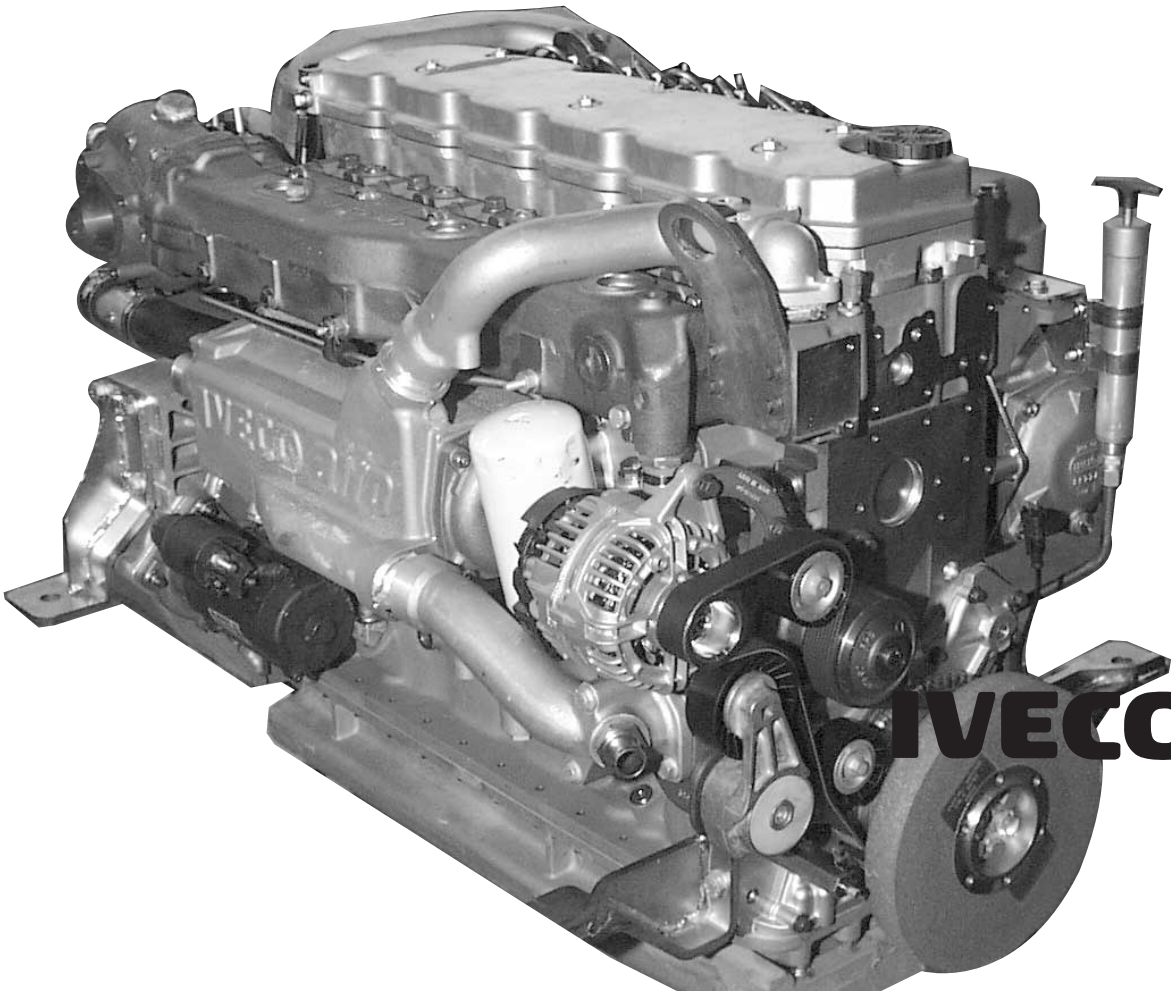
INSTALLATION INSTRUCTIONS

N60 ENT M37

MARINE ENGINE



IVECO aifo

FOREWORD

Please read carefully the indications provided in this document: compliance with them will ensure the engine will continue to run smoothly and reliably, protecting users and service personnel against the risk of mishaps.

The instructions contained in this document pertain specifically to the N60 ENT M37 engine and complement the IVECO Aifo publication "Marine Engine Installation Manual", which should be referred to for all matters not covered herein.

Any installation not in compliance with the contents of these instructions, or modifications to the engine and its fittings are not admitted. The installing Yard is required to conduct tests to verify the functional compatibility between the engine's electrical-electronic equipment and the other electronic devices present on the boat.

Engineers and installation personnel are reminded of their obligation to comply with workplace safety rules.

To ready the engine for starting, follow the procedure set out at the end of Section 2 of this document.

To get the best possible performance out of the engine, it is mandatory to conform with its intended mission profile. The engine must not be used for purposes other than those stated by the manufacturer. IVECO Aifo is willing to examine beforehand any requirements for particular installations.

In particular

- ❑ Use of unsuitable fuels and oils may compromise the engine's regular operation, reducing its performance, reliability and working life.
- ❑ For the engine to maintain its original condition, it is absolutely mandatory to use only Original IVECO Parts.
- ❑ Any tampering, modifications, or use of non-original parts may jeopardize the safety of service personnel and boat users.

Spares may be supplied only if the following are indicated:

- Commercial code and serial number of the engine;
- Part number as per spares catalog.

The information provided below refers to engine features as of the date of publication. The manufacturer reserves the right to make modifications at any time and without advance notice, to meet technical or commercial requirements or to comply with local legal and regulatory requirements.

The manufacturer is not liable for any errors or omissions.

The IVECO competence and professionalism of the Customer Service Network is always available to our customers.

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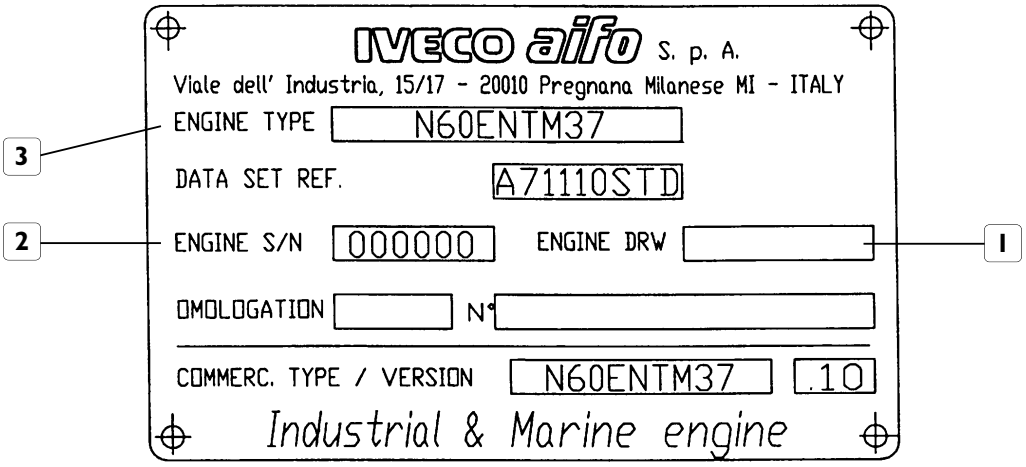
SECTION CONTENTS

