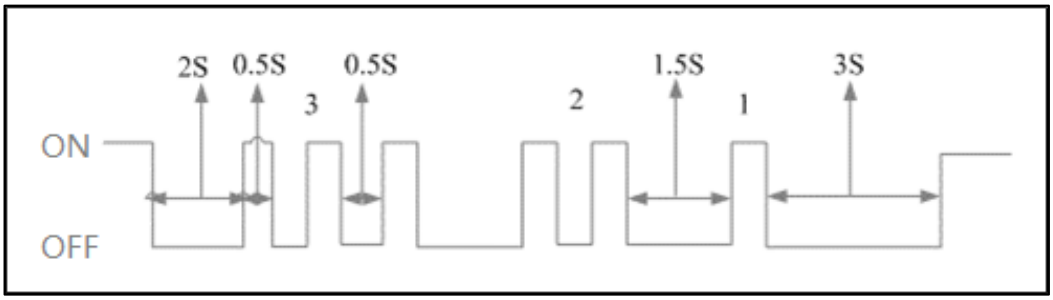


Figure 2.7.1F-Flash Diagram

- Engine speed output
  - Pin No.: X1-19
  - Functional description: This pin outputs the Pulse Width Modulation (PWM) square wave signal to provide the engine speed information for the ordinary instruments, and the speed is 4 pulses per revolution by default. If the instrument used is a Controller Area Network (CAN) instrument, it is not necessary to connect this pin.

  Note: When matching the instrument, it is necessary to inform the engine manufacturer of the receiving pulse number of the instrument. 1 pulse/revolution, 2 pulses /revolution and 4 pulses /revolution are recommended.

- Intake air heating function
  - Grid heater relay Pin No.: X1-37, X2-24
  - Preheat lamp Pin No.: X1-40, X2-74

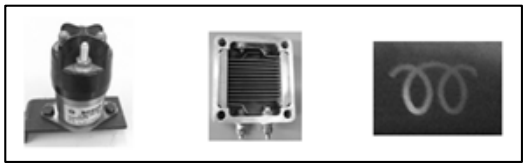


Figure 2.7.1G-Intake Air Heating

  - Functional description: ECU senses the ambient temperature based on the temperature sensor on the engine and automatically controls the operation of the intake grille via the intake air heating relay to facilitate cold start. When the intake air heating is working, the light will stay on. After the air intake heating is completed, the light will flash 3 times and then go out.

- Water in fuel alarm function
  - Water in fuel sensor Pin No.: X1-12, X1-32, X2-24
  - Water in fuel lamp Pin No.: X1-23, X2-74

Figure 2.7.1H-Water in Fuel Alarm

  - Functional description: It is used to detect the water accumulated in the water cup of the fuel coarse filter. When the water level exceeds the MAX scale, the water level sensor (switch signal) will input the signal to ECU, and ECU will light up the water in fuel lamp to prompt the operator to drain the water as soon as possible and to maintain the coarse filter.

- CAN communication
  - Pin No.: X1-42, X1-43
  - Functional description: It is used for information exchange between engine ECU and other CAN nodes on the genset control card.

  Note:

  The twisted-pair wire is required, 25 units/m, and 120Ω terminal resistor is integrated inside ECU;

  If the CAN wire is shielded, the shielded wire must be grounded at one end only and the other end is left unconnected. Two-end grounding is forbidden. In order to prevent the influence on ECU as a result that the current interference from the ground voltage difference is coupled to CAN wire.

- CAN flashing
  - Pin No.: X1-45, X1-46
  - Functional description: It is used for data transmission between external equipment and ECU and is mainly used for data flashing and reading of engine fault codes.

- 2P connector
  - Pin No.: X2-24, X2-74
  - Functional description: It is used as 24V power supply for relays/lamps of PowerKit plug, the sum voltage of X2-56 and X2-74 shall less than 6A.

- Diagnostic interface
  - Diagnostic interface connector has a standard OBD II 16-pin interface: square
  - Part number: AMP 179631-1/2 Terminal: 776001-1.

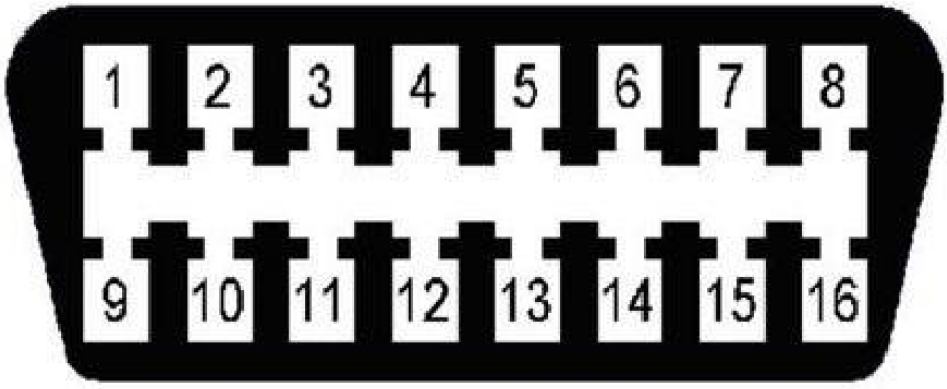


Figure 2.7.1I-Diagnostic Interface

Diagnostic interface number	ECU terminal number	Description
1	X1-45	CAN H_1
4	GND	Ground
6	X1-42	CAN H_0
7	None	K line
9	X1-46	CAN L_1
14	X1-43	CAN L_0
16	BAT+	+24V

2.8 Electronic Governor System for Mechanical Pump Engine

2.8.1 The Principle of the Electronic Governor System

Its system type is all-electronic single pulse speed and close loop position structure, provided with functions of non-corresponding or corresponding control, speed and rated speed during running maximum fuel supply control, emergency stop and etc.

It is also capable of adding other control functions according to the customer's particular requirements.

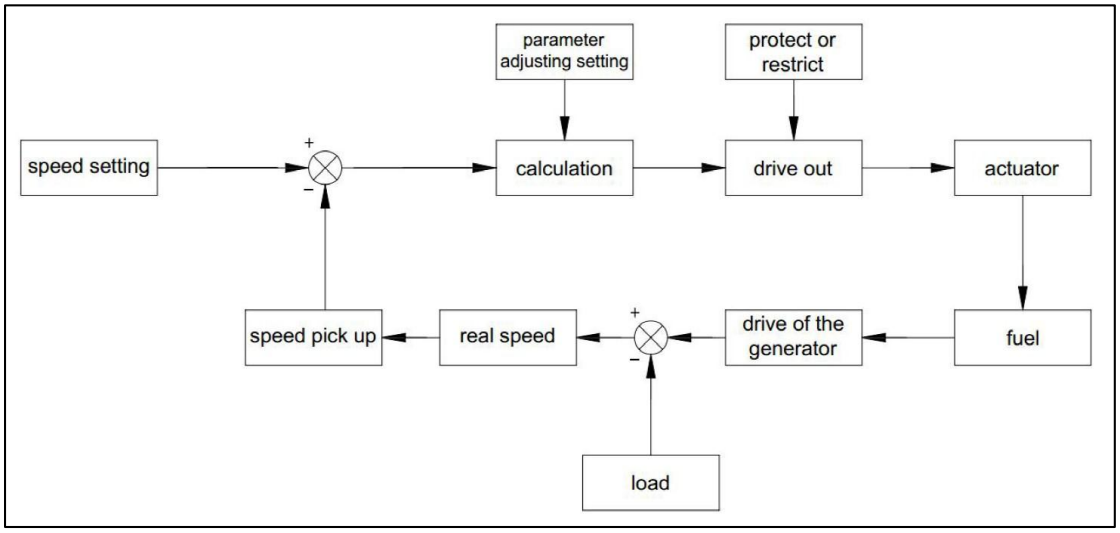


Figure2.8.1A-Principle of the Electronic Governor System

2.8.2 Speed Controller

- The basic electronic characteristics
  - Supply voltage : DC 24V（Scope 18V～32V）or DC12V（Scope9V～16V）
  - Supply consumption: < 0.1A (static state)
  - Speed fluctuation ratio: ≤ ±0.25%
  - Steady state speed droop: 0~5% Adjustable
  - Ambient temp. : -40°C ~ +85°C
  - Relative humidity: <95%

2.8.3 The Electromagnetic Actuator

The Electromagnetic Actuator is the executive element of the electronic governor. C2002 speed Controller that is single-loop control mode can matching all kinds of electromagnetic actuator, such as A800C-W, A900C-W, A1000C-W-d1, A2000C-W-d1, A08A-W, A1AWL, A1AWT, A3A-W, A3B, CA2-W.

2.8.4 Speed Pick-up

The Speed Pick-up of the Electromagnetic Governor is Speed Pick-up of magnetoelectricity, inner structure of which are made of sensor, loop, alnico and plug. Its structure refers to Figure 2.8.4A. The gap between the magnetic speed sensor and the ring gear teeth should not be any smaller than 0.02 in. (0.45 mm). Usually, backing out the speed sensor 3/4 turn after touching the ring gear tooth will achieve a satisfactory air gap.

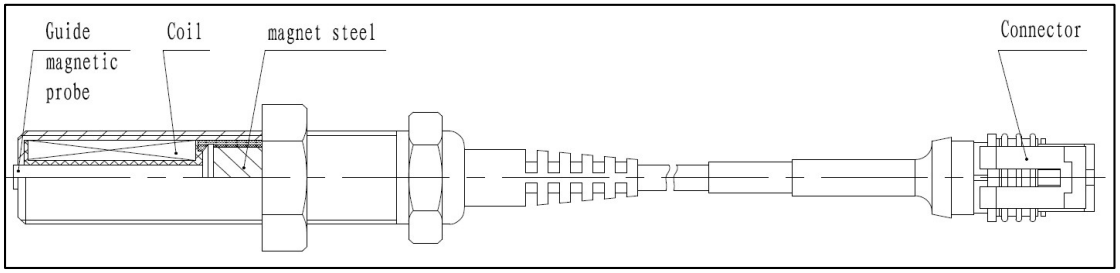


Figure2.8.4A-Speed Pick-up Structure

3. Installation

Safety instructions

Users should carefully read and fully understand the safety instructions before installing and operating the engine.

The purpose of these installation instructions is to:

- provide insight and advice in installing your engine
- establish conditions for trouble-free operation; avoid installation-related malfunctions and any resulting consequential damage

It is essential when installing and operating diesel engines also to comply with the necessary guidelines of the local authority.

S. I. Moteurs Baudouin is only liable for quality defects when these installation instructions have been fully observed.

Failure to comply with the installation and operating instructions defined by S. I. Moteurs Baudouin will void the warranty.

Notice:

After the diesel engine is unpacked, the user shall first check the diesel engine and its accessories as per the delivery packing list and check the engine appearance for damage and loose connections before carrying out the following tasks.

Check the water plug and oil plug check for water temperature and oil temperature sensors and ensure that all parts to be self-provided are completely fitted.

Do not start the diesel engine before it is probably installed. When the diesel engine is running in an enclosed environment, keep it well ventilated to ensure that the exhaust gas is ventilated to the open air.

Please refer to the **Generator Set Installation and Commissioning Manual** for details.

3.1 Engine Lifting

3.1.1 Lifting device

- Use lifting devices to lift and move heavy parts over 20kg (44 lb.). Check the condition of lifting hooks and chains.
- Verify the expiration date of appropriate protective equipment (goggles, gloves, shoes, masks, overalls, helmet etc.) before beginning work.
- Do not use faulty or unsuitable tools.

3.1.2 Lifting the engine

The resistance of a lifting ring is reduced as the angle between the slings or chains and the engine hoist points fall below 90°.

- Use a lifting device with crossbars as illustrated opposite.
- Avoid any contact between the slings and the engine parts.
- Use fastening links and properly calibrated slings or chains.

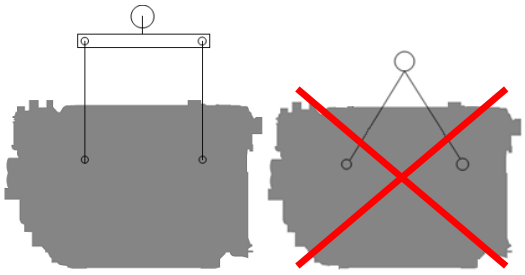


Figure 3.1.2-Lifting the Engine

Risk of death or injury due to heavy suspended loads

⚠ WARNING

3.1.3 Lifting Points

Note

Please refer to the **Generator Set Manual** when lifting generators.

For lifting the engine, use two lifting eyes fitted on it.

During the lifting operation, never work under suspended component, imminent danger of injury or death. Place the load on the load before leaving your workplace. Never be placed in the crane swing radius.

⚠ CAUTION

The lifting points of 6M21 series engine are illustrated as followings:

6M21CR

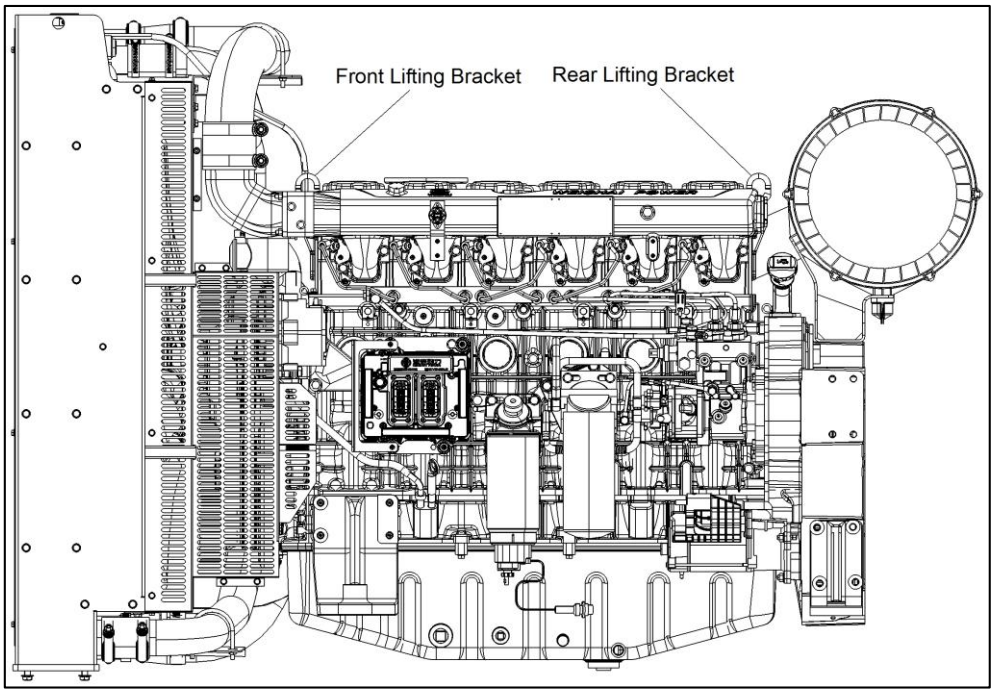


Figure 3.1.3A-6M21CR Lifting

6M21MP

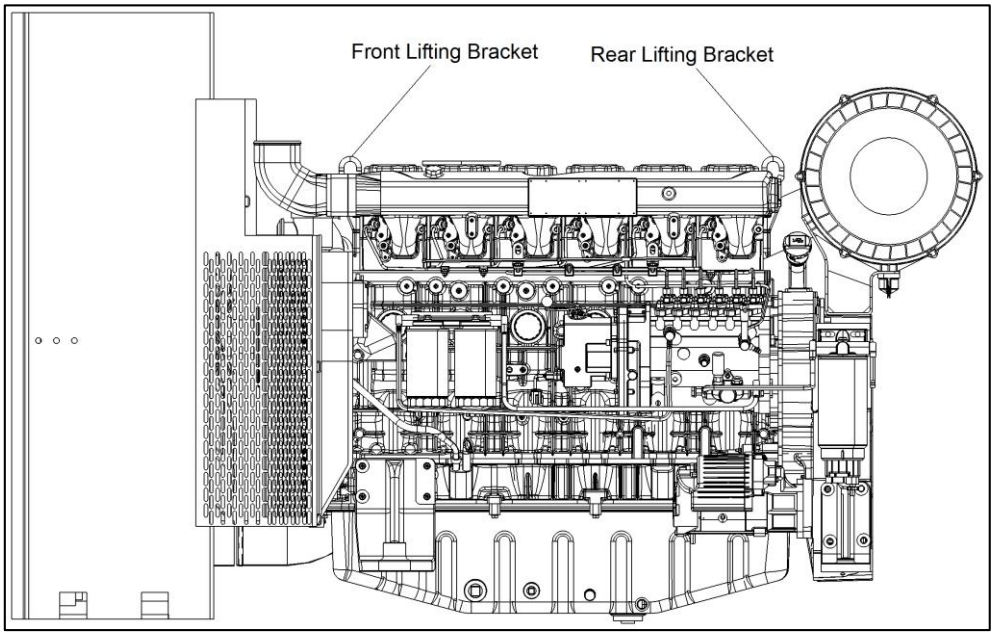


Figure 3.1.3B-6M21MP Lifting

3.2 Engine Mounting

In order to ensure the durability of the engine installation, the installation of the engine must meet the following criteria:

- The engines' own mounting bracket should be used, and four-point support should be adopted. The number of engine supports must not be reduced.
- Flexible support between the engine and the chassis should be arranged to reduce engine vibration.

The mounting points of 6M21 series engine are illustrated as followings:

6M21CR

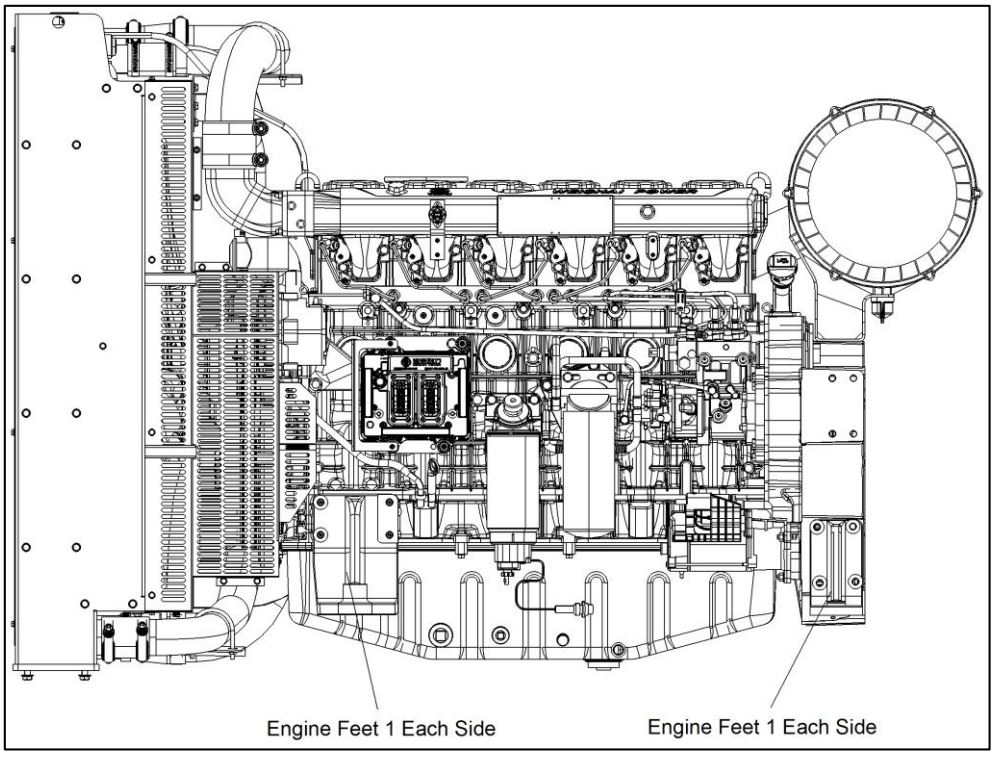


Figure 3.2A-6M21CR Mounting

6M21MP

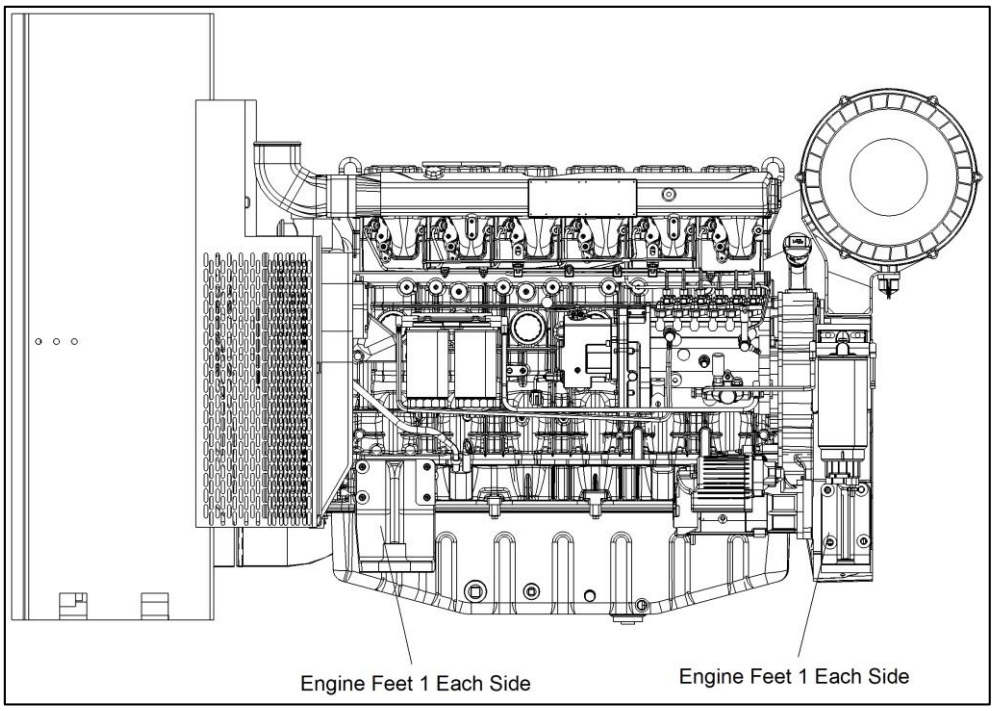


Figure 3.2B-6M21MP Mounting

3.3 Accessories

In order to ensure satisfactory engine life and performance, the installation of pipes must meet the following criteria:

- The intercooler pipe and the engine are connected by a V-clamp. When installing, ensure that the direction of the pipe in the expansion joint is consistent with the direction of the air flow. Add O-ring seal during installation.

