INTRODUCTION

Thank you for preferring FPT and we congratulate you on your choice of engine.

Before performing any operation that involves the engine or its equipment, please carefully read the instructions contained in this manual; following these instructions is the best way to guarantee that the engine will run perfectly for a long period of time.

The content of this manual refers only to the standard engine configuration and the illustrations are purely indicative. Some instructions are given by describing the sequence of operations that make it possible to obtain the expected behaviour from the engine and/or its equipment. In some cases they depend on the configuration of the controls and versions of the car or machinery in which the engine is installed; for anything that differs from the content of this manual, refer to the indications of the engine manufacturer or its specific manual.

The following information is current as of the date of publication.

The Manufacturer reserves the right to make changes without notice at any moment for technical or commercial reasons as well as due to adaptations of the engine to the laws of various countries.

No liability is accepted for errors or omissions.

Remember that the skills and professionalism of the FPT Technical Service Network will be at your side wherever you are.
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GENERAL INFORMATION

WARRANTY
To ensure the best engine performance and rely on the FPT warranty, the instructions provided in this publication must be followed carefully; failure to observe them or following them incorrectly could invalidate the warranty.

SPARE PARTS
It is required to exclusively use Original FPT Spare Parts to maintain the engine in its original condition. The use of non-original spare parts shall invalidate the warranty and exonerate FPT from all liability for the entire life of the engine.

RESPONSIBILITY
The Manufacturer’s responsibility is subordinate to the performance of the check and maintenance operations specified and described in this manual; their performance must be demonstrated for this purpose. Any necessary unscheduled maintenance operations must be carried out by qualified FPT Network Workshop personnel, using the specifically provided instruments and equipment.

SAFETY
The purpose of the following information is to focus attention on engine use to prevent damage to people and property deriving from improper or incorrect behaviours.

- The engines must only be used for the purposes declared by the Manufacturer.
- Tampering, modifications and the use of non-original spare parts could adversely affect the proper operation of the engine and its safety during use; changes must not be made to the wiring and the units that equip the engine as well as its connections to external electrical networks.
- Pay attention to the engine's moving parts, those at a high temperature and the circuits with pressurised fluids; its electrical equipment is a source of electrical voltage and currents.
- The exhaust gas emitted by the engine is harmful to health.
- The engine must only be handled with suitable lifting devices and using the specific eyebolts provided on the engine.
- The engine must not be started and used before satisfying the safety requirements for the car in which it is installed and before ensuring compliance of the latter with the standards and local laws.
- The operations required for guaranteeing the best state of use and preservation of the engine must be carried out by personnel with proven experience using instruments considered appropriate by FPT.

Additional safety recommendations can be found in the CHECKS AND MAINTENANCE chapter.
SAFETY WARNING SYMBOLS
You will find these symbols on the following pages; follow the instructions to which they refer, for your own safety and that of your engine.

**Risk of injury:** failure to comply with these instructions can result in the risk of serious injury.

**Risk of serious damage to the engine:** the partial or total non-observance of these instructions could cause serious damage to the engine and may nullify the warranty.

**General risk:** combines the risks of both the signs described above.

**Safeguarding the environment:** indicates the correct behaviour so that vehicle use is as environmentally friendly as possible.
ENGINE TECHNICAL DATA

The technical code and serial number are specified on the nameplate positioned on different parts of the engine, depending on the model: flywheel case, tappet cover, coolant tank.

<table>
<thead>
<tr>
<th>Code</th>
<th>CR16TE1W</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine family</td>
<td>F3J</td>
</tr>
<tr>
<td>Cycle</td>
<td>Diesel 4-stroke</td>
</tr>
<tr>
<td>Number and arrangement of cylinders</td>
<td>6, in line</td>
</tr>
<tr>
<td>Bore x stroke</td>
<td>141 X 170mm</td>
</tr>
<tr>
<td>Total displacement</td>
<td>15.926 cm³</td>
</tr>
<tr>
<td>Compression ratio</td>
<td>16.5:1</td>
</tr>
<tr>
<td>Air supply</td>
<td>Turbocharged - with Intercooler</td>
</tr>
<tr>
<td>Injection method</td>
<td>Electronically controlled common rail</td>
</tr>
<tr>
<td>Max. injection pressure</td>
<td>-</td>
</tr>
<tr>
<td>Engine rotation direction</td>
<td>Anti-clockwise (flywheel side view)</td>
</tr>
<tr>
<td>Dry weight</td>
<td>1450 kg (1)</td>
</tr>
</tbody>
</table>

**Code**

<table>
<thead>
<tr>
<th>CR16TE1W</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooling</td>
</tr>
<tr>
<td>Control system</td>
</tr>
<tr>
<td>Electric system 24 V</td>
</tr>
<tr>
<td>Recommended battery capacity</td>
</tr>
<tr>
<td>Starter motor maximum output</td>
</tr>
<tr>
<td>Alternator output</td>
</tr>
<tr>
<td>Battery discharge current</td>
</tr>
</tbody>
</table>

**Performance (2)**

<table>
<thead>
<tr>
<th>CR16TE1W</th>
</tr>
</thead>
<tbody>
<tr>
<td>50Hz Prime Stand-by</td>
</tr>
<tr>
<td>505 kWm @ 1,500 rpm</td>
</tr>
<tr>
<td>60Hz Prime Stand-by</td>
</tr>
<tr>
<td>523 kWm @ 1,800 rpm</td>
</tr>
<tr>
<td>557 kWm @ 1,500 rpm</td>
</tr>
<tr>
<td>578 kWm @ 1,800 rpm</td>
</tr>
</tbody>
</table>

(1) For short periods of time

(2) Without additional accessories

Water

Electronic

54
(1) Approximate dry weight of the basic engine without A/C compressor, oil and coolant.

(2) Power at the flywheel in accordance with directive 97/68 EC (without fan), after 50 hours' operation, tolerance ±3%, fuel EN590; Test in compliance with specification ISO 3046/1, turbocharger inlet air temperature 25°C, atmospheric pressure 100 kPa, humidity 30% - Also in compliance with specification DIN 6271, BS 5514, SAE J1349.

All the data are based on engine operation with fuel system, water pump, lubricant oil pump and intake and exhaust restriction within or below, the limits indicated in the "data sheet". Additional loads estimated at 20 Nm from idle speed to nominal speed.

**WARNING**

*It is strictly forbidden to alter the aforesaid characteristics and, in particular, to modify the stored data in the injection system's electronic units or the characteristics of the engine and its components. Failure to comply with the above shall result in the loss of warranty, in addition to FPT declining all responsibility.*
**CR16TE1W**

1. Line intercooler - 2. Gas outlet line from blower - 3. Turborcharger -

**CR16TE1W**

1. Cylinder head cover - 2. Oil filler cap - 3. Tie rod - 4. Water pipe -
5. Air intake manifold - 6. Protection - 7. Alternator - 8. Delivery line -
9. Fuel pressure & temperature sensor - 10. ECU - 11. Electric starter -
15. Camshaft rpm sensor.
CR16TE1W

CR16TE1W
LABELS
Some warning labels (below the description) are affixed to the engine.

