

USE AND MAINTENANCE  
USO E MANUTENZIONE  
UTILISATION ET ENTRETIEN  
BETRIEB UND WARTUNG  
USO Y MANTENIMIENTO

INDUSTRIAL ENGINES

**C** **SERIES**

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# C SERIES

**C78 ENT**

**C87 ENT**

**C10 ENT**

**C13 ENT**

**C78 TE2S**

**C87 TE1D**

**C10 TE1D**

**C13 TE2S/TE3S**

**C13 TE3X**

## USE AND MAINTENANCE

## 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 authorised 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 of the engine and safe use; **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 only be moved 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 C78 ENT

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.

Code	C78 ENT
Engine family	F2B
Cycle	4-stroke diesel
Number and arrangement of cylinders	6, in line
Bore x stroke	115 x 125 mm
Total displacement	7,800 cm <sup>3</sup>
Air system	Supercharged aftercooled
Injection type	EUI (PDE) Common Rail electronically managed
Engine direction of rotation	Anticlockwise (seen from flywheel side)
Dry weight	675 kg

Electrical system	24 V
Accumulator/s	
- capacity	180 Ah or above
- discharge current	800 A or above

### Performance (\*)

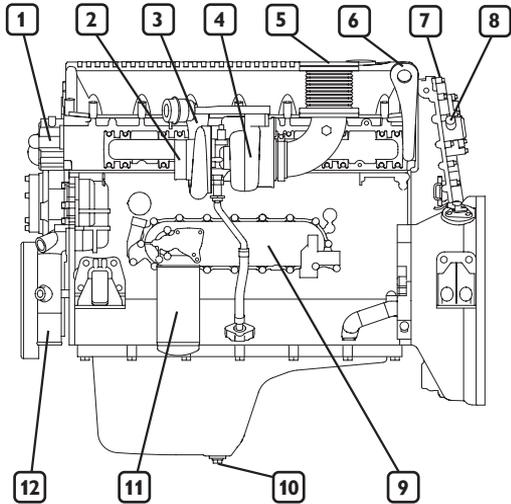
### C78 ENT

(TIER2) 220 kW (300 HP) @ 2200 rpm  
1250 Nm (127 Kgm) @ 1200 rpm

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

### WARNING

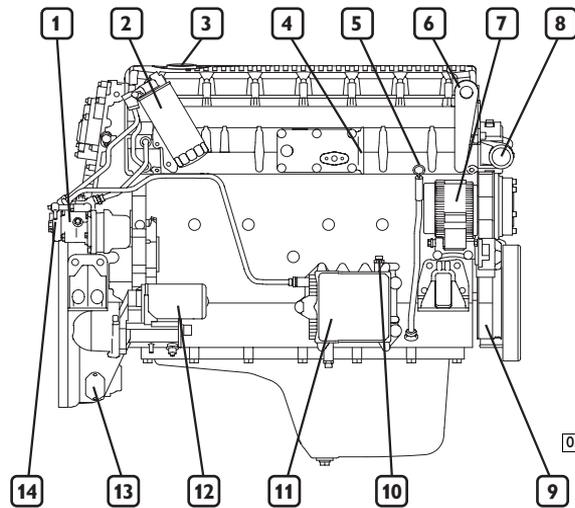
*Any alteration of the above mentioned characteristics, in particular modification of the data stored in the injection system electronic units or the characteristics of the engine and its fittings, is strictly prohibited, penalty invalidation of the guarantee and absence of all liability on the part of FPT.*



05\_005\_C

**C78 ENT**

- 1. Thermostat valve location - 2. Turbocharger air inlet - 3. Turbocharging air outlet to after-cooler - 4. Turbine - 5. Exhaust gas discharge - 6. Lifting U-bolt - 7. Oil vapour filter housing - 8. Oil vapour outlet manifold - 9. Lubricant oil heat exchanger - 10. Sump oil discharge plug - 11. Oil filter - 12. Manifold for return of coolant to the engine.



05\_006\_C

**C78 ENT**

- 1. Fuel supply pump - 2. Fuel filter - 3. Oil feeder hole - 4. Intake manifold inlet - 5. Oil dipstick - 6. Lifting U-bolt - 7. Alternator - 8. Coolant outlet manifold from engine - 9. Auxiliary member belt - 10. Fuel inlet manifold from tank - 11. Electronic control unit - 12. Electrical starter motor - 13. Flywheel crank insertion flange - 14. Fuel outlet connector to tank.

## ENGINE TECHNICAL DATA C87 ENT

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.

Code	C87 ENT
Engine family	F2C
Cycle	4-stroke diesel
Number and arrangement of cylinders	6, in line
Bore x stroke	117 x 135 mm
Total displacement	8,700 cm <sup>3</sup>
Air system	Supercharged aftercooled
Injection type	Common Rail electronically managed
Engine direction of rotation	Anticlockwise (seen from flywheel side)
Dry weight	675 kg
Electrical system	24 V
Accumulator/s	
- capacity	180 Ah or above
- discharge current	800 A or above

### Performance (\*)

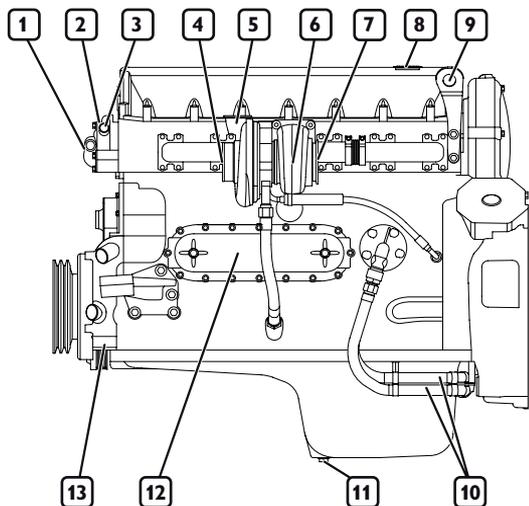
### C87 ENT

(TIER3) 260 kW (354 HP) @ 2100 rpm  
1500 Nm (153 Kgm) @ 1500 rpm

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

### WARNING

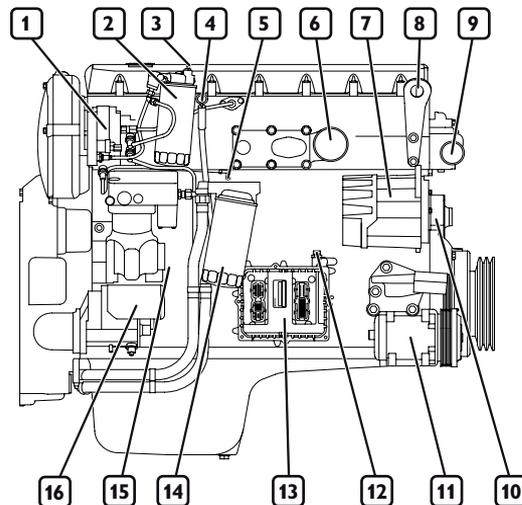
*Any alteration of the above mentioned characteristics, in particular modification of the data stored in the injection system electronic units or the characteristics of the engine and its fittings, is strictly prohibited, penalty invalidation of the guarantee and absence of all liability on the part of FPT.*



07\_001\_C

### C87 ENT

1. Thermostat valve location - 2. Oil vapour filter housing - 3. Oil vapour outlet manifold - 4. Turbocharger air inlet - 5. Turbocharging air outlet to after-cooler - 6. Turbine - 7. Exhaust gas discharge - 8. Oil feeder hole - 9. Lifting U-bolt - 10. Remote oil filter pipes (optional) - 11. Sump oil discharge plug - 12. Lubricant oil heat exchanger - 13. Manifold for return of coolant to the engine.



07\_002\_C

### C87 ENT

1. High-pressure supply pump - 2. Fuel filter - 3. Fuel system vent fitting - 4. Oil dipstick - 5. Fuel outlet connector to tank - 6. Intake manifold inlet - 7. Alternator - 8. Lifting U-bolt - 9. Coolant outlet manifold from engine - 10. Auxiliary member belt - 11. A/C compressor (optional) - 12. Fuel inlet manifold from tank - 13. Electronic control unit - 14. Oil filter - 15. Electrical starter motor - 16. Air compressor for services (optional).

## ENGINE TECHNICAL DATA C10 ENT

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.

