

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

NEF SERIES

G-DRIVE ENGINES

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USE AND MAINTENANCE

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1 - GENERAL INFORMATION

Guarantee

For the engine to perform at its best and to be covered by the FPT warranty, pay close attention to the instructions provided in this manual; failure to observe the instructions could invalidate the warranty.

Spare parts

Always use original FPT spare parts. This will enable the engine to run as efficiently as it did originally.

The use of non-original spare parts not only invalidates the warranty, but also means that FPT cannot be held responsible in any way during the entire life cycle of the engine.

Liability

The manufacturer shall be held responsible provided that the checks and maintenance work indicated and described in this manual are carried out; it shall therefore be necessary to provide proof that such maintenance work has been carried out. Non-routine maintenance work must be carried out by qualified technicians from workshops belonging to the FPT network, using the tools and equipment that have been specifically provided.

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

Additional safety recommendations can be found in the CHECKS AND MAINTENANCE chapter.

Safety warnings symbols

You will find these symbols on the following pages; follow the instructions to which they refer, for your own safety and that of your engine.

<p>Risk of injury: failure to comply with these instructions can result in the risk of serious injury.</p>	
<p>Risk of serious damage to the engine: the partial or total non-observance of these instructions could cause serious damage to the engine and may nullify the warranty.</p>	
<p>General risk: combines the risks of both the signs described above.</p>	
<p>Safeguarding the environment: indicates the correct behaviour so that vehicle use is as environmentally friendly as possible.</p>	

Engine technical data

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 case, tappet cover, other.

Code	N67 ENT Z W
Engine series	F4
Cycle	Diesel 4-stroke
Number and arrangement of cylinders	Six, in line
Bore x stroke	104 mm x 132 mm
Total displacement	6.700 cm³
Air supply	Turbocharged - with Intercooler
Injection method	Direct - Fuel supply with high pressure pump and common rail system
Compression ratio	-
Cooling	liquid
Engine direction of rotation	Anticlockwise (seen from flywheel side)
Dry weight	530 kg

Electrical system	12 V / 24 V (24 V standard / 12 V optional)
Accumulator/s - capacity - discharge current (EN 50342)	130 A-h (24 V) or greater 500 A (24 V)
Electric starter motor - Maximum power rating	4 kW

Performance [gross] (*)		N67 ENT Z W
F4HFE615 B*B003	Continuous Power (1)Prime power (2) Stand-by Power (3)	106 kWm at 1800 RPM 132 kWm at 1800 RPM 145 kWm at 1800 RPM
F4HFE615 C*B003	Continuous Power (1)Prime power (2) Stand-by Power (3)	122 kWm at 1800 RPM 152 kWm at 1800 RPM 167 kWm at 1800 RPM
F4HFE615 D*B003	Continuous Power (1)Prime power (2) Stand-by Power (3)	142 kWm at 1800 RPM 177 kWm at 1800 RPM 195 kWm at 1800 RPM
F4HFE615 E*B003	Continuous Power (1)Prime power (2) Stand-by Power (3)	163 kWm at 1800 RPM 203 kWm at 1800 RPM 223 kWm at 1800 RPM
F4HFE615 F*B001	Continuous Power (1)Prime power (2) Stand-by Power (3)	- kWm at 1800 RPM - kWm at 1800 RPM 146 kWm at 1800 RPM

Performance [gross] (*)		N67 ENT Z W
F4HFE615 G*B001	Continuous Power	
	(1) Prime power	- kWm at 1800 RPM
	(2) Stand-by Power	- kWm at 1800 RPM
	(3) Power	168 kWm at 1800 RPM

(*) Power at the flywheel in accordance with standard ISO 3046-1. Test conditions: temperature **25 °C**; atmospheric pressure **100 kPa**; relative humidity **30%**.

(1) The continuous power is that which a generating set is capable of delivering continuously for an unlimited number of hours per year, according to the specified maintenance intervals and under standard ambient conditions.

(2) The prime power is the maximum power available with varying loads for an unlimited number of hours. The average power supplied during an

operating period of **24 h** must not exceed **80%** of the declared primary power between the specified maintenance intervals and under standard ambient conditions. An overload of **10%** is permitted for **1 h** every **12 h** of operation.

(3) The Stand-by power is the maximum power available for a period of 500 hours/year with a mean load factor of **90%** of the declared stand-by power. No kind of overload is permissible for this use.



Risk of damage

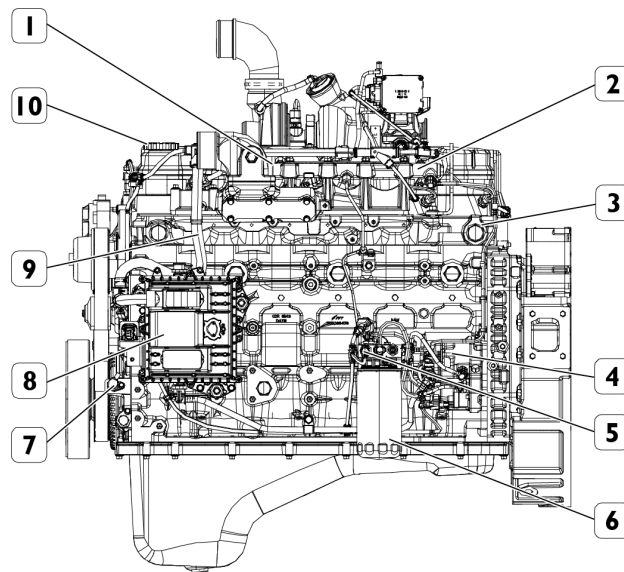
It is strictly forbidden to alter the aforesaid characteristics and, in particular, to modify the stored data in the injection system's electronic units or the characteristics of the engine and its components.

Failure to comply completely or partially with these requirements may result in the risk of serious damage to the engine and may even, on occasion, invalidate the warranty

External view

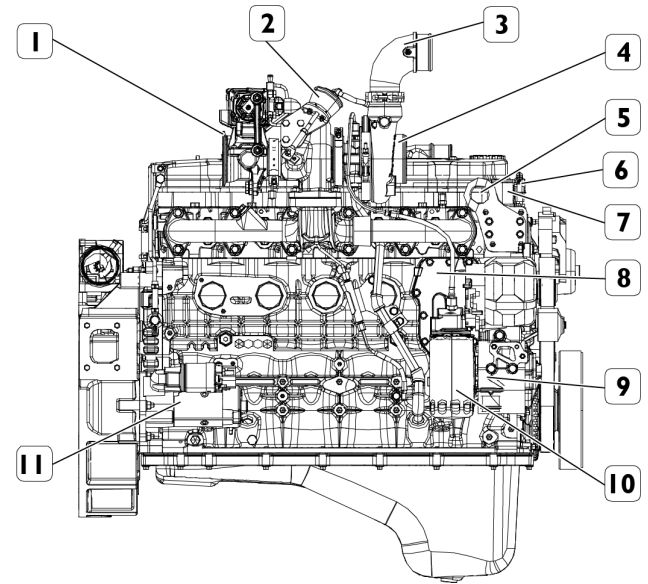
N67 ENT Z W

1. Rail pressure sensor
2. Common rail
3. Fuel exhaust pipe
4. Fuel high pressure pump
5. Fuel temperature sensor
6. Fuel filter
7. Crankshaft rpm sensor
8. EDC17CV41 engine control unit
9. Engine cable
10. Lubricant oil filler cap



