INTRODUCTION

We would like to thank you for buying an FPT product, and compliment you on your choice of engine. Before you carry out any operation involving the engine or its fittings, please read the contents of this manual carefully; compliance with the instructions provided in the manual is the best way to guarantee trouble-free, long term operation of the engine.

The contents of this manual refer to the standard configuration of the engine, and the illustrations are purely indicative. Some instructions are provided by giving the sequence of operations to be carried out in order to allow the engine and/or its fittings to perform in a certain way. In some cases they will be dependent on the configuration of the commands and the set-up of the machine on which the engine is installed; for any points that differ from the contents of this manual, please consult the instructions provided by the machine Manufacturer or a specific manual.

The information provided below was current at the date of publication.
The Manufacturer reserves the right to make modifications at any time without prior notice, for technical or commercial reasons or to update the engines to comply with legal requirements in the various Countries.
The Manufacturer declines all liability for any errors or omissions.

Please remember that the FPT Technical Service Network is available to offer you its experience and professional skills, wherever you may be.
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GENERAL INFORMATION

GUARANTEE
In order to ensure that your engine gives the best possible performance and to take advantage of the FPT guarantee, you must follow the indications provided in this publication with great care; failure to do so may result in invalidation of the guarantee.

SPARE PARTS
Always use Original FPT Spare parts. This is essential to keep the engine in original running order. The use of non-original spare parts will not only invalidate the guarantee, but will mean that FPT will not be considered liable in any way during the whole working life of the engine.

LIABILITY
The Manufacturer will only be considered liable subject to performance of the control and maintenance operations indicated and described in this manual; to this effect, proof that these operations have been performed must be provided. Any special maintenance operations that may be necessary must be carried out by qualified technicians from Workshops in the FPT Network, using the instruments and equipment provided for the purpose.

SAFETY
The following information is intended to encourage caution when using the engine, so as to avoid damage to persons or property as a result of improper or incorrect behaviour.

- The engines must only be used for the purposes indicated by the Manufacturer.
- Any tampering, modification and use of non-original spare parts may compromise proper operation and safe use of the engine; **never, under any circumstances** make modifications to the wiring and to the units equipping the engine, or connect them to other power systems.
- Pay particular attention to moving parts of the engine, to high temperature components and to circuits containing pressurised fluids; its electrical equipment houses electrical currents and voltage.
- The exhaust fumes produced by the engine are bad for your health.
- The engine must be handled using suitable lifting tackle, making use of the U-bolts provided on the engine for that purpose.
- The engine must not be started up and used until the machine in which it installed has satisfied all necessary safety requirements, or until the machine has been guaranteed to comply with local laws and regulations.
- The operations required to guarantee the best possible use and preservation of the engine must only be carried out by persons of proven experience, equipment with tools considered suitable by FPT.

For the purpose of safety, further recommendations are given in the chapter CONTROLS AND MAINTENANCE.
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, etc.

<table>
<thead>
<tr>
<th>Code</th>
<th>NEF45 TM3.S500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine family</td>
<td>F4</td>
</tr>
<tr>
<td>Cycle</td>
<td>4-stroke diesel</td>
</tr>
<tr>
<td>Number and arrangement of cylinders</td>
<td>4, in line</td>
</tr>
<tr>
<td>Bore x stroke</td>
<td>104 x 132 mm</td>
</tr>
<tr>
<td>Total displacement</td>
<td>4,500 cm³</td>
</tr>
<tr>
<td>Air system</td>
<td>Supercharged with turbocharger and intercooler</td>
</tr>
<tr>
<td>Injection type</td>
<td>Direct injection with rotary pump</td>
</tr>
<tr>
<td>Compression ratio</td>
<td>17.5:1</td>
</tr>
<tr>
<td>Cooling</td>
<td>Liquid</td>
</tr>
<tr>
<td>Engine direction of rotation</td>
<td>Anticlockwise (seen from flywheel side)</td>
</tr>
<tr>
<td>Control system</td>
<td>Mechanical</td>
</tr>
<tr>
<td>Dry weight</td>
<td>~500 kg (G-Drive)</td>
</tr>
</tbody>
</table>

**Electrical system**

<table>
<thead>
<tr>
<th>12 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery capacity</td>
</tr>
<tr>
<td>Pick-up current</td>
</tr>
<tr>
<td>Maximum input</td>
</tr>
<tr>
<td>Discharge current</td>
</tr>
</tbody>
</table>