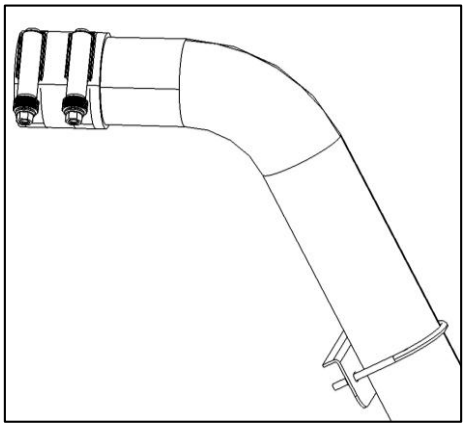


Figure 3.3A-6M21 Intercooler Connection

- Two cooling brackets need be installed between the intermediate cooling pipe and the radiator through the V-type clamp.

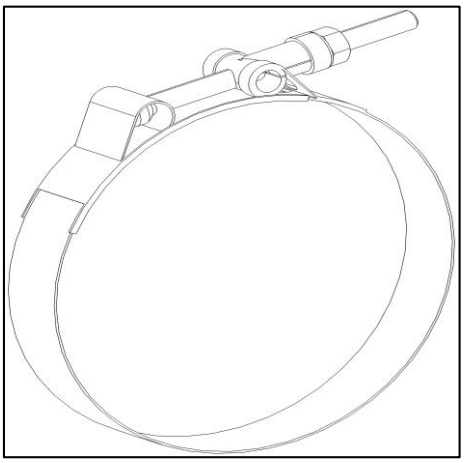


Figure 3.3B-6M21 Clamp

- The coolant connecting pipe relates to the engine through clamp hoops, and O-rings are installed between the connecting points.

- The coolant connecting pipe relates to the clamp and the radiator through the hose.

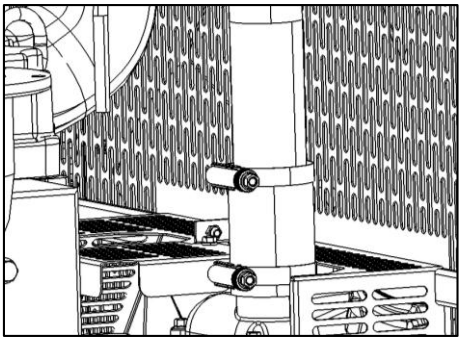


Figure 3.3C-6M21 Coolant Pipe

3.4 Air Intake System

The air intake system must avoid the followings entrance:

- Water
- Dust
- Exhaust gas.

3.5 Exhaust System

The exhaust system must meet at least the following requirements:

- Exhaust back pressure must not exceed the limits in the engine data sheet.
- Exhaust system components should not exert excessive stress on the exhaust manifold or turbocharger due to their own weight, inertia, relative movement between components, or dimensional changes due to thermal expansion.
- The exhaust pipe must not have sharp turns or right-angle bends. The bend radius of the pipeline should be increased as much as possible and welding with sharp corners is not allowed.
- When the exhaust pipe is close to the intake pipe, rubber parts, plastic parts, fuel tanks, etc., an insulation board must be added in the middle and the distance should be increased as much as possible.
- The inner diameter of the exhaust pipe should not be smaller than the inner diameter of the engine exhaust port.
- The exhaust system must be able to completely prevent rain, snow or splashing water from entering the engine block or turbocharger.
- The exhaust gas must be ventilated so that it does not negatively affect the function of the air filter, the efficiency of the cooling system, the surroundings of the engine or the health and safety of personnel.

3.6 Cooling System

In order to ensure satisfactory engine life and performance, the installation of the radiator must meet the following criteria:

- When installing the radiator, install the elastic support.

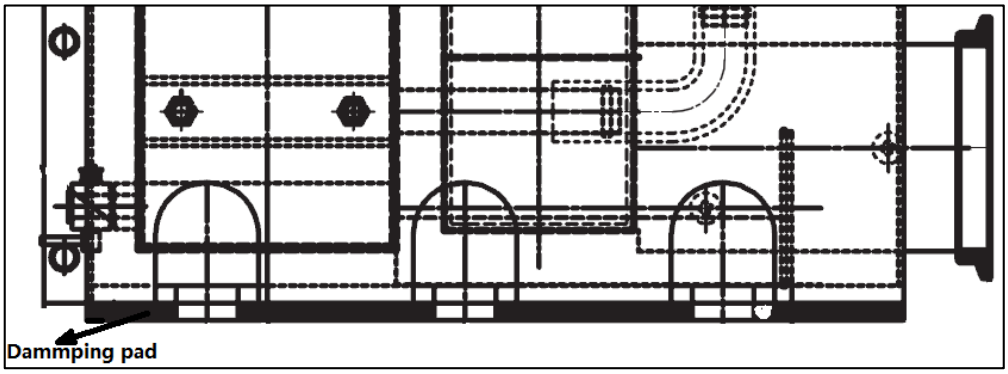


Figure 3.6-Elastic Support

- If the PowerKit is installed in a soundproof box, seal rubber is installed around the radiator to prevent the hot air in the engine compartment from flowing back into the air intake channel.
- Radiator grounding measures must be taken to eliminate potential differences and prevent electrical corrosion (aluminum radiators do not require this).
- The direct windward surface of the radiator should not be blocked, and the direct wind area should be greater than or equal to 80% of the radiator's positive area.

3.7 Lubrication System

Users must follow the requirements in **6.2 Lubricant Recommendation.**

3.8 Fuel System

The installation of the fuel system must comply with the following requirements:

- When the engine is stopped, the fuel system does not allow the fuel to flow into the engine through the fuel inlet pipe or the injector return line due to gravity.
- The injection resistance of the fuel injection pump shall not exceed the specified value with a clean fuel filter. The resistance is based on the half-full fuel tank.
- The return oil must not generate pressure fluctuations in the pipeline.
- The fuel tank must have a vent and fuel return connection to allow air and other gases to properly separate from the fuel without pressure in the fuel tank. The vent must also prevent the entry of dirt and water.
- The temperature of the fuel entering the engine must be lower than the specified value in the engine data sheet.

3.8.1 Fuel Tank

- The lowest position of the fuel tank shall be less than 500mm from the fuel pump of the engine, and the location shall be far away from the heat source. The fuel tank shall have proper space and ventilation.
- The device should be set up to periodically drain the condensed water in the fuel tank and the filter, and signs should be placed to remind the user of such.
- The fuel tank has ventilation function to prevent the pressure inside the tank from being too high and the vent hole should be dustproof and waterproof.
- The fuel tank must have 5% liquid thermal expansion space to prevent the fuel from overflowing after it expands.

3.8.2 Fuel Line

- The fuel line shall comply with the requirements of the fuel line matching specification. Inner diameter $\geqslant$ ø 12mm, length $\leqslant$ 10m tubing.
- The diesel piping should be able to withstand sufficient operating vacuum without damage

or collapse.

- Both suction and return lines must be installed at the bottom of the tank and must be kept at a distance (⩾300 mm) from each other, and the line must be open.
- If the fuel line needs to be fixed, clamps with rubber gaskets should be used on the pipeline. No other components can be fixed on the pipeline. DO NOT tie the fuel line bundles with the wire harnesses.

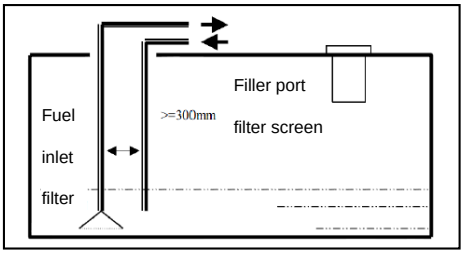


Figure 3.8.2-Fuel Line

3.9 Engine Control System

3.9.1 Startup Circuit

- Wire size of starting main cable: ⩾70mm^2.
- Wire size of battery negative terminal ground wire: ⩾70mm^2.
- Wire size of starting system control end cable: ⩾1.5mm^2.
- The wiring terminals of starter shall be equipped with protective caps.
- Resistance sum of startup cables (terminals No. 30 and 31): ≤1mΩ.
- Permissible voltage drop of main cable for 24V starting system: ≤0.17V/100A.
- Non-electronic controlled engine shall be equipped with starting protection preventing second start up.
- Battery capacity: 150~400Ah, with discharge current at low temperature: 750-900CCA.
- Before performing electrical connection, remove the paint on connecting points.
- Working environment temperature: -40°C~105°C.
- Rated voltage 24V, maximum power 8.5kW.
- The maximum resistance of the main circuit of the starter is ≤8mΩ, and the maximum resistance of the control circuit is ≤500mΩ.

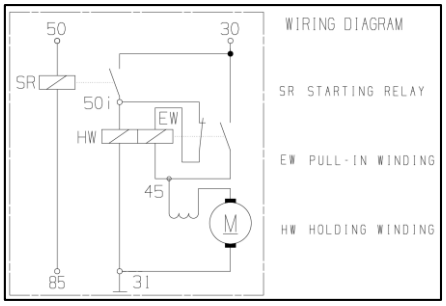


Figure3.9.1A-6M21CR Starter Wiring Diagram

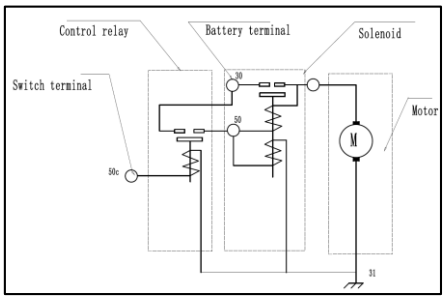


Figure3.9.1B-6M21MP Starter Wiring Diagram

3.9.2 Charging Circuit

- The alternator must be agile rotation and have not abnormal noise.
- The charging cable shall be a complete cable without intermediate connector.
- The alternator and battery in parallel may not operate without battery.
- Terminals of B+/D+/W shall be provided with protective caps.
- Working environment temperature: -40°C~105°C.
- The maximum leakage current: 2mA.
- Rated alternator speed 6000rpm, maximum operating speed 12000rpm.

The schematic diagram of the charging motor wiring is as follows:

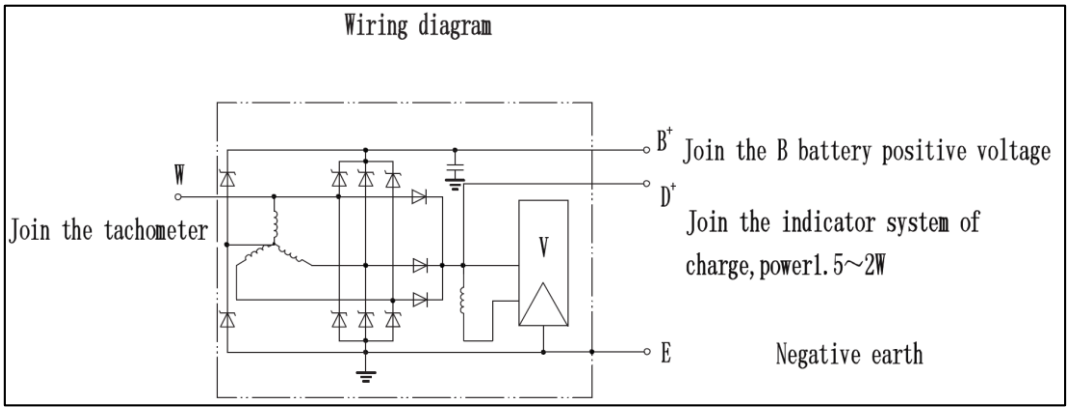


Figure3.9.2A-6M21 Charging Motor Wiring Diagram

Parameters table				
Rated Voltage		Rate Current		
28V		70A		
TEST	Ambient Temp	Voltage	Speed	Current
Cold state	25±5 ℃	27V	n=1600rpm	I≥37A
			n=6000rpm	I≥80A
Hot state			n=1600rpm	I≥30A
			n=6000rpm	I≥70A
Regulator		Current	Rated Speed	Regulator Voltage
		7A	n=6000rpm	28.5±0.3V
Generator zero current ≤1150rpm				

3.10 Electrical Components

3.10.1 Sensors

- Sensor wiring terminal (male tab type) shall be provided with protection after connection.
- Sensor connector shall be inserted in place, well positioned and firmly fastened.
- For resistance type sensors, for example, temperature and pressure sensors, their cable lengths connecting to the instrument shall be less than 10m.
- Sensor harness sheath shall be protected (preferably by expansion joint).
- All sensor harnesses of the generating set shall comply with specifications, without copper conductor exposure or burrs.
- For analog sensors, resistance type temperature and pressure sensors, their harnesses shall be shielded wire, with shielding layer reliably grounded and not exposed. Rotation speed sensor wire should be twin twisted.
- Harness must be far from hot parts and components, for example, turbocharger and exhaust pipe.
- The power supply of sensor system must be under the control of the master key switch of the generating set.
- Ensure the power supply of sensor is reliably cut off when the generating set is powered off.
- The wire size of sensor harness (copper conductor) shall not be less than 1.5 mm^2 (0.0023 in^2).

3.11 Installation and debugging of Electronic Governor System

3.11.1 Speed controller

The speed Controller is installed on the control box or fixed other peripheral equipment in the engine. It should be installed in the place of air drying and temperature suitable. If it be installed in the place of more water and humidity, the speed Controller should be mounted vertically. Its outline and installing size refers to Figure3.11.1A.

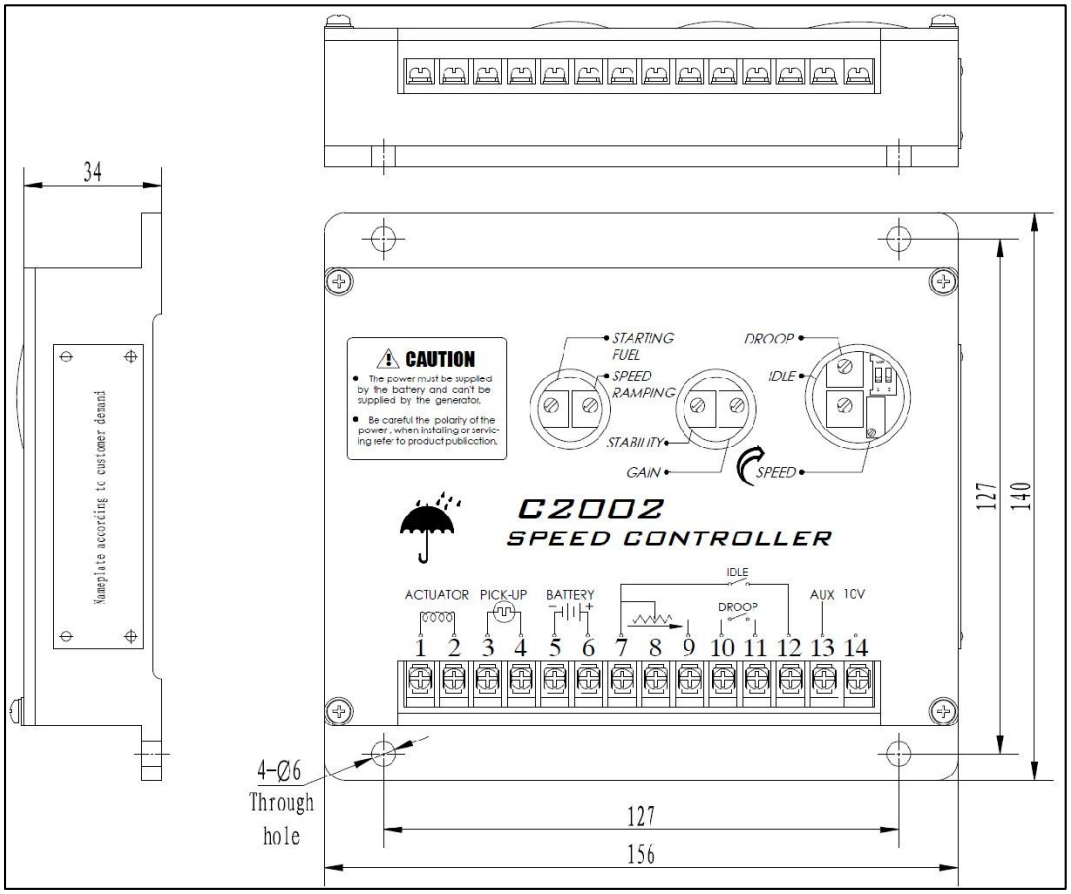


Figure3.11.1A-Outline and Installing Size of the C2002 Speed Controller

Note!

An overspeed shutdown device, independent of the governor system, should be provided to prevent loss of engine control which may cause personal injury or equipment damage. Do not rely exclusively on the governor system of electric actuator to prevent overspeed. A secondary shut off device, such as a fuel solenoid, should be used.

- **Connection diagram of the C2002 speed Controller**

C2002 speed Controller's connection diagram for normal generator set refers to Figure3.11.1B

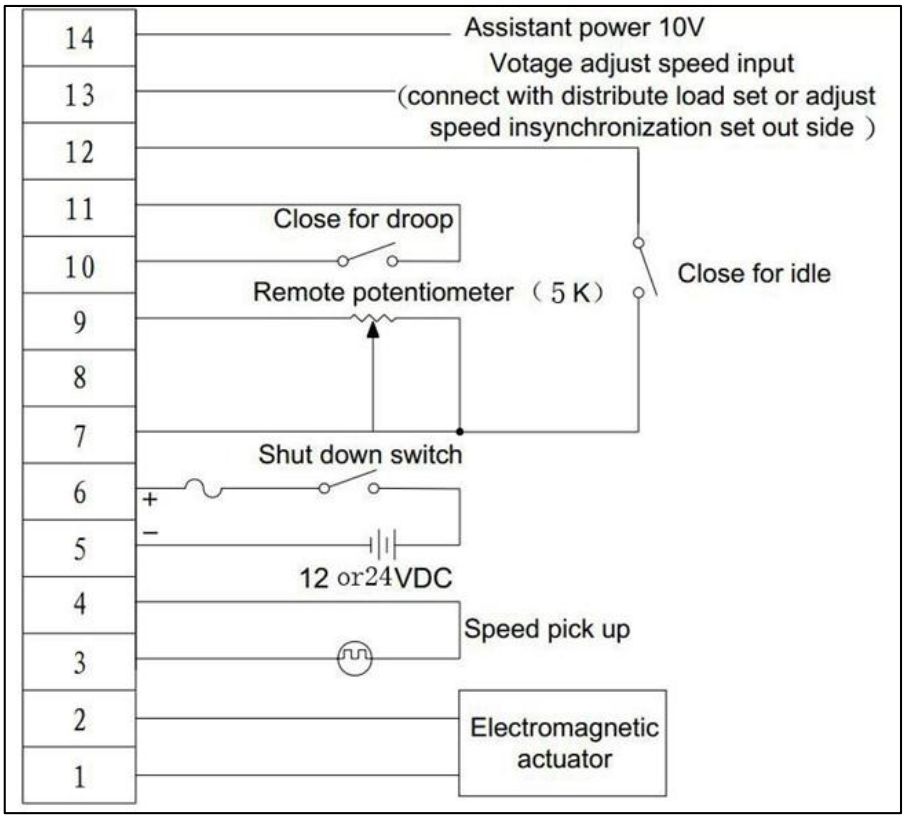


Figure3.11.1B-Connection Diagram of the C2002 Speed Controller for Normal Generator Set

Terminal	**Wire harness**	
	Less than 6 meters	More than 6 meters
1,2 shall connect with the actuator winding end	1 mm²	2.5 mm²
3,4 shall connect with a speed sensor (the minimum operation signal are both 2.5V AC)	0.5 mm²	1 mm²
5,6 shall connect with the battery (reference to the controller voltage value)	1 mm²	2.5 mm²
7,9 shall connect with the Speed Potentiometer	The signal points are millampere level current, so it can be used 0.5 mm2 ~ 1 mm2 wire harness to connect. In a strong magnetic field environment, you shall use the shield lines to connect; shielding net shall connect the grounded end of the controller effectively.	
7,12 shall connect with the idle switch		
10,11 shall connect with the droop switch		
13 is the access terminal (as input signals for synchronizer, load distribution, ramp generator access points which for the combined machine or extraordinary setting)		
14 is the auxiliary power output for +10V DC, load should be less than 20mA		

- The Electromagnetic Actuator connects to Terminals 1 and 2 and battery connects to Terminals 5 and 6. Terminals 1, 2, 5, and 6 should be #16 AWG (1 mm sq) or larger. Long cables require an increased wire size to minimize voltage drops. The battery positive (+) input, Terminal 6, should be fused for 15 amps as illustrated.
- Magnetic speed sensor connects to Terminal 3 and 4 MUST BE TWISTED AND/OR SHIELDED for their entire length. The speed sensor cable shield should only be connected to Terminal 4. The shield should be insulated to insure no other part of the shield comes in connect with engine ground, otherwise stray speed signals may be introduced into the speed Controller to stop the engine.
- The remote potentiometer connects to Terminal 7 and 9. If it resistance is 5KΩ, speed adjusting range is 2400HZ.
- Speed droop connects to Terminal 10 and 11. When the Terminal 10 and 11 is off, speed droop is 0; When the Terminal 10 and 11 is closed, speed droop range is 0-5%.
- Rated and idle speed switch connects to Terminal 7 and 12. The switch close for idle, the switch off for rated speed.
- Terminal 13 receives input signal from load distribution device, automatic synchronizer device and other governor system auxiliary device.
- Terminal 14 output +10 volt regulated supply.