SECTION 1

Overview

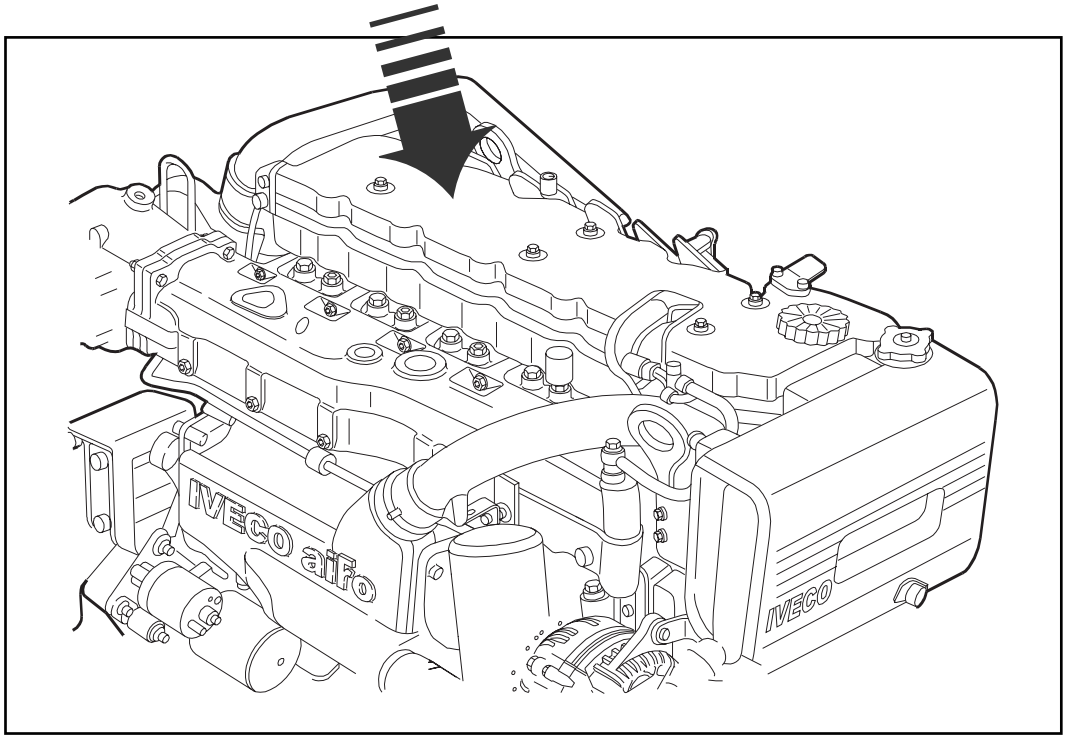
IDENTIFYING DATA

Figure 1



1. Drawing Number - 2. Serial Number - 3. Commercial Code.

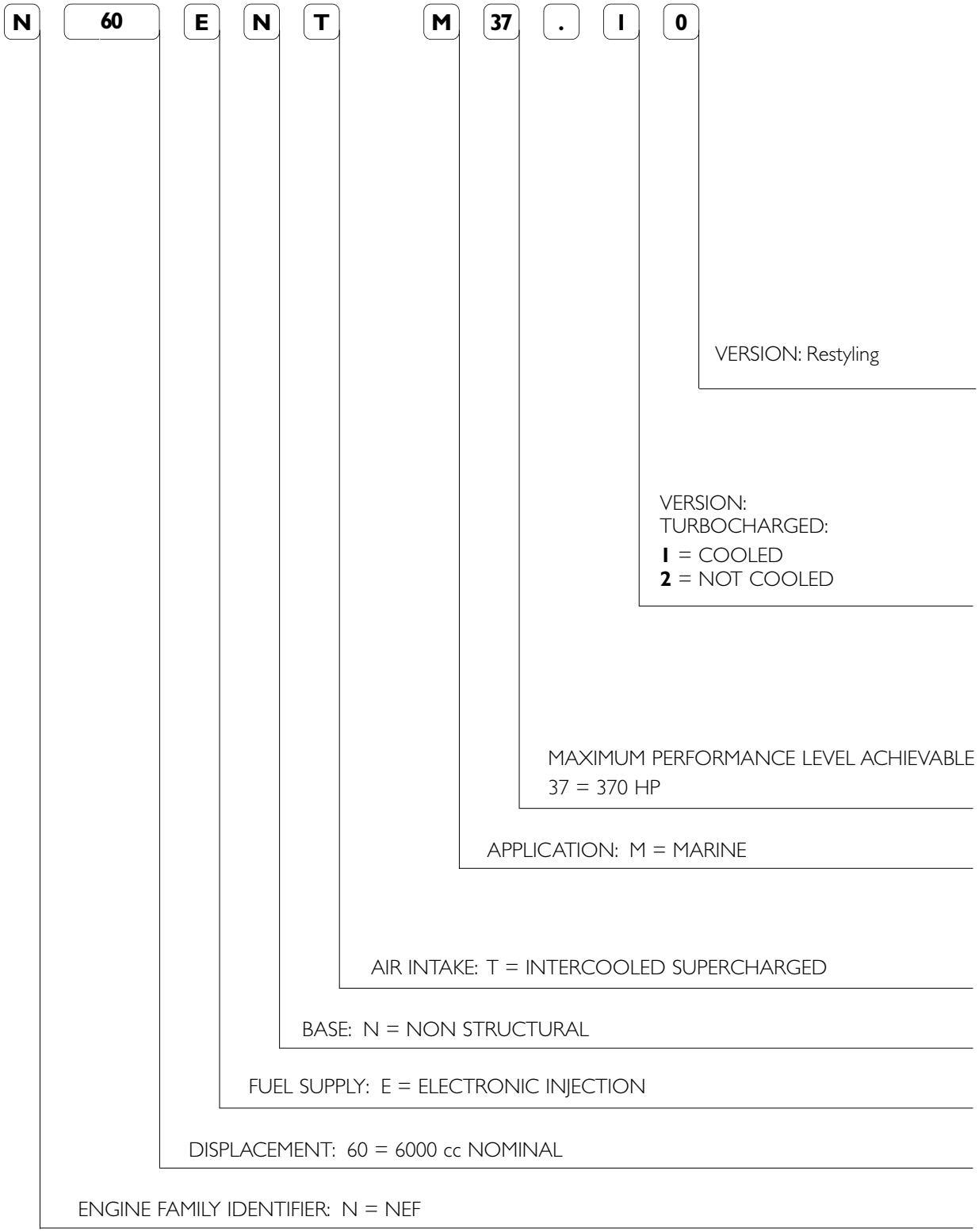
Figure 2



The engine's identifying data are stenciled on a tag located on the engine rocker-arm cover.

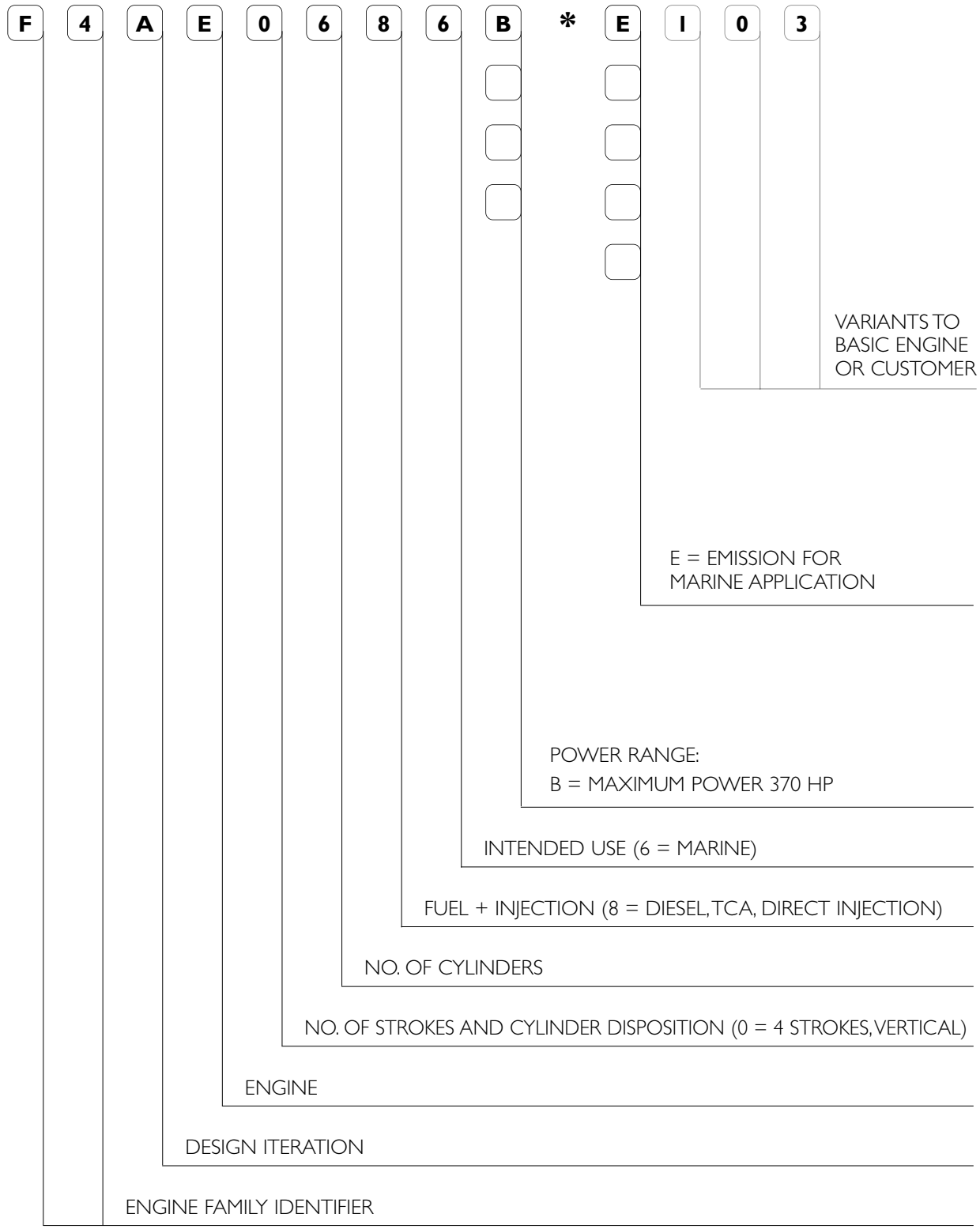
COMMERCIAL CODE

The purpose of the commercial code is to make it easier to understand the characteristics of the product, categorizing the engines according to their family, origins and intended application. The commercial code, therefore, cannot be used for technical purposes to recognize the engine's components, this purpose is served by the "ENGINE S/N".



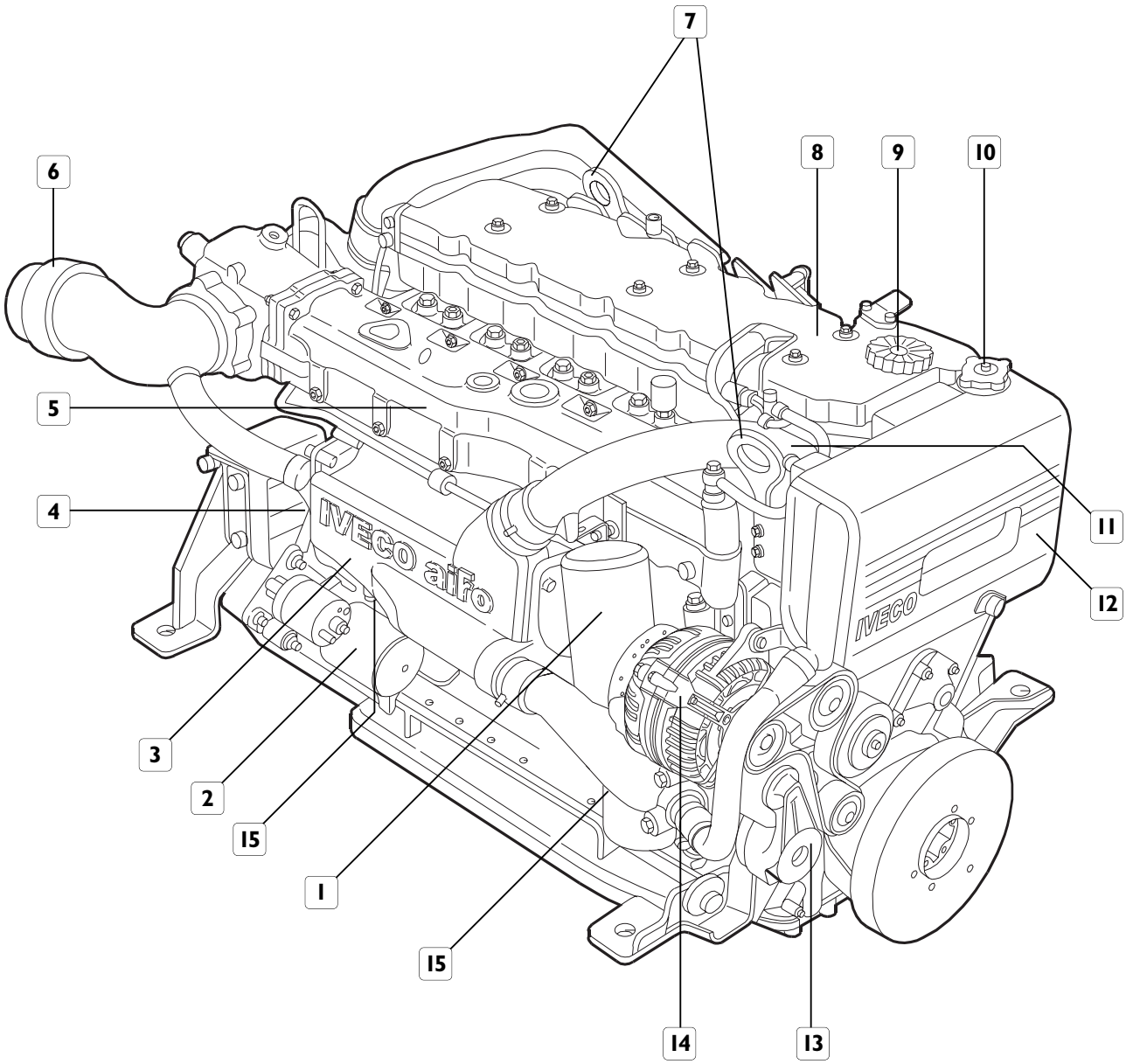
PRODUCT MODEL NUMBER

The model number is assigned by the manufacturer; it is used to identify the main characteristics of the engine, and to characterize its application and power output level. It is stamped on a side of crank-case.