NOTE: labels containing an exclamation mark highlight a potential danger.

- Lifting point (only the engine).
- Fuel filling cap (on the tank, if present).
- Lubricant oil filling cap.
- Lubricant oil level dipstick.

- Risk of burns:
  Expulsion of pressurized hot water.
- Risk of burns:
  Presence of parts at high temperature.
- Risk of fire:
  Presence of fuel.
- Risk of injury from moving parts:
  Presence of fans, pulleys, belts or other.
**USE**

**PRELIMINARY CHECKS**

Each time before starting the engine:

- Check and top up the level of the technical fluids, if necessary (fuel, engine oil and coolant).
- Make sure that the air intake filter is not obstructed or clogged and check, at the same time, that the visual indicator (1) on the filter is not showing the "red" signal. The air filter clogged indicator (1) shows when maintenance needs to be carried out in order to protect and optimize filter operation. The sensor (1) remains blocked in the alarm position ("red") until it has been restored.

- Make sure that the batteries are efficient and that the terminals are correctly connected.

---

**ATTENTION!**

Make sure that the environment where the engine will operate is free of combustible vapours or gases. Make sure that there is sufficient ventilation and a suitable exhaust gas extraction system for closed environments.
STARTING AND STOPPING THE ENGINE

The methods for starting and stopping will vary if the equipment or genset Manufacturer has created a customised dashboard; these methods vary based on the different choices of the Manufacturer.

In these cases, refer to what is indicated in the specific documentation for information regarding the start and stop sequences and the interpretation of the indicator instruments.

For the proper use of the system, closely observe the instructions and information contained in the wiring diagrams. The necessary alerts for the protection and monitoring of the engine to be set up in the framework (by the manufacturer of the generating set unit) are:

- High engine coolant temperature
- Low lubricant oil pressure
- Presence of water in the diesel
- EDC system fault

The completeness of the information given will depend on the application and needs of the user.

ATTENTION

It is not allowed to stop the engine by means of off-device batteries. The batteries could be plugged-out not before a certain period of time (approximately 3 minutes) in order to allow the completion of "after run" procedure of the electronic control unit.
INTERCONNECTION ELECTRICAL UNIT

In order to allow the unit’s correct electrical functioning, an interconnection unit has been fitted to the engine. The engine electronic control system and the power unit system depend from the aforesaid interconnection unit.

Some indications relating to its components and functions controlled by programming commutators are reported here following.
**Relay**

K1  ATS intelligent sensor
K2  After run B
K3  Run
K4  Starter
K5  SCR heating
K6  Fuel filter heating
K7  Pre-fuel filter heating
K8  Starter control
CN1 Diagnose

**Engine speed and accessory functions control**

Programming of the functions here following is possible commuting the position of the JP switches.

**JP1 (Engine speed selection) +JX (Connector: Engine speed selection)**

<table>
<thead>
<tr>
<th>JP1</th>
<th>JX</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="JP1 Diagram" /></td>
<td><img src="image2.png" alt="JX Diagram" /></td>
</tr>
</tbody>
</table>

- **1500 rpm. (50 Hz)**
- **1800 rpm. (60 Hz)**
- **IDLE**

**JP2: Mode selection**

<table>
<thead>
<tr>
<th>JP2</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image3.png" alt="JP2 Diagram" /></td>
</tr>
</tbody>
</table>

- **Diagnostic position**
- **Working position (default)**
**JP3: Cold start heater relay**

<table>
<thead>
<tr>
<th>Connected</th>
<th>JP3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><img src="image1" alt="JP3 Connected Diagram" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Not connected (default)</th>
<th>JP3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><img src="image2" alt="JP3 Not Connected Default Diagram" /></td>
</tr>
</tbody>
</table>

**JP4: Cold start lamp**

<table>
<thead>
<tr>
<th>Connected</th>
<th>JP4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><img src="image3" alt="JP4 Connected Diagram" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Not connected (default)</th>
<th>JP4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><img src="image4" alt="JP4 Not Connected Default Diagram" /></td>
</tr>
</tbody>
</table>

**JP5: It CAN line**

<table>
<thead>
<tr>
<th>Connected</th>
<th>JP5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><img src="image5" alt="JP5 Connected Diagram" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Not connected (default)</th>
<th>JP5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><img src="image6" alt="JP5 Not Connected Default Diagram" /></td>
</tr>
</tbody>
</table>
**SPECIAL WARNINGS**

**High coolant temperature**
In the event of an excessive temperature being signalled by the alarm of the instrument panel, reduce the engine speed and stop it in order to check the condition of the cooling circuit; also check and have the following checked:
- the tension of the water pump and alternator control belts;
- the operation of the thermostatic valve;
- the cleanliness of the heat exchangers.

<table>
<thead>
<tr>
<th>ATTENTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>When the engine is hot, pressure builds up in the cooling circuits which may eject hot liquid violently, resulting in a risk of burns. Open the filler cap of the coolant tank only if necessary and only when the engine is cold.</td>
</tr>
</tbody>
</table>

**Low lubricant oil pressure**
If the pressure indicated by the instrument panel is insufficient or if the “low oil pressure” warning light comes on, stop the engine and check the oil level. Top up the oil if necessary (see section CHECKS AND MAINTENANCE).
If the fault persists then stop the engine and contact an authorized service center.

<table>
<thead>
<tr>
<th>ATTENTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pay maximum attention when refuelling, making sure that solid or liquid pollutants do not enter the tank; please remember that smoking is prohibited while refuelling.</td>
</tr>
</tbody>
</table>

**Presence of water in the fuel pre-filter**
It is advisable to drain the water from the filters before the relevant warning light comes on.
Do not use the engine if the tank only contains the quantity of fuel kept as reserve; this condition promotes the formation of condensate and the intake of sludge or air, causing the engine to stop.

<table>
<thead>
<tr>
<th>ATTENTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visually check that the exhaust circuit is not obstructed or damaged to prevent the formation of noxious and harmful fumes inside the ducts.</td>
</tr>
</tbody>
</table>

**Clogged air filter and exhaust circuit inefficiencies**
Regularly inspect the cleanliness of the air intake inlets and the exhaust ducts. The maintenance intervals contained in this manual only take into account the performances of the engine parts and not of those parts manufactured at the Yard or any other external intervention.
Battery or alternator charging fault
Periodically check the cleanliness, condition and correct tensioning of the drive belt.

The drive belt members are located under protective grilles. Their removal must be carried out only when the engine is not running.

