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.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>GENERAL INFORMATION</td>
<td>3</td>
</tr>
<tr>
<td>GUARANTEE</td>
<td>3</td>
</tr>
<tr>
<td>SPARE PARTS</td>
<td>3</td>
</tr>
<tr>
<td>LIABILITY</td>
<td>3</td>
</tr>
<tr>
<td>SAFETY</td>
<td>3</td>
</tr>
<tr>
<td>ENGINE TECHNICAL DATA N45 ENT</td>
<td>4</td>
</tr>
<tr>
<td>(75 kW - 89 kW - 110 kW - 125 kW)</td>
<td></td>
</tr>
<tr>
<td>ENGINE TECHNICAL DATA N67 ENT</td>
<td>7</td>
</tr>
<tr>
<td>(129 kW - 151 kW)</td>
<td></td>
</tr>
<tr>
<td>ENGINE TECHNICAL DATA N67 ENT</td>
<td>10</td>
</tr>
<tr>
<td>(122 kW - 129 kW - 140 kW - 151 kW - 162 kW)</td>
<td></td>
</tr>
<tr>
<td>ENGINE TECHNICAL DATA N67 ENT</td>
<td>13</td>
</tr>
<tr>
<td>(122 kW - 129 kW - 140 kW - 151 kW - 162 kW)</td>
<td></td>
</tr>
<tr>
<td>SIGNS</td>
<td>16</td>
</tr>
<tr>
<td>USE</td>
<td>17</td>
</tr>
<tr>
<td>PRELIMINARY CHECKS</td>
<td>17</td>
</tr>
<tr>
<td>STARTING AND STOPPING THE ENGINE</td>
<td>17</td>
</tr>
<tr>
<td>RECOGNISING ALARMS</td>
<td>19</td>
</tr>
<tr>
<td>ENGINE MANAGEMENT AND DIAGNOSIS</td>
<td>20</td>
</tr>
<tr>
<td>FROM THE INSTRUMENT PANEL</td>
<td></td>
</tr>
<tr>
<td>FOR PROPER USE OF THE ENGINE</td>
<td>21</td>
</tr>
<tr>
<td>SPECIAL WARNINGS</td>
<td>22</td>
</tr>
<tr>
<td>RUNNING IN</td>
<td>23</td>
</tr>
<tr>
<td>CONTROLS AND MAINTENANCE</td>
<td>24</td>
</tr>
<tr>
<td>MAINTENANCE PERSONNEL</td>
<td>24</td>
</tr>
<tr>
<td>ACCIDENT PREVENTION</td>
<td>24</td>
</tr>
<tr>
<td>REFUELLING</td>
<td>25</td>
</tr>
<tr>
<td>FREQUENCY</td>
<td>26</td>
</tr>
<tr>
<td>REQUIREMENTS</td>
<td>28</td>
</tr>
<tr>
<td>HOW TO PROCEED</td>
<td>28</td>
</tr>
<tr>
<td>MOVING THE ENGINE</td>
<td>34</td>
</tr>
<tr>
<td>DISPOSAL OF WASTE</td>
<td>34</td>
</tr>
<tr>
<td>LONG PERIODS OF INACTIVITY</td>
<td>35</td>
</tr>
<tr>
<td>PREPARING THE ENGINE FOR A LONG PERIOD OF INACTIVITY</td>
<td>35</td>
</tr>
<tr>
<td>RESTARTING THE ENGINE AFTER A LONG PERIOD OF INACTIVITY</td>
<td>36</td>
</tr>
<tr>
<td>ENGINE MALFUNCTIONS</td>
<td>37</td>
</tr>
<tr>
<td>BEHAVIOUR IN CASE OF FAILURE</td>
<td>37</td>
</tr>
<tr>
<td>BEHAVIOUR IN AN EMERGENCY</td>
<td>41</td>
</tr>
<tr>
<td>ELECTRONIC CONTROL PANEL USE REQUIREMENTS</td>
<td>44</td>
</tr>
</tbody>
</table>
## 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.
ENGINE TECHNICAL DATA N45 ENT  
(75 kW - 89 kW - 110 kW - 125 kW)

The technical code and serial number are indicated on a plate, which is located on different parts of the engine, according to the model: flywheel casing, tappet cover, other.