ENGINE COMPONENTS

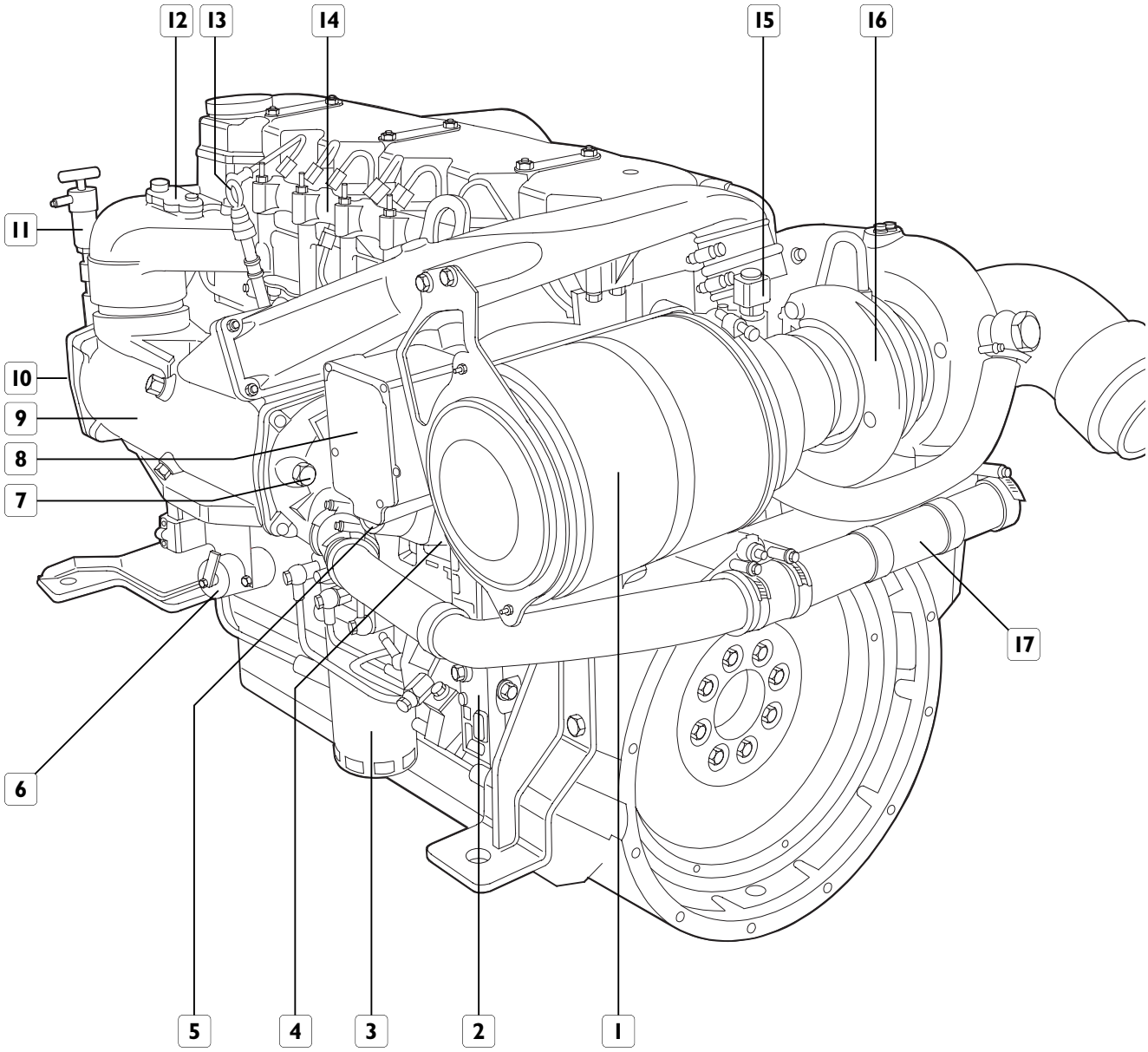
Figure 3



1. Lubricating oil filter - 2. Electrical starter motor - 3. Coolant - sea water tube bundle heat exchanger - 4. Location of sacrificial anode - 5. Cooled exhaust manifold - 6. Exhaust gas and sea water manifold - 7. Lifting padeyes - 8. Rocker-arm cover - 9. Lubricating oil refill cap - 10. Coolant refill cap - 11. Location of thermostatic valve - 12. Coolant tank - 13. Automatic belt tensioner - 14. Alternator - 15. Coolant drain plugs.

ENGINE COMPONENTS

Figure 4



1. Intake air filter - 2. Common rail high pressure pump - 3. Fuel filter - 4. Sea water pump - 5. Sea water intake - 6. Throttle position sensor potentiometer - 7. Sacrificial anode - 8. Blow-by filter - 9. Air-sea water heat exchanger - 10. Sea water drain plug location - 11. Lubrication oil hand pump - 12. Intake air pressure and temperature sensor - 13. Lubricating oil dipstick. - 14. Common rail - 15. Air filter clogging sensor - 16. Cooled turbo-charger - 17. Sea water pipe from air heat exchanger to engine coolant heat exchanger.

PERFORMANCE

Brake horsepower values in accordance with ISO 3046-1, attainable after about 50 hours of operation under reference environmental conditions characterized by 750 mmHg, 25°C, 30% relative humidity. Values fall within a tolerance of 5%.

Pleasure Service (A)

Type of boat

Pleasure and military boats with planing hull for high speed or semi-planing and displacing leisure hulls that use maximum power for short periods alternating with prolonged periods at lower than maximum speed.

Engine utilization

Use of maximum power limited to 10% of the time. Cruising speed at engine rpm < 90% of nominal calibration rpm. Operating limit: 300 hours/year. Definition of calibrations and operating limits for military and government agencies according to contractual specifications.

Nominal maximum power:	kW (HP) @ rpm	272 (370) @ 2800
Nominal maximum torque	Nm (kgm) @ rpm	1070 (112) @ 1800

Light Service (B)

Type of boat

Light boats for tourism, professional, or military use, with frequent speed changes. E.g.: leisure boats, chartering, light passenger boats, high speed patrol boats for police, emergency, rescue, and special operations uses.

Engine utilization

Use of maximum power limited to 10% of the time. Cruising speed at engine rpm < 90% of nominal calibration rpm. Operating limit: 1,000 hours/year. Definition of calibrations and operating limits for military and government agencies according to contractual specifications.

Nominal maximum power:	kW (HP) @ rpm	242 (330) @ 1900
Nominal maximum torque	Nm (kgm) @ rpm	1001 (102) @ 1900

Intermediate Service (C)

Type of boat

Light boats for commercial, military, work and light fishing uses with variable speed. E.g.: patrol boats, pilot boats, light fishing vessels, water taxies, medium range seasonal passenger transport, fire-fighting.

Engine utilization

Use of maximum power limited to 25% of the time. Cruising speed at engine rpm < 90% of nominal calibration rpm. Operating limit: 1,000 - 3,000 hours/year. Definition of calibrations and operating limits for military and government agencies according to contractual specifications.

Nominal maximum power:	kW (HP) @ rpm	198 (270) @ 1900
Nominal maximum torque	Nm (kgm) @ rpm	834 (85) @ 1900

Fuel Economy - Pleasure Use (A)

Specific fuel consumption at maximum power	g/kWh (g/HPh) @ rpm	≤ 224 (164) @ 2800
Specific fuel consumption at maximum torque	g/kWh (g/HPh) @ rpm	≤ 207 (152) @ 1800
Lubricating oil consumption at maximum power	g/h @ rpm	≤ 485 @ 2800

Gas Emissions

Compliance with Standard	IMO MARPOL 73/78 ADDENDUM DIR. 94/25/EC

Sound Emissions

Maximum value of average level for engines in basic configuration dBA (measurement standard)	94 (ISO 3744)

Power Takeoffs (Optional)

2- throated Front Pulley for V belts

Basic diameter	mm	187
Throat size	mm	12,7
Power available @ 900 rpm	kW (HP)	6 (8,1)
Power available @ 1800 rpm	kW (HP)	12 (16,3)
Radial force given by belts tension (*)	N	≤ 1340

(*) Direction of radial force from 60° to 300° referred to cylinder axis (piston at Tdc = 0°)

3-throated Front Pulley + Elastic Joint

Available torque in crank axis	Nm (kgm)	150 (15)
Moment of inertia of rigidly added mass	kgm^2	≤ 0,015

GENERAL SPECIFICATIONS

Cycle		4-Stroke Diesel
Charge		Supercharged and intercooled
Injection		Direct
Number of cylinders		6 in line
Bore	mm	102
Stroke	mm	120
Total displacement	cm^3	5900
Compression ratio		17 ± 0.8 : 1
Direction of rotation, brake side		counterclockwise
Minimum idling rpm	rpm	650 ± 25
Maximum engine rpm, no load	rpm	3050 ± 25

Engine inclination angles in continuous operation

Statical minimum/maximum	degrees/360	+3 / +9
Maximum longitudinal (static + dynamic)	degrees/360	+ 18
Maximum transverse (static + dynamic)	degrees/360	± 23
Oil dipstick valid for static inclination	degrees/360	+3 ÷ + 6

Supercharge

Turbo-charger with water-cooled body		HOLSET HX40M
Maximum pressure	bar	-

Lubrication

Oil	type	SAE 15 W40/E 3 /
Oil compliant with specifications		ACEA E3 / API CF4 / MIL L2104E/F
Total oil capacity on first filling	liters (kg)	16,5 (14,8)
Total oil capacity with sump at minimum level	liters (kg)	9 (8,1)
Total oil capacity with sump at top level	liters (kg)	14,5 (13)
Oil pressure, warm engine, minimum idling rpm	bar	≥ 1.2
Oil pressure, warm engine, maximum rpm	bar	≥ 3,8
Maximum allowed temperature	°C	120
Oil dipstick valid for static inclination	degrees/360	+3 ÷ +6

Fuel Supply

Fuel oil compliant with standard			EN 590
Low pressure transfer pump			gear pump
Flow rate at maximum rpm		liters/h	250
Fuel return flow rate to tank		liters/h	240
Filtering:	pre-filter	µm	300
	filter	µm	4

Injection System

Type		Common rail
System		Bosch EDC 7
Maximum injection pressure	bar	1450

Low Temperature Starting

Allowed, without external aids, down to	°C	- 15

Cooling

Closed coolant loop with sea water heat exchanger		50% mixture of water/Paraflu II or equiv Compliant with SAE J 1034 specification
Total coolant quantity	liters	-
Engine-only capacity	liters	-
Expansion tank		standard
Forced circulation		centrifugal pump
Flow rate at maximum rpm	liters/h	-
Temperature regulation		with thermostatic valve
initial opening	°C	72 ± 2
maximum opening	°C	82 ± 2
Sea water line		forced circulation
Water pump		self-priming with neoprene impeller
Altezza pompa acqua mare da livello del mare	m	≤ 2
Max. pump capacity	liters/h	11700

Exhaust gas expulsion

Standard		mixed with sea water

Electrical system

Nominal voltage	V dc	12
Self-regulated alternator:		
Voltage	V dc	14
Maximum current intensity	A	90
Electrical starter motor:		
Nominal voltage	V dc	12
Absorbed electrical power	W	4000
Recommended battery capacity	Ah	≥ 120
Current discharge at - 18°C (SAE J 537)	A	≥ 900

