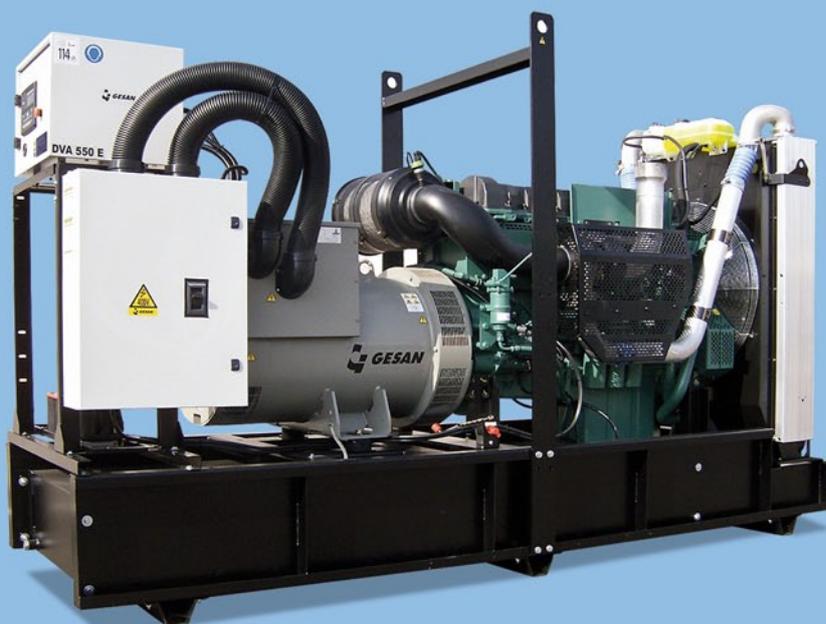


# USER'S MANUAL

# STANDBY GENERATOR SETS



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## 1. WELCOME

*Thank you for choosing a GRUPOS ELECTRÓGENOS EUROPA S.A.generator set.*

The purpose of this manual is to familiarize the user on how to use and work with the electrical generator, its components and maintenance.

We recommend a carefully reading this document prior to working with the equipment to ensure its correct use.

Save this manual for future reference and if the generator set is resold be sure to include the manual along with the unit.

The following is a general description of the unit and the information necessary for installation, operation and preventive maintenance.

Additionally, you should have received a specific user manual for the Engine and Alternator, electrical setup, a set of keys, ATS (upon order), silencer or exhaust tube and flexible tube (supplied separately for open-skid units).

Should you have any problem with the equipment provided, please contact the distributor directly.

GRUPOS ELECTRÓGENOS EUROPA S.A., in a constant effort towards product improvement, shall revise its manuals and include improvements made to the supplied units. Thus the information contained in this document is subject to change without prior notice and without obligation to update.

## 2. BASIC SAFETY RULES



Safety precautions and recommendations for handling the Electrical Generator supplied by GRUPOS ELECTRÓGENOS EUROPA S.A.

- 1) Do not allow the unit to be used by non-authorized personnel or minors not accompanied by an adult.
- 2) Use the necessary individual protection equipment.
- 3) Ground the machine and ATS panel.
- 4) Make sure there is sufficient lighting on the genset and on the control panels before start-up; the minimum lightning level should be 20 lux.
- 5) Do not install the open-skid electrical generator outdoors: risk of electrocution and non-functioning.
- 6) The connection should be made by a qualified electrician in accordance with current norms and regulations. An incorrectly made connection can cause electrical feedback with electrocution hazards for anyone working with the mains power supply. The mains connection should always be made using an automatic transfer switch (ATS); if none has been supplied, contact your distributor or GRUPOS ELECTRÓGENOS EUROPA S.A.
- 7) The supply line between the generator set and the consumers should be protected by means of a differential relay for protection against earth leakage.
- 8) The electrical installation between the generator unit and ATS should be protected using electromagnetic circuit breaker for protection against short circuits and overcurrents. The circuit breaker is supplied optionally by GRUPOS ELECTRÓGENOS EUROPA S.A.
- 9) Do not operate the unit with the doors open: risk of electrocution, burns or entrapment. Be sure the doors are closed with keys before the start-up.
- 10) The exhaust system generates enough heat to ignite some materials. Therefore, never install the generator set near flammable materials or near materials that may ignite easily or in locations where the risk of a fire occurring is high.
- 11) The gases generated by the set's engine are highly toxic and may result in death. Never inhale the exhaust gases generated by the set. If the unit must be operated in an enclosed area or in a poorly ventilated area, the engine exhaust gases must be routed towards the exterior for a safe operation.
- 12) Do not touch the engine or the exhaust during operation of the generator set: Severe burns may occur. The exhaust hot areas are protected against accidental contact. In areas where this type of protection is not feasible, the risk is indicated using appropriate signs.
- 13) Ensure proper ventilation in the area where the generator is installed in order to guarantee sufficient flow of cooling air.

- 14) Know how to stop the unit in case of emergency. Be special careful with his handling and storage.
- 15) For refueling the engine, the generator set incorporates an exterior fuel filler neck and cap for filling the tank with diesel. Never refuel with the engine running or in poorly ventilated areas; remember that fuel vapors are toxic and flammable. Take the necessary safety precautions when handling fuel; the use of gloves and safety goggles is recommended.
- 16) The fuel used is flammable, volatile and toxic. Prevent any spill and carefully wash your hands after handling.
- 17) If you notice abnormal behavior by the generator set, stop the unit, and then locate, examine and resolve the potential failure of the unit prior to restarting. Contact our technical services department if needed.
- 18) Keep the unit at least one meter away from buildings or other units.
- 19) Be cautious when switching or installing batteries as they contain acids which are highly hazardous. Avoid spills and use protection to avoid contact with the skin and eyes. In case of accidental contact, rinse thoroughly with water and contact a doctor service immediately.
- 20) In case of ingestion of battery acid, drink large amounts of water and milk and contact a doctor immediately.
- 21) Use only distilled water in the battery, the tap water
- 22) If a battery is filled above the maximum level, the electrolytes will spill out; if this happens, clean the area quickly to avoid corrosion of the parts it has come in contact with.
- 23) Frequently clean the unit to avoid obstructions or the entry of foreign elements into the unit (dust, moisture, etc.).
- 24) Regularly inspect the unit's electrical cables.
- 25) Engine oil is toxic and hazardous to the environment. Adopt the necessary safety measures when handling engine oil. Prolonged exposure to used engine oil may cause skin cancer. Carefully wash your hands after handling.
- 26) Avoid oil spills on both the inside and outside of the generator. In case of oil spill on the inside of the unit, clean it properly as it could potentially become a flammable material.
- 27) Do not overfill the tank and make sure it is closed properly after filling. Use extreme precaution if fuel is spilled: the vapors and the fuel itself are flammable. Clean the area completely before starting up the unit.
- 28) Do not smoke or bring any flames or sparks in the vicinity of the electrical generator: risk of explosions.

### 3. DESCRIPTION OF GENERATOR SET

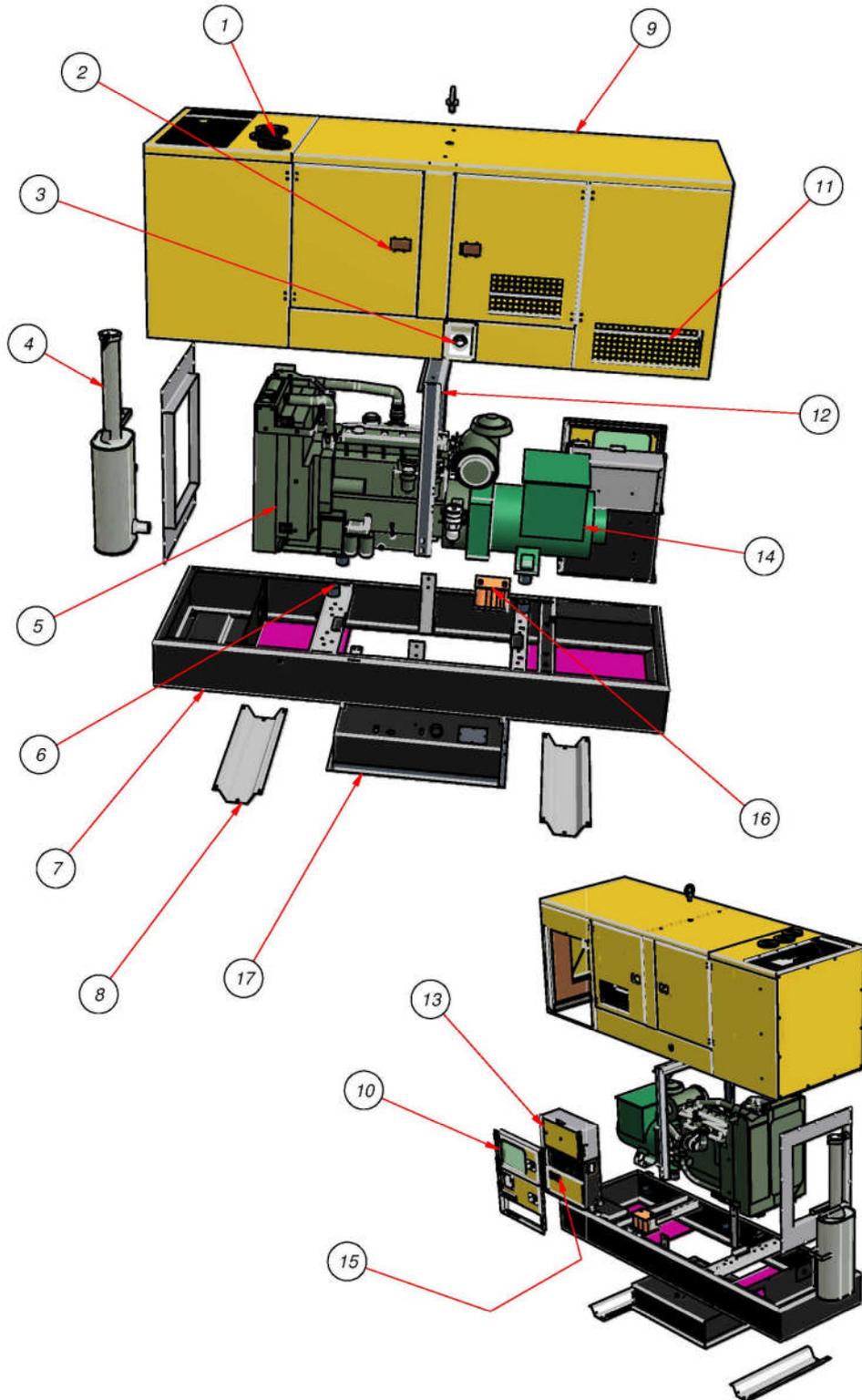
Following you have general overview of the generator set (doesn't match with the delivered genset) and its different configurations manufactured by GRUPOS ELECTRÓGENOS EUROPA S.A.



*Image 1- Generator set with sound proof canopy.*



*Image 2- Generator set without canopy*



*Image 3- Detailed view of Insonorized genset*

- 1) Coolant tank hatch
- 2) Side access door
- 3) Fuel tank cap
- 4) Exhaust silencer
- 5) Engine
- 6) Shock absorbers
- 7) Base frame
- 8) Base support
- 9) Canopy
- 10) Electrical Panel Doors
- 11) Ventilation grill
- 12) Lifting frame and eyebolt
- 13) Control panel
- 14) Alternator
- 15) Electrical power panel
- 16) Battery
- 17) Fuel tank

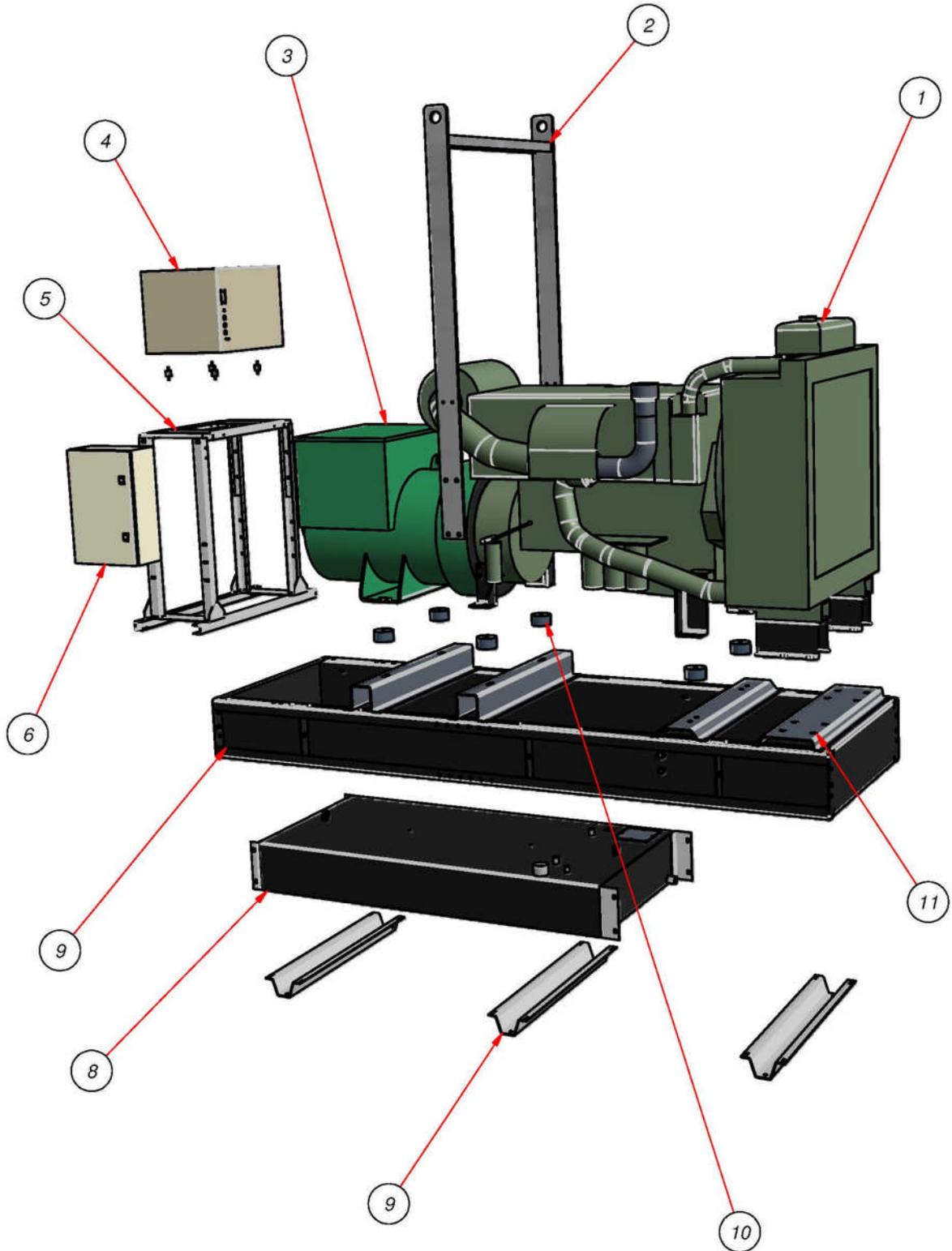


Image 4- Detailed view of openskid genset

- 1) Lifting frame
- 2) Engine
- 3) Shock absorbers
- 4) Base frame
- 5) Fuel tank
- 6) Base support
- 7) Control panel
- 8) Electrical power panel (optional)
- 9) Alternator
- 10) Battery

### 3.1. SOUND INSULATION

The supplied unit may be:

- **Soundproofed.** Includes sound-insulating canopy.
- **Over base support Open skid.** You must keep in mind that in compliance with current regulations may require that proper room sound insulation will be provided for this model. (See 4.2 INSTALLATION)

Each Electrical Generator is provided with a sticker indicating the level of noise output produced and the need to use hearing protection.

		
<p><i>Noise output 90 dBA</i></p>	<p><i>Noise output 114 dBA</i></p>	<p><i>Use of hearing protection required.</i></p>

*Image 5- Noise output pictograms and hearing protection required*

The noise level has been measured according to the European directive 2000/14/EC and in compliance with the maximum levels established by directive 2005/88/EC.