**Performance (*)**

<table>
<thead>
<tr>
<th>NEF45 TM3.S500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without emissions certificate</td>
</tr>
<tr>
<td>Prime - 107.2 kWm @ 1,500 rpm</td>
</tr>
<tr>
<td>Stand-by - 118.2 kWm @ 1,500 rpm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>60 Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prime - kWm @ 1,800 rpm</td>
</tr>
<tr>
<td>Stand-by - kWm @ 1,800 rpm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>50 Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine idle speed</td>
</tr>
<tr>
<td>Unladen - 1,500 rpm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>60 Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum engine rpm unladen</td>
</tr>
<tr>
<td>1,570 rpm</td>
</tr>
</tbody>
</table>

It is strictly forbidden to alter the aforesaid characteristics and, in particular, to modify the calibration of the injection pump 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.

(*) Net power at the flywheel in accordance with the standard ISO 8528. Test conditions: T 25 °C; atmospheric pressure 100 kPa; relative humidity 30%. 
NEF45 TM3.S500

NEF45 TM3.S500
## SIGNS

Certain warning signs are affixed to the engine by the Manufacturer, and their meanings are indicated below.

**N.B.** The signs with an exclamation mark on them underline a potential **danger**.

<table>
<thead>
<tr>
<th>Sign</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Lifting point" /></td>
<td>Lifting point (engine only).</td>
</tr>
<tr>
<td><img src="image" alt="Fuel Cap" /></td>
<td><strong>DIESEL</strong> Fuel Cap (on the fuel tank, if there is one).</td>
</tr>
<tr>
<td><img src="image" alt="Oil Cap" /></td>
<td>Oil Cap.</td>
</tr>
<tr>
<td><img src="image" alt="Oil dipstick" /></td>
<td>Oil dipstick.</td>
</tr>
<tr>
<td><img src="image" alt="Danger of burning" /></td>
<td>Danger of burning: Expulsion of hot water under pressure.</td>
</tr>
<tr>
<td><img src="image" alt="Danger of burning" /></td>
<td>Danger of burning: Presence of high temperature parts.</td>
</tr>
<tr>
<td><img src="image" alt="Danger of fire" /></td>
<td>Danger of fire: Fuel present.</td>
</tr>
<tr>
<td><img src="image" alt="Danger of impact or catching" /></td>
<td>Danger of impact or catching on moving parts: Presence of fans, pulleys, belts or the like.</td>
</tr>
</tbody>
</table>
**USE**

**PRELIMINARY CHECKS**

Before starting the engine each time:

- Check the level of technical fluids (fuel, engine oil and coolant), and top-up if necessary.
- 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 clogging visual indicator (1) signals when it is necessary to carry out maintenance in order to protect and optimize filter operation. The sensor (1) remains locked in the alarm position ("red") until it is reset.

**Note:** The procedures required to clean the filter are indicated in the chapter CONTROLS AND MAINTENANCE.

**CAUTION!**

Make sure that no combustible vapours or gasses are present in the area in which the engine is to operate. Ensure that closed areas are adequately ventilated and fitted with a suitable exhaust extraction system.
ENGINE PRE-HEATING (optional)
The engines which require low start-up temperatures and an immediate delivery of power may be equipped with an electrical heating device enabling an increase in the temperature of the air entering the engine. The device is mounted on the intake manifold and is fitted with a coolant temperature sensor which interrupts the power supply once the required temperature has been reached.

SWITCHING OF OPERATING FREQUENCY
Based on the specific operational requirements of the engine, it is possible to vary the adjustment of the rotary injection pump so as to obtain a different operating frequency:
- 1,500 rpm @ 50 Hz
- 1,800 rpm @ 60 Hz
To switch from 50 Hz to 60 Hz it is necessary to turn the adjustment screw (1) of the “droop setting”, clockwise a number of turns depending on the identification code of the pump indicated on the nameplate.
FOR PROPER USE OF THE ENGINE

- Before starting the engine, check there is enough fuel in the fuel tank.
- Do not keep on starting.
- Do not idle for long periods since this increases the production of harmful emissions from the engine and does not guarantee its optimum performance.
- The engine speed must be increased and decreased gradually so as to permit normal combustion and the optimum functioning of all engine components.
- During use, check periodically that:
  - the temperature of the engine coolant does not reach the alarm thresholds;
  - the oil pressure remains within normal values.
- Actual power values must comply with the rated values reported in the technical documentation.
- Particular attention must be drawn on emergency power unit engines, which must be submitted to frequent overhauls in order to ensure their prompt start whenever required.