Drive train coupling

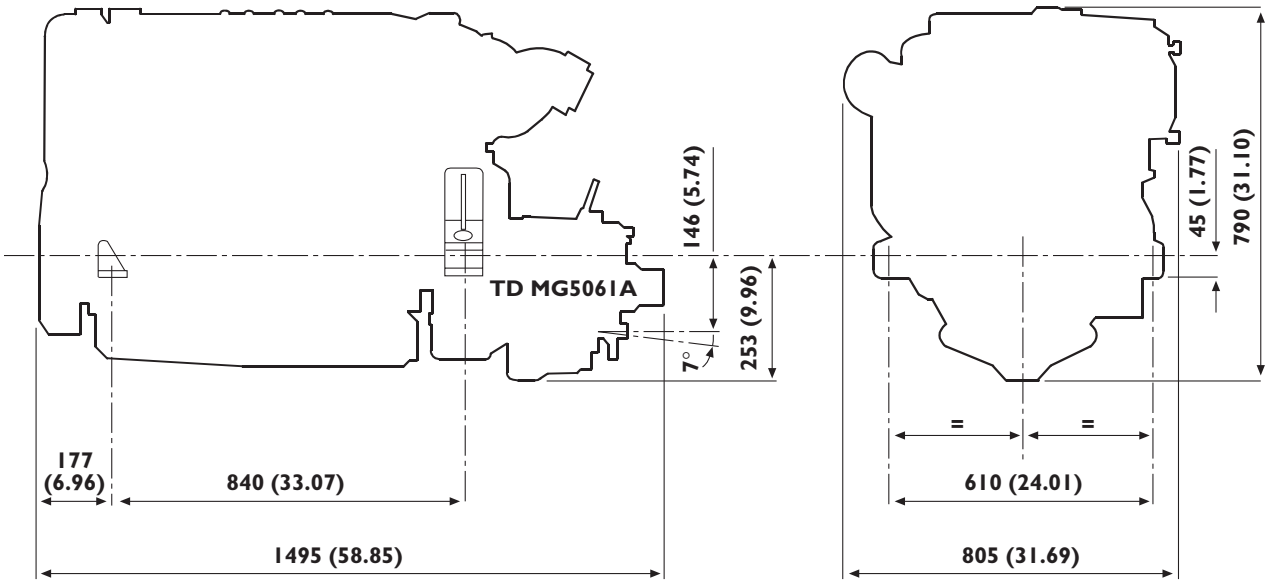
Flywheel diameter	mm (inches)	- (14)
Flywheel case	type	SAE 3

Weights

Without liquids and without inverter	kg	605
Without liquids with TDMG 5061 A inverter	kg	720
Without liquids with ZF 280 A inverter	kg	698

Dimensions

Figure 5



Measurements in: millimeters (inches)

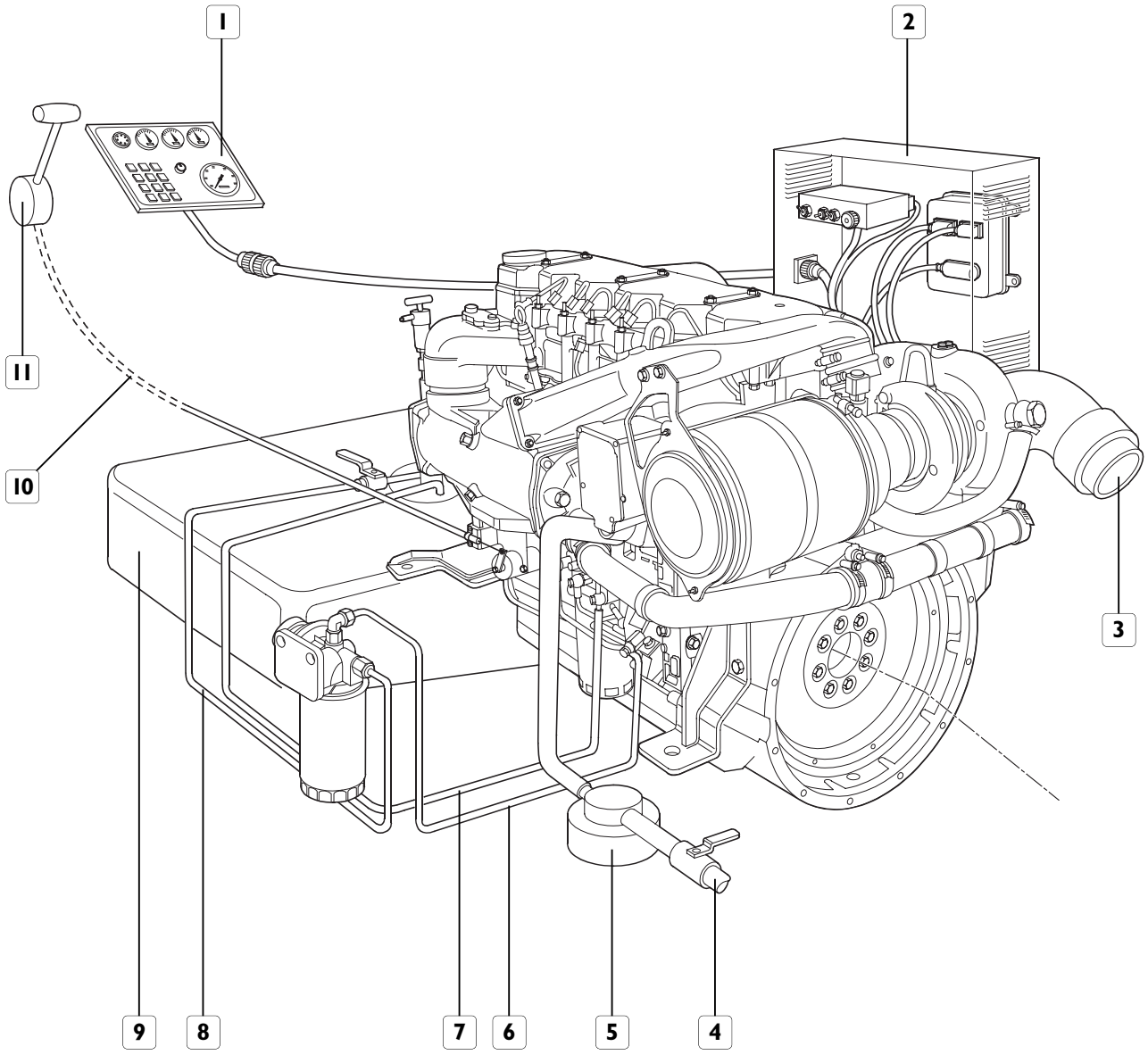
SECTION 2

Installation Instructions

Page

INSTALLATION OVERVIEW

Figure 1



1. Instrument panel – 2. Electrical system cabinet with Eletronic Central Unit and rele box – 3. Exhaust gas and sea water drain pipe – 4. Sea water suction – 5. Decanting filter – 6. Fuel feed pipe for high pressure pump – 7. Fuel tank return pipe – 8. Fuel suction pipe – 9. Fuel tank with suction/return assembly – 10. Linkage for throttle potentiometer operation – 11. Throttle lever

The figure shows the set of components of an installation including those supplied, as standard or optional items, with the engine equipment, and those supplied or built by the yard. The figure is meant to provide an overall picture of the operations required for engine installation.

Component positions and illustrations are not binding, but merely provided by way of indication, and they depend on the choices made by yard engineers according to their competence, to the spaces and the prescriptions set out in the chapter that follows.

CAUTIONS

While an electronically controlled injection system provides for better engine performance, it also makes it mandatory for installing and servicing personnel to comply with some fundamental rules that will surely become the norm as electronic engine control equipment becomes ever more widespread.
Boat fitters and servicing personnel are invited to familiarize themselves with the notes that follow and to contact IVECO Aifo personnel whenever compliance should prove impossible.

Failure to comply with the rules set out below shall void the warranty and exonerate IVECO Aifo from all liabilities.

Handling

The engine shall be handled by experienced personnel, using the prescribed tool or an equalizer that will keep the lifting lines parallel and with suitable equipment in terms of load bearing capacity and size.
The two padeyes provided for lifting the engine alone shall always be used simultaneously.

Installation

- Use of knife switches or battery disconnects on the EMB power supply line is not allowed.
- Do not modify wiring; wire length cannot be changed.
- Use only electronic device wiring compliant with the IVECO standard, in terms of length, conductor type, location, clamping, shielding and grounding braids connection.
- To avoid any interference, the wiring for devices other than engine electronic systems must follow different paths.
- Do not connect any extraneous device to the engine electrical equipment.
- Do not provide electrical voltage to the boat's system before first verifying that there are no short circuits.
- Do not insert pipes for drawing fuel from the engine fuel supply pipelines.
- Do not make any modification to the engine's hydraulic circuits and components.
- Do not perform any electric arc welding operations without first removing the electronic units from the seat, placing them at a suitable distance for safety.
- Do not subject electronic units to temperatures exceeding 80°C.
- Do not paint electrical components and connections.
- Do not alter the data contained in the engine control unit.
- Tighten threaded elements according to the prescribed procedures and torque values.

Engine's first start

Follow the procedure set out in the paragraph entitled "Engine's first start / Restoring normal operating conditions" at the end of this section.

Use and Servicing

- When starting the engine the first time, have available appropriate means to shut off combustion air intake in case of runaway speed rate.
- Never disconnect the batteries electrically when the engine is turning.
- Remove the batteries' electrical connections before any operation on the electrical system.
- Ensure that battery terminals comply with the correct polarity, that they are properly tightened and protected against any short circuits and corrosion phenomena.
- Do not connect or disconnect electrical connections on live circuits.
- Do not cause any sparks in the attempt to verify the presence of electrical voltage.
- Do not draw fuel from tanks made of copper alloys and/or with pipes lacking filtering systems.
- Do not wash the engine and its components with corrosive or abrasive detergents, to avoid jeopardizing the operating condition of the electrical connections.

Prolonged engine inactivity

The end of this section contains a list of the steps for preparing the engine before long inactivity periods, and for restoring it to its operating condition.

DESIGN STANDARDS

Accessibility

The engine shall be located in such a way as to allow to refill and drain engine fluids as required by servicing operations and to provide, even when underway, for easy access to Relay Box and to the diagnostics push-button on it.

Securing

Securing shall be accomplished by means of elastic blocks able to support the engine's mass and the longitudinal thrust exerted by the propeller shaft when in motion.
Dimension and fastening information is provided in the "Installation Diagram".

Combustion and Ventilation Air

Compliance with prescriptions on the quantity of air necessary for combustion and ventilation assures regular engine operation even under adverse conditions and allows the engine to reach its maximum design power output. (1)

Sea Water Pipeline

It shall be provided with an inlet suitable for preventing extraneous bodies from entering the intake pipe. Between the inlet and the pump it is advisable to place a gate, to be closed in case of emergency or for extended stops, and a filter to hold the smaller impurities; it is also advisable to install a suitably sized, easily replaced zinc anode.
The engine sea water pipeline is fitted by the manufacturer with protective anodes to be replaced periodically.
The rubber hoses positioned along the pipeline shall be sufficiently rigid to avoid creating choke points due to pinching. (1)

Enginepre-heating

In case of usage requiring maximum power output immediately, installation of an auxiliary pre-heater on the closed cooling loop is recommended.

