

USE AND MAINTENANCE FPT CURSOR 87TE3

CURSOR SERIES

FPT CURSOR 87TE3

G-DRIVE ENGINES



ENGINE TECHNICAL DATA CURSOR 87

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		CURSOR 87
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 ³	
Air system	Turbo aftercooler and after-cooled	
Injection type	Common Rail electronically managed	
Engine direction of rotation	Anticlockwise (seen from flywheel side)	
Dry weight (G-Drive)	~ 1050 kg	
Electrical system		24 V
Accumulator/s		
- capacity	180 Ah or above	
- discharge current	1200 A or above	

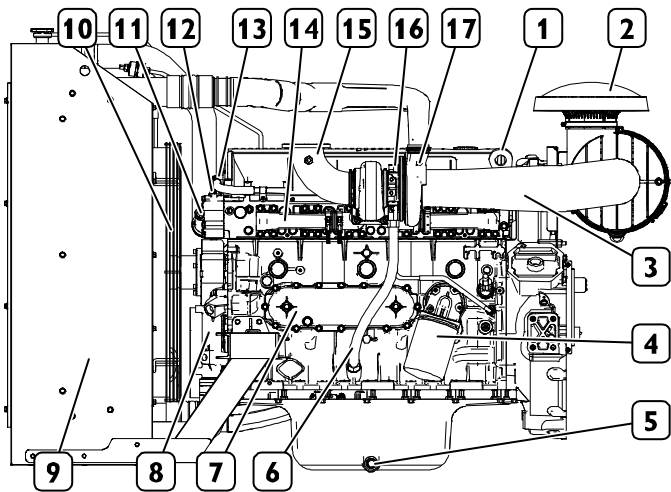
Performance (*)	CURSOR 87TE3
Prime	229 kWm @1500 rpm
	249 kWm @1800 rpm
Stand-by	249 kWm @1500 rpm
	271 kWm @1800 rpm

Performance (*)	CURSOR 87TE4
Prime	275 kWm @1500 rpm
	306 kWm @1800 rpm
Stand-by	299 kWm @1500 rpm
	333 kWm @1800 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

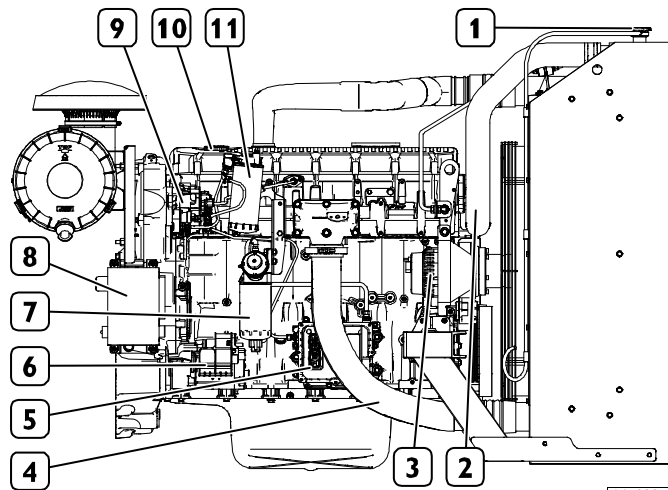
Any alteration of the above mentioned characteristics, in particular modification of the data stored in the injection system electronic units or the characteristics of the engine and its fittings, is strictly prohibited, penalty invalidation of the guarantee and absence of all liability on the part of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



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CURSOR87TE

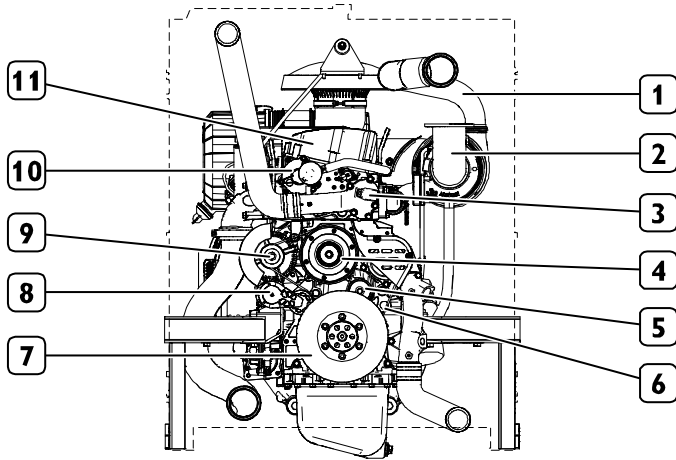
1. Lifting eyelet - 2. Air filter - 3. Air delivery duct from filter to compressor - 4. Lubrication oil filter - 5. Sump oil drain plug - 6. Turbocharger oil return pipe - 7. Heat exchanger - 8. Coupling of engine coolant return - 9. Radiator - 10. Fan protective grille - 11. Thermostatic valve location - 12. Oil vapour filter seat - 13. Oil vapour outlet coupling - 14. Exhaust manifold - 15. Turbocharger exhaust gas outlet - 16. Turbocharger oil delivery pipe - 17. Turbocharger