SPECIAL WARNINGS

High coolant temperature

In the event of an excessive temperature or the signalling of the alarm, disengage the load and stop the engine in order to check the condition of the cooling circuit. Moreover, check the following:

- tension of ancillary belt;
- the thermostatic valve’s efficiency;
- the conditions of the heat exchanger (to be cleaned if necessary).

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.

Low lubricant oil pressure

Should the pressure indicated by the instrument be considered insufficient or if the “low oil pressure” warning light comes on, stop the engine and check the oil level. If necessary, top up the oil according to the instructions contained in the section CHECKS AND MAINTENANCE. If the fault persists, contact a Service centre.
**Presence of water in the fuel filter**

It is advisable to drain the water from the filters before the relevant warning light comes on. Avoid using the engine with only a small reserve of fuel in the fuel tank; this encourages the formation of condensation and makes it more likely you will suck up dirt or air, resulting in engine stoppage.

> Refuelling from drums or jerry cans may contaminate the diesel, resulting in problems with the fuel supply system; in these cases it is necessary to carry out adequate filtration or sedimentation of any impurities present.

**Intake and exhaust circuit inefficiencies**

Inspect the cleanliness of the air intake circuit on a regular basis. The maintenance intervals indicated in this manual vary according to the conditions in which the engine is used. In particularly dusty environments it is necessary to carry out maintenance at more frequent intervals than indicated in the chapter CONTROLS AND MAINTENANCE.

> Visually check that the exhaust circuit is not blocked or damaged, so as to prevent dangerous fumes.

**Electrical start-up system irregularities**

Periodically check, particularly during the winter, to ensure that the batteries are clean and in full working order, checking and topping up as indicated in the chapter CONTROLS AND MAINTENANCE. In the event of battery replacement, please observe the characteristics contained in the section ENGINE TECHNICAL DATA.

> Contact a specialised workshop and check battery and recharging system efficiency if the voltmeter indicates a voltage below 11 V (for 12 V rated systems), or 22 V (for 24 V rated systems).
Battery or alternator recharging faults
Periodically check or have someone check the cleanliness, wear and full tensioning of the drive belt.

CAUTION!
The ancillary members are located under protective grilles. Their removal must be carried out only when the engine is not turning.

RUNNING IN
Thanks to modern engine construction technology, no particular running in procedure is required. However, it is recommended that, for the first 50 hours, you do not use the engine at high power for long periods.

**REFUELLING**
**NEF45 TM3.S500**

<table>
<thead>
<tr>
<th>Parts to be supplied</th>
<th>litres (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooling circuit (1)</td>
<td></td>
</tr>
<tr>
<td>engine (4)</td>
<td>8.5</td>
</tr>
<tr>
<td>G-Drive (5)</td>
<td>18.5</td>
</tr>
<tr>
<td>Lubrication circuit (2) (3)</td>
<td>12.8 (11.8)</td>
</tr>
<tr>
<td>Periodic changing:</td>
<td></td>
</tr>
<tr>
<td>oil sump at minimum level</td>
<td>5.5 (5.1)</td>
</tr>
<tr>
<td>oil sump at maximum level</td>
<td>8.5 (7.8)</td>
</tr>
</tbody>
</table>

(1) Use a 50% mixture of water and PARAFLU 11 or the equivalent corresponding to the specification SAE J1034.
(2) Use lubricants which meet the international standards ACEA E5-E7 (high power engines). The oil used is considered to be acceptable until a quantity equalling 0.1% of fuel consumption is reached.
(3) The quantities indicated relate to the first refuel only and are relative to the engine, oil sump and filter filling.
(4) The quantities indicated only relate to the engine in its standard configuration.
(5) The quantities indicated relate to the total capacity of the generating set including the engine capacity, the radiator and the pipes.
Coolant refilling
For the initial engine start-up and in the cases in which the refilling of the cooling circuit is required with a considerable quantity of coolant, proceed as follows:

- Refill the engine and the exchanger until the exchanger is completely filled.
- With the coolant filler plug open, start the engine and let it idle for approx. 1 minute. This helps to completely bleed the air contained in the cooling circuit.
- Stop the engine and then top up with coolant if necessary.

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

Refuelling
Use only diesel oil in accordance with EN 590 standard normally commercially available. Fuel additives are not recommended. Use of additives can limit the guarantee performance offered for the vehicle.

CAUTION!
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. The couplings of the fuel circuit under high pressure must not be loosened under any circumstances.