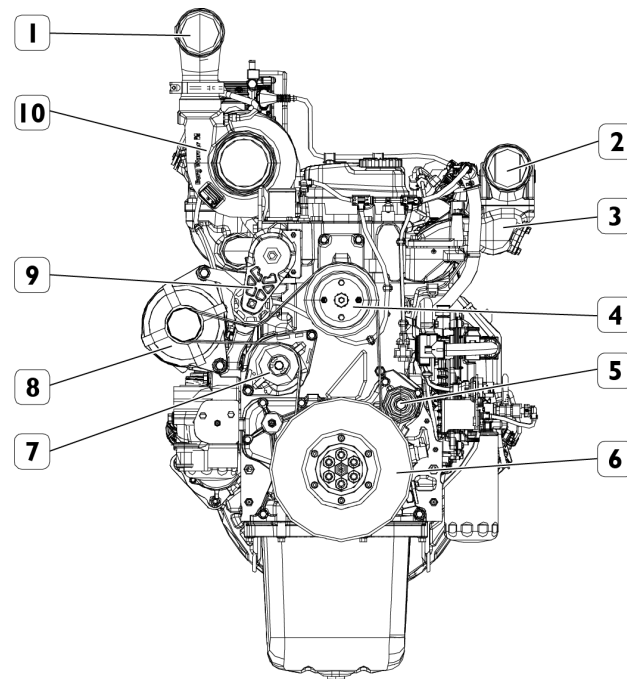
N67 ENT Z W

1. Turbocharger exhaust gas outlet from motorized throttle valve (exhaust flap)
2. Waste-Gate valve
3. Air pipe on turbocharger
4. Turbocharger comburent air intake from the air filter
5. Lifting hook
6. Coolant temperature sensor
7. Engine coolant outlet pipe (to the radiator)
8. Coolant/lubricant oil heat exchanger
9. Engine coolant inlet pipe (from the radiator)
10. Oil filter
11. Electric starter motor



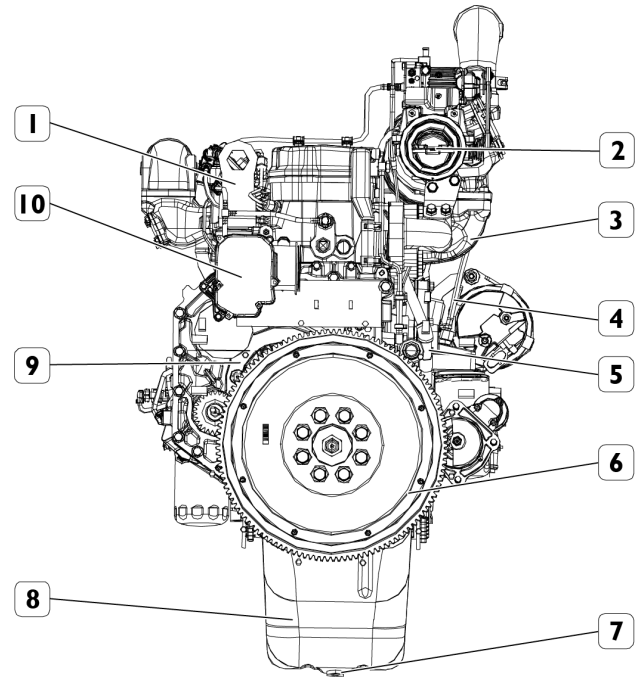
N67 ENT Z W

1. Turbocharger comburent air outlet to the intercooler
2. Engine air intake
3. Intake manifold
4. Fan control pulley
5. Idler pulley
6. Crankshaft pulley with damper
7. Water pump
8. Alternator
9. Automatic belt tensioner
10. Turbocharger

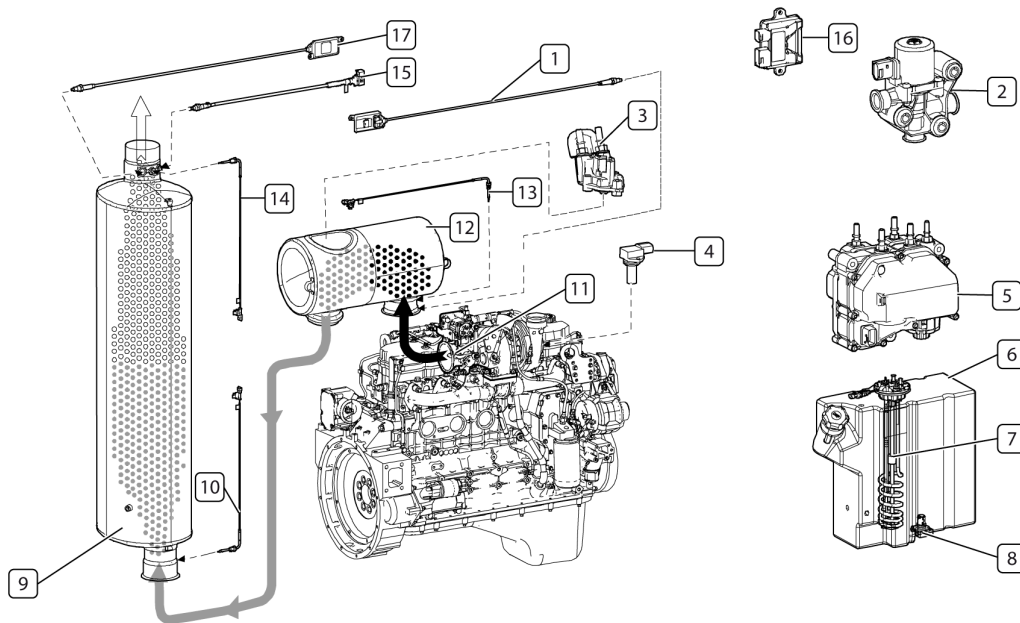


N67 ENT Z W

1. Lifting hook
2. Motorised throttle valve (exhaust flap)
3. Exhaust manifold
4. Turbocharger lubricant oil delivery pipe
5. Turbocharger lubricant oil return pipe
6. Engine flywheel
7. Lubricant oil drain cap
8. Oil sump
9. Flywheel case
10. Blow-by filter



EXHAUST GAS AFTER-TREATMENT SYSTEM (ATS)




1. NOx sensor upstream of DOC 2. Engine coolant 3-way valve — 3. DeNOx 2.2 dosing module — 4. Intake air humidity and temperature sensor — 5. DeNOx 2.2 supply module — 6. AdBlue tank - 7. AdBlue tank level sensor - 8. Urea quality sensor (UQS) — 9. Selective Catalytic Reduction (SCR) — 10. Exhaust gas temperature sensor upstream of

SCR 11. Exhaust valve module - 12. Diesel oxidation catalyst (DOC) - 13. Exhaust gas temperature sensor upstream of DOC 14. Exhaust gas temperature sensor downstream of SCR 15. NH3 sensor — 16. NH3 control unit sensor — 17. NOx sensor downstream of SCR


Plates

IDENTIFICATION PLATE

- Box "A" Model
- Box "B" S/N

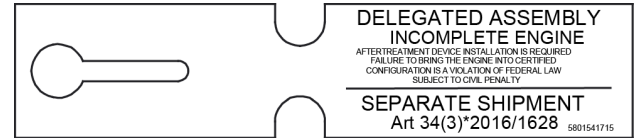
 FPT Industrial S.p.A. Made in Italy			
MODEL	A	S/N	B

TYPE-APPROVAL PLATE

 FPT Industrial S.p.A.		EMISSION CONTROL INFORMATION USE IN CONSTANT-SPEED OPERATION ONLY				
ENGINE FAMILY:	<input type="text"/>	ENGINE MODEL:	<input type="text"/>	DATE of MFG (mm-yy):	<input type="text"/>	
Displ.	<input type="text"/>	ADV. POW.	<input type="text"/>	kW POW. rpm CAT	<input type="text"/>	
SERIAL NUMBER:	<input type="text"/>	ECS.:	<input type="text"/>			
THIS ENGINE COMPLIES WITH U.S. EPA REGULATIONS FOR					<input type="text"/>	MODEL YEAR
NON ROAD AND STATIONARY DIESEL ENGINES AND CALIFORNIA REGULATIONS FOR					<input type="text"/>	
MODEL YEAR NON ROAD DIESEL ENGINES. THIS ENGINE IS CERTIFIED TO OPERATE ON: ULTRA LOW SULFUR FUEL ONLY						
DELEGATED ASSEMBLY						

"DELEGATED ASSEMBLY" PLATE

This plate highlights the fact that the engine must be installed with the corresponding ATS system by the bodybuilder. When installation has been completed, it must be removed.



Signs

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



Lifting point (only the engine).



DIESEL

Fuel filling cap
(on the tank, if present).



Lubricant oil filling cap.



Lubricant oil level dipstick.



Risk of burns:
Expulsion of pressurised hot water.



Risk of burns:
Presence of parts at high temperature.



Risk of fire:
Presence of fuel.



Risk of injury
from moving parts:
Presence of fans, pulleys, belts or other.