Code	C10 ENT
Engine family	F3A
Cycle	Diesel a 4 tempi
Number and arrangement of cylinders	6, in line
Bore x stroke	125 x 140 mm
Total displacement	10,300 cm <sup>3</sup>
Air system	Supercharged aftercooled
Injection type	EUI (PDE), electronically managed
Engine direction of rotation	Anticlockwise (seen from flywheel side)
Dry weight	950 kg

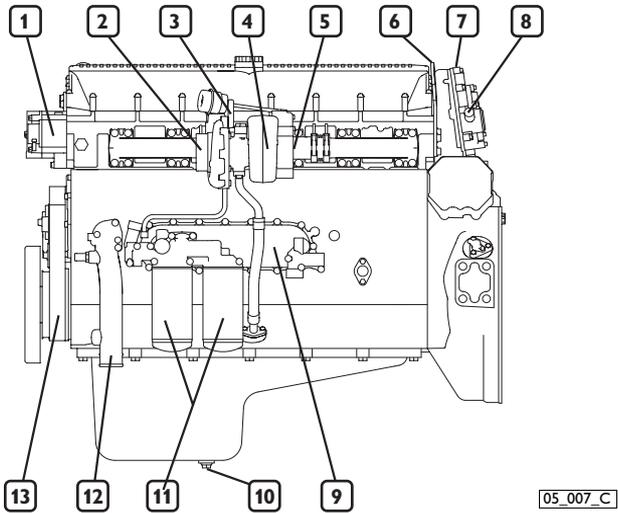
Electrical system	24 V
Accumulator/s	
- capacity	180 Ah or above
- discharge current	800 A or above

Performance (*)	C10 ENT
(TIER 2)	295 kW (400 HP) @ 2100 rpm 1750 Nm (178 Kgm) @ 1100 rpm
(TIER 3)	315 kW (428 HP) @ 2100 rpm 1900 Nm (194 Kgm) @ 1500 rpm

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

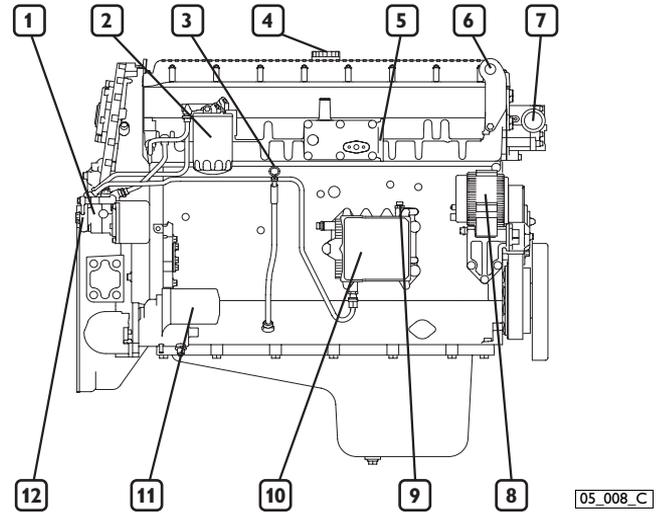
### WARNING

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**C10 ENT**

1. Thermostat valve location - 2. Turbocharger air inlet - 3. Turbocharging air outlet to after-cooler - 4. Turbine - 5. Exhaust gas discharge - 6. Lifting U-bolt - 7. Oil vapour filter housing - 8. Oil vapour outlet manifold - 9. Lubricant oil heat exchanger - 10. Sump oil discharge plug - 11. Oil filter - 12. Manifold for return of coolant to the engine - 13. Auxiliary member belt.



**C10 ENT**

1. Fuel supply pump - 2. Fuel filter - 3. Oil dipstick - 4. Oil feeder hole - 5. Intake manifold inlet - 6. Lifting U-bolt - 7. Coolant outlet manifold from engine - 8. Alternator - 9. Fuel inlet manifold from tank - 10. Electronic control unit - 11. Electrical starter motor - 12. Fuel outlet connector to tank.

## ENGINE TECHNICAL DATA C13 ENT

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.

Code	C13 ENT
Engine family	F3B
Cycle	Diesel a 4 tempi
Number and arrangement of cylinders	6, in line
Bore x stroke	135 x 150 mm
Total displacement	12,880 cm <sup>3</sup>
Air system	Supercharged aftercooled
Injection type	EUI (PDE), electronically managed
Engine direction of rotation	Anticlockwise (seen from flywheel side)
Dry weight	1040 kg

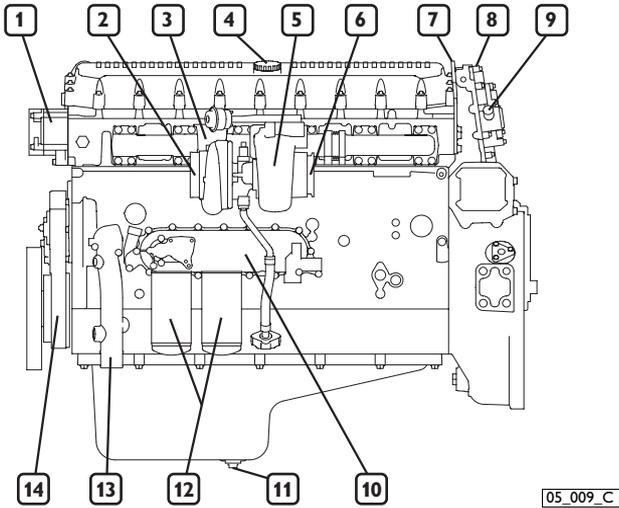
Electrical system	24 V
Accumulator/s	
- capacity	180 Ah or above
- discharge current	800 A or above

Performance (*)	C13 ENT
(TIER 2)	368 kW (500 CV) @ 1900 rpm 2250 Nm (229 Kgm) @ 1200 rpm
(TIER 3)	375 kW (510 CV) @ 2100 rpm 2300 Nm (234 Kgm) @ 1500 rpm

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

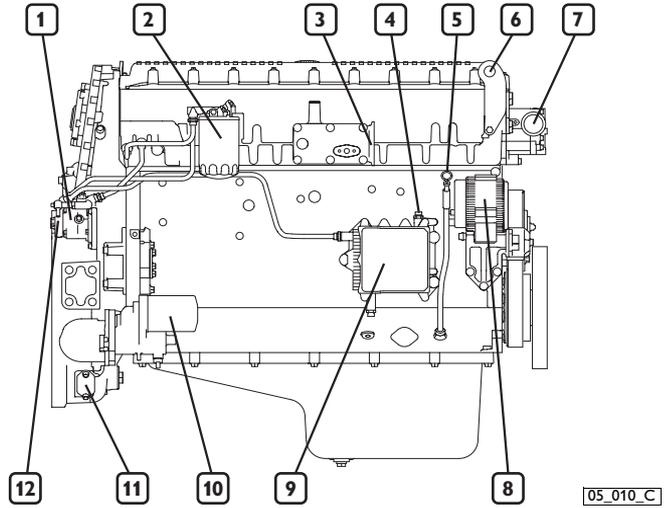
### WARNING

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**C13 ENT**

- 1. Thermostat valve location - 2. Turbocharger air inlet - 3. Turbocharging air outlet to after-cooler - 4. Oil feeder hole - 5. Turbine - 6. Exhaust gas discharge - 7. Lifting U-bolt - 8. Oil vapour filter housing - 9. Oil vapour outlet manifold - 10. Oil heat exchanger - 11. Sump oil discharge plug - 12. Oil filter - 13. Manifold for return of coolant to the engine - 14. Auxiliary member belt.



**C13 ENT**

- 1. Fuel supply pump - 2. Fuel filter - 3. Intake manifold inlet - 4. Fuel inlet manifold from tank - 5. Oil dipstick - 6. Lifting U-bolt - 7. Coolant outlet manifold from engine - 8. Alternator - 9. Electronic control unit - 10. Electrical starter motor - 11. Flywheel crank insertion flange - 12. Fuel outlet connector to tank.

## ENGINE TECHNICAL DATA C78 TE2S

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.