Electrical system irregularities
Periodically check the cleanliness and efficiency of the batteries, particularly during winter, by performing the checks and top-ups as described in the CHECKS AND MAINTENANCE chapter; close attention must be paid to the caution notices. In the event of battery replacement, please observe the characteristics contained in the ENGINE TECHNICAL DATA section.

If the voltmeter indicates a voltage value lower than 22 V, contact a specialised workshop and diagnose the efficiency of batteries and charging system.

RUN-IN
Thanks to modern engine construction technologies a particular run-in procedure is not required. However, it is recommended to avoid using the engine at high power for long periods during the first 50 hours.
CHECKS AND MAINTENANCE

MAINTENANCE PERSONNEL
The engine check and maintenance operations specified in this chapter require preparation, skill and compliance with safety standards; therefore, they must be carried out by responsible personnel, as indicated below.

- **Checks**: by workshop personnel or if necessary by the genset operator.
- **Periodic maintenance**: by qualified personnel equipped with proper work tools and suitable protections.
- **Extraordinary maintenance**: by qualified Service Centre personnel in possession of precise technical information and specific equipment.

The most qualified Service Centres are those included in the FPT Technical Service Network.

ACCIDENT PREVENTION

- Always wear safety footwear, gloves and suits.
- Do not wear loose clothing, rings, bracelets and/or necklaces near the engines or moving parts.
- Wear protective gloves and goggles while:
  - filling the batteries with acid solution
  - refuelling with inhibitors or antifreeze
  - changing or filling the lubricant oil (hot engine oil can cause burns. It is recommended to perform these operations only when their temperature is lower than 50 °C).
- When working in the engine compartment, pay maximum attention to all movements to avoid coming into contact with rotating or hot components.
- Wear goggles while using compressed air (the maximum air pressure used for cleaning is 200 kPa (2 bar, 30 psi, 2 kg/cm²)).
- Wear a protective helmet if working in an area with suspended loads or overhead systems.
- Use protective creams for hands.
- Immediately replace wet gloves.
- Always keep the engine clean, removing spots of oil, diesel and coolant.
- Return oily rags to fire-proof containers.
- Do not leave foreign objects on the engine.
- Use adequate and safe containers for the used oil.
- At the end of a repair, implement suitable measures to stop air intake by the engine if, after starting, the engine runs at uncontrolled speeds.

Do not perform maintenance in the case of live electrical voltage: check the condition of the equipment’s ground connection. During the diagnostics and maintenance operations, make sure your hands and feet are dry and use insulating footboards if possible.
REFILLING

<table>
<thead>
<tr>
<th>Parts to be refilled</th>
<th>CR16TE1W</th>
<th>Litres (l)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cooling circuit</strong> (*)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engine</td>
<td></td>
<td>27</td>
</tr>
<tr>
<td>Radiator and hoses</td>
<td></td>
<td>25.5</td>
</tr>
<tr>
<td>G-drive **:</td>
<td></td>
<td>52.5</td>
</tr>
<tr>
<td><strong>Lubrication circuit</strong> (2) (4) (*)</td>
<td></td>
<td>34</td>
</tr>
<tr>
<td>total capacity</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Periodic replacement</strong>: (3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sump at minimum level</td>
<td></td>
<td>24</td>
</tr>
<tr>
<td>Sump at maximum level</td>
<td></td>
<td>32</td>
</tr>
<tr>
<td><strong>Fuel tank</strong> (5)</td>
<td></td>
<td>-</td>
</tr>
</tbody>
</table>

(* It is prohibited to mix fluids of different brands and origins inside the circuit.

(**) Total capacity including engine, radiator and hoses.

(1) The quantities refer to the engine in standard configuration. The coolant should comply with ASTM D-6210 standard. Concentrated coolants should be used as a 50% mixture in water. FPT suggest to use original PETRONAS products.

(2) Use lubricants which meet the international standards: SAE 10W-40 API CJ-4 / ACEA E9. FPT suggest to use original PETRONAS products comply with SAE 10W-40 standard. Please refer to the 'Maintenance Schedules' section for alternative products and relative maintenance intervals.

(3) Oil consumption is considered acceptable up to quantities of 0.5% of fuel consumption.

(4) The quantity indicated refers to the first refuelling and concerns the engine, oil sump and filter.

(5) Use STANDARD fuel which complies with standards ASTM D975 or EN 590. The indications relating to the fuel tank capacity apply to the generating set Manufacturer since they are subject to variations depending on the different configurations.

WARNING

Refuelling from drums or tanks can cause contamination of the diesel, with the consequent risk of damaging the injection system; if necessary, perform suitable filtration or sedimentation of the impurities before refuelling.

Diesel oil for low temperatures

Standard EN590 defines different diesel classes, identifying the characteristics of those most suitable for use at low ambient temperatures.

It is entirely the responsibility of the oil companies to comply with the regulations regarding the distribution of fuels suitable for the clматic and geographical conditions of the various countries.
### MAINTENANCE SCHEDULE

The frequencies indicated below take into account factors of use of different engine uses; the most suitable duration of the maintenance intervals for the different applications will be indicated by the maintenance personnel based on the use and operating conditions of the engine.

<table>
<thead>
<tr>
<th>Checks in periods of use</th>
<th>Frequency*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine lubricant oil level check</td>
<td>daily</td>
</tr>
<tr>
<td>Engine coolant level check</td>
<td>daily</td>
</tr>
<tr>
<td>Engine visual inspection</td>
<td>50 hours/15 days</td>
</tr>
<tr>
<td>Air filter &amp; housing cleanness check***</td>
<td>1 month</td>
</tr>
<tr>
<td>Tension and condition check of auxiliary members’ belt</td>
<td>300 hours/6 months</td>
</tr>
<tr>
<td>Exhaust duct(s) condition check</td>
<td>6 months</td>
</tr>
<tr>
<td>Blow-by filter condition check</td>
<td>6 months</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Planned maintenance</th>
<th>Frequency*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water drainage from the fuel pre-filter (if present)</td>
<td>150 hours/6 months (1)</td>
</tr>
<tr>
<td>Condensed water drainage from the fuel tank</td>
<td>150 hours/6 months</td>
</tr>
<tr>
<td>Turbocharger visual inspection</td>
<td>6 months</td>
</tr>
<tr>
<td>Heat exchanger (radiator) cleaning ***</td>
<td>6 months</td>
</tr>
<tr>
<td>Engine lubricant oil change</td>
<td>600 hours/1 year (2)(4)</td>
</tr>
<tr>
<td>Lubricant oil filter replacement</td>
<td>600 hours/1 year (2)(3)(4)</td>
</tr>
<tr>
<td>Fuel pre-filter replacement (if present)***</td>
<td>600 hours/1 year (1)(2)</td>
</tr>
<tr>
<td>Fuel filter replacement</td>
<td>600 hours/1 year (1)(3)(2)</td>
</tr>
<tr>
<td>Air filter replacement ***</td>
<td>1200 hours/2 years</td>
</tr>
<tr>
<td>Auxiliary members’ belt replacement</td>
<td>1200 hours/3 years</td>
</tr>
<tr>
<td>Blow-by filter replacement</td>
<td>1800 hours/1 year</td>
</tr>
</tbody>
</table>
**Intervention frequencies expressed by hours & temporal (whichever occurs first)**

**Indicated frequencies are valid only if the components are supplied by FPT**

***For first time after 600 hours***

1) Maximum period relating to the use of high quality fuel, (specification ASTM D975 or EN 590); which is reduced in the event of fuel contamination and alarm signals caused by filter clogging and/or the presence of water in the pre-filter. The filter clogging signal indicates that the filter must be replaced. If the warning light of water present in the pre-filter does not go off after drainage, then the pre-filter must be replaced.