<table>
<thead>
<tr>
<th>Code</th>
<th>N45 ENT</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>4,485 cm³</td>
</tr>
<tr>
<td>Air system</td>
<td>Supercharged - with intercooler</td>
</tr>
<tr>
<td>Injection type</td>
<td>Direct with rotating pump</td>
</tr>
<tr>
<td>Engine direction of rotation</td>
<td>Anticlockwise (seen from flywheel side)</td>
</tr>
<tr>
<td>Dry weight</td>
<td>425 kg</td>
</tr>
<tr>
<td><strong>Electrical system</strong></td>
<td><strong>24V</strong></td>
</tr>
<tr>
<td>Accumulator/s</td>
<td></td>
</tr>
<tr>
<td>- capacity</td>
<td>130 Ah or above</td>
</tr>
<tr>
<td>- discharge current</td>
<td>500 A or above</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Performance (*)</th>
<th>N45 ENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>75 kW (102 CV) @ 2.200 rpm</td>
<td></td>
</tr>
<tr>
<td>472 Nm (48 kgm) @ 1.400 rpm</td>
<td></td>
</tr>
<tr>
<td>89 kW (121 CV) @ 2.200 rpm</td>
<td></td>
</tr>
<tr>
<td>549 Nm (56 kgm) @ 1.500 rpm</td>
<td></td>
</tr>
<tr>
<td>110 kW (150 CV) @ 2.200 rpm</td>
<td></td>
</tr>
<tr>
<td>676 Nm (69 kgm) @ 1.500 rpm</td>
<td></td>
</tr>
<tr>
<td>125 kW (170 CV) @ 2.200 rpm</td>
<td></td>
</tr>
<tr>
<td>700 Nm (71 kgm) @ 1.500 rpm</td>
<td></td>
</tr>
</tbody>
</table>

(Tier 4i)

(*) Net power to the flywheel in compliance with ISO 3046-1. Test conditions: temperature 25 °C; atmospheric pressure 100 kPa; relative humidity 30%.

**WARNING**

Any alteration of the above mentioned characteristics is strictly prohibited, penalty invalidation of the guarantee and absence of all liability on the part of FPT.
N45 ENT

N45 ENT
N45 ENT

N45 ENT
ENGINE TECHNICAL DATA N67 ENT
(129 kW - 151 kW)

The technical code and serial number are indicated on a plate, which is located on different parts of the engine, according to the model: flywheel casing, tappet cover, other.

<table>
<thead>
<tr>
<th>Code</th>
<th>N67 ENT</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>6, in line</td>
</tr>
<tr>
<td>Bore x stroke</td>
<td>104 x 132 mm</td>
</tr>
<tr>
<td>Total displacement</td>
<td>6,700 cm³</td>
</tr>
<tr>
<td>Air system</td>
<td>Supercharged - with intercooler</td>
</tr>
<tr>
<td>Injection type</td>
<td>Direct with rotating pump</td>
</tr>
<tr>
<td>Engine direction of rotation</td>
<td>Anticlockwise (seen from flywheel side)</td>
</tr>
<tr>
<td>Dry weight</td>
<td>520 kg</td>
</tr>
</tbody>
</table>

**Electrical system** 24 V

| Accumulator/s         |                                           |
| - capacity            | 130 Ah or above                           |
| - discharge current   | 500 A or above                            |

**Performance (**)**

<table>
<thead>
<tr>
<th>N67 ENT</th>
<th>129 kW (176 CV) @ 2.200 rpm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>810 Nm (81 kgm) @ 1.500 rpm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(Tier 4i)</th>
<th>151 kW (206 CV) @ 2.200 rpm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>960 Nm (91 kgm) @ 1.500 rpm</td>
</tr>
</tbody>
</table>

(**)Net power to the flywheel in compliance with ISO 3046-1. Test conditions: temperature 25 °C; atmospheric pressure 100 kPa; relative humidity 30%.

**WARNING**

Any alteration of the above mentioned characteristics is strictly prohibited, penalty invalidation of the guarantee and absence of all liability on the part of FPT.
**N67 ENT (151 kW- 129 kW)**


**N67 ENT (151 kW- 129 kW)**

**N67 ENT (151 kW-129 kW)**


**N67 ENT (151 kW-129 kW)**

ENGINE TECHNICAL DATA N67 ENT (122 kW - 129 kW - 140 kW - 151 kW - 162 kW)

The technical code and serial number are indicated on a plate, which is located on different parts of the engine, according to the model: flywheel casing, tappet cover, other.

<table>
<thead>
<tr>
<th>Code</th>
<th>N67 ENT</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>6, in line</td>
</tr>
<tr>
<td>Bore x stroke</td>
<td>104 x 132 mm</td>
</tr>
<tr>
<td>Total displacement</td>
<td>6,700 cm³</td>
</tr>
<tr>
<td>Air system</td>
<td>Supercharged - with intercooler</td>
</tr>
<tr>
<td>Injection type</td>
<td>Direct with rotating pump</td>
</tr>
<tr>
<td>Engine direction of rotation</td>
<td>Anticlockwise (seen from flywheel side)</td>
</tr>
<tr>
<td>Dry weight</td>
<td>520 kg</td>
</tr>
</tbody>
</table>

**Code**

**N67 ENT**

<table>
<thead>
<tr>
<th>Performance (*)&amp;</th>
<th>N67 ENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>122 kW (166 CV) @ 2.200 rpm</td>
<td></td>
</tr>
<tr>
<td>129 kW (175 CV) @ 2.500 rpm</td>
<td>726 Nm (74 kgm) @ 1.500 rpm</td>
</tr>
<tr>
<td>140 kW (191 CV) @ 2.200 rpm</td>
<td>810 Nm (83 kgm) @ 1.500 rpm</td>
</tr>
<tr>
<td>151 kW (206 CV) @ 2.200 rpm</td>
<td>129 kW (175 CV) @ 2.500 rpm</td>
</tr>
<tr>
<td>162 kW (221 CV) @ 2.200 rpm</td>
<td>866 Nm (88 kgm) @ 1.500 rpm</td>
</tr>
<tr>
<td>162 kW (221 CV) @ 2.200 rpm</td>
<td>960 Nm (98 kgm) @ 1.500 rpm</td>
</tr>
</tbody>
</table>

(*Net power to the flywheel in compliance with ISO 3046-1. Test conditions: temperature 25 °C; atmospheric pressure 100 kPa; relative humidity 30%.