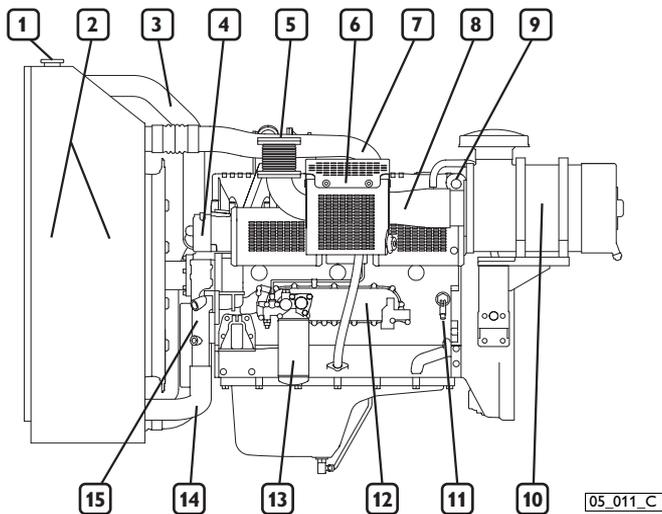
Code	C78 TE2S
Engine family	F2B
Cycle	Diesel a 4 tempi
Number and arrangement of cylinders	6, in line
Bore x stroke	115 x 125 mm
Total displacement	7,800 cm <sup>3</sup>
Air system	Supercharged aftercooled
Injection type	EUI (PDE), electronically managed
Engine direction of rotation	Anticlockwise (seen from flywheel side)
Isochronous speed regulator	Electronically controlled
Dry weight	1030 kg
Electrical system	24 V
Accumulator/s	
- capacity	185 Ah or above
- discharge current	1200 A or above

Performance (*)	C78 TE2S	
(STAGE 2)	Prime	215 kWm @ 1500 rpm
	Stand-by	236 kWm @ 1500 rpm
	Prime	230 kWm @ 1800 rpm
	Stand-by	253 kWm @ 1800 rpm

(\*) Net power to the flywheel in compliance with ISO 8528.

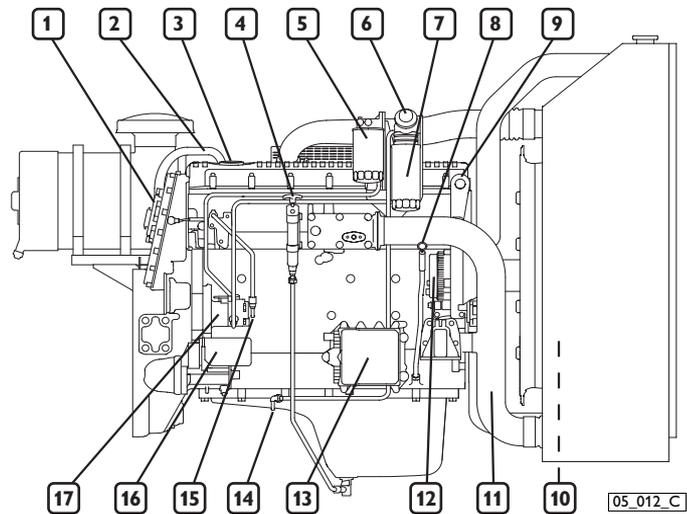
### WARNING

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### C78 TE2S

1. Coolant filler hole - 2. Heat exchangers - 3. Coolant outlet manifold from engine 4. Location of thermostat valve - 5. Exhaust gas discharge - 6. Location of turbocharger - 7. Turbocharging air outlet to after-cooler - 8. Turbocharger air inlet - 9. Lifting U-bolt - 10. Air filter - 11. Electrical engine pre-heating device - 12. Oil heat exchanger - 13. Oil filter - 14. Manifold for return of coolant to the engine - 15. Location of auxiliary member belt.



### C78 TE2S

1. Oil vapour filter housing - 2. Oil vapour outlet manifold - 3. Oil feeder hole - 4. Hand pump to extract oil - 5. Fuel filter - 6. Fuel pre-filter hand pump - 7. Fuel pre-filter - 8. Oil dipstick - 9. Lifting U-bolt - 10. Fan - 11. Intake manifold inlet connector - 12. Alternator - 13. Electronic control unit - 14. Fuel inlet manifold from tank - 15. Fuel outlet connector to tank - 16. Electrical starter motor - 17. Fuel supply pump.

## ENGINE TECHNICAL DATA C87 TE1D

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.

Code	C87 TE1D
Engine family	F2C
Cycle	Diesel a 4 tempi
Number and arrangement of cylinders	6, in line
Bore x stroke	117 x 135 mm
Total displacement	8,700 cm <sup>3</sup>
Air system	Supercharged aftercooled
Injection type	Common Rail electronically managed
Engine direction of rotation	Anticlockwise (seen from flywheel side)
Isochronous speed regulator	Electronically controlled
Dry weight	1030 kg

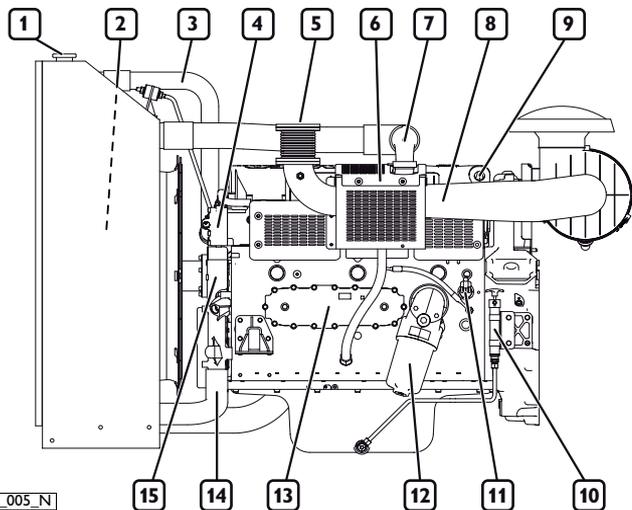
Electrical system	24 V
Accumulator/s	
- capacity	185 Ah or above
- discharge current	1200 A or above

Performance (*)		C87 TE1D
(STAGE 2)	Prime	232 kWm @ 1500 rpm
	Stand-by	255 kWm @ 1500 rpm
(TIER 3)	Prime	251 kWm @ 1800 rpm
	Stand-by	276 kWm @ 1800 rpm

(\*) Net power to the flywheel in compliance with ISO 8528.

### WARNING

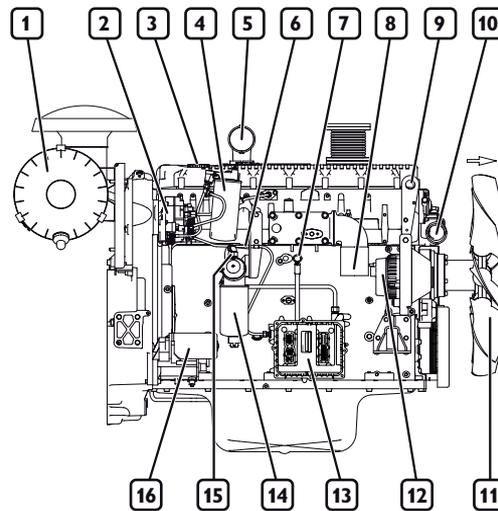
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07\_005\_N

### C87 TE1D

1. Coolant filler hole - 2. Heat exchangers - 3. Coolant outlet manifold from engine - 4. Location of thermostat valve - 5. Exhaust gas discharge - 6. Location of turbocharger - 7. Turbocharging air outlet to after-cooler - 8. Turbocharger air inlet - 9. Lifting U-bolt - 10. Manual lubricating oil extraction pump - 11. Electrical engine pre-heating device - 12. Oil filter - 13. Oil drainage nozzle - 14. Manifold for return of coolant to the engine - 15. Auxiliary member belt.



07\_006\_N

### C87 TE1D

1. Air filter - 2. High-pressure pump for common rail system - 3. Oil feeder hole - 4. Fuel filter - 5. Turbocharging air outlet to after-cooler - 6. Fuel outlet connector to tank - 7. Oil dipstick - 8. Intake manifold inlet connector - 9. Lifting U-bolt - 10. Coolant outlet from engine - 11. Fan - 12. Alternator - 13. Electronic control unit - 14. Fuel pre-filter - 15. Fuel inlet manifold from tank - 16. Electrical starter motor.

## ENGINE TECHNICAL DATA C10 TE1D

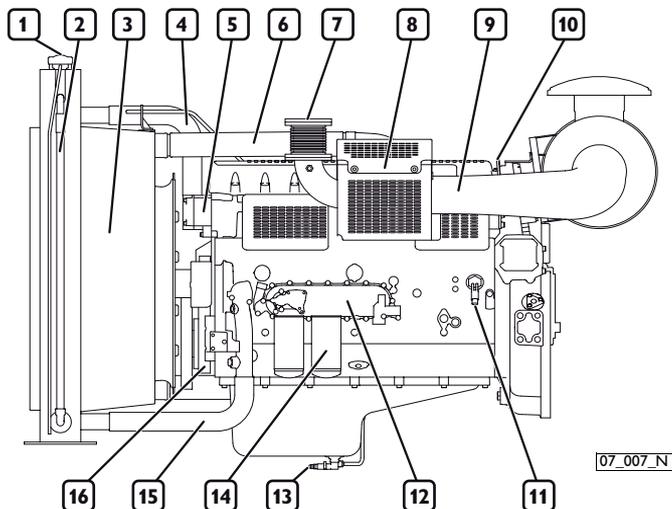
The technical code and serial number are indicated on a plate, which is located on different parts of the engine, according to the model: flywheel casing, tappet cover, other.