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

2 - USE

Preliminary checks

Before each engine start-up:

- Check and top up the level of the fluids if necessary (fuel, engine oil and cooling liquid).
- Make sure that the air intake filter is not obstructed or clogged, checking at the same time that the mechanical indicator on the filter does not show the "red" signal. If the engine has an electric clogging sensor, the alarm will be produced on engine start-up by means of an indicator light on the dashboard.
- The procedures specified for cleaning the filter are provided in **3-23**.



General prescriptions

Make sure that the environment where the engine will operate is free of combustible vapours or gases.

Make sure that there is sufficient ventilation and a suitable exhaust gas extraction system for closed environments. Failure to comply with these prescriptions can result in the risk of serious injury and serious damages to the vehicle

For proper use of the engine

- Before starting the engine, check there is enough fuel in the fuel tank.
- Avoid prolonging the duration of the start control.
- Follow the indications provided in the maintenance schedule.
- During use, check periodically that:
 - the temperature of the engine coolant does not reach the alarm thresholds;
 - the oil pressure remains within normal values.

- Actual power values must comply with the rated values reported in the technical-commercial documentation.
- Particular attention must be paid to engines that equip the emergency generator sets for which frequent efficiency checks are required in order to ensure they start promptly whenever required.



General prescriptions

If using in extremely dusty environments and on the basis of the final configuration of the current generator, soundproofed or without sound-proof casing, suitable protections are required for most sensitive components.

Failure to comply completely or partially with these requirements may result in the risk of serious damage to the engine and may even, on occasion, invalidate the warranty

Special warnings

Coolant temperature high

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

Also check and have the following checked:

- condition of the auxiliary members' belt;
- operation of the thermostatic valve;
- cleanliness of the heat exchanger (radiator).



Risk of injury:

When the engine is hot, the pressure inside the cooling circuit can be such that it may expel the hot liquid in an extremely violent manner with the risk of burns. Only open the refill plug of the coolant tank when the engine is cold. Failure to comply with these prescriptions can result in the risk of serious injury

Low lubricant oil pressure

Should the pressure indicated by the instrument be considered insufficient or if the "low oil pressure" warning light comes on, stop the engine and check the oil level. Top up as required following the instructions provided in **3-23**. If the fault persists, contact a Service centre.

If the fault persists, stop the engine and an authorised Service centre.

Presence of water in the fuel filter

It is a good rule to drain the water from the filters, before the relevant indicator comes on.

Do not use the engine if the tank only contains the quantity of fuel kept as reserve; this condition promotes the formation of condensate and the intake of sludge or air, causing the engine to stop.



Contamination, fire

When refuelling, always make sure that no solid or liquid pollutants enter the fuel tank; remember that it is prohibited to smoke or use naked flames when refuelling. Failure to comply with these prescriptions can result in the risk of serious injury and serious damages to the vehicle



Risk of burns

Never loosen the high pressure fuel circuit connectors. Failure to comply with these prescriptions can result in the risk of serious injury and serious damages to the vehicle

ATS system

This system is used to limit the nitrogen oxide (NOx) emissions in the exhaust within the limits required by standards, transforming the nitrogen oxide into inert compounds: free nitrogen (N₂) and water vapour (H₂O). Periodically clean the filters observing the intervals indicated in **3-23**

Intake and exhaust circuit inefficiencies

Regularly inspect the cleanliness of the air intake circuit. The maintenance intervals indicated in this manual change with the conditions of use.

In particularly dusty environments, it is necessary to carry out maintenance at more frequent intervals than indicated in the chapter **3-23**.



Risk of burns

Visually check that the exhaust circuit is not clogged or damaged, to prevent hazardous or toxic emissions inside the pipes. Failure to comply with these prescriptions can result in the risk of serious injury and serious damages to the vehicle

Electrical start-up system irregularities

Periodically check, and especially in winter, to ensure that the batteries are clean and in full working order, checking and topping up as indicated on the page **3-23**.

If replacing the battery, ensure full observance of the specifications indicated in **1-7**.



General prescriptions

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).

Failure to comply completely or partially with these requirements may result in the risk of serious damage to the engine and may even, on occasion, invalidate the warranty



Risk of damage

The batteries contain sulphuric acid which is highly caustic and corrosive. Always wear gloves and protective glasses while topping up. If possible, ensure that the check is carried out by specialised personnel.

Failure to comply with these prescriptions can result in the risk of serious injury and serious damages to the vehicle

Battery or alternator charging fault

Periodically check the cleanliness, condition and correct tensioning of the drive belt.



Risk of injury:

The cranking elements are located below the protective bonnet. They must only be removed when the engine is not turning over.

Failure to comply with these prescriptions can result in the risk of serious injury

Running in

Thanks to modern engine construction technologies a particular run-in procedure is not required.

3 - INSPECTION AND MAINTENANCE

Refuelling

Parts to be refilled		N67 ENT Z W
Coolant circuit (1)		11 L
(4) engine G-Drive		- -
Lubrication circuit (2)	Total capacity	18 L (16,2 kg)
	Periodical replacement: oil sump at min level oil sump at max level	9 L (8,1 kg) 15 L (13,5 kg)
Fuel tank (4)		—
Urea total capacity		43/65/80 L

(1) The quantities refer to the engine in the standard configuration. Use an ORGANIC ACID TECHNOLOGY (Ethylene glycol/Propylene glycol) based coolant which complies with ASTM D-6210 standard. Concentrated coolants must be used as a **50%** solution in water.

(2) For the oil specifications, refer to the table of the oils (3-22).

(3) The quantities indicated relate to the first refill only and are relative to the engine, oil sump and filter filling.

(4) Fuel tank not supplied by FPT. Refer to the data provided by the genset supplier/manufacturer. Use STANDARD fuel which meets the requirements of standard ASTM D975 (maximum permitted sulphur content: < **15 ppm**) or EN 590 (maximum permitted sulphur content: < **10 ppm**). Instructions connected to the fuel tank capacity are the responsibility of the vehicle/equipment manufacturer since these are subject to changes depending on the various vehicle configurations.

(5) Use only AdBlue®/DEF (**32,5%** solution in water) in compliance with ISO 22241 specification.

ATTENTION: It is prohibited to mix fluids of different brands and origins inside the circuit.

Coolant refilling

To start the engine and if the coolant circuit needs to be filled with a significant amount of coolant, proceed as indicated below:

- Refill the engine and the exchanger until the exchanger is completely filled.
- With the coolant filler cap open, start the engine and let it idle for approx. **1 min**. This helps to completely blowing off the air contained in the cooling circuit.
- Stop the engine and top up with the required amount.



General prescriptions

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

Failure to comply completely or partially with these requirements may result in the risk of serious damage to the engine and may even, on occasion, invalidate the warranty



Risk of burns

When the engine is hot, pressure builds up in the cooling circuits which may eject hot liquid violently, resulting in a risk of burns.

Failure to comply with these prescriptions can result in the risk of serious injury and serious damages to the vehicle

**Risk of burns**

Open the filler cap of the coolant tank only if necessary and only when the engine is cold.

Failure to comply with these prescriptions can result in the risk of serious injury and serious damages to the vehicle

Refuelling

Use STANDARD fuel which meets the requirements of standard ASTM D975 (maximum permitted sulphur content: < **15 ppm**) or EN 590 (maximum permitted sulphur content: < **10 ppm**). Instructions connected to the fuel tank capacity are the responsibility of the vehicle/equipment manufacturer since these are subject to changes depending on the various vehicle configurations.

The use of additives can limit the warranty services offered for the equipment.

**Risk of burns**

Pay maximum attention when refuelling, making sure that solid or liquid pollutants do not enter the tank; please remember that smoking is prohibited while refuelling.

Failure to comply with these prescriptions can result in the risk of serious injury and serious damages to the vehicle

Winter diesel

The degree of fluidity of the diesel fuel may be reduced at low temperatures due to the separation of the paraffin. This results in the filters becoming clogged.

The specifications EN590 make distinctions between different classes of diesel fuel, identifying the characteristics of those which are most suitable for operating at cold 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.

Main characteristics of oil



Oil Specifications (*)	International specifications
359	10W-40 API CJ-4 / API CK-4 ACEA E9 (FPI9.LUBR001-TLS CK4) (STD.) 10W-40 API CK-4 /ACEA E9 (FPI9.LUBR001-TLS CK4) (STD.) 0W-40 API CK-4 (FPI9.LUBR001-TLS CC) (COLD CLIM. PREM.)