2) Frequencies are valid for operating fluids which comply with the international specifications as indicated in the REFILLING table.

3) Only use filters with the following specifications:
   - degree of filtering < 12 μm
   - filtering efficiency 99.5% (β > 200).

4) possible operating fluids and corresponding frequencies of change:
   - 600 hours/1 Year for 10W-40 API CJ-4/ACEA E9 (sulphur in fuel less than 500 ppm)
   - 500 hours /1 Year for 15W-40 API CI-4/ ACEA E7 (sulphur in fuel less than 1000 ppm)
   - 300 hours /1 Year for 15W-40 API CF/ ACEA E2/E3 (sulphur in fuel less than 1000 ppm)
   - 300 hours /1 Year for 20W-50 API CF/ ACEA E2/E3 (sulphur in fuel less than 1000 ppm)

---

### Extraordinary maintenance Frequency*

<table>
<thead>
<tr>
<th>Maintenance</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fan drive belt replacement</td>
<td>600 hours / 1 year</td>
</tr>
<tr>
<td>Valves/rocker arms clearance adj.</td>
<td>2400 hours</td>
</tr>
<tr>
<td>Engine coolant replacement</td>
<td>3000 hours / 2 years (2)</td>
</tr>
</tbody>
</table>

* Intervention frequencies expressed by hours & temporal (whichever occurs first)

** Indicated frequencies are valid only if the components are supplied by FPT

*** For first time after 600 hours

---

The operations described above require the use of specific tools which guarantee safe and effective results. It is recommended that such operations are carried out by qualified personnel of the FPT Technical Service Network.
REQUIREMENTS

- Do not disconnect the battery supply while the engine is running.
- Do not perform arc welding near the engine without first removing its electrical wiring.
- After performing all maintenance operations that require disconnection of the batteries, make sure the clamps have been securely reconnected on the poles.
- Do not use a battery charger to start the engine.
- Electrically disconnect the battery/ies from the network during charging.
- Do not paint the devices, components and electrical connectors of the engine equipment.
- Electrically disconnect the battery/batteries before performing any electrical work.
- Contact the Manufacturer before installing any electronic equipment.

**ATTENTION**

- Do not perform any operation that would change the calibration of the injection pump. It was adjusted during the engine test phase and based on its application.
- It is not allowed to stop the engine by means of off-device batteries. The batteries could be plugged-out not before a certain period of time (approximately 3 minutes) in order to allow the completion of "after run" procedure of the electronic control unit.
CHECKS (IN PERIODS OF USE) - HOW TO PROCEED

Engine lubricant oil level check
Only proceed when the engine is not running and is at low temperature in order to avoid the risk of burns; make sure the engine is in its normal operating position in order to obtain an accurate oil level reading.

- Use the oil level dipstick (1) to check that the lubricant oil level is between the "Min" and "Max" limits.
- If the level is insufficient, it is necessary to top up the oil by removing the cap and pouring lubricant oil through the hole (2).

For the top-up only use lubricant oil that complies with the international standards as indicated in the 'CHECKS AND MAINTENANCE' SECTION.

Clean the oil cap before performing the operation so as to minimize the risk of contaminating the system.

Make sure that the dipstick is fully inserted and that the filler plug is tightened fully in the clockwise direction.

Use the oil level dipstick (1) to check that the lubricant oil level does not exceed the "Max" limit on the dipstick.
**Engine coolant level check**

Only proceed when the engine is not running and is at low temperature in order to avoid the risk of burns.

- Remove the pressurization cap from the expansion tank.
- Check that the coolant in the expansion tank is above the minimum level.
- If necessary, top up the expansion tank with fluids, as indicated in the REFILLING table.
- Top up the expansion tank until the “MAX” limit is reached; if there is no level indicator on the expansion tank, make sure that the coolant in the expansion tank is a few centimetres below the filling hole in order to allow an increase in the coolant volume following a rise in temperature.

> **When the engine is hot, pressure builds up in the cooling circuits which may eject hot liquid violently, resulting in a risk of burns.**
> 
> **Open the filler cap of the coolant tank only if necessary and only when the engine is cold.**

> **Clean the pressurization cap of the expansion tank before performing the operation so as to minimize the risk of contaminating the system.**

---

**Engine visual inspection**

Perform a thorough check before start-up.

Check for any leaks (oil, coolant and fuel), broken or weakened pipes, loose clips and bolts, worn belt, wiring (loose connections, worn or frayed cables) and a build-up of dirt; in the event of any problems, perform the operations necessary to restore the engine optimum operating condition.

> **Any spilt of fluids must be removed for all types of leak (coolant, oil or fuel).**
> 
> **If a leak is discovered then find its source and carry out the necessary operations.**

> **A build-up of oil or grease on the engine represents a fire risk.**
Air filter & housing cleanliness check

Carry out these operations if the air filter clogged indicator (1) shows that the filter is clogged. It signals the exact moment in which maintenance must be carried out, remaining blocked in the alarm position (red optical signal) in order to protect filter operation.

The air filter clogged indicator can operate at temperatures of -30 °C to +120 °C and is resistant to the most severe weather conditions and any type of corrosion.

The tightening torque must not exceed 1.5 Nm. Only proceed when the engine is not operating.

- Remove the cover (4) of the air filter after having unscrewed the handwheel screw (5).
- After having unscrewed the wing nut (2), extract the filter cartridge (1); make sure that dust does not enter during this operation.
- Make sure there are no impurities. If necessary clean the filter element (1) according to the following instructions.
- Blow dehumidified compressed air onto the filter elements (1), working from the inside outwards (maximum pressure 200 kPa).
- Check the condition of the air filter before refitting it. Replace it if broken or torn.
- Check that the gasket (3) at its base is in good condition.
- Position the filter cartridge (1) in its housing and tighten the wing nut (2).
- Fit the cover (4) of the air filter and fasten it by tightening the handwheel screw (5).

Do not use detergents or diesel to clean the air filter. Never strike the filter element with tools. Make sure that the parts are all fitted correctly. Incorrect fitting could cause the engine to intake unfiltered air, leading to serious damage to the engine.
Tension and condition check of auxiliary members’ belt
Only proceed when the engine is not running and is at low temperature to avoid the risk of burns.