Code	C10 TE1D
Engine family	F3A
Cycle	4-stroke diese
Number and arrangement of cylinders	6, in line
Bore x stroke	125 x 140 mm
Total displacement	10,300 cm <sup>3</sup>
Air system	Supercharged aftercooled
Injection type	EUI (PDE), electronically managed
Engine direction of rotation	Anticlockwise (seen from flywheel side)
Isochronous speed regulator	Electronically controlled
Dry weight	1110 kg
Electrical system	24 V
Accumulator/s	
- capacity	185 Ah or above
- discharge current	1200 A or above

Performance (*)	C10 TE1D	
(STAGE 2)	Prime	260 kWm @ 1500 rpm
	Stand-by	286 kWm @ 1500 rpm
(TIER 3)	Prime	282 kWm @ 1800 rpm
	Stand-by	311 kWm @ 1800 rpm

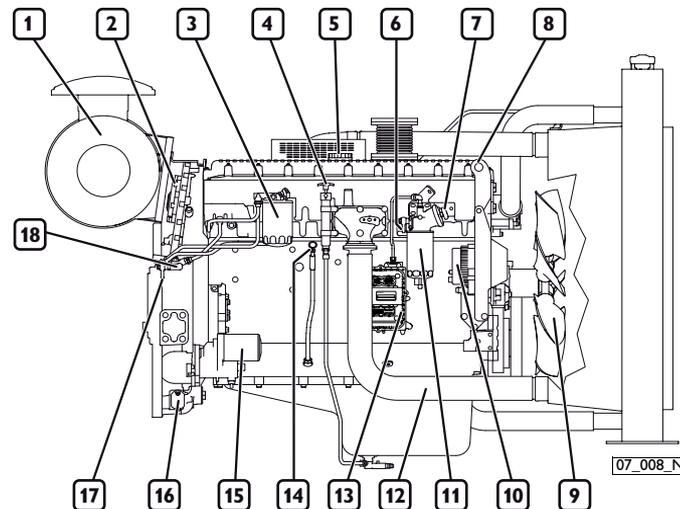
(\*) Net power to the flywheel in compliance with ISO 8528.

WARNING
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### C10 TE1D

1. Coolant filler hole - 2. Coolant level display - 3. Heat exchangers - 4. Coolant outlet manifold from engine - 5. Location of thermostat valve - 6. Turbocharging air outlet to after-cooler - 7. Exhaust gas discharge - 8. Location of turbocharger - 9. Turbocharger air inlet - 10. Lifting U-bolt - 11. Electrical engine pre-heating device - 12. Oil heat exchanger - 13. Oil drainage nozzle - 14. Oil filter - 15. Manifold for return of coolant to the engine - 16. Auxiliary member belt.



### C10 TE1D

1. Air filter - 2. Oil vapour filter housing - 3. Fuel filter - 4. Hand pump to extract oil - 5. Oil feeder hole - 6. Fuel inlet manifold from tank - 7. Fuel pre-filter hand pump - 8. Lifting U-bolt - 9. 10. Fan - 10. Alternator - 11. Fuel pre-filter - 12. Intake manifold inlet connector - 13. Electronic control unit - 14. Oil dipstick - 15. Electrical starter motor - 16. Flywheel crank insertion flange - 17. Fuel outlet connector to tank - 18. Fuel supply pump.

## ENGINE TECHNICAL DATA

### C13 TE2S/TE3S/TE3X

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.

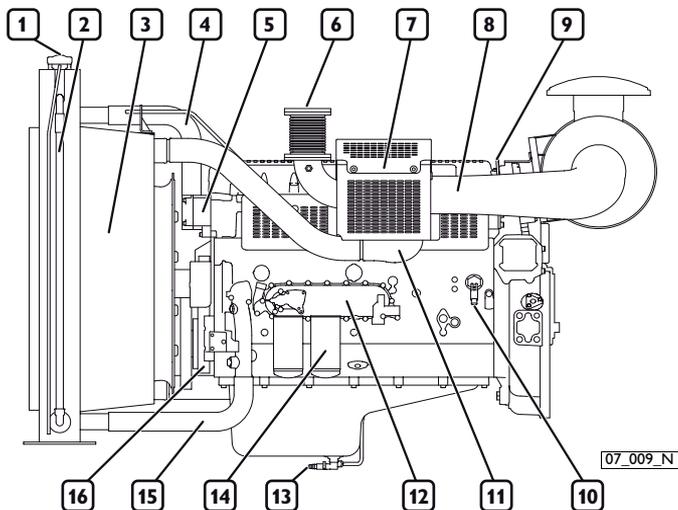
Code	C13 TE
Engine family	F3B
Cycle	4-stroke Diesel
Number and arrangement of cylinders	6, in line
Bore x stroke	135 x 150 mm
Total displacement	12,880 cm <sup>3</sup>
Air system	Supercharged aftercooled
Injection type	EUI (PDE), electronically managed
Engine direction of rotation	Anticlockwise (seen from flywheel side)
Isochronous speed regulator	Electronically controlled
Dry weight	1228 kg
Electrical system	24 V
Accumulator/s	
- capacity	185 Ah or above
- discharge current	1200 A or above

Performance (*)		C13 TE2S
(STAGE 2)	Prime	304 kWm @ 1500 rpm
	Stand-by	335 kWm @ 1500 rpm
	Prime	329 kWm @ 1800 rpm
	Stand-by	362 kWm @ 1800 rpm
Performance (*)		C13 TE3S
(STAGE 2)	Prime	352 kWm @ 1500 rpm
	Stand-by	387 kWm @ 1500 rpm
	Prime	362 kWm @ 1800 rpm
	Stand-by	398 kWm @ 1800 rpm
Performance (*)		C13 TE3X
(TIER 3)	Prime	337 kWm @ 1800 rpm
	Stand-by	371 kWm @ 1800 rpm

(\*) Net power to the flywheel in compliance with ISO 8528.

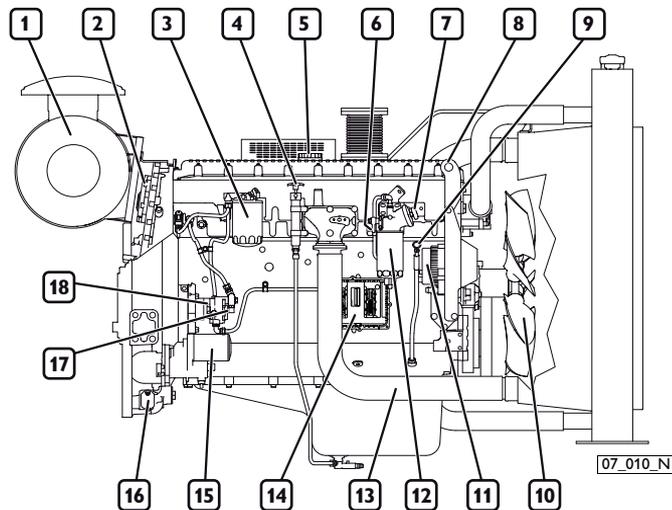
### WARNING

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### C13 TE

1. Coolant filler hole - 2. Coolant level display - 3. Heat exchangers - 4. Coolant outlet manifold from engine - 5. Location of thermostat valve - 6. Exhaust gas discharge - 7. Location of turbocharger - 8. Turbocharger air inlet - 9. Lifting U-bolt - 10. Electrical engine pre-heating device - 11. Turbocharging air outlet to after-cooler - 12. Oil heat exchanger - 13. Oil drainage nozzle - 14. Oil filter - 15. Manifold for return of coolant to the engine - 16. Auxiliary member belt.



### C13 TE

1. Air filter - 2. Oil vapour filter housing - 3. Fuel filter - 4. Hand pump to extract oil - 5. Oil feeder hole - 6. Fuel inlet manifold from tank - 7. Fuel pre-filter hand pump - 8. Lifting U-bolt - 9. Oil dipstick - 10. Fan - 11. Alternator - 12. Fuel pre-filter - 13. Intake manifold inlet connector - 14. Electronic control unit - 15. Electrical starter motor - 16. Flywheel crank insertion flange - 17. Fuel outlet connector to tank - 18. Fuel supply pump.

## SIGNS

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

**NOTE:** 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.

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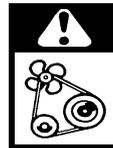
Danger of burning:  
Expulsion of hot water under pressure.