(*) For the oil specifications, please refer to <https://www.fptindustrial.com/global/en/service/fluids/oils-and-coolants>



Maintenance personnel

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

Checks: by workshop technicians or the engine user if necessary.	
Regular maintenance: By qualified personnel using suitable equipment and adequate protection tools.	
Non-routine maintenance: By qualified personnel from authorised service centres that have detailed technical information and specific equipment.	

The most qualified service centres are those that are part of FPT's technical service network.

Accident prevention

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



Risk of injury:

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.

Failure to comply with these prescriptions can result in the risk of serious injury



Risk of injury:

The conditions which cause the emergency generator assembly to start may occur unexpectedly. Always pay careful attention to the safety precautions indicated by the Manufacturer of the assembly and the generator Bodybuilder to ensure the maximum safety of the maintenance technicians. Failure to comply with these prescriptions can result in the risk of serious injury

Frequencies

Controls (when in use)	Frequency (**)
Engine lubricant oil level check	daily
Engine coolant level check	daily
Visual inspection of engine	50 h / 15 days
Check of air filter and cleanliness of housing (*)	1 month
Check tension and condition of ancillary belt	300 h / 6 months
Exhaust duct(s) condition check	6 months

Periodic maintenance	Frequency (**)
Drainage of water from the fuel pre-filter (if present)	150 h / 6 months
Drainage/suction of water, condensation and impurities from the fuel tank/s (*)	150 h / 6 months
Change engine lubricant oil (1)	600 h / 1 year
Lubricant oil filter replacement	600 h / 1 year
Fuel pre-filter replacement (if fitted)	600 h / 1 year
Fuel filter replacement	600 h / 1 year
Replace the air filter (*)	Defined by the Manufacturer of the Generator
Auxiliary members' belt replacement	1200 h / 3 years
Replacing the blow-by filter	1500 h / 2 years

Extraordinary maintenance	Frequency (**)
Visual inspection of turbocharger	1200 h / 2 years
Clean heat exchanger (radiator) (*)	1200 h / 2 years
Adjustment of valve/rocker arm clearance (***)	2400 h
Change engine coolant	3000 h / 2 years

(*) Components not supplied by FPT.

(**) Respect the hour or time period interval, whichever is reached first.

(1) For the oil specifications, refer to the table of the oils (3-22).



General prescriptions

The operations indicated above require the use of specific equipment which will guarantee that the result is safe, effective and of a good quality. It is recommended that these operations are carried out by qualified personnel belonging to the FPT Service Network.

Failure to comply completely or partially with these requirements may result in the risk of serious damage to the engine and may even, on occasion, invalidate the warranty



General prescriptions

Extraordinary maintenance operations are the only to be carried out by qualified personnel with the appropriate technical knowledge and equipped with suitable working and protection means. All the technical instructions are provided in the FPT repair and technical manuals.

Failure to comply completely or partially with these requirements may result in the risk of serious damage to the engine and may even, on occasion, invalidate the warranty

Planned maintenance for the ATS system	Action
Tank pre-filter (300 µm or 100 µm (1))	No maintenance planned (clean if necessary)
Supply module pre-filter (100 µm or 70 µm (1))	Clean with water at each oil change interval (2)
AdBlue inlet filter to supply module (100 µm)	No maintenance planned (clean if necessary)
Filter supply module	Replace every 1200 h (3)
AdBlue return filter from supply module to tank 100 µm	No maintenance planned (clean if necessary)
Dosing module filter 36 µm	Not serviceable

(1) For applications operating in dusty environments.

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

(3) To be performed every two years even if the specified operating hours interval has not been reached.

Requirements

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



Risk of damage

Do not perform any operation that would change the calibration of the injection pump.

It was adjusted during the engine test phase and based on its application.

Failure to comply completely or partially with these requirements may result in the risk of serious damage to the engine and may even, on occasion, invalidate the warranty

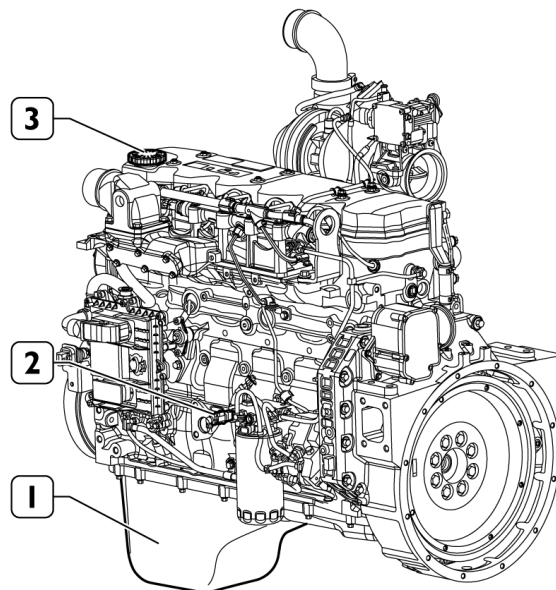
Check the engine lubricant oil level Level of engine lubricant oil

Check the engine lubricant oil level

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

Using the dipstick **(2)**, check that the oil level is between the " Min" and " Max" levels.

- If the level is insufficient, it needs to be topped up with lubricating oil as specified in **3-20**: remove the lubricant oil filler cap **(3)** and introduce the engine lubricating oil via the filler hole.
- Use the oil level dipstick to check that the lubricant oil level does not exceed the " Max" limit on the dipstick.



General prescriptions

After refilling, make sure that the oil level does not exceed the "Max" limit indicated on the dipstick. Make sure that the oil dipstick is inserted correctly and that the oil refill filler neck plug has been tightened fully in a clockwise direction.

Failure to comply completely or partially with these requirements may result in the risk of serious damage to the engine and may even, on occasion, invalidate the warranty



Check coolant level

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

- Remove the pressurization cap from the expansion tank.
- Check that the coolant in the expansion tank is above the minimum level.
- Fill the engine and heat exchanger until the cooling circuit is completely full, as specified in the **3-20**. Do not fill the expansion tank to the brim.
- When the engine is cold, make sure that the coolant is a few centimetres below the filling hole.

If there is a level indicator with is outside of the heat exchangers, top up ensuring that the coolant does not overflow the internal volume of the exchanger. This is to allow the expansion of coolant volume if there is a temperature increase.



General prescriptions

If frequent top-ups are necessary, the cooling circuit must be diagnosed.

Failure to comply completely or partially with these requirements may result in the risk of serious damage to the engine and may even, on occasion, invalidate the warranty



Risk of burns

When the engine is hot, pressure builds up in the cooling circuits which may eject hot liquid violently, resulting in a risk of burns.

Failure to comply with these prescriptions can result in the risk of serious injury and serious damages to the vehicle

Check of air filter and cleanliness of housing (component not supplied by FPT)

Only proceed when the engine is not turning over.

Visual inspection of the engine

Before starting, it is recommended to carry out a series of simple checks that can significantly help avoid problems, also of a serious nature, while the engine is operating. These checks are generally only assigned to genset operators.

- Check the levels and check for any leaks from the fuel, cooling and lubrication circuits.
- Informing maintenance personnel if any problems are found; top up if necessary.

After starting the engine and with the engine operating, perform the following checks and controls:

- Check for any leaks from the fuel, cooling and lubrication circuits.
- Make sure there is no unusual noise or beating during operation.
- Use the genset instruments to check the required pressure, temperature values, etc.
- Visually checking the smoke (colour of the exhaust gas).
- Visually check the coolant level in the expansion tank.

- Remove the air filter cover after having released the lock hooks.
- Remove the filter element; make sure that dust does not enter the sleeve during this operation.
- Make sure there are no impurities. Otherwise, clean the filter element according to the instructions provided below.
- Blow dehumidified compressed air onto the filter element, from the inside outwards (maximum pressure **200 kPa**).
- Check the condition of the air filter before refitting it. Replace it if broken or torn.
- Check the condition of the gasket at its base.
- Correctly position the filter element in its seat.
- Restore the air filter cover and secure using the hooks.

Risk of damage

Do not use detergents or diesel to clean the air filter. Never strike the filter element with tools.