Exhaust gas discharge

The exhaust gas discharge pipeline shall be positioned in compliance with the indications contained in the IVECO Aifo Publication "Marine Engine Installation Manual", which also provides indications for the dimensional computation of the exhaust pipeline although the Yard remains responsible and liable for them.

Electrical-electronic equipment

Provide for a suitable setting of the engine control electronic unit and of the relay Box, referring to the dimensions and disposition of the wiring and connectors.
Both units shall be fastened in such a way as to dampen the vibration and stresses the hull undergoes while underway and/or induced by the running engine.

(1) The EDC electronic engine control is programmed to reduce maximum power output whenever the operating parameters measured by the sensors indicate that critical conditions have been reached which, if exceeded, would lead to the risk of damaging the engine.

TECHNICAL DATA FOR INSTALLATION

Combustion and ventilation air when underway

Static vacuum allowed downstream of the air filter	kPa mmH_2O	≤ 3,5 ≤ 350
Combustion air flow rate	m^3/h	≥ 1050
Engine room ventilation air flow rate	m^3/h	≥ 3500
Static vacuum allowed in the engine room	kPa mmH_2O	≤ 0,1 ≤ 10
Temperature allowed in the engine room	°C	≤ 50
Temperature increase in the engine room to ext. temperature	°C	≤ 15

Exhaust gas discharge

Allowed static back pressure	kPa mmH_2O	≤ 10 ≤ 1000
Temperature at maximum power	°C	635 ± 25
Flow rate at maximum power	kg/h	1300
Outer diameter of exhaust mixed with sea H_2O	mm inches	45 1,77

Fuel supply

Transfer pump delivery at maximum rpm	litres/h	≤ 250
Flow rate return to tank	litres/h	≤ 240
Fuel temperature to allow maximum power	°C	≤ 80
Inner diameter, intake pipe	mm	≥ 8
Inner diameter, return pipe	mm	≥ 8
Thread on pre-filter junctions	M	12 x 1,5
Free height below filter to replace filter	mm	≥ 30

Open sea water cooling line

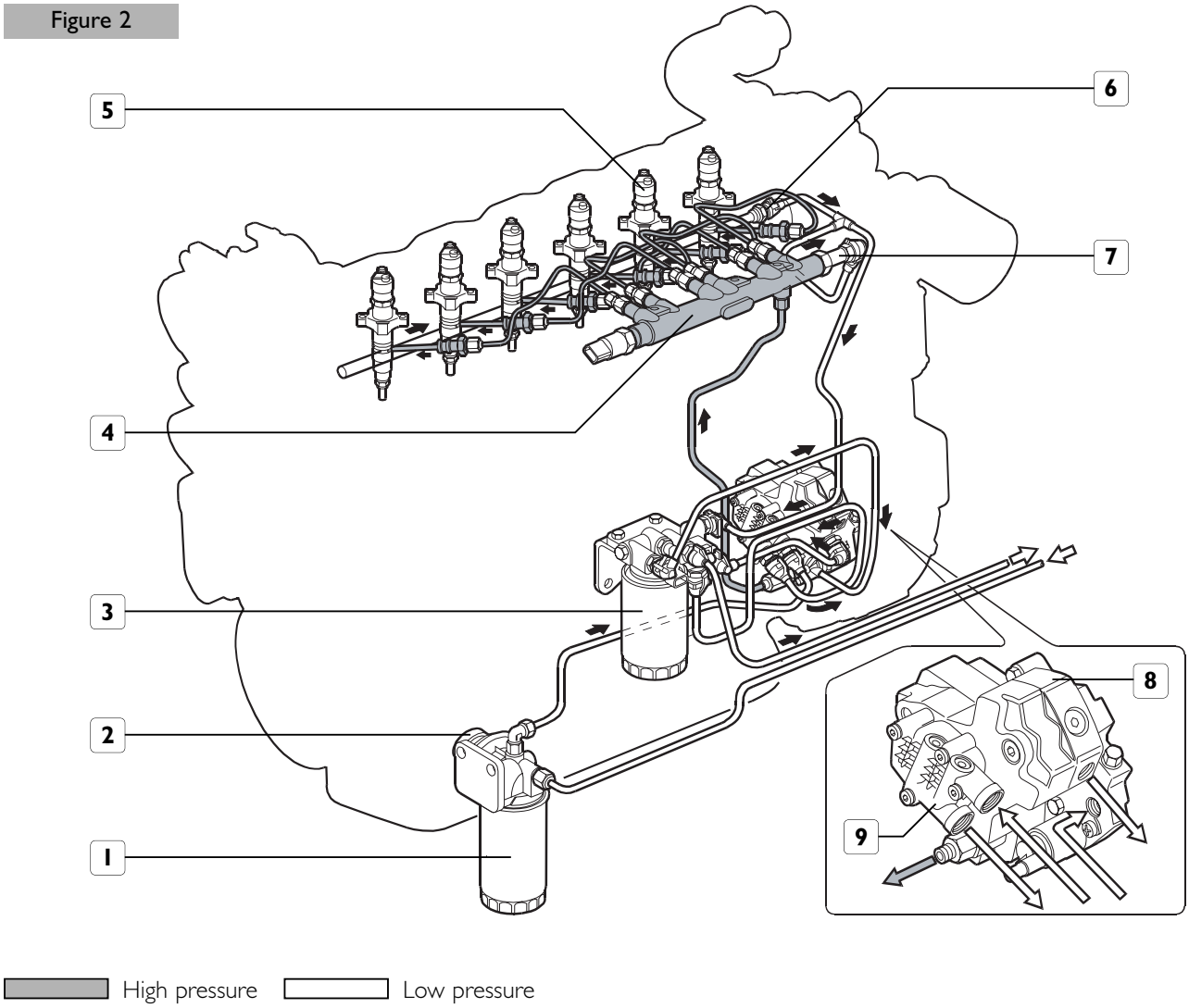
Intake pipeline diameter	mm inches	45 1,77
Pump delivery at maximum rpm	l/h	11700
Altezza pompa acqua mare da livello del mare	m	≤ 2
Allowed intake vacuum	kPa mmH_2O	≤ 20 ≤ 2000
Discharge pipeline diameter	mm inches	45 1,77

Engine inclination angles in continuous operation

Statical minimum/maximum	degrees/360	+3 / +9
Maximum longitudinal (static + dynamic)	degrees/360	+ 18
Maximum transverse (static + dynamic)	degrees/360	± 23
Oil dipstick valid for static inclination	degrees/360	+3 ÷ +6

FUEL LINE

Figure 2



1. Prefilter - 2. Primping pump - 3. Filter - 4. Common rail - 5. Electroinjector - 6. Pressure relief valve - 7. Overpressure valve - 8. High pressure pump - 9. Gear pump.

Pre-filter

The pre-filter with primping pump, supplied separate from the engine, must be adequately fastened in such a way as to enable easily to replace the filtering cartridge and/or to operate the pump.
To avoid introducing impurities in the feeding pipelines inside the engine, we reccomend not installing filtering cartridges previously filled with fuel in the system.

Material Characteristics

The fuel tank, the suction and return assembly and the feed pipes shall withstand the continuous abrasion caused by a 250 l/h flow of fuel oil at a temperature of 120°C without noticeable warping, wear, or release of material.
Use of metallic materials, though not copper alloys, is allowed provided they are connected to the battery's negative terminal to avoid the accumulation of electrostatic discharges.
The tank shall be provided with a vent to prevent internal pressure from exceeding ± 5kPa (± 0.5 mmH_2O).
Fuel tank and suction assembly shall be so shaped as to assure suction even at the maximum longitudinal and transverse inclination allowed for the boat, with a residual quantity of fuel oil considered "reserves".

It is best to position the intake inlet in such a way as to prevent the intake of sludge. The return flow must occur in such a way as to promote the mixing of the returning fuel oil with the fuel oil present internally. If the tank is positioned below the filter, the return pipe must always be submerged.

The pipes and junctions of the fuel line must withstand a fuel oil flow with a rate of 250 l/h at a temperature of 120°C and a pressure of 3 bar (300 kPa) without noticeable warping, wear or release of material. Metallic pipes are allowed, e.g. steel, but not copper or copper alloys, taking care to connect to engine ground each individual segment to prevent the accumulation of electrostatic discharges and insert an elastic vibration damping joint on each segment.
The pipes to be used shall be certified according to the regulations currently enforced in individual Countries (EC, Classification Agencies, etc.).

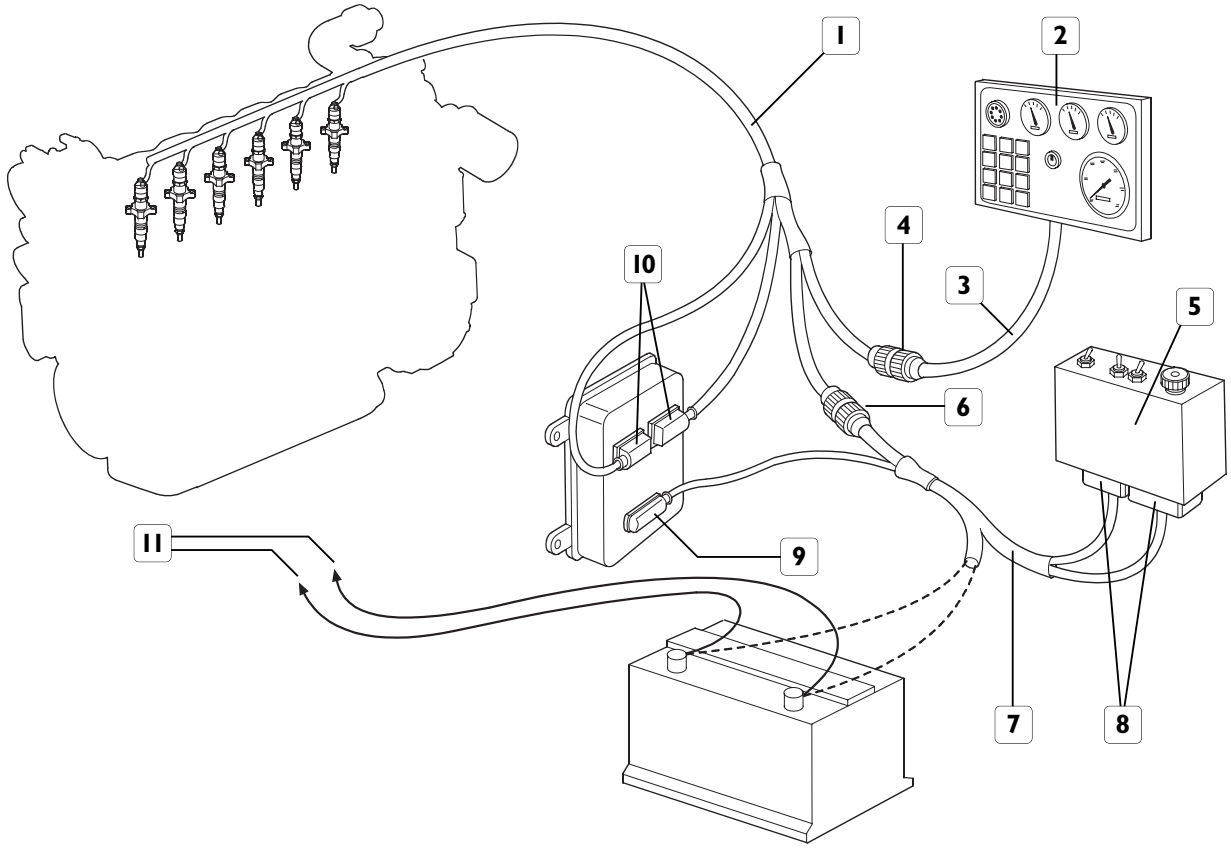
ELECTRICAL CIRCUIT

General notes

DO NOT USE wiring belonging to the engine's electrical equipment to supply power to other devices in the boat.
PLACE engine electrical wiring independently from the other wiring installed on the boat.
USE of knife switches or battery disconnects on the EMB power supply line **IS NOT ALLOWED**.
EXTREME CARE SHOULD BE PLACED in the polarization of the electrical connections and in the correct coupling of their retention elements.