Please consider the local and national regulations that could be more restrictive. In any case, it's the installer and owner responsibility to comply with the current legislation

### 3.2. CONTROL PANEL

The unit provided may be controlled by different modules depending on the type of function it has been designed to perform.

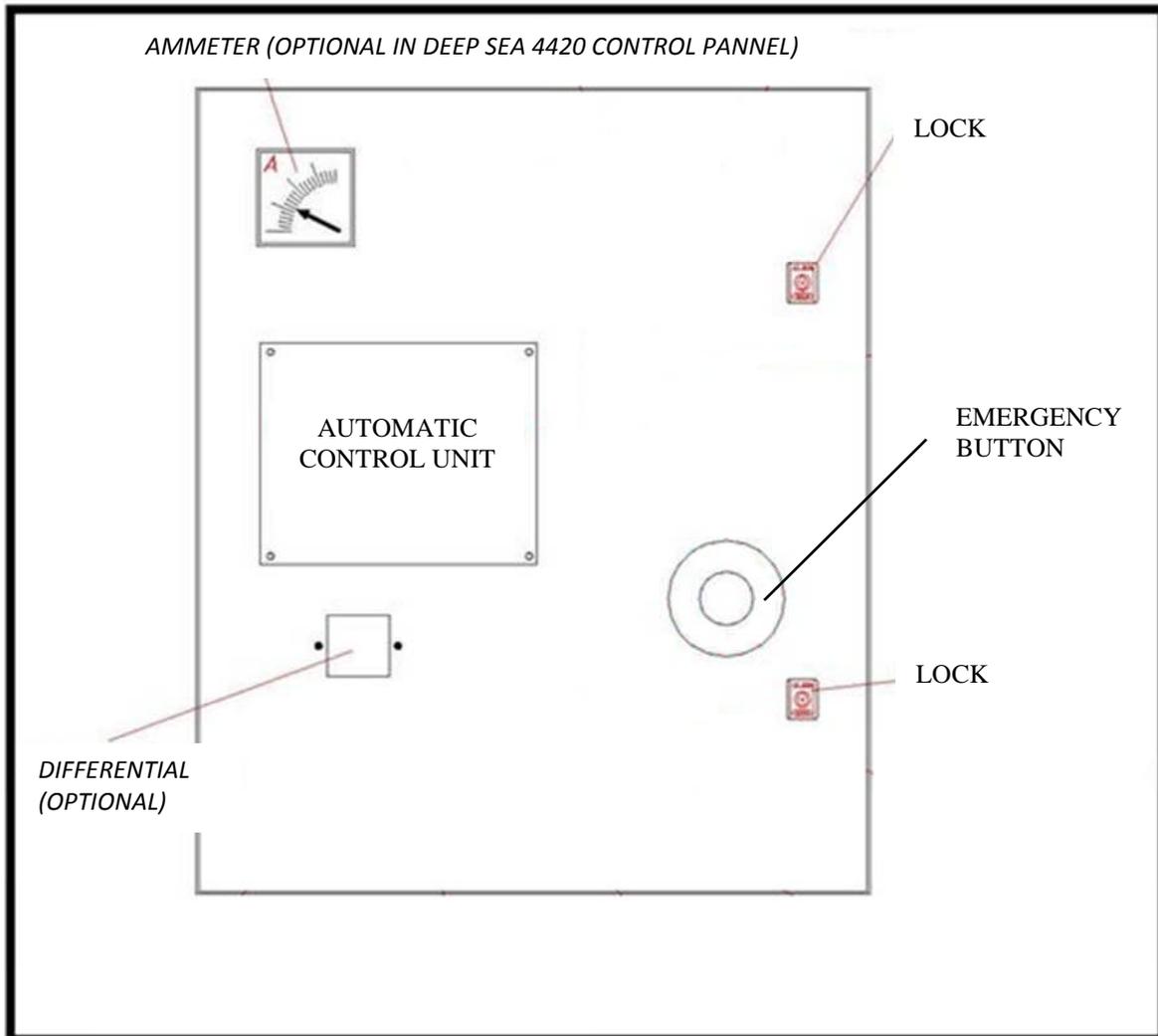


Image 6- Generic Control Panel

- 1-3 →.Electrical Gauges
- 4→ Hour meter
- 5→ Earth leakage relay (It may be installed inside the electrical panel)

- 6→ Indication lamps (green, red, yellow)
- 7→ Mode Switch
- 8→ Engine Gauges

3.2.1. INTELIGEN<sup>NT</sup> DIGITAL CONTROL PANNEL

If you have acquired a genset with INTELIGEN control panel; the electrical box will have an appearance as shown in the figure below:

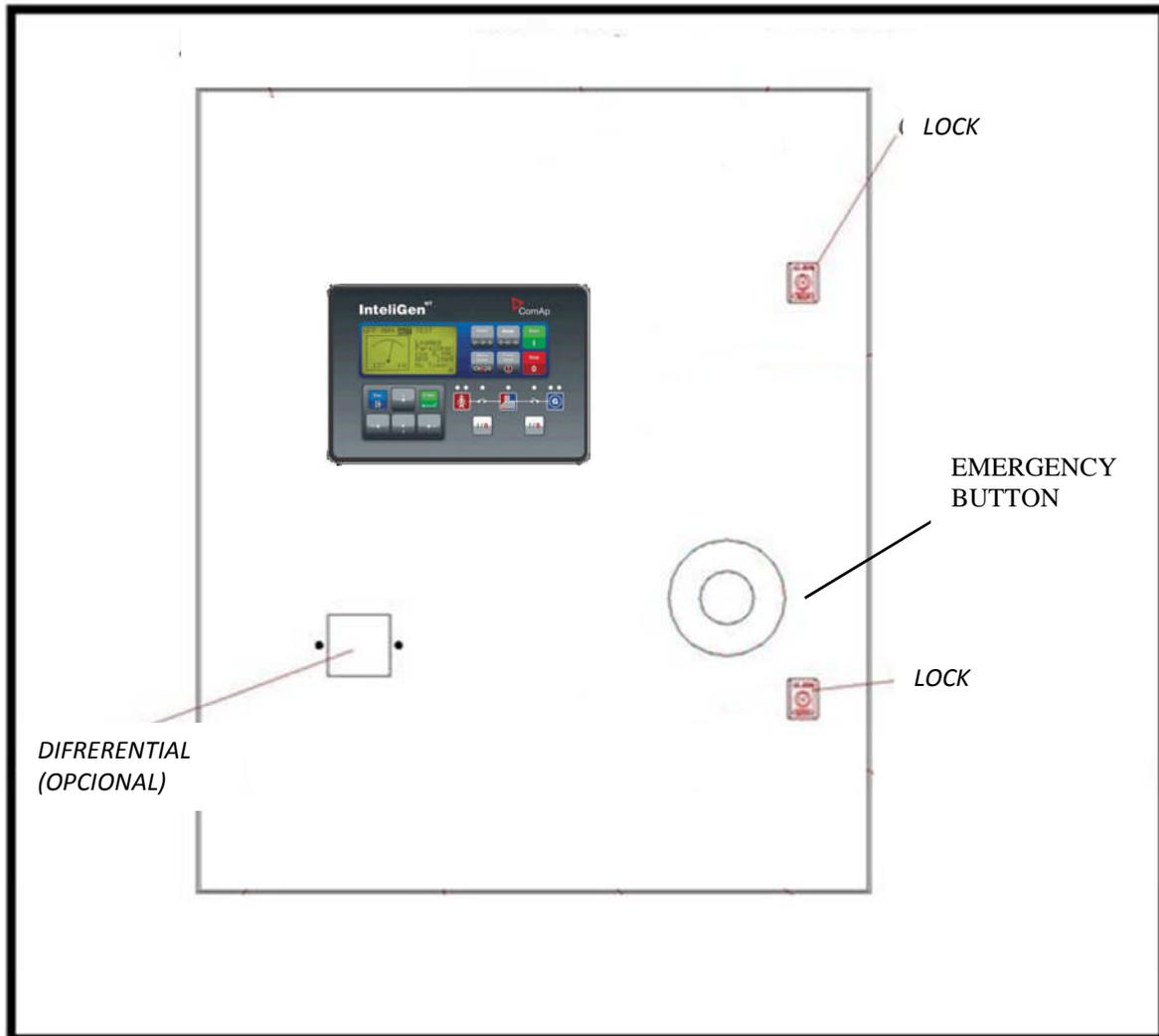
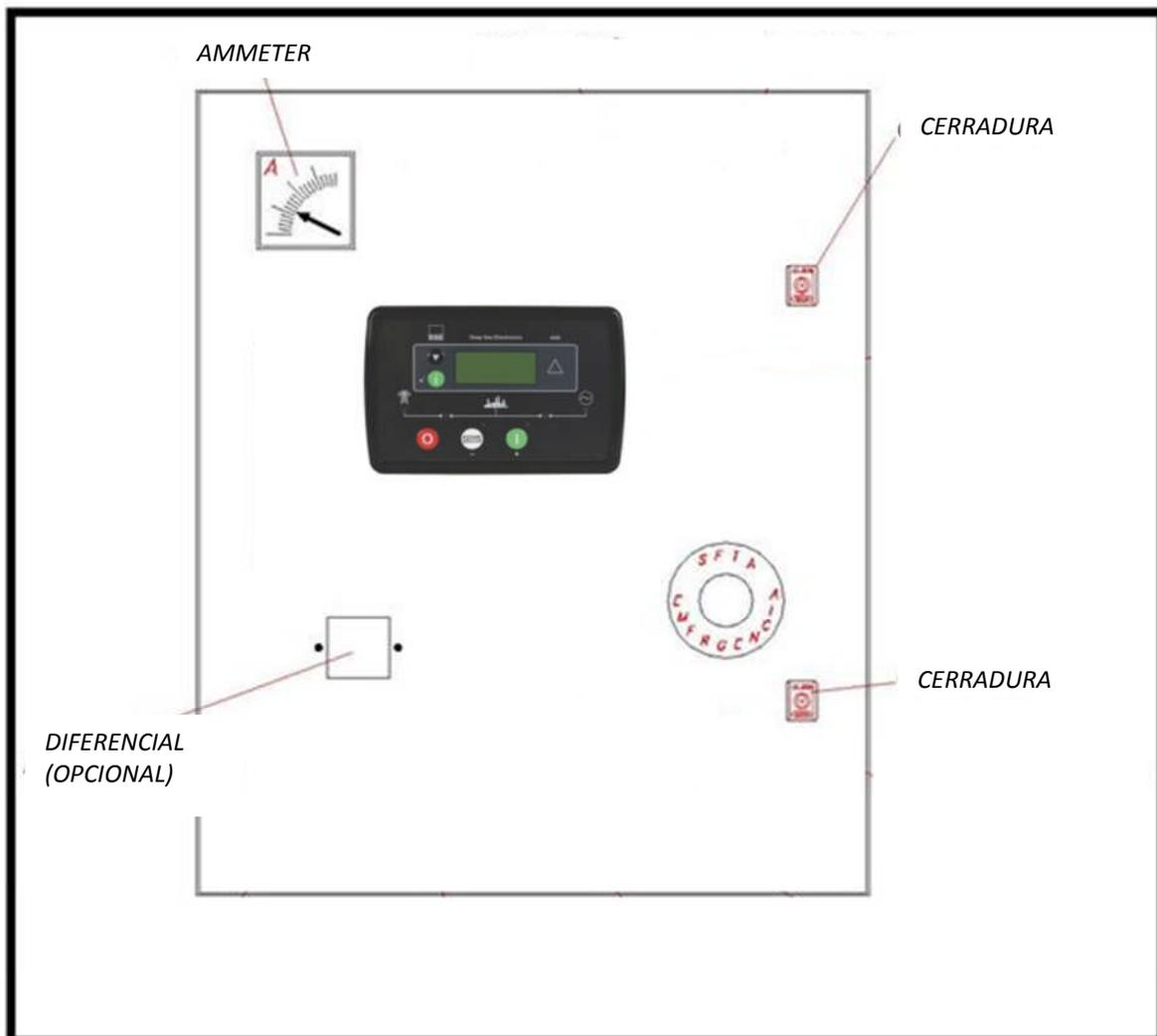


Image 7-Control panel with IntelGen<sup>NT</sup> module

### 3.2.2. PLACA DIGITAL DE CONTROL DEEP SEA

If you have acquire a genset with INTELIGEN control panel; the electrical box will have an appearance as shown in the figure below:

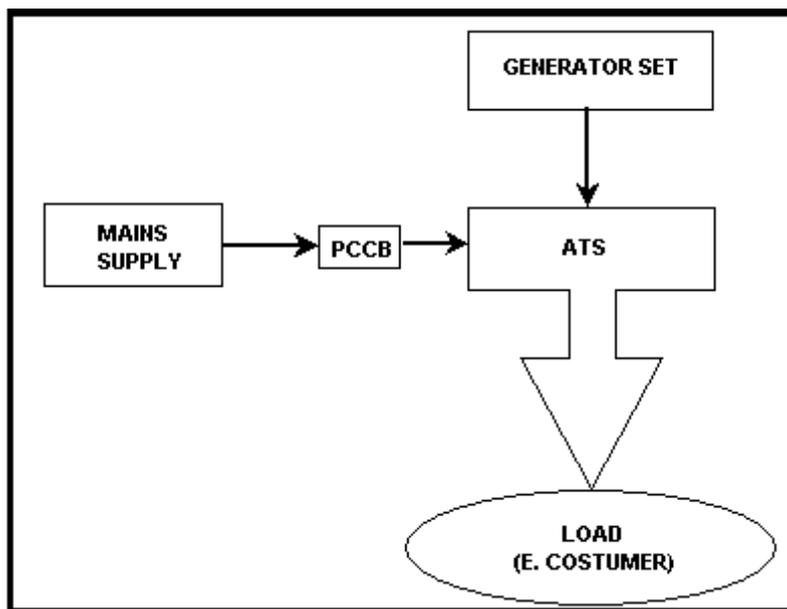


*Image 8-Control panel with DEEP SEA Control module*

### 3.3. ELECTRICAL CONFIGURATION

The supplied unit may be one of three types:

- The generator unit is supplied **with automatic transfer switch (ATS)**.
- The generator unit is supplied **without ATS**. Note that its installation is required.



*Image 9- Load Transfer diagram*

*Note: PCCB = Power Control Circuit Breaker*

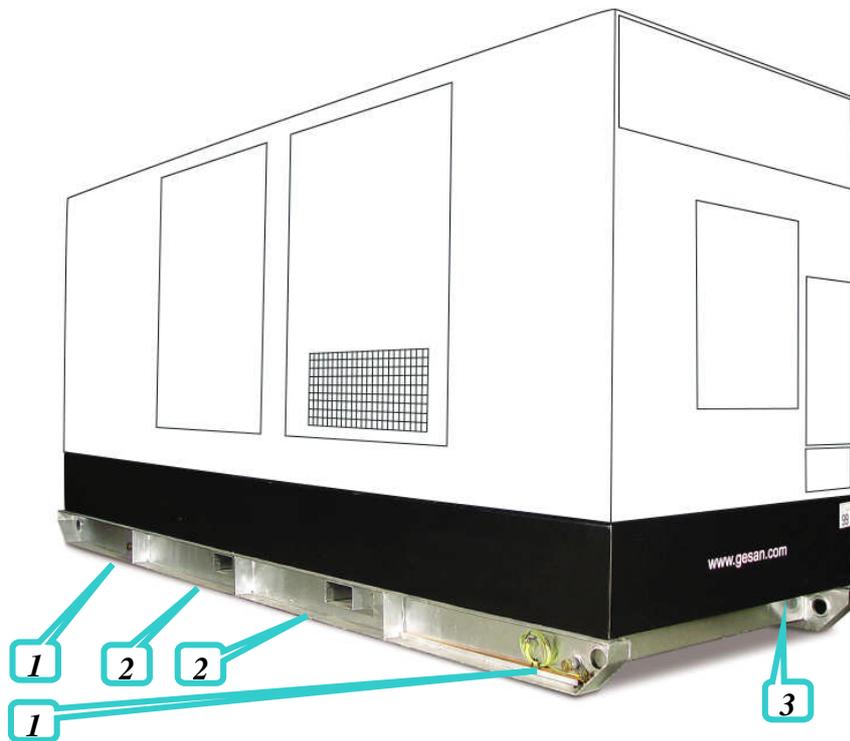
*ATS may be with contactors, motorized changeover switch or motorized circuit breakers*

- **The genset is supplied as “Standby by signal” without ATS.** The Electrical Generator stands idle until it receives a signal from an autonomous external system which monitors the mains and controls the automatic transfer switch for startup.