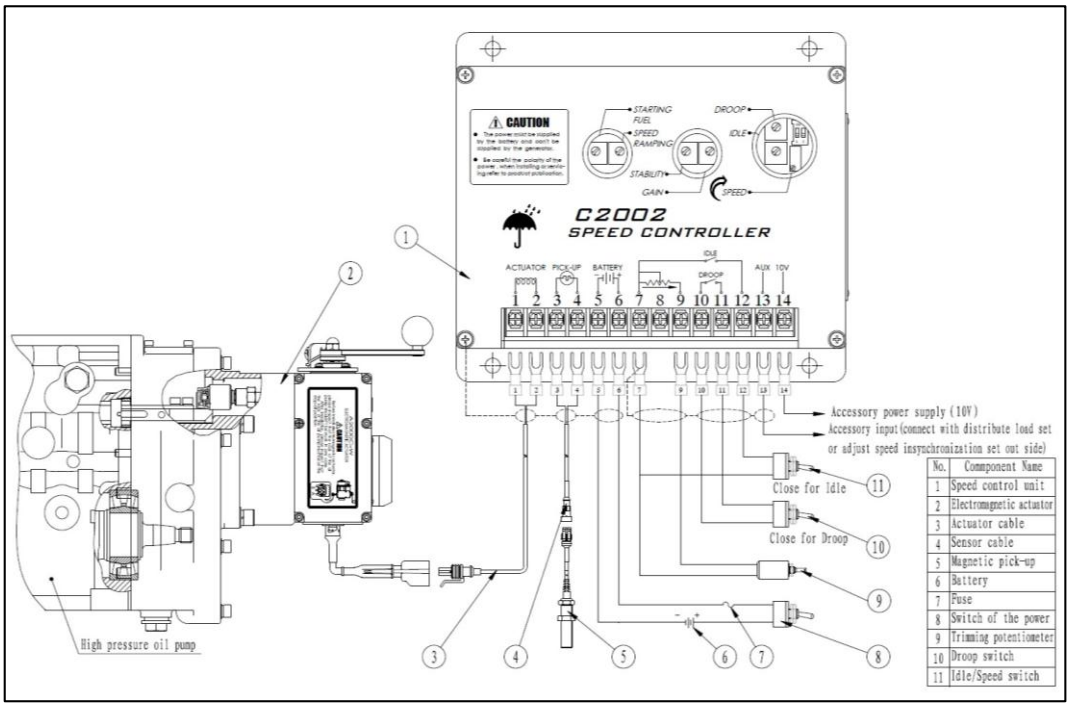


Figure3.11.1C-Connection Diagram of the ESG2002 Series Electronic Governor System

3.11.2 Adjustments before Starting Engine

Check to insure the **GAIN** and **STABILITY** adjustments, normally this value is set mid position by factory.

Leave factory conditions of Red State Switch is  , namely RSW-1, RSW-3 = OFF, RSW-2 = ON.

Rated and idle speed of the speed Controller had been set by factory. Normally, this value is near from the user's engine working rotate speed value. In practice, after some adjustments, controller can achieve rated and idle speed, and the stability would be very well.

3.11.3 Adjustment of the Controller after Starting

- Crank the engine with D.C. power applied to the governor system. Start fuel quantity varies with environmental temperature of engine start. Though adjusting start fuel quantity potentiometer; exhaust smoke from the engine can be adjusted to the best state.
- The governor system should control the engine at low idle speed. If the engine is unstable after starting, turn the **GAIN** and **STABILITY** adjustments counterclockwise until the engine is stable.
- The governed speed set point is increased by clockwise rotation of the **SPEED** adjustment control. Remote speed adjustment can be obtained with an optional Speed Trim Control.
- Once the engine is at the operating speed and at no load, the following governor performance adjustments can be made.

  (1) Rotate the **GAIN** adjustment clockwise until instability develops. Gradually move the adjustment counterclockwise until stability returns. Move the adjustment one division further counterclockwise to insure stable performance.

  (2) Rotate the **STABILITY** adjustment clockwise until instability develops. Gradually move the adjustment counterclockwise until stability returns. Move the adjustment one division further counterclockwise to insure stable performance.

  (3) Gain and stability adjustments may require minor changes after engine load is applied. Normally, adjustments made at no load achieve satisfactory performance. A strip chart recorder can be used to further optimize the adjustments.
- After the governor speed setting has been adjusted, place the optional external selector switch in the IDLE position. The idle speed set point is increased by clockwise rotation of the **IDLE** adjustment control.

  When the engine is at idle speed, the speed Controller applies droop to the governor system to insure stable operation.
- Through the above adjustments engine still unable to stability, it needs to be adjusted Red State Switch now, Figure3.11.3A four cases (a: RSW-1、RSW-3 = ON、RSW-2 = OFF; b: RSW-1、RSW-2 = OFF、RSW-3 = ON; c: RSW-1、RSW-2 = ON、RSW-3 = OFF; d: RSW-1、RSW-3 = OFF、RSW-2 = ON). After every adjusting Red State Switch go on the (1) and (2) adjusting procedure again. If it is still unable to stability, should inspect engine and fuel pump for service condition. And then, contact with manufacturer.

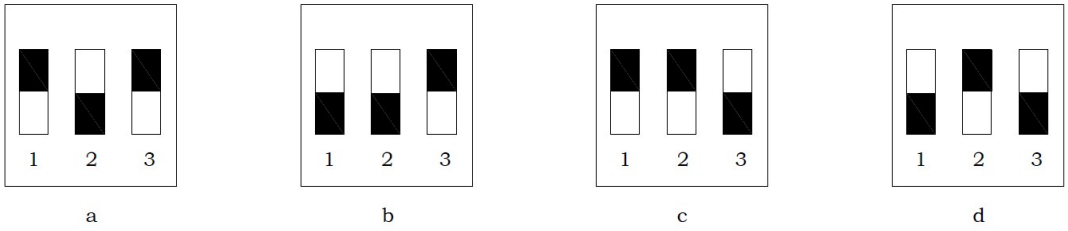


Figure3.11.3A-Red State Switch

3.11.4 Speed Droop Operation

- Droop is typically used for the paralleling of engine driven generators.
- Place the optional external selector switch in the **DROOP** position, which is connected Terminals 10 and 11. Droop is increased by clockwise rotation of the **DROOP** adjustment control. When in droop operation, the engine speed will decrease as engine load increases. The percentage of droop is based on current change from no load to full load of the actuator.
- After the droop level has been adjusted, the rated engine speed setting may need to be reset. Check the engine speed and adjust the speed setting accordingly.

3.11.5 Accessory Input and Output

- When the Auxiliary Terminal 13 accepts input signals from load sharing units, auto synchronizers and other governor system accessories are directly connected to this terminal. It is recommended that this connection form accessories should be shielded as it is a sensitive input terminal.
- When an accessory is connected to Terminal 13, the speed will decrease and the speed adjustment must be reset.
- The +10Volt regulated supply, Terminal 14, can be utilized to provide power to our governor system accessories. Up to 20mA of current can be drawn from this supply. Ground reference is Terminal 7.

Note!

A short circuit on this terminal can damage the speed Controller.

3.12 Genset Installation Recommendations

Users must choose the genset installation location very carefully in order to not disturb anyone and not to cause noise pollution. If the location is not appropriate, enclosures have to be insulated for noise reduction. Also, the correct type of exhaust silencer must be used if necessary.

- The genset room should be well ventilated. The foundation of the unit should be solid and conform to local code. After compacting hard soil, the minimum precast concrete structure foundation of 200mm thick should be built on this foundation.
- When installed, the shock absorber is evenly placed under the two channel steel of the common chassis of the unit, leveling with the flat pad, and its levelness is measured with the level gauge. Keep the unit level; In addition, the packaging base is not allowed to be used as the basis for starting up operation.
- When the user is building the genset room, the steel I-beam for lifting should be embedded in the roof above the unit for later maintenance.
- The inner diameter of the exhaust pipe should not be less than 140mm, the bending pipe should not be more than 3, and the bending Angle should be greater than 90 degrees.
- There should be sufficient maintenance and inspection space around the unit. There should be at least 1.5m space around the unit.
- The machine room should be equipped with fire extinguishers and other fire tools.

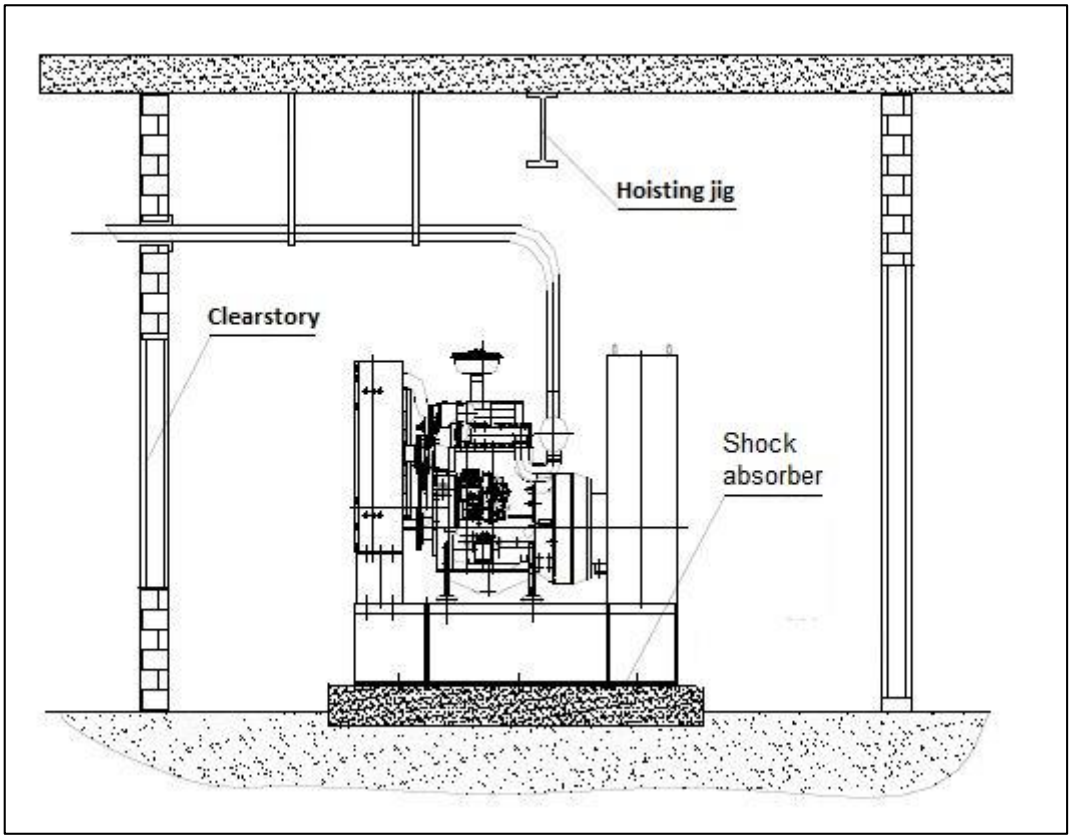


Figure 3.12-Genset installation

4. Operation

The first engine commissioning process should be handled by **S. I. Moteurs Baudouin** approved personnel. The successful completion of this process, along with the checks and adjustments required by **S. I. Moteurs Baudouin**, will ensure that the engine runs efficiently, reliably, and safely.

Failure to comply with the installation and operating instructions as defined by **S. I. Moteurs Baudouin** will void the warranty.

People will be required to wear Individual Protection Equipment (IPE) and use correct tools following official standards.

Make sure that the engine is correctly protected regarding its environment conditions.

Take the necessary measures for the emergency shut-off of the fuel or air supply to prevent from over-speed risks.

- Check the cleanliness of circuits.
- Check for free circulation of gases in exhaust ducts.
- Check the fuel supply.
- Check coolant level and fill if necessary.
- Check oil level and fill if necessary.
- Check air clogging indicator.

4.1 Preparations before Start

Oil

- Adding of engine oil
  - Open the oil filler cap and add the engine oil.
  - Using the dipstick to check the oil level.

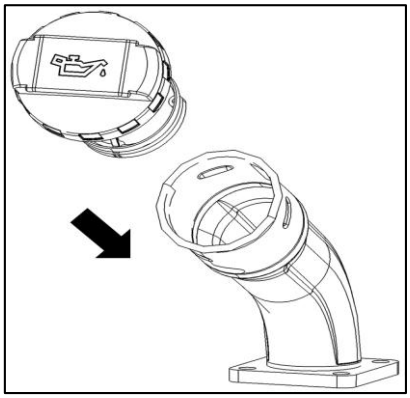


Figure 4.1A-Adding of Engine Oil

Fuel

- Adding of fuel
  - The diesel fuel used shall meet the specification.
  - The diesel fuel used must be clean. It's better to place the diesel fuel under stationary state for more than 72 hours before adding. The diesel fuel shall be added into the fuel tank via the built-in filter screen.

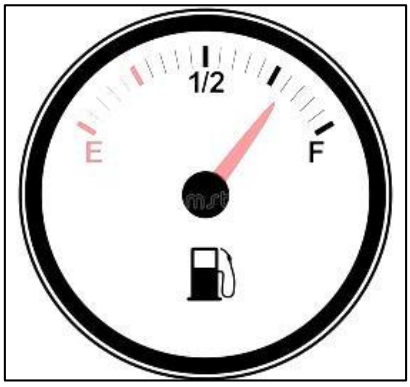


Figure 4.1B-The Fuel Level

Coolant

- Adding of coolant
  - The coolant is mixed from treated clean water and anticorrosive agent or antifreeze. Ensure to strictly abide by the specification of the additive manufacturer during mixing.
  - Add coolant through the water filler port of radiator and bleed the air from the cooling circulation system.

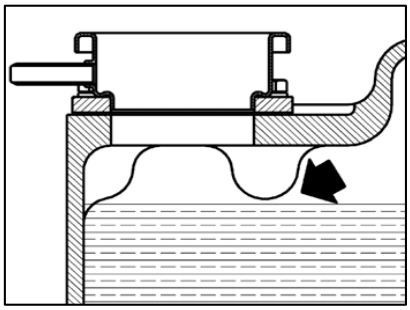


Figure 4.1C-Adding the Coolant

Note!

After the genset is installed in site, please make sure must remove all long adjustment bolts of bellows before starting the genset.

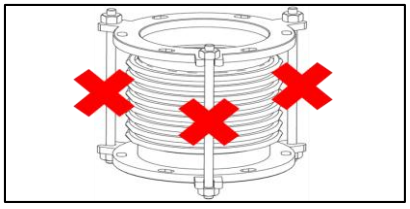


Figure 4.1C-Bellow

4.2 Starting Up

The following starting/stopping procedure is a simple example (not binding) and it's based on a simple starting control panel equipped with starting key. Please refer to the genset and/or genset control panel use & maintenance manual for the starting operation mode.

- Before starting the engine, double check the emergency stop works. Press the emergency stop button and try to start the engine. The engine should not start. Rotate the crankshaft of diesel engine for several turns to ensure smooth rotation.
- The following start / stop procedure is a simple example (not binding) and it's based on a simple starting control panel equipped with starting key. Please refer to the genset and/or genset control panel operation & maintenance manual for the starting operation sequence.
- Turn the key to position "1" to power on the control panel. The "oil pressure warning lamp" will automatically turn on for 10s (Safety line test of ultra-low engine oil pressure). It's recommended to test the indicator lamps, bulbs, and buttons once (by pressing the touch button on the control panel).
- Turn the key to position "START" to start the engine and then release the key. The key will automatically return to position "1".

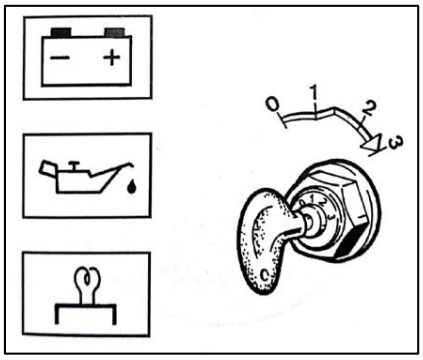


Figure 4.2-Switch

- At the start of diesel engine, if the diesel engine fails to start within 10s, immediately release the button and wait for 1min before retry.
- If the engine can't be started by three consecutive attempts, stop the attempt and find out and solve the malfunction before retry.
- During the working of engine, the "oil pressure warning lamp" and the "battery power" indicator lamps are all off.
- All indicator lamps are off during normal running of engine.
- In event of abnormality, the "horn" will issue warning sound.
  - The auxiliary starter shall be used to start the diesel engine under cold temperature.
  - By activate the electric heating flange via relay, the engine can be started successfully under low-temperature environment.

4.3 Operation of the PowerKit Engine

- After the start of diesel engine, idle the engine for 3min, and then increase the speed to 1000r/min to 1200r/min with some load. Only when the coolant temperature is above 60ºC and the oil temperature is above 51ºC, can the engine run with full load. The load and speed should be increased gradually.
- In the first running in period of 60h, the diesel engine should work with load less than the moderate load.
- Parameters and checking locations to be observed always during operation are as below: Oil pressure of main oil passage130-250 kPa(idling working conditions), 350~550 kPa (rated working conditions).
  - The oil temperature in main oil passage: ≤105 ºC.
  - Coolant outlet temperature: (76~88) ºC.
  - Exhaust temperature after turbine: ≤580 ºC.
  - Intake temperature after intercooler: ≤55 ºC.
- Check the exhaust color, to estimate the performance of the injector and the load of the engine. In the case of serious black or white smoke, stop and check the engine.
- Check the diesel engine for presence of water, gas, and oil leakages.

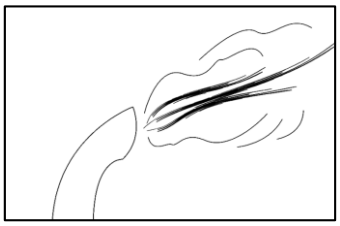


Figure 4.3-Smoke

⚠ CAUTION

Users should immediately stop the genset, check and troubleshooting if there is abnormal phenomenon!

4.4 Precautions for running in cold environments

- Fuel: Choose a grade of diesel fuel depending on the environmental temperature.
- Lubricating oil: Choose lubricating oil of different viscosities depending on the seasons.
- Coolant: Add antifreeze additive into the cooling system and choose the coolant of different grades depending on the ambient temperature.
- Start: The auxiliary starter can be adopted if necessary in winter. After starting the engine, only operate the engine with load when the oil pressure and water temperature are normal.
- Before the cold season begins, be sure to check the electrolyte liquid level, viscosity and battery voltage. If the engine is not going to be operated for a long time and under very low temperatures, the battery should be removed and stored in a warmer room.
- Shut-down of the engine: When shutting down the engine in a cold climate, unload the engine first and then run the engine at idling speed for 1 to 2 minutes. And then stop the engine after the water and oil temperatures decrease. The coolant with antifreeze additives should not be drained out after shutdown. Otherwise, open the drain valve or plug on the engine body, oil cooler cover, and radiator and water inlet pipe to drain the coolant completely to prevent the engine from being frost cracked.

4.5 Stopping the PowerKit Engine

Avoid shutting down the engine at full load. Before the shut-down, engine load and should be reduced, and the engine should operate at ow-load condition for 3 to 5 minutes. This allows the piston, cylinder head, liner, bushing and turbocharger to cool down, avoiding cylinder and bearing damage. This is particularly important for turbocharged engines because the bearing and oil seal in the turbocharger can be affected by the high temperature of the exhaust gas. When the engine is running, the heat will be transferred away by the cycling lubricating oil. When the engine shuts down suddenly, the turbocharger temperature will increase greatly and cause the bearing or the oil seal to fail.

- Turn the key switch to position “0” or press the stop button to stop running of engine, till the engine stops rotation or the speed indicator on the instrument panel points zero.
- For the engines that don't use anti-freeze in the engine coolant, drain the coolant after shut-down in cold weather to prevent freezing damage to the engine. The draining valve under the oil cooler can be used to drain the water inside the engine. The drain plug on the radiator should also be removed to discharge the coolant in the radiator.

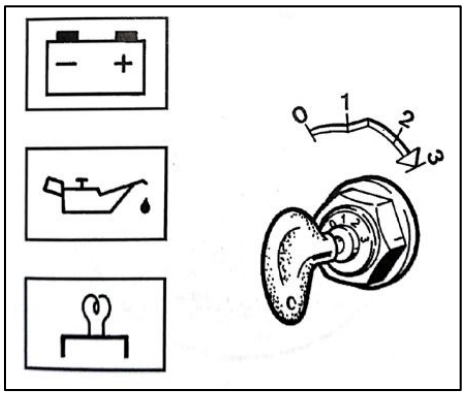


Figure 4.5-Switch

4.6 Electronic control system

Reading the fault code via the diagnostic switch:

- Press the diagnostic switch (diagnostic lamp comes on), and then release to reset the diagnostic switch (diagnostic lamp turns off).
- The diagnostic lamp flashes and reports the fault code.
- Repeat step 1st for several times, the subsequent fault codes will be shown one by one. When the first fault code is repeated, it indicates that all the fault codes have been read.
- Check the "List of fault codes" to find the explanation corresponding to each fault code and you can determine the current fault.

Please check the code sheet at **6.4 Common Faults and Troubleshooting.**

Clearing the memory of historical errors manually:

- Press the fault request switch before ignition switch (T15) is on, then turn on the: Ignitionswitch (T15) and hold the diagnostic request switch for 4-30s before releasing.
- If you fail to delete a fault code, it remains a current fault.

You need to resolve the current fault before clearing the error memory in ECU.

If you fail to clear the fault code, please notify your local Baudouin representative as soon as possible.

5. Maintenance

5.1 General Safety Conditions for Maintenance

SAFETY WARNING

Users should carefully read the safety instructions before installation and operation of the engine.
Electrical insulation controls must NOT be done with a voltage higher than 50VDC

Safety conditions for preventive and corrective maintenance operations are intended to check.

- Engine and generator alignment.
- The tightness of the entire engine unit on the frame.
- The tightness of the couplings and all elements transmitting power.
- The isolation and condition of electrical equipment.
- The condition and tightness of electrical connections.
- Control of oil, fuel and coolant levels.
- Operation of the alarm safety devices.
- Replacement of oil, fuel and air filters.