**WARNING**

Any alteration of the above mentioned characteristics is strictly prohibited, penalty invalidation of the guarantee and absence of all liability on the part of FPT.
N67 ENT (122 kW - 129 kW - 140 kW - 151 kW - 162 kW)


N67 ENT (122 kW - 129 kW - 140 kW - 151 kW - 162 kW)

N67 ENT (122 kW - 129 kW - 140 kW - 151 kW - 162 kW)


N67 ENT (122 kW - 129 kW - 140 kW - 151 kW - 162 kW)

ENGINE TECHNICAL DATA N67 ENT (181 kW - 210 kW)

The technical code and serial number are indicated on a plate, which is located on different parts of the engine, according to the model: flywheel casing, tappet cover, other.

<table>
<thead>
<tr>
<th>Code</th>
<th>N67 ENT</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>6, in line</td>
</tr>
<tr>
<td>Bore x stroke</td>
<td>104 x 132 mm</td>
</tr>
<tr>
<td>Total displacement</td>
<td>6,700 cm³</td>
</tr>
<tr>
<td>Air system</td>
<td>Supercharged - with intercooler</td>
</tr>
<tr>
<td>Injection type</td>
<td>Direct with rotating pump</td>
</tr>
<tr>
<td>Engine direction of rotation</td>
<td>Anticlockwise (seen from flywheel side)</td>
</tr>
<tr>
<td>Dry weight</td>
<td>520 kg</td>
</tr>
</tbody>
</table>

### Electrical system

<table>
<thead>
<tr>
<th>24V</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Accumulator/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>- capacity 130 Ah or above</td>
</tr>
<tr>
<td>- discharge current 500 A or above</td>
</tr>
</tbody>
</table>

### Performance (*)

<table>
<thead>
<tr>
<th>N67 ENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>181 kW (247 CV) @ 2,200 rpm</td>
</tr>
<tr>
<td>1120 Nm (114 kgm) @ 1,500 rpm</td>
</tr>
<tr>
<td>210 kW (286 CV) @ 2,200 rpm</td>
</tr>
<tr>
<td>1143 Nm (116 kgm) @ 1,500 rpm</td>
</tr>
</tbody>
</table>

(*) Net power to the flywheel in compliance with ISO 3046-1. Test conditions: temperature 25 °C; atmospheric pressure 100 kPa; relative humidity 30%.

**WARNING**

Any alteration of the above mentioned characteristics is strictly prohibited, penalty invalidation of the guarantee and absence of all liability on the part of FPT.
**N67 ENT (181 kW - 210 kW)**


**N67 ENT (181 kW - 210 kW)**

N67 ENT (181 kW - 210 kW)


N67 ENT (181 kW - 210 kW)

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.

- **Lifting point (engine only).**
- **Fuel Cap**
  (on the fuel tank, if there is one).
- **Oil Cap.**
- **Oil dipstick.**

---

- Danger of burning:
  Expulsion of hot water under pressure.

- Danger of burning:
  Presence of high temperature parts.

- Danger of fire:
  Fuel present.

- Danger of impact or catching on moving parts:
  Presence of fans, pulleys, belts or the like.
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 aspiration filter is not blocked or obstructed, checking at the same time that the mechanical indicator on the filter does not show the “red” sign. If the engine is equipped with an electrical blockage sensor, an alarm will be displayed on start-up, by means of the indicator light on the instrument panel.

**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.*

STARTING AND STOPPING THE ENGINE
The start-up and shut-down operations described below apply to an on-board control panel manufactured by FPT; if the Manufacturer of the vehicle or machine has fitted a customised instrument panel, these operations may vary according to the various choices made during construction.

In these cases, follow the start-up/shut-down sequences and use the instrument panel description provided in the specific documentation.
Starting the engine from the FPT control panel (supplied on demand)

1. Insert the key into the switch (1) and turn it to the right to position 1B. “Run”. Once the indicator lights have been tested and the beeper has stopped sounding, make sure that the analogue instruments are showing values that conform with the relevant physical parameters of temperature, battery voltage and oil pressure; (information on how to interpret the indicators and alarms is given in the relevant paragraph).

2. If the engine is fitted with a pre-heating system (optional) and the engine temperature is lower than the minimum value foreseen for it to come into operation, wait for the relevant indicator light to go out.

3. Turn the key to position 1C “Start” and release it once the engine has started, without accelerating.

4. Make sure that the “Battery recharge” and “Oil pressure low” indicators have turned off and that the analogue instruments are showing values that conform with the relevant new physical parameters. If the pre-heating system has intervened, the relevant indicator will turn on again to indicate that the post-heating phase is in progress; the duration of this function is proportional to the temperature value.