Low temperature diesel
At low temperatures the degree of fluidity of the diesel can become low due to the separation of the paraffin resulting in the filters becoming clogged. EN590 specifications distinguish different classes of diesel fuel, identifying the characteristics of those best suited to low temperatures. It is entirely up to the Oil companies to comply with these regulations, which foresee that fuels suited to the climactic and geographic conditions of the various Countries be distributed.
CONTROLS AND MAINTENANCE

MAINTENANCE PERSONNEL
The engine control and maintenance operations described in the following chapter require training, experience and compliance with current safety regulations; for this reason they must be carried out by special technicians, as indicated below.

□ Controls: by workshop technicians or the machine user if necessary.

□ Periodic maintenance: by qualified personnel using suitable equipment and adequate means of protection.

□ Special maintenance: by qualified personnel from Authorised Service Centres who have detailed technical information and specific equipment.

The most qualified Assistance Centres are those which make up the FPT Technical Assistance Network.

ACCIDENT PREVENTION

□ Always wear heavy-duty footwear and overalls.

□ Never wear loose, flapping garments, rings, bracelets and/or necklaces in the vicinity of engines or moving parts.

□ Always wear protective gloves and goggles when:
  • filling up batteries with acid solution
  • refuelling with inhibitors or antifreeze

□ replacing or topping up lubricant (hot engine oil may cause burns and scalds. Only carry out these operations when the oil has dropped to a temperature of below 50°C).

□ When working in the engine compartment, pay particular attention to how you move, to avoid contact with moving parts or high temperature components.

□ Wear goggles and use high pressure air jets (maximum air pressure used to clean is 200 kPa (2 bar, 30 psi, 2 kg/cm²)).

□ Wear a protective helmet when working in an area were there are suspended loads or systems installed at head-height.

□ Use protective hand creams.

□ Immediately replace wet overalls.

□ Always keep the engine clean, removing oil, grease and coolant stains.

□ Store cloths in flame-proof containers.

□ Do not leave foreign bodies on the engine.

□ Use suitable, safe containers for used oil.

□ When completing a repair, make suitable provisions to stop the engine taking in air if, after start-up, an uncontrolled increase in engine speed were to occur.
Do not carry out maintenance operations when the electric power supply is turned on: always check to ensure that the appliances are properly earthed. During diagnosis and maintenance operations, make sure that your hands and feet are dry, and whenever possible use insulating stands.

The conditions provoking the emergency power unit start may suddenly occur. Whenever executing checks and maintenance operations, strictly follow the safety instructions prescribed by the unit’s Manufacturer and power unit system’s outfitter to operate safely and prevent injury.

### FREQUENCY NEF45 TM3.S500

<table>
<thead>
<tr>
<th>Controls when in use</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check oil level in engine</td>
<td>Daily</td>
</tr>
<tr>
<td>Check engine coolant level</td>
<td>Daily</td>
</tr>
<tr>
<td>Check cleanliness of the heat exchanger</td>
<td>Daily</td>
</tr>
<tr>
<td>Check that the air filter is clean</td>
<td>300 hours $^{(2)}$ $^{(4)}$</td>
</tr>
<tr>
<td>Inspection of the exhaust duct/s</td>
<td>Daily</td>
</tr>
<tr>
<td>Check tightening and cleanliness of battery clamps</td>
<td>Six-months</td>
</tr>
<tr>
<td>Check electrolyte level of the batteries</td>
<td>Six-months</td>
</tr>
</tbody>
</table>

The maintenance intervals indicated below take into account the typical working factors for various types of engine use; the most suitable interval for maintenance operations for the various applications will be indicated by the maintenance staff, according to the way and working conditions in which the engine is used.
1) Maximum period relating to the use of high quality fuel, (specification EN 590); this is reduced, basing on fuel contamination and alarm signals caused by filter clogging and/or the presence of water in the filter. The filter clogging signal indicates that the filter must be replaced. If the warning light of water present in the filter does not go off after drainage, then the filter must be replaced.

2) The frequency depends on the ambient conditions and product efficiency/wear. After long periods of engine inactivity, perform the check before starting the engine. The filter clogging signal indicates that the filter must be replaced.

3) The frequencies are applicable for lubricants which meet the international standards ACEA E5-E7 (high power engines).

4) To be performed every year even if the specified operating hours interval has not been reached.