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CURSOR87TE

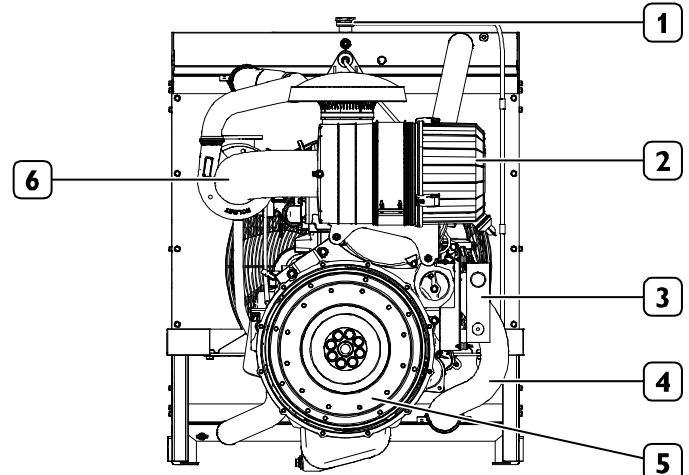
1. Radiator coolant inlet plug - 2. Engine coolant outlet pipe - 3. Alternator - 4. Intake manifold - 5. ECU - 6. Electric starter motor - 7. Fuel prefilter - 8. Completion kit - 9. High pressure fuel pump - 10. Oil filling cap - 11. Fuel filter



14_023_C

CURSOR87TE

- 1. Compressed air outlet pipe - 2. Turbocharger exhaust gas outlet pipe - 3. Thermostat assembly - 4. Fan pulley - 5. Guide pulley - 6. Poly-V belt - 7. Crankshaft damper - 8. Automatic belt tensioner - 9. Alternator - 10. Oil vapour filter - 11. Tappet cover



14_024C

CURSOR87TE

- 1. Radiator coolant inlet plug - 2. Air filter - 3. Completion kit - 4. Engine air intake pipe - 5. Engine flywheel - 6. Turbocharger

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.



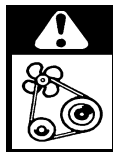
Danger of burning:
Expulsion of hot water under pressure.



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.

ENGINE PRE-HEATING (optional)

(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.

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.

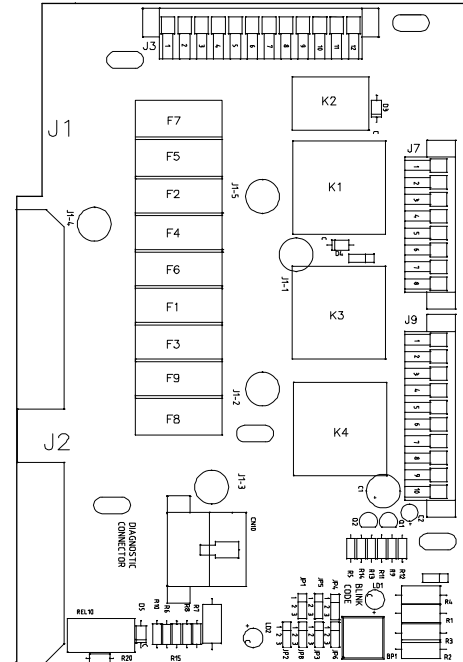
Some indications relating to its components and functions controlled by programming commutators are reported here following.

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. power 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



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

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 CONTROLS AND MAINTENANCE section.

CAUTION!



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 the CONTROLS 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.

CAUTION!



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

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

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.

Periodically check or have someone check the cleanliness, wear and full tensioning of the drive belt.