Electrical equipment

Figure 3



1. Engine electrical wiring - 2. Instrument panel - 3. Specific wiring - 4. JB connector - 5. Relay box - 6. JA connector - 7. Power and interface wiring harness - 8. JF1 and JF2 connectors - 9. A2 ECU connector - 10. A and A1 ECU connectors - 11. Power grid for starter motor and alternator.

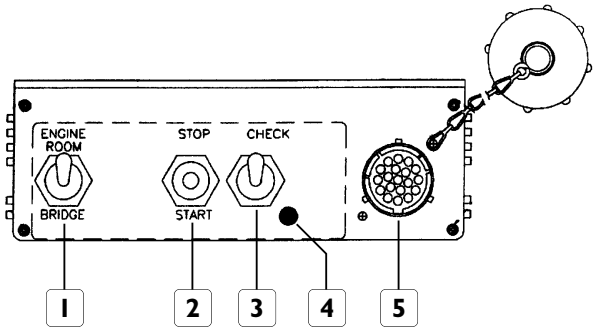
The electrical equipment of the engine comprises a series of components supplied separately from the engine, to allow for easy and diversified installation, according to the Yard's design choices. The need for easy access, even at sea or underway, for inspections on electrical components and to the diagnosing connector contained in the relay box can be met with different arrangements.

ECU

This is the electronic unit that oversees the management and control of the engine's operation.
It shall be positioned vertically, in compliance with the length of the wiring and the orientation of the connectors. It must be supported in such a way as to dampen the vibration and stresses the hull undergoes while underway and/or induced by the running engine.

Relay box

Figure 4



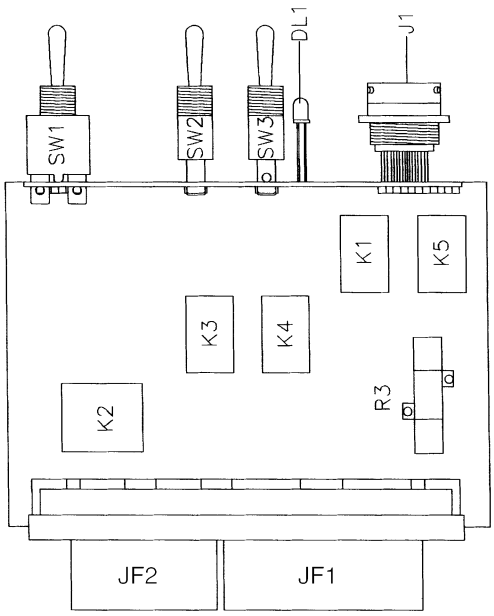
It shall be installed and fastened in such a way as to dampen the vibration and stresses that occur while underway. It must also be possible to access it for servicing and underway. The electrical controls on the panel enable to start and stop (2) the engine directly from the engine room, while preventing inadvertent engine starts from the bridge (1) during servicing operations. Among the controls on the panel are also the push-button (3) and the blink code light indicator (4), useful to obtain, even when underway, indications to identify any casualties or anomalous engine operation (see "Diagnosis" section).

Also provided is the multipolar connection, protected by a screw-on lid (5), to be used to connect with the computerized diagnosing tools provided by IVECO (see "DIAGNOSIS" section).

Inside the box, anchored to a printed circuit board, are the relays for the power management of some components and the elements that protect electrical lines from accidental short circuits or excessive current absorption. These components serve a similar purpose to that of fuses, almost entirely avoiding the need for intervention to restore the electrical continuity of faulty circuits. The components are able to limit and cancel short circuit currents without actually melting, restoring their own electrical continuity as well as the circuit's when the cause of the fault is removed.

Relay functions

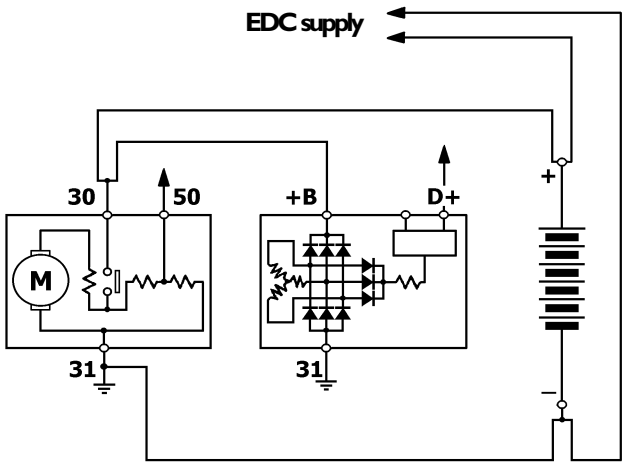
Figure 5



K1. Heating element on fuel filter;
K2. Starter control;
K3. Key switch discharge;
K4. Engine shut down;
K5. Crank request from key switch to EDC unit.

Power grid

Figure 6



Ensures with two different lines the connection of the battery to the engine control system and to the electric starter motor and to the alternator.
The connection between relay Box and ECU with the accumulator is achieved through a wiring terminated with the connectors JA - JF1, JF2 - A2 of the ECU.

The connection between the terminal **+B** of the alternator and the positive terminal **+30** of the electric starter motor must be achieved with a conductor whose cross section is at least 16 mm^2.
The connection of the positive terminal **+30** of the electric starter motor to the positive pole of the battery must be achieved with a conductor whose cross section is at least 70 mm^2 and it allows to obtain, as shown in Figure 6, the simultaneous connection to the alternator.
The connection between engine ground and the negative pole of the accumulator must be accomplished according to the indications provided in the previous paragraph.
To have a sufficient quantity of energy available when starting the engine, we recommend installing two series of dedicated batteries separately, the first for starting the engine and powering the injection system, the second one for on-board electrical machinery. The battery used to power the machinery may be recharged by interposing on the power supply line a relay commanded by the voltage of the alternator's electronic regulator recharge signal (D+).

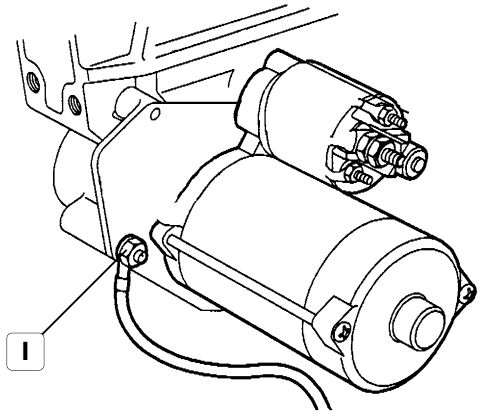
WARNING

If magneto-thermal protection and intervention devices are interposed, they must not be used to shut the engine down or otherwise used just a few seconds after shutting the engine down.

Engine Electrical Ground

The engine electrical connection is achieved by connecting, with a 70 mm^2 cable, the negative terminal of the battery to the fastening point of the electrical starter motor as shown in Figure 7.

Figure 7

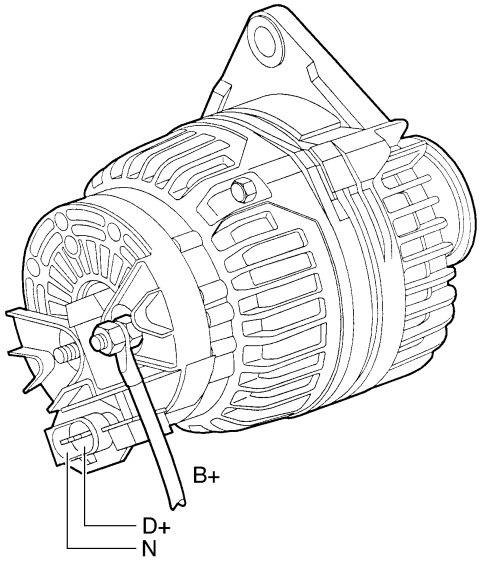


1. Engine electrical ground connection point.

The grounding terminal is secured to the motor proceeding as follows:
Completely remove the conducting paint or the old conducting paint from both parts constituting the connection, either with mechanical means or with a suitable chemical product; if parts whose surface has been treated need to be used for the securing operation, first completely remove the anaphoretic paint by mechanical means, obtaining a smooth support plane.
Apply a uniform layer of the BH44D product (IVECO Standard 18-1705) with a brush or spray gun.
Join the parts constituting the ground node within 5 minutes after applying the product.

Battery recharge

Figure 8



B+ wired to + 30 of electrical starter motor -
D+ - N not used.

Takes place through the power supply line of the electric starter motor and the connection to the +B of the alternator. The electronic regulator of the alternator that equips the motor allows effective control over battery recharging.

If installation requirements call for positioning the batteries at a distance from the engine, we recommend increasing the section of the power line conductors and to verify the effectiveness of the recharging by measuring the voltage across the battery poles.

Instrument and control panel

Supplied on request by IVECO Aifo, it is connected to the electrical circuit with different lengths of wiring.
Technical information and data for the manufacture of panels by the Yard must be requested from the IVECO Aifo technical assistance service.