5. If the engine does not start, after releasing the key it will only be possible to turn it back to the start position after first returning the switch to the rest position 1A.

1A “REST” position allowing the key to be removed
1B Stable “RUN” position
1C Unstable “START” position
STOP Unstable position used in EXCITED STOP set-ups for engines fuelled by a mechanical injection pump.
Stopping the engine from the FPT control panel

Before stopping the engine it is recommended you run it for a few minutes at minimum speed with no load; this will allow the temperature to drop evenly and will avoid harmful thermal shocks.

The shutdown method will depend on the type of equipment installed.

**With “unexcited” stop circuit**
- Turn the key switch to position 1A - REST.

**With “excited” stop circuit**
- Turn the key switch to the STOP position.

In the absence of FPT control panels, always follow the instructions provided by the Manufacturer of the machine.

**Should you intend to re-start the engine:**
1. Return the key switch to the rest position 1A, thus resetting all the on-board panel functions (Required for electronically controlled engines).
2. Turn the key to position 1C “Start” and release it once the engine has started, without accelerating.
3. Proceed as described previously.

**RECOGNISING ALARMS**

**Indicator and alarm synoptics**

The FPT instrument panel contains the indicator lights used to indicate the state of operation of the engine. Light-up of these indicators is piloted by electronic circuits, which have a simultaneous alarm timer and storage function.

- 7A. Maximum allowed rotation speed exceeded (on request)
- 7B. Air filter blocked
- 7C. Fuel level low
- 7D. Coolant temperature high
- 7E. Oil pressure low
- 7F. Alternator malfunction
- 7G. Engine coolant level low
- 7H. Pre-post heating

Some types of engine and relevant equipment only make some of the functions indicated in the key available.

If the machine Manufacturer uses different technical options there may also be further changes to the above.
Operation
When the key is turned in the switch to position 1B an efficiency test is performed, for 5 seconds, on all the indicator lights, with the exception of the “Pre-post heating” indicator, while at the same time the beeper sounds.
During start-up and for the following 15 seconds, all synoptic functions are disabled; after this period, each critical state detected by the sensors provided on the engine will result in the relevant indicator lighting up.
Some alarms, which are of critical importance for efficient running of the engine, will not only light the relevant optical indicator, but will also start the beeper and cause automatic shutdown of the engine:
- Maximum allowed rotation speed exceeded
- Coolant temperature high
- Oil pressure low
- Engine coolant level low.

ENGINE MANAGEMENT AND DIAGNOSIS FROM THE INSTRUMENT PANEL
The FPT control panel makes it possible to manage engine rotation speed and to recognise the origin of any malfunctions in the engine and its equipment, using the Electronic Control Unit self-diagnosis function.

8A. Malfunction indicator light - 8B. Diagnosis button - 8C. Button to increase running speed - 8D. Button to decrease running speed.

Running speed management
The running speed, which is normally managed using the accelerator control lever, can also be modified using buttons 8C and 8D.
To accelerate: press and hold button 8C until the required engine speed is achieve, then release it.
To decelerate: press and hold button 8D until the required engine speed is achieve, then release it.
The engine speed reached each time it is carried out will be maintained until the next time the engine is stopped.

CAUTION!
In the event of momentary stoppages of the engine, pay attention to the synoptics and check for any alarm signals. Do not restart the engine until the cause of the problem has been removed or proper operating conditions have been restored.
Diagnosis
Use of button 8B enables FPT Technical Service Network staff to obtain the self-diagnosis information stored in the electronic Unit controlling the engine. The codes, which relate to any malfunctions encountered, will be issued in the form of flashes by the indicator 8A. The FPT Technical Service Network staff are responsible for decoding and interpreting the codes.
If the Installer uses different technical options there may be changes to the above.

Starting the engine at low temperatures
The electrical device - managed by the Electronic Control Unit controlling the engine - for the preheating of the inducted air is used to assist the starting of the engine at low temperatures. The device is disabled in cases where, after turning the key in the 1B RUN position, the engine is not started during the relevant indicator blinking phase. Proceed to the next starting repeating the sequence beginning with the key on the position 1A REST.

FOR PROPER USE OF THE ENGINE
- Do not leave the key turned to the start position 1C, when the engine has started.
- It is not efficient to leave the engine running at minimum speed while waiting for it to reach the proper working temperature; it is preferable that, after approximately one minute from start-up, you gradually increase the engine load.
- Do not leave the engine running at minimum speed for long, as this increases the production of harmful emissions and does not guarantee the best performance.
- The engine speed must be increased and decreased gradually, to allow regular combustion and proper operation of all engine components.
- The running speed and power values must comply with the specifications on the technical and commercial documentation.

During use, periodically check that:
1. The engine coolant temperature does not reach the alarm threshold.
2. The oil pressure remains within normal values.
**SPECIAL WARNINGS**

**Coolant circuit**

When a state of “Coolant temperature high” and “Engine coolant level low” is found, this triggers stoppage of the engine; in these cases, check the efficiency of the circuit components, remembering that 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.