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 - Industrial appliance

### 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.*

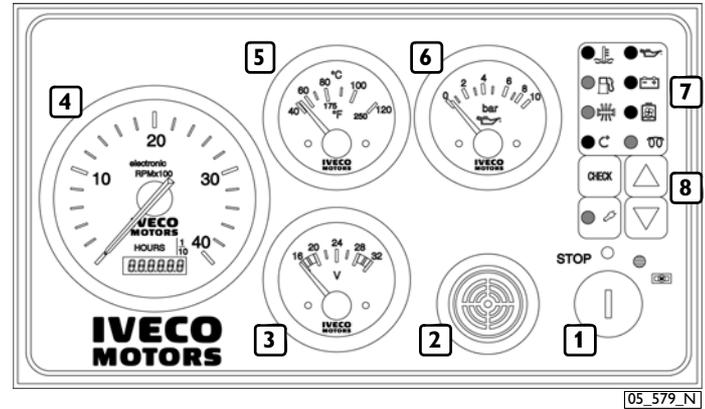
## STARTING AND STOPPING THE ENGINE

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.

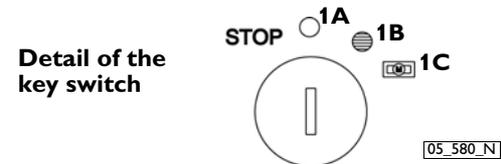
In these cases, follow the start-up/shut-down sequences and use the instrument panel description provided in the specific documentation.

## Start-up 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 "Alternator 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**.



1. Key switch to start/stop the engine - 2. Beeper - 3. Voltmeter - 4.Rev counter and hour counter - 5. Coolant temperature indicator - 6. Engine oil pressure indicator - 7. Alarm and indicator module - 8. Management and diagnosis module.



- 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.

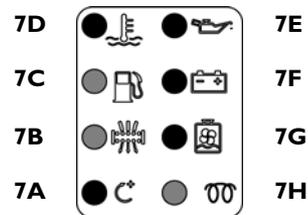
### Should you intend to re-start the engine:

1. Return the key switch to the rest position **1A**, thus resetting all the on-board panel functions (only essential 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.



[05\_581\_N]

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.

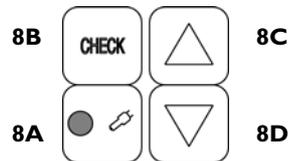
### CAUTION!



*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.*

## 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.



05\_582\_N

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 achieved, then release it.

To decelerate: press and hold button **8D** until the required engine speed is achieved, then release it.

The engine speed reached each time it is carried out will be maintained until the next time the engine is stopped.

## 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.

## ENGINE PRE-HEATING (optional)

(230 V, single phase electrical device)

The engines for which low temperature start-up and immediate delivery of power are required may be fitted with a 230 V single phase electrical heating device, which allows the temperature of the coolant to be raised to or maintained at suitable values. The device is fitted with a thermostat to cut the power supply when the required temperature is reached.

## 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.

#### CAUTION!



*Only open the coolant tank cap if strictly necessary, and only when the engine is cold.*

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.

#### CAUTION!



*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.*

The common rail injection system in the C87 ENT engine does not require air to be bled from the fuel circuit.

#### CAUTION!



*Never loosen the high pressure fuel circuit connectors in any way.*

### Air intake and exhaust discharge 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.

### CAUTION!



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

## 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.

### 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.

## ■ USE - G-Drive appliance

### PRELIMINARY CHECKS

Check the engine to ensure its efficiency and, more particularly:

- ❑ Check the fluids' levels and top up if necessary (fuel, engine oil and cooling liquid).
- ❑ Make sure that the exhaust gas system is efficient and that the intake air filter/s is not clogged. Furthermore, check that the mechanical indicator placed on the filter/s is not signalling "red".
- ❑ Make sure that the start batteries are efficient and that their clamps are correctly connected.

#### WARNING!

*In case it is necessary to top up the engine cooling liquid with a considerable quantity of coolant, follow the specific procedure reported in the herein SPECIAL WARNINGS section.*

**Note:** the maintenance procedures are reported in CHECKS AND MAINTENANCE section.

### STARTING AND STOPPING THE ENGINE

Engine start and stop modes will meet the needs of the power unit system. These may vary depending on the different options chosen for the realization of the power unit, control panel and working system. Their full and detailed description should be provided by the power unit system outfitters or by the power unit manufacturer. Once the start phase is concluded, carefully follow the instructions provided by the unit's measurement instruments, checking that the values detected correspond to the normal working rated ones.

### ENGINE PRE-HEATING (optional)

(Electric device)

The engines requiring low temperature start and immediate power erogation may be equipped with the heating electric device allowing to increase or maintain the cooling liquid temperature to suitable values.

The device is provided with a thermostat in order to interrupt power supply when reaching the prescribed temperature.

## INTERCONNECTION ELECTRICAL UNIT

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

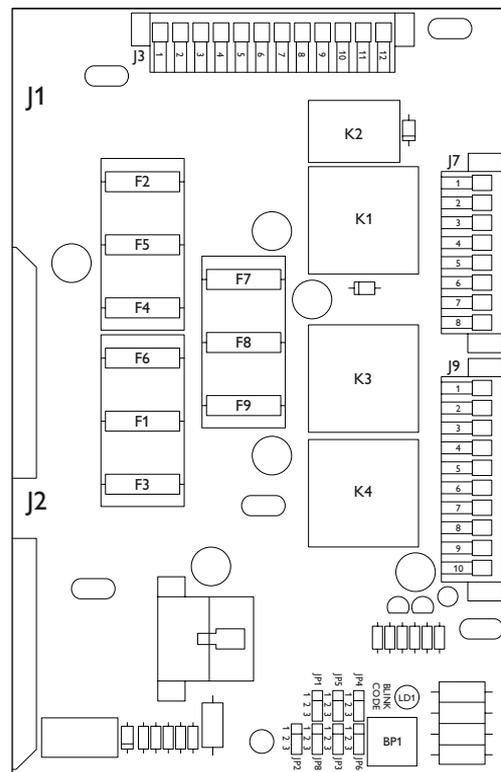
Some indications relating to its components and functions controlled by programming commutators are reported here following.

### Fuse

- F1** Engine start
- F2** Diagnosis connector
- F3** Fuel heater on filter
- F4** Engine electronic control unit
- F5** Interface electronic unit
- F6** E.C.U. supply (enabling)
- F7/8/9** Reserve

### Relays

- K1** E.C.U. supply (enabling)
- K2** Engine start signal
- K3** Engine start
- K4** Fuel heater on filter



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## Engine speed and accessory functions control

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

**JP1:** Engine speed selection

1-2 = 1,800 rev. /min (60 Hz power generation)

2-3 = 1,500 rev. /min (50 Hz power generation)

**JP2:** Mode selection

1-2 = DIAGNOSIS MODE

2-3 = OPERATING MODE

**JP3:** Pre-heating warning light

1-2 = connected

2-3 = not connected

**JP4:** Fuel pre-heating

1-2 = relay on

2-3 = relay off

**JP5:** It CAN line

1-2 = available

2-3 = unavailable

**BP1:** Blink code request switch button (\*)

**LD1:** Blink code display (\*)

(\*) With the exception of the C87 engine and TIER 3 engines.

## 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 keep the engine idling for a long while since this has negative effects to the engine performance.
- Actual power values must comply with the rated values reported in the technical documentation.
- When operating the engine, regularly check that:
  - the cooling liquid temperature does not exceed the threshold value;
  - the oil pressure keeps within normal values;
- 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.

### WARNING!

*Pay attention to the board panel instrument readings and indications.*

## SPECIAL WARNINGS

### Engine cooling liquid

When the engine is running, regularly check that the engine cooling liquid temperature does not reach the alarm threshold.

In case the temperature detected is excessive, disconnect the load and stop the engine to check the cooling circuit status. Wait that the engine is cold before checking: it is important to remind that, when the engine is heated, the pressurized hot liquid within the cooling circuits may be ejected causing burns and serious injury.

Moreover, check the following:

- a) the alternator's belt tension;
- b) the thermostatic valve's efficiency;
- c) the conditions of the heat exchanger (to be cleaned if necessary).

#### CAUTION!



*Open the cooling liquid tank cap only if it is necessary and exclusively if the engine is cold.*

### Cooling liquid refill

For engine servicing and whenever the system requires significant cooling liquid refill, proceed as follows:

- 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.

Further information on the cooling liquid technical specifications and quantity prescribed are reported in the CHECKS AND MAINTENANCE section.

#### ATTENZION!



*Failure to comply with the procedure may cause the incorrect engine cooling liquid refill and, as a consequence, wrong quantity within the engine.*

### Lubrication circuit

Regularly check that the oil pressure keeps within normal values. In case the value detected is too low, check the oil level and refill if necessary following the instructions reported in CHECKS AND MAINTENANCE section.