Make sure that the parts are fitted correctly. Incorrect assembly could cause the engine to take in unfiltered air, causing serious damage to the engine.

Failure to comply completely or partially with these requirements may result in the risk of serious damage to the engine and may even, on occasion, invalidate the warranty

Check tension and condition of ancillary belt

Belt tensioning is carried out by means of the automatic tensioner and therefore does not require any intervention other than verification of the state of wear of the belt.

Carefully check that the surface of the belt shows no sign of cuts, rubbing, excessive wear on the teeth or pulling on the sides and on the surface.



Risk of injury:

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

Failure to comply with these prescriptions can result in the risk of serious injury and serious damages to the vehicle

Check the condition of the exhaust duct(s)

Visually check that the exhaust system for exhaust gases is not obstructed, corroded or damaged.

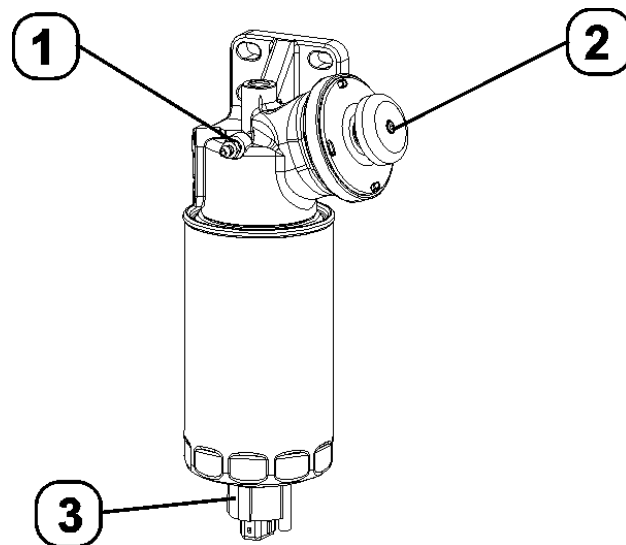
Make sure that there is no risk of harmful fumes in the environment where the engine is being worked on.

Contact the manufacturer if necessary.

Water drainage from the fuel pre-filter (component not supplied by FPT)

The high risk of refuelling with fuel that is polluted by foreign bodies or water makes it advisable to carry out these control every time you refuel. Proceed with the engine stopped.

1. Place a container below the filter or pre-filter to collect the fluid.
2. Unscrew the valve plug **(3)** located at the bottom of the filter; in some lay-outs the plug includes a sensor to detect the presence of water in the diesel.
3. Drain off liquid until only "diesel" can be seen.
4. Close the plug again, tightening it fully by hand.
5. Dispose of the drained fluids according to current requirements.



General prescriptions

The components of the common rail system will be quickly damaged if the fuel contains water or other impurities. Immediately carry out the operation on the pre-filter to drain the water in the supply circuit.

Failure to comply completely or partially with these requirements may result in the risk of serious damage to the engine and may even, on occasion, invalidate the warranty



Drainage or suction of impurities from fuel tank

Perform the drainage/suction of water, condensation and impurities from the fuel tank/s by following the instructions contained in the manual supplied by the tank manufacturer.

Proceed as necessary based on the structure or location of the tank: engines that operate in adverse environments and conditions and/or that are refuelled using drums or jerry cans, require more attention when cleaning the tank.

Change engine lubricant oil

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

Arrange a container to collect the spent oil beneath the oil sump **(1)** next to the lubricant oil drain plug.

Unscrew the lubricant oil drain plug; then extract the oil level dipstick **(2)** and remove the lubricant oil plug **(3)** to facilitate the flow of the engine lubricant oil.

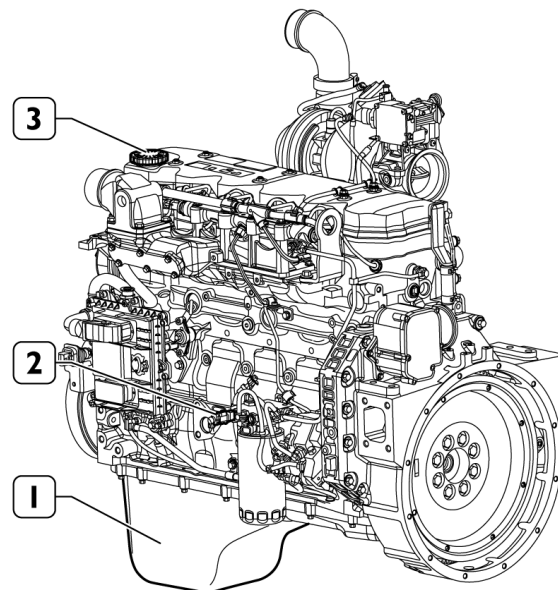
Wait until the oil sump **(1)** has completely emptied, then screw the lubricant oil drain plug back on.

Refill through the filler hole on the tappet cover of cylinder no. 1, using lubricant oil which meets the specifications as indicated in **3-20**.

Use the dipstick to check that the level of lubricant oil does not exceed the "Max" limit.

Tighten the lubricant oil plug **(3)**.

The oil filter must be changed when the engine lubricant oil is changed, following the indications provided in **3-33**.



Risk of damage

Make sure that the oil dipstick is fully inserted and that the oil filler cap is fully tightened in a clockwise direction.

Failure to comply completely or partially with these requirements may result in the risk of serious damage to the engine and may even, on occasion, invalidate the warranty



Risk of injury:

Dispose of consumable materials and the parts in contact with them (for example filters) in accordance with the law. The workshops of the Service Network are equipped for this purpose.

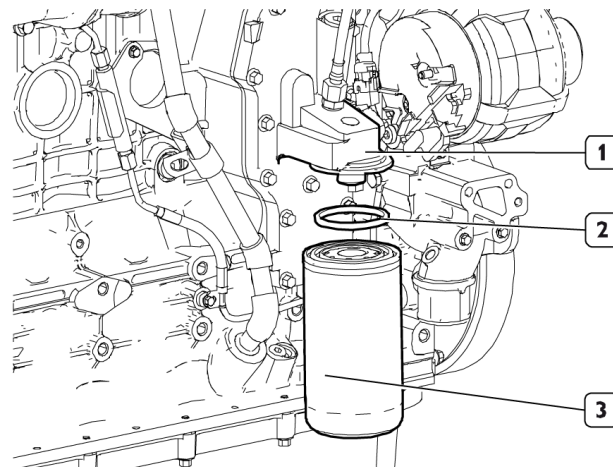
Correct behavior will ensure that vehicle is used as environmentally friendly as possible

Oil filter change

The filter must also be replaced when the lubricant oil is changed.

Only use filters with a filtration level equivalent to the ones you are replacing.

- Position a container to collect the used oil below the filter mount **(1)**.
- Unscrew and remove the filter **(3)** from the relative support **(1)** using a suitable tool.
- Replace the filter element and the seal contained **(2)** inside the filter **(3)**.
- Carefully clean the surfaces of the support **(1)** in contact with the seal **(2)**.
- Manually tighten the new filter **(3)** on the support **(1)** until it comes into contact with the gasket **(2)**. Tighten it further, using a specific tool, to a torque of **20 +/- 2 N·m**.
- Operate the engine for a few minutes and then check the level using the dipstick. If necessary, top up to compensate for the quantity of oil used to fill up the filtering cartridge.