<table>
<thead>
<tr>
<th>CAUTION!</th>
</tr>
</thead>
<tbody>
<tr>
<td>Only open the coolant tank cap if strictly necessary, and only when the engine is cold.</td>
</tr>
</tbody>
</table>

If the temperature is considered too high, reduce speed and stop to check the state of the cooling system circuits; also check and have checked:

a) the tension of the auxiliary member drive belt;

b) operation of the thermostat valve;

c) whether or not the heat exchanger is clean.

**Lubrication circuit**

When a state of “Oil pressure low”, is found, this triggers stoppage of the engine; in this case, check the oil level and top up if necessary, following the instructions given in the chapter on CONTROLS AND MAINTENANCE.

If the condition persists, contact the Service Centre.

**Fuel circuit**

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.

<table>
<thead>
<tr>
<th>CAUTION!</th>
</tr>
</thead>
<tbody>
<tr>
<td>When refuelling, always pay great care to ensure that no solid or liquid pollutants enter the fuel tank; you must also remember that smoking and live flames are prohibited when refuelling.</td>
</tr>
</tbody>
</table>

The common rail injection system does not require air to be bled from the fuel circuit.

<table>
<thead>
<tr>
<th>CAUTION!</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never loosen the high pressure fuel circuit connectors in any way.</td>
</tr>
</tbody>
</table>

**Air intake and exhaust gas circuits**

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.
DeNO\textsubscript{x} 2 System
This system is applied to limit the amount of nitrogen oxide (NO\textsubscript{x}) expelled by exhaust gas in order to comply with Tier 4i values, transforming nitrogen oxide into inert compounds: nitrogen gas (N\textsubscript{2}) and water vapour (H\textsubscript{2}O).
Perform scheduled tests on the system using PT-Box and scheduled filter cleaning as indicated in the chapter CHECKS AND MAINTENANCE.

Electrical starter system
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.
Remember that the Electronic engine control units are programmed to increase the minimum running speed if the voltage in the electrical system reaches values considered to be at the limits of efficiency. In this case, check the efficiency of the battery/ies and if necessary perform a check-up on the system components.
Should it be necessary to replace the batteries, always respect the capacity and minimum discharge current intensity requirements.

CAUTION!
The batteries contain an acid solution that will burn the skin and corrode clothing; when checking them, always wear protective clothing, gloves and goggles, do not smoke or use live flames in the vicinity, and make sure that the room they are housed in is adequately ventilated.

WARNING
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).

CAUTION!
The batteries contain an acid solution that will burn the skin and corrode clothing; when checking them, always wear protective clothing, gloves and goggles, do not smoke or use live flames in the vicinity, and make sure that the room they are housed in is adequately ventilated.

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.
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.
**CAUTION!**

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.

---

**CAUTION!**

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.

---

### REFUELLING

<table>
<thead>
<tr>
<th>Parts to be supplied</th>
<th>N45</th>
<th>N67</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>litres (kg)</td>
<td>litres (kg)</td>
</tr>
<tr>
<td>Cooling circuit <em>(1)</em></td>
<td>6,1 (*)</td>
<td>10,5 (*)</td>
</tr>
<tr>
<td>Lubrication circuit <em>(2)</em></td>
<td>14,4 (13,2)</td>
<td>17,2 (15,8)</td>
</tr>
<tr>
<td>total capacity <em>(3)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Periodic changing:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>oil sump at minimum level</td>
<td>6,0 (5,5)</td>
<td>8,7 (8)</td>
</tr>
<tr>
<td>oil sump at maximum level</td>
<td>11,5 (10,5)</td>
<td>15,2 (14)</td>
</tr>
<tr>
<td>Fuel tank <em>(4)</em></td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

*(*) The amounts indicated relate to the standard configuration of the engine only.

(1) Use a mixture of water and 50% PARAFLU 11 even during the summer months. As an alternative to PARAFLU 11, use another product that complies with international specifications SAE J 1034.

(2) Use lubricants that comply with international specifications ACEA E7 - E9 (high power engines).

The viscosity level of oil to be used depending on surrounding temperatures is given in the table provided in the appendix.

Oil consumption is considered acceptable when it reaches a maximum of 0.5% of fuel consumption.

(3) The amounts indicated refer to initial refuelling, and include filling the engine, sump and filter.

(4) Use STANDARD fuel compliant to the EN 590.
Low temperature diesel

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.

<table>
<thead>
<tr>
<th>Controls (when in use)</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual engine check</td>
<td>Daily</td>
</tr>
<tr>
<td>Check for water in the fuel filter or pre-filter</td>
<td>Daily</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) Replace lubricants according to the frequency indicated in the REFUELLING table.

2) Only use filters with the following characteristics:
   - filtration level < 12 μm
   - filtering efficiency β > 200.

3) or every 2 years

**Note:** The prefilter on the supply module and metering module (at intake and outlet) require no maintenance.
REQUIREMENTS

1. Do not disconnect the batteries with the engine running.
2. Do not carry out arc welding operations in the vicinity of the engine without first removing electrical cables.
3. After each maintenance operation involving disconnection of the battery/batteries, make sure that the terminals have been properly locked onto the poles.
4. Do not use battery chargers to start the engine.
5. Disconnect the on-board network battery/batteries when recharging.
6. Do not paint the appliances, components and electrical connectors equipping the engine.
7. Disconnect the battery/batteries before any electrical operations.
8. Contact the Manufacturer before installing electronic equipment on board (two-way radios and the like).