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

<table>
<thead>
<tr>
<th>Planned maintenance</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine lubricant oil change</td>
<td>800 hours (3) (4)</td>
</tr>
<tr>
<td>Change oil filter</td>
<td>800 hours (3) (4) (5)</td>
</tr>
<tr>
<td>Change fuel filter</td>
<td>600 hours (1) (4) (5)</td>
</tr>
<tr>
<td>Drain water from the fuel pre-filter</td>
<td>300 hours (1)</td>
</tr>
<tr>
<td>Drainage/suction of water, condensation</td>
<td>300 hours (1)</td>
</tr>
<tr>
<td>and impurities from the fuel tank/s</td>
<td></td>
</tr>
<tr>
<td>Check tension and condition of ancillary</td>
<td>300 hours</td>
</tr>
<tr>
<td>belt</td>
<td></td>
</tr>
<tr>
<td>Change engine coolant</td>
<td>1200 hours / 2 years</td>
</tr>
<tr>
<td>Change air filter</td>
<td>1200 hours / 2 years (2)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Special maintenance</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change ancillary belt</td>
<td>1200 hours / 3 years</td>
</tr>
<tr>
<td>Clean heat exchanger</td>
<td>1200 hours</td>
</tr>
<tr>
<td>Turbocharger visual inspection</td>
<td>1200 hours</td>
</tr>
<tr>
<td>Injector calibration</td>
<td>1800 hours</td>
</tr>
<tr>
<td>Adjust play in valves-rocker arms</td>
<td>3000 hours</td>
</tr>
</tbody>
</table>

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

2) The frequency depends on the ambient conditions and product efficiency/wear. After long periods of engine inactivity, perform the check before starting the engine. The filter clogging signal indicates that the filter must be replaced.

3) The frequencies are applicable for lubricants which meet the international standards ACEA E5-E7 (high power engines).

4) To be performed every year even if the specified operating hours interval has not been reached.

5) Only use filters with the following specifications:
   - degree of filtering < 12 μm
   - filtering efficiency 99.5% (β > 200).
In the event in which fuel is used with a sulphur percentage greater than 0.5%, or oils are used which do not meet the specifications in the section FLUIDS, then the replacement frequencies of the engine oil, engine oil filter and blow-by filter must be halved, or suitably adjusted, in accordance with the use and operating conditions of the engine; please consult the personnel in charge of maintenance operations for appropriate advice.

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.
The unscheduled maintenance operations described in the relative table are under the exclusive responsibility of qualified personnel in possession of suitable technical information and equipped with suitable work tools and protective devices. The instructions for their fulfilment are contained in the FPT technical and repair manuals.

**REQUIREMENTS**
- Do not disconnect the batteries with the engine running.
- Do not carry out arc welding operations in the vicinity of the engine without first removing electrical cables.
- After each maintenance operation involving disconnection of the battery/batteries, make sure that the terminals have been properly locked onto the poles.
- Do not use battery chargers to start the engine.
- Do not paint the appliances, components and electrical connectors equipping the engine.
- Disconnect the battery/batteries before any electrical operations.
- Contact the Manufacturer before installing electronic equipment.

Do not execute any operation which may change the ignition pump’s calibration.
The ignition pump’s calibration has been carried out in phase of engine system test based on its final use or destination.
HOW TO PROCEED

Check oil level in engine

Only proceed with the engine stopped and at a low temperature, so as to avoid the risk of burning.

- Take all necessary action to ensure that the machine is “level”.
- Using the dipstick (1), check that the oil level is between the “Min” and “Max” levels.
- If the level is too low, top up through the inlet, after first removing the relevant cap (2).

WARNINGS

- After topping up, make sure that the oil level does not exceed the “Max” limit marked on the dipstick.
- Make sure that the dipstick is inserted properly and the filler cap is turned in a clockwise direction until it stops turning completely.
**Check coolant level**

Proceed only with engine not running and at low temperature to avoid any risk of burns.

- With the engine at low temperature, make sure that the fluid level in the expansion tank is above the minimum level.
- Visually check that the fluid level is not more than 2/3 of the height of the tank in order to enable any increase in volume of the fluid caused by the temperature increase.
- Top up the tank if necessary, using clean water. Do not use distilled water; see the table REFUELLING.

**Note:** If the refill operations occur frequently a diagnosis of the cooling circuit is necessary.

In the event that only the heat exchanger without the expansion tank is available on the vehicle, refill it if necessary, paying attention that the fluid does not saturate the internal volume of the exchanger in order to enable any increase in volume of the fluid caused by the temperature increase.

---

**CAUTION!**

When the engine is warm, a pressure liable to cause hot liquid to be expelled with extreme violence is created within the cooling circuits. This results in a danger of burning.

---

**Clean heat exchangers**

Check that the radiator air inlets are free from dirt (dust, mud, straw, etc.). Clean them if necessary, using compressed air or steam.
Cleaning the air filter

Only proceed with the engine stopped.

