NEF 280
(N67 MNT M28)
USE AND MAINTENANCE

ENGLISH

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FOREWORD

We thank you for having selected IVECO MOTORS and extend our compliments for the engine selected.
Before putting in place any operation involving the engine or its fittings and equipment, please read carefully the instructions set forth in this Manual; the related observance thereof ensures to you their perfect operation and enhanced duration over time.

The content of this Manual refers exclusively to the engine, in its standard configuration, and the illustrations are purely indicative. Some instructions are given describing the sequence of operations that enable the engine and/or its fittings and equipment to deliver expected performance. In certain cases, these depend upon the configuration of the controls and equipping of the craft in which the engine is installed; as and when differing from this Manual's content, reference should be made to the instructions issued by the Building Yard or contained in a specific manual.
As set forth herein below, the information is correct at the date of publication.
Constructor reserves the right to implement modifications without prior notice and at any time whatever, for technical or commercial cause or reason and, not least, to adapt the engines to ensure compliance with the legal requirements enacted in the differing nations.
All and any liability is declined for errors and omissions, if any.

Please remember that the IVECO MOTORS Technical Support Network is there wherever you are with its professional skills and expertise.

■ GENERAL INFORMATION

WARRANTY

To ensure the best engine efficiency and to exercise the IVECO MOTORS warranty, it is necessary to strictly follow the indications set forth in the herein Manual. The guarantee may lapse in the event of non-performance or incorrect performance of the above mentioned indications.

SPARE PARTS

Utilisation of IVECO MOTORS Original Spare Parts is an essential condition for maintaining he engine's original integrity.
Use of non-original spare parts will make the warranty lapse and will also exempt IVECO MOTORS form any responsibility on the engine's life.

RESPONSIBILITY

The responsibility of the Manufacturer is subject to the execution of check-up and maintenance operations described in the herein Manual: the relevant execution shall be duly evidenced.
Any extraordinary maintenance operation which may be necessary shall be executed by qualified engineers operating at authorized Technical Support Centres IVECO MOTORS Network.

SAFETY

The purpose of the following information is to draw your attention on the use of the engine in order to prevent injury or damages to people and things which may derive from incorrect behaviour or misconduct.

- ❑ The engines must be used exclusively for the applications specified by the Manufacturer.
- ❑ Any manumission, change and/or use of non-original spare parts may compromise the engine's working efficiency and safe navigation insofar; **it is strictly prohibited to provide** any change to the electric networks and to the wiring harness of the engine units.
- ❑ The engine has some parts in motion, other heated to high temperature and other parts containing pressurized fluids; its electrical equipment includes voltages and electric currents.
- ❑ Exhaust gas emissions from the engine are harmful.
- ❑ Engine handling must be executed by means of suitable hoisting equipment, using the specially provided ringbolts on the engine.
- ❑ The engine must not be started and used before safety requirements prescribed for the craft on which it is installed are fully complied with; moreover, craft compliance with the laws and local legislation must be ensured as well.
- ❑ All operations required ensuring the best conditions of use and preservation of the engine must be executed only by qualified and experienced engineers, provided with IVECO MOTORS certified tools.

Further recommendations concerning safety are reported in the "CHECKING AND MAINTENANCE" chapter following.

ENGINE DATA

The technical acronym and the matrix number are reported on a plate applied, depending on the model, on different parts of the engine: fly-wheel cover carter, tappet cover, cooling liquid reservoir.

Acronym	N67 MNT M28
Engine family	NEF
Cycle	4-stroke Diesel
Number of cylinders available	6, on line
Stroke boring	104 x 132 mm
Total Swept Volume	6.700 cm^3
Air feed	Boost fed and post-cooled (TCA or TAA)
Ignition mode	Direct with mechanical pump
Engine rotation direction (from fly-wheel side view)	Anti-clock-wise
Dry Weight	595 kg

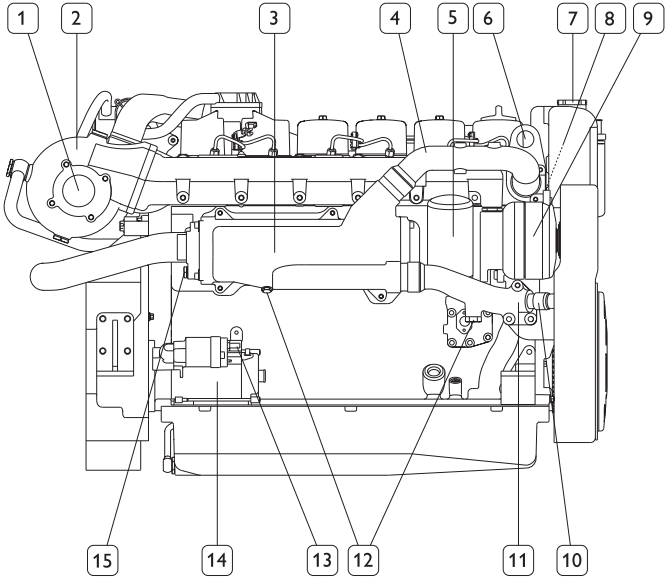
Electrical Equipment	12 V Rated voltage (24 V on request)
Accumulator/s	
- capacity	120 Ah or more
- discharging current	900 A or more

Calibration available (*)		
A1	206 kW (280 CV)	@ 2800 rev/min
B	191 kW (260 CV)	@ 2800 rev/min
C	147 kW (200 CV)	@ 2800 rev/min
D	132 kW (180 CV)	@ 2500 rev/min

(*) Net Power to the fly-wheel in compliance with ISO 3046-1 Standard. Test conditions: 25 °C temperature, atmosphere p. 100 kPa; 30% relative humidity.