HOW TO PROCEED

Visual engine check

It is a good habit to execute, before engine start, a series of simple checks that might represent a valid warranty to avoid inconveniences, even serious, during engine running. Such checks are usually up to the operators and to the vehicle’s drivers.

- Level controls and checks of any eventual leakage from the fuel, cooling and lubricating circuits.
- Notify the maintenance if any inconvenience is detected or if any filling is necessary.

After engine start and while engine is running, proceed with the following checks and controls:

- Check presence of any eventual leakage from the fuel, cooling and lubricating circuits.
- Verify absence of noise or unusual rattle during engine working.
- Verify, using the vehicle devices, the prescribed pressure, temperature and other parameters.
- Visual check of fumes (colour of exhaust emissions)
- Visual check of cooling liquid level, in the expansion tank.

WARNING

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.
Check for water from fuel filter/pre-filter (Refers to FPT components)

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 tap plug (1) in the bottom part of the filter; in some lay-outs the plug includes a sensor to detect the presence of water in the diesel.
- Drain off liquid until only “diesel” can be seen.
- Close the plug again, tightening it completely by hand.
- Dispose of the drained fluids according to current requirements.

Note: The components of the common rail system can be damaged very quickly in presence of water or impurity within the fuel.

Timely proceed operating on the pre-filter (not available on the engine block) to carry out the drainage of the water within the feed circuit.
Replacement of engine oil and filter

Due to the several applications, the pan shape and the oil quantity can change slightly. However, the following operations are valid for all applications. We recommend to carry out the oil drainage when the motor is hot.

- Place a proper container for the oil collecting under the pan connected with the drain plug.
- Unscrew the plug and then take out the control dipsick and the inserting plug to ease the downflow of the lubrication oil.

Whereas you replace the lubrication oil, it is necessary to replace the filter. According to the application the filter can be located in different positions: the following procedure is a valid guide for all applications.

- The filter is composed by a support and a filtering cartridge. Use the specific tool to replace this.
- Replace the filtering cartridge with a new one and screw manually until when the gasket is in contact with the support.
- Further tighten to a torque of 20 ± 2 Nm with the aid of the special tool.
- Operate the motor for some minutes and check the level through the dipsick again. If it is necessary, carry out a topping up to compensate the quantity of oil used for the filling of the filtering cartridge.

- After the complete drainage, screw the plug and carry out the clean oil filling.
- Check the level through the dipsick until when the filling is next to the maximum level notch indicated on the dipsick.
### WARNING
- Warning: We recommend to wear proper protections because of high motor service temperature.
- The motor oil reaches very high temperature: you must always wear protection gloves.

### WARNING!
- The oil motor is very pollutant and harmful.
- In case of contact with the skin, wash with much water and detergent.
- Protect properly skin and eyes: operate according to safety rules.
- Dispose of the residual properly following the rules.

### WARNING
- Use only the recommended oil or oil having the requested features for the correct motor functioning.
- In case of topping up, don't mix oils having different features.
- If you don't comply with theses rules, the service warranty is no more valid.

### WARNING!
- Warning: the oil filter contains inside a quantity of oil of about 1 kg.
- Place properly a container for the liquid.
- Warning: avoid the contact of skin with the motor oil: in case of contact wash the skin with running water.
- The motor oil is very pollutant: it must be disposed of according to the rules.
Changing the fuel pre-filter
(Refers to FPT components)

Only proceed with the engine stopped.

- Should the filter be fitted with a sensor to detect the presence of water (3), remove the whole sensor from its seat.
- Remove the pre-filter 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.
- Place the water presence sensor in its seat, taking care to couple the threads correctly.
- Loosen the bleeder screw (1) on the pre-filter support and activate the hand pump (2) until the supply circuit is full. Ensure that any fuel coming out is not dispersed into the environment.
- Lock the bleeder screw tightly.
- Start the engine and run it at idle for a few minutes to eliminate any residual air.

**Note:** Should it be necessary to accelerate the bleeding phase, the hand pump can be used during start-up.
Replacement of fuel filter
According to the applications the filters position and the quantity can change.
However the following operations are valid for all applications.

- Drain the fuel inside the filter by operating the water release screw. Collect the fuel in a container without impurities.
- Unscrew the cartridge using the special tool.
- Collect the eventual fuel inside the filtering cartridge.
- Clean the gasket seat on the support and oil slightly the gasket on the new filtering cartridge.
- Screw manually the new filtering cartridge until when the gasket is completely on its seat.
- Further tighten to a torque of 20 ± 2Nm with the aid of the special tool.

**WARNING!**
During this operation don’t smoke and don’t use free flames. Avoid to breathe the vapors coming from filter.

Inspection/replacement of blow-by filter
The filter in subject has been developed and equipped for the collection, filtering and condense of the lubricating oil vapours. Within the filter unit (1) two cartridge filters are included (2).