5.2 Maintenance Table

MOTEURS BAUDOUIN								
Check =	•	**Mandatory maintenance, in operation working hours (H) or period (months - M), every, which occurs first**						
Adjust =	o							
Clean =	Δ							
Replace =	☐	**MD**	**M1**	**M2**	**R1**	**R2**	**R3**	**R4**
OPERATION	**Hour**	**8**	**500**	**1,000**	**2,000**	**4,000**	**8,000**	**16,000**
	Month		**12**	**12**	**12**	**24**	**60**	**96**
Coolant level and temperature		•						
Fuel level in the tank		•						
Oil level at 3 mm below the maximum level on the dipstick		•						
Presence of water, fuel and oil leakages		•						
Air cleaner service indicator		•						
Air filter valve vacuator		•						
Cooling fan status		•						
Exhaust gas colour		•						
Engine sound		•						
Engine speed and vibrations		•						
Fuel pre-filter / water separator filter(s) element(s)		•	☐ [1]					
Cooling fan and alternator belt(s)		•			☐			
Simple engine overall check		•						
Status of all hoses and tightness of all hose clamps		•						
Battery, battery electrolyte level, battery charger, battery cables		•						
Engine and generator elastic supports		•						

Note 1: The indicated change interval running hours is the maximum period when using good quality fuel, (EN 590 standard); this is reduced if the fuel is low quality fuel, if the fuel is contaminated, if the fuel has presence of water.

MOTEURS BAUDOUIN								
Check =	•	**Mandatory maintenance, in operation working hours (H) or period (months - M), every, which occurs first**						
Adjust =	**o**							
Clean =	**Δ**							
Replace =	☐	**MD**	**M1**	**M2**	**R1**	**R2**	**R3**	**R4**
OPERATION	**Hour**	**8**	**500**	**1,000**	**2,000**	**4,000**	**8,000**	**16,000**
	Month		**12**	**12**	**12**	**24**	**60**	**96**
Engine oil			☐					
Oil filter(s) element(s)			☐					
Condensing draining pipes			**Δ**					
Defaults recorded in ECU (if equipped)			•					
Leaks, oil, coolant and fuel levels with engine running			•					
Fuel filter element(s)			☐[2]					
Centrifugal oil filter element(s) (if equipped)			☐					
Air filter element - Clean when visual indicator turns red - max 3 times.			**Δ**	☐				
Breather filter element (if equipped)			**Δ**		☐			
Aftercooler			•	**Δ**				
Engine and generator mechanical connection			•					
Conditions and tightness of all electrical connections			•					
State and tightness of starter			•					
Tightness of couplings and all elements of the transmitting power			•					
The rocker arm and cross-bar clearance				**o**				
Oil cooler (if equipped)				**Δ**				

Note 2: The indicated change interval running hours is the maximum period when using good quality fuel, (EN 590 standard); this is reduced if the fuel is low quality fuel, if the fuel is contaminated, if the fuel has presence of water.

MOTEURS BAUDOUIN								
Check =	•	**Mandatory maintenance, in operation working hours (H) or period (months - M), every, which occurs first**						
Adjust =	**o**							
Clean =	**Δ**							
Replace =	☐	**MD**	**M1**	**M2**	**R1**	**R2**	**R3**	**R4**
OPERATION	**Hour**	**8**	**500**	**1,000**	**2,000**	**4,000**	**8,000**	**16,000**
	Month		**12**	**12**	**12**	**24**	**60**	**96**
Radiator and cooling system				**Δ**				
Turbocharger - axial and radial clearances					•			
Turbocharger air intake side and air pipes					**Δ**			
Radiator pressurized cap					•			
Turbocharger						•		
Oil pressure sensor						•		
Coolant temperature sensor						•		
Coolant						☐		
Fuel flexible hoses/pipes						☐		
Coolant flexible hoses						☐		
Injectors						•		
Fuel supply pump						•		
Fuel injection pump						•		
Belt tensioner(s)						•		
Overhaul (In-Struction)							☐[3]	
Overhaul (Major)								☐[4]

Note 3: Reference to Chapter 5.3.5.2 Overhaul (In-Structure).

Note 4: Reference to Chapter 5.3.5.3 Overhaul (Major).

5.3 Maintenance Operation

NOTE!

Before performing any maintenance work, the engine must be turned off and have cooled off, the battery main switch must be switched off and the ignition key removed, put 'Do not start the engine' sign aside the gen-set.

5.3.1 MD Maintenance Operations

- **Check the coolant level**

NOTE!

Risk of scalding!

The cooling system is under pressure and the coolant is hot. Never open the radiator filler neck to check the coolant level while the engine is in operation or immediately after it is stopped to avoid the skin burns.

- Inspect the coolant level gauge on the radiator tank to check if the coolant level is appropriate.

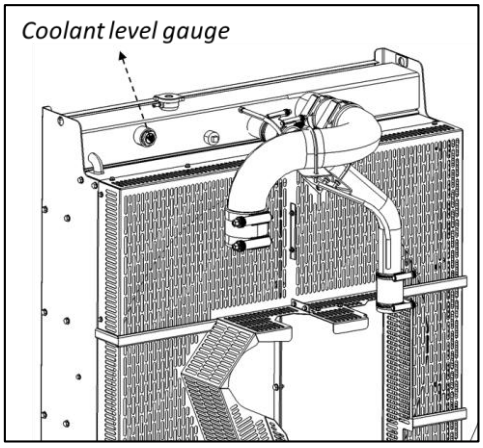


Figure 5.3.1.A

■ Filling Coolant

NOTE!

Do not let coolant drip or leak out onto the ground or into the bodies of water while filling. Otherwise, the environment will be damaged.

The engine's cooling system is to be filled with a mixture of coolant, glycol, and special additives .Never add the normal plain water only. Specific requirement about coolant, see the Part "Annexes".

Coolant can only be filled at the filler.

The engine damage can be caused by excessive temperature difference. When filling with cold coolant in an engine at operating temperature there is a risk of engine damage caused by excessive temperature difference. For this reason, do not add cold coolant to a warmed-up engine.

- Remove coolant filler cap.
- Slowly fill coolant until the coolant higher than the min. mark.

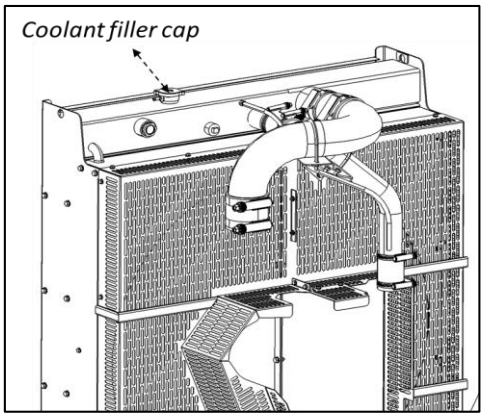


Figure 5.3.1.B

- Close cap.
- Run engine for apporx.15 minutes at rated speed.
- Check the coolant level gauge. If it is need to fill, shut off engine and carefully unscrew cap with safety valve to the first stop to release pressure. Let the engine cool down, and then fill the coolant.
- Check coolant before the next commissioning (with engine cold). Add coolant if necessary.
- Repeat this procedure until coolant no longer is added.

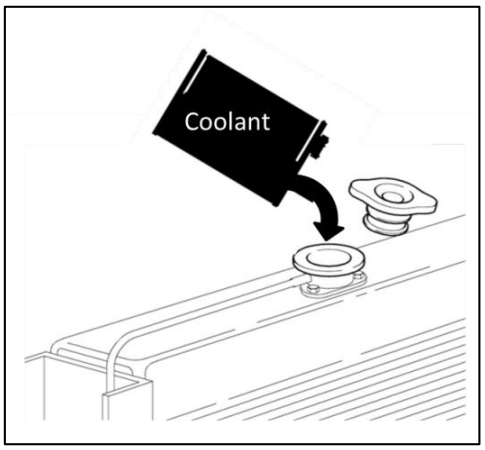


Figure 5.3.1.C

■ **Check the fuel**

NOTE!

Do not allow dirt to enter the fuel system. Before disconnecting any part of the fuel system, thoroughly clean around the connection. When a component has been disconnected, for example a fuel pipe, always fit protective covers and plugs to prevent dirt ingress. Failure to follow these instructions will lead to dirt entering the fuel system. Dirt in the fuel system will seriously damage the fuel injection equipment and could be expensive to repair.

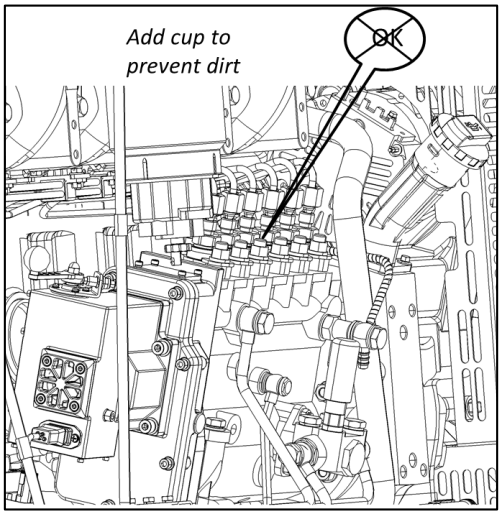


Figure 5.3.1.D

Never use tanks made of galvanized steel for fuel storage. The fuel oil reacts chemically with the zinc coating to produce powdery fragments which clog the fuel filter and may damage the fuel pump and injection nozzle.

When adding fuel, never allow fuel overflow as this may cause a fire. If any fuel is spilled, wipe it up completely. Never bring flames near fuel because it is highly flammable and dangerous.

Check the fuel level with fuel meter or fuel gauge, which is installed in the side of the fuel tank. If the fuel is not enough, add the recommended fuel through fuel filler to fill the tank. Keeping the tank filled with fuel reduces the condensation of moisture and helps to maintain the fuel at a low temperature (important for engine performance).

Refill at the end of work each day in order to prevent fuel contamination caused by condensation. Condensation which occurs in a partially filled tank accelerates the reproduction of microorganisms, causing the fuel filter to be clogged and restricting fuel flow.

The engine is equipped with a fuel-water separator, completely discharge all accumulated water. Water in fuel has a severe impact on engine performance and may damage the engine.

■ **Check the oil level**

NOTE!

Check the oil level when the engine is horizontal at idle speed or engine stopped. If check the oil level when engine stopped only after at least 20 minutes have passed since the engine was switched off.

- Pull out oil dipstick.
- Wipe off oil dipstick with a lint-free cloth.
- Reinsert oil dipstick all the way.

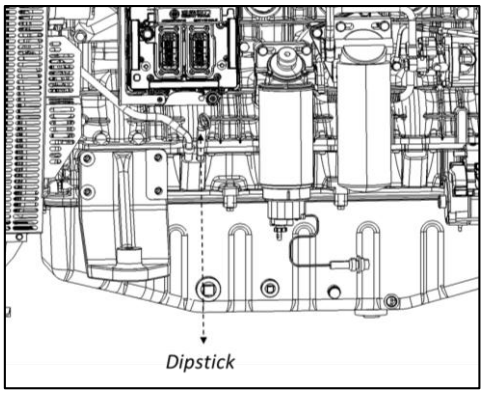


Figure 5.3.1.E

- Pull out oil dipstick again and check oil level.
  The oil level should be between both of the marks on the dipstick and should never drop below the lower mark.
- Reinsert the oil dipstick all the way.
  If the oil level is too low, refill with new oil.

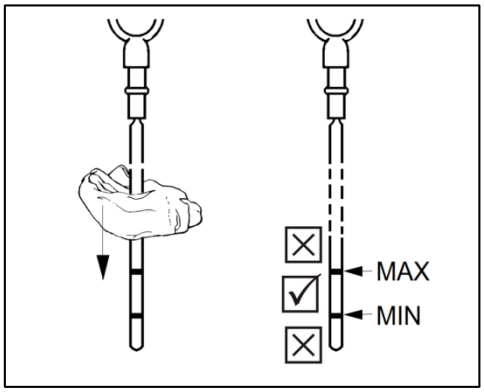


Figure 5.3.1.F

■ **Inspect the exterior of the engine to make sure there is no fuel, oil and coolant leakage, if a fuel or oil leak is found, please stop the engine.to check and repair.**

■ Check the air cleaner service indicator and the air filter valve vacuator.

◆ Conduct maintenance when the clog warning sign appears.

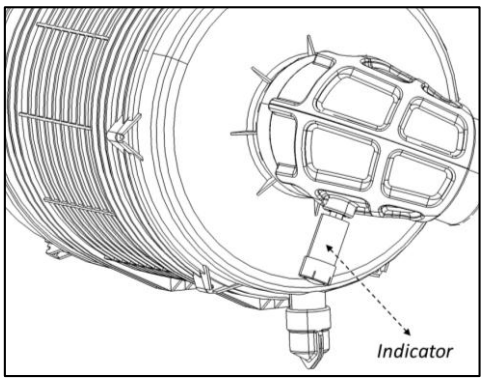


Figure 5.3.1.G

◆ A red signal appears as a warning when the air cleaner element becomes clogged and causes an abnormally large pressure difference between be-fore and after the air cleaner. When a red signal appears, clean the air cleaner element immediately or replace it with a new element.

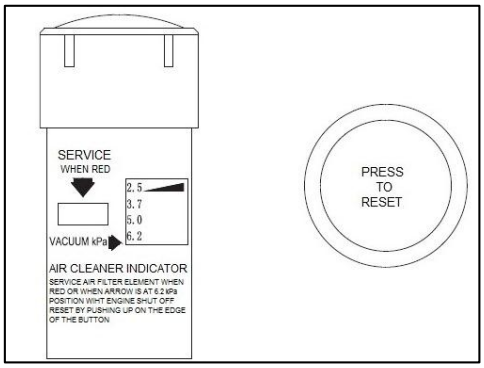


Figure 5.3.1.H

◆ After the element is cleaned or replaced, press the reset button located at the upper part of the indicator to cancel the red signal.

◆ While serving the air cleaner, do not enter dust into the air cleaner or damage the element.

◆ Check the valve vacuator.

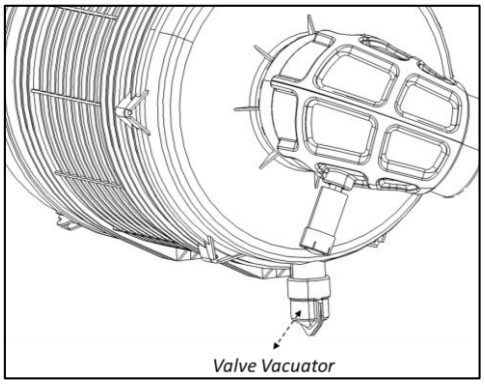


Figure 5.3.1.J

■ **Check the fan**

NOTE!

Do not rotate the engine by pulling or moving the fan. Otherwise, it will damage the fan blades, cause fan failure and cause personal injury or property loss. The crankshaft should be rotated using an accessory drive shaft or crankshaft turning tool.

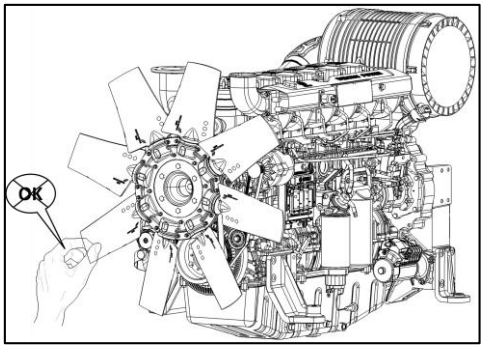


Figure 5.3.1.K

◆ Visually inspect the cooling fan daily. Check for cracks, rivet looseness, blade bend or looseness. Check the fan and make sure it is firmly installed. Tighten the screws if necessary.

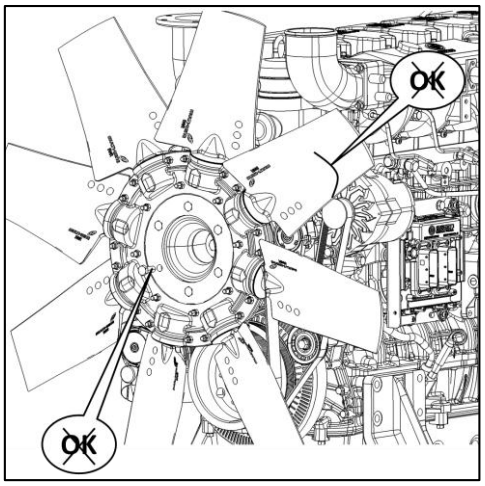


Figure 5.3.1.L

◆ Replace the damaged fan on the original equipment with a fan of the same part number. Refer to the tightening torque of bolts in the maintenance manual.

■ **Check the exhaust gas color**

During the normal running of diesel engine, contrast exhausts color with white paper. When the color changes, check the cause and do troubleshooting.

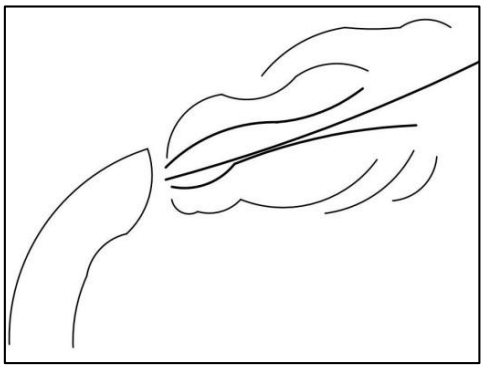


Figure 5.3.1.M

■ **Check if the vibration and sound is in normal condition, and if the speed is stable.**

NOTE!

The abnormal vibration and unsteady speed can cause serious damage to your engine. When there is this type problem, stop your engine and inspect.

- If the foundation vibration is more serious than before, stop the engine and check if there are problem on the engine parts or engine mounting system.
- Inspect the engine with the help of trouble shooting information listed in the Part ANNEX.
- If the problem cannot be solved, consult your **Baudouin** dealer in time.

■ **Check the fuel water separator**

Note!

Before handling fuel, make sure there is no flame or heat source in the area

Wipe spilled fuel thoroughly. Spilled fuel can cause a fire.

Check the water collecting vessel, draining water as follows:

- Place a container under the water separator to receive drained fuel.
- Open the Drain Plug at bottom of water collecting vessel to drain discharge sediment from the filter until diesel flow out.
- Retighten up the water drain plug.

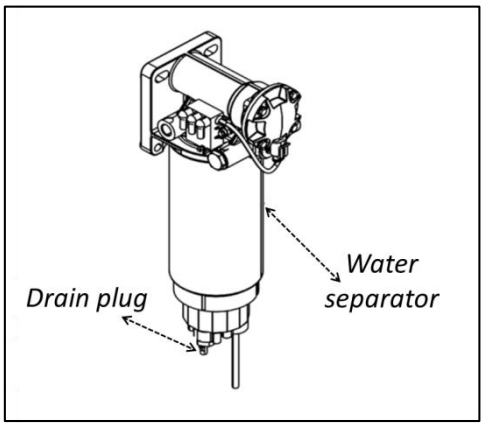


Figure 5.3.1.N

■ **Check the belt**

- Make sure all belts are fully engaged on all pulleys and riding in the correct grooves.

  Look for cracks on the ribs of the belt, fraying at the edges of the belt, or any other signs of unusual wear.

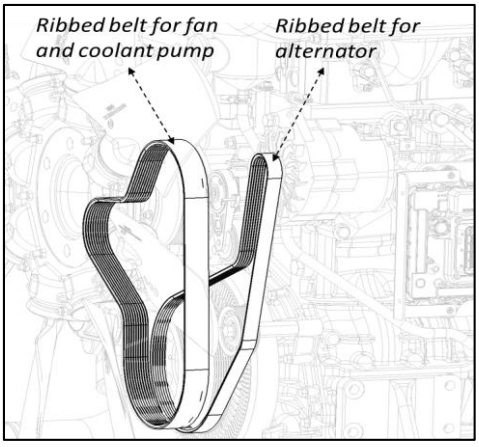


Figure 5.3.1.P

■ **Check the hoses and hose clamps**

- ◆ Inspect all clamps, tighten any loose clamps. Make sure there is no crack on clamps.
- ◆ Inspect any loose or damaged of lines; tighten all connections to the recommended torque.
- ◆ Make sure there is no crack, swell, collapse, rubber peeling on the hoses and lines.

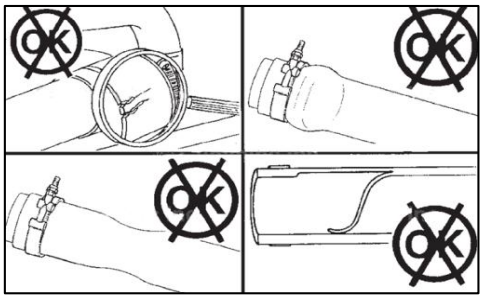


Figure 5.3.1.Q

■ **Check the battery, battery electrolyte level, battery charger, battery cables**

Note !

Clean the top surface of the battery after performing maintenance work. Dust on the battery may cause short-circuit.

Before inspecting or servicing any electrical component, disconnect the ground cable from the negative (-) battery to prevent short-circuits and fire.

Do not use flames near the battery. When handling the battery, be careful of sparks generated by accidental shorting.

If electrolyte is spilled on the eyes, skin or clothes, wash immediately with plenty of water. If electrolyte enters the eyes, flush immediately with lots of fresh water and see a physician.

- ◆ Check the battery electrolyte level. Electrolyte evaporates during use and the fluid level gradually decreases. The fluid surface should be between the LOWER LEVEL and UPPER LEVEL lines. If the fluid level is lower, remove the caps and add electrolyte to the proper level.

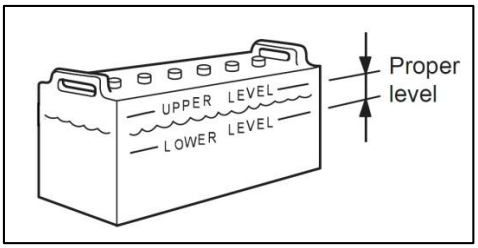


Figure 5.3.1.R

- ◆ Measure the specific gravity of the electrolyte. If the specific gravity measured is lower than the minimum values the battery dealer gives, charge the battery.

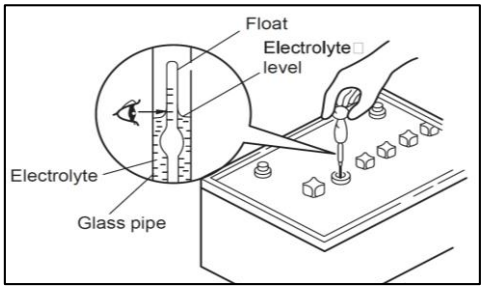


Figure 5.3.1.S

- ◆ Check battery cables and connectors for cracks or corrosion. Replace broken terminals, joints, or cables.

5.3.2 M1 Maintenance Operations

■ **Replace the fuel water separator**

NOTE !