If the failure persists, apply to the Technical Service for assistance.

### 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.

#### CAUTION!



*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.*

The common rail injection system for C87 ENT engine does not require air to be bled from the fuel circuit.

### CAUTION!



*Never loosen the high pressure fuel circuit connectors in any way.*

### Air intake and exhaust discharge 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.

### CAUTION!



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

### 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.

Should it be necessary to replace the batteries, always respect the capacity and minimum discharge current intensity requirements.

### 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/cm<sup>2</sup>).
- Wear a protective helmet when working in an area where there are suspended loads or systems installed at head-height.
- Use protective hand cremes.
- 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

Parts to be supplied	C78 ENT C87 ENT litres (kg)	C10 ENT litres (kg)	C13 ENT litres (kg)	C78 TE C87 TE litres (kg)	C10 TE litres (kg)	C13 TE litres (kg)
Cooling circuit <sup>(1)</sup> Total capacity	15.5	17.5	19.5	15.5 63	17.5 63	19.5 67
Lubrication circuit <sup>(2)</sup> total capacity <sup>(3)</sup>	28 (25)	32 (30)	35 (31.5)	28 (25)	32 (30)	35 (31.5)
Periodic changing: oil sump at minimum level	15 (13.5)	17 (15.3)	20 (18)	15 (13.5)	17 (15.3)	20 (18)
oil sump at maximum level	22 (20)	25 (22.5)	28 (25)	22 (20)	25 (22.5)	28 (25)
Fuel tank <sup>(4)</sup>	-	-	-	-	-	-

- (1) Amounts relate to the engine only in standard configuration. Use a mixture of water and 50% PARAFU 11 even during the summer months. As an alternative to PARAFU 11, use another product that complies with international specifications SAE J 1034.
- (2) Use lubricants that comply with international specifications ACEA E3 - E5 (high power engines), API CF - CH4 (associated with fuels with a percentage sulphur < 0.5%), MIL - L - 2104 F. 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 (2005/55 - 2005/78). The use of additives is discouraged. A fuel known as BIO DIESEL is allowed only if it is compliant with the EN 14214 - ASTM 6751 norm, mixed in standard fuel with a maximum percentage of 20% (C78 ENT = 5%). Contact the FPT commercial network if KEROSENE-based fuel known as XF63, F63, F34, F35, JP8 are to be used. Only the use of mixtures containing suspension water is permitted, as indicated in the CUNA NC 637-01 (GECAM) and AFNORM 5-02 (AQUAZOLE) norms, in a maximum percentage of 12% and by using special additives. A 12% performance reduction is foreseen.

## WARNING

*Refuelling from drums or tanks may result in pollution of the diesel fuel, with the risk of damage to the injection system; if necessary, filter the fuel in a suitable manner or allow sedimentation of the impurities before refuelling.*

### 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.

## FREQUENCY

Controls (when in use)	Frequency
Check oil level in engine	Daily
Check coolant level	Daily
Check that the heat exchangers are clean	Daily
Check that the air filter is clean	Daily
Drain water from the fuel pre-filter	150 hours <sup>(1)</sup>
Check/top up electrolyte level in batteries and clean terminals	Half-yearly

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.



### Planned maintenance

### Frequency

Check state and tension of belt	300 hours <sup>(2)</sup>
Check state of oil vapour filter (indicator may be present)	300 hours <sup>(3)</sup>
Change oil	600 hours <sup>(3) (4)</sup>
Change oil filter/s	600 hours <sup>(3) (4) (5)</sup>
Change fuel filter/s	600 hours <sup>(3) (1) (5)</sup>
Change fuel pre-filter	600 hours <sup>(3) (1)</sup>
Check exhaust pipe/s for damage	Half-yearly
Impurity drainage/suction from the fuel tank	Half-yearly <sup>(1)</sup>
Change auxiliary member belt	1200 hours
Change air filter	1200 hours <sup>(6)</sup>
Change coolant	1200 hours or 2 years
Change oil vapour filter	2 years <sup>(4)</sup>



### Special maintenance

### Frequency

Clean the turbocharger	1200 hours <sup>(7)</sup>
Check the efficiency of the pre-post heating system (if there is one)	1200 hours
Adjusting play in valves-rocker arms and pumps-rocker arms	1200 hours

- 1) Maximum period when using good quality fuel, (EN 590 standard); this is reduced if the fuel is contaminated and alarms are triggered due to blockage of the filters and presence of water in the pre-filter. When blockage of the filter is indicated, it must be replaced. If the water in pre-filter indicator does not go out after drainage, the pre-filter must be replaced.
- 2) Refers to engines with traditional and automatic tensioning devices
- 3) Must be performed annually, even if the required number of working hours are not reached
- 4) Replace lubricants according to the frequency indicated in the REFUELLING table.
- 5) Only use filters with the following characteristics:
  - filtration level < 12 µm
  - filtering efficiency  $\beta > 200$ .
- 6) The frequency with which operations are carried out will depend on the working conditions and efficiency/wear of the product.
- 7) Required by oil vapour recirculation.

## WARNING!



*The extraordinary maintenance operations described hereunder fall within the exclusive competence of manufacturer's personnel or specialised personnel having proper working tools and adequate protection devices. The procedure and modality for carrying out these operations are illustrated in the FPT Technical and Repair Manual.*

## REQUIREMENTS

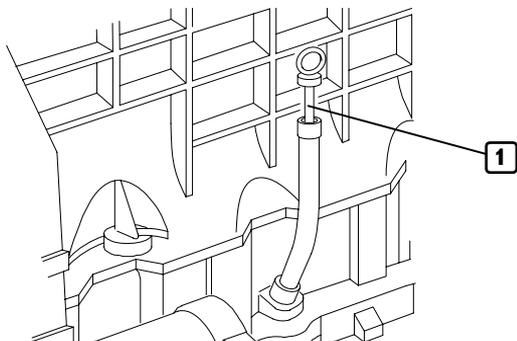
1. Do not disconnect the batteries with the engine running.
2. Do not carry out arc welding operations in the vicinity of the engine without first removing electrical cables and electronic units.
3. After each maintenance operation involving disconnection of the battery/batteries, make sure that the 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

### 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.



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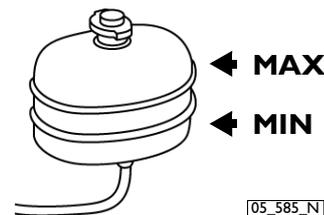
### WARNING

- ❑ 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.

### Coolant level inspection

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 REFILLING.



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**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

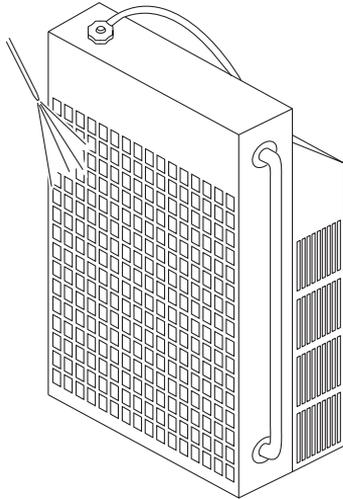


When the engine is warm, a pressure liable to cause hot liquid to be expelled with extreme violence is created within the cooling circuits. This results in a danger of burning.

## 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.



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### CAUTION

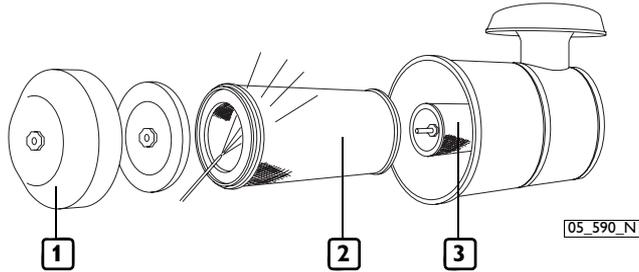


*The use of compressed air makes it necessary to use suitable protective equipment for the hands, face and eyes. Please see the prescriptions in the paragraph on ACCIDENT PREVENTION.*

## Cleaning the air filter (Refers to FPT components)

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 dehumidified 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

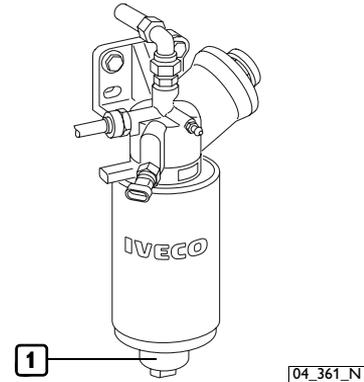
*Take care to ensure that the parts are reassembled correctly. Imperfect assembly might result in unfiltered air being sucked into the engine, causing serious damage.*

## Drain water from the fuel 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 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.