The check of the filtering element is carried out by removing the cover and drawing off the cartridges (2).
Replacement of alternator belt

- Operate on the tightener (1) and withdraw the belt (2) from the alternator and water pumps from pulleys and from the returns pumps;
- Replace the worn belt with a new one.
- Place the belt on the pulleys and the guide rollers.
- Place the automatic tightener in order to key the belt in the functioning position (tightly close the tensioner to a torque of 43 ± 6 Nm).
- Further adjustments are not required...

**WARNING!**

With switched off motor (but still hot) the belt can operate without advance notice. Wait for the motor temperature lowering to avoid very serious accidents.

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.
ENGINE MALFUNCTIONS

The electronic unit overseeing management and control of all operation of the engine is capable of recognising any malfunctions that may occur, and of adopting strategies that will allow you to proceed in full safety.
The event, signalled by light-up of the EDC MALFUNCTION indicator on the on-board control panels, results in programmed limitation of power within certain thresholds, set according to the severity of the case.
In the case of temporary malfunctions the reduction in performance will remain in force until the engine is stopped.

BEHAVIOUR IN CASE OF FAILURE

Accelerator electronic circuit malfunction

When certain problems in the accelerator electric circuit are recognised, the Electronic Unit controlling the engine adopts a strategy known as “accelerated minimum speed running”, that will enable running/work to continue in emergency mode.
The possible operating modes are as follows:
A. The accelerator lever does not “respond”: the engine speed stabilises at 750 rpm to allow manoeuvring at crawling speed by simply engaging and disengaging the clutch without accelerating.
B. The accelerator lever “responds partially”: the minimum running speed is set to 750 rpm. When the accelerator lever is moved to approximately half way, the speed gradually increases up to 2000 rpm; when the lever is returned to minimum the speed rapidly decreases to 750 rpm.

Malfunction in the recharging system

The Electronic engine control units are programmed to increase the minimum running speed if the voltage in the electrical system reaches values considered to be at the limits of efficiency. In this case, check the efficiency of the battery/ies and if necessary perform a check-up on the system components.

CAUTION!
The engine electronic control unit can adopt safety strategies at any time during use of the machine or vehicle, should conditions arise that are considered to put the engine at risk.
When conditions of this kind occur, proceed only if necessary and with the greatest possible care and attention.

CAUTION!
Do not leave vehicles or machines with the engine running without first putting the parking lock or brake on.
<table>
<thead>
<tr>
<th>ANOMALY</th>
<th>POSSIBLE CAUSE</th>
<th>RECOMMENDED TESTS OR INTERVENTION</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low performance at load request. Possible excessive smoke.</td>
<td>Insufficient fuel level in the tank.</td>
<td>Check fuel level.</td>
<td>The excessive smoke is due to the fact that, in case of insufficient fuel feeding, the engine control module tries to compensate prolonging the injectors working time.</td>
</tr>
<tr>
<td></td>
<td>Fuel tank device partially obstructed by impurities or deformed because of overheating.</td>
<td>Check if the priming pump of the pre-filter is working correctly.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>If the pump plunger is permanently depressed disassemble and check the tank pick-up tube. If this is in order, replace the pre-filter.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Obstructed air filter.</td>
<td>Replace the air filter.</td>
<td>Solve the cause of the filter’s obstruction.</td>
</tr>
<tr>
<td></td>
<td>Excessive fuel blow-by from rail boost valve.</td>
<td>Check the O Rings and the correct connection of the pipe fittings under the feeding pump (the lockers must stay outside and the fittings must be well locked). Visually check the low pressure pipeline integrity.</td>
<td>Unless the leakage is significant, no performance failures will be detected. To verify O-rings integrity, extract from the tank the fuel recycling pipeline, seal the end and activate the priming pump driving the low pressure circuit.</td>
</tr>
<tr>
<td></td>
<td>Excessive fuel blow-by from rail boost valve.</td>
<td>Disconnect the pipe and visually check if there are any significant blow-by from the boost gauge valve; in such case replace the valve.</td>
<td></td>
</tr>
<tr>
<td>ANOMALY</td>
<td>POSSIBLE CAUSE</td>
<td>RECOMMENDED TESTS OR INTERVENTION</td>
<td>REMARKS</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>The engine suddenly stops (with no previous problems) and does not start again.</td>
<td>Obstructed fuel filter.</td>
<td>Replace the fuel filter.</td>
<td>Solve the cause of the filter’s obstruction (empty and clean the tank and the part of the circuit over the filter, refill with clean fuel).</td>
</tr>
<tr>
<td>Difficult start and low performance in all conditions.</td>
<td>Inefficient high pressure pump.</td>
<td>After having excluded any other possible cause, replace the high pressure pump.</td>
<td></td>
</tr>
<tr>
<td>Difficult start, low performance and engine running with one cylinder less.</td>
<td>Injector with obstructer or solenoid (mechanical part) blocked open.</td>
<td>The non-working injector is easily recognisable detecting by feeling the absence of pulsing within the relevant high pressure pipe.</td>
<td>In case of low entity blow-by, inficiating the mechanical working of the injector but not involving flow limiter activation, there is no error memorisation in the engine control module. If the flow limiter is activated. Check error code memory.</td>
</tr>
<tr>
<td><strong>ANOMALY</strong></td>
<td><strong>POSSIBLE CAUSE</strong></td>
<td><strong>RECOMMENDED TESTS OR INTERVENTION</strong></td>
<td><strong>REMARKS</strong></td>
</tr>
<tr>
<td>-----------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Starting requires in excess of ten seconds, followed by huge white exhaust fumes, and a fuel smell.</td>
<td>Injector blocked in open position (with no return).</td>
<td>The non-working injector is easily recognisable detecting by feeling the absence of pulsing within the relevant high pressure pipe.</td>
<td>Usually, whether such symptoms appear, it is instinctive to give up engine start. However, by insisting, it is possible to start the engine. As a matter of facts, by insistent, if within the rail the pressure makes the flow limiter close up, the engine starts with one cylinder less and gradually the grade of fumes reduces and disappears.</td>
</tr>
<tr>
<td>Breaking of high pressure pipeline from pump to rail.</td>
<td>Strange vibrations provoked by slack of pipe bracket.</td>
<td>Replace the pipeline ensuring the correct tightening of the anti-vibration bracket screws.</td>
<td>It is very important, in addition to correct blocking, to keep the brackets in the original position.</td>
</tr>
<tr>
<td>The engine works with one cylinder less, without memorising failure codes in the engine control module.</td>
<td>Injector blocked in closed position.</td>
<td>Identify the injector that is not working any more and the relating high pressure filler.</td>
<td>The non-working injector is easily recognisable detecting by feeling the absence of pulsing within the relevant high pressure pipe.</td>
</tr>
</tbody>
</table>
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 or 24 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.