Risk of injury:

Given the high operating temperature of the engine, it is recommended that suitable protection is worn. The engine oil reaches extremely high temperatures: always wear protective gloves. Failure to comply with these prescriptions can result in the risk of serious injury



Risk of skin irritation or allergic reactions
The engine oil is highly pollutant and harmful.
In case of contact with skin, wash thoroughly with water and detergent.
Suitably protect skin and eyes; take measures as set forth by safety regulations.
Failure to comply with these prescriptions can result in the risk of serious injury



General prescriptions
For correct engine operation, only use recommended oils or oils with the required characteristics. In the case of refilling, do not mix oils with different characteristics. Failure to observe these indications will void the guarantee.
Failure to comply completely or partially with these requirements may result in the risk of serious damage to the engine and may even, on occasion, invalidate the warranty



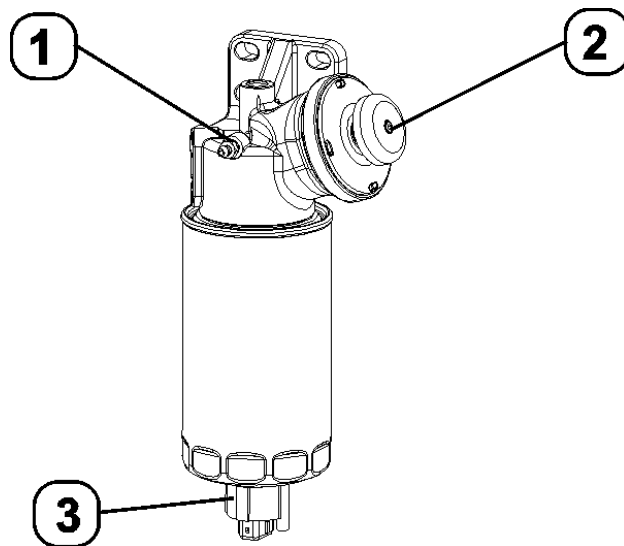
General prescriptions
Dispose of consumable materials and the parts in contact with them (for example filters) in accordance with the law. The workshops of the FPT Service Network are equipped for this purpose.
Correct behavior will ensure that vehicle is used as environmentally friendly as possible

Replace the fuel pre-filter

Only proceed with the engine off.

- If the filter is equipped with a water detection sensor (3), remove the sensor from its housing.
- Remove the pre-filter by loosening it.
- Check that new filter guarantees performance levels that meet the engine requirements (e.g. comparing them with previous ones).
- Moisten the seal ring for the new filter with diesel or engine oil.
- Hand-tighten the new filter in position, so that the sealing gasket is in contact with the support, then tighten by a further 3/4 of a turn.
- Position the water detection sensor, paying attention to the wires to ensure they are correctly connected.
- Loosen the breather screw (1) on the pre-filter support and activate the hand pump (2) until the fuel circuit is full. Ensure that there are no fuel spillages that could harm the environment.
- Fully tighten the breather screw.
- Start the engine and let it run idle for several minutes to eliminate any residual air.

NOTE: component not provided by FPT. The image may not show the actual component used.



General prescriptions

If the residual air bleed phase needs to be accelerated, use a hand pump also during start-up.

Failure to comply completely or partially with these requirements may result in the risk of serious damage to the engine and may even, on occasion, invalidate the warranty



Replace fuel filter

Only continue with the engine off and at a low temperature, to avoid the risk of burns.

- Arrange a container to collect the fuel below the filter bracket **(1)**.
- Remove the filter **(3)** by loosening it from its relative support.
- Replace the filter element and the O-ring sealing gasket **(2)** inside the filter **(3)**.
- Carefully clean the surfaces of the support **(1)** in contact with the seal **(2)**.
- Smear the O-ring **(2)** for the new filter with oil.
- Screw the new filter **(3)** onto the support **(1)**.

Risk of injury:

During this operation, do not smoke or use naked flames.

Do not breathe in vapours from the filter. Pay close attention to the electric fuel reheater (if fitted) and the relative electrical connections.

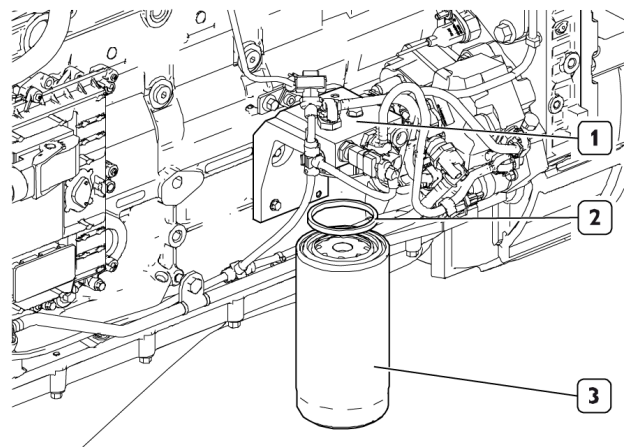
Failure to comply with these prescriptions can result in the risk of serious injury



Risk of electrocution

Pay attention to the electric fuel pre-heater (if installed) and the relative electric connections.

Failure to comply with these prescriptions can result in the risk of serious injury and serious damages to the vehicle





General prescriptions

Do not fill the new fuel filter until it has been positioned on the support, to prevent any damaging impurities from entering the fuel circuit and injection system.

Failure to comply completely or partially with these requirements may result in the risk of serious damage to the engine and may even, on occasion, invalidate the warranty



General prescriptions

Dispose of consumable materials and the parts in contact with them (for example filters) in accordance with the law. The workshops of the FPT Service Network are equipped for this purpose. Correct behavior will ensure that vehicle is used as environmentally friendly as possible

Change the ancillary belt

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

Act on the automatic belt tensioner **(8)** with the appropriate tool **(6)** and remove the belt **(2)** from alternator **(7)**, water pump **(5)**, fan drive pulley **(1)**, crankshaft pulley with damper **(4)** and fixed guide roller **(3)**.

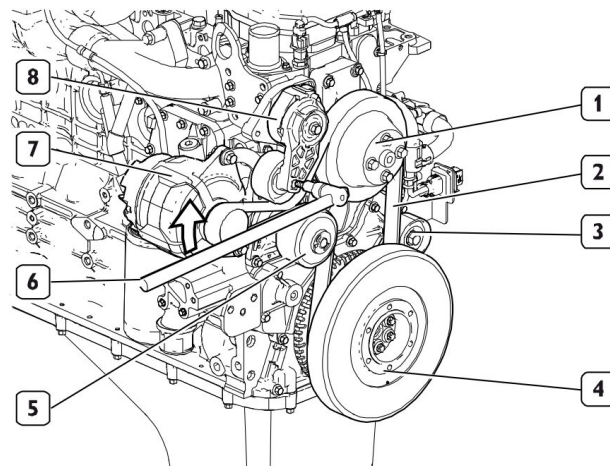
Replace the worn belt **(2)** with a new one.

Fit the Poly V belt **(2)** on the pulleys and guide roller.

Use the designated tool **(6)** on the automatic belt tensioner **(8)** to fit the new belt **(2)** in the correct operating position

Additional adjustments are not required. The belt tension **(2)** is adjusted automatically by the calibrated spring in the automatic belt tensioner **(8)**.

Run the engine for a few hours and check that the belt **(2)** is positioned correctly.



General prescriptions

Replace the belt if there are any signs of abrasions, cracks, lacerations, oil or fuel stains.

Failure to comply completely or partially with these requirements may result in the risk of serious damage to the engine and may even, on occasion, invalidate the warranty



Risk of injury:

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

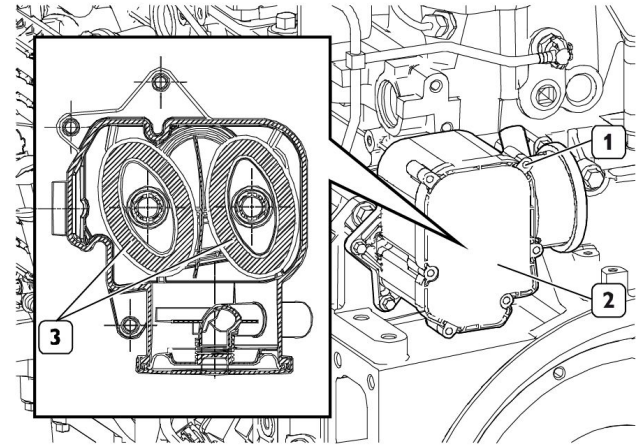
Failure to comply with these prescriptions can result in the risk of serious injury and serious damages to the vehicle

Replacing the blow-by filter

The filter in question serves to collect, filter and condense lubrication oil vapours.

The filter body (2) contains two filter cartridges (3).

To check the filter elements, remove the cover (1) and remove the cartridges (3).