### 3.4. RETENTION BATH

The generator set may include a built-in retention bath to prevent spills from the unit—such as fuel, oil or coolant—with a capacity of 110% with respect to the total volume of liquids.

It is the responsibility of the installer and the owner to take the appropriate measures to avoid contaminants spillage, in case your genset doesn't include retention bund and consider that it should have it, please contact with our technical service.



*Image 10- Retention Bath*

- 1) 4 drain plugs, 2 on each side of the pan
- 2) Slots for inserting forklift arms
- 3) Retention bath level senders (optional)

## 4. INSTALLATION OF THE GENERATOR SET

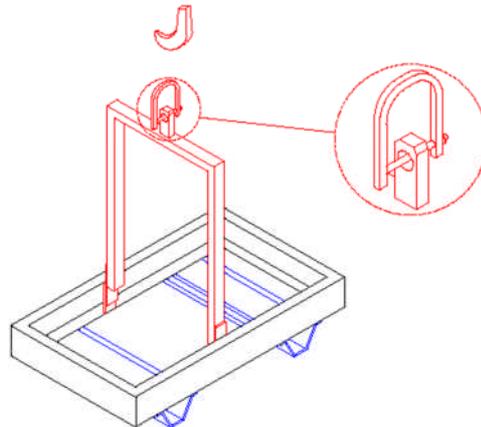
In this part of the manual it is described how to install a “generic” generator set composed of a diesel engine, alternator and electrical panel supplied by GRUPOS ELECTROGENOS EUROPA S.A. For other applications, our technical service will advise.

### 4.1. UNLOADING AND TRANSPORT

Unloading and transport must be performed by qualified personal, taking into account minimal security conditions.

- The floor must be capable of supporting the full weight of the Generator and the forklift.
- Make sure that the battery is disconnected.
- Make sure that the fuel tank is empty.
- Place the arms of the forklift below the chassis at an equal distance with respect to the lifting frame.
- With a hoist, raise the unit using the lifting frame eyebolt.

The image below shows a drawing of a generator unit which includes a frame with a single lifting point.



*Image 11- Lifting frame*

## 4.2. INTALLATION PRINCIPLES

### 4.2.1. Premises

The following considerations must be kept in mind: the fuel supply, ventilation of the premises, the output and direction of the exhaust gases and the noise produced.

- *Dimensions*

The dimensions should allow for the various required maintenance or disassembly operations. A minimum of one meter should be left on all sides of the generator to allow for the doors to be opened.

- *Openings*

The premises should have an entrance that is large enough for the generator to pass through and openings large enough for ventilation (fresh-air intake and radiator hot air outlet), with the appropriate surface area based on the generator's output, the premises' cooling system and the soundproofing system used.

GRUPOS ELECTRÓGENOS EUROPA S.A. does not recommend installing canopied units in closed spaces.

If the unit must be installed in an enclosed space, it is recommended to use an open-skid model and soundproof the work area, in keeping with the current fire-prevention regulations.

The following image shows a typical installation of an open-skid unit in a closed space.

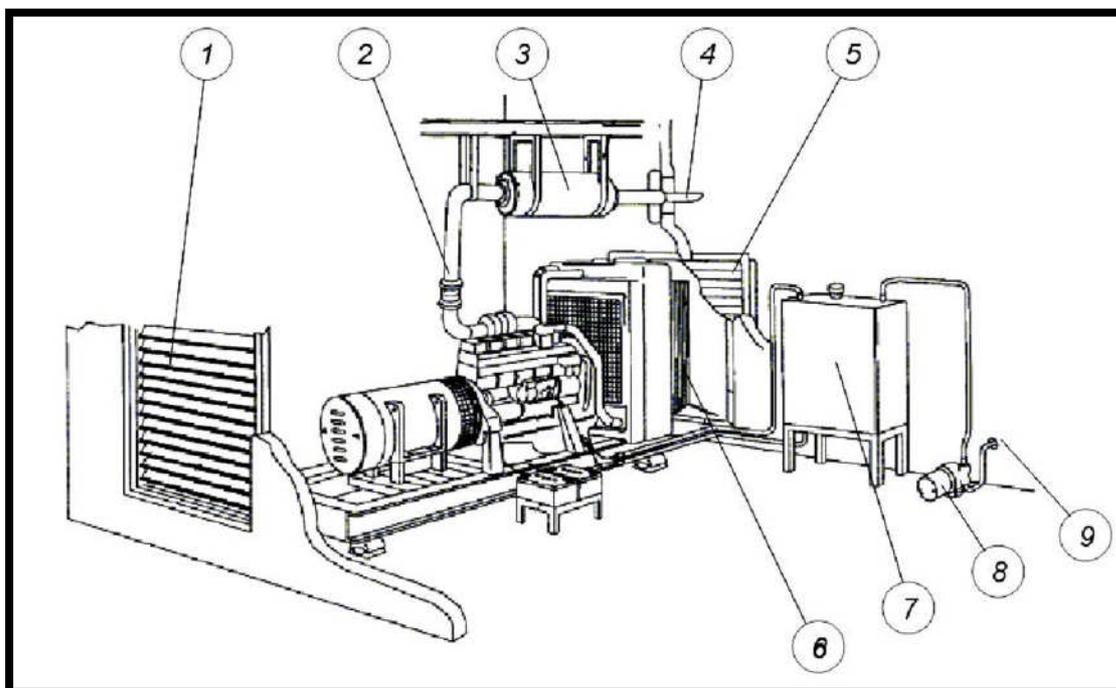


Image 12- Detailed view of installation of an open-skid unit

- 1) Air intake grill. Will be at least 1.4 times the surface area of the engine's radiator panel.
- 2) Smoke exhaust line. This will be explained in more detail later.
- 3) Silencer. Must be firmly installed and fastened to a stable structure.
- 4) Smoke exhaust outlet. Smoke must flow out through a point which impedes its re-entry into the space where the working unit is installed.
- 5) Radiator air outlet grill. Will be at least 1.25 times the surface area of the engine's radiator panel.
- 6) Cooling air channel. Prevents re-entry of hot air into the space where the unit is installed.
- 7) Optional external fuel tank (optional).

#### 4.2.2. Ventilation and cooling

The heat produced by the generator's thermal engine must be evacuated from the premises.

The heat is generated by the cooling of the cylinders, the radiation from the engine block, the exhaust pipe, the cooling of the alternator and the radiator air output.

Insufficient ventilation could produce an increase in the ambient temperature of the premises and cause the generator to lose engine power until finish in a shut down.

#### 4.2.3. Fuel

In keeping with current regulations, special attention should be paid to the storage of fuel, which is classified as a hazardous product. The installation of the generator will include a day tank and an optional external fuel storage tank.

Depending on the output of the generator, the fuel tank may be external instead of being built into the base frame. This tank should be installed within a maximum distance according to the engine fuel pump suction capability (see the Engine manufacturer's manual). The installation will be carried out according to current regulations.

#### 4.2.4. Automatic fuel transfer system

The unit may include a self-suction, eccentric fuel transfer pump (SAB-BE) for the transfer of the fuel from an external fuel tank to the internal one. This pump will self-prime with self-adjusting blades. Includes a recirculation bypass valve. The pump has an internal removable filter, which must be used.



*Image 13- SAB-BE Pump*

To install the pump, consult the manual supplied by the client.

*Note: If unit is positioned beyond the recommended distance, pump should be dismantled and placed near external tank. Pump will function if the unit is running; it has an OFF/AUTO switch located on the door of the unit's electrical panel.*

4.2.5. Exhaust

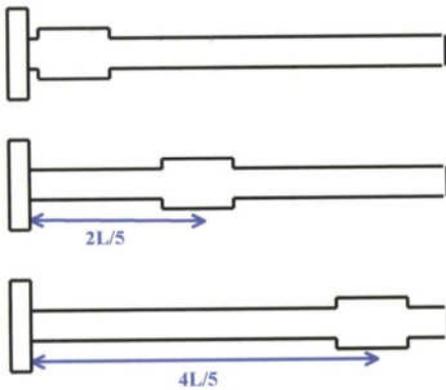
In the exhaust installation, pressure drop, insulation, suspension and sound levels should all be taken into account.

The compensators and flexible pipes used in the installation will absorb the displacement of the unit (due to dilations and vibrations).

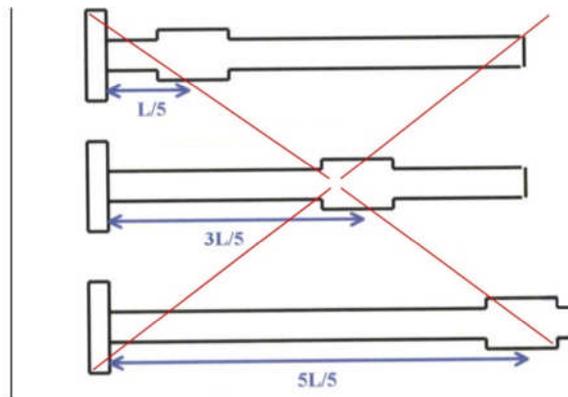
The units supplied by GRUPOS ELECTRÓGENOS EUROPA S.A., depends on the model, may or may not include a rain cap. The units are equipped with two holes on the underside to prevent internal water accumulation.

The optimum muffler locations are, first, directly behind the exhaust manifold, and secondly at 2/5 or 4/5 of the total exhaust system length. The reason for this is the existing standing waves, especially for long exhaust systems, when the natural pipe frequency is in resonance with the fundamental engine frequency or one of its harmonics. The worst muffler locations in order of value are 1/3, 3/5 or at the end of the system.

The best muffler locations in order of values are



The worst muffler locations in order of value are



L = total exhaust system length (elbows may be considered as straight portions).

Note: In installations where it is required, the exhaust pipe diameter must be increased. If the installation isn't correct, seriously engine damage can be caused.

In some models, the silencer is exactly symmetric, in this case, manufacturers often marks the exhaust side with an "S" mark.

#### 4.2.6. Generator set startup

The startup system used by the generator set is electrical and consists of a 12 or 24 V electric engines powered by one or more batteries, usually lead.

Low temperatures make engine cranking difficult. Start-up failure (three attempts without success) entails the stopping of the motor and, as a result, of the entire generator unit. In order to avoid it, and to ensure correct start up of the generator set at any external temperature, heating of the entire unit is made (heating of coolant water) by means of a boiler powered by mains. This system will work automatically, by a thermostat (setup in factory from 40 to 60°C) and it will be correctly indicated on the control panel by a lamp.

If the genset is supplied outside Spain, the batteries will be supplied charged.

The placement into service of the this batteries should be done by removing the vent caps and filling each cell using sulphuric acid with a density of 1.28 (or 1.23 in tropical countries). Let it sit for at least 20 minutes and check the electrolyte level (25 mm above the plates; never fill to the brim). Finally put the caps back on.



*It is recommended that protective eyewear and gloves be worn when adding battery acid. Make sure that there is nearby access to tap water in order to wash any areas that come into contact with the acid.*



*Caution should be performed indicated in this Manual. (Be especially careful with potential short circuits that could occur when coming in contact with the unit's metallic objects).*

In the case that an MTU engine has been purchased, when a shutdown occurs due to continuous operation, the central unit uses a large amount of battery power, which may cause the battery to run out and not be able to restart the engine; therefore, a selector is available in the control panel, which allows disconnecting the battery in the case of a prolonged stoppage. For this purpose, we advise you carry out the following start-up process:

- 1) Place the switch in position 1.
- 2) Start the generator set.
- 3) Place the switch in position 0.

*Note: Step 1 is strongly recommended, as if the selector is in position 0 once the generator set is running, the board will remain without a power supply.*

*It is recommended that the central unit not be set to position 1 for more than 2 days since the battery would completely discharge, which would not allow restarting the set.*

If your generator set does not have an MTU engine installed, you will find an informative sticker warning you to disconnect the battery to avoid it discharging during extended stops.

#### 4.2.7. Electrical connection

##### 4.2.7.1. *Safety instructions*

These connections should be made while following a number of safety measures:

- 1) Use the proper individual protection equipment to ensure complete safety while performing the electrical installation.
- 2) Set the control module switch to the OFF position.
- 3) Make sure the emergency button has been pressed.
- 4) Verify that the battery is disconnected.
- 5) Switch off main power
- 6) Before beginning the installation of the unit provided, make sure that it meets your particular needs for voltage and frequency.
- 7) Check the cables are free-voltage.
- 8) Connect correctly the generator set and ATS. (Identified by the following icon: ).

##### Antifreeze resistors, battery charger and heater connection:

Those connections are realized through L-N external power terminals.

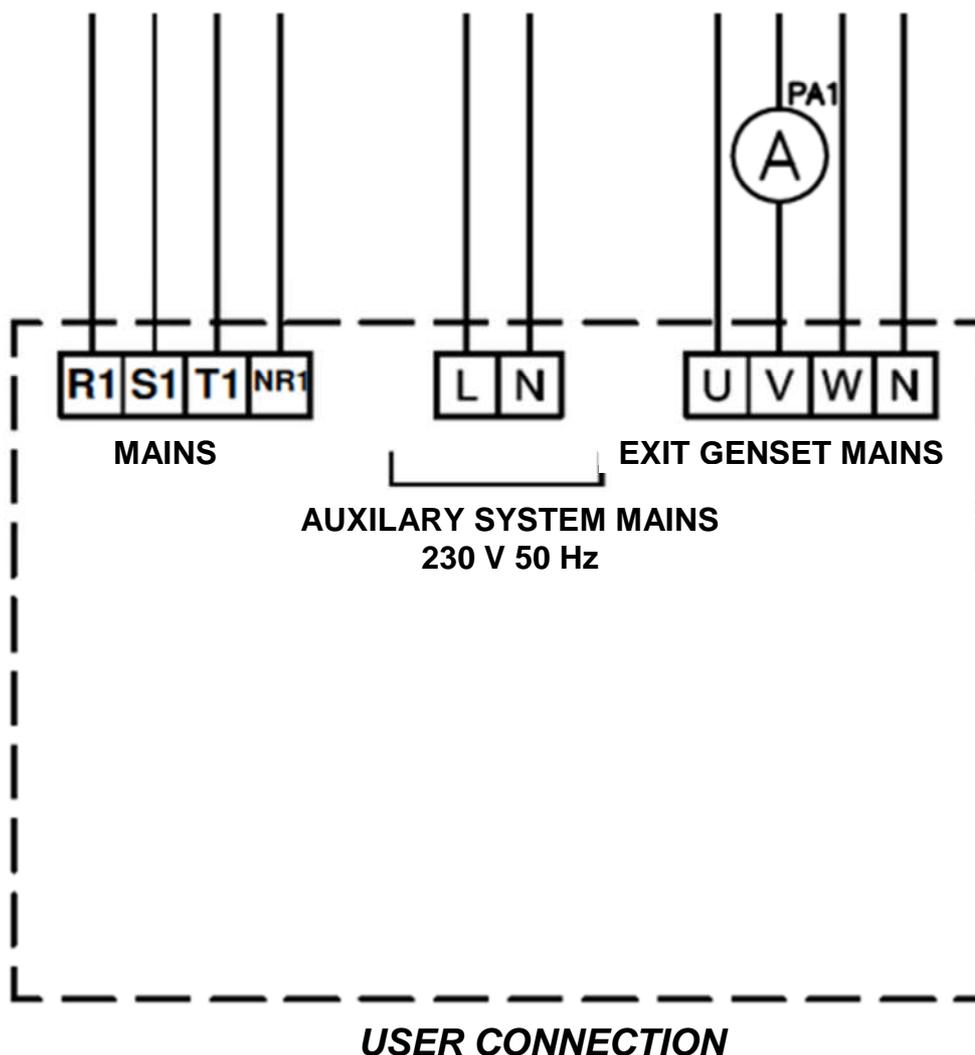


Image 14- Connecting external power input

-400/230 50 Hz: Phase-neutral connection.