## Checking/topping 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 for about 5 mm.
- ❑ Top up with distilled water only those elements in which the level is below the minimum.
- ❑ On this occasion, make sure that the terminals and clamps are clean, properly tightened and protected by Vaseline.

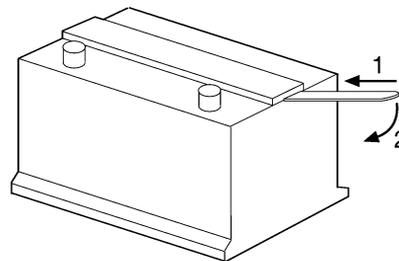
### WARNING!

*If all the elements of the battery need refilling with a considerable quantity of distilled water, contact specialised technical personnel in order to perform a diagnostic check on the efficiency state of the recharge system and battery.*

### 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.*



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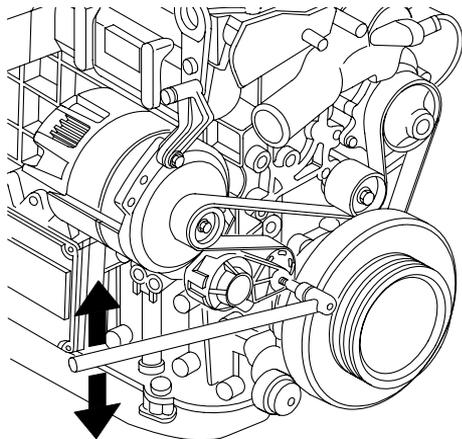
Some types of battery have a single cover for all the inspection plugs. To access the elements, use a lever as shown in the figure.

## 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.

### Refers to engines with automatic tensioning devices

- ❑ Remove any casing protecting the pulleys.
- ❑ 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 it.
- ❑ At the same time, make sure that the tensioning device is working properly, proceeding as indicated in the figure.
- ❑ Replace the guard casing in its housing, and lock all the retaining elements.

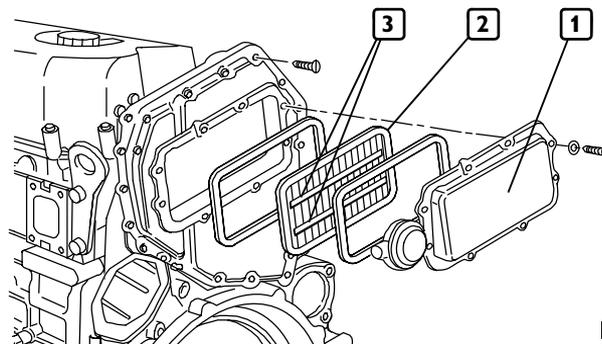


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## Check state of oil vapour filter

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

- ❑ Unfasten the screws and remove the cover (1) to the filter compartment.
- ❑ Remove the filter (2) and check the filter element for deposits, replacing it if necessary.
- ❑ Insert the filter and relevant gasket again, taking care that it is fitted the right way round, i.e. with the metal reinforcements (3) facing outwards.
- ❑ Replace the cover over the compartment.



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### CAUTION!



The filter (2) only filters effectively in one direction, and it must be fitted into its housing with the two metal reinforcements (3) facing out, as shown in the figure.

## Change oil

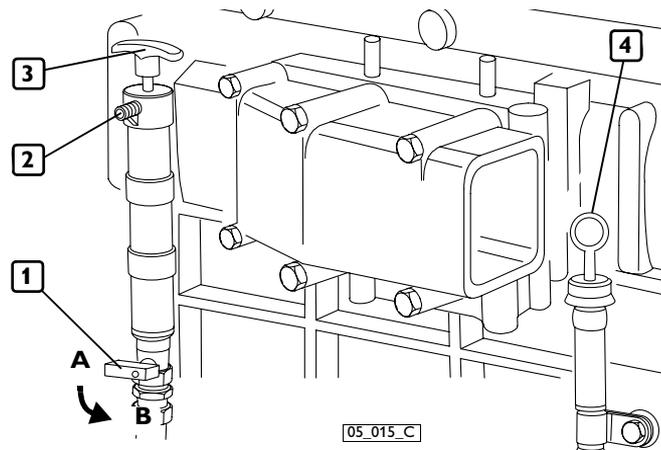
Only proceed with the engine stopped and at a low temperature, so as to avoid the risk of burning.

- ❑ 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 with fresh oil through the feeder hole on the timer cover, using the types and amounts of oil indicated in the table REFUELLING.
- ❑ Using the dipstick, check that the oil level is between the "Min" and "Max" levels.
- ❑ Dispose of used oil according to current requirements.

## Refers to setups with a transfer pump

- ❑ Place a container under the hand pump (3) outlet pipe (2), to collect the used oil.
- ❑ Open the drainage tap by turning the lever (1) to the vertical position **B**.
- ❑ Unscrew the filler cap, turn the hand pump provided (3), which is set up to extract the oil only, until the oil sump is completely empty.
- ❑ Fill up with fresh oil through the feeder hole on the timer cover, taking care to use the types and amounts of oil indicated in the table REFUELLING. Screw down the filler cap.
- ❑ Using the dipstick (4), check that the oil level is between the "Min" and "Max" levels.

- ❑ Close the drainage tap, by returning the lever (1) to the horizontal position **A**.
- ❑ Dispose of used oil according to current requirements.



### WARNING

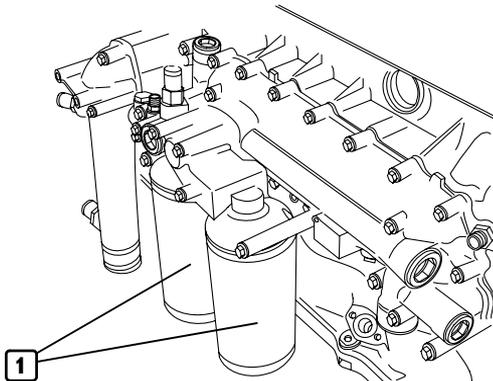
- ❑ After filling up, make sure that the oil level does not exceed the "Max" limit marked on the dipstick.
- ❑ Make sure that the dipstick is inserted properly and the filler cap is turned in a clockwise direction until it stops turning completely.

## 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, to collect the used oil.
- ❑ Unscrew the filter/s (1) and remove it/them.
- ❑ Carefully clean the surfaces of the support that are in contact with the seal gasket.
- ❑ Damp the new filter/s seal 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.



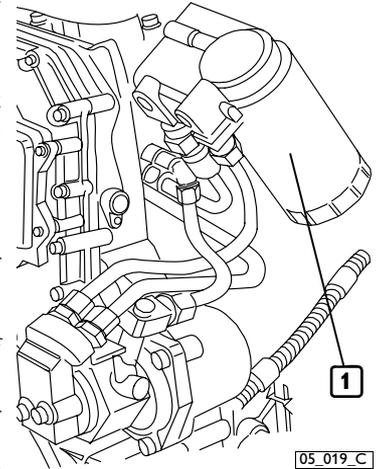
05\_018\_C

## Changing the fuel 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).

- ❑ Remove the filter (1) by unscrewing it.
- ❑ Check that the new filter has performance levels that satisfy the needs of the engine.
- ❑ 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 attention to whether or not there is an electrical fuel pre-heater and relevant connector.



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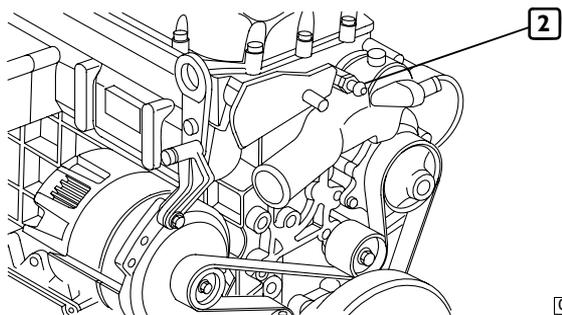
### WARNING

*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.*

**NOTE:** The injection systems in the various engines do not require bleeding to remove residual air.

Should it be necessary to accelerate the bleeding phase, with the exception of the C87 ENT engine, loosen the manifold on the cylinder head (2) during the initial phases of start-up.

Ensure that any fuel coming out of the manifold does not dirty the auxiliary member drive belt and is not dispersed into the environment.



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### CAUTION!