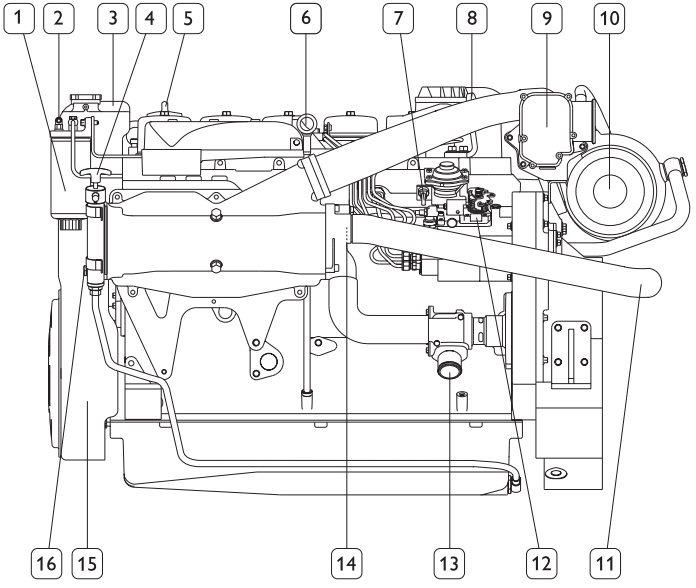
WARNING

It is strictly prohibited, warranty lapses as well as IVECO Motors Responsibility, to alter the above specified characteristics and, in particular, to change the ignition system adjustment or the features of the electric system.



N67 MNT M28 NEF ENGINE: right side view

1. Exhaust gas discharge - 2. Turbo-compressor - 3. Heat exchanger for the engine cooling liquid/sea water - 4. Pipe fitting for cooling liquid heat release from the engine - 5. Oil filter - 6. Engine eyebolt for hoisting - 7. Cooling liquid filling cap - 8. Solenoid valve displacement - 9. Alternator - 10. Pipe fitting to the cooling liquid reservoir - 11. Cooling liquid input to the engine - 12. Caps for cooling liquid drainage - 13. Connection to the positive pole of the battery - 14. Electric starter - 15. Anode.



N67 MNT M28 NEF ENGINE: left side view

1. Fuel filter - 2. Fuel input pipe fitting - 3. Cooling liquid expansion tank - 4. Oil priming pump - 5. Oil filling cap - 6. Oil level check rod - 7. Fuel output pipe fitting - 8. Engine eyebolt for hoisting - 9. Oil vapour filter - 10. Air filter - 11. Sea water pipe-fitting - 12. Ignition pump - 13. Sea water pump input - 14. Anode displacement - 15. Pulley fairing of auxiliary units - 16. Sea water drainage cap.

LABELS

The yard organization shall ensure that the following warning labels are placed on the engines. The meaning of such labels is explained here below.

Warning: Labels with exclamation mark highlight potential **danger**.

Hoisting point (of engine only)

Fuel filling cap (on tank, if available)

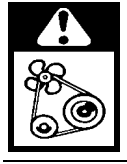
Lubrication oil filling cap

Lubrication oil level check rod

Danger: burns
Expulsion of pressurized heated water

Danger: burns
Presence of high temperature heated parts

Danger: fire
Presence of fuel



Danger: crash and hook-up to parts in motion
Presence of fans, pulleys, belts and other.

PERSONNEL APPOINTED TO MAINTENANCE

All necessary operations prescribed to ensure the best conditions to use and preserve the engine, and reported in the herein Manual, require preparation, competence and respect of the safety regulations and therefore must be executed by specially appointed personnel, as indicated here following:

- **Checking,** to be performed by workshop staff or by the person using the craft.

- **Periodical maintenance**, to be performed by qualified staff appropriately equipped with tools and instruments, and duly protected; periodical maintenance is highlighted by the key symbol (see picture).

- **Extraordinary maintenance**, to be performed by qualified and skilled staff, endowed with specific technical expertise and know-how, operating at authorized Technical Support Centres equipped with proper tooling and equipment. Extraordinary maintenance is highlighted by the key symbol (see picture).

The "Authorised Technical Support Centres" are those Centres forming part of the IVECO MOTORS Technical Support Network.

■ USE

PRELIMINARY CHECKS

Before starting the engine:

- ❑ Ensure that the sea water intake valve is open. Dry working of the sea water pump would cause irreparable deterioration of the internal rotor in few seconds.
- ❑ Check the level of the technical fuels (fuel, engine oil and cooling liquid).

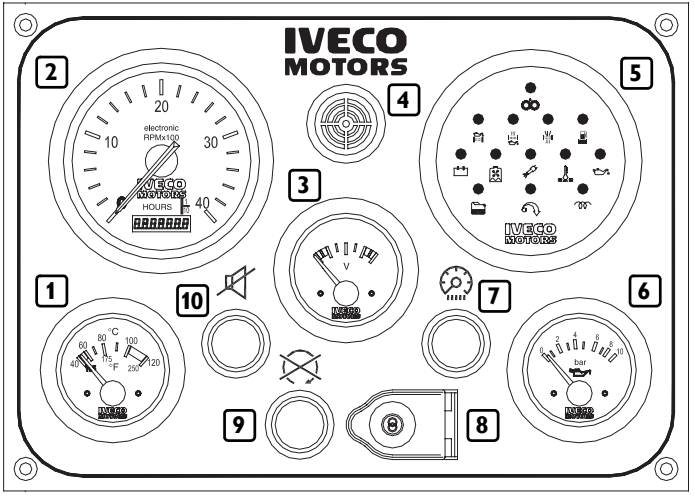
ATTENTION!

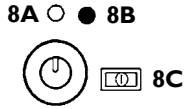
Before starting the engine, ensure that there is no presence of vapours or fuel gas in the engine room.