Fuel is flammable. If these liquids are leaking onto hot surfaces they can cause a fire which can cause injury and/or damage.

◆ Clean the area around the fuel water separator;

◆ Drain the water from water collecting vessel screw 2;

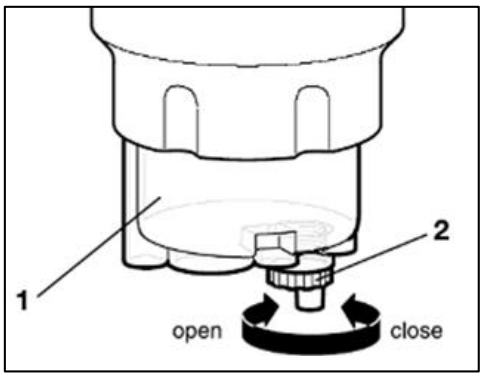


Figure 5.3.2.A

◆ Remove the water collecting vessel from the fuel water separator.

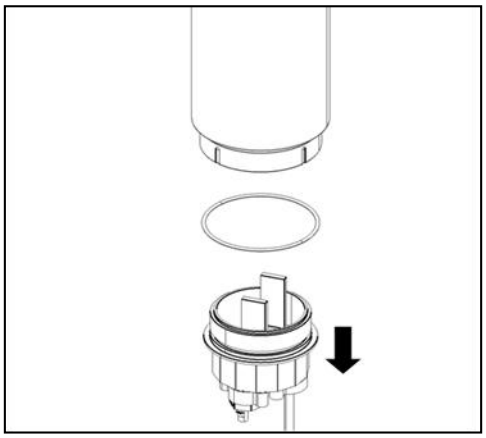


Figure 5.3.2.B

◆ Using the filter wrench, remove the fuel filter element.

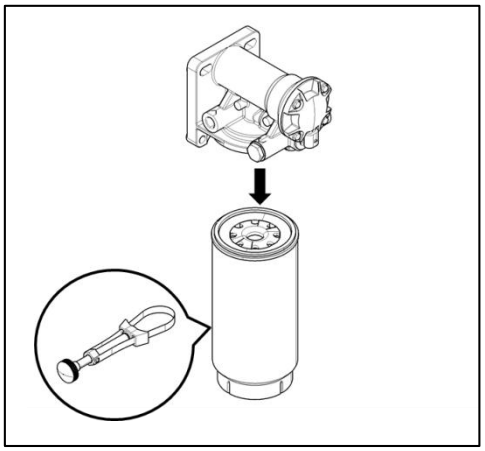


Figure 5.3.2.C

- Apply oil (instead of lubricating grease) onto the sealing gasket and fill the filter with clean fuel.

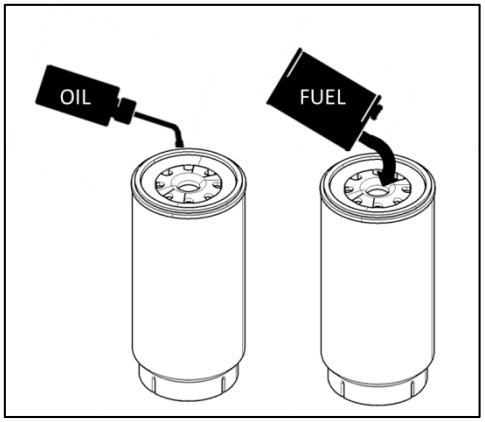


Figure 5.3.2.D

- Screw the filter by hand until the seal combines with the port; Continue to screw the filter by hand until the filter is securely installed (by about 3/4 round).

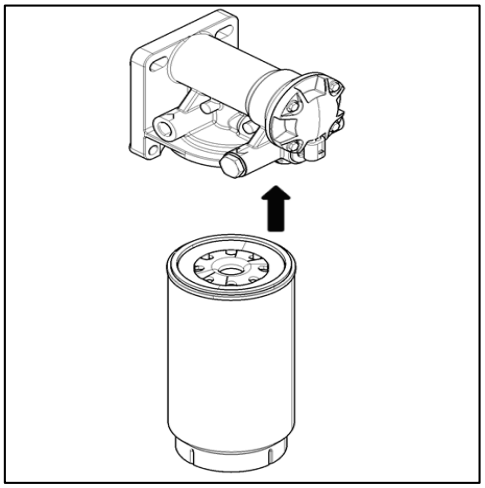


Figure 5.3.2.E

- Assemble the water collecting vessel by hand, and tighten it up.
- Exhaust the air until no bubble appears.
- Start the engine, and let it under no load low idling for several minutes. Check each fuel filter for fuel leaks. If fuel leaks from a filter, loosen the filter and check the gasket for scratches or other abnormalities.

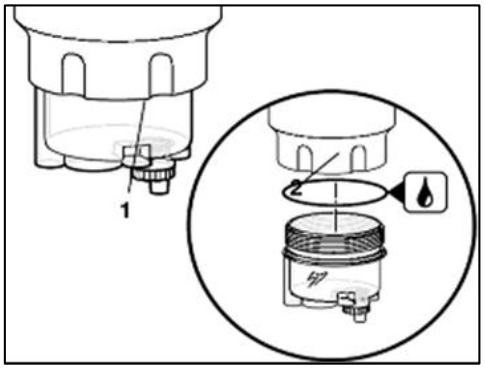


Figure 5.3.2.F

■ Replace engine oil

Note!

Be careful when draining hot engine oil. Hot engine oil can cause burns to un-protected skin. Comply with applicable rules and regulations for the work place. Obey environmental regulations for the disposal of used oil.

To perform this operation with warm engine, to get a better fluidity of the oil and get a full discharge of oil and impurities contained it.

- Remove the oil drain nut and remove the lubricant oil cap to assist the flow of the engine oil. Wait until the oil sump has completely emptied to make sure all the oil and suspended contaminants are removed from the engine.

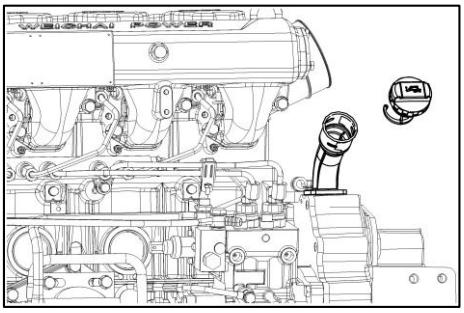


Figure 5.3.2.G

- Fit oil drain plug and tighten firmly.

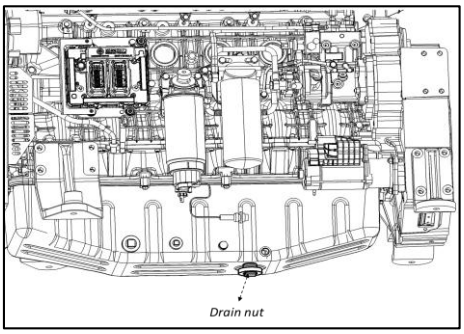


Figure 5.3.2.H

- Pour clean engine oil to the specified level. Refer to “Oil recommendation”.
- Engine oil capacity: 36L

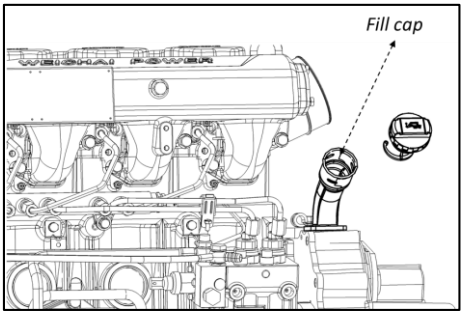


Figure 5.3.2.J

- Check the oil level after finished; refer to “Engine oil check”. And retighten the lubricant oil cap.
- Start engine and let it run at slow idle for 1 minute. Check for oil leaks at engine oil filter. Tighten only enough to stop leaks.

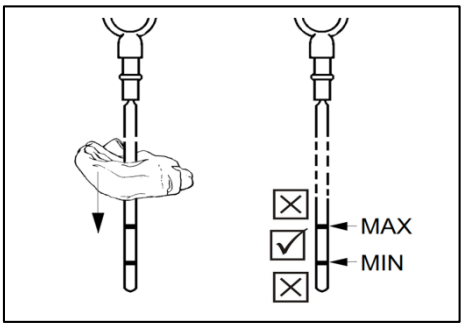


Figure 5.3.2.K

■ Replace oil cartridges

Note!

Hot oil and components can cause personal injury. Wear gloves to prevent hot oil or components from contacting your skin. Do not install the cartridges over tighten.

- Clean the area around the oil cartridges and place a proper container under the oil cartridges, Remove the used cartridges and discard it in a safe place and in accordance with your local regulations.
- Make sure the gasket from the used cartridges does not remain stuck to the cartridges head. Wipe the oil from the cartridges seat with a cloth.

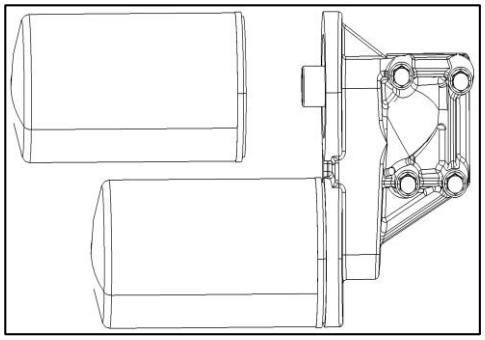


Figure 5.3.2.L

- Apply a thin layer of oil to the gasket on the new cartridges.
- Tighten the cartridges by hand until the gasket contacts the sealing surface, then tighten it an additional ¾~1 turn.
- Start the engine and run at idle. Inspect the cartridges for any oil leak, and inspect the oil pressure. If there is leak, retighten the cartridges, clean the leak, and then inspect for the leak in idle again.

Figure 5.3.2.M

■ Check defaults recorded in ECU(if equipped)

◆ Reading the fault code via the diagnostic smart. Contact **Baudouin** dealer for the diagnostic smart purchasing and using.

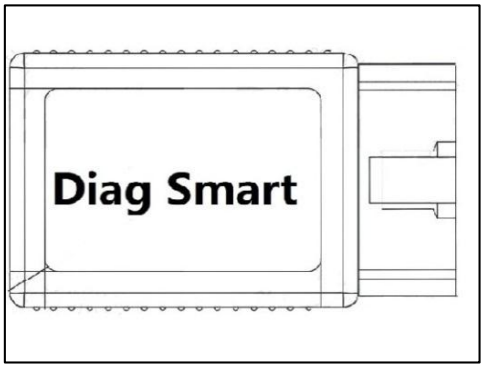


Figure 5.3.2.N

◆ Refer to "List of fault codes" to find the text explanation corresponding to each fault code and you can determine the current fault.

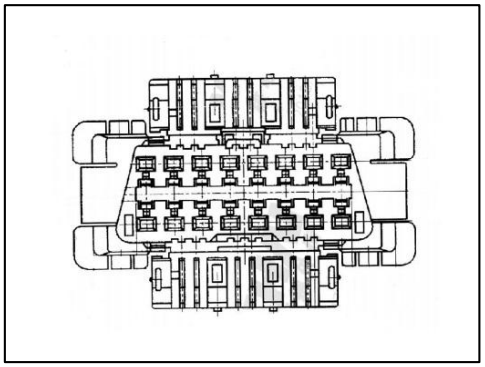


Figure 5.3.2.P

◆ Clearing the memory of historical errors after solving the problems.

Note!
If you encounter electronic control problems, please contact a professional Baudouin representative to consult;
Refer to the diagsmart operation manual for the operation of the diagnostic smart.

■ Replace fuel cartridges

Note!

When handling fuel, make sure there are no flames or heat source in the area. Spilled fuel can ignite and cause fire. Wipe any spilled fuel completely. Do not allow dirt to enter the fuel system. Clean thoroughly the area around fuel system component that is disconnected. Fit a suitable cover to any disconnected component of the fuel system. Do not loosen fuel pipes or fittings except what indicated in this manual.

- Clean the area around the fuel cartridges and place a container under the fuel cartridges. Remove the used cartridge and discard it in a safe place and in accordance with your local regulations.
- Make sure the gasket from the used cartridges does not remain stuck to the cartridges head and wipe the fuel from the cartridges seat with a cloth.

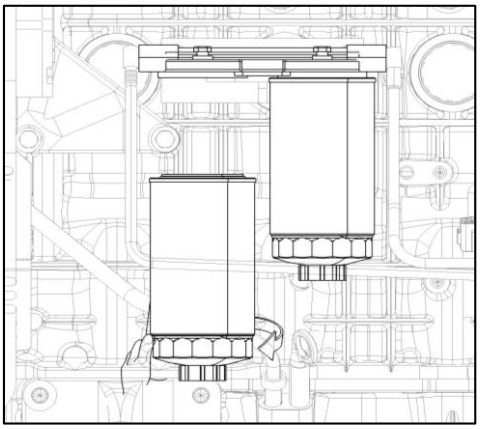


Figure 5.3.2.Q

- Apply a thin layer of oil to the gasket on the new cartridges. Fill the new fuel cartridges with clean fuel via the fuel entry side.
- Tighten the cartridges by hand until the gasket contacts the cartridges seat. Then tighten it an additional ¾~1 turn.
- Start the engine and run at idle. Inspect the cartridges for any fuel leak. If there is leak, retighten the cartridges, clean the leak, and then inspect for the leak in idle again.

Figure 5.3.2.R

■ **Clean the air filter(s), replace if needed**

Note!

Never start the engine without the air filter as this could cause injury and severe engine damage.

A dirty and blocked air filter will reduce the amount of air entering the engine which can cause black smoke and weak power.

Dirty air filter can also lead to early abrasion of cylinder liners and valves, which can cause excessive oil consumption, black smoke and weak power.

After the air filters are cleaned for 3 times, the air filters should be renewed. Unless that, the air filters should be renewed every one year.

Clean the air filters

◆ Use clean air under 0.5MPaor blow and sweep the dust on external filter element from inside to the outside, and it is forbidden to wash the filter element with oil or water.

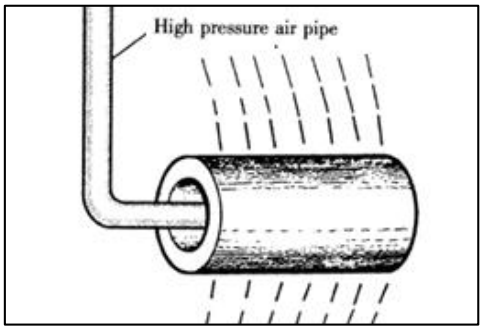


Figure 5.3.2.S

◆ After cleaning, place a light to check for damage, pinholes and worn sections. If any breakage is found, replace the air filter with a new one.

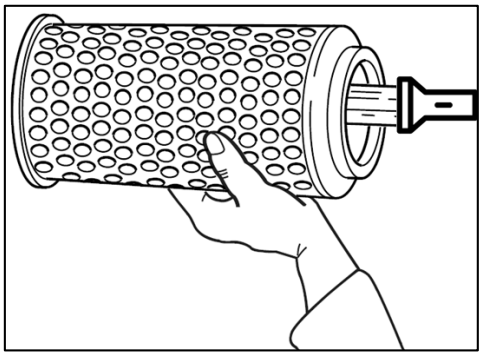


Figure 5.3.2.T

■ Clean the breather filter cartridge

◆ After opening the cover of oil-gas separator, can remove the filter cartridge.

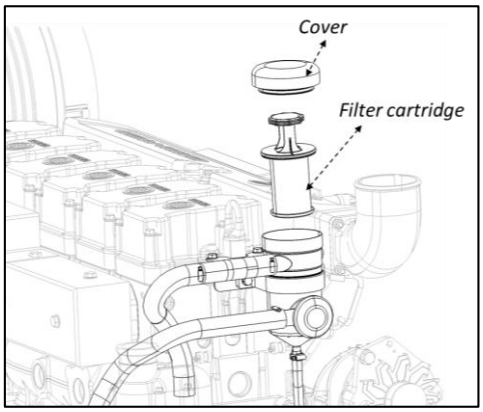


Figure 5.3.2.U

◆ Clean the breather cartridge with fuel.

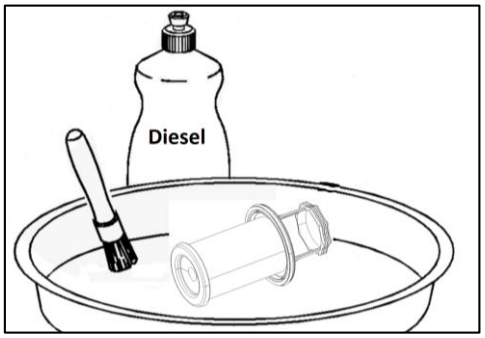


Figure 5.3.2.V

◆ Assemble the cartridge and cover.

■ Check the engine and generator connection

◆ Check if the engine and generator connection is tight; if not, retighten it. Reference to the Appendix about the torque.

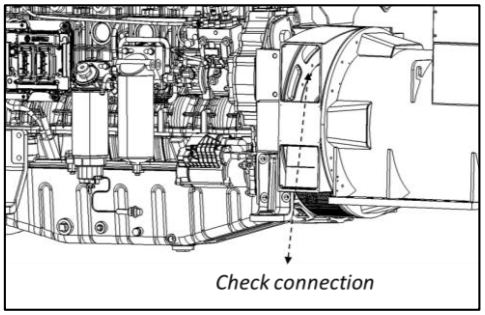


Figure 5.3.2.W

- **Check conditions and tightness of electrical connections(if equipped)**
  - Do not splash water on electrical parts. Water can cause electrical leakage and short-circuiting, resulting in equipment damage. Wet electrical parts can also cause electric shock.
  - When cleaning the engine, keep water away from electrical parts.
  - If malfunctioning of electrical parts is suspected, consult a **Baudouin** dealer.
  - Also, do not use disassembled or reassembled electrical parts.

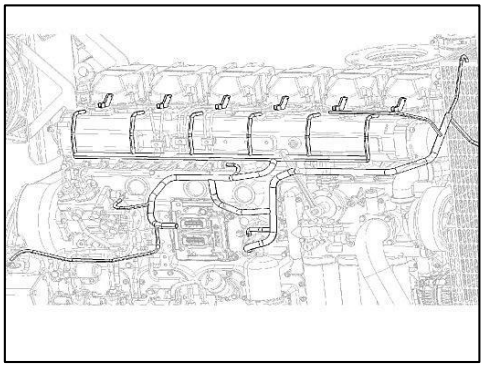


Figure 5.3.2.X

- **Check state and tightness of starter**
  - Check the electrical connections of the starter motor assembly and clean them. Check the starter motor for correct operation.

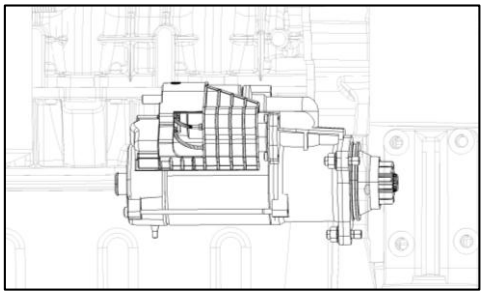


Figure 5.3.2.Y

5.3.3 M2 Maintenance Operations

M2 maintenance operations include **ALL M1 MAINTENANCE OPERATIONS** and the followings:

- **Clean the intercooler, air and water side (if equipped)**
  - Check that the intercooler is not clogged on the air side and that the cooling fins are not damaged.
  - Carefully scrape away any deposits from the cooling fins. Use a paraffin-based engine cleaner if necessary.
  - Carefully straighten bent cooling fins using a steel brush or the like.

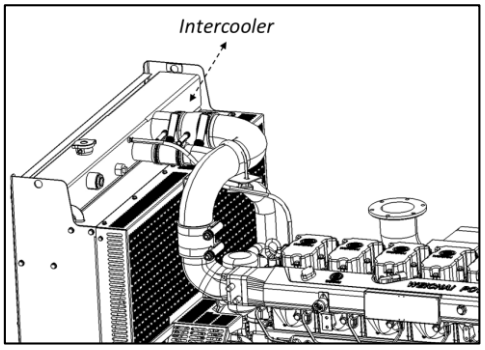


Figure 5.3.3.A

- **Clean the radiator and cooling system**
  - Clean radiator cooling fins with compressed air. Cleaning should be done always in opposite direction of air flow.

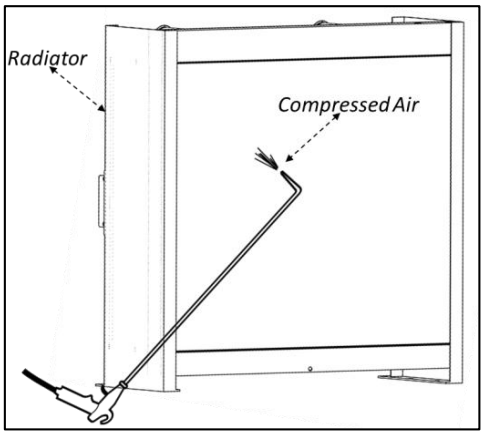


Figure 5.3.3.B

- **Change the air filters**
  - Release clamps.
  - Remove the cover.
  - Remove the dirty filter.
  - Install new air filter.
  - Install the cover and tighten clamps.

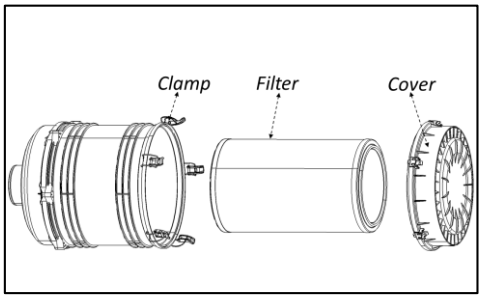


Figure 5.3.3.C

5.3.4 R1/R2 Repair Operations

■ **Change Belt**

Note!

The fan belt idler is under tension. Do not allow your hands to get between the idler and the belt or the fan hub. Personal injury can result.

◆ Remove the grid of radiator, and then loose the fan.