Throttle Position Sensor

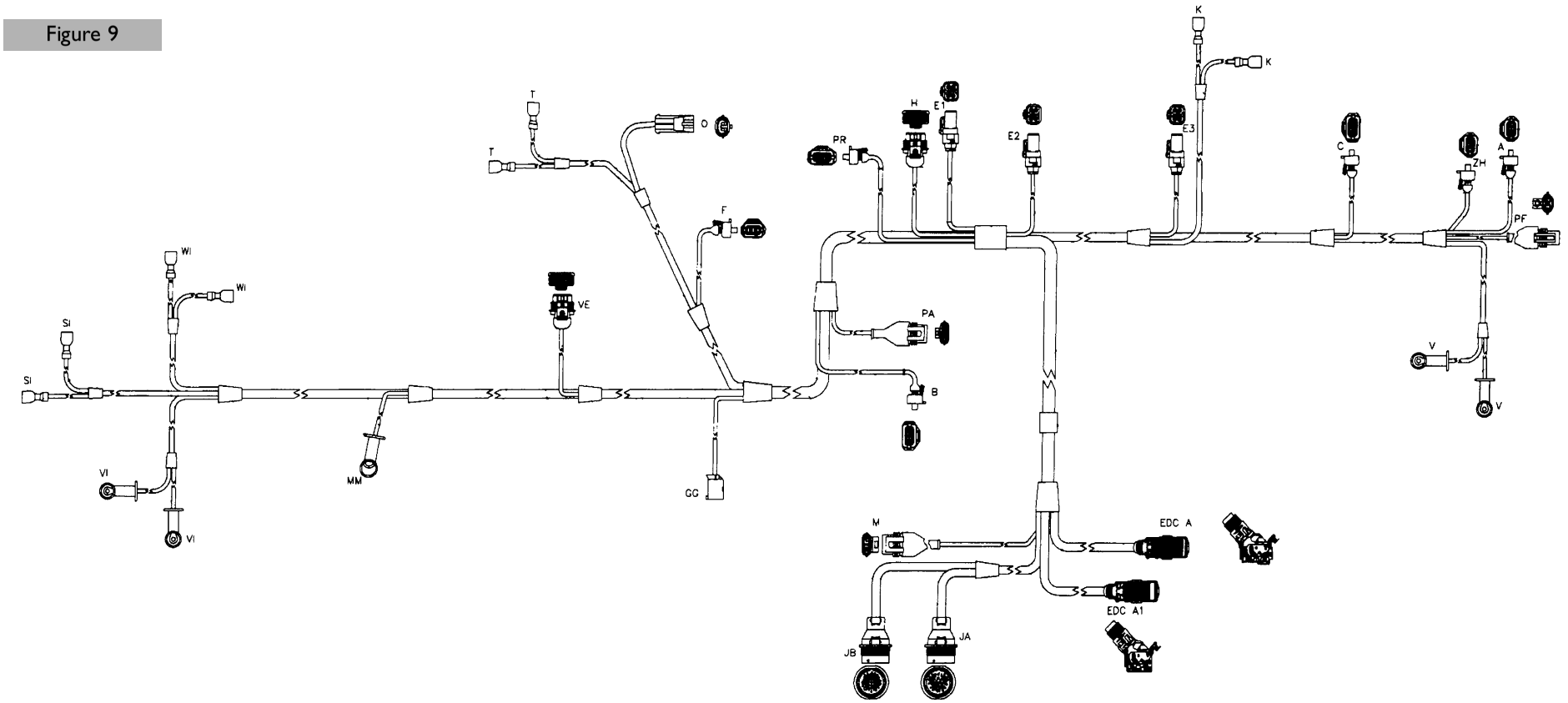
After testing the operating condition of the linkage, adjust the travel of servo components so that:

- ❏ With the throttle at idle, the potentiometer rod is in the resting position.
- ❏ With the throttle at the maximum rpm stop, the rod of the potentiometer is in the maximum travel position.

ENGINE ELECTRICAL WIRING

Position of connectors for standard components and optional equipments

Figure 9



EDC A. ECU connector - EDC A1. ECU connector - JA. Connector for power supply and interface wiring - JB. Connector for instrument and controlo panel - E1. Electroinjector 1 - 2 connector - E2. Electroinjector 3 - 4 connector - E3. Electroinjector 5 - 6 connector - ZH. Electrovalve high pressure pump - B. Flywheel sensor - C. Timing sensor - PR. Rail pressure sensor - H. Intake air pressure and temperature sensor - VE. Oil pressure sensor - F. Coolant temperature sensor - A. Fuel temperature sensor - PA. Throttle position sensor potentiometer - MM. Electric starter motor - T. Coolant thermal switch - V. Oil pressure switch - K. Air filter clogged switch - PF. Fuel filter heater - GG. Alternator D+ (DF) - M. Sensor for detecting presence of water in the fuel filter.

OPTIONALS

V1. Oil gear pressure sensor - S1. Oil gear temperature sensor - W1. Oil gear pressure switch - O. Thermocouple sensor for exhaust gas

INSTALLATION TESTS

"Common sense" tests, such as exposing heat-sensitive parts to heat (plastic, wiring, electronic units, etc.…..), and those that for years have characterized the quality of the work performed in yards, are not mentioned herein, although they are of the utmost importance.

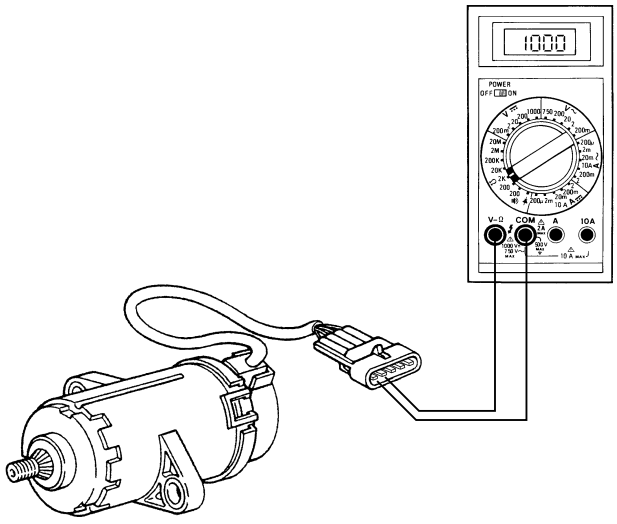
Tests to verify the engine's and the electronic control system components' operating condition can be performed quickly and with top reliability using specific diagnostic tools, available to the IVECO Aifo Technical Assistance Centers.

Fuel Tank Suction

Check assembly suction at the maximum allowed longitudinal and transverse inclinations, with such a residual quantity in the tank as to cause the reserve indicator light to stay on permanently.
If there are symptoms indicating that air may be present in the fuel supply line, a clear see-through pipe can be placed in inverted "U" position before the engine inlet joint.

Throttle Position Sensor

Figure 10



Verify, in the idling and maximum rpm positions, the correlation between the throttle on the bridge and the sensor rod, noting:

- ❑ Whether, with the lever in the idle position, the switch in the sensor is electrically open. Measure by an ohmmeter between the points D and E of the potentiometer connector with readings of:
- Measured value ∞ Ω = optimal adjustment;
- Measured value 1 kΩ = the resting position requires better mechanical adjustment, to bring the value back to ∞ Ω.
- ❑ With the throttle at the maximum rpm stop, the rod of the potentiometer is in the maximum travel position.

First Start

Prepare the engine's first start as set out in the paragraph entitled "Engine's first start / Restoring normal operating conditions" at the end of this section.
Before starting the engine the first time, it is necessary to verify lubricant oil and coolant liquid levels and completely purge the air from the fuel supply line, acting on the hand pump of the pre-filter or with the aid of a dedicated electrical pump. Purge valve is provided on the pre-filter supplied by IVECO Aifo.
Loosen the bleeder stopper on the pre-filter and operate the pump until fuel with no air bubbles comes out.
Tighten the bleeder stopper and continue to pump during the initial starting stages.

CAUTION

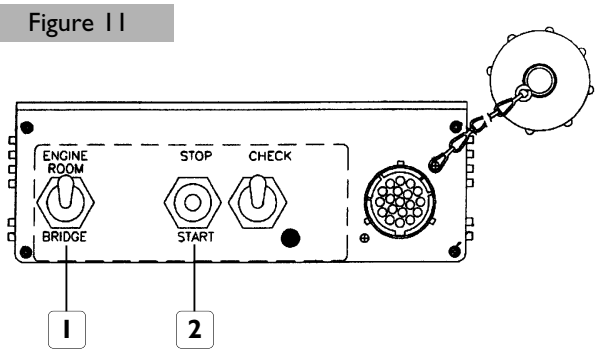
Never attempt to bleed air out of the high pressure system: it would be useless and extremely dangerous.

Carefully prevent the fuel from coming in contact with the auxiliaries drive belt.
Also check that:

- There are no water leaks from the connecting hoses of the cooling loop pipes.
- There are no exhaust gas leaks inside the hull.

Starting procedures

Figure 11



The electrical equipment of this engine enables to start the engine both from the vessel's Engine Room and from the Bridge.

Starting from the "Engine Room"

By setting the switch (1) of the relay Box to the "ENGINE ROOM" position (which must never be done while the engine is running), irrespective of the position of the key switch on the instrumentation and control panel, use of the adjacent STOP - START push-button (2) is enabled. The engine can now be started and stopped independently from the bridge controls.
If the switch (1) is placed back in the "BRIDGE" position, use of the START - STOP push-button on the Box will be disabled, allowing operation only from the bridge controls.

Starting from the bridge

With the switch (1) of the Relay Box in the "BRIDGE" position, the engine can be started using the solution set up by the yard on the control panel.

RPM control

To allow for easy control over engine rpm from the "engine room", in the "start" function a simultaneous function SET+ / SET-, active only when the switch (1) is in the "ENGINE ROOM" position

SET +

If the "start-stop" push-button is pressed to the "start" position while the engine is running, a progressive increase in engine rpm is obtained; the increase ends when the push-button is release, letting the engine run at the desired rpm.

SET –

If the "start-stop" push-button is again brought to the "start" position, after releasing it during the engine rpm increase phase, engine rpm decreases progressively; when the push-button is released, the function is inhibited and the rpm reached at that point is maintained.

Note: any additional operations on the push-button will alternatively enable to increase and decrease engine rpm. The "stop" function takes priority and always causes the engine to stop.

CAUTION

NEVER operate the "BRIDGE - ENGINE ROOM" switch with the engine running

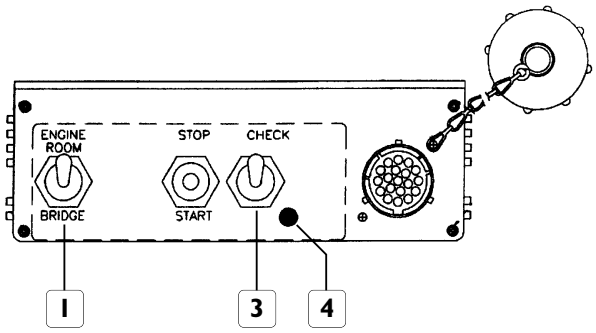
Instrument and Control Panel

Check the operation of all indicator lights simulating the behavior of the sensors connected to them.

Delete any errors that may be stored in the engine electronic control unit.

Fault memory reset

Figure 12



A. Shut the engine down, rotating the key switch to the "OFF" position.

B. Move close to the relay box. Keeping the "CHECK" push-button (3) pressed, operate the adjacent "BRIDGE - ENGINE ROOM" switch (1), setting it in the "ENGINE ROOM" position while keeping the check push-button for 8 more seconds.