ENGINE START

For crafts equipped with IVECO MOTORS analogic instrument board panel. (supplied on request)

1. Lift the safety cover, insert the key in the change-over switch (8) and turn it rightwards into **8B** position.
2. Check that the analogic instruments display compatible information wit the values of the relevant physical parameters (temperature, battery voltage and oil pressure).
3. Wait until the alarm warning lights on the warning module (5) turn off, with the exception of the "alternator recharge" and "oil low pressure" warning lights, checking that the indicators' test result is positive (instructions for the test evaluation as well as module information are reported in the relevant paragraph).
4. Turn the key in **8C** position; once the engine has been started, release the key quickly without accelerating.
5. Check that the analogic instruments display compatible information wit the values of the relevant new physical parameters (temperature, battery voltage and oil pressure).
6. In case of start failure, after having released the key, it will be possible to return to start position only after having set the change-over switch back to the home position.

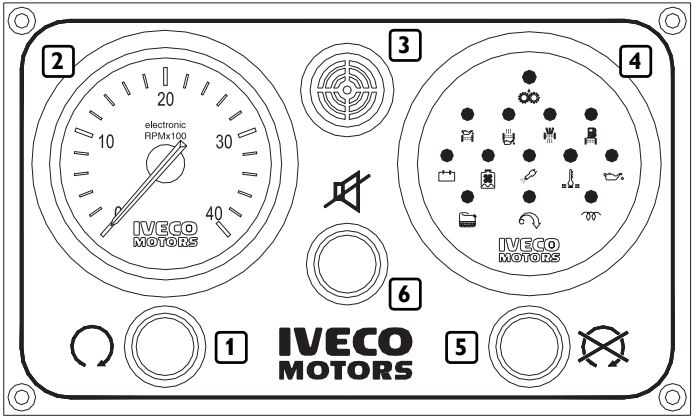




1. Cooling liquid temperature indicator - 2. Engine speed indicator and hour counter - 3. Voltmeter - 4. Acoustic warning device - 5. Alarm warning module - 6. Engine oil pressure indicator - 7. Instrument and instrument board lighting switch - 8. Key change-over switch for engine start/disconnection - 9. Engine disconnection switch - 10. Push button to exclude the acoustic warning device.

For crafts equipped with secondary IVECO MOTORS analogic instrument board panel (supplied on request).

1. **Enable the secondary board panel (fly bridge) to work, turning the key change-over switch of the main board in 8B position** (see procedures and checks set forth in the previous paragraph).
2. Wait until the alarm warning lights on the warning module (4) turn off, with the exception of the "alternator recharge" and "oil low pressure" warning lights, checking that the indicators' test result is positive (instructions for the test evaluation as well as module information are reported in the relevant paragraph).
3. Press the green push button (1) and hold it pressed until start has been completed, and then release it.
4. Check that the engine speed indicator displays reliable information.



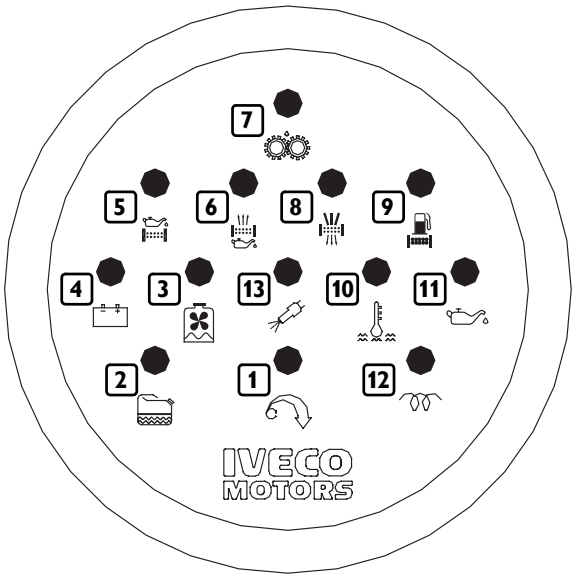
1. Engine start switch - 2. Engine speed indicator - 3. Acoustic warning device - 4. Alarm warning module - 5. Engine disconnection switch - 6. Push button to exclude the acoustic warning device.

For crafts equipped with customised instrument board panel (Not manufactured by IVECO MOTORS)

The starting procedures described previously must be followed even in case the instrument board panel has been customised for the craft.

ALARM STATUS RECOGNITION

IVECO MOTORS on-board consoles are equipped with an electronic module housing illuminated symbols and alarm memorization and timing interface circuits.
The chart illustrates the module's dial and explains all illuminated symbols; some engine typologies and related equipment thereof make available certain functions, and only certain functions, as referred to above.
Owing to the differing technical options selected by the Yard, the foregoing may be modified.



1. Permitted maximum rotation operation in excess (on demand) - 2. Water present in fuel pre-filter - 3. Engine cooling fluid low level - 4. Alternator anomaly - 5. Clogged oil filter - 6. Clogged blow-by filter - 7. Pre-lubrication in progress - 8. Clogged air filter - 9. Clogged fuel filer 10. Cooling fluid high temperature - 11. Low oil pressure - 12. Pre-post warm up - 13. EDC failure.

Operation logic

Excluding those relating to "Pre-lubrication", "Pre-post warm up" and "EDC failure", the efficiency test for all illuminated symbols is activated, for 5 seconds, by turning the change-over switch's key into position **8B**; by pressing the relevant press-button, the warning horn produced during testing is inhibited.
All alarm functions are inhibited during start-up phase and for 15 seconds immediately thereafter; after 15 seconds, each and every alarm status detected by the engine's sensors alights in flashing mode the related illuminated symbol and, at the same time, the warning horn. The warning horn may be silenced by pressing the relevant push-button. As a consequence thereof, the illuminated symbol turns from flashing to steady mode and alarm memorization remains until the engine is switched off.

ENGINE STOP

Before switching off the engine, the engine should be kept in rotation for a few minutes at minimum and without load; this will reduce consistently the temperature of the engine parts and will help to avoid damaging thermal shocks.