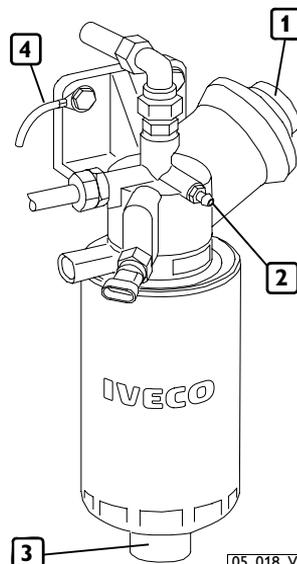


*Never loosen the high pressure common rail injection circuit connectors in the C87 ENT engine in any way.*

## Changing the fuel pre-filter

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 (2) on the pre-filter support and activate the hand pump (1) 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 minimum speed for a few minutes to eliminate any residual air.



05\_018\_V

- Check the efficiency of the earthing connection of the filter support (4).

**NOTE:** should it be necessary to accelerate the bleeding phase, the hand pump can be used during start-up.

### **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.

### **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.

### **Change oil vapour filter**

- Refer to the indications provided when checking the filter conditions, and ensure you comply with the assembly requirements.

## MOVING THE ENGINE

The operations necessary to disconnect and subsequently reconnect the engine must only be carried out by technicians from Authorised 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 running speed stabilises at 750 rpm. to allow the machine to proceed slowly and be manoeuvred simply by turning the inverter on and off, **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.*

## FAILURE CODE DECODING

### G-Drive appliance

The emission of the anomaly codes detected during self-testing and stored in the ECU starts after pressing and releasing the BP1 push-button on the Interconnection Electrical Unit.

The LED LD1 will signal, with two series of emissions at different frequencies, the blink codes that indicate the anomaly with decimal numbering.

Slow blinks identify the area of the anomaly (engine, injectors, etc.), fast blinks identify a specific anomaly.

Every time the push-button is pressed and released, only one of the stored codes is emitted; therefore, the procedure must be repeated until an error indication identical to the first one is obtained, which means the entire error memory has been analyzed.

If no anomalies are stored, the light comes on when the push-button is pressed and comes off about 1 second after its release, without any subsequent blinking.

### Blink Code

Someone of this codes are not significant in power unit appliance

Code	Failure signal origin
1 - 1	Vehicle speed signal
1 - 2	Multi-status programming
1 - 3	Cruise control / PTO commutators
1 - 4	Signal from accelerator pedal
1 - 5	Signal from clutch control
1 - 6	Non plausibility of brake activation sensors
1 - 7	Non plausibility of accelerator/brake activation sensors
2 - 1	Cooling liquid temperature signal
2 - 2	Boosting air temperature signal
2 - 3	Fuel temperature signal
2 - 4	Boosting air temperature signal
2 - 5	Atmospheric pressure signal
2 - 6	Engine brake pre-selection controls
3 - 5	Battery voltage
4 - 1	VGT driving pressure signal
4 - 2	Turbocharger impeller speed signal
4 - 3	Turbocharger overrun signal
4 - 4	Non plausibility of VGT activation

<b>Code</b>	<b>Failure signal origin</b>
4 - 5	VGT activation power stage
4 - 6	Engine brake activation power stage
4 - 7	VGT activation (Insufficient) pressure signal
5 - 1	Cylinder 1 injector drive circuit
5 - 2	Cylinder 3 injector drive circuit
5 - 3	Cylinder 5 injector drive circuit
5 - 4	Cylinder 2 injector drive circuit
5 - 5	Cylinder 6 injector drive circuit
5 - 6	Cylinder 4 injector drive circuit
6 - 1	Engine rev. / speed signal
6 - 2	Ignition phase signal
7 - 2	CAN line network
7 - 3	Message from TC (TEC)
7 - 4	Message from ATC (EBS)
7 - 5	Message from DR (INT)
7 - 6	Concurrent external access to CAN network
7 - 7	Safety time out for external unit
7 - 8	Time out for BC2EDC message
7 - 9	Time out for TSC1_PE message
9 - 1	ECU failure

<b>Code</b>	<b>Failure signal origin</b>
9 - 2	EEPROM memory failure
9 - 3	IMMOBILIZER failure
9 - 4	ECU supply relay failure
9 - 5	Afterrun procedure interrupted too many times
9 - 6	ECU disabling procedures

## ■ 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 manouevering 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.
- 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.

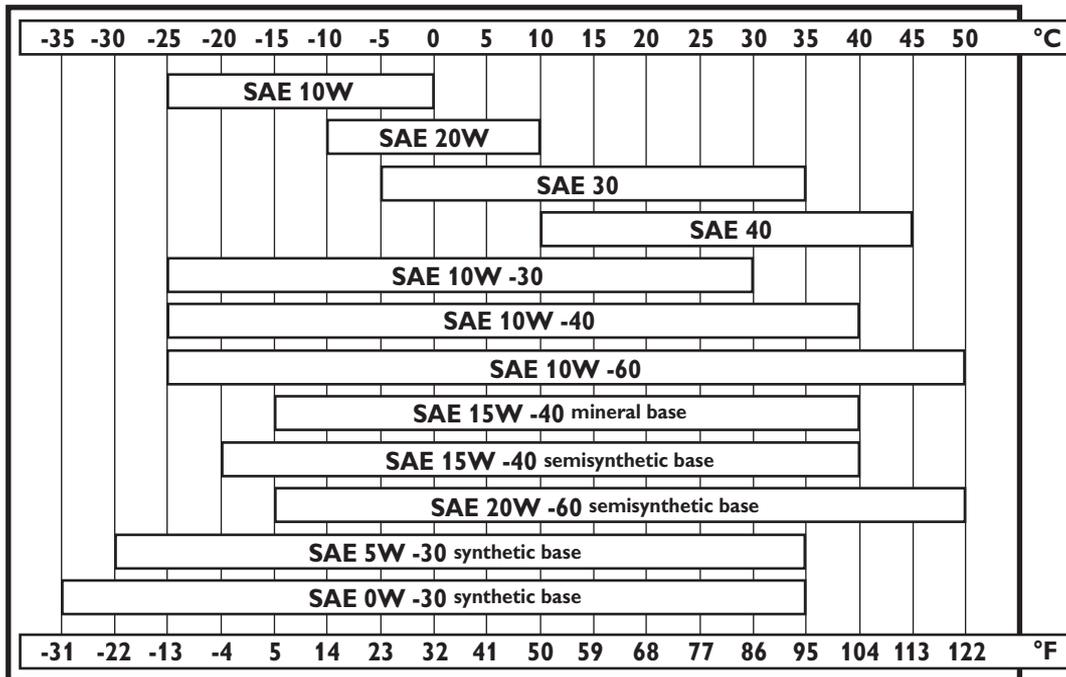
## Caustic burns

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).



## CONTROL PANEL USER REQUIREMENTS

The following data refer to FPT branded equipment in its original configuration.

The requirements and technical features of conversions may differ from these specifications and specific information must be supplied by those responsible for the conversion.

<b>FPT control panels</b>	<b>With analogue instruments</b>	<b>With digital instruments</b>
<b>Environmental operating conditions</b>		
Operating temperature range	from -10°C to +60°C;	from -10°C to +60°C;
Temperature limits while moored	min. -20°C / max. +75°C	min. -20°C / max. +75°C
Protection level against dust and rain (front)	IP 65 – DIN 40050 – IEC 529	IP 66
Salt spray resistance (reference Standard)	IEC 60068-2-52	IEC 60068-2-52
<b>Electrical and electromagnetic properties</b>		
Operating voltage (excluding polarity reversals)	min. 9 V / max. 32 V (*)	min. 9 V / max. 32 V (*)
Maximum permitted over-voltage	60 V for 1 ms	60 V for 1 ms
Maximum current uptake by main panel	1.1 A (12 V) – 1 A (24 V)	310 mA (12 V) – 200 mA (24 V)
Maximum current uptake by secondary panel	400 mA (12 V) – 400 mA (24 V)	310 mA (12 V) – 200 mA (24 V)
Electromagnetic compatibility (reference Standard)	IEC 945	IEC 945
Wiring connector requirements (reference Standard)	MIL 1344/1001	MIL 1344/1001
Wiring requirements (reference Standard)	CEI 20/22 - CEI 20/38 - CEI 2000/532/CE	
<b>Mechanical properties</b>		
Vibration resistance (expressed as acceleration due to gravity)	1 g max. eff. -25-500 Hz	2 g max. eff. -25-500 Hz
Impact resistance (expressed as acceleration due to gravity)	15 g - 1.5 ms - sinusoidal wave	15 g - 1.5 ms - sinusoidal wave

(\*) 16 V max. with reference to equipment for which power is required only at rated voltage of 12 V.