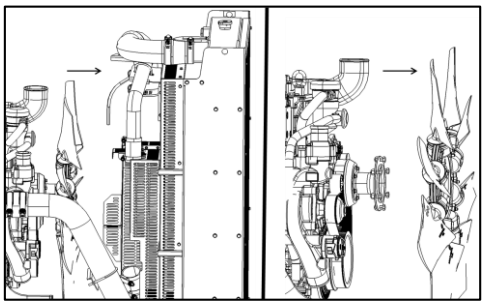


Figure 5.3.4.A

◆ Use a wrench to hold the belt tensioner. Rotate the idler cap clockwise to relieve the tension on the idler.

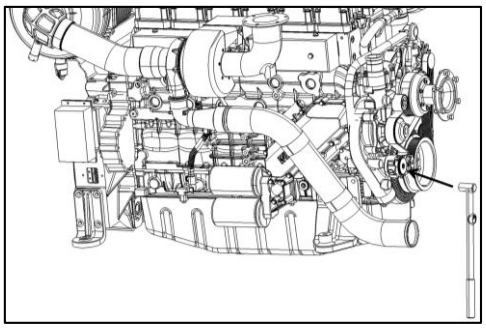


Figure 5.3.4.B

◆ Remove the belt.

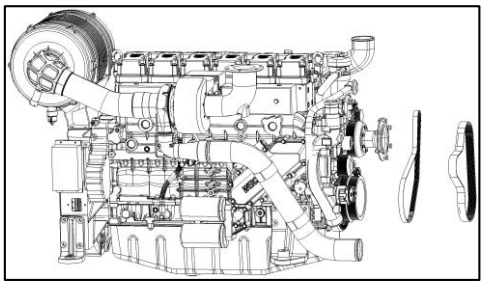


Figure 5.3.4.C

◆ Use a wrench to hold the belt tensioner. Rotate the idler cap clockwise to relieve the tension on the idler .Install the belt. Make sure it is fully seated on the pulley grooves. Belt tension is automatically set. Reinstall the fan and radiator.

■ Check the turbocharger

◆ Disassemble the inlet pipe and exhaust pipe from the turbocharger.

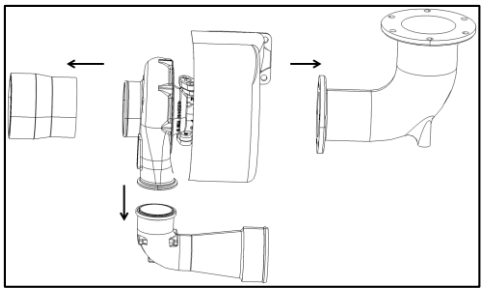


Figure 5.3.4.D

◆ Inspect the turbocharger compressor impeller blades for damage. Contact a **Baudouin** authorized service center if damage is found.

◆ Care must be taken to the air filters. For if the impellor was polluted, the balance adjusted precisely would be deviated to cause a vibration that may cause the stuck or abnormal wear of the bearing.

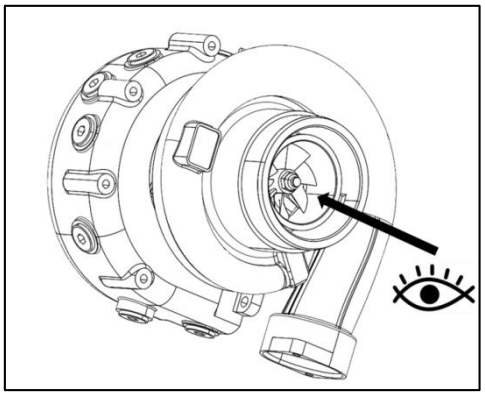


Figure 5.3.4.E

◆ Use a dial indicator to measure the axial motion (end-to-end), in case that the clearance to axial directions exceeds the standard values, replace or repair the turbocharger.

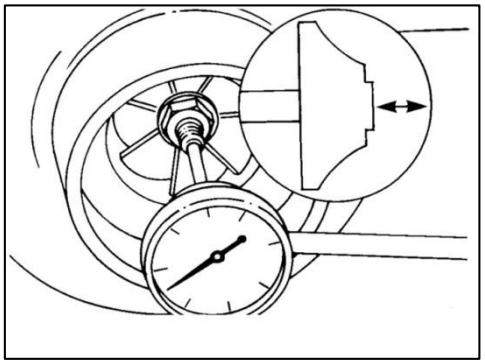


Figure 5.3.4.F

◆ Measure the radial clearance (side-to-side) at the compressor impeller nose using a dial indicator. In case that the clearance to radial directions exceeds the standard values, replace or repair the turbocharger.

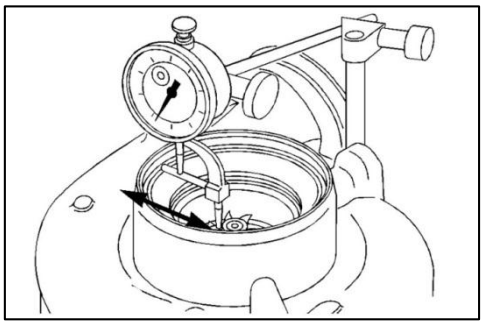


Figure 5.3.4.G

■ **Replace the Coolant**

Note!

For information regarding the disposal and the recycling of used coolant, consult your Baudouin dealer.

Stop the engine and allow the engine to cool. Ensure that the engine will not start when the cooling system is drained.

◆ Stop the engine; add the special cleaning detergent for engine cooling system to the old coolant.

◆ Start the engine, run engine for 15min at idle speed.

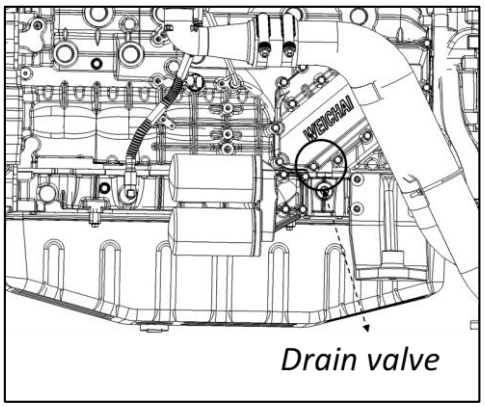


Figure 5.3.4.H

◆ Stop the engine, drain the old coolant completely to the container by opening the drain valves of cooling system and radiator.

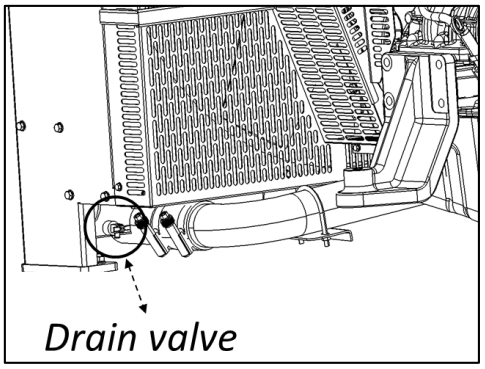


Figure 5.3.4.J

◆ Remove the thermostats; fill the cooling system with clean water, run engine until it has reached operating temperature for approximately 20-30 minutes.

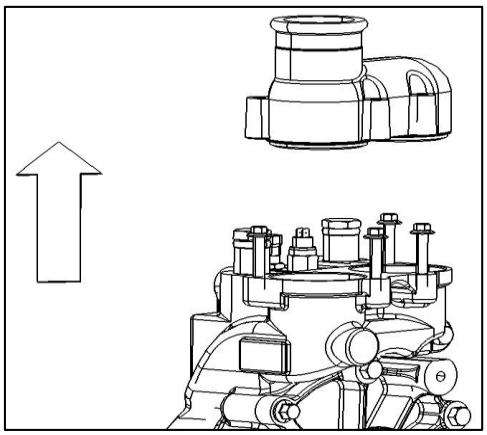


Figure 5.3.4.K

- Shut the engine OFF, allow it to cool to 50°C, and drain the cooling system. If the water drained is still dirty, the system must be flushed again until the water is clean.
- Assemble the thermostats.
- Make sure the radiator drain valves are closed, fill new coolant.

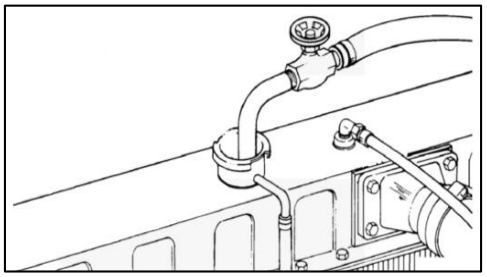


Figure 5.3.4.L

- Check the o-ring of the cooling systemfiller cap. If the o-ring is damaged, replace the old cooling systemfiller cap with a new cooling system filler cap.

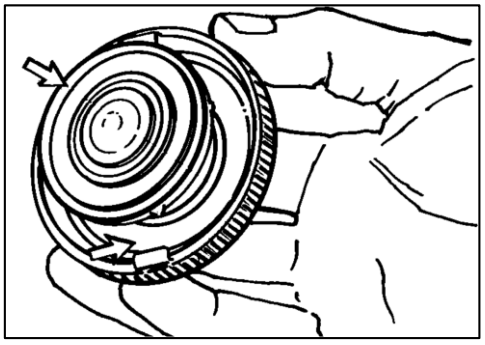


Figure 5.3.4.M

■ **Check the belt tension**

NOTE!

Slippage of loose belts can reduce the efficiency of the driven components. Vibration of loose belts can cause unnecessary wear on the belts, pulleys, and the relevant bearings.

- Pull on the belt and check the tensioner is moving. If the belt has a manual tensioner, press on the belt in the middle of the longest span between pulleys. The belt should deflect 12mm~19mm (1/2"~3/4") with a force of about 15kg (33lbs). If the belt deflection is out of spec, adjust the tensioner to reset the belt tension. Do not over tighten.

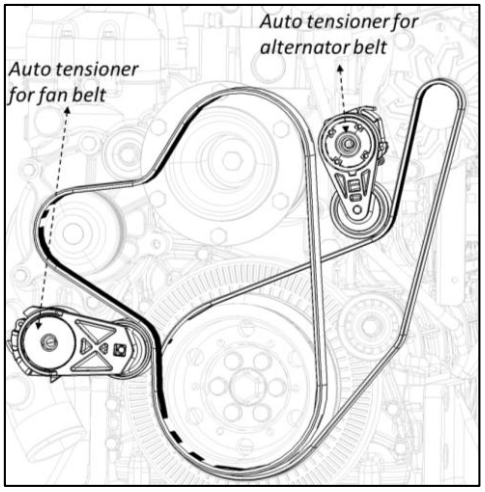


Figure 5.3.4.N

5.3.5 Overhaul Operations

5.3.5.1 Overhaul Information

An overhaul is replacing the major worn components of the engine. An overhaul is a maintenance interval that is planned. The engine is rebuilt with certain rebuilt parts or new parts that replace the worn parts.

An overhaul also includes the following maintenance:

- Inspection of all the parts those are visible during the disassembly
- Replacement of the seals and gaskets that are removed
- Cleaning of the internal passages of the engine and the engine block.

5.3.5.2 Overhaul (In-Structure)

■ **Scheduling an In-Structure Overhaul**

Scheduling an in-structure overhaul normally depends on the following three conditions:

- An increase of oil consumption(Oil consumption≥1g/kw·h)
- Power reduction ≥10%
- Fuel consumption rise ≥10%

Each individual condition may not indicate a need for an overhaul. However, evaluating the three conditions together is the most accurate method of determining when an in-structure overhaul is necessary.

Periodically measure each of the three conditions. The first measurement should occur during the engine commissioning. This establishes a baseline for future measurements. Additional measurements are scheduled at regular intervals in order to determine a schedule for the next in-structure overhaul.

Note!

These indications do not require an engine to be shut down for service. These indications only mean that an engine should be scheduled for service in the near future. If the engine operation is satisfactory, an immediate overhaul is not a requirement.

Note!

The generator or the driven equipment may also require service when the engine overhaul is performed. Refer to the literature that is provided by the OEM of the driven equipment.

■ **In-Structure overhaul**

Some components that wear are replaced. The condition of components is inspected. Those components are replaced, if necessary.

The recommendations of parts for in-structure overhaul is as followed:

Clean Inspect Test	
➢ Condition of the cylinder head seating in the plane of the cylinder head gasket	➢ Perform sealing pressure test of cylinder heads
➢ Injection pipes	➢ Cylinder head assemblies
➢ Fuel injection pump	
Inspect Replace	
➢ Seats valves, guides, valves, springs, sleeves.	➢ Pistons
➢ Liners	
Replace	
➢ Starter	➢ Fuel injectors
➢ Alternator	➢ Coolant pump
➢ Radiator pressurized cap	➢ The lubricating pipes (rocker arm, turbochargers …)
➢ Fuel supply pump	
➢ Rocker arm and shaft	➢ Thermostatic valves

■ **Cylinder head assemblies**

The valves and the valve seats are worn over time. This causes the valves to recede into the cylinder head. This condition is called valve recession.

In order to determine the wear condition between the valve seat and the valve, it is necessary to further measure the valve recession. Valve recession is the vertical distance between the valve bottom face and the bottom plane of the cylinder head.

- ◆ Perform sealing pressure test of cylinder heads.
- ◆ Measure the valve recession with a depth gauge.
- ◆ Check whether the upper and lower end face of valve guide has eccentric wear, damage, etc. Measure inner diameter of valve guide with inner diameter gauge.
- ◆ If valve recession and valve guide wearing exceeds the limit, need to rebuild the cylinder.
- ◆ Rebuild the cylinder head: replace new valves, valve seats, valve guides, valve stem seals all together if any of them need to be replaced.
- ◆ Grind to ensure the seal ability between valve and valve seat.

5.3.5.3 Overhaul (Major)

The need for a major overhaul is determined by several factors. Some of those factors are the same factors that determine the in-structure overhaul:

- ◆ A decrease of main oil pressure at rated speed ≤400kPa (Main factor)
- ◆ An increase of oil consumption
- ◆ An increase of crankcase blowby

Other factors must also be considered for determining a major overhaul:

- Power output
- The service hours of the engine
- Reduced oil pressure
- The wear metal analysis of the lube oil
- An increase in the levels of noise and vibration

An increase of wear metals in the lube oil indicates that the bearings and the surfaces that wear may need to be serviced. An increase in the levels of noise and vibration indicates that rotating parts require service.

A major overhaul includes all of the work that is done In-Structure overhaul. A major overhaul includes additional parts and labor. Additional parts and labor are required in order to completely rebuild the engine. In some cases, the engine is relocated for disassembly.

For the major overhaul, all of the bearings, seals, gaskets, and components that wear are disassembled. The parts are cleaned and the parts are inspected. If necessary, the parts are replaced. The crankshaft is measured for wear. The crankshaft may require regrinding. Alternatively, the crankshaft may be replaced.

The recommendations of parts for major overhaul is as followed:

Clean Inspect Test	
➢ Timing gears clearances	➢ Camshaft
➢ Crankshaft	
Replace	
➢ Engine and generator elastic supports	➢ Connecting-rod bearings
➢ Piston rings	➢ Tappets and push rods
➢ Radiator and cooling system	➢ Front and rear seals on the crankshaft
➢ Pistons	➢ Cooling fan bracket
➢ Liners	➢ Damper and fixing screws
➢ Turbocharger	➢ Cylinder head
➢ Fuel injection pump	➢ Oil cooler

5.4 Storage Protection Instruction

5.4.1 Necessity of Anti-rust Protection

If your engine is out of operation and using for a period of time, then precautions should be taken to protect your engine from damage and to ensure proper operation when you re-operate the engine.

The recommendations indicated below are designed to prevent damage to the engine when it is withdrawn from service for a prolonged period. Use these procedures after the engine is withdrawn from service. Where necessary protect the engine against frost damage.

5.4.2 Storage Environment Requirement

If the engine is placed in storage area, the following precautions should be taken to protect it.

- **Equipment must be kept clean.**
  - Store indoors, cover it with a VCI plastic bag.
  - Keep the engine covered to avoid airborne dust and dirt.
  - Cover the ventilation openings, conduit connections, etc., to prevent entry of rodents, snakes, birds, insects, etc.

- **Keep the equipment dry.**
  - Store in a dry indoor area.
  - Temperature swings should be minimal to prevent condensation.
  - If stored in an unheated or damp building, space heaters will be required to prevent internal condensation.
  - Apply a rust inhibitor for unpainted flanges, shafts, drive discs, and fittings.
  - Check insulation resistance of all windings before starting the engine. Dry out the windings if reading is low.

5.4.3 Preparation before Storage

- Clean the engine for dirt, rust, grease, and oil. Inspect the exterior. Paint the damaged paint area with good quality paint.
- Remove the dirt from the air cleaner(s). Check all seals, gaskets, and the filter elements for damage.
- If the engine is stored outside, cover it with a waterproof canvas or other suitable protective material and use a strong waterproof tape.

5.4.4 Instructions for Short-Term Storage

- **Up to one week**
  - No special treatment is necessary.
  - Just clean the area around the engine body.

■ **Up to three months**

Each week operate the engine until the normal temperature of operation is reached. If the engine is not going to be operated, turn the crankshaft by hand, in the normal direction of rotation (anti-clockwise as seen on the flywheel), a minimum of three revolutions.

5.4.5 Necessary Materials

■ **Calibration oil**

Calibration Oil is a low viscosity mineral oil-based test fluid.
Calibration Oil is a calibration and storage oil for diesel fuel system. Rust preventative properties of this oil ensure proper functioning of the equipment in normal conditions even after one year storage, without cleaning the equipment after calibration.

Safety protection is recommended while using the calibration oil, such as barrier cream or rubber gloves.

■ **VCI oil**

Volatile corrosion inhibitor (VCI) provides liquid and vapor protection to ferrous metal surfaces against corrosion caused by moisture. In a closed compartment, protection is either by direct contact with VCl oil or by contact with VCl vapors. Contact your local supplier for similar type of oil.

VCI oil can be used in all tanks, engine, fuel tank, hydraulic tank, power steering tank, transmission, differential, and other components. The inhibitor is an oil stabilizer and rust preventive.

For correct use of VCl oil, the engine must be sealed when stored. VCI oil is so volatile that any opening left unsealed will allow the vapors to escape, causing the engine to lose protection.

Note!

- **VCI oil should not be used full strength on non-ferrous metals where the inhibitor will have direct, prolonged contact.**
- **The inhibitor can be used in combination with any petrochemical. Apply by using a spraying or fogging pattern. The VCI oil must be diluted according the instruction of suppliers.**

VCI oil cleaning method

- Drain the VCI oil from the engine.
- Refill standard-compliant engine lubricating oils. For lubricating oil, please refer to the manual “Fluids RECOMMENDATIONS”.
- Operate the engine for 5 minutes at low idle rated speed.
- Drain the oil completely and refill new lubricating oil.

■ **Sprayer**

Load the VCI oil dilution into the sprayer, then can be used to prepare the engine for storage. Change the nozzle adjustment to provide either a spray or a fog pattern.
VCI oil dilution: mixture of 50 percent VCI oil and 50 percent engine oil.

■ **Plastic bag**

Use ultraviolet light resistant plastic bags. The bag must have a minimum thickness of 0.10 mm (0.004 inch) if the bag is filled with Volatile Corrosion Inhibitor (VCI) oil.

■ **Waxed paper**

Wax paper is a surface-coated wax that has excellent water and oil resistance.
Wrap parts and sealing to prevent rust.

■ **Adhesive tape**

Use a sealing tape with appropriate adhesive properties. DO NOT use duct tape because duct tape gets loosen over time. Rolls of sealing tape that are 2 inches wide are recommended.

An appropriate quality sealing tape is available from the following suppliers: 3M Product Information Center.

■ **Biocide**

Diesel Fuel Biocide is used to prevent the growth of small organisms in the diesel fuel; use diesel fuel biocide such as Biobor JF or equivalent.

5.4.6 Long Term Storage（More Than Three Months）

■ **Lubricating oil system**

Drain and replace the crankcase oil and change the oil filters. Add VCI oil to the crankcase at the rate of 3 to 4 percent by the volume of the crankcase.

Note!
If the engine crankcase is full, drain enough engine oil so the mixture can be added.

■ **Coolant system**

Drain the coolant and flush the cooling system, such as engine blocks, separate circuit after-coolers, and other related components. It is not necessary to have engine stored for less than three months. However, for extended storage periods of three months or longer, it is recommended that the cooling system to be drained, flushed, and refilled. Refill with appropriate coolant.

Recommend TOTAL GLACELF AUTO SUPRA concentrates, the coolant concentrates must be diluted according the instruction of suppliers.

Note!

◆ **If the stored engine is subjected to below freezing temperatures, completely drain**

the freshwater system. Drain the system by removing the drain plugs from the engine block, oil cooler, heat exchanger body, and radiator.

- **The mixture must NOT contain less than 50% inhibited ethylene glycol or propylene glycol and may contain up to 70% by volume.**

Fresh Water Systems

Drain the coolant from cooling system and thoroughly flush with the clean water. The system then should be refilled with mixture of clean water and any of the coolant preservative containing VCI. If the storage is less than three months, drain mixture of clean water and any of the VCI coolant from cooling system after finished running of the engine.

For clean water, please refer to the manual" Fluids RECOMMENDATIONS Diesel".

Raw Water Systems

Completely drain the raw water system by removing all the drain plugs from the raw water pump, water shield manifolds, heat exchanger bonnets, and aftercooler. After the system has been drained, inspect all zinc plugs (normally painted red) for corrosion damage.

Note!

To ensure complete drainage and evaporation during storage, DO NOT install the drain plugs and zinc plugs. Place all removed plugs in a cloth bag and fasten the bag to the engine for storage.

Caution!

When finished all above operations of lubricating oil system and coolant system, then start the engine for 5 minutes at low idle rated speed.

Turn off the engine and wait about 30 minutes to get it cooled completely, then make operations as follows.

- **Fuel system**

Calibration oil

Calibration oil is the preferred choice as a preservation fluid because the calibration oil contains Rust and Oxidation inhibitors.

Recommend CASTROL CALIBRATION OIL 4113, please follow the supplier's instructions.

Fuel filter

Remove the fuel from the secondary fuel filter housing or empty and reinstall the spin-on fuel filter element to remove any dirt and water. Drain the fuel injection pump (sleeve metering only).Clean the primary fuel filter. Fill with calibration oil. Install the primary fuel filter and operate the priming pump. This will send clean oil to the secondary filter and engine.