- Remove the filter cover (1) after first unscrewing the locking handle.
- Remove the external cartridge (2), after unfastening the second locking handle; during this operation, take care to ensure that no dust get into the sleeve.
- Check that there is no dirt. If there is, clean the filter element as indicated below.
- Blow dry compressed air through the filter element, from the inside outward (maximum pressure 200 kPa). Do not use detergents; do not use diesel.
- Never use tools to beat the filter element, and check its condition before replacing it.
- Replace the filter if any breakages or tears are found.
- Check that the gasket at its base is in good condition. Some filter systems are fitted with a second filter element (3) which does not require cleaning; this must be replaced at least once every 3 changes in the main element.
- Reassemble by repeating the above operations in reverse order.
- Set up the mechanical blockage indicator for operation by pressing the button located on the top part of the indicator. This operation is not necessary if there is an electrical sensor.

WARNING

Take care to ensure that the parts are reassembled correctly. Imperfect assembly might result in unfiltered air being sucked into the engine, causing serious damage.
Drain water from the fuel filter/pre-filter
The high risk of refuelling with fuel that is polluted by foreign bodies and water makes it advisable to carry out this control every time you refuel. Proceed with the engine stopped.

- Place a container under the filter or pre-filter to collect the fluid.
- Unscrew the water bleeding screw (1) in the lower part of the filter.
- Drain off liquid until only “diesel” can be seen.
- Tighten the bleeding screw as far as possible by hand.
- Dispose of the drained fluids according to current requirements.

Check/top up electrolyte level in batteries
Place the batteries on a level surface, then proceed as follows.

- Visually check that the fluid level is between the “Min” and “Max” limits; in the absence of references, check that the fluid covers the Lead plates inside the elements.
- Top up with distilled water only those elements in which the level is below the minimum.
- Contact specialised technical staff if the battery needs recharging.
- Have the efficiency of the battery recharging system tested if a voltage of less than 11 V (for 12 V rated systems) or 22 V (for 24 V rated systems) is detected with the engine running.
- On this occasion, make sure that the terminals and clamps are clean, properly locked and protected by vaseline.

CAUTION!

- The batteries contain sulphuric acid, which is extremely caustic and corrosive; always wear protective gloves and goggles when topping them up. Whenever possible it is recommended that this control be carried out by specialised personnel.
- Do not smoke or use live flames near the batteries during the control, and make sure that the room you are working in is adequately ventilated.
Some types of battery have a single cover for all the inspection plugs. To access the elements, use a lever as shown in the figure.

Check tension and state of the auxiliary member drive belt

Only proceed with the engine stopped and at a low temperature, so as to avoid the risk of burning.

- Check that the belt is not torn or worn, and that there are no lubricants or fuel on it. If this is not the case, replace them.

Should it be necessary to restore tension in the belt, proceed as follows:

- Loosen the alternator fastening nut (1) and screw (2).
- Screw in the micrometric screw (3) and lock the relative counter nut.
- Using a suitable tool, check the tension of the belt at the intermediate point (4) of the branch between the pulley and the water pump pulley.
- The correct tension is 245 ± 10 Hz (1200 ± 100 N).
- When the correct tension has been obtained, tighten the alternator screw and bolt to a torque of 43 ± 6 Nm.
For engines without a screw tensioner proceed, after loosening the fixing screws (1) and anchor bolt, by turning the alternator as shown in the figure until the required tension is reached, after which tighten the fixing screws and anchor bolt firmly.

**Change oil**

Only proceed with the engine stopped and at a low temperature, so as to avoid the risk of burning.

- Place a container under the drainage plug to collect the used oil (see illustrations in the chapter ENGINE TECHNICAL DATA).
- Unscrew the plug and wait until the sump has emptied completely, then fasten the plug in place again.
- Fill up through the feeder hole (2) on the timer cover or elsewhere (opt.), using the types and amounts of oil indicated in the table REFUELLING.
- Using the dipstick (1), check that the oil level is between the "Min" and "Max" levels.
- Dispose of used oil according to current requirements.
**Change oil filter**

Only proceed with the engine stopped and at a low temperature, so as to avoid the risk of burning.
Only use filters with a filtration level equivalent to the ones you are replacing (see section FREQUENCY).

- Place a container under the filter support (1), to collect the used oil.
- Unscrew the filter and remove it (2).
- Carefully clean the surfaces of the support that are in contact with the seal gasket.
- Damp the new seal gasket with a thin layer of oil.
- Hand screw the new filter into place until the seal gasket touches the support, then lock by a further 3/4 of a turn.
- Dispose of the old filter according to current requirements.