-208/120 60 Hz: Phase-phase connection.

-220/127 60 Hz: Phase-phase connection.

-400/230 60 Hz: Phase-phase connection.

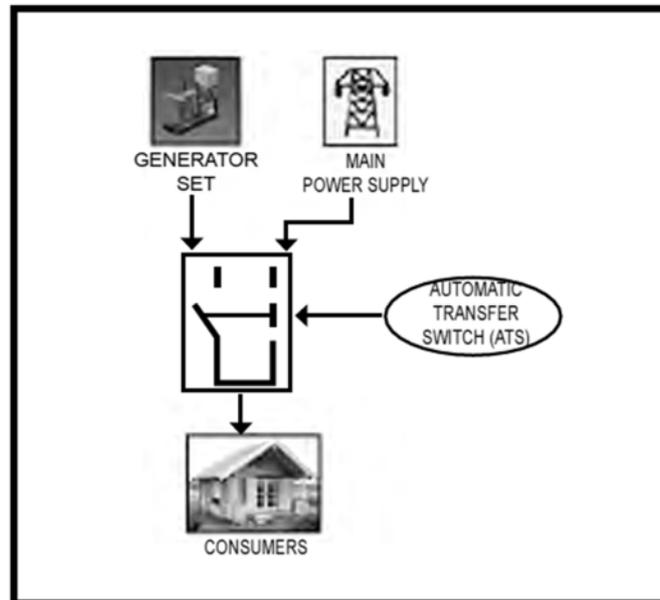
-480/277 60 Hz: Phase-neutral connection.

The unit manufactured by GRUPOS ELECTRÓGENOS EUROPA S.A., may or may not be supplied with ATS (depends on electrical configuration: see section 3.3); if it is not supplied, it must be added by the customer.

There are three kinds of different control switchgear used in GRUPOS ELECTRÓGENOS EUROPA S.A. automatic transfer switch systems:

- **Contactors: mechanically and electrically interlocked:** They are manufactured from 40A to 125A.
- **Motor operated changeover switches:** They are manufactured from 160A.
- **Motor operated circuit breakers:** They are supplied only on customer request.

The following diagram shows a basic ATS setup.



*Image 15- ATS setup*

The electrical installation of the ATS is performed in two separate steps: firstly, the installation of the CONTROL section and secondly, the ELECTRICAL POWER section.

ATS schemes:

The electrical schemes of a typical ATS manufactured by GRUPOS ELECTRÓGENOS EUROPA S.A. are:

a) ATS by contactors:

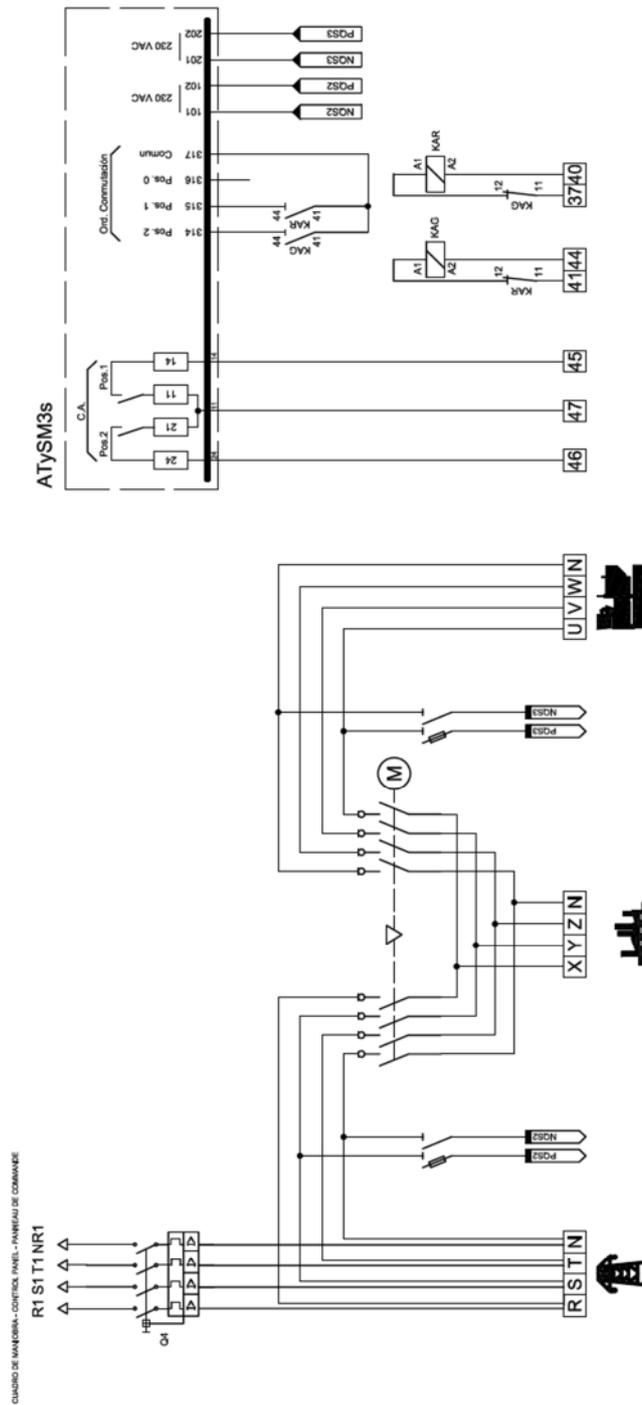


Image 16- Diagram of ATS Panel

b) ATS by motorized contacts:

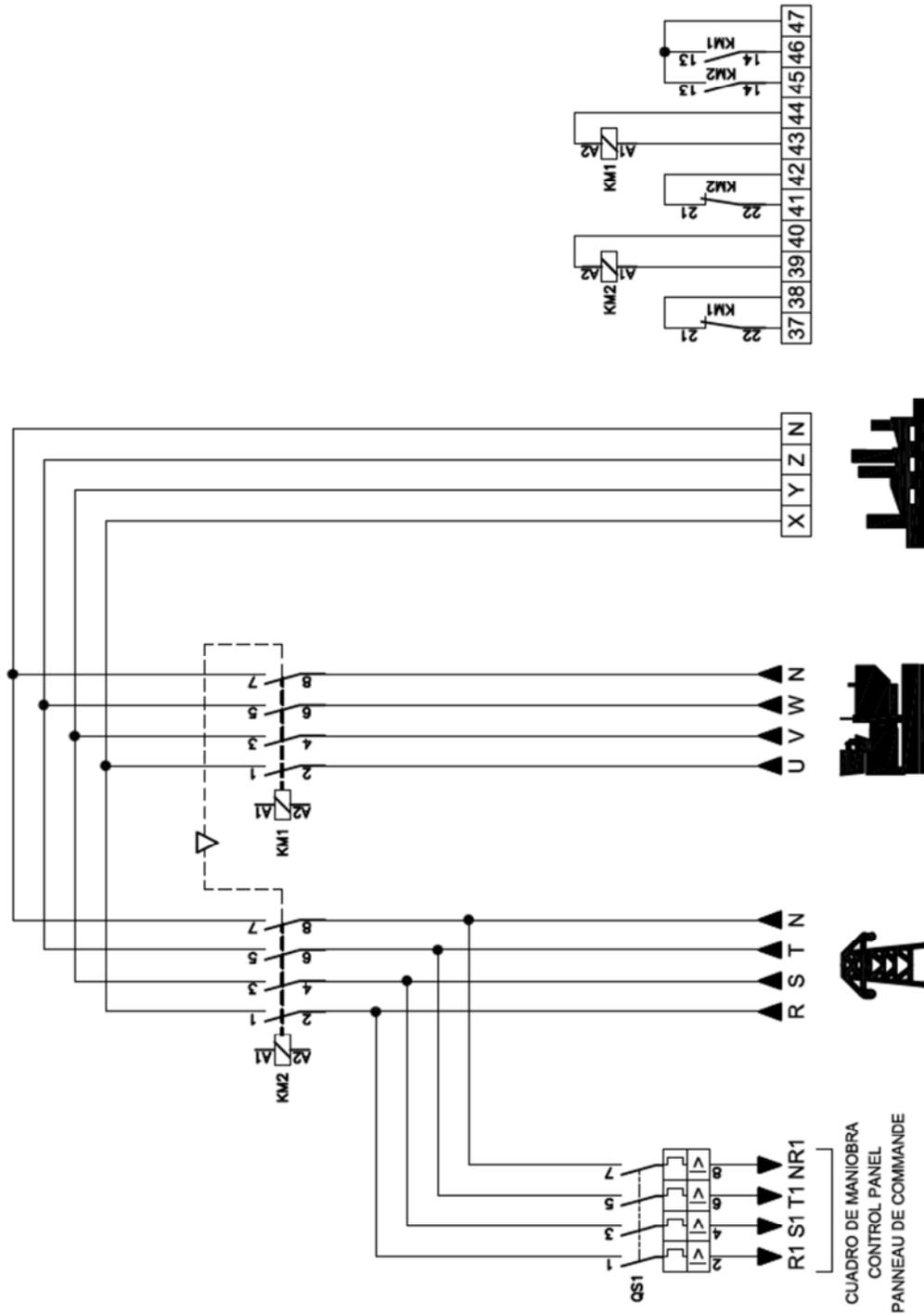


Image 17- Diagram of ATS Panel by motorized contactors

#### 4.2.7.2. Installation of CONTROL section

The installation of the Control section can be done in three different ways:

- 1) ATS supplied by GRUPOS ELECTRÓGENOS EUROPA S.A.
- 2) ATS not supplied by GRUPOS ELECTRÓGENOS EUROPA S.A.
- 3) Unit is a “Standby by signal” type.

##### 1) **ATS provided by GRUPOS ELECTRÓGENOS EUROPA S.A.**

- a) Connect the terminals R1 S1 T1 NR1 on the control panel installed on the generator to the ATS terminals equally named.
- b) Connect the terminals numbered as 37, 40, 41, 44, of the control panel installed in the genset to the ATS terminals equally named.
- c) It's not necessary to connect the terminals 38, 39, 40 and 43 of the genset control box.
- d) Do not connect terminals 38-39-40-43 in the control panels.

In making these connections, you must use an 8-wire conductor of 1.5mm<sup>2</sup>. This cable is not provided with the generator set. The maximum distance between the control panel and the ATS panel should be 25m for a 1.5mm<sup>2</sup> cross section and a generator set power of 650 kVA. In case of higher power or distance, increase the cross section to avoid excessive voltage drop.

##### 2) **ATS not supplied by GRUPOS ELECTRÓGENOS EUROPA S.A.,**

Check the user manual of the corresponding ATS and follow these steps:

- Connect the terminals R1 S1 T1 NR1 of the control panel (referential mains voltage) to the input of the electric company mains.
- Connect the terminals numbered 37 to 47 (both inclusive) to the ATS control panel (check the electrical setup on the generator set control panel).
- Make sure that the electrical and mechanical interlocking is completed correctly. Also make sure that the ATS that you want to install is compatible with the generator unit provided.
- The cable cross section must be appropriate for your installation.

### 3) Generator unit is “Standby by signal” type:

Neither the generator set will monitor the mains nor control the ATS; these must be controlled by the user’s management system.

The terminals through which the generator set receives the startup signal are 184 and 185, which should be volt-free.

The generator set uses terminals 120 and 121 to return a volt-free signal when the voltage and frequency of the generator set are correct.

Terminals R S T N should be connected to a mains input prior to the ATS, as these terminals provide the power supply for the engine block heater and battery maintainer. The cable cross section should be appropriate for your installation.

#### 4.2.7.3. *Installation of ELECTRICAL POWER section:*

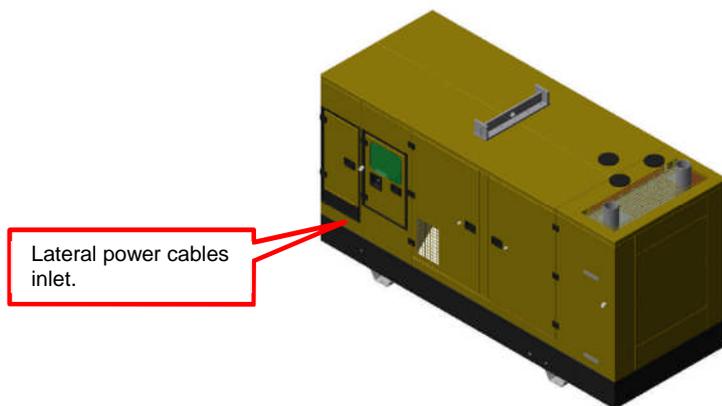
The power installation could be carried out in two ways:

- 1) ATS supplied by GRUPOS ELECTRÓGENOS EUROPA S.A.
  - Connect the generator’s current output terminals U V W N to the ATS terminals U V W N.
  - Connect the electric company’s power control switch (PCS) to terminals R S T N.
  - Then connect ATS terminals X Y Z N to the installation.
- 2) ATS not supplied by GRUPOS ELECTRÓGENOS EUROPA S.A. or the generator set is the “Standby via signal” type.
  - Connect the generator’s current output terminals U V W N to the input of the ATS on the generator set. Check the manual of your ATS.

This installation should be performed by qualified personnel, who should determine the conductor section to be used.

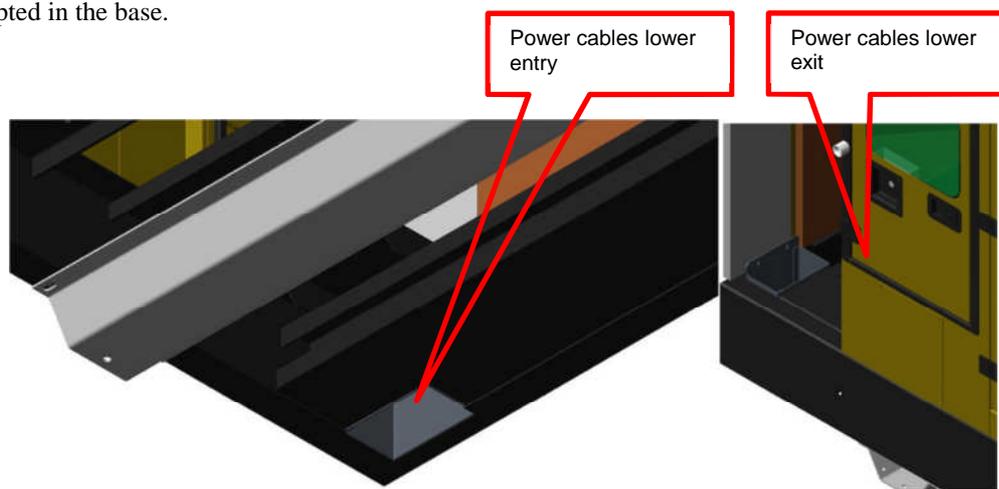
In isolated power box gensets, mains cable installation could be realized by two ways:

**-Lateral power cables outlet:** This way, power cables come out by the trapdoor with protective rubber placed in the control box door, as shown in the image:



*Image 18- Lateral power cables trapdoor entry*

**-Power cables lower exit:** This way, the power cables enter directly from the bedplate lower part through the duct adapted in the base.



*Image 19- Power cables entry by bedplate*

In the installation drawing you could find the exact measures, and also relative positions.

#### 4.2.7.4. *Earthing:*

Ensure that the generator set, including mobile ones, is effectively grounded (earthed) in accordance with every relevant regulation, electrical code, standard or other requirement, prior to start operations.

The electrical resistant of earthing installation must be enough low in order to allow earth leakage protection systems to work properly and to limit the voltage in exposed conductive parts, to avoid dangers to people or goods. Check regularly this value to avoid its increasing.

To avoid the transfer of currents or voltages from other electrical systems (for example, high voltage network), independence between grounding systems must be guaranteed.

#### 4.2.7.5. *Motorized changeover switches:*

Motorized changeover switches are a kind of special designed control switchgear for electrical networks transfer, which simplify the equipment and control wiring needed.