Fuel tank

Open the fuel tank drain valve and allow any water or dirt to drain from the fuel tank. Apply a

VCI oil of 30 ml per 30 L (1 oz per 7.50 gal) of fuel tank capacity to prevent rust in the fuel tank. Add 0.15 ml per L (.02 oz per 1 gal) of commercial biocide such as Biobor JF or an equivalent to the fuel.

Fuel nozzle and spark plug

Remove the fuel nozzles or spark plugs and apply 30 ml (1 oz) of VCI oil mixture (50 percent VCI oil and 50 percent engine oil) in each cylinder.

Use a bar or turning tool to rotate the engine slowly to put the oil on the cylinder walls. Install all the fuel nozzles or spark plugs and tighten to the correct torque.

■ Intake and exhaust system

Air filter

Remove the air filter elements. Seal the air filter inlets, with VCI plastic bag and adhesive tape. Use the starter to drive the engine, but no fuel. Then use a sprayer to add VCI oil dilution into the air inlet and turbocharger inlet, multiple times, total 60s.

Exhaust openings

Use a sprayer to apply VCI oil dilution into the exhaust openings. The minimum application rate is 5.5 ml per L (3 oz per 1000 cu in) of engine displacement. Seal the exhaust pipe, including any drain holes in the muffler.

Vents

All vents i.e. engine inlet pipe, exhaust pipe, air cleaner inlet, coolant inlet & outlet, crankcase breather, the crankcase breather and all other openings etc. must be carefully sealed with VCI plastic bag and adhesive tape.

Note!

VCI oil mixture can also be added to the inlet by removing the plug for checking turbocharger boost pressure. The minimum application rate is 5.5 ml per L (3 oz per 1000 cu in) of engine displacement.

■ Electrical system

Battery

If battery is provided for engine starting, it should be disconnected and stored in a cool, dry place after ensuring electrolyte level (refill with distilled water if necessary). It is recommended to recharge the battery once in a month.

Starter

Clean the electric starter and wiring harness, keep them dry, then cover the alternator in moldable waxed paper, and seal with adhesive tape.

Alternator

Cover the alternator in moldable waxed paper, and seal with adhesive tape.

Engine wiring harness

Clean the engine wiring harness, and keep it dry.

■ **The others**

V-belt

Loosen all the belts (tension, fan, alternator, etc.)

Flywheel

Spray a thin amount of VCI oil mixture on the flywheel, ring gear teeth, and starter pinion. Install the covers to keep in the VCI vapors.

Note!

Use a VCI plastic bag to cover the engine. Ensure the engine cover is secure, but loose enough to allow air to circulate around the engine to prevent damage from condensation, and put some desiccants, then seal with the adhesive tape.

Attach a tag to the engine with a notation of the date that the unit was preserved.

Remove the waterproof cover every three months and check the engine for corrosion. If the engine has signs of corrosion at the check period, repeat the protection procedure.

5.4.7 Removal from Storage

Refer to the appropriate section for detailed services listed below or have your authorized servicing dealer or engine distributor perform services that you may not be familiar with.

- Remove all the outside protective covers. Unseal all the openings in engine and remove the covering from electrical systems.
- Change the oil and oil filters. Then drain the oil and refilled with new lubricating oil. For lubricants, please refer to the manual" Fluids RECOMMENDATIONS".
- Drain the VCI coolant from the engine. Use clean water to flush any compartment that contains VCI coolant to remove all residuals. Then drain the clean water and refill new coolant. For coolant, please refer to the manual" Fluids RECOMMENDATIONS".
- Replace the fuel filter elements and fill the fuel tank with diesel fuel.(Gas machine does not need to do this operation)
- Check the battery level.
- Check the condition of the fan and alternator belts. Replace the belts, if necessary. Tighten the belts as specified in the Operation & Maintenance Manual.
- Check the engine harness if the harness is not aging. Replace the harness, if necessary.
- Remove the batteries from storage. Install batteries (fully charged) and connect the electric wires.
- Install fan/alternator poly-vee belt if removed earlier.
- Perform all appropriate pre-starting checks.
- Please assemble all the other parts back to engine.

5.4.8 Initial Running after Storage

The purpose of this operational check is to ensure that the correct pressures and temperatures are maintained in the lubrication, cooling, and fuel systems. Also, these operation ensures that

any leaks are corrected.

To ensure a safe operation, use the following procedure:

- Before starting the engine, use hand oil pump or electric pre-supply pump to establish the oil pressure of the engine.
- Crank engine for 20 seconds with starter (do not allow the engine to start). Wait 2 minutes and crank the engine for additional 20 seconds to assure bearing surfaces are adequately lubricated.
- Start the engine and run at low idle and no load for several minutes. Warm up carefully and check all gauges before placing engine under load.
- Operate the engine for 10 minutes at low idle rated speed.
- Operate the engine for 15 minutes at half rated load and 3/4 rated speed.
- Operate the engine for 30 minutes at full rated load and full rated speed.
- Check regularly for leaks such as oil, coolant, and fuel during the first few hours of operation. Repair any leaks as soon as detected.
- Check all kinds of indicators to confirm that there is no abnormality, if there are any abnormal parameters, please handle it promptly.

6. Appendix

6.1 Coolant Recommendation

The coolant ensures the best efficiency of the cooling system and protection against corrosion (chemical and galvanic). It improves also boiling temperature, resistance to rust and avoids scale deposit formation.

- The coolant used in Baudouin engines should meet the **ASTM D6210** standard, and the coolant used in Baudouin engines should not contain **2-ethylhexanoate**, which has compatibility problems with silicone rubber.
- Do not use a commercial coolant that only meets the **ASTM D3306** specification. This type of coolant is made for light-duty engine applications.
- The coolant recommended in '**Fluids Manual** ' is preferred for Baudouin engines.

Important Note
45% glycol content is the minimum required values to maintain the best boiling temperature. Do not use ethylene glycol content that exceed **60%**.

6.2 Lubricant Recommendation

It is important to comply with the oil drain and filter change intervals to guarantee the proper operation of your **S. I. Moteurs Baudouin** equipment.

Lubricant grade for the engine

Present lubricant certification process according to API and ACEA standards is adequate to guarantee adequate quality and performances.
Therefore **S. I. Moteurs Baudouin** requires use of following lubricants:

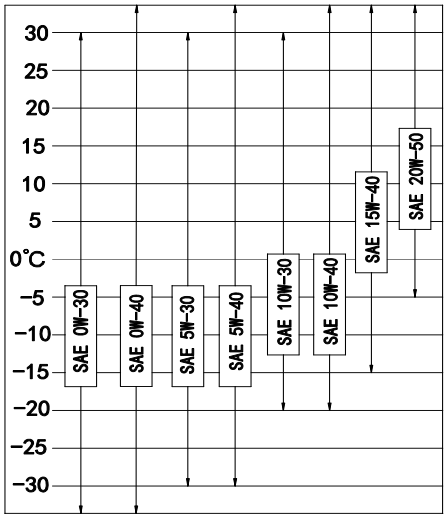
API CI-4 or ACEA E7 15W40

- **Quality Grade**
  Lubricating oils are differentiated according to their performance and quality class. Oils with comparable specifications can be used.

Approved Oil		
Baudouin Engine	Off-road stage Ⅱ	Off-road stage Ⅲ
API	**CI-4**	**CI-4**
ACEA	**E7**	**E7**

- **Viscosity**
  As the viscosity of lubricating oil is dependent on temperature, the choice of SAE grade should be governed by the ambient temperature prevailing at the engine operating site. Should the temperature fall temporarily below the limits of the SAE grade selected, cold star-ting may be affected but the engine will not be damaged. In order to keep wear to a minimum, do not exceed application limits for extended periods of time. Synthetic lubricating oil features an improved temperature and oxidation stability.

Viscosity selction based on ambient temperature



Viscosity and temperature properties specification

Project	Low-temperature kinematic viscosity /mPa·s(℃) ≤	Viscosity（100℃） /mm²/s	High-temperature and high-shear viscosity （150℃, $10^6 s^{-1}$） /mPa·s ≥	Pour point/℃ ≤
Test method / Viscosity grade	GB/T 6538 ASTM D5293	GB/T 265 ASTM D-445 /ISO 3104	SH/T 0618 SH/T 0703 SH/T 0751 CECL-36-T-84 ASTM D4741-87 ASTM D 4582-95 ASTM D4624-93	GB/T 3535 ASTM D 97
0W-20	6200(-35)	5.6～<9.3	2.6	-40
0W-30	6200(-35)	9.3～<12.5	2.9	
0W-40	6200(-35)	12.5～<16.3	2.9	
5W-20	6600(-30)	5.6～<9.3	2.6	-35
5W-30	6600(-30)	9.3～<12.5	2.9	
5W-40	6600(-30)	12.5～<16.3	2.9	
5W-50	6600(-30)	16.3～<21.9	3.7	
10W-30	7000(-25)	9.3～<12.5	2.9	-30
10W-40	7000(-25)	12.5～<16.3	2.9	
10W-50	7000(-25)	16.3～<21.9	3.7	
15W-30	7000(-20)	9.3～<12.5	2.9	-25
15W-40	7000(-20)	12.5～<16.3	3.7	
15W-50	7000(-20)	16.3～<21.9	3.7	
20W-40	9500(-15)	12.5～<16.3	3.7	-20
20W-50	9500(-15)	16.3～<21.9	3.7	
20W-60	9500(-15)	21.9～<26.1	3.7	

6.3 Fuel Recommendation

IMPORTANT:
Improper fuel additive usage may cause damages to fuel injection equipment of diesel engines.

- **Quality Grade**

Use commercially available diesel fuel with less than **0.35%** Sulphur content. If the sulfur content is higher than **0.5%**, oil change intervals should be halved.
The following fuels can be used on Baudouin engine:

--- **European standard EN 590**.
--- **ASTM D-975**
--- **BS 2869 Part 1 Class A 1 standard**

- **Winter-grade Fuel**

When temperature is low and the fuel you currently use is not proper, there will be wax in the fuel. Wax can clog the fuel system and reduce engine performance. If the ambient temperature is less than 0℃， winter-grade fuel should be used.
When temperature is below -20℃, please choose proper diesel fuel that can be used in this temperature range.
For more information about fuel selection, please consult your local fuel supplier.
The pour point of diesel fuel should be at least 6℃ lower than the minimum ambient temperature. The proper pour point is essential for engine start-up and running performance.
If diesel fuel with proper pour point is unavailable, Baudouin recommends using fuel heater to resolve the wax problem. Fuel heater is a low cost solution in most application.

6.4 Common Faults and Troubleshooting

6.4.1 Troubleshooting

■ Engine Turns, But It Does Not Start

Table 6-1 Engine turns, but it does not start

Problem	Cause	Remedy
A: Engine emits hardly any exhaust smoke	(1) No fuel supplied to fuel injection pump	
	a) Air trapped in fuel supply system	Bleed air from fuel filter and fuel feed pipes, and inspect each part for damage and air leaks. Disassemble and repair, if necessary.
	b) Empty daily fuel tank	Add fuel.
	c) Fuel filter is blocked	Disassemble and clean, or replace filter element.
	d) fuel feed pipe is blocked	Clean inside of pipe.
	e) Fuel is not supplied due to malfunction of fuel feed pump or drive unit	Disassemble and inspect, or replace fuel feed pump or drive unit.
	f) Electronic governor problem for mechanical pump	Check the governor power, speed controller set, and the actuator, or replace the controller.
	(2) Fuel supplied to fuel injection pumps	
	a) Loose fuel injection pipe and low injection pressure	If loosened, tighten.
	b) Seized or damaged parts in fuel injection pump Malfunction of fuel lever Control rack does not move	Inspect control link. If there is a fuel lever linkage problem, disassemble and repair. Remove cam chamber cover, and operate by hand. If parts are defective, disassemble and repair, or replace.
	c) Seized plunger	Replace, if defective.
	d) Clogged two-way delivery valve	Inspect two-way delivery valve, and disassemble and clean.
	e) Broken plunger spring	Disassemble and repair, or replace if defective.

B: Engine emits small amount of exhaust smoke. (Check the cause of insufficient injected fuel. Check all items in A-(1) and (2)- b, and also check items at right.)	a) Fuel lever does not open fully	Check relation of movement with fuel lever, and disassemble and repair if defective.
	b) Seized tappet in fuel injection pump	Check for uneven movement, and disassemble and repair, or replace.
	c) Worn tappet roller or camshaft in fuel injection pump (reduced amount of injected fuel)	Replace, if worn.
	d) Seized or worn plunger in fuel injection pump, worn broken plunger spring (reduced amount of injected fuel)	Check for uneven movement, and disassemble and repair, or replace.
	e) Loose tightening screw of control rack of fuel injection pump	Tighten screw.
	f) Defective oil sealing performance of two-way delivery valve, or broken two-way delivery valve spring	Disassemble and repair, or replace.
	g) Fuel viscosity too high to allow smooth flow	Use fuel with viscosity suitable for ambient temperature. If fuel quality is improper, change fuel.
	h) Large amount of fuel leaks from fuel injection nozzles, and insufficient injected fuel	Check leak-off pipe for amount of fuel leaks, check with nozzle tester, and replace defective parts if necessary
C：Engine emits large amount of exhaust smoke. (Check the cause of ignition failure despite sufficient amount of injected fuel.)	(1) Improper fuel injection timing	
	a）Malfunction of camshaft drive	Inspect camshaft drive section, and adjust fuel injection timing correctly.
	b） Deviation of fuel ignition timing due to worn fuel injection pump tappet roller or camshaft cam	Replace if worn.
	(2) Poor spray condition of fuel injection nozzles	

	a）Sticking of needle valve in fuel injection nozzle, or improper valve seat sealing	Check with nozzle tester, and disassemble and repair, or replace.
	b）Low fuel injection nozzle valve opening pressure	Using nozzle tester, adjust adjustment screw so that fuel is injected at specified valve opening pressure.
	c）Damaged or broken nozzle spring	Replace if damaged.
	d) Large amount of fuel leaks from nozzle	Clean mounting surfaces of nozzle and holder. Replace if necessary.
	(3) Insufficient compression pressure (cylinder internal temperature does not reach ignition temperature)	
	a）Inadequate rotation speed	If starting air pressure is low, increase pressure. If engine oil viscosity is high, heat oil or change oil to one with appropriate viscosity Repair if there are other abnormalities.
	b）Inlet/exhaust valve not contacting valve seat properly	Disassemble and repair by lapping valve in valve seat, or replace if necessary.
	c）Valve remaining open	Check for sticking of valve and valve guide, incorrect tappet assembly, and valve clearance, and correct abnormalities if necessary.
	d）Leaking of compression pressure due to worn cylinder liners or sticking of piston rings	Disassemble and repair, or replace if necessary.
	e）Leaking of compression pressure from cylinder cover	Check for gas leaks, and tighten cylinder cover properly. Repair gas seal surface or replace gas seal ring, if necessary.
	(4) Inappropriate fuel	
	a）Inappropriate fuel or water in fuel	Drain fuel and check. Change to higher- quality fuel, if necessary

■ Engine Does Not Turn

Table 6-2 Engine does not turn

Problem	Cause	Remedy
A：Malfunction of starting air system	a）Malfunction of starting valve	Inspect starting valve, and repair or replace
	b）Starting air pressure lower than specified	Check air tank pressure, and increase pressure if low
B：Malfunction of mechanical engine parts	a）Seizing of moving parts in engine	Disassemble and inspect pistons, connecting rods, crankshaft, camshaft, bushings of timing gear and others, inlet and exhaust valves, etc., and repair.
	b）Deviation of timing due to incorrect engine assembly Pistons are hitting valves	Disassemble and repair.
	c）Viscosity of engine oil too high, or clotted oil	Change oil to one with lower viscosity.

■ Engine Output is Low

Table 6-3 Engine output is low

Problem	Cause	Remedy
A：Engine emits small amount of exhaust(Engine output and speed are inadequate due to insufficient injected fuel.)	(1) Tendency of engine moving parts toward seizing	
	a）Tendency toward seizing due to insufficient clearances of engine parts	Check abnormal heating of parts listed in B-a in Table 6-2, and repair defective parts
	b）Inadequate lubrication	Check oil level, oil pressure and oil viscosity, and add, adjust or replace oil, and also clean lubricating system if there is oil clogging
	(2) Insufficient amount of fuel supply	
	a）Clogged fuel system or loose pipe	Clean or replace. (Refer to A in Table 6-1.)
	b）Malfunction of fuel supply or injection system	Clean or replace. (Refer to B in Table 6-1.)
B：Engine emits excessive white exhaust smoke	(1) Engine knocking and excessive white smoke when engine is cold	
	Injection timing too advanced	Correct. (Refer to C-(1) in Table 6-1.)
	(2) Poor combustion due to low compression pressure	

	a）Valve remaining open.	Check for valve, valve guide sticking and valve clearances, and repair.
	b）Inlet/exhaust valve not contacting valve seat properly	Disassemble and correct by lapping valve in valve seat, or replace if necessary.
	c）Broken inlet/exhaust valve spring	Disassemble and repair, or replace if necessary.
	d）Leaking of compression pressure due to worn cylinders or sticking of piston rings.	Disassemble and repair, or replace if necessary.
	(3) Poor fuel condition (water in fuel)	Open drain cock and check fuel. Drain water or change fuel.
C: Engine emits excessive black exhaust smoke	(1) Fuel injection timing too retarded	Correct. (Refer to C-(1) in Table 6-1.)
	(2) Uneven fuel injection among cylinders (Poor combustion condition, unstable rotation with knocking)	
	a) One or more worn tappet rollers or cams on camshaft in fuel injection pumps causing deviation of fuel injection timing	Replace if worn
	b) One or more plunger springs seized, worn or broken	Disassemble, repair or replace
	(3) Poor spray condition of some fuel injection nozzles (Exhaust temperature of cylinders with poor fuel spray condition may become high.)	Refer to C-(2) in Table 6-1
	(4) Poor combustion due to insufficient inlet	
	a) Malfunction of turbocharger (damage of vanes, seizing of bearing, etc.)	Disassemble and repair, or replace if necessary
	b) Malfunction of inlet/exhaust valve	Refer to B-(2) in Table 6-3
	c) Air cleaner clogged with dust	Disassemble and clean, or replace if necessary

■ Engine Knocks

Table 6-4 Engine knocks

Problem	Cause	Remedy
A：Engine knocks slightly and emits black exhaust smoke	Fuel injection timing too retarded	Refer to C-(1) in Table 6-1
B：Knocking is severe, and exhaust smoke is white	Fuel injection timing is too advanced	Refer to C-(1) in Table 6-1
C：Knocking is severe in certain cylinders	Uneven fuel injection among cylinders	
	a)Excessive fuel injection in some cylinders	Refer to C-(2)-a in Table 6-1
	b) Fuel injection timing too advanced in some cylinders	Refer to C-(2)-b in Table 6-1
D：Ignition retardation occurs and results in simultaneous ignition to cause severe knocking.	Improper spray of fuel by fuel injection nozzles	
	Fuel is not sprayed in proper condition in some cylinders	Refer to C-(2) in Table 6-1
E：Ignition retardation occurs frequently and results in simultaneous ignition to cause severe knocking	Low engine compression	
	Amount of intake air is low in some cylinders	Refer to C-(3) in Table 6-1
F： Injection of fuel generates knocking, and engine emits large amount of black or gray exhaust smoke. When oil does not rise, engine does not knock severely and emits bluish white exhaust smoke	Engine oil rising above pistons	
	a） Oil level too high in crankcase	Discharge oil to appropriate level.
	b） Worn piston rings or sticking of piston rings, resulting in inadequate scraping of oil	Check crankcase breather pipe for gas leak, and replace if there are defective parts.
	c） Excessive clearance between cylinder and piston	Check crankcase breather pipe for gas leak, and replace if necessary.
	d） Engine oil viscosity too low	Change to high-quality oil with higher viscosity.
G：Abnormal noise produced when injection is stopped suddenly and engine is allowed to rotate by inertia (engine mechanical failure)	a) Excessive connecting rod bearing clearance, or bearing metal flaking	Disassemble and inspect, and repair or replace if necessary.
	b) Loose connecting rod cap tightening bolts	Disassemble and inspect, and repair or replace if necessary.
	c)Excessive clearance between cylinder and piston	Check crankcase breather pipe for gas leak, and replace if necessary.

	d)Piston hitting foreign item fallen inside cylinder	Disassemble and inspect.
H：Low compression temperature and retarded ignition cause severe knocking, especially after engine starts in cold weather	Engine too cold	Operate engine until it warms up before increasing engine speed

■ Engine Produces Large Amount of Smoke While in Operation

Table 6-5 Engine produces large amount of smoke while in operation

Problem	**Cause**	**Remedy**
A：Engine emits excessive white exhaust smoke	(1) Severe knocking	
	Fuel injection timing too advanced	Refer to C-(1) in Table 6-1.
	(2) Knocking produced only in cylinders with insufficient compression	
	Low engine compression	Refer to C-(3) in Table 6-1.
	(3) Improper fuel	
	a Water contained in fuel	Open drain cock and check. Remove water or change fuel.
	(4) Other	
	a）Lange amount engin e oil rising above pistons	Inspect and repair or replace as described in F in Table 6-4.
	b）Engine too cold, resulting in poor combustion	Inspect temperature regulator, and adjust it properly to prevent overcooling.
	c）Engine operating too long with no load	Unburned oil is trapped in exhaust pipe. White smoke stops after engine is operated under load.
B：Engine emits excessive black exhaust smoke.	(1) Minor knocking	
	a Injection timing too retarded	Refer to C-(1) in Table 6-1.
	(2) Other	
	a）Excessive amount of injected fuel	Check if fuel injection pump rack set screw or bolt is loose, and repair.
	b）Fuel injection not uniform	Inspect, and repair or replace as described in C-(2) in Table 6-3

	c） Improper spray of fuel by fuel injection nozzles	Inspect, and repair or replace as described in C-(2) in Table 6-3
	d） Low engine compression	Inspect, and repair or replace as described in C-(2) in Table 6-3
	e） Large amount engine oil rising above pistons	Inspect and repair or replace as described in F in Table 6-4.