**Change fuel filter/s**

Only proceed with the engine stopped and at a low temperature, so as to avoid the risk of burning.
Only use filters with a filtration level equivalent to the ones you are replacing (see section FREQUENCY).

- Remove the filter/s (1) by unscrewing it.
- Check that the new filter has performance levels that satisfy the needs of the engine (e.g. by comparing them with the old one).
- Damp the new filter seal with diesel or engine oil.
- Hand screw the new filter into place until the seal gasket touches the support, then lock by a further 3/4 of a turn.
- Pay particular attention to the electrical fuel pre-heater (if available) and relevant electrical connection.
Check exhaust pipe/s for damage
Visually check that the exhaust system is not blocked or damaged.
- Make sure that there is no risk of dangerous fumes within the machine. Contact the Manufacturer if necessary.

Impurity drainage or suction from fuel tank
Proceed taking into consideration the constraints of the tank’s placement and structure.
The engines working in harsh environments and conditions and/or to be refuelled from cans or barrels require even more accurate tank cleaning.

Change auxiliary member belt
Please refer to the information provided for checking the belt tension.

Air filter replacement
Refer to the instructions provided for air filter cleaning.

WARNING
Do not fill up the new filter before it is fitted to the support, to avoid inserting harmful impurities into the injection system and circuit.

Change coolant
Only proceed with the engine stopped and at a low temperature, so as to avoid the risk of burning.
- Provide suitable containers to ensure that no coolant is dispersed into the environment.
- Loosen the seal elements, remove the sleeves connecting the engine circuit to the heat exchanger and wait until it has emptied completely. When empty, repair the circuit making sure that the sleeves are perfectly sealed.
- Fill up the circuit as indicated in the table REFUELLING.
- Refill the engine and the heat exchanger until complete top up.
- With the filler cap open, start the engine and keep it idling for nearly one minute. This phase facilitates the cooling liquid air bleed.
- Stop the engine and top up again.
MOVING THE ENGINE

The operations necessary to disconnect and subsequently reconnect the engine must only be carried out 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 single U-bolt only is not allowed.

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 the engine components.

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; the laws in force in the various Countries foresee severe penalties for transgressors:

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

PREPARING THE ENGINE FOR A LONG PERIOD OF INACTIVITY

In order to prevent oxidation of the internal parts of the engine and of certain components in the injection system, when the engine is expected to be inoperative for periods of more than two months, the following operations must be carried out in preparation for this:

1. Drain the lubricant from the sump, after first warming up the engine.
2. Fill the engine with protective oil type 30/M (or alternatively oil that complies with MIL 2160B type 2 specifications), up to the "minimum" level indicated on the dipstick. Start the engine and keep it running for approximately 5 minutes.
3. Drain the fuel from the injection circuit, from the filter and from the injection pump pipes.
4. Connect the fuel circuit to a tank containing CFB (ISO 4113) protective fluid, and feed in the fluid by putting the circuit under pressure and running the engine for approximately 2 minutes, after first disabling the injection system. This operation can be performed by polarising terminal 50 of the starter motor with a positive voltage equivalent to the rated voltage of the system, using a conductor provided for that purpose.
5. Nebulise approximately -- g of 30/M protective oil (10 g per litre displacement) into the turbocharger suction inlet, during the pressurised filling operation described in the previous point.
6. Close all the suction, delivery, ventilation and bleeder openings in the engine with suitable plugs, or seal them with adhesive tape.
7. Drain the residual 30/M protective oil from the sump. This oil can be used again for a further 2 preparation operations.
8. Fit signs reading "ENGINE WITHOUT OIL" to the engine and to the on-board control panel.
9. Drain the coolant, if it has not been mixed with suitable antifreeze and corrosion inhibitors, and affix a sign to indicate the fact.

In the event of prolonged inactivity, the operations described must be repeated every 6 months, following the procedure given below:
A) drain the 30/M protective oil from the sump;
B) repeat the operations described from point 2 to point 7.