☐ Check that the belt is not worn, soiled with oil or fuel, or showing signs of tears. Otherwise replace the belt if necessary.

☐ Use a ½ inch square wrench to check the efficiency of the automatic belt tensioner.

Exhaust duct(s) condition check
Visually check that the exhaust gas system is not blocked, corroded or damaged.
In case of any problems, perform the operations necessary to restore the exhaust duct’s optimum condition.

 Blow-by filter condition check
Only proceed when the engine is not turning and is at low temperature in order not to run the risk of burns.

☐ Check that the filtering element is not encrusted in any way. If it is, replace it.

Dispose of consumable materials and parts in contact with them (e.g. filters) in accordance with the law.
PLANNED MAINTENANCE - HOW TO PROCEED

Water drainage from the fuel pre-filter (if present)
In the case of a high risk of refuelling with fuel polluted with external particles and water, the following check should be performed also at each refuelling apart from the scheduled maintenance.
Proceed when the engine is not running.

- Place a container for collecting liquids under the pre-filter (2).
- Unscrew the valve plug (1) located at the bottom of the filter; in some versions, the plug includes the water in fuel sensor.
- Drain the liquid until only fuel is draining.
- Fully retighten the plug manually.
- Dispose of the drained liquids according to the applicable regulations in force.

Clean the drain valve (1) before performing the operation to minimize the risk of contaminating the system.

Condensed water drainage from the fuel tank
Perform the drainage/suction of water, condensation and impurities from the fuel tank/s by following the instructions contained in the instruction provided by the generating set manufacturer.
Proceed as necessary based on the structure or location of the tank: engines that operate in adverse environments and conditions and/or that are refuelled using drums or jerry cans, require more attention when cleaning the tank.
**Turbocharger visual inspection**
Only proceed when the engine is not turning over. Visually check that the turbine and compressor impellers and the relative inlet and outlet pipes are not obstructed or damaged, otherwise replace them.

**Heat exchanger (radiator) cleaning (demonstrative)**
The surfaces of the heat exchanger (radiator) come into contact with external air and may be subjected to deposits of impurities (dust, mud, straw, etc.).
Clean them if necessary using compressed air or steam.

**Engine lubricant oil change**
Only proceed when the engine is not running and is at low temperature avoid the risk of burns.
- Place a suitable container for collecting the used oil under the oil sump next to the lubricant oil drain plug (3, 4).
- Unscrew the lubricant oil drain plug (3, 4); afterwards extract the oil level dipstick (1) and remove the lubricant oil cap (2) to assist the flow of the engine lubricant oil.
- Wait until the oil sump has completely emptied, then retighten the lubricant oil drain plug (3, 4) to the torque indicated in the table.
- Proceed with the refilling operation through the hole (2) situated on the tappet cover, using lubricant oil that complies with the international standards as indicated in the REFILLING table.
- Use the oil level dipstick (1) to check that the quantity of lubricant oil does not exceed the "Max" limit and remain above the "Min" limit.
- Retighten the lubricant oil cap (2).
- Together with the replacement of the engine lubricant oil it is necessary to replace the oil filter (see paragraph LUBRICANT OIL FILTER REPLACEMENT).

<table>
<thead>
<tr>
<th>Ref.</th>
<th>No.</th>
<th>Description</th>
<th>Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>2, 1</td>
<td>1</td>
<td>Oil drain plug</td>
<td>30 ± 3 Nm</td>
</tr>
</tbody>
</table>
Clean the plugs before performing the operations so as to minimize the risk of contaminating the system.

After changing the engine lubricant oil make sure that the level does not exceed the "Max" limit on the oil level dipstick and remain above the "Min" limit.

Make sure that the dipstick is fully inserted and that the filler plug is tightened fully in the clockwise direction.

Dispose of consumable materials and parts in contact with them (e.g. filters) in accordance with the law.
Lubricant oil filter replacement

Only use filters with the following specifications:

- degree of filtering < 12 μm
- filtering efficiency $\beta > 200$ (99.5%)

Only proceed when the engine is not running and is at low temperature to avoid the risk of burns.

- Proceed with draining the used lubricant oil (see paragraph ENGINE LUBRICANT OIL REPLACEMENT).
- Place a suitable container for collecting the used oil under the oil filter next to the drain plug (3).
- Remove the filter body (2) by unscrewing it.
- Replace the filter element (4) and the O-ring seal (1) contained inside the filter body (2).
- Carefully clean the surfaces.
- Moisten the O-ring seal (1) of the new filter with oil.
- Tighten the drain plug (3) and the filter body (2) to the torque indicated in the table.
- Proceed with the refilling operation of the lubricant oil (see paragraph ENGINE LUBRICANT OIL REPLACEMENT).

Operate the engine for a few minutes and then check the level using the dipstick.

If necessary, top up to compensate for the quantity of oil used to fill up the filtering cartridge.

<table>
<thead>
<tr>
<th>Ref.</th>
<th>No.</th>
<th>Description</th>
<th>Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>1</td>
<td>Engine oil filters body</td>
<td>60 ± 5 Nm</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>Drain plug on engine oil filter</td>
<td>6.5 ± 1.5 Nm</td>
</tr>
</tbody>
</table>

ATTENTION! When using compressed air, it is required to use suitable personal protections for hands, face and eyes. The requirements can be found in the ACCIDENT PREVENTION paragraph.

After changing the engine lubricant oil make sure that the level does not exceed the "Max" limit on the oil level dipstick and remain above the "Min" limit.

Make sure that the dipstick is fully inserted and that the filler plug is tightened fully in the clockwise direction.

Dispose of consumable materials and parts in contact with them (e.g. filters) in accordance with the law.
Fuel pre-filter replacement (if present)

Disengage the connection (3).
Unscrew the screws (1) and remove the protective panel (2) (if present).
Disconnect the connection cable (5); place a container, open the drain valve (6) and drain the fuel present in the filter.
Unscrew the filter (4) and replace it.
Before replacing the new cartridge moisten the gasket with fuel or engine oil.
Screw in the cartridge until it touches the surface and tighten it to the specified torque.
Close the fuel drain plug, connect the electrical connection, replace the protective panel and engage the connection cable on the panel.

The filter cartridge does not have to be pre-filled. This is to prevent the entry into the circulation of any impurities that could damage fuel system components. Blow the air off from the fuel circuit.

Fuel filter replacement

Only proceed when the engine is not running and is at low temperature to avoid the risk of burns.

- Close the tap of the tank.
- Place a suitable container for collecting the fuel under the fuel filter next to the drain plug (4).
- Open the drain plug (4) and the bleeder connection (1) and drain any residual fuel.
- Remove the filter element (3) by unscrewing the relative bell-shaped support (5).
- Replace the filter element (3) and the O-ring seal (2) contained inside the bell-shaped support (5).
- Moisten the O-ring seal (2) of the filter with oil.
- Insert the filter element (3) and tighten the relative bell-shaped support (5) to the torque indicated in the table.
- Tighten the drain plug (4) to the torque indicated in the table.