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 where 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

Parts to be supplied	CURSOR 87	
		litres (kg)
Cooling circuit ⁽¹⁾	engine ^(*)	15 (13.5)
	G-Drive ^(**)	58 (52.2)
Lubrication circuit ⁽²⁾		
total capacity ⁽³⁾		28 (25)
Periodic changing:		
oil sump at minimum level		12.5 (11.5)
oil sump at maximum level		23 (20.7)
Fuel tank ⁽⁴⁾		-

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

(**)Engine with radiator and piping.

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

(2)Use lubricants that comply with international specifications API CL4-ACEAE4/E5/E6/E7 5W30.

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 0.2% 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.

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

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.

Checks and scheduled maintenance procedures	Frequency
Check oil level in engine	Daily
Check coolant level	Daily
Check that the heat exchangers are clean	Daily
Check exhaust pipe/s for damage	Daily
Check that the air filter is clean	Monthly
Check tightening and cleanliness of battery clamps	Half-yearly
Check/top up electrolyte level in batteries	Half-yearly
Check condition of the blow-by filter	Half-yearly



Planned maintenance

Frequency

Change oil	600 hours/1 year ⁽³⁾ (4)
Change oil filter	600 hours/1 year ⁽³⁾ (4) (5)
Change fuel filter	600 hours/1 year ⁽¹⁾ (3) (5)
Drain water from the fuel filter	150 hours ⁽¹⁾
Impurity drainage/suction from the fuel tank	150 hours ⁽¹⁾
Change air filter	1200 hours/2 years
Change coolant	1200 hours/2 years
Replacing the blow-by filter	900 hours



Special maintenance

Frequency

Change auxiliary member belt	1200 hours/3 years ⁽²⁾
Clean heat exchanger (radiator)	1200 hours
Visual inspection of turbocharger	1200 hours



Special maintenance

Frequency

Adjust play in valves-rocker arms	3000 hours
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- 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 $< 12 \mu\text{m}$
 - filtering efficiency $\beta > 200$.

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.
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).

WARNING

Do not execute any operation which may change the ignition pump's calibration.

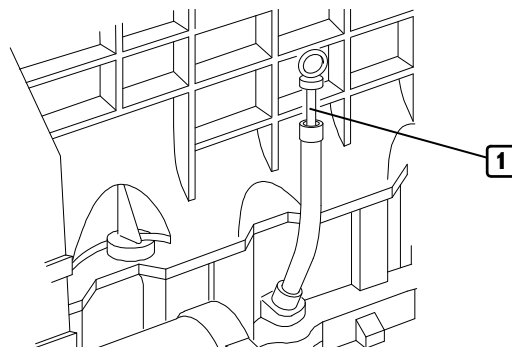
The ignition pump's calibration has been carried out in phase of engine system test based on its final use or destination.

HOW TO PROCEED

Check oil level in engine / Change oil

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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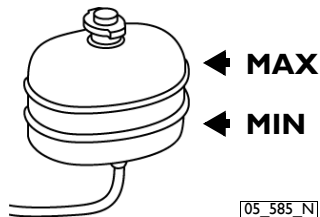
WARNING

- 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.



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

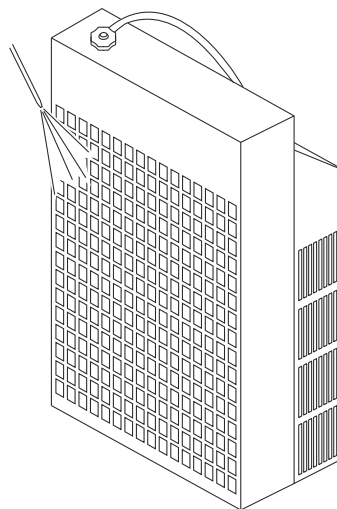


When the engine is warm, a pressure liable to cause hot liquid to be expelled with extreme violence is created within the cooling circuits. This results in a danger of burning.

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.



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.

Check exhaust pipe/s for damage

Visually check that the exhaust system is not blocked or damaged.

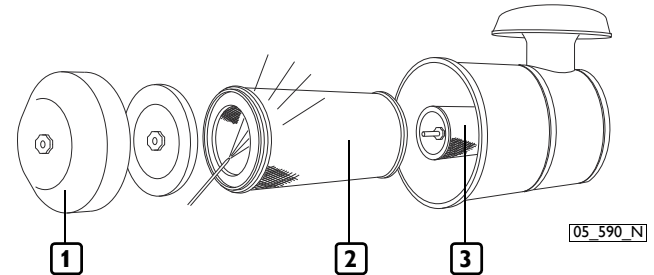
- ❑ Make sure that there is no risk of dangerous fumes within the machine. Contact the Manufacturer if necessary.