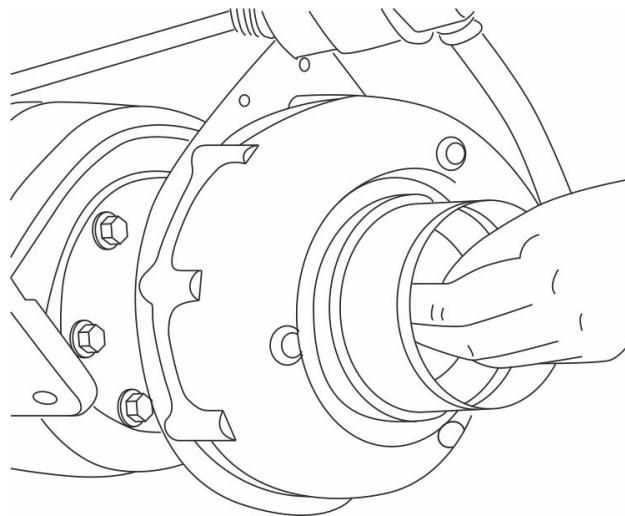


Visually inspect turbocharger

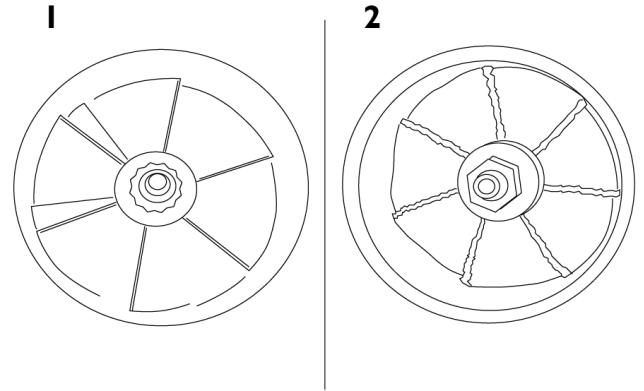
Visual inspection of turbocharger

Only proceed when the engine is off.

Apply a manual torque to the shaft to check that it turns smoothly and for any sticking effect.
Check for any wear in the supercharger's internal housing.

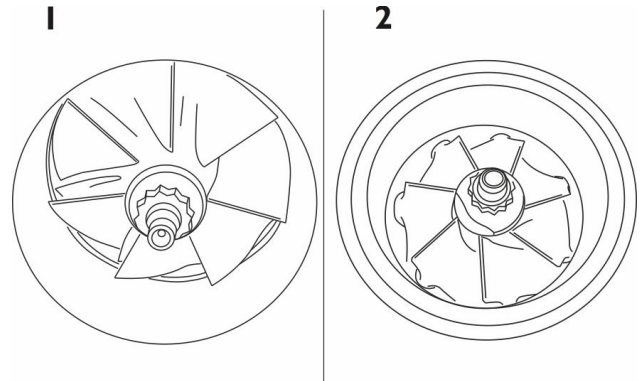


1. There are no signs of wear on the internal diameter of the supercharger
2. There are signs of contact between the impeller and the internal diameter of the supercharger



Visually check the integrity of the supercharger blades and turbine.

1. There are no signs of wear on the internal diameter of the supercharger
2. There are signs of contact between the impeller and the internal diameter of the supercharger



Clean the heat exchanger (radiator)

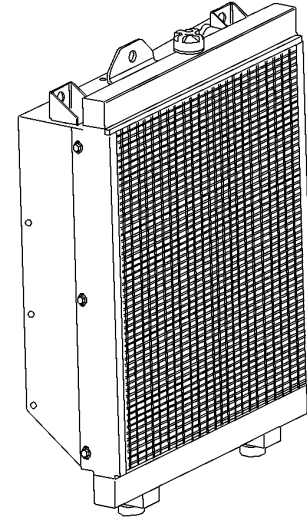
The surfaces of the heat exchanger (radiator) come into contact with external air and may be subjected to deposits and impurities (dust, mud, straw, etc.). Clean them if necessary using compressed air or steam.



Risk of injury:

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

Failure to comply with these prescriptions can result in the risk of serious injury

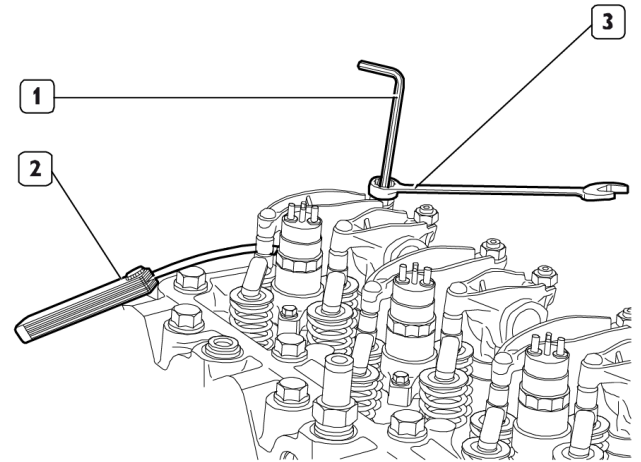


Valves/rocker arms clearance adjustment

The clearance between the beams and the intake and exhaust valve control rods must be carefully adjusted using a hex key (1), a box wrench (3) and a feeler gauge (2).

The values to be checked are detailed below:

- Intake valve: **0,25 +/- 0,05 mm**
- Exhaust valve: **0,50 +/- 0,05 mm**



Change engine coolant

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

- Place a container for collecting coolant under the heat exchanger (radiator).
- Remove the pressurization cap from the expansion tank.
- Loosen the retaining elements and remove the sleeves connecting the engine cooling circuit to the heat exchanger.
- Drain the coolant from the heat exchanger (radiator) and wait until it is completely empty.
- After draining it, reconnect the cooling circuit making sure that the sleeves are perfectly sealed.
- Fill the engine and heat exchanger until the cooling circuit is completely full, as specified in **3-20**.
Do not fill the expansion tank to the brim.
- With the coolant filler cap open, start the engine and let it idle for approx. one minute. This helps to completely blowing off the air contained in the cooling circuit.
- Stop the engine and top up with more coolant, if necessary.
- When the engine is cold, make sure that the coolant in the expansion tank is a few centimetres below the filling hole.

If the level indicator is located outside the heat exchangers, top up the coolant if necessary, but make sure that the coolant does not completely fill the internal volume of the exchanger as you need to allow the coolant volume to expand following the increase in temperature.



General prescriptions

The failure to observe the aforesaid procedure does not guarantee the presence of the correct quantity of coolant in the engine. Failure to comply completely or partially with these requirements may result in the risk of serious damage to the engine and may even, on occasion, invalidate the warranty



Risk of injury:

When the engine is hot, the pressure inside the cooling circuit can be such that it may expel the hot liquid in an extremely violent manner with the risk of burns. Only open the refill plug of the coolant tank when the engine is cold. Failure to comply with these prescriptions can result in the risk of serious injury

Moving the engine

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

When lifting the engine only, use the U-bolts indicated in this manual in the section ENGINE TECHNICAL DATA on page 1-7 and marked on the engine with special stickers.

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

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

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

Disposal of waste

The engine is composed of parts and elements that, if discarded, could cause environmental damage.

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

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

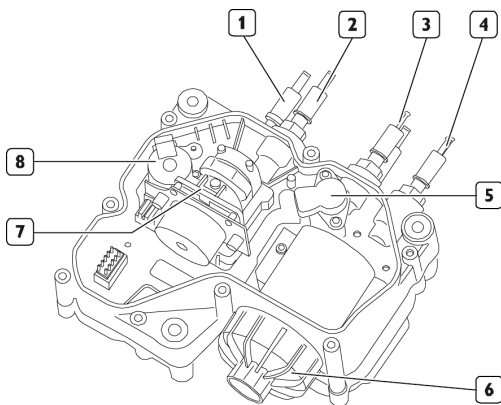
The laws in force in the various countries provide for severe penalties for lawbreakers.

Schedule maintenance for the ATS system - how to proceed

Change Supply Module main-filter

To prevent damage to the pump and dosing module, the supply module contains a filter which removes any impurities from the AdBlue.

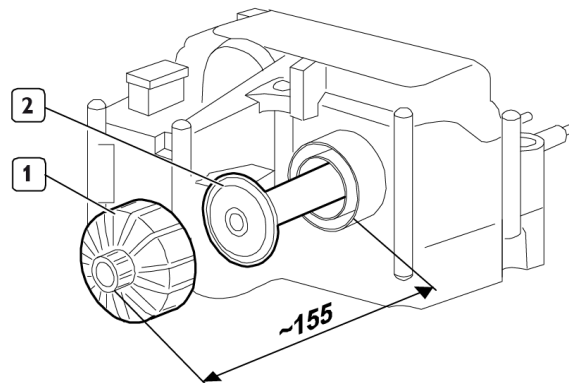
Please refer to the following procedure for replacement of the filter.