Do not fill the new filter until it has been positioned on the support: this prevents allowing impurities to enter and damage the circuit and injection system.

<table>
<thead>
<tr>
<th>Ref.</th>
<th>No.</th>
<th>Description</th>
<th>Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>1</td>
<td>Fuel filter</td>
<td>32.5 ±2.5 Nm</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>Threaded plug</td>
<td>1.5 ±0.5 Nm</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>Bleeder connection</td>
<td>17.5 ±2.5 Nm</td>
</tr>
</tbody>
</table>
Loosen the following bleeder connections and connect them with appropriate pipes to allow any residue to drain into suitable containers to prevent soiling:
- Screw (1) situated on the pre-filter support (if present).
- Bleeder connection (3) situated on the filter support.

Operate the pump (2) situated on the fuel pre-filter (if present) until fuel flows out without air from the bleeder screw (1); upon completion of the operation tighten the screw.

Continue to operate the pump until fuel flows out without air from the bleeder connection (3) situated on the fuel filter; upon completion of the operation tighten the screw.

Tighten the bleeder screws to the prescribed torque.

<table>
<thead>
<tr>
<th>Ref.</th>
<th>No.</th>
<th>Description</th>
<th>Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>Pre-filter bleeder screw</td>
<td>18 ±2 Nm</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>Bleeder connection</td>
<td>17.5 ±2.5 Nm</td>
</tr>
</tbody>
</table>

Start the engine and allow it to idle for a few minutes to blow off any residual air from the circuit.

Take utmost care to prevent any fuel from soiling the control belt.
Air filter replacement

Carry out these operations if the air filter clogged indicator (1) shows that the filter is clogged.

It signals the exact moment in which maintenance must be carried out, remaining blocked in the alarm position (red optical signal).

The air filter clogged indicator can operate at temperatures of -30 °C to +120 °C and is resistant to the most severe weather conditions and any type of corrosion.

The tightening torque must not exceed 1.5 Nm.

Only proceed when the engine is not turning over.

For proper operation of the engine, the fuel circuit must be free from air.

Dispose the consumable materials and parts in contact with them (e.g. filters) in accordance with the law.
Remove the cover (4) of the air filter after having unscrewed the handwheel screw (5).

Unscrew the wing nut (2) and extract the filter cartridge (1); make sure that dust does not enter the sleeve during this operation.

Replace the filter cartridge (1).

Position the filter cartridge (1) in its housing and tighten the wing nut (2).

Replace the gasket (3).

Replace the cover (4) of the air filter and fasten it by tightening the handwheel screw (5).

Auxiliary members’ belt replacement

Only proceed when the engine is not running and is at low temperature to avoid the risk of burns.

Remove the protective grilles, the radiator assembly and the fan.

Using a 1/2 inch square wrench, operate on the belt tensioner (1) and pull off the control belt of the crankshaft pulley / idler pulley / water pump / alternator (2).

Replace the worn belt with a new one and fit it on the pulleys and guide rollers.

Using the aforesaid tools, operate on the automatic belt tensioner in order to force fit the new belts in their operating position.

Do not use detergents or diesel to clean the air filter.

Never strike the filter element with tools.

Make sure that the parts are all fitted correctly. Incorrect fitting could cause the engine to intake unfiltered air, leading to serious damage to the engine.

Replace the belt if it shows signs of abrasion, cracks or tears or if it is soiled with oil or fuel.
Blow-by filter replacement

- Unscrew the screws (4) and remove the cover (3).
- Unscrew the screws (2) and remove the blow-by filter element (1).
- Position the new blow-by filter element (1) in its seat.
- Apply some Loctite 2045 on the screws (2) and tighten them to the torque indicated in the table.
- Position the cover (3) and tighten the screws (4) to the torque indicated in the table.

Carefully clean the filter seat and the cover.

When the engine is stopped, but still hot, the belt may start to move without warning. Wait for the engine temperature to decrease to prevent serious danger of an accidents.

![Diagram of engine parts](16_197_C)

<table>
<thead>
<tr>
<th>Ref. No.</th>
<th>Description</th>
<th>Torque</th>
</tr>
</thead>
</table>
| 2 3     | Fastening screws for blow-by filter element M6x1x40 | Pre-tightening 5 Nm  
|         |                                             | Tightening 15 ±1.5 Nm |
| 4 6     | Fastening screws for blow-by cover M6x1x25  | 7 ±0.7 Nm       |
Dispose of consumable materials and parts in contact with them (e.g. filters) in accordance with the law.
EXTRAORDINARY MAINTENANCE - HOW TO PROCEED

Fan drive belt replacement

- Remove the upper two belt guards (1).

- Loosen the nut (1) and the two nuts (4) then turn the nut (2) counter clockwise Until the belt tensioner support (6) does not make contact with the nuts (4).

- Remove the belts (8, 9).

- Place the new belt (9) on the pulley hub (7) past the pulley.

- Place the new belt (8) on the pulley hub (5) connected to the drive shaft before the pulley.

- Fit belts (9) and (8), first putting the belts in the races of the pulley (5) and then on the pulley (7). Turn the fan until the belts (8, 9) fit into the races of the pulley (7).

- Belt pre-tensioning:
  - Turn the adjustment nut (3) clockwise.
  - Check the tension of the belts (8, 9) (for example with the Clavis meter) on the long branch.
  - Tension the belts to 80/90 Hz.
  - Tighten the two nuts (4).

- Start the engine and let it run for at least 30 seconds.

- Final belt tensioning
  - Unscrew the two nuts (4).
  - Check the tension with the Clavis meter.
  - Turn the adjustment nut (3) clockwise until reaching the tension of 130 Hz.
  - Tighten the two nuts (4) and the nut (1).

- Refit the guards (1) (see the figure on the left).
Valves/rocker arms clearance adjustment

- Clearance between rockers (1) and intake/exhaust valve control bridges (3) must be strictly adjusted with maximum care using special spanner (5), polygonal spanner (2) and feeler gauge (4).
- Bring the cylinder under examination to the firing stage: the valves of this cylinder should remain closed and the clearance could be adjusted while the symmetric cylinder valves are balanced.
- The cylinder pairs are 1-6, 4-3 and 2-5.
- In order to carry out these operations correctly, follow the indications provided in the relevant Technical and Repair manual.

The pulleys (7, 5) must be aligned accurately.
Check the alignment of pulleys (7, 5) each time the belts are replaced and / or tensioned.
Refer to the Technical Repair manual of particular Gdrive model for detailed procedure.
Engine coolant replacement

Only proceed when the engine is not running, and is at low temperature, to avoid the risk of burns.