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.

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.

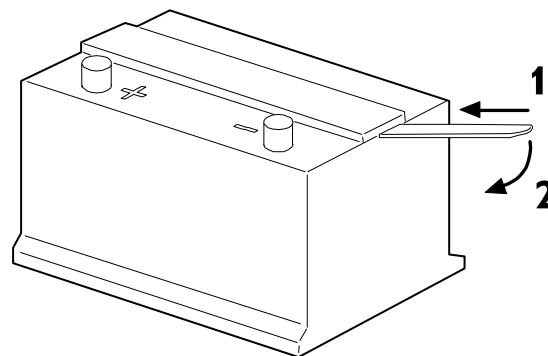
WARNING!

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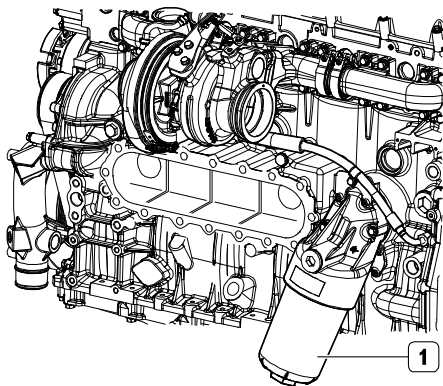
Some types of battery have a single cover for all the inspection plugs. To access the elements, use a lever as shown in the figure.

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.



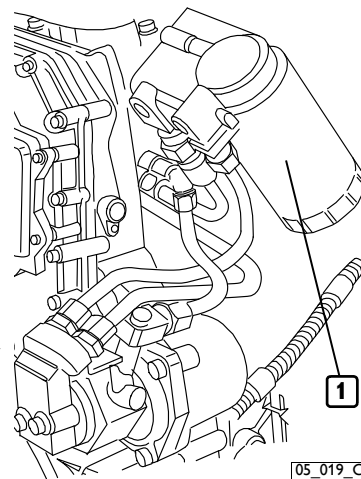
12_008 C

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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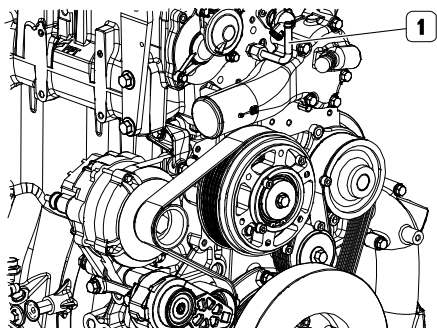
WARNING

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 (1) 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.



12_010_C

CAUTION!

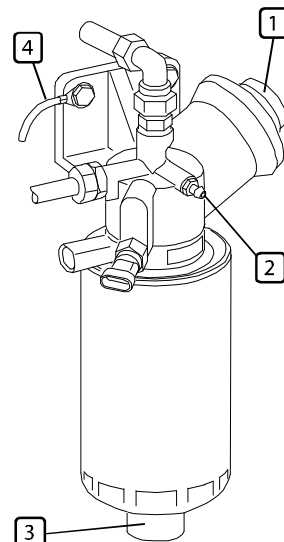


Never loosen the high pressure common rail injection circuit connectors in the C87 ENT engine in any way.

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.



10_009_C

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

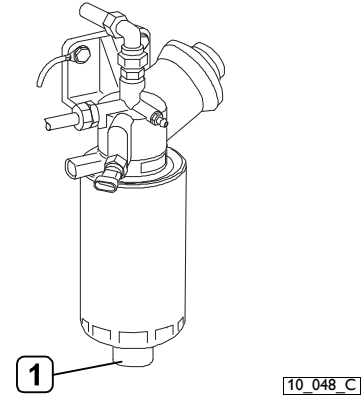
NOTE: should it be necessary to accelerate the bleeding phase, the hand pump can be used during start-up.

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.



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.

Air filter replacement

Refer to the instructions provided for air filter cleaning.