1. The engine is arrested by pressing the red push-button positioned on the IVECO MOTORS consoles or similar push-button as and when fitted in personalized consoles.
2. Should the engine be equipped with a "drop-out arrest" device (on demand), the IVECO MOTORS primary instrument board is arrested by turning the key-switch into the **8A** rest position.

Restarting engine from the primary board:

A. Turn the key-switch back to the rest position (8A) thereby disenabling all functions performed by the on-board consoles

B. Proceed as indicated under paragraph "ENGINE START-UP".

Restarting engine from the secondary board:

A. Press the green push-button (1) until engine start-up, and then release it.

B. Make sure that the number rotation symbol provides plausible indications.

ENSURING PROPER ENGINE USE

- ❑ Once the engine has been started, do not prolong the start-up command, insofar as this might damage the engine and the starter.
- ❑ Do not remain docked while waiting for the engine to warm up. After start-up, start navigating at low speed; proper attainment of running temperatures is obtained with the engine at running conditions other than minimum running conditions and with limited engine load.
- ❑ Do not continue minimum running conditions for a long time as this heightens the release of hazardous emissions by the engine and does not assure best performance.
- ❑ Upward and downward curved engine running conditions should be attained gradually in order to assure regular combustion and better engine operation as a whole; sudden and abrupt acceleration may generate exhaust fumes.
- ❑ As and when the craft is new, maximum rotation conditions attained by the engine should be more than 50 revolutions/min. vis-à-vis engine's maximum power conditions, as detected when navigating a craft at full load and with proper propeller.
- ❑ Maximum cruising conditions should be maintained at a value inferior to approximately 10% of max. power conditions.
- ❑ During navigation, make sure that:
  - the temperature of the engine's cooling fluid does not exceed the alarm thresholds, and;
  - the oil pressure remains within normal values.

Should the temperature be deemed to be excessive, reduce speed and return to the harbor to check the sea-water circuit's status; also check. The following should be checked:

a) voltage of water pump command belts and alternator;
b) thermostat operation; and
c) heat exchanger cleanliness

SPECIFIC WARNINGS

Cooling fluid circuit

Once the engine has warmed up, established within the cooling circuits is a pressure having the capability to expel hot liquid with extreme violence thereby giving rise to the risk of burns.

ATTENTION!

Where necessary, the cooling liquid float chamber's refuelling plug should be removed when, and only when, the engine is cold.

Lubrication circuit

Should the "low oil pressure" (11) warning light on the ALLARMS AND SIGNALLING MODULE alight, the engine should be arrested. With the craft running under safety conditions, check the oil level and, where applicable, add oil.
Should the warning light continue to stay alight, call an authorized Technical Support Centre.

Exhaust and suction circuit

Inspect regularly the air suction circuit for cleanliness. The maintenance frequency schedules set forth below vary according to how the engine is used.

ATTENTION!

In order to avoid fumes and hazardous releases to the air, examine the exhaust circuit to ensure that it is neither obstructed nor damaged.

Fuel circuit

Try not to use the engine when its fuel tank is in reserve; operating in reserve might cause the formation of condensation or air suction thereby arresting the engine.

ATTENTION!

Maximum attention is required during refuelling in order to ensure that no liquid or solid pollutants enter into the tank; of particular note, do not smoke or alight flames during refuelling.

Starter electric system

Check periodically the batteries, especially in the winter season, for cleanliness and efficiency, controlling and topping up the batteries as recommended under the heading "CHECKING AND MAINTENANCE".

ATTENTION!

The batteries contain an acid solution, which cauticizes skin and corrodes garments; when checking the batteries, please wear protective clothing, gloves and glasses; do not smoke or alight flames near to them and, not least, ensure that the rooms in which the batteries are housed are properly ventilated.

REFILLING

Parts to be refilled	Quantity (liters kg.)		Product
Cooling Circuit	≈24.5	-	PARAFLU 11 and 50% water (1)
Engine oil pan and oil filter (total capacity)	16.5	15	Lubricating oil (3) ACEA E3 - E5 (3)
Engine oil pan only:			
• at minimum level	9	8	
• at maximum level (2)	14.5	13.2	
Fuel Tank	-	-	Diesel-oil (4)

.

1) Use 50% PARAFLUE 11 and 50% water also in the summer season in order to ensure cooling circuit optimum protection. On condition that international standard SAEJ 1034 compliance is ensured, a similar product may be employed in alternative to PARAFLU 11.
2) The quantity indicated is the quantity needed for periodical oil replacement.
3) Use lubricants that comply with the following international standards:
   - for supercharged engines: ACEA E3-E5 (MIL. L 2104E/F)
   - for non-supercharged engines: ACEA 32 (MIL. L 2104/F)

   Acceptable oil consumption: not more than 0.2% of fuel consumption.
4) With atmospheric temperature below 0° C, use winter fuel.

WARNING

Should fuel with a sulphur percentage in excess of 0.5% or ACEA E2 (MIL. L 2104E/F) be used in supercharged engines, engine oil must be changed every 300 hours.

ENGLISH

Refuelling

Use only normally commercialized diesel-oil (EN 590 Standard). Fuel additives should be avoided. Fuel additives should be used for engine performances only.
Drum or jerry-can refuelling may cause diesel-oil pollution, with resultant damage to the fuel-injection system; where applicable, filter adequately or sediment impurities prior to refuelling.

Diesel-oil in low temperatures

In the instance of low temperatures, diesel-oil fluidity may be inadequate due to paraffin solidification thus giving rise to filter clogging risk. EN 590 Standard envisages the employment of diverse diesel-oil classes at low environmental temperatures.

Entrusted entirely to Oil Companies is compliance with the Standard calling for the distribution of fuel in accordance with the geographic and weather conditions prevailing in the differing countries.

Reversing gear oil refilling

Information as to the quantity and type of oil to be employed in the reversing gear can be found in the manual supplied by Manufacturer.

RUNNING IN

Owing to the modern technologies applied when constructing the engines, no particular running in procedures are required. However, use of the engine for long periods of time at high power is not recommended for the first 50 hours.