- Place a container for collecting coolant under the heat exchanger (radiator).
- Remove the pressurization cap from the expansion tank.
- Loosen the retaining elements and remove the sleeves connecting the engine cooling circuit to the heat exchanger.
- Drain the coolant from the heat exchanger (radiator) and wait until it is completely empty.
- Once emptied, refit the cooling circuit making sure the sleeves are perfectly sealed.
- Refill the engine and the heat exchanger until the cooling circuit has been completely refilled using fluids, as indicated in the REFILLING section. Do not fill the expansion tank to the brim.
- With the coolant filler cap open, start the engine and let it idle for approx. one minute. This helps to completely blowing off the air contained in the cooling circuit.
- Stop the engine and top up with more coolant, if necessary.
- When the engine is cold, make sure that the coolant in the expansion tank is a few centimetres below the filling hole.

In the event of an externally located level indicator as regards the heat exchangers, proceed with the top up operation by making sure that the coolant does not overfill the internal volume of the exchanger in order to allow the expansion of coolant volume as a result of the temperature increase.

The failure to observe the aforesaid procedure does not guarantee the presence of the correct quantity of coolant in the engine.

CAUTION!

When the engine is hot, pressure builds up in the cooling circuits which may eject hot liquid violently, resulting in a risk of burns. Open the filler cap of the coolant tank only if necessary and only when the engine is cold.
MOVING THE ENGINE

The operations necessary to disconnect and subsequently reconnect the engine must be carried out only by technicians from Service Centres.

When lifting the engine only, use the U-bolts indicated in this manual in the section ENGINE TECHNICAL DATA and marked on the engine with special stickers.

Lifting must be carried out using a rocker arm that keeps the metal cables supporting the engine parallel, using all the U-bolts provided simultaneously; the use of a lower number of lifting eyelets is not permitted.

The engine lifting system must have a capacity and size suited to the weight and dimensions of the engine; check that there is no interference between the lifting system and other accessories.

Do not lift the engine before removing the transmission members that are coupled to it.

DISPOSAL OF WASTE

The engine is made up of parts and elements that, if discarded, may cause damage to the environment.

The materials listed below must be handed over to specialised Collection Centres:

- Starter batteries.
- Used lubricants.
- Mixtures of water and antifreeze.
- Filters.
- Additional cleaning materials (e.g. greasy or fuel-soaked cloths).

The laws in force in the various countries provide for severe penalties for lawbreakers.
LONG PERIOD OF ENGINE INACTIVITY

PREPARING THE ENGINE FOR A LONG PERIOD OF INACTIVITY

In the case of a planned period of inactivity that lasts longer than two months, to prevent the interior parts of the engine and some components of the injection system from oxidising, prepare the engine as follows:

1. Drain the lubricant oil from the sump after heating the engine.
2. Pour protective oil type 30/M into the engine up to the "minimum" level indicated on the oil level dipstick. Start the engine and run it for approx. 5 minutes.
3. Drain the fuel from the injection circuit, from the filter and from the injection pump channels.
4. Connect the fuel circuit to a tank containing CFB protective liquid (ISO 4113) and introduce the liquid by pressurising the circuit and driving the engine for approx. 2 minutes, after excluding the operation of the injection system. The required operation may be completed by directly polarising terminal 50 of the electric starter motor with positive voltage equal to that of the nominal system voltage, using the specifically provided conductor.
5. Nebulize the protective oil 30/M in a quantity of approx. 160 g. (10 g per litre of displacement) in the turbocharger intake inlet, during the engine turning operation described in the previous paragraph.
6. Close all of the engine's intake, discharge, ventilation and bleeder holes with plugs or seal them with adhesive tape.
7. Drain the residual 30/M protective oil from the sump, which can be used for an additional 2 preparations.
8. Place warning notices of ENGINE WITHOUT OIL on the engine and dashboard.
9. Drain the coolant if it was not mixed if necessary with antifreeze and corrosion inhibitors, positioning signs that this operation was performed.

In the case of prolonged inactivity, repeat these operations every 6 months, according to the following procedure:

A) drain the 30/M protective oil from the sump;
B) repeat the operations from point 2 to point 7.

To protect the external parts of the engine, spray the OVER 19 AR protective liquid on the unpainted metal parts such as the flywheel, pulleys, etc., and do not spray it on belts, connector cables and electrical equipment.
ENGINE START-UP AFTER A LONG PERIOD OF INACTIVITY

1. Drain the residual 30/M protective oil from the sump.
2. Add the type and quantity of lubricant oil to the engine as specified in the REFILLING table.
3. Drain the protective fluid CFB from the fuel circuit bringing to a close the operations as indicated in point 3 of the PREPARATION OF THE ENGINE FOR A LONG PERIOD OF INACTIVITY.
4. Remove the plugs and/or seals from the engine's intake, discharge, ventilation and bleeder holes, restoring normal conditions of use. Connect the turbocharger intake inlet to the air filter.
5. Join the fuel circuits to the machine's tank bringing to a close the operations as indicated in point 4 of the PREPARATION OF THE ENGINE FOR A LONG PERIOD OF INACTIVITY. During the filling operations, connect the tank fuel return pipe to a collection container to prevent the residual CFB protective liquid from flowing into the tank.
6. Check and fill the engine with coolant as required, degassing if necessary.
7. Start the engine and let it idle until completely stabilised.
8. Check that the indications on the dashboard are plausible and that there are no alarm signals.
9. Stop the engine.
10. Remove the warning notices of ENGINE WITHOUT OIL from the engine and dashboard.
ENGINE FAULTS

The Electronic Unit that manages and controls all engine operations is able to detect the occurrence of faults and adopt strategies to proceed in a safe manner.

The event, signalled by the switching on of the EDC Fault indicator on the dashboard involves the programmed limitation of power within the thresholds determined based on the severity of the situation.

In the case of brief anomalies, the performance will be reduced until the engine stops.

BEHAVIOUR IN THE CASE OF A FAULT

Recharging system fault

The electronic engine control units may are programmed to increase the speed if the electrical system voltage reaches the values considered at the limit of efficiency. In that case, check the state of the battery or batteries and if necessary, have diagnostics performed for the system components.

ATTENTION!

The engine electronic unit adopt the safety strategies, while using the generating set, once the conditions are verified that could lead the engine’s integrity at risk.

If these conditions occur, proceed only if necessary in a cautious and attentive manner.

ATTENTION!