Change coolant

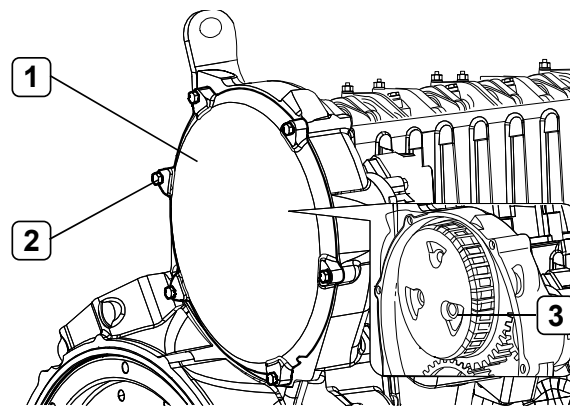
Only proceed with the engine stopped and at a low temperature, so as to avoid the risk of burning.

- ❑ 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.

Replacing the blow-by filter

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

- ❑ Unlock screws (2) and remove cover (1). Remove the centrifugal filter (3) underneath and replace it.



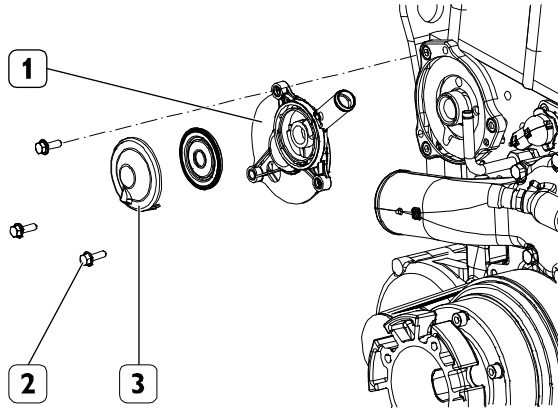
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WARNING!



The blow-by casing should be fitted perfectly aligned with the camshaft in order not to damage the gasket.

- Install blow-by body (1) with related seal and lock screws (2) at required torque.
- Install cover (3) and lock screws (2) at required torque.



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Change auxiliary member belt

Please refer to the information provided for checking the belt tension.

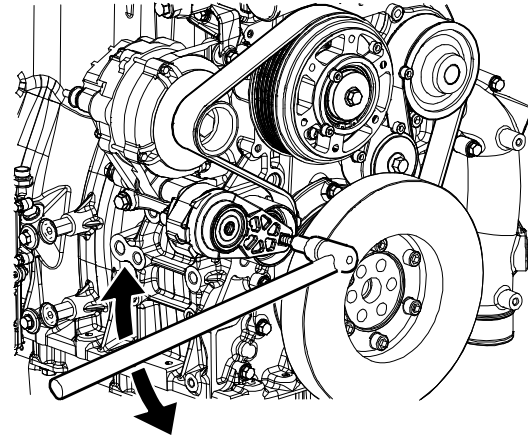
NOTE: Belt tensioner is automatic, therefore no further adjustment are required after installation

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

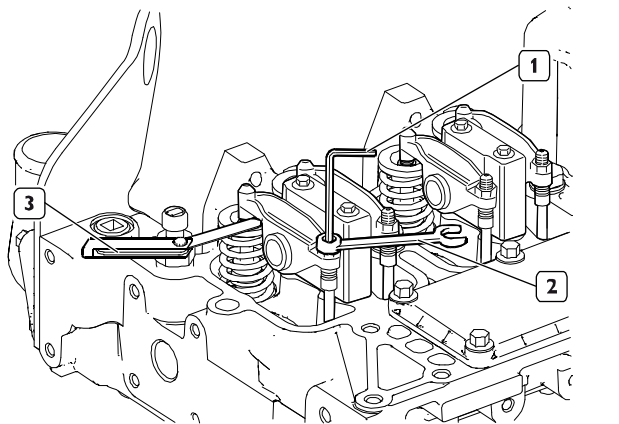
- Remove any casing protecting the pulleys.
- Check that the belt is not torn or worn, and that there are no lubricants or fuel on it. If this is not the case, replace it.
- At the same time, make sure that the tensioning device is working properly, proceeding as indicated in the figure.
- Replace the guard casing in its housing, and lock all the retaining elements.



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Adjustment of valve/rocker arm clearance

The adjustment of the clearance between the rocker arms and the intake and exhaust valve control rods must be strictly carried out using an Allen wrench (1), box-end wrench (3) and a feeler gauge (2).



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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 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.

■ 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).