C. Release the push-button and set the "ENGINE ROOM" switch to the "BRIDGE" position.

At the end of this procedure, the ECU will have erased the codes of any anomalies detected during the engine installation and 1st start operations. To make sure that no anomaly data remains stored in the unit or that no other faults are present in the system, set the "BRIDGE - ENGINE ROOM" switch to the "ENGINE ROOM" position; when the check push-button is pressed, the flashing code indicator light (4) must not emit any codes.

At the completion of these operations, place the switch back on the "BRIDGE" position.

If the ECU detects the presence of errors or operating anomalies, the indicator light will emit the code of the first stored error with two series of flashes of different frequency; after a few seconds have elapsed from the end of the emission, the codes of any subsequent errors will be emitted if the push-button is pressed again. The repetition of the first of the emitted code will indicate that all information contained in the memory have been emitted.
Such an event will require a review of the installation, in order to remove the cause of the error or of the anomaly. The table containing the explanation of each code is provided in the "DIAGNOSTICS" section.

Electrical power supply to the system

Verify that the power supply voltage across the battery, after 15 minutes underway and with engine running, is no less than about 13 V.

ECU Temperature

Check whether the temperature of the surface of the electronic engine control unit, after 30 minutes with the engine at maximum power output, is less than +70°C.

Engine Compartment Vacuum

Verify that ambient pressure in the engine room, with the engine at full load and maximum power output, complies with the technical data set out herein.

Combustion Air Temperature

Verify that temperature in the engine room, after 30 minutes underway with the engine at maximum power output, does not exceed 50°C, or +15°C over outside temperature.

Exhaust Back-pressure

Verify that the back pressure at the inlet of the exhaust gas duct, with the engine at full load and maximum power output, complies with the technical data set out herein.

Exhaust Temperature

Verify that the temperature of the exhaust gas under maximum power conditions is close to the prescribed value.

CAUTION

The propeller absorption curve can be obtained with the PT01 instrument, reading the fuel introduction value, at increasing rpm from idling to maximum power at intervals of 200 rpm.

Fuel Temperature

Verify that temperature of the fuel in the transfer line, while underway at maximum power output and with a stable quantity of fuel in reserve does not exceed 80°C. A higher value would lead to a reduction in engine performance due to the safety strategies built in the electronic control unit. If the fuel tends to reach the maximum allowed temperature, install a heat exchanger for the fuel.

Pressure in the fuel supply line

To assure the regular operation of the engine and the reliability of the components of the fuel supply and injection system, the following must be verified:

- ❑ vacuum in the fuel oil line to the transfer pump is less than 0.5 bar relative (5000 mm H_2O);
- ❑ pressure in the fuel oil return line to the tank is less than 0.2 bar relative (2000 mm H_2O).

To conduct the measurements, insert a "T" fitting near the fuel inlet and outlet, carefully avoiding the intake of air. The values must be read at variable rpm from idling to maximum power at 200 rpm intervals.

PREVENTIVE MAINTENANCE IN CASE OF PROLONGED ENGINE INACTIVITY

To prevent oxidation to the inner parts of the engine and some components of the injection system, if periods of inactivity exceeding two months are expected, the engine must be prepared every six months by proceeding as follows:

1. Drain the lubricating oil from the sump, after heating the engine.
2. Fill the engine with protective oil type 30/M (or MIL 2160B type 2) up to the "minimum" level indicated on the dipstick.
   Start the engine and let it run for about 5 minutes.
3. Drain the fuel from the injection line and from the filter, taking care to prevent the fuel from coming in contact with the auxiliaries belt.
4. Connect the fuel line with a tank containing CFB protective liquid (ISO 4113) and let the liquid enter the by pressurizing the line and turning the engine over for about 2 minutes, after excluding the operation of the injection system. The required operation can be completed by directly polarizing the terminal 50 of the electric starter motor with 12V positive voltage, by means of a conductor prepared for the occasion.
5. Nebulize about 60 g (10 g per liter of displacement) of protective oil type 30/M into the intake mouth of the turbocharger, while turning the engine over as described in the previous paragraph.
6. Close all the engine's intake, exhaust, aeration and vent ports with appropriate caps or seal with adhesive tape.
7. Drain from the oil sump the residual protective oil type 30/M, which may be reused for 2 more engine lay-ups.
8. Apply tags bearing the inscription "ENGINE WITHOUT LUBE OIL" on the engine and on the panel.
9. Drain the cooling liquid if it is not mixed with anticorrosive substances.

If exterior parts of the engines are to be protected as well, spray OVER 19 AR protective liquid on unpainted metal parts, such as flywheel, pulleys and others, taking care not to spray it on belts, connecting cables and electrical equipment.

ENGINE'S FIRST START / RESTORING NORMAL OPERATING CONDITIONS

1. Drain the residual protective oil type 30/M from the sump.
2. Pour lubricating oil into the engine, as provided by the specifications and in the quantities set out in the Table of Refills.
3. Drain the CFB protective liquid from the fuel line, completing the operations set out in item 3 of "PREVENTIVE MAINTENANCE IN CASE OF PROLONGED ENGINE INACTIVITY".
4. Remove the caps and/or the seals from the engine's intake, exhaust, aeration and vent ports, restoring normal operating conditions. Connect the turbocharger intake to the air filter.
5. Attach the fuel lines to the vessel's fuel tank, completing the operations set out in item 4 of "PREVENTIVE MAINTENANCE IN CASE OF PROLONGED ENGINE INACTIVITY". During the filling operations, attach the fuel tank return pipe to a collecting container to prevent residues of CFB protective liquid from flowing into the vessel's fuel tank.
6. Verifiy the quantity of cooling liquid and refill as provided by the specifications.
7. Start the engine and keep it running until idling speed has completely stabilized.
8. Shut the engine down and delete the "errors" which may have been stored in the injection system ECU during the operation stabilization phases. For reset operation, see "Blink code" paragraph at page 3 in the next section.
9. Remove the tags with the inscription "ENGINE WITHOUT LUBE OIL" from the engine and from the panel.

SEZIONE 3

Diagnostics

ECU BEHAVIOR

Fault Indicator Light

The ECU continuously monitors its own operating conditions as well as those of the components connected to it and of the engine itself, with complex self-diagnostics routines.
If faults are detected, the fault indicator light on the indications and control panel is lit in ways that provide an initial indication of the severity of the problem.

Light off: no fault detected or minor fault that does not compromise operating safety.

Light on: significant fault, allowing to proceed to a diagnostics center.

Blinking light: severe fault, requiring immediate servicing if circumstances allow shutting the engine down.

Blink Code

The emission of the fault codes detected by the self-diagnostics routines and stored in the ECU starts after the push-button located on the relay box is pressed and released.
The LED to the side of the push-button and the EDC indicator light on the indications and control panel will simultaneously signal the codes by blinking two series of emissions at different frequency, reproducing the digits indicating the fault with decimal numbering.

Slow blinking indicates the area of the fault (engine, injectors, …), **fast blinking** indicates a specific fault.

Every time the push-button is pressed and released, only one of the stored codes is emitted; therefore, the procedure needs to be repeated until the system emits the same error data as the first one: this will mean that the entire fault memory has been analyzed.

If there are no faults present in the system, the EDC indicator light will not communicate any information, illuminating only once.

Note: The blink code diagnostic procedure provides indications about faults that are currently present but also about other faults, which arose in the past and are no longer present at the time of the diagnostic procedure. Therefore, it is absolutely necessary, at the end of each servicing operation, to reset the fault memory to prevent the system from signaling faults, in the future, whose cause has already been removed.

Fault memory reset

To reset the memory, proceed as follows:

1. Stop the engine and keep the key switch in the "OFF" position.
2. Move close to the relay box. Keeping the "CHECK" push-button pressed, operate the adjacent "BRIDGE - ENGINE ROOM" switch, setting it in the "ENGINE ROOM" position while keeping the check push-button for 8 more seconds.
3. Release the push-button and set the "ENGINE ROOM" switch to the "BRIDGE" position.

The completion of the reset procedure will be confirmed by operating the check push-button again and obtaining no codes from the blink code indicator light.

Recovery

Associated to the detection of significant or severe faults, the ECU adopts strategies that, to allow safe use of the engine, limit performances within pre-set thresholds according to the severity of the situation.

As a result of these strategies, the engine's maximum power output is reduced. In case of intermittent faults, i.e. faults that are detected by the ECU and subsequently are no longer present, performance reduction will be active until the engine is shut down.

Normal operation will be restored only at the subsequent start-up, while the fault data will be "saved" in the fault memory.

BLINK CODE TABLE

Blinking Code	EDC indicator light	Indicated fault	Max power reduction
		Control area	
1.1	(on)	not significant in marine applications	×
1.3	(on)	not significant in marine applications	-
1.4	blinking	throttle position sensor	×
1.5	(on)	not significant in marine applications	-
1.6	(off)	not significant in marine applications	-
1.7	(on)	not significant in marine applications	-
1.8	off	EDC lamp indicator	×
		Engine 1 Area	
2.1	on	water temperature sensor	-
2.2	off	air temperature sensor	-
2.3	off	fuel temperature sensor	-
2.4	on	supercharge air pressure sensor	×
2.5	off	ambient pressure sensor (inside the unit)	-
2.6	on	lubrication oil pressure sensor	-
2.7	on	lubrication oil temperature sensor	-
2.8	off	coil relay fuel heater	-
2.9	(on)	not significant in marine applications	-
		Engine 2 Area	
3.7	on	battery voltage	×
3.8	(off)	not significant in marine applications	-
3.9	(on)	not significant in marine applications	-
4.6	(on)	not significant in marine applications	-
		Injectors	
5.1	on	cylinder 1 electro-injector fault	×
5.2	on	cylinder 2 electro-injector fault	×
5.3	on	cylinder 3 electro-injector fault	×
5.4	on	cylinder 4 electro-injector fault	×
5.5	on	cylinder 5 electro-injector fault	×
5.6	on	cylinder 6 electro-injector fault	×
5.7	on	electro-injector cylinder 1-2-3 power driver	×
5.8	on	electro-injector cylinder 4-5-6 power driver	×
		Engine RPM sensor	
6.1	on	flywheel sensor	×
6.2	on	timing system sensor	×
6.3	on	engine speed signal plausibility	×
6.4	blinking	runaway engine	×
6.5	on	coil relay electric starter motor	-
6.6	off	revolution counter signal	-
6.8	off	synchronism trouble with diagnosis tool	-
		Fuel pressure	
8.1	blinking	fuel pressure control	×
8.2	blinking	fuel pressure signal	×
8.3	blinking	pressure regulator solenoid valve	×
8.4	blinking	twin stage valve tripping	×
8.5	blinking	MIN/MAX rail pressure error	×
		Electronic unit	
9.3	(blinking)	not significant in marine applications	×
9.4	on	main relay	-
9.6	on	after-run procedure not completed	×
9.7	on	sensor/ECU supply	×

IVECO *aifo*

Iveco Aifo S.p.A.
Viale Dell'Industria, 15/17
20010 Pregnana Milanese - MI - (Italy)
Tel. +39 02 93.51.01 - Fax +39 02 93.59.00.29
www.iveco.com