■ Engine Operates at High Speed and Does Not Stop

Table 6-6 Engine operates at high speed and does not stop

Problem	**Cause**	**Remedy**
Fuel injection pump does not set to no-injection condition	Link between fuel increase/ decrease lever and governor failing to return smoothly to original position	Check if link returns without catching, and repair if necessary.
	a） Loose control link lever	Repair if rack does not move in connection with governor lever.
	b）Sticking of rack disallowing its return to original position	Check rack for smoothness, and disassemble and repair.

■ Malfunction of Lubricating System

Table 6-7 Malfunction of lubrication system

Problem	**Cause**	**Remedy**
A： Oil pressure does not rise immediately after start	a) Engine oil level too low	Check oil level gage, and add oil if level is low
	b) Engine oil viscosity too high for smooth pumping of oil (Especially when temperature is low)	Change oil to one with appropriate viscosity
	c) Clogged oil pump suction side or strainer screen	Remove pipe from pump discharge side, and check oil discharge. If no oil is discharged, disassemble, clean and repair, or replace
	d) Malfunction of regulator valve	Repair or replace defective parts, such as broken valve spring and seized valve
	e) Clogged oil filter element	Disassemble, clean, replace

	f) Defective oil pressure gage	Disconnect oil pressure gage pipe. If oil pours out, replace oil pressure gage
B：Oil pressure drops gradually during operation	a) Clogged oil filter element	Disassemble, clean, replace
	b) Engine oil viscosity too low	Oil temperature rises and causes oil pressure to drop. Change oil to one with higher viscosity
	c) Abnormally high oil temperature	Engine is overheated. Do not operate engine until oil temperature is low
	d) Tendency toward bearing seizing	Disassemble, repair
C：Oil pressure abruptly drops during operation and remains there	a) Damage bearing causing increased oil leaks	Disassemble and repair
	b) Cracking in engine oil passage, or oil leakage from joint	Check for leaks, and repair or replace defective parts
D：Oil pressure fluctuates suddenly during operation	Engine oil level too low, causing air to mix into oil	Check oil level gage, and add oil if level is low

6.4.2 Diagnostic Fault Codes List

Description	Code	SPN	FMI	P- code
Fault path of air condition power stage	3-1-3	985	12	P2519
			2	P2519
Error status of ADC monitoring	1-1-1	520192	3	P060B
			4	P060B
			11	P060B
			2	P060B
Fault path of Accelerator Pedal 1	2-2-1	91	3	P0123
			4	P0122
			2	P2135
Fault path of Accelerator Pedal 2	2-2-1	29	3	P0223
			4	P0222
			2	P2135
Error path of atmospheric pressure sensor	2-3-2	108	3	P2229
			4	P2228
			12	P0000
			2	P2227
Error path for the Adjustable Speed Limit lamp	3-3-6	520194	3	P0649
			4	P0649
			5	P0649
			2	P0649
Error path for AccPed and Brake Plausibility	2-2-5	91	7	P2299
AirCtl permanent positive governor deviation	4-5-3	520195	15	P0402
AirCtl permanent negative governor deviation	4-5-3	520196	17	P0401
Grid heaters always switched on	3-2-2	676	7	P0540
Fault path1 of air heater test switch on	3-2-3	729	3	P1020
			4	P1021
Fault path2 of air heater test switch off	3-2-3	730	3	P1022
			4	P1023
Error path of power stage air heater 1 actuator	3-2-1	729	3	P0542
			4	P0541

Description	Code	SPN	FMI	P- code
Fault path for short circuit to battery for BPA power stage	3-4-4	1192	3	P0048
Fault path for short circuit to ground for BPA power stage	3-4-4	1192	4	P0047
Fault path for no load and excess temperature for BPA power stage	3-4-4	1192	12	P0045
			2	P0046
Error path for boost pressure sensor	2-3-1	102	3	P0238
			4	P0237
			12	P0235
			2	P0236
Battery voltage fault	1-2-4	168	3	P0563
			4	P0562
Error path for brake signal	2-2-3	597	12	P0571
			2	P0504
Error path of Intercooler Bypass Valve Power stage	2-2-4	520197	3	P022C
			4	P022B
			12	P022A
Error path for coolant level sensor	2-4-6	111	3	P2559
			4	P2558
			12	P2556
			2	P2557
Fault path of CRERCD condition power stage	3-2-5	1072	3	P0080
			4	P0079
			255	P1633
			255	P1634
Error path for the cold start lamp	3-3-5	1081	3	P1635
			4	P1636
			12	P1637
			2	P1638
Error path of coolant temperature sensor	2-4-1	110	3	P0118
			4	P0117
			12	P0115
			2	P0116

Description	Code	SPN	FMI	P- code
Coolant temperature sensor absolute test	2-4-5	520198	2	P0116
Coolant temperature sensor dynamic test	2-4-5	520198	2	P0116
Error path for Misfire cylinder 1	5-1-1	1323	3	P0301
Error path for Misfire cylinder 2	5-1-2	1324	3	P0302
Error path for Misfire cylinder 3	5-1-3	1325	3	P0303
Error path for Misfire cylinder 4	5-3-1	1326	3	P0304
Error path for Misfire cylinder 5	5-3-2	1327	3	P0305
Error path for Misfire cylinder 6	5-3-3	1328	3	P0306
Error path for misfire in multiple cylinders	5-1-4	1322	3	P0300
Physical plausibility DCS	2-2-8	520199	2	P0856
Fault path for compression test	5-2-1	520200	20	P161F
Diagnostic fault path signals errors of main clutch signal	2-2-2	598	12	P0704
			2	P0704
Error path of environment air temperature sensor	2-3-5	171	3	P0073
			4	P0072
			12	P0071
Error path of BET temperature sensor	2-3-5	520201	3	P1505
			4	P1506
Error path of ClgZn temperature sensor	2-3-5	520202	3	P1507
			4	P1508
Error path of Inside air temperature sensor	2-3-5	520203	3	P1509
			4	P150A
Fault path for Engine Brake Pre-Selection switch status	3-4-2	520204	2	P1635
Error path of power stage for EGR Bypass valve actuator	3-5-1	520205	3	P245D
			4	P245C
			12	P245A
Fault path 1 for Engine Compartment Start Button	3-4-3	1041	8	P2530
Error path for Exhaust Gas Pipe Pressure Sensor	3-4-5	520206	3	P0473
			4	P0472
			2	P0470

Description	Code	SPN	FMI	P- code
Fault path for short circuit to battery for EGR power stage	3-5-1	2791	3	P0490
Fault path for short circuit to ground for EGR power stage	3-5-1	2791	4	P0489
Fault path for no load and excess temperature for EGR power stage	3-5-1	2791	5	P0404
			2	P0403
If running with camshaft only is active the fault path is set	1-1-4	190	12	P0008
Error path of camshaft failure	1-1-3	636	12	P0340
			11	P0341
Error path of crankshaft failure	1-1-2	190	12	P0335
			11	P0336
Error path of offset between camshaft and crank-shaft	5-4-1	190	7	P0016
Fault path of engine Protection	2-2-6	533	15	P0219
Error path for Short circuit to Batt of power stage for Exhaust Flap actuator	3-1-1	1074	3	P0478
Error path Short circuit to Ground of power stage for Exhaust Flap actuator	3-1-1	1074	4	P0477
Error path for Open circuit and excess temperature of Exhaust Flap actuator	3-1-1	1074	12	P0476
			2	P0476
Fault FMTC_trq2qBas_MAP contains non-strictly monotonous q curves	1-2-5	520236	13	P1007
Fault Path for Fuel Temperature sensor	2-1-5	174	3	P0183
			4	P0182
Error path of power stage fan actuator	3-1-2	1071	3	P0692
			4	P0691
			12	P0480
			2	P0483
Error path of power stage fan 2 actuator	3-1-2	1071	3	P0694
			4	P0693
Error path of fan speed sensor signal	3-1-2	1639	3	P0526
			4	P0527
Fuel filter fouling switch	2-1-3	95	3	P1015
Fuel filter fouling switch	2-1-3	95	4	P1016

Description	Code	SPN	FMI	P- code
Fuel filter fouling switch	2-1-3	95	2	P1017
Fault path for fuel filter heating output	2-1-6	520207	3	P1008
			4	P1009
Water in fuel sensor	2-1-4	97	3	P2267
Water in fuel sensor	2-1-4	97	4	P2266
Fuel filter fouling detection	2-1-2	95	7	P1018
Dfp for Water Detection Sensor	2-1-1	97	11	P2269
Dfp for Heater used in EGR Mass Flow rate	4-3-3	520208	3	P0406
			4	P0405
			12	P0409
			2	P0409
Dfp for Recirculated Engine Exhaust Gas Temperature sensor	4-3-2	520209	3	P040D
			4	P040C
			12	P040A
			2	P040B
Dfp for message Dash Dspl	4-3-4	520210	3	U0158
Faults of CAN message EBC1	4-4-1	520211	12	P0000
Dfp for message ERC1DR	4-4-2	520212	3	U1100
Faults of CAN message ETC1	4-4-3	520213	12	U0103
Dfp for CAN message EngGsFlowRt	4-1-5	520214	12	U0113
Dfp timeout for message HRVD	4-1-6	520215	3	U1101
Df p for message RxAMCON	4-4-4	520216	3	U0156
Dfp for Time-out error of RxCCVS message	4-4-5	523218	12	U0104
Dfp for CAN message RxEngTemp2	4-5-1	523604	12	U1102
Faults of CAN message TCO1	4-4-6	523222	12	U0157
Dfp for message TF	4-5-2	520217	3	U1103
Dfp for messages TSC1-AE	4-2-1	523605	11	U1104
			12	U1105
Dfp for message TSC1-AR	4-2-1	523606	11	U1106
			12	U1107
Dfp for messages TSC1-DE	4-2-2	523607	11	U1108
			12	U1109

Description	Code	SPN	FMI	P- code
Dfp for message TSC1-DR	4-2-2	523608	11	U110A
			12	U110B
Dfp for message TSC1-PE	4-2-3	520218	3	U110C
			4	U110D
Dfp for messages TSC1-TE	4-2-4	898	11	U110E
			12	U110F
Dfp for message TSC1-TR	4-2-4	520	11	U113A
			12	U113B
Dfp for messages TSC1-VE	4-2-5	520219	3	U1110
			12	U1111
Dfp for message TSC1-VR	4-2-5	520220	3	U1112
			12	U1113
Dfp timeout for message Time Date	4-1-7	520237	3	U1114
Faults of CAN message WSI	4-3-5	520238	12	U1115
Faults in CAN send messages	4-3-1	523500	12	U0001
Physical plausibility TSC	2-2-7	520221	2	U0404
Power Stage fault status for Generic Lamp 1	3-3-4	624	3	P1623
			4	P1624
			12	P1625
			2	P1626
Power Stage fault status for Generic Lamp 2	3-3-4	624	3	P1627
			4	P1628
			12	P1629
			2	P162A
Power Stage fault status for Generic Lamp 3	3-3-4	624	3	P162B
			4	P162C
			12	P162D
			2	P162E
Error state communication - SPI	2-6-3	523617	11	P060A
Error state of EEPROM	2-6-5	630	255	P0000
			4	P062F
			12	P062F
			2	P062F

Description	Code	SPN	FMI	P- code
Error path for Recovery which is locked	2-6-1	520222	14	P0607
Error path for Recovery which is suppressed		520222	14	P0607
Error path for Recovery which is visible		520222	14	P0607
Error state supply voltage CJ940 upper limit	2-6-3	523612	3	P1607
Error state supply voltage CJ940 lower limit	2-6-3	523612	4	P1608
Error path of air humidity sensor	2-3-6	520224	3	P150B
			4	P150C
Error path of air temperature sensor	2-3-3	105	3	P0098
			4	P0097
			12	P0099
Fault path of injection limitation	1-5-5	520225	16	P1300
			15	P1301
			11	P1302
Fault path bank1-specific errors -> stop engine	1-5-1	523350	3	P1203
			4	P1204
			11	P1205
			11	P1206
Fault path bank1-specific warnings -> stop engine	1-5-1	523351	11	P1207
			11	P1208
			12	P1209
			11	P120A
Fault path bank2-specific errors -> stop engine	1-5-2	523352	3	P120B
			4	P120C
			11	P120D
			11	P120E
Fault path bank2-specific warnings -> stop engine	1-5-2	523353	11	P120F
			11	P1210
			12	P1211
			11	P1212

Description	Code	SPN	FMI	P- code
Fault path Chip-specific errors -> stop engine	1-5-3	523354	3	P062B
			4	P062B
			12	P062B
			2	P062B
Fault path Chip-specific errors -> stop engine	1-5-3	523355	3	P062B
			4	P062B
			12	P062B
			2	P062B
Fault path cylinder1-specific errors -> stop engine	1-4-1	651	3	P0262
			11	P0263
			8	P0261
			11	P0263
Fault path cylinder1-specific warnings	1-4-1	651	11	P1213
			11	P1214
			12	P0201
			11	P1215
Fault path cylinder2-specific errors -> stop engine	1-4-2	652	3	P0265
			11	P0266
			8	P0264
			11	P0266
Fault path cylinder2-specific warnings	1-4-2	652	11	P1216
			11	P1217
			12	P0202
			11	P1218
Fault path cylinder3-specific errors -> stop engine	1-4-3	653	3	P0268
			11	P0269
			8	P0267
			11	P0269
Fault path cylinder3-specific warnings	1-4-3	653	11	P1219
			11	P121A
			12	P0203
			11	P121B

Description	Code	SPN	FMI	P- code
Fault path cylinder4-specific errors -> stop engine	1-4-4	654	3	P0271
			11	P0272
			8	P0270
			11	P0272
Fault path cylinder4-specific warnings	1-4-4	654	11	P121C
			11	P121D
			12	P0204
			11	P121E
Fault path cylinder5-specific errors -> stop engine	1-4-5	655	3	P0274
			11	P0275
			8	P0273
			11	P0275
Fault path cylinder5-specific warnings	1-4-5	655	11	P121F
			11	P1220
			12	P0205
			11	P1221
Fault path cylinder6-specific errors -> stop engine	1-4-6	656	3	P0277
			11	P0278
			8	P0276
			11	P0278
Fault path cylinder6-specific warnings	1-4-6	656	11	P1222
			11	P1223
			12	P0206
			11	P1224
Fault path - The minimal number of injections was not reached -> stop engine	1-5-4	520226	12	P1225
Fault path for cruise control actuating device evaluation error	3-4-1	596	2	P0564
Power Stage fault status for MIL	3-3-3	1213	3	P0650
			4	P0650
			12	P0650
			2	P0650
Error path for main relay 2	1-3-2	1485	3	P0687
			4	P0686

Description	Code	SPN	FMI	P- code
Error path of multiple state switch	3-2-7	520227	3	P154A
			4	P154B
			2	P154C
Error path for main relay 1	1-3-2	2634	3	P160E
Error path for main relay 1	1-3-2	2634	4	P160F
The fault path contains the supervision of the communication between Watchdog of CY310 and the controller. The path is used to handle the re-versible Shut-down of the system using the engine coordinator	2-6-4	523420	2	P060C
Bus off in CAN A	4-1-1	639	12	U0029
Bus off in CAN B	4-1-2	1231	12	U0038
Bus off in CAN C	4-1-3	1235	12	U0047
Error path for engine oil level sensor	2-4-7	98	3	P250D
			4	P250C
			12	P250A
			2	P250B
Error path of oil pressure sensor	2-4-3	100	3	P0523
			4	P0522
			12	P0520
			2	P0521
Error path for oil pressure too low error	2-4-3	100	17	P0524
Error path of oil temperature sensor	2-4-4	175	3	P0198
			4	P0197
			12	P0195
			2	P100D
Error path of oil temperature sensor for above norm-al error	2-4-4	175	17	P0196
Fault path of overrun monitoring	2-6-2	1108	16	P1613
Fault path for redundant engine speed calculation in overrun monitoring	2-6-2	520228	15	P1614
Permanent governor deviation in PCR	4-5-4	520229	15	P2263
Permanent governor deviation in PCR	4-5-4	520230	17	P2263

Description	Code	SPN	FMI	P- code
Error path of power stage pre-supply pump	3-2-6	520231	3	P0629
			4	P0628
			12	P0627
			2	P062A
Fault path for run up test	5-2-3	520232	255	P1615
Fault path for test of redundant shut off paths during initialization	1-1-6	970	12	P1616
			3	P1617
			4	P1618
Sensor supply voltage 1	1-3-1	1079	3	P0643
			4	P0642
Sensor supply voltage 2	1-3-1	1080	3	P0653
			4	P0652
Sensor supply voltage 3	1-3-1	523601	3	P0699
			4	P0698
Fault path for shut off test	5-3-4	520233	20	P1621
Power Stage fault status for System lamp	3-3-1	624	3	P1619
			4	P161A
			12	P161B
			2	P161C
Error path for terminal 15 - contains plausibility error [Sig] of T15	1-2-3	158	12	P2533
Fault path for Terminal 50 component driver - T50CD	1-2-2	1041	7	P2530
Fault path 1 for vehicle speed sensing	3-2-4	84	0	P0501
			11	P1510
			12	P0500
			2	P0501
Fault path 2 for vehicle speed sensing	3-2-4	1624	3	P2158
			4	P2160
			12	P2157
			2	P2159
Fault path 3 for vehicle speed sensing	3-2-4	645	3	P1511
			4	P1512
			12	P1513

Description	Code	SPN	FMI	P- code
Error path for dataset variant coding, Npl = Requested variant could not be set, Sig = variant dataset defect	5-2-4	520239	11	P161D
			2	P161E
Power Stage fault status for Warning Lamp	3-3-2	624	3	P162F
			4	P1630
			12	P1631
			2	P1632
Fault path of air condition power stage	3-1-3	1351	3	P0647
			4	P0646
			12	P0645
			2	P0645
HpTst	5-2-2	520223	20	P160C
Error path of metering unit PWM-power stage	1-3-5	523615	5	P0251
			2	P0252
Error path of metering unit PWM-power stage	1-3-5	523615	3	P0254
Error path of metering unit PWM-power stage	1-3-5	523615	4	P0253
Error path of metering unit AD-channel	1-3-5	523615	16	P025D
			18	P025C
Error path of rail pressure relief valve	1-3-4	523470	0	P100E
			11	P100F
			7	P1010
Error path of rail pressure	1-3-3	157	3	P0193
			4	P0192
Error path RPS offset monitoring	1-3-3	157	15	P0191
			17	P0191
Faults for checks in MeUn controlled mode	2-5-1	523613	16	P1011
Faults for checks in MeUn controlled mode	2-5-2	523613	15	P1012
Faults for checks in MeUn controlled mode	2-5-4	523613	17	P1013
Faults for checks in MeUn controlled mode	2-5-3	523613	4	P0087
Faults for checks in MeUn controlled mode	2-5-3	523613	3	P0088
Faults for checks in MeUn controlled mode	2-5-7	523613	18	P101A
Faults for checks in MeUn controlled mode	2-5-5	523613	2	P1014

Description	Code	SPN	FMI	P- code
Faults for checks in MeUn controlled mode	2-5-6	523613	7	P1018
Faults for checks in MeUn controlled mode	2-5-4	523613	5	P1019
12V sensor supply voltage	1-3-1	520235	3	P1636
			4	P1637
Fault path for short circuit to battery or ground for high power stage	1-2-1	677	3	P0617
			4	P0616
Fault path for short circuit to battery or ground, no load, or excess temperature for low side power stage	1-2-1	677	3	P1638
			4	P1639
			5	P163A

6.5 Engine Maintenance Log

Frequency	Current Maintenance		Preventive Overhaul				Note		
Operating Hours / Period	M1	M2	R1	R2	R3	R4	Date	Hours / Period	Visa or stamp

Frequency	Current Maintenance		Preventive Overhaul				Note		
Operating Hours / Period	M1	M2	R1	R2	R3	R4	Date	Hours / Period	Visa or stamp

Frequency	Current Maintenance		Preventive Overhaul				Note		
Operating Hours / Period	M1	M2	R1	R2	R3	R4	Date	Hours / Period	Visa or stamp

6.6 Recommended Torques for Bolts

6.6.1 Recommended Torques for Hollow Bolts

Specification	Head type	Recommended tightening torque (N·m)
M8×1	Hexagon head	7±1
M10×1	Hexagon head	17±2
		13±2 (Copper bolt and small combination washer)
	Flange bolt	20±3
M12×1.5	Hexagon head	22±3
	Flange bolt	28±3
M14×1.5	Hexagon head	27±3
	Flange bolt	32±3
M16×1.5	Hexagon head	30±3
	Flange bolt	36±3
M18×1.5	Hexagon head and flange bolts	60±5

6.6.2 Recommended Torques for Standard Bolts

Friction coefficient	0.125 (zinc plated)				0.14 (polished)			
Strength grade	6.9	8.8	10.9	12.9	6.9	8.8	10.9	12.9
Bolt size	Recommended torque (N·m)							
M4	2.3	2.7	3.8	4.6	2.4	2.9	4.1	4.9
M5	4.7	5.5	8.0	9.5	5.0	6.0	8.5	10
M6	8.0	9.5	13.0	16.0	8.5	10	14.0	17
M8	19	23	32	39	21	25	35	41
M10	39	46	64	77	41	49	69	83
M12	67	80	110	135	72	86	120	145
M14	105	125	180	215	115	135	190	230
M16	165	195	275	330	180	210	295	355
M18	225	270	390	455	245	290	405	485
M20	325	385	540	650	345	410	580	690
M22	435	510	720	870	465	550	780	930
M24	560	660	930	1100	600	710	1000	1200
M27	830	980	1400	1650	890	1050	1500	1800
M30	1100	1350	1850	2250	1200	1450	2000	2400
M8×1	21	25	35	42	23	27	38	45
M10×1.25	41	49	66	82	44	52	73	88
M12×1.25	74	88	125	150	80	95	135	155
M12×1.5	70	83	115	140	76	90	125	150
M14×1.5	115	140	195	235	125	150	210	250
M16×1.5	175	210	295	350	190	225	315	380
M18×1.5	255	305	425	510	275	325	460	550
M20×1.5	360	425	600	720	385	460	640	770
M22×1.5	480	570	800	960	520	610	860	1050
M24×1.5	610	720	1000	1200	650	780	1100	1300
M27×1.5	890	1050	1500	1800	970	1150	1600	1950
M30×1.5	1250	1450	2050	2500	1350	1600	2250	2700

Index

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