Do not leave the engine at low idle for a long time while the generating set is not in use.
<table>
<thead>
<tr>
<th><strong>SIGNALLED FAULT</strong></th>
<th><strong>POSSIBLE CAUSE</strong></th>
<th><strong>RECOMMENDED TESTS OR OPERATIONS</strong></th>
<th><strong>NOTES</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Low performance upon load request. Possible smoke.</td>
<td>Low fuel level in the tank.</td>
<td>Check the fuel level.</td>
<td>The possible smoke derives from the fact that if not enough fuel arrives, the control unit tries to compensate by extending the excitation time of the injectors.</td>
</tr>
<tr>
<td></td>
<td>Fuel suction in the tank partially blocked by impurities or deformation caused by overheating.</td>
<td>Check whether the priming pump on the pre-filter is working correctly. If the pump knob remains sucked downwards by the vacuum, remove and check the tank suction unit. If the suction unit is functional, replace the pre-filter.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Air filter or air intake ducts clogged.</td>
<td>Check the filters and intake ducts.</td>
<td>Remove the cause of the filter clogging and clean the air intake ducts.</td>
</tr>
<tr>
<td></td>
<td>Fuel leaks from couplings or low pressure pipes downstream of the feed pump.</td>
<td>Check the O-Rings and the correct connection of the hose couplings down stream of the feed pump (the stops must be out and the couplings properly connected). Visually check the integrity of the low pressure pipes.</td>
<td>As long as the leak is not excessive, there will not be any performance problems. To check the condition of the O-Rings, remove the fuel return pipe from the tank, hermetically plug the end and operate the priming pump, pressurising the low pressure circuit.</td>
</tr>
<tr>
<td>SIGNALLED FAULT</td>
<td>POSSIBLE CAUSE</td>
<td>RECOMMENDED TESTS OR OPERATIONS</td>
<td>NOTES</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>Low performance upon load request. Possible smoke.</td>
<td>Excessive fuel blow-by from the rail over-pressure valve.</td>
<td>Disconnect the pipe and visually check if there are evident blow-bys from the over-pressure valve: in that case replace the valve.</td>
<td></td>
</tr>
<tr>
<td>The engine stops suddenly (without previous hesitations) and does not restart.</td>
<td>Fuel filter clogged.</td>
<td>Replace the fuel filter.</td>
<td>Remove the cause of filter clogging (empty and clean the tank and the part of the hydraulic circuit up-line of the filter; fill-up with clean fuel).</td>
</tr>
<tr>
<td>Difficult starting and low performance.</td>
<td>Inefficient high-pressure pump.</td>
<td>After excluding all other causes, replace the high pressure pump.</td>
<td></td>
</tr>
<tr>
<td>Difficult starting, low performance and the engine runs with one less cylinder.</td>
<td>Injector with shutter or core of the solenoid (mechanical part) locked open.</td>
<td>The non-operative injector can be easily identified by feeling the lack of pulsations in the relative high pressure pipe.</td>
<td>In the case of slight blow-bys, which prevent the mechanical operation of the injector but does not activate the flow limiter, errors are not stored in the control unit. If the flow limiter is activated, also the error is signalled.</td>
</tr>
</tbody>
</table>
**Starting requires many seconds, considerable development of white smoke at the exhaust, fuel odour.**

- **POSSIBLE CAUSE:** Injector locked open (irreversibly).
- **RECOMMENDED TESTS OR OPERATIONS:** The non-operative injector can be identified by feeling the lack of pulsations in the relative high pressure pipe.
- **NOTES:** In the presence of such symptoms, it is instinctive to stop trying to start the engine. However, by insisting, the engine may start. By insisting, if the pressure is able to close the flow limiter in the rail, the engine starts with one less cylinder and the smoke gradually reduces and disappears.

**Breakage of the high pressure pipe from the pump to the rail.**

- **POSSIBLE CAUSE:** Anomalous vibrations caused by the pipe brackets coming loose.
- **RECOMMENDED TESTS OR OPERATIONS:** Replace the piping, properly tightening the screws of the anti-vibration brackets.
- **NOTES:** In addition to correct tightening, it is important to keep the brackets in their original position.

**The engine operates with one less cylinder, without storing the faults in the control unit.**

- **POSSIBLE CAUSE:** Injector locked open.
- **RECOMMENDED TESTS OR OPERATIONS:** Identify the injector that is no longer functioning and replace the injector and the relative high pressure union.
- **NOTES:** The non-operative injector can be easily identified by feeling the lack of pulsations in the relative high pressure pipe.
**BEHAVIOURS IN CASE OF EMERGENCY**

The user of the engine, implemented according to safety regulations, following the instructions provided in this manual and with the support of the instructions located on the engine label, operates in safe conditions.

If incorrect behaviours cause accidents, request the immediate help of specialised emergency personnel.

In the case of an emergency and while waiting for emergency personnel to arrive, the following instructions are provided.

**Fire**

Put out the fire using the foreseen devices and according to the methods indicated by the competent authorities (the fire-fighting equipment machinery has been made mandatory by current safety regulations).

**Burns**

- Put out the flames on the clothing of the burn victim by means of:
  - flooding with water;
  - use of powder extinguishers, without directing the jet towards the face;
  - covers or rolling the victim on the ground.
- Do not remove the shreds of clothing that adhere to the skin;
- If the burns are caused by liquids, quickly but carefully remove the clothing saturated with the hot liquid;
- Cover the burned area with an anti-burn pack or with a sterile bandage.

**Carbon monoxide (CO) poisoning**

The carbon monoxide contained in the engine's exhaust gas is dangerous both because it causes poisoning as well as because it forms an explosive mixture with the air.

In closed areas, carbon monoxide is very dangerous because it can reach a critical concentration in a short period of time.

If aiding a poison victim in a closed room:

- Immediately ventilate the room to reduce the concentration of gas.
- When accessing the room, the rescuer must hold his/her breath, not light flames, turn on lights or activate electric bells or telephones in order to prevent explosions.
- Bring the poison victim to safety in a ventilated room, or in the open air, placing the victim on his/her side if unconscious.
**Electrocution**

The engine's 24 V electrical system does not involve any electrocution risks. However, in the event of a short circuit caused, for example, by a metal tool, there shall be the risk of burns caused by the object overheating due to conduction of the electric current. In that case:

- Remove the object that caused the short circuit by using means that provide sufficient thermal insulation.
- If present, use the main switch to cut off the power supply.

**Injuries and fractures**

Take necessary steps if abnormal behaviors of the engine or the entire set-up of the generating set are found. While doing so, pay maximum attention to ensure the security of the people around the generating set & it's room.

- If the victim is bleeding, compress the injury externally until the rescuers arrive.
- If there is a possibility of fractures, do not move the affected part of the body and transfer the injured person very carefully and only if absolutely necessary.

**Corrosion**

Skin corrosion is caused by contact with substances with a high degree of acidity or basicity.

For personnel performing maintenance on electrical devices, this is typically caused by acid escaping from the batteries; in this circumstance proceed as follows:

- Remove any clothing saturated with the caustic substance.
- Wash thoroughly with flowing water, without spraying uninvolved parts.

If battery acid, lubrication oil or diesel has entered the eyes: wash the affected eye with water for at least 20 minutes, keeping the eyelids open so the water flows onto the eyeball (facilitate washing of the eye by moving it in all directions).