■ CHECKING AND MAINTENANCE

As reported hereunder, engine checking and maintenance requires preparation, competence and compliance with Safety Standards; as a consequence thereof, engine checking and maintenance should be carried out, as set out below, by specifically assigned personnel:

- ❑ **Engine checking**, to be performed by workshop staff or by the person using the craft.
- ❑ **Periodical maintenance**, to be performed by qualified staff appropriately equipped with tools and instruments, and duly protected; periodical maintenance is highlighted by the key symbol.
- ❑ **Extraordinary maintenance**, to be performed by qualified and skilled staff, endowed with specific technical expertise and know-how, operating at authorized Technical Support Centres equipped with proper tooling and equipment.

"Authorized Technical Support Centres" are those Centres forming part of the IVECO MOTORS Technical Support Network.

ACCIDENT PREVENTION

- ❑ Always wear accident prevention shoes and overalls.
- ❑ Do not wear loose clothing, rings, bracelets and/or necklaces when standing near to the engines or moving engine parts.
- ❑ Wear protective gloves and glasses when:
  - topping up batteries with acid solution;
  - refilling with inhibitors or anti-freeze, and;
  - replacing or refilling with lubricating oil (hot engine oil may cause burns. We recommend that this should be replaced or refilled when, and only when the temperature of the oil is less than 50°C).
- ❑ Wear glasses using pressurized air (maximum air pressure employed for cleaning must not exceed 200 kPa (2 bar, 30 psi, 2 kg/cm^2).
- ❑ Wear a protective helmet when working in places with overhanging loads or with head-height installations.
- ❑ Use protective hand-cream.
- ❑ Remove and change immediately wet overalls.
- ❑ Always keep the engine clean, eliminating any spots of oil, diesel oil and/or cooling fluids.
- ❑ Place greasy rags in flame-retardant cases.
- ❑ Do not leave any cloths or rags on the engine.
- ❑ Use proper and safe containers to store used oil.
- ❑ Once overhauled and repaired, appropriate measures should be taken to arrest air suction should starter be out-of-revolution.

ATTENTION!

Avoid performing maintenance in the presence of electric voltage: in all cases, check installation's effective earthing. When regulating the installation, make sure that your hands and feet are dry and stand on insulating footboards.

ATTENTION!

Unless you are fully qualified and sufficiently informed, do not try to make repairs. Always follow the instructions contained in the Repair & Overhaul Manuals. In the absence thereof, please contact Vendor or IVECO MOTORS Network qualified staff members.

CHECKING FREQUENCY

Checks (to be carried out when engine is not left idle)	Frequency
Oil pan oil level check	daily
Reversing gear oil level check	daily
Cooling fluid level check	daily
Fuel pre-filter check for the presence of water	daily
Battery [1] electrolytic solution level check	six-monthly

As discussed below, the following checks should be carried out by authorized Technical Support Centre maintenance crews.
As indicated in the form of engine operating hours, maintenance frequency compliance is required.
The more appropriate space of time elapsing from one maintenance intervention to another shall be indicated by the maintenance crew on a basis consistent with engine operating conditions and usage.

Routine maintenance	Frequency
Air filter cleaning [1]	300 hours
Zinc anode corrosion checking [5]	300 hours
Oil pan oil replacement [2] [3]	≈ 600 hours
Oil filter replacement [2] [3]	600 hours
Fuel filter replacement [2] [4]	600 hours
Fuel pre-filter replacement [2] [4]	1200 hours
Rotating sea-water pump inspection [2]	1200 hours
Equalizer/Valve gap regulation	3000 hours
Reversing gear oil replacement [6]	-

Extraordinary maintenance	Frequency
Turbo-compressor cleaning (where applicable)	1200 hours
Water/Air exchanger cleaning [2]	1200 hours
Water/Water exchanger cleaning [2]	1200 hours
Reversing gear water/oil exchanger cleaning (where applicable) [2]	1200 hours
Alternator/Water pump belt command replacement	1200 hours

1) Frequency depends upon environmental conditions and product effectiveness.
   After long periods of engine idle time, check prior to start-up.
2) To be performed every year even if number of operating hours envisaged is not reached.
3) Frequency applicable to ACEA E3-E5 and API CH 4.
   Standards compliant lubricants.
   Frequency reduced to 300 hours for ACEA E3-E5 and API CH 4 Standards compliant lubricants.
   Should fuel having a sulphur percentage in excess of 0.5% be used, the engine oil replacement span is halved.
4) Maximum period relating to the employment of good quality fuel; this is reduced in relation to fuel contamination and alarms signalling clogging and the presence of water in the pre-filter.
   At low temperatures, diesel-oil fluidity may become inadequate due to paraffin separation with resultant risk of filter clogging.
   Clogging signalling calls for filter replacement; the presence of water calls for drainage using the specific drain plug. Should the warning light remain alight, replace pre-filter (further information can be found under the heading "CHECKING AND MAINTENANCE").
5) Zinc corrosion limit is equal to 50%; should such limit be exceeded, this must be replaced.
6) Please refer to reversing gear Manufacturer's Manual.