Should you intend to protect external parts of the engine, proceed by spraying OVER 19 AR protective liquid on unpainted metal parts, such as the flywheel, pulleys and the like, avoiding belts, connector cables and electrical equipment.
RESTARTING THE ENGINE AFTER A LONG PERIOD OF INACTIVITY

1. Drain the residual 30/M protective oil from the sump.
2. Fill the engine, as prescribed, with lubricant of the type and amount indicated in the table REFUELLING.
3. Drain the CFB protective fluid from the fuel circuit, carrying out this operation as indicated under point 3. of PREPARING THE ENGINE FOR A LONG PERIOD OF INACTIVITY.
4. Remove the plugs and/or seals from the suction, delivery, ventilation and bleeder openings in the engine, restoring it to a normal state of use. Connect the turbocharger suction inlet to the air filter.
5. Connect the fuel circuits to the machine's fuel tank, completing the operations as indicated in point 4. of PREPARING THE ENGINE FOR A LONG PERIOD OF INACTIVITY. During filling operations, connect the fuel return pipe to a collection tank, so as to prevent any residual CFB protective fluid from flowing into the machine's fuel tank.
6. Check the engine and fill it up with coolant as prescribed, bleeding it if necessary.
7. Start the engine and keep it running until the idling speed rate has stabilised completely.
8. Check that the instruments on the on-board control panel/s are showing plausible values, and that no alarms are shown.
9. Stop the engine.
10. Remove the "ENGINE WITHOUT OIL" signs from the engine and from the on-board control panel.
BEHAVIOUR IN AN EMERGENCY

The user of a machine that has been constructed according to safety regulations, when following the instructions provided in this manual and the indications given on the engine labels, will be working in safe conditions. Should improper conduct result in accidents, always request the intervention of trained first aid specialists immediately. In an emergency and while awaiting the arrival of first aid specialists, follow the instructions given below.

Engine malfunctions
When operating with a malfunctioning engine, take the greatest possible care when manoeuvring and make sure that all those aboard are holding firmly to safe hand-holds.

In case of fire
Extinguish the fire using the fire-fighting equipment foreseen, and in the manner indicated by Fire prevention authorities (fire-fighting equipment for certain machines and equipment is compulsory under current safety legislation).

Burns and scalds
1. Extinguish any flames on the burned person’s clothing, by:
   • throwing water over them;
   • using a powder fire-extinguisher, without directing the jet at the person’s face;
   • covering with blankets or rolling the victim on the ground.
2. Do not attempt to remove pieces of clothing that may have stuck to the skin;
3. In the case of scalding, immediately but carefully remove any clothing that may be soaked in the hot liquid;
4. Cover the burn with a special burn dressing or sterile bandage.

Carbon monoxide intoxication (CO)
Carbon monoxide from the engine exhaust is without smell, and is dangerous both because it causes intoxication, and because when combined with air it forms an explosive mixture. In closed rooms, carbon monoxide is extremely dangerous, as it can reach critical concentrations within a very short time. When assisting an intoxicated person in a closed room:
1. Ventilate the room immediately, to reduce the concentration of gas.
2. When entering the room, hold your breath, do not light flames, lights or ring electric doorbells or phones, to avoid the risk of explosion.
3. Carry the intoxicated person out into the fresh air or into a well ventilated room, resting him on one side if he is unconscious.
Electrocution

A. The engine’s electrical 12 V electrical system does not involve the risk of electrocution, however, in the event of a short-circuit caused, for example, by a metal tool, there is a risk of burning due to overheating of the object through which the electrical current runs. In these circumstances:

1. Remove the object that caused the short-circuit, using means that provide sufficient heat insulation.
2. Switch off the power at the main switch, if there is one.

B. The electric generator systems (generator units) normally produce high voltages that are liable to result in extremely dangerous current levels. In the event of medium or high voltage electrocution:

1. Turn off the power supply at the main switch before touching the victim. If this is not possible, use equipment that is both safe and adequately insulated when touching the victim; remember that touching a victim of electrocution is also extremely dangerous for the person giving aid.
2. Proceed as indicated by the competent authorities (cardiac massage, mouth-to-mouth resuscitation, etc.)

Injuries and fractures

The vast number of possible circumstances and the specific nature of operations required means that the intervention of a medical team is necessary.

1. In the event of bleeding, keep the edges of the wound pressed together until help arrives.
2. If there is any suspicion of a fracture, do not move the injured part and only move the patient if absolutely necessary.

Caustic burns

Caustic skin burns are caused by contact with extremely acid or alkaline substances.
For electric maintenance technicians these are typically caused by acid from batteries; in these circumstances, proceed as follows:

1. Remove any clothing soaked in the caustic substance.
2. Wash the area with lots of running water, avoiding parts that have not been burned.
If either battery acid, lubricants or diesel come into contact with the eyes: wash the eyes with water for at least 20 minutes, keeping the eyelids open so that the water flows over the eyeball (move the eye in all directions to wash more thoroughly).