Motorized changeover switches can also be manually operated. They include a handle key to network switching in case of emergency when any power source is available.

For security purposes, the changeover switch can be padlocked in position 0 (then manual operations are impossible and electrical controls are disabled).

For additional information, please consult manufacturer manual.

### 4.3. STORAGE

If you think your generator will be inactive for a long period of time, follow these instructions:

- 1) Switch the control module to the OFF position.
- 2) Press the emergency stop button to avoid future involuntary startups when connecting.
- 3) Empty the fuel tank.
- 4) Disconnect the battery.
- 5) Avoid storing the unit in spaces with high dust accumulation or excessive humidity.
- 6) Do not use pressurized water when cleaning the unit.
- 7) Check your engine manual for care instructions; the manual has been provided together with this document.
- 8) Check your alternator manual for maintenance instructions; the manual has been provided together with this document.

## 5. STARTUP

Prior to start up the generator set, or after making a change in location, you must follow these steps:

- 1) Check the genset right mechanical balance and the right contact of every base support with the floor.
- 2) Check and retighten, when necessary, radiator to base frame and radiator to motor screws.
- 3) Check and retighten, when necessary, engine-alternator coupling to base frame screws.
- 4) Check and adjust, when necessary, the fan belt and battery charger alternator belt alignment. If generator set output is over 750 kVA, this recommendation turns into mandatory. Please, contact with your distributor to request specific information to make this task.
- 5) Check canopy sealing material, especially in the roof. Clean and reseal when necessary.
- 6) Check battery connections, and retighten, clean and grease when necessary.

After checking the mechanical, in order to proceed to the genset shut down.

- 1) Check levels: oil, coolant and fuel.
- 2) Close the battery isolator switch.
- 3) Release the emergency push button if it has been pressed.
- 4) Connect to the mains power and verify that the voltage indicator is giving an adequate reading.
- 5) Check circuit breaker (the lever must be above).
- 6) After completing the pre-startup tasks, make sure that the generator's control module switch is in the desired position. For this reason, the user should carefully read about the operation of the control module in section 6 of the OPERATION MANUAL.

It is recommendable to run a simulation of mains failure to verify that the unit is functioning properly.

To proceed with the genset stop:

- 1) Disconnect the batteries.
- 2) Disconnect the main switch.
- 3) Leave the engine running without load during 2 minutes in order to cool the genset.
- 4) Stop the engine completely, changing the control module switch to OFF position.

### 5.1. POWER FACTOR AND GENERATOR SETS

The power factor ( $\cos \phi$ ) of the generator set loads must be determined. Lagging power factor below 0,8 can overload the generator. It can work properly from 0,8 to 1 lagging power factor.

Special attention must be given to installation with power factor corrections equipment (based on capacitors) in order to avoid leading power factor. This could prompt the generator set to voltage instability and could result in dangerous over voltages. Whenever generator set is supplying the load, any power factor correction equipment must be switched off.

### 5.2. LIGH LOAD OPERATION ON DIESEL ENGINES

If an engine is operated on a load less than 25-30% of its rated output, certain symptoms will be observed which may be cause for concern. The engine is designed to run up to a maximum power and so the size of the piston, the wall loading of the piston rings, etc., is designed for this.

When an engine is run at light load then the energy put into the cylinder is low and consequently the cylinder pressure is lower and so is the temperature. The result is the piston to bore clearance is increased allowing more oil to pass the piston and be burnt, which is indicated by high oil consumption.

Oil will start to appear from the manifolds from the bearing arrangement in the turbocharger.

Turbochargers are fitted to an engine to increase power by supplying more air to the cylinders. When running a turbocharger, air is sucked in, which can have vacuum levels up to 500 mm H<sub>2</sub>O, with pressure ratios of 3:1. The compressor seals are designed to work most efficiently when the turbocharger compressor is operating at its' most efficient point. If the engine is running at low powers then the turbocharger is running at low speed (no energy from the exhaust because the fuel inlet to the engine is low) and the inlet vacuum is low resulting in poor turbocharger seal loading and pull over of oil from the bearing assembly. This oil is mixed with the air and pumped into the manifolds where some separates from the air when it collides with the inside of the manifold. The manifold gaskets will become impregnated with oil, eventually this will show as an oil leak from the manifold mating surfaces.

Black smoke will be produced from the exhaust outlets, due to poor combustion at light load, as excess fuel is pumped through into the exhaust system, resulting in soot being expelled into the exhaust system.

A further result is that of abnormal carbon build-up on the valves, piston crowns and exhaust ports. Thus the normal service interval of 2500 hours between top overhauls may be reduced. Fuel dilution of the lubricating oil will also occur.

It is therefore recommended that the following precautions are observed:

- Running on light load should be avoided or reduced to a minimum period. If weekly exercising on no load is carried out, the running period should be kept down to maximum 15 minutes or until the battery charge rate returns to normal.

- Every year the engine / generating set should be run on full load for four (4) hours, to burn off accumulations of carbon in the engine and exhaust system. This may require a “dummy” load. The load should be built-up gradually from zero over the four hour run.
- If you expect prolonged operation at low load is necessary to plan an additional charge through resistor banks.

## 6. OPERATION MANUAL

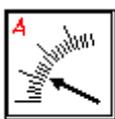
Never, under no circumstance shall the generator adjustment parameters be modified. Consult with the Technical Service if the parameters need to be modified.

The generator set you purchased was designed for standby use, which means that it will mainly be operational when the mains voltage is inadequate.

Therefore it is necessary to connect the mains to the unit’s ATS as well as to the generator set (see section 4 – Installation).

The following is a description of the different variable elements, according to the generator set chosen.

### 6.1. CONTROL PANEL COMPONENTS



Ammeter:

Is an indicator of the current generated (A), by means of a switch, you may read the same of the different phases of the generator set.



Frequency meter:

Is an Indicator the frequency of the generator set (Hz).



Voltmeter:

Is an indicator of the voltage (V) of the main power supply or generator set, depending on the position of the voltmeter switch (Ph-Ph, Ph-N).



Emergency stop button:

Pressing this button brings the generator set to an immediate stop. To cancel, turn to the left, assuring plenty of the end of the emergency.



Gauges indicating engine parameters:

Oil Pressure

Battery charger current

Engine Temperature

Fuel Level

Activated by temperature and fuel button when generator set is stopped. When the generator is operating, the gauges show the corresponding levels.



Diagnostic Button:

Allows engine parameters to be checked when generator set is stopped (electronically controlled engines). Also gives readout of the generator's different alarms.



Differential:

Protection against earth leakage of one phase, switching off the generator set circuit breaker.



DEEP SEA 4420, Control module which controls the mains, and if it fails, the genset startup.



DEEP SEA 7320, control module which controls the mains, and if it fails, the genset startup.



ComAp INTELLIGENT (optional). Automatic control module which controls the mains, and if it fails, the genset startup.

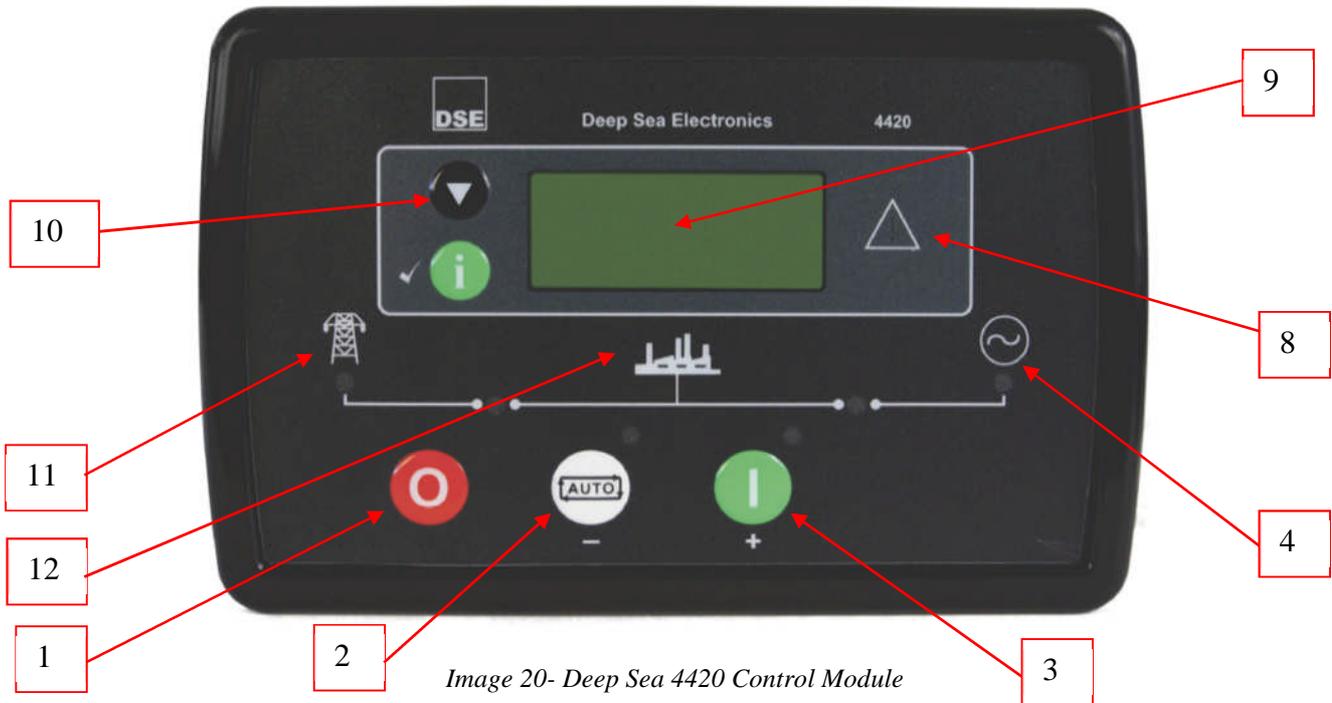
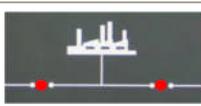
6.1.1. Deep sea 4420 digital control module


Image 20- Deep Sea 4420 Control Module

	SYÍMBO L	DESCRIPCIÓN		SYMBOL	DESCRIPT IÓN
(1)		Stop / Manual mode / Reset button	(9)		Status generator set display
(2)		AUTOMATIC mode button	(10)		Menu navigator
(3)		Generator set start up button	(11)		Mains available
(4)		Generator led	(12)		Status of ATS for mains and generator set.
(8)		Warning “!”.			

Deep Sea 4420 is an automatic control module that monitors the main power supply; if a mains failure occurs, generator set will start up and loads are transferred. This control module also allows the option of manual startup. The user can also control all of the generator unit's parameters as well as the status of mains power supply. This model is supplied with standby generator sets with or without ATS.

Deep Sea 4410 control module is supplied with "stand-by by signal" type units.

• **AUTOMATIC Mode (AUTO):**

This is the normal operating mode.

The automatic mode is activated by pressing the button  (4), at which point the LED at the top of the button will turn on, indicating that it is operational.

If the mains power supply fails for longer than the unit's programmed period, the LED  (11) indicating that the mains power is available will be turned off.

The engine will start; if it should fail, there will be a maximum number of startup attempts (3). If all three startup attempts have been unsuccessful, the information screen will display a startup alarm: 

When mains power is restored (or when the remote startup signal disappears) there will be a period of time in which the engine will continue operating at no load to cool down before stopping completely.

If a mains failure occurs or remote startup signal appears again during the no-load operating period (cool-down period), the generator set would begin the startup process again.

Press  (1) or the emergency stop button to intentionally stop the unit.

• **MANUAL Mode:**

The manual mode is activated by pressing the button ,

To begin the starting sequence, press the button. 

If a mains failure occurs, a remote startup signal is received; loads will be transferred to the generator set. Once the load has been transferred to the generator, it will not be automatically transferred back to the mains supply.

To terminate this mode, press the  (2) button, once is pressed and there is adequate mains power supply (without the remote startup signal activated), the shutdown sequence will begin as described in the automatic mode.

Press  (1) or the emergency stop button to intentionally stop the unit.

• Mode icon

An icon is displayed in the mode icon area of the display to indicate what mode the unit is currently in.

Icon	Graphic	Details
Stopped		Appears when the engine is at rest and the unit is in stop mode.
Auto		Appears when the engine is at rest and the unit is in auto mode.
Manual		Appears when the engine is at rest and the unit is in manual mode.
Timer animation		Appears when a timer is active, for example cranking time, crank rest etc.
Running animation		Appears when the engine is running, and all timers have expired, either on or off load. The animation will be rate is reduced when running in idle mode.
Front panel editor		Appears when the unit is in the front panel editor

• Instrumentation icons

Icon	Graphic	Details
Generator		Used for generator voltage and generator frequency
Mains		Used for mains voltages and mains frequency
Engine speed		Flexible sensor 
Hours Run		Event log 
Battery voltage		
Engine temperature		
Oil pressure		

• Alarm icons

Alarm	Icon
External input alarm	
Failed to start	
Failed to stop	
Low oil pressure	
Water temperature / Low coolant level	
Under speed	
Over speed	
Charge alternator	
Low fuel	
Plant battery volts (under/over)	

Alarm	Icon
Emergency stop	
Flexible sender alarms	
Generator contactor alarm	
Mains Failure	
Mains Return	
Under voltage	
Over voltage	
Under frequency	
Over frequency	

• Warnings alarms

Warnings are non-critical alarm conditions and do not affect the operation of the generator system, they serve to draw the operators attention to an undesirable condition. The condition that provokes the warning must be solved before the reset. Shutdown alarms

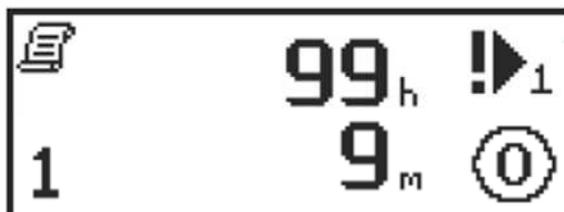
Shutdowns are latching alarms and stop the Generator. Clear the alarm and remove the fault then press Stop/Reset  to reset the module.

NOTE: The alarm condition must be rectified before a reset will take place. If the alarm condition remains, it will not be possible to reset the unit (The exception to this is the Low Oil Pressure alarm and similar 'delayed alarms', as the oil pressure will be low with the engine at rest).

• Event log

The info button  toggles between the display of the instrumentation and the event log. Pressing the down button will move to the previous event, the event log entry at position 1 being the most recent. On moving from the instrumentation value to the event log the unit will display the most recent entry.

Example of Auxiliary Input Shutdown Alarm..



6.1.2. DEEP SEA 7310/7320 Digital Control Module



Image 21- Deep Sea 7320 Control Module



Image 22- Deep Sea 7310 Control Module

NUMBER	SYMBOL	DESCRIPTION	IDENTIFICATION
(1)		Stop button.	Red LED
(2)		MANUAL mode button	Red LED
(3)		TEST mode button	Green LED (available on model 7320 only)
(4)		AUTOMATIC mode button	Red LED
(5)		Mute alarm / Lamp test button	
(6)		Generator set start up button	
(7)		“Transfer to generator” button	Green LED on when generator set is available
(8)		Configurable LED indicators.	Red LED
(9)		Status generator set display.	
(10)		Menu navigator	
(11)		”Transfer to mains” button	Green LED (available on Model 7320 only)
(12)		Status of ATS for mains and generator set.	Left LED on: mains closed / Right LED on: generator closed.
(A)		“Open generator” button	LED on: generator set is supplying loads.

Deep Sea **7320** is an automatic control module that monitors the main power supply; if a mains failure occurs, generator set will start up and loads are transferred. This control module also allows the option of manual startup. The user can also control all of the generator unit’s parameters as well as the status of mains power supply. This model is supplied with standby generator sets with or without ATS.

Deep Sea **7310** control module is supplied with “standby by signal” type units.

• **AUTOMATIC mode (AUTO):**

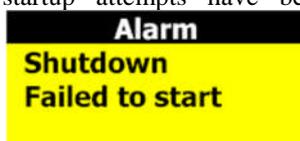
This is the normal operating mode.