INSTRUCTIONS

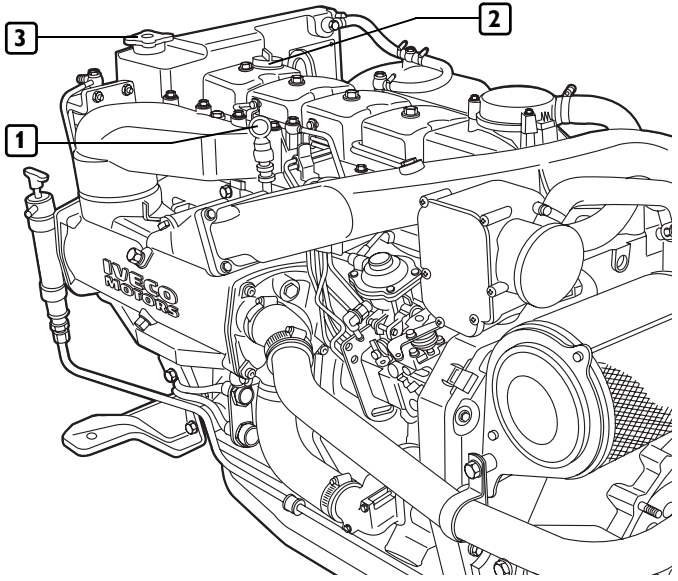
1. Do not disconnect supply to the batteries while engine is in motion.
2. Do not arc weld near to the engine without having first removed its electric cable.
3. After every maintenance intervention requiring battery disconnection, make sure that the terminals are once again well clamped on the poles.
4. Do not use battery chargers to start engine.
5. Disconnect electrically the battery/batteries from the board network during its/their recharging.
6. Do not paint the engine equipment sets, components and electric components.
7. Disconnect electrically the battery/batteries prior to any electrical intervention whatever.
8. Contact the Yard before installing any onboard electronic equipment (two-way radio sets, echo-sounders, etc.).

HOW TO PROCEED

Oil pan oil level check

In order to obviate the risk of burns, do not check engine when in rotation or hot.

- ❑ Using the dipstick (1), make sure that the quantity of oil is encompassed between the "Min" and "Max" limits.
- ❑ Should the oil level be inadequate, top up using the filler situated on the cylinder head, after having removed its plug (2).



WARNING

- ❑ *Make sure that the oil level does not exceed the "Max" limit engraved on the dipstick.*
- ❑ *Reposition properly the dipstick and screw up tightly the filler cap turning it clockwise until it can be turned no more.*
- ❑ *When not left idle, make sure that the oil level always remains between the "Min" and "Max" limits.*

Reversing gear oil level check

As instructed in the manual supplied by the reversing gear's Manufacturer, check oil level in the reversing gear.

Float chamber cooling fluid level check

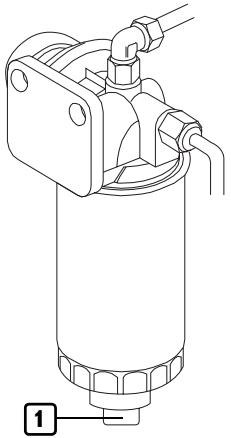
In order to obviate the risk of burns, do not check engine when in rotation or hot.

- ❑ Turning it anti-clockwise, remove the float chamber's pressurization plug (3).
- ❑ Look at and check the cooling fluid's level.
- ❑ Where applicable, top up chamber using purified water. Do not use distilled water.
- ❑ When the engine is cold, make sure that the level of the fluid in the expansion chamber exceeds minimum level.

Pre-filter check for the presence of water

Due to the high risk of refuelling being polluted by chemical agents and water, the check should be performed even when no alarm is signalled on the board panel.
Check should be performed with engine at rest.

- ❑ Place a case or tray under the pre-filter so that the fluids can be collected.
- ❑ Unscrew the tap plug (1) situated on the lower part of the pre-filter; in on-demand equipment, the plug comprises the sensor detecting the presence of water in diesel-oil.
- ❑ Drain fluid until only diesel-oil is detected.
- ❑ Screw plug completely back by hand.
- ❑ Get rid of drained fluids in accordance with currently prevailing waste disposal laws and regulations.



Battery electrolytic solution level check

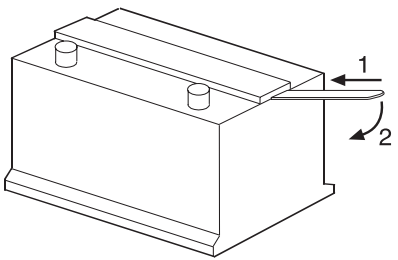
Check should be performed once batteries are placed on a horizontal plane.

- ❑ Visually check that the liquid level is between the "Min." and "Max." references. If there are no references, check that the liquid covers the lead plates inside the elements.
- ❑ Top up the elements whose level is underneath the minimum with distilled water only.
- ❑ Contact specialised workshop personnel if the battery needs recharging.
- ❑ During the procedure, check that the battery terminal and clamps are clean, tight and protected by a coat of Vaseline

WARNING

- ❑ *Batteries contain highly caustic and corrosive sulphuric acid; when topping up, wear protective gloves and glasses. Where possible, we recommend that the check should be performed by specifically assigned staff members.*
- ❑ *When checks are being performed, do not smoke or alight flames near the batteries. Of particular note, make sure that the rooms in which the checks are being performed are properly ventilated.*
- ❑ *Should the voltage be lower than 21V (for installation at nominal 24V) or 10V (for installation at 12V), the batteries and the electric recharging system must be checked for serviceability.*

Some batteries are equipped with a single inspection cap lid. Lever as shown in the figure to access the elements.

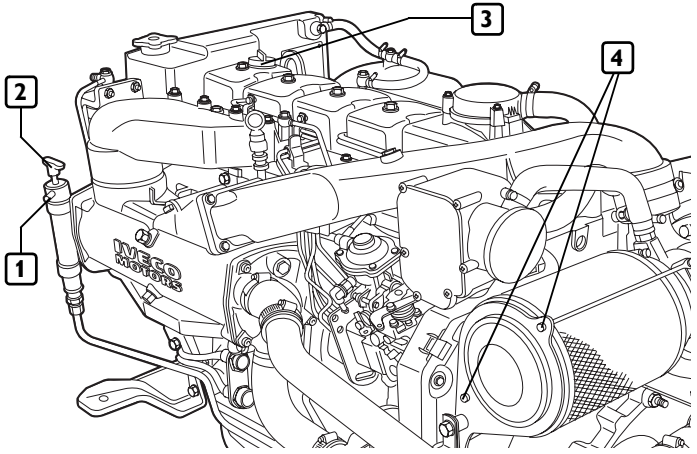


ENGLISH

Engine oil replacement

In order to obviate the risk of burns, do not check engine when in rotation or hot.