**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).
Oil viscosity grade in relation to ambient temperature
**ELECTRONIC CONTROL PANEL USE REQUIREMENTS**

The data indicated below refer to FPT equipment in its original configuration. The requirements and technical characteristics of the customisations may differ from those indicated and must be dealt with in a specific document prepared by those who have performed any such customisations.

### Environmental working conditions

<table>
<thead>
<tr>
<th>FPT control panels</th>
<th>With analogue instruments</th>
<th>With digital instruments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operating temperature range</strong></td>
<td>from -10°C to +60°C</td>
<td>from -10°C to +60°C</td>
</tr>
<tr>
<td><strong>Temperature limits during stationing</strong></td>
<td>min. -20°C / max. +75°C</td>
<td>min. -20°C / max. +75°C</td>
</tr>
<tr>
<td><strong>Degree of protection against dusts and rain (front)</strong></td>
<td>IP 65 – DIN 40050 – IEC 529</td>
<td>IP 66</td>
</tr>
<tr>
<td><strong>Saline mist resistance (Reference standard)</strong></td>
<td>IEC 60068-2-52</td>
<td>IEC 60068-2-52</td>
</tr>
</tbody>
</table>

### Electric and electromagnetic characteristics

<table>
<thead>
<tr>
<th>FPT control panels</th>
<th>With analogue instruments</th>
<th>With digital instruments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operating voltage (excluding polarity inversions)</strong></td>
<td>min. 9 V / max. 32 V (*)</td>
<td>min. 9 V / max. 32 V (*)</td>
</tr>
<tr>
<td><strong>Maximum allowed overvoltage</strong></td>
<td>60 V per 1 ms</td>
<td>60 V per 1 ms</td>
</tr>
<tr>
<td><strong>Maximum allowed current on main control panel</strong></td>
<td>1.1 A (12 V) – 1 A (24 V)</td>
<td>310 mA (12 V) – 200 mA (24 V)</td>
</tr>
<tr>
<td><strong>Maximum allowed current on secondary control panel</strong></td>
<td>400 mA (12 V) -400 mA (24 V)</td>
<td>310 mA (12 V) -200 mA (24 V)</td>
</tr>
<tr>
<td><strong>Electromagnetic compatibility (Reference standard)</strong></td>
<td>IEC 945</td>
<td>IEC 945</td>
</tr>
<tr>
<td><strong>Wiring connector requirements (Reference standard)</strong></td>
<td>MIL 1344/1001</td>
<td>MIL 1344/1001</td>
</tr>
<tr>
<td><strong>Wiring requirements (Reference standard)</strong></td>
<td>CEI 20/22 - CEI 20/38 - CEI 2000/532/CE</td>
<td></td>
</tr>
</tbody>
</table>

### Mechanical characteristics

<table>
<thead>
<tr>
<th>FPT control panels</th>
<th>With analogue instruments</th>
<th>With digital instruments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vibration resistance (expressed as gravity acceleration)</strong></td>
<td>1 g eff. max. -25-500 Hz</td>
<td>2 g eff. max. -25-500 Hz</td>
</tr>
<tr>
<td><strong>Shock resistance (expressed as gravity acceleration)</strong></td>
<td>15 g - 1.5 ms - semisinusoidal wave</td>
<td>15 g - 1.5 ms - semisinusoidal wave</td>
</tr>
</tbody>
</table>

(*) min. 9 V / max. 16 V referring to the equipment designed to be supplied only at the rated voltage of 12 V.