The automatic mode is activated by pressing the button  (4), at which point the LED at the top of the button will turn on, indicating that it is operational.

(7320) If the mains power supply fails for longer than the unit's programmed period, the LED

(7310) If a mains failure occurs, the external management system should send a startup signal to the generator set, at which point the LED indicating remote startup active (8) turns on and the startup process of the generator set begins.

The engine will start; if it should fail, there will be a maximum number of startup attempts (3). If all three startup attempts have been unsuccessful, the information screen will display a startup alarm:



When mains power is restored (or when the remote startup signal disappears) there will be a period of time in which the engine will continue operating at no load to cool down before stopping completely.

If a mains failure occurs or remote startup signal appears again during the no-load operating period (cool-down period), the generator set would begin the startup process again.

Press  (1) or the emergency stop button to intentionally stop the unit.

• **MANUAL mode:** The manual mode is activated by pressing the button  (2), at which point the LED at the top of the button will turn on, indicating that it is operational.

Press  (6) to start up the unit.

If a mains failure occurs, a remote startup signal is received or "transfer to generator" button  (7) is pressed, loads will be transferred to the generator set. Once the load has been transferred to the generator, it will not be automatically transferred back to the mains supply.

Loads can be manually transfer back to mains pressing "transfer to mains" button  (11) (7320) or

pressing "open generator" button  (A) (7310).

To terminate this mode, press the button  (4).

Once button (4) is pressed and there is adequate mains power supply (without the remote startup signal activated), the shutdown sequence will begin as described in the automatic mode.

Press  (1) or the emergency stop button to intentionally stop the unit.

• **LOAD TEST mode (7320):**

A test for proper functioning of the generator set can be done pressing  (3).

To start up, press the start button  (6).

In this operating mode, a mains failure is simulated, with the loads being transferred to the generator set.

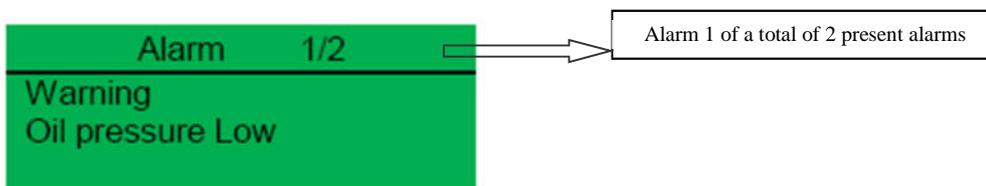
To terminate this mode, press the button  (4).

Once button  (4) is pressed and there is adequate mains power supply (without the remote startup signal activated), the shutdown sequence will begin as described in the automatic mode. After this period of time, the load will be carried by the mains power.

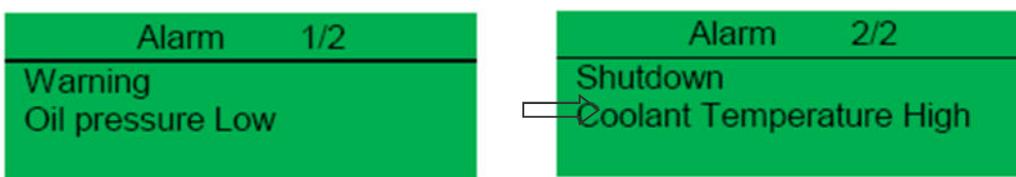
Press  (1) or the emergency stop button to intentionally stop the unit. **ALARMS:**

Press  (5) to silence the audible alarm and acknowledge the common alarm LED.

By default, the information screen will show the status screen and if an alarm occurs, the screen will display the following:



If shutdown occurs while a warning is active, the screen will cycle through the active alarms:



The warnings do not entail generator unit shutdown.

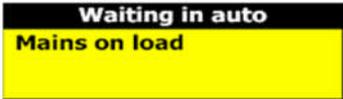
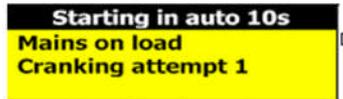
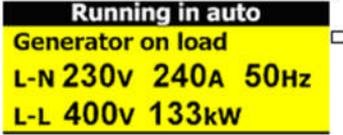
Press  (1) to reset all the alarms which causes the stops. If the cause which caused the alarm has not gone we cannot reset the board

INCIDENT	ALARM DESCRIPTIONS
ALARM Warning Charge failure	Charge alternator voltage not detected
ALARM Warning Battery under voltage	Battery voltage beyond established limits
ALARM Warning Battery over voltage	
ALARM Warning Fail to Stop	After shutdown command, engine continues running. Could also indicate faulty oil pressure sender
ALARM Warning Auxiliary inputs	Auxiliary inputs can be configured and will display the message as written by the user
ALARM Warning Low fuel level	Fuel level below established limits
ALARM Warning CAN ECU error	Engine ECU has detected a warning alarm. The exact error is also indicated on module display (only for electronic engines).
ALARM Warning kW overload	The total kW are above the warning setting.
ALARM Warning Earth fault	The earth fault current is above alarm settings (only under customer request)
ALARM Warning Negative phase sequence	Indicates “out of balance” current loading of the generator set.
ALARM Warning Low oil Pressure	Low oil pressure, below established limit
ALARM Warning Engine high temperature	Engine temperature beyond established limits
ALARM Warning Engine low temperature	
ALARM Warning Underspeed	Engine speed beyond established limits
ALARM Warning Overspeed	
ALARM Warning Generator over frequency	Generator set frequency beyond established limits
ALARM Warning Generator under frequency	
ALARM Warning Generator over voltage	Generator set voltage beyond established limit
ALARM Warning Generator under voltage	
ALARM Warning High Current	Current of the generator set output beyond established limits

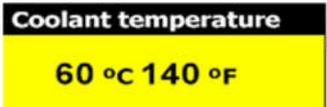
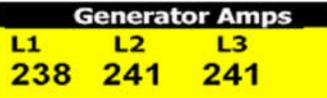
INCIDENT	DESCRIPTION OF SHUTDOWNS
ALARM Shutdown Earth fault	The earth fault current is above shutdown settings (only under customer request)
ALARM Shutdown Failed to Start	Engine does not start, three attempts made.
ALARM Shutdown Emergency stop	Controlled shutdown of the unit. It will not be functional until the emergency stop button has been reset.
ALARM Shutdown Low oil pressure	Oil pressure below established limit
ALARM Shutdown High temperature	Engine temperature above established limit
ALARM Shutdown Phase rotation	The phase rotation is different to the configured direction
ALARM Shutdown Overspeed	Engine speed beyond established limits
ALARM Shutdown Underspeed	
ALARM Shutdown Generator over frequency	Generator set frequency beyond established limits
ALARM Shutdown Generator or under frequency	
ALARM Shutdown Generator over voltage	Generator set voltage beyond established limit
ALARM Shutdown Generator under voltage	
ALARM Shutdown Oil pressure sender open circuit	Faulty oil pressure sender
ALARM Shutdown Auxiliary input	An active auxiliary input configured as a shutdown will cause the engine to shutdown. The display shows the text as configured by the user.
ALARM Shutdown Loss of speed signal	The speed signal from magnetic pick up as not received by the module.
ALARM Shutdown ECU data fail	The module configured for CAN operation and doesn't detect data on data link.
ALARM Shutdown ECU shutdown	Engine ECU has detected a shutdown alarm. The exact error is also indicated on module display (only for electronic engines).
ALARM Shutdown kW overload	The total kW is above the shutdown setting.
ALARM Shutdown Negative phase sequence	Indicates "out of balance" current loading of the generator set.
ALARM Shutdown High Current trip	Current of the generator set output beyond established limits
<i>Note: If the established limit for shutdown is exceeded, a corresponding alarm screen will be displayed and on the configurable LED indicator (8) the Common Shutdown alarm will appear.</i>	

INCIDENT	DESCRIPTION OF ELECTRICAL TRIPS
ALARM Electrical trip Generator over current	Generator set current above electrical trip setting.
ALARM Electrical trip Auxiliary inputs	Auxiliary inputs can be configured and will display the message as written by the user
ALARM Electrical trip kW overload	The total kW is above electrical trip setting.
ALARM Electrical trip Earth fault	The earth fault current is above electrical trip settings (only under customer request)
ALARM Electrical trip Negative phase sequence	Indicates “out of balance” current loading of the generator set.
<i>Note: Electrical trips are latching and stop the generator set but in a controlled manner. Firstly de-energize the “close generator” output to remove the load from the generator set, and later, cool down and shutdown the unit.</i>	

### Typical LCD Display Screens

	<p>Indicates that the generator set will respond to either a mains failure or an active remote start.</p>
	<p>Indicates that generator set is in automatic mode and has been initiated after a mains failure has been detected.</p>
	<p>Indicates generator set running normally in automatic mode. Also indicates the average line to neutral voltage (L-N), the highest of the three phase currents, the rated frequency, average line-to-line voltage (L-L) and total kilowatts.</p>

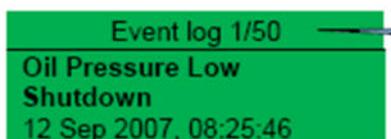
#### – Measurement Parameter Display Screens:

	<p>Coolant temperature in degrees (°C) Celsius and degrees Fahrenheit (°F)</p>
	<p>Displays engine oil pressure in Bar, PSI and kPa.</p>
	<p>All three generator line currents.</p>

– **Event Log:**

To view the event log, press the following button repeatedly  until the LCD display the event log.

It registers the shutdown alarms occurring in the generator unit. A screen similar to this is shown:



*“On September 12, 2007, at 08:25:46, the unit detected that the oil pressure was below the minimum level and has shut down the generator. It’s the event 1 of a total of 50 logged events”*

To move from one event to the next, press .

To exit the main screen, press .

*Note: Warning alarms are not logged.*

– **Displaying information:**

Pressing this button: .

Page order:

- Status display
- Instrument display (engine, generator and mains)
- Alarms display
- ECU DTCs (electronic engines only)
- Event Log
- Scheduler (if enabled)
- About

It is possible to scroll through the different display screens by pressing the next page button: . Once selected, the page will remain on the screen until the user selects a different page or after a period of inactivity for the control module, at which point the status display appears.

If no buttons are pressed upon entering an instrumentation page, the instruments will be displayed automatically.

Alternatively, by pressing on  or  buttons, the user can scroll through all the instruments on a particular screen. This disables autoscroll. When autoscroll is disabled, if no buttons are pressed the display will return to the status page. To re-enable autoscroll, press on  or  buttons to scroll to the title of the instrument page.

If an alarm becomes activated while viewing instruments, the Alarms page will be automatically displayed.

Instrument page content:

#### Engine

- Engine speed
- Oil pressure
- Coolant temperature
- Engine battery volts
- Run time
- Oil temperature\*
- Coolant temperature\*
- Inlet temperature\*
- Exhaust temperature\*
- Fuel temperature\*
- Turbo pressure\*
- Fuel pressure\*
- Fuel consumption\*
- Fuel used\*
- Fuel level\*
- Auxiliary sensors (if fitted and configured)
- Engine maintenance due (if configured)
- Engine ECU link\*

\* When connected to suitably configured and compatible engine ECU.

#### Generator

- Generator AC voltage L-N
- Generator AC voltage L-L
- Generator frequency
- Generator current
- Generator earth current (under customer request)

- Generator load (kW)
- Generator load (kVA)
- Generator power factor
- Generator load (kVAr)
- Generator load (kWh, kWAh, kVArh)
- Generator phase sequence

Mains (DSE 7320 only)

- Mains voltage L-N
- Mains voltage L-L
- Mains frequency

About

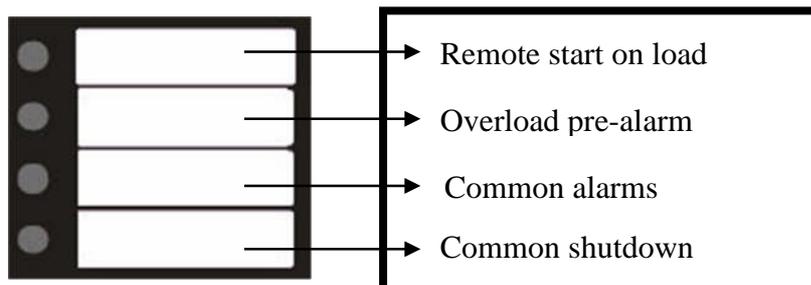
- Module type
- Application version
- USB ID – unique identifier for PC USB connection
- Analogue measurements version
- Firmware update boot loader version

If the following appears in an instrument display: \*\*\*\*\*, this means that the engine can't provide this parameter; the control module, however, does provide this option.

If the following appears in an instrument display: ##### with the generator set in OFF/AUTOMATIC mode (with the engine stopped), this means that the control module is not connected to the engine. Press

this button  (6) to display the given value.

- **Alarm LED:**



### — Editing the current Date and Time:

The date and time are adjustable. When the battery is disconnected, the date and time are frozen; when the battery is reconnected, the date and time shown will be from the last time the battery was disconnected.

The date and time reflected in the Event Log will be taken from the configuration according to the following steps:

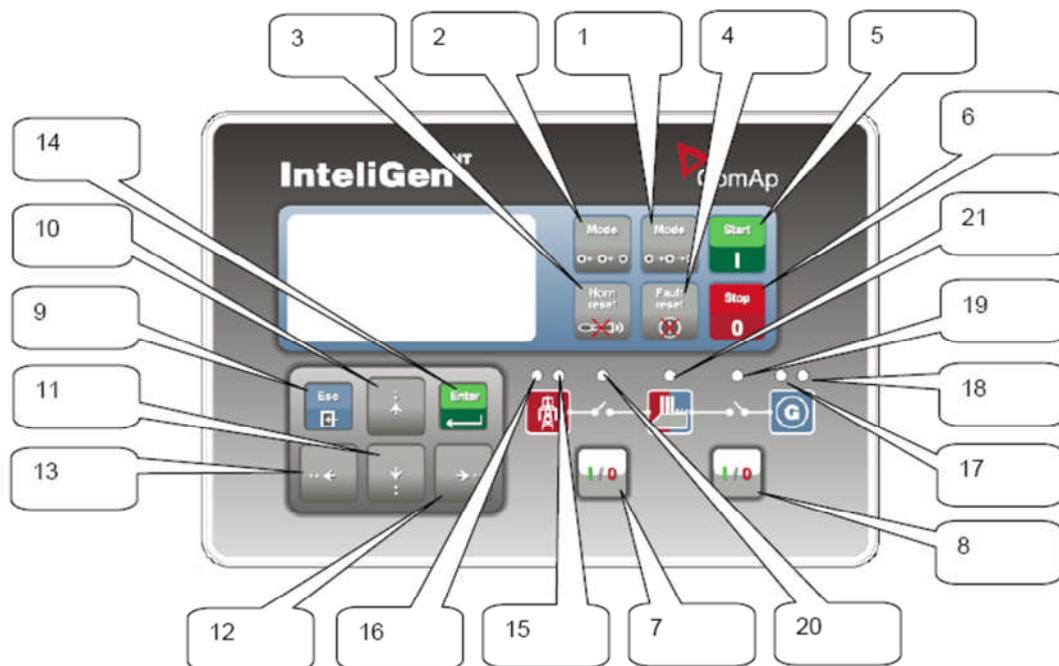
Press  and  simultaneously, then enter the correct PIN number using  or  buttons to select the right figure, and using  and  to move from one figure to another. Finally press  button

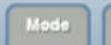
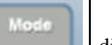
Press  until the Display section. Press  until “Current date and time”.

When “Current Date and Time” appears, press the  button. The figures will start to flash. Press  or  to adjust to the desired values.

Press the  button to confirm the value entered.

Press and hold  to exit the editor at any time.