1. Coolant connector
2. AdBlue inlet from tank
3. AdBlue back-flow to tank
4. AdBlue outlet to Dosing Module
5. Pressure sensor
6. Supply Module main-filter
7. Membrane pump
8. 4/2 Way valve.

Filter disassembly

- Unscrew and remove the filter cover (1).
- Remove the equalizing element (2).



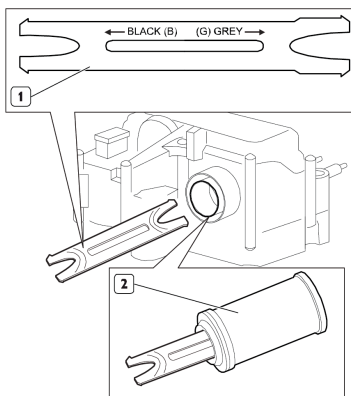
General prescriptions

When installing the Supply Module on the vehicle, take into account the minimum opening necessary for replacing the filter. The minimum value is approximately 155 mm.

Failure to comply completely or partially with these requirements may result in the risk of serious damage to the engine and may even, on occasion, invalidate the warranty

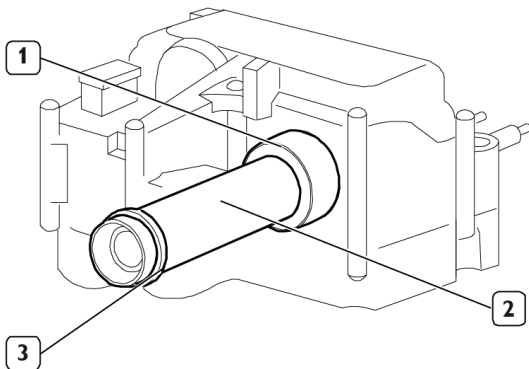


- Insert the appropriate tool (1) in the correct direction in the filter, based on the colour of the filter supplied.
- Insert the appropriate tool (1) until a click is felt which indicates the complete engagement of the filter (2).
- Remove the filter (2).

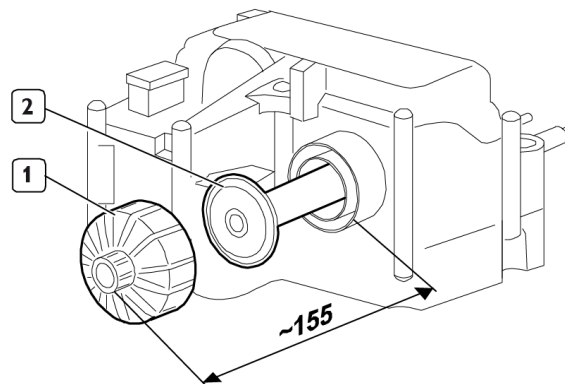


Filter assembly

- Carefully clean with water the contact surface **(1)**.
- Oil gasket **(3)** and assembly the new filter **(2)**.



- Assembly a new equalizing element **(2)**.
- Carefully clean the filter cover **(1)**.
- Tighten the filter cover **(1)** to a torque of **20 +/- 5 N·m**.



General prescriptions



Check that the filter cover and the contact surface of the Supply Module do not have any lacerations or show any sign of damage. If necessary, replace any damaged parts. Failure to comply completely or partially with these requirements may result in the risk of serious damage to the engine and may even, on occasion, invalidate the warranty

4 - LONG PERIOD OF INACTIVITY

Preparing the engine for a long period of inactivity

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

1. Drain the lubricant oil from the sump after heating the engine.
2. Fill the engine with protective oil (compliant with standard MIL-L-2160B type 2 / ISO 3498/6743-4 HM) until it reaches the "minimum" level 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 channels.
4. Connect the fuel circuit to a tank containing CFB (ISO 4113) protective liquid and introduce the liquid by pressurising the circuit and letting the engine run for approx. 2 minutes after excluding injection system operation. The required operation may be completed by directly polarising terminal 50 of the electric starter motor with positive voltage equal to that of the nominal system voltage, using the specifically provided conductor.
5. Spray around **67 g** of protective oil (**10 g** per litre of displacement) on the turbocharger inlet manifold, when carrying out pressurised refilling operations as 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 protective oil from the sump. This oil can be used again for a further 2 preparation operations.
8. Place warning notices of ENGINE WITHOUT OIL on the engine and dashboard.
9. Drain the coolant if it has not been mixed with a sufficient amount of anti-freeze and anti-corrosion additive and affix a sign indicating that the operation is in progress.

In the event of prolonged inactivity, the operations described must be repeated every 6 months, following the procedure given below:

- A. drain the protective oil from the sump;
- B. repeat the operations described from point 2 to point 7.

To protect the external parts of the engine, spray the (Anticorit) protective liquid on the unpainted metal parts such as the flywheel, pulleys, etc., and do not spray it on belts, connector cables and electrical equipment. Protect the connectors and electric connections using VCI spray. Wrap the engine in a VCI bag with hygroscopic salt filled bags.

Engine start-up after a long period of inactivity

1. Drain the residual protective oil from the sump.
2. Fill the engine with the type and quantity of lubricant oil as specified in the table **3-20**.
3. Drain the CFB protective fluid from the fuel circuit, operating as indicated at point 3 of **4-50**.
4. Remove the plugs and/or seals from the engine's intake, discharge, ventilation and bleeder holes, restoring normal conditions of use. Connect the turbocharger intake inlet to the air filter.
5. Connect the fuel circuits to the fuel tank of the machine completing the operation as indicated at point 4 of **4-50**. During the filling operations, connect the tank fuel return pipe to a collection container to prevent the residual CFB protective liquid from flowing into the tank.

6. Check the engine and top up with coolant as recommended; bleed if necessary.
7. Start the engine and let it idle until completely stabilised.
8. Check that the indications on the dashboard are plausible and that there are no alarm signals.
9. Stop the engine.
10. Remove the warning notices of ENGINE WITHOUT OIL from the engine and dashboard.

5 - ENGINE MALFUNCTIONS

Engine fault

The electronic control unit that manages and controls all operations of the engine can recognise any malfunction and implement specific strategies in order to operate in full safety conditions.

The event, signalled by activation of the EDC MALFUNCTION indicator light on the on-board control panels, causes the scheduled limitation of

the supply, within certain limits, set according to the seriousness of the specific case.

In the case of temporarily malfunctions, the performance reduction will remain active until the engine is turned off.

6 - BEHAVIOUR IN EMERGENCY

Behaviour in emergency conditions

By following the instructions supplied in this manual and the indications shown on the engine labels, the user of a machine manufactured according to safety rules will be able to work in safe conditions.

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

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

What to do in the event of a fire

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

Scalding and burns

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

Carbon monoxide (CO) poisoning

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

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

If aiding a poison victim in a closed room:

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

Electrocution

The **12 V** or **24 V** electrical system of the engine 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 burns due to the overheating of the object through which the electric current flows. In that case:

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

Injuries and fractures

The high number of possible circumstances and the specific nature of the operations needed requires the intervention of a medical team.

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

Burns from caustic substances

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

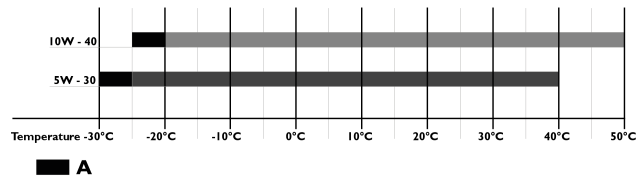
For personnel performing maintenance on electrical devices, this is typically caused by acid escaping from the batteries; in this circumstance proceed as follows:

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

If either battery acid, lubricants or diesel come into contact with the eyes: wash your eyes with water for at least **20 min**, keeping the eyelids open so that the water flows over the eyeball (move the eye in all directions to wash more thoroughly).

SAE classification of oils in relation to the ambient temperatures of use of the engine/vehicle

The viscosity index to be used depends on the ambient temperature, as shown in the figure below:



- A. Installation of engine coolant heating system with heater on the crankcase is recommended

NOTE: Cold start capabilities are strongly correlated with the quality of the diesel.

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