- ❑ Place a case or tray under the output tube (1) of the manual pump (2) so that waste oil can be collected.
- ❑ Use the appropriate manual pump (envisaged exclusively for this operation) in order to empty the oil pan completely.
- ❑ Refill using the filler (3) situated on the distribution lid, employing oil in the quantity and type specified in the "REFILLING" table.
- ❑ Using the dipstick, check that the quantity of oil is encompassed between the "Min" and "Max" limits.
- ❑ Get rid of waste oil in accordance with currently prevailing waste disposal laws and regulations.



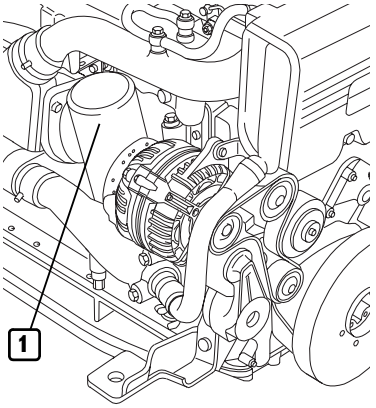
Air filter cleaning

- ❑ Remove the filter by unscrewing the screws (4) shown in the chart.
- ❑ Blow the filtering element with dehumidified compressed air, blowing from the inside towards the outside (200 kPa maximum pressure) Avoid using detergents; **do not use diesel-oil**.
- ❑ Replace filter when breakage is detected.
- ❑ Replace filter every 2 years.

Engine oil filter replacement

In order to obviate the risk of burns, do not check engine when in rotation or hot.

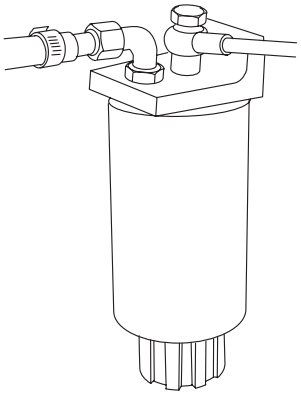
- ❑ Place a case or tray under the filter support (1) so that waste oil can be collected
- ❑ Unscrew and remove filtering cartridge.
- ❑ Clean surfaces accurately.
- ❑ Dampen the new cartridge's gasket with a spot of oil.
- ❑ Tighten by hand the new filter on the support until it touches the gasket, clamping it by turning it 3/4 round.
- ❑ Get rid of the cartridge in accordance with currently prevailing waste disposal laws and regulations.



Fuel filter replacement

- ❑ Unscrew the filter and remove it.
- ❑ Make sure that the new filter's performance meets the needs of the engine (e.g., on a comparative basis with the replaced filter's performance).
- ❑ Dampen the new filter's gasket with diesel-oil or engine oil. In order to obviate the risk of introducing hazardous impurities in the circuit and in the fuel-injection system, do not fill the new filter before it has been placed on the support.
- ❑ Tighten by hand the new filter on the support until it touches the gasket, clamping it by turning it 3/4 round.

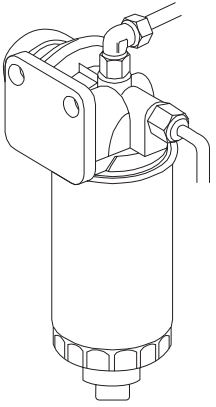
N.B.: Air may be blown out by loosening the diesel-oil delivery pipe's connector to the engine



Fuel pre-filter replacement

- ❑ Unscrew and remove pre-filter.
- ❑ Make sure that the new filter's performance meets the needs of the engine (e.g., on a comparative basis with the replaced filter's performance).
- ❑ Dampen the new filter's gasket with diesel-oil or engine oil.
- ❑ Tighten by hand the new filter on the support until it touches the gasket, clamping it by turning it 3/4 round.
- ❑ Operate the manual pump situated on the pre-filter's support until the feeding circuit is refilled.
- ❑ Start the engine and keep it rotating at minimum for a few minutes until all residual air has been removed.

N.B.: Air may be blown out by loosening the diesel-oil delivery pipe's connector to the engine.



WARNING

The operations listed below should be carried out exclusively by Technical Support Centre maintenance crews. The related modalities thereof are set out in the Repair and Overhaul Technical Manuals.

Equalizer/Valve gap regulation
Reversing gear oil replacement
Turbo-compressor cleaning
Water/Air exchanger cleaning
Water/Water exchanger cleaning
Reversing gear water/oil exchanger cleaning
Alternator/Water pump belt command replacement
Rotating sea-water pump inspection

ENGINE HANDLING

The engine should be disembarked and successively re-embarked exclusively by authorized Technical Support Centre crews.
When lifting the **engine only**, use the eyelets indicated herein under the heading "ENGINE PLAN VIEWS" and labelled appropriately on the engine.
The engine should be lifted by a rocker arm that holds in parallel the wire ropes supporting the engine, and using, at the same time, all of the eyelets made available; the use of one eyelet only is not permitted.
The rage and size of the engine's lifting system should be consistent with the engine's weight and dimension; make sure that nothing interferes with the lifting system and the engine's gears.
Do not lift the engine before having removed the transmission gears coupled thereto.

WASTE DISPOSAL

Composing the engine are parts and elements, which, if released to the environment, might create ecological hazards.
The materials listed below should be delivered to properly authorized hazardous waste collection Centres; enacted laws currently prevailing around the globe punish transgressors severely:

- ❑ starter batteries
- ❑ waste lubricating oil
- ❑ water mixed with anti-freeze
- ❑ filters
- ❑ ancillary cleaning material (e.g., greasy rages or rags soaked in fuel).