6.1.3. INTELIGEN<sup>NT</sup> Digital Control Module

 Image 23- INTELIGEN<sup>NT</sup> Digital Control Module

#	SYMBOL	DESCRIPTION	IDENTIFICATION
(1)		Scrolls through different operating modes	OFF←MAN←AUT←TEST
(2)			OFF→MAN→AUT→TEST
(3)		Deactivates audible alarm	
(4)		Fault reset	Acknowledges faults and alarms
(5)		Start button	In manual mode
(6)		Stop button	In manual mode
(7)		MCB ON/OFF	Opens and closes MCB in manual mode
(8)		GCB ON/OFF	Opens and closes GCB in manual mode
(9)		Exit from actual screen (without save changes if editing)	
(10)		Selects on-screen value, set point, history record or increase/decrease set point value	Increases value
(11)			Decreases value

(12)		Moves history record displayed columns to the right/left, 5% increase/decrease of edited set point, a value or go out/into alarm list.	6.1.4. Increases value
(13)			Decreases value
(14)		Enter button	Confirms on-screen value
(15)		Mains power status	Green if mains power correct
(16)		Mains failure	Red light flashes if mains failure occurs and generator set doesn't run; continuous if generator is operating, turns off when Mains power restored.
(17)		Generator voltage present	Green led is on if unit voltage is present and within limits.
(18)		Generator set failure	Flashing Red LED indicates alarm
(19)		State of GCB	Green led is on if GCB is closed. Flashes during synchronization with mains.
(20)		State of MCB	Green led is on if MCB is closed Flashes during reverse synchronization with mains.
(21)		State of bus	Green led is on if bus voltage is correct

NOTE: GCB = Generator Circuit Breaker; MCB = Mains Circuit Breaker.

The IntelliGen<sup>NT</sup> module contains a main menu screen and the following seven submenu screens:

- Alarmlist
- Measurement
- Measurement I/O
- History
- Setpoints
- User/Password
- Languages

Pressing several times the main menu is displayed. To enter in a submenu, scroll up and down using



(10) or



(11) buttons and press



(14) button. To display the different instruments

or parameters on each screen menu, press  (10) or  (11) buttons. To come back to a

previous menu screen, press  (9) button.

The alarmlist screen display the alarms detected by the module. Pressing  button (4) faults and alarms are acknowledged.

The measurement screen displays the parameters measured on the engine; if the engine uses an electronic management system, many additional parameters can be displayed. In addition to these parameters, measurements can be displayed for fuel level, oil pressure, current, voltage, frequency, run hours and battery charge level.

The measurement I/O screen display the status of digital inputs and outputs and the measured parameter of analogue inputs (senders).

The history screen menu displays the log of alarms that have occurred in the generator unit. It also logs the opening and closing of the mains circuit breaker as well as the starting and shutting down of the generator unit.

The set points menu screen displays the adjustment parameters already configured; it is not necessary to edit any of these.

The users/password screen allows to define users and passwords. The languages screen allows to change the display language

• **AUTOMATIC mode (AUTO):**

If a mains failure is detected, the IntelliGen<sup>NT</sup> module will open the MCB (main circuit breaker). Startup command is issued to generator set. If generator voltage is within the established limits, the LED indicator



(17) will be on and the control module closes the GCB (generator circuit breaker). Once mains power has been restored, synchronization between mains and generator occurs; then the MCB is closed, causing the generator to discharge, followed by the opening of the GCB. When mains power is restored, there will be a period of time during which the engine continues operating at no load to cool down before stopping completely.



Note: If  (4) is pressed following a disconnection alarm, the engine could automatically start without any warning.

• **NO-LOAD TEST mode (MANUAL):**

Press the START button  (5) to start up the generator set. When the generator voltage is within the established limits, the LED indicator  (17) will be on. To stop the unit, press STOP  (6).

• **LOAD TEST mode (TEST):**

This operating mode is used for generator set start test if the mains is OK or to transfer the load to the generator set when a mains failure is announced in advance. To stop this mode, change to another mode by

means of the buttons  (1) or (2).

**OFF mode:**

The generator set will not start. Even if we press the buttons START  (5), STOP , GCB ON/OFF  (8), the generator will not respond.

**ALARMS:**

The IntelliGen<sup>NT</sup> control module includes the following warnings:

INCIDENT	STORED IN HISTORY RECORD
Startup sequence initiated	Startup of Gen-Set
Shutdown of the Gen-Set	Gen-Set stops
Electrical Generator circuit breaker closed	GCB connected
Electrical Generator circuit breaker opened	GCB disconnected
Some GCB in group was opened (in MINT)	Other GCB trip
Mains circuit breaker closed	MCB connected
Mains circuit breaker opened	MCB disconnected
Time mode has been changed	TimeModeChngd
STARTUP INFO	
AMF Startup	GenSetMF start
AMF Stop	GenSetMF stop
Remote startup by binary input (SPM, SPtM)	GenSetRemStart
Remote stop by binary input (SPM, SPtM)	GenSetRemStop
System startup by binary input (MINT, MEXT)	GenSetSysStart
System stop by binary input (MINT, MEXT)	GenSetSysStop
Peak start (SPtM)	GenSet PKstart
Peak stop (SPtM)	GenSet PKstop

ENGINE		
EVENT SPECIFICATION	ALARM	HISTORY
Electrical Generator Startup failure	Sd Start Fail	Sd Start Fail
Electrical Generator Overspeed	Sd Overspeed	Sd Overspeed
Electrical Generator Underspeed	Sd Underspeed	Sd Underspeed
SD Stop fail	Sd Stop Fail	Sd Stop Fail
Emergency Stop	Emergency Stop	Emergency Stop
RPM Pickup fail	SdPickupFail	SdPickupFail
Battery voltage warning	Wrn Batt volt	Wrn Batt volt
Battery is discharged	Sd Batt flat	0

<b>GENERATOR</b>	
<b>EVENT SPECIFICATION</b>	<b>HISTORY</b>
Generator phase 1 overvoltage	Unl Vg1 Over
Generator phase 1 undervoltage	Unl Vg1 Under
Generator phase 2 overvoltage	Unl Vg2 Over
Generator phase 2 undervoltage	Unl Vg2 Under
Generator phase 3 overvoltage	Unl Vg3 Over
Generator phase 3 undervoltage	Unl Vg3 Under
Generator Overfrequency	Unl Fgen Over
Generator Underfrequency	Unl Fgen Under
Generator voltage unbalance	Unl Vgen Unbal
Generator overload	UnlGen Overload
Load surge protection	LoadSurge
Reverse power	Unl Rev Pwr
Synchronization timeout	Stp SyncTO
Ground fault protection	Unl EarthFltC
Failure of generator circuit breaker	GCB fail
Generator short circuit protection	Unl Short Igen
Generator IDMT protection	Unl IDMT
Generator current unbalance	Unl Igen Unbal
Voltage on mains terminals (SPM)	UnlCounterVolt
Bus voltage error (MINT)	Unl BusMeasErr

<b>PHASE SEQUENCE</b>		
<b>EVENT SPECIFICATION</b>	<b>ALARM</b>	<b>HISTORY</b>
Generator phase L1 is inverted	GEN L1 neg	0
Generator phase L2 is inverted	GEN L2 neg	0
Generator phase L3 is inverted	GEN L3 neg	0
Wrong generator phase sequence	G ph opposed	0
Wrong generator phase sequence and phase L1 is inverted	G ph + L1 neg	0
Wrong generator phase sequence and phase L2 is inverted	G ph + L2 neg	0
Wrong generator phase sequence and phase L3 is inverted	G ph + L3 neg	0
Mains phase L1 is inverted	B L1 neg	0
Mains phase L2 is inverted	B L2 neg	0
Mains phase L3 is inverted	B L3 neg	0
Wrong mains phase sequence	B ph opposed	0
Wrong mains phase sequence and phase L1 is inverted	B ph + L1 neg	0
Wrong mains phase sequence and phase L2 is inverted	B ph + L2 neg	0
Wrong mains phase sequence and phase L3 is inverted	B ph + L3 neg	0

## 7. MAINTENANCE OF GENERATOR SET

You must make sure that the person who will perform this duty is qualified to do so and uses the appropriate individual protection equipment.

### 7.1. PRIOR TO MAINTENANCE

You must first:

- Switch Control Module to the OFF position.
- Press the emergency stop button.
- Disconnect the battery; use the battery isolator switch.



To cut Mains voltage, switch off the 10 A circuit breaker in the ATS panel supplied by GRUPOS ELECTRÓGENOS EUROPA S.A. If made by another manufacturer, make sure that this cut is done properly before handling the unit.

### 7.2. DURING MAINTENANCE

Preventive maintenance tasks are necessary to preserve the unit; doing so will result in optimum performance. Be sure to verify the following items:

- 1) While the engine is cold, the oil level should be between the minimum and maximum values. If it is below the minimum, add Engine oil.

*NOTE: With the DEEP SEA and IntelliGen<sup>NT</sup> modules, at 50 hours run notice will be given to change the oil. The recommended oil is 15W40.*

*For temperature condicions diferent from indicated, choose the fuel type according to the following table:*

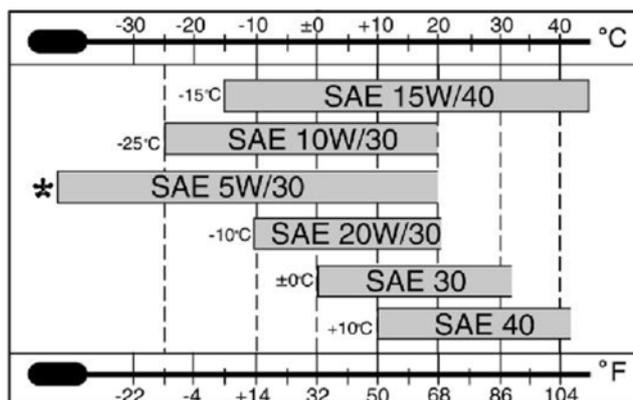
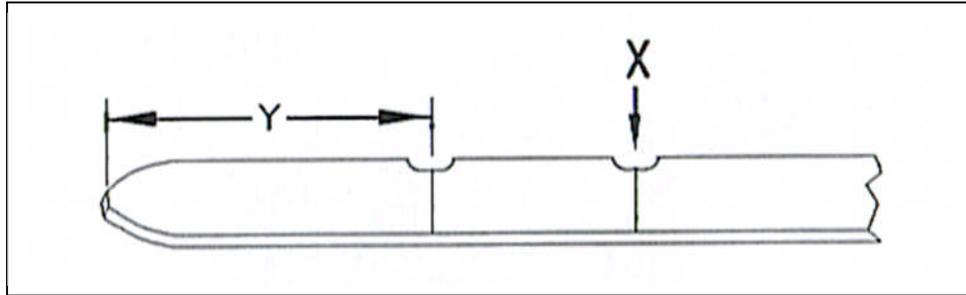


Figure 24 - Recommended types of oil as a function of temperature

2) The Engine oil level shall also be checked periodically. This will be accomplished by pulling out the dipstick. It shall be carried out with the engine cold and in a horizontal position. If you wish to check the oil level upon shutting down the Engine, wait for the housing to drain prior to checking the oil level.



*Image 25-Oil level dipstick.*

The dipstick has two markings; a minimum oil level marking (Y) and a maximum oil level marking (X). The recommended service level is between both markings.

If the oil level is below the minimum, the engine oil must be serviced. However, the oil level shall never exceed the maximum level.

Unscrew the Engine's oil filler plug; completely remove the plug in order to have free access to the oil tank. Once serviced with oil, clean the oil tank cover and reinstall the oil filler plug. If the engine oil must be replaced, first the engine oil must be drained. To accomplish this, the generator set may include an external connection with a plug, from which the engine oil can be drained; otherwise, the generator set must be opened and the engine oil shall be drained through the lower plug located under the engine housing (refer to the engine manual delivered separately). Once the engine oil is drained, re-install the plug that was removed and service the engine oil as indicated for checking the oil level (refer to the engine manual, which is delivered separately for this task).

Take into account the capacity of the tank where the used fluid is going to be poured and be careful not to spill any fluid. Remember that the fluid is hazardous to the environment. Adopt the necessary protective measures for handling the fluid; especially the use of protective goggles. If fluid comes in contact with the skin, immediately wash the affected area.

- 3) The radiator coolant level should be adequate.
- 4) The fuel level in the tank should be sufficient for the service to be performed. In the DEEP SEA 4420 generator control panel is equipped with a fuel gauge, which will be functional whenever the electrical panel is receiving power. The generator set's fuel tank incorporates a lower plug to drain the tank if required. Be careful to not spill fuel when carrying out this task and adopt the necessary protective measures for handling fuel; especially the use of protective goggles. If fuel comes in contact with the skin, immediately wash the affected area.
- 5) Always refuel in a well ventilated area with the engine stopped.
- 6) Closely inspect the connections and the electrical circuit, for both the mechanical and electrical sections.
- 7) Check carefully for possible liquid leaks. If a leak is detected, find its source and resolve the problem. If your unit has a retention bath, drain it (see section 3.4 RETENTION BATH).
- 8) The air inlet and outlet vents should be completely unobstructed to allow for free circulation of cooling air.
- 9) Check the state of the unit's radiator and clean if necessary. The Engine cooling fluid levels shall be checked periodically, and shall be serviced if found below the minimum. The cooling fluid used will be 50% ethylene glycol with a corrosion inhibitor (BS 658: 1992 or MOD AL39) and 50% distilled water. To drain the engine cooling circuit, depending on the model, the generator set may incorporate an external connection with a drain plug for that circuit; otherwise, the draining must be carried out through the bottom part of the radiator. Servicing with coolant once the circuit has been drained will be accomplished through the top part of the radiator, through the radiator's top plug, which is accessible through the covered openings arranged on the generator set's fairing. Take into account the capacity of the tank where the used fluid is going to be poured and be careful not to spill any fluid. Remember that the fluid is hazardous to the environment. Adopt the necessary protective measures for handling the fluid; especially the use of protective goggles. If fluid comes in contact with the skin, immediately wash the affected area.

For further information, refer to the engine manual, which is delivered separately.

- 10) Make sure the exhaust tube is not obstructed.
- 11) Check the battery's connection terminals and electrolyte level (if necessary, add demineralized or distilled water). Acid should never be added. The battery should be recharged if the terminal voltage is below 12.3 V.
- 12) If the battery needs recharging after being taken out of the unit, remove the vent caps and charge battery with direct current only. Connect the charger's positive (+) cable to the battery's positive (+) terminal and the charger's negative (-) cable to the battery's negative (-) terminal. Recharge battery with a current equivalent to 1/10 the rated capacity (Ah). Battery is fully charged

when acid density is 1.28. Before completing recharging process: turn off charger before disconnecting battery and check electrolyte level.

13) If the battery is discharged and you want to perform an emergency startup with the battery from another generator, first check the tightness of the discharged battery's terminals. Stop the engines of both units and connect the two positive terminals of the batteries first and then connect the negative terminal of the charged battery to a metal area on the disabled unit (ground). Start up the auxiliary unit and then the unit being repaired. Disconnect the cables in reverse order to avoid a short circuit. Finally, fully charge the battery.



*While performing preventive maintenance tasks it is advisable to wear protective eyewear and gloves during all operations involving the handling of battery acid. Make sure there is nearby access to tap water in order to wash all potentially affected areas.*



*Remember to always perform all operations with the utmost precaution and safety as indicated in this Manual. (Pay special attention to the risk of short circuits that could be caused by coming in contact with the unit's metallic objects.)*

## 7.3. MAINTENANCE CHART

FREQUENCY	MAINTENANCE OPERATION
MONTHLY	Perform a mains failure simulation; the unit should supply power to consumers for one hour.
	For parallel units, check the connection and the load sharing.
	Review the connections of the startup battery, clean and cover with vaseline.
	Make sure the battery charger is functioning properly.
	Make sure fuel pump is functioning properly.
	Check fuel level on the main fuel tank.
	Check coolant and oil levels.
	Make sure smoke extractor is functioning properly.
	Make sure all of the electrical panel lights are functioning properly.
	Make sure the ATS functions properly in transfers.
	Check the state of all of the gauges and indicators on the electrical panel.
	Check the engine manufacturer's manual for specific tasks.
EVERY 6 MONTHS	Start up the engine manually three times, noting each time the voltage and density readings for each of the battery's elements. If any of the voltage readings varies significantly from those of the battery's other elements, do not perform the remaining manual engine startups.
	Fully charge the battery and check the electrolyte level.
	Make sure there are no leaks in the coolant tubes.
	Make sure that all of the unit's alarms display correctly.
	Check the engine manufacturer's manual for specific tasks.
YEARLY	Clean the outside of the fuel tank and check the diesel pipes.
	Clean radiator, change antifreeze.
	Clean and lube the water pump and fan.
	Make sure meters are correct.
	Clean control panel and tighten the panel's connections.
	Verify that the antivibration feet, fittings and belts are in proper condition.
	Make sure that vibration and noise levels comply with the current regulations.
	Make sure noise emission level is compliant with the current regulations.
	Check the engine manufacturer's manual for specific tasks.
	In case you had a soundproofed group, clean and grease the lock of the access and panel door.
EVERY 3 YEARS	Replace startup batteries.