■ ENGINE LEFT IDLE FOR THE LONGER TERM

PREPARING THE ENGINE FOR LONG-TERM IDLE TIME

Should the engine not be expected to be used for more than two months straight, the following must be performed on a six-monthly basis in order to avoid any parts inside the engine and/or certain fuel injector components oxidizing:

1. After warming up the engine, drain out the lubricating oil from the oil pan.
2. Pour 30/M protective oil (or, alternatively, MIL 2160B type 2 compliant oil) into the engine, up to the "minimum" oil level marked on the dipstick. Turn on the engine and keep it rotating for about 5 minutes.
3. Drain the injection circuit, filter and injection pump ducts from fuel.
4. Having excluded injection system operation, joint the fuel circuit to a tank containing CFB protective liquid (ISO 4113) and help the fluid to flow out by exerting pressure on the circuit and dragging in rotation the engine for about 2 minutes. This may then be terminated by polarizing directly terminal 50 of the electric starter with positive current equal to the system's rated current, using the applicable voltage conductor.
5. During the dragging discussed earlier, spray 30/M protective oil in a quantity approximating 70 g. (10g. per displacement litre) over the turbo-compressor's suction head.
6. Obscure appropriately with plugs, or seal with adhesive tape, all engine vents and aeration, draining and suction vents.
7. Drain from the crankcase any residual 30/M protective oil, which can be used again for another 2 engine preparations.
8. Affix "ENGINE WITHOUT OIL" labels to the engine and board console.
9. As and when not mixed with anti-freeze and anti-corrosives, drain out the cooling fluid, affixing labels confirming that the fluid has been drained.

Should you wish to protect the external parts of the engine, spray unpainted metal parts, such as the flywheel, pulleys and other, with OVER 19 AR protective fluid, without spraying belts, connection cables and electric equipment.

PUTTING INTO SERVICE AN ENGINE LEFT IDLE FOR THE LONGER TERM

1. Drain out any residual 30/M protective oil from the oil pan.
2. As prescribed, pour into the engine lubricating oil of the type and in the quantity shown in the "REFUELLING" table.
3. Drain the CFB protective fluid from the fuel circuit terminating the operations as indicated earlier under the heading "PREPARING THE ENGINE FOR LONG-TERM IDLE TIME", paragraph 3.
4. Remove the plugs and/or seals from the engine vents and aeration, draining and suction vents restoring normal working conditions. Connect the turbo-compressor's suction head to the air filter.
5. Joint the fuel circuits to the craft's tank terminating the operations as indicated earlier under the heading "PREPARING THE ENGINE FOR LONG-TERM IDLE TIME", paragraph 4. During refuelling, joint the fuel's feedback tube to a fluid collector in order to avoid any residual CFB protective fluid flowing into the craft's tank.
6. Check and refuel the engine with cooling fluid as prescribed.
7. Turn on the engine and keep it rotating until running smoothly at minimum.
8. Check that the indications shown by the instruments fitted in the board console (consoles) are plausible and that there are no alarm signals.
9. Turn off the engine.
10. Remove the "ENGINE WITHOUT OIL" labels from the engine and from the board console.

■ EMERGENCIES

As created and built in accordance with safety standards, and on a basis consistent with the instructions set forth herein in conjunction with the indications reported on the engine labels, the person using the craft operates under safety conditions.
Should improper use or conduct cause accidents, please call immediately for the assistance of qualified first-aid personnel.
In the event of emergency and pending the arrival of rescue squads, reference should be made to the following:

Fire

Put out the fire using the fire-fighting appliances fitted on board as required by the competent Authorities (mandatory on-board fire-prevention appliances required by enacted and currently prevailing safety laws and regulations).

Burns

1. Put out the flames on the garments worn by the victim by:
   - pouring water on the victim's garments;
   - using a powder fire extinguisher, trying not to spray the victim's face;
   - cover or role the victim on the floor.
2. Do not pull off any pieces of clothing sticking to the victim's skin.
3. In the case of burns caused by fluids, remove the victim's garments drenched in hot fluids.
4. Cover the burn with anti-burn dressing or sterile bandage.

Carbon monoxide (CO) intoxication

The carbon monoxide contained in the engine's exhaust gas is odourless and dangerous because it causes intoxication and, not least, forms and explosive mixture when mixed with air.
In closed rooms and premises, carbon monoxide is very dangerous because it can reach critical concentration in a very short time.
As and when rescuing an intoxicated person in a closed room:

1. Ventilate immediately the room in order to reduce the concentration of gas.
2. When entering the room, the rescuer must hold his breath, not turn on any lights, or press electric bells or telephones in order to avoid explosions.
3. Help the victim out the room taking him or her to a well ventilated room or outside in the open air, lying the victim on his or her side if unconscious.

Electric shocks

The engine's 12V or 24V electric system does not give rise to the risk of electric shocks. However, in the instance of a short circuit caused, for example, by a metal tool, the risk of burns might arise due to the overheating of the object touched by the electric current. In this instance:

1. Remove the object that caused the short circuit using means that ensure adequate thermal insulation.
2. Where applicable, turn off the cut-out switch in order to cut off the electricity supply.

Injuries and fractures

The broad array of case studies and the specificity of the steps and measures to be taken call necessarily for medical aid.

1. In the instance of injuries with loss of blood, compress the wound from the outside until rescuers arrive.
2. In the instance of suspected fracture, do not move the part of the body concerned and transfer the injured person with extreme caution, and only in the case of extreme need.

Causticization

Skin causticization is caused by coming into contact with substances with high acidity or basicity content.
Typically, causticization suffered by electric system maintenance crews is caused by battery acid leakage; in this instance:

1. Remove the garments drenched in the caustic substance.
2. Wash abundantly with running water, trying not to wet any parts not affected.

In the instance of eye causticization, whether caused by coming into contact with battery acid or lubricant oil or diesel oil: wash the eye with water for 20 minutes at least holding the eyelid open so that the water flows over the eyeball (help the eyewash by moving the eye in all directions).