## 8. TROUBLESHOOTING

		INCIDENT	LIKELY CAUSE	SOLUTION		
In the electrical panel	Engine does not start	Starter does not turn	1.-Defective battery	1.-Replace battery		
			2.-Defective starting system	2.-Replace starting system 3.-Contact technical service.		
	Engine starts	Starter functioning properly	1.-Faulty voltage detector on control module	1.-Contact technical service.		
			2.-Low fuel level	2.-Refill fuel tank		
	Engine stops	Stops with cause	1.-Emergency has occurred	1.-Take appropriate measures		
		Stops for no apparent reason	1.-Emergency not indicated due to faulty LED indicator	1.-Contact technical service.		
		Does not stop when emergency occurs	1.-Defective stopping system	1.-Press emergency stop button		
				2.-Contact technical service.		
	Generator does not stop when in stop position	1.-Faulty control unit	1.-Press emergency stop button			
		2.-Defective Stopping System	2.-Contact technical service.			
Originating in engine's interior	Unit in operation	High voltage at no load	1.-Overspeed	1.-Contact technical service.		
			2.-Alternator failure			
	Low voltage at no load	1.-Underspeed	2.-Alternator failure	1.-Contact technical service.		
					2.-Alternator failure	
	Correct voltage but low when on load	1.-Heavy load 2.-Underspeed on load 3.-Alternator failure	1.-Reduce power of loads 2.-Contact technical service.			
				Voltage unstable	1.-Voltage meter damaged 2.-Engine unsteady 3.-AVR damaged	1.-Contact technical service.
	2.-Contact technical service.					

## **9. PROTECTION FROM THE ENVIRONMENT**

Once the generator set has been installed, it is necessary to remove the packaging, accessories, electrical tools, etc., that were used during the installation process.

When it is time to dispose of the batteries, in keeping with environmental regulations it is advisable to take them to an authorized recycling center.

For a cleaner environment, recycle all possible items and be sure to not throw electrical components in with the regular garbage so as to comply with European directive 2002/96/EC. These items should be stored separately until being taken for ecological recycling.

## **10. WARRANTY**

- The warranty of the generator set is extended for a calendar year from the date it is commissioned. This must be reported to GRUPOS ELECTRÓGENOS EUROPA S.A., (hereafter the manufacturer) in writing, whether by fax, or e-mail. The data that must be communicated is the MODEL NUMBER, SERIAL NUMBER AND COMMISSIONING DATE.

- If the manufacturer is not notified of the commissioning within a maximum period of sixty days from the invoice date, then the invoice date itself will be used as the effective start date of the warranty period. If for any reason the commissioning cannot be performed in the sixty days following the invoice date, the manufacturer must be informed of this in writing. This extension of the warranty is subject to the acceptance of the end supplier of the engine and alternator. This shall never exceed 120 days from the invoice date. This acceptance shall be sent by staff of GRUPOS ELECTRÓGENOS EUROPA S.A.

- The warranty covers defects in components and assembly, not due to improper use, manipulation, modification or insufficient maintenance. The warranty does not cover failures caused by use of the generator set with other devices that have not been installed or supplied by the manufacturer. Also excluded are any failures and damages caused by prolonged or improper storage. In this last case, refer to the manufacturer's user manuals.

- The warranty for the generator set ONLY covers spare parts and labor required for operating the set by personnel authorized by the manufacturer. Travel, and other expenditures derived from the repairing of a set under warranty are excluded from the warranty coverage therefore, under no circumstance shall the manufacturer cover these expenses, which must be paid for in full.

- The decision to accept or deny a warranty claim will be made by the manufacturer. Regarding engine and alternator failures, the warranty will be granted by the supplier of these components in accordance with their warranty conditions. The manufacturer reserves the right to require that the faulty component be returned to them. In this case, all expenses arising from this recovery shall be covered by the customer until the resolution of the warranty. If the warranty is accepted, the transport costs of this return shall be paid provided the cost is not greater than that caused by shipping the material in advance.

- Any repair made within the warranty period shall not lead to the modification of expiry date for the generator set warranty.
- The warranty does not cover damages caused by terrorist acts, natural disasters, sabotages or similar occurrences.
- If any of the stated provisions does not comply with the legislation of a specific country, the importer is required to notify the manufacturer prior to executing the purchasing-sale operation.
- This warranty expressly replaces all other warranties, explicit or implicit, including any warranty that is commercial or suitable for personal use. The warranty presented here is for exclusive use in resolving claims based on defects and non-conformities in generator sets, regardless of whether the claim is based on a contract or grievance, and replaces other resolutions, responsibilities or rights, whether or not they arise by law.

## **11. NOISE LEVEL**

Generator sets manufactured by GRUPOS ELECTRÓGENOS EUROPA S.A. produce different acoustic levels depending on the output and soundproofing of the generator set. The noise output is indicated on a sticker affixed to the unit's base frame.

*Note: If you work near the unit for any extended period of time, it is advisable to use hearing protection.*

## **12. DECLARATION OF CONFORMITY**

GRUPOS ELECTRÓGENOS EUROPA S.A., shall deliver a CE “declaration of conformity” form along with the unit, in compliance with the referenced regulations or standardized documents.

### 13. APPENDIX 1: FIGURES

Detail of the unit's Identification Label:

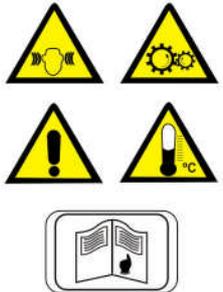
<b>Generator set</b>		
Class	DVAS 450 E LS	
Prime Power	328 kW	
Power Factor	0,8	
Frequency	50 Hz	
Voltage	400/230 V	
Current	649,5 A	
Performance Class	G3	
Gross weight	4.607 kg	
Serial N°	298521	
Manufacturing date	04/03/11	

Poligono Pitarco II, Parcela 20, 50450 Muel (ZARAGOZA) SPAIN

[www.gesan.com](http://www.gesan.com) [www.gesan.es](http://www.gesan.es)

Image 26- Identification Label

#	LABELED ITEM	DESCRIPTION
(1)	DVAS 450 E	D => Engine uses Diesel fuel at 1500/1800 rpm
		V => Engine manufacturer is (V)olvo, (P)erkins, (C)ummins, Mitsubis(H)I or M(T)U.
		A => The generator set is automatic
		S => The generator set is soundproofed
		450 => Commercial name
		E => Indicates generator set is standby type
(2)	Rated power	Rated power of generator set expressed in kW.
(3)	Power factor	Indicates power factor of generator set
(4)	Rated frequency	Rated frequency of generator set (Hertz)
(5)	Rated voltage	Rated voltage of generator set (Volts)
(6)	Product class	When withstanding a load, engine will perform according to catalogued response times per ISO 8528
(7)	Weight	Total weight of generator set
(8)	Serial no.	Serial number of generator manufacture
(9)	Manufacture date	Manufacture date of generator set
(10)		CE marking indicates that generator set complies with the relevant directives

 <p>ESTE EQUIPO PUEDE ARRANCAR SIN PREVIO AVISO. THIS GENSET MAY START WITHOUT PRIOR WARNING. CE GROUPE ÉLECTROGÈNE PEUT DEMARRER SANS AVIS PRÉALABLE. DIESES GERÄT KANN OHNE VORANKÜNDIGUNG STARTEN. ESTE GRUPO ELECTROGÉNICO PODE ARRANCAR SEM AVISO PREVIO. Оборудование может начать работу без предварительного предупреждения. ارنزا قيس رونب ليعشرفي نا ركسفي ويواسفكلا طوبيا انه 该设备可无提前通知直接启动。</p>		
<p><i>Image 27: This genset may start without prior warning</i></p>	<p><i>Image 28: General warning</i></p>	<p><i>Image 29: Undefined warning notice</i></p>
		
<p><i>Image 30: Electrical hazard</i></p>	<p><i>Image 31: Electrical hazard 230 Volts</i></p>	<p><i>Image 32: Electrical hazard 400 Volts</i></p>
		
<p><i>Image 33: Possible spillage of battery acid</i></p>	<p><i>Image 34: Electrical grounding</i></p>	<p><i>Image 35: Noise output 90 dB</i></p>
		
<p><i>Image 36: Noise output 114 dB</i></p>	<p><i>Image 37: Mandatory hearing protection.</i></p>	<p><i>Image 38: Coolant flush</i></p>
		
<p><i>Image 39: Oil flush</i></p>	<p><i>Image 40: Battery isolator</i></p>	<p><i>Image 41: High temperature</i></p>
<p><i>On hot surfaces where it has not been possible to minimize the risk of burns, the following warning pictogram will be installed.</i></p>		

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15. **APPENDIX 3: PRE-DELIVERY INSPECTION DOCUMENT**

## 16. APPENDIX 4: DERATING OF ENGINE POWER RATING:

Engine power rating is declared for the following conditions in accordance with the norms ISO-8528-1:2005 and ISO-3046-1:2002.

- Air pressure: 100 kPa
- Temperature: 25°C
- Relative humidity: 30%

If site ambient conditions are different from standard, derating of engine power rating is possible.

This derating depends on the characteristics of every engine. Please consult those derating in his technical sheets.

According to norm ISO-3046-1:2002, the derating of engine power rating could be found are:

### 16.1. DERATING OF POWER RATING OF TTURBOCHARGED ENGINES WITHOUT CHARGE AIR COOLING:

Altitude from sea	Barometric pressure	Temperature (°C)												
		m	kPa	-10	0	5	10	15	20	25	30	35	40	45
0	101,3		1,33	1,23	1,18	1,13	1,09	1,05	1,01	0,97	0,94	0,90	0,87	0,84
100	100,1		1,32	1,22	1,17	1,12	1,08	1,04	1,00	0,96	0,93	0,90	0,86	0,83
200	99,5		1,31	1,21	1,16	1,12	1,08	1,03	1,00	0,96	0,92	0,89	0,86	0,83
300	98,7		1,31	1,20	1,16	1,11	1,07	1,03	0,99	0,95	0,92	0,89	0,85	0,82
400	96,7		1,29	1,18	1,14	1,09	1,05	1,01	0,97	0,94	0,90	0,87	0,84	0,81
500	95,5		1,27	1,17	1,13	1,08	1,04	1,00	0,96	0,93	0,89	0,86	0,83	0,80
600	94,4		1,26	1,16	1,12	1,07	1,03	0,99	0,96	0,92	0,89	0,85	0,82	0,79
700	93,2		1,25	1,15	1,11	1,06	1,02	0,98	0,95	0,91	0,88	0,85	0,82	0,79
800	92,1		1,24	1,14	1,10	1,05	1,01	0,97	0,94	0,90	0,87	0,84	0,81	0,78
900	90,9		1,23	1,13	1,08	1,04	1,00	0,96	0,93	0,89	0,86	0,83	0,80	0,77
1000	89,9		1,22	1,12	1,07	1,03	0,99	0,96	0,92	0,88	0,85	0,82	0,79	0,76
1100	88,8		1,20	1,11	1,06	1,02	0,98	0,95	0,91	0,88	0,84	0,81	0,78	0,76
1200	87,7		1,19	1,10	1,05	1,01	0,97	0,94	0,90	0,87	0,84	0,80	0,78	0,75
1300	86,7		1,18	1,09	1,04	1,00	0,96	0,93	0,89	0,86	0,83	0,80	0,77	0,74
1400	85,6		1,17	1,08	1,03	0,99	0,96	0,92	0,88	0,85	0,82	0,79	0,76	0,73
1500	84,5		1,16	1,07	1,02	0,98	0,95	0,91	0,87	0,84	0,81	0,78	0,75	0,73
1600	83,5		1,15	1,06	1,01	0,97	0,94	0,90	0,87	0,83	0,80	0,77	0,75	0,72
1700	82,4		1,14	1,05	1,00	0,96	0,93	0,89	0,86	0,82	0,79	0,77	0,74	0,71
1800	81,5		1,13	1,04	1,00	0,96	0,92	0,88	0,85	0,82	0,79	0,76	0,73	0,70
1900	80,5		1,12	1,03	0,99	0,95	0,91	0,87	0,84	0,81	0,78	0,75	0,72	0,70
2000	79,5		1,11	1,02	0,98	0,94	0,90	0,87	0,83	0,80	0,77	0,74	0,72	0,69
2200	77,6		1,08	1,00	0,96	0,92	0,88	0,85	0,82	0,79	0,76	0,73	0,70	0,68
2400	75,6		1,06	0,98	0,94	0,90	0,87	0,83	0,80	0,77	0,74	0,71	0,69	0,66
2600	73,7		1,04	0,96	0,92	0,88	0,85	0,81	0,78	0,75	0,73	0,70	0,67	0,65
2800	71,9		1,02	0,94	0,90	0,86	0,83	0,80	0,77	0,74	0,71	0,68	0,66	0,63
3000	70,1		1,00	0,92	0,88	0,85	0,81	0,78	0,75	0,72	0,70	0,67	0,64	0,62
3200	68,4		0,98	0,90	0,87	0,83	0,80	0,77	0,74	0,71	0,68	0,66	0,63	0,61
3400	66,7		0,96	0,88	0,85	0,81	0,78	0,75	0,72	0,69	0,67	0,64	0,62	0,60
3600	64,9		0,94	0,87	0,83	0,80	0,76	0,73	0,71	0,68	0,65	0,63	0,60	0,58
3800	63,2		0,92	0,85	0,81	0,78	0,75	0,72	0,69	0,66	0,64	0,61	0,59	0,57
4000	61,6		0,90	0,83	0,80	0,76	0,73	0,70	0,68	0,65	0,62	0,60	0,58	0,56

*Note: Environmental conditions of  $T=298\text{ K}$  y  $P=100\text{ kPa}$ .*

*In order to know the particular engine power rating derating, refer to manufacturer technical specifications.*

### 16.2. DERATING OF ENGINE POWER RATING OF TURBOCHARGED ENGINES WITH CHARGE AIR COOLING:

Altitude from sea	Barometric pressure	Temperature (°C)											
		-10	0	5	10	15	20	25	30	35	40	45	50
m	kPa												
0	101,3	1,28	1,22	1,19	1,16	1,13	1,11	1,08	1,06	1,04	1,01	0,99	0,97
100	100,1	1,27	1,21	1,18	1,15	1,12	1,10	1,07	1,05	1,03	1,00	0,98	0,96
200	99,5	1,26	1,20	1,17	1,14	1,12	1,09	1,07	1,04	1,02	1,00	0,98	0,96
300	98,7	1,25	1,19	1,16	1,14	1,11	1,09	1,06	1,04	1,02	0,99	0,97	0,95
400	96,7	1,23	1,17	1,15	1,12	1,09	1,07	1,04	1,02	1,00	0,98	0,96	0,94
500	95,5	1,22	1,16	1,13	1,11	1,08	1,06	1,03	1,01	0,99	0,97	0,95	0,93
600	94,4	1,21	1,15	1,12	1,10	1,07	1,05	1,02	1,00	0,98	0,96	0,94	0,92
700	93,2	1,20	1,14	1,11	1,09	1,06	1,04	1,01	0,99	0,97	0,95	0,93	0,91
800	92,1	1,19	1,13	1,10	1,08	1,05	1,03	1,01	0,98	0,96	0,94	0,92	0,90
900	90,9	1,18	1,12	1,09	1,07	1,04	1,02	0,99	0,97	0,95	0,93	0,91	0,89
1000	89,9	1,17	1,11	1,08	1,06	1,03	1,01	0,99	0,96	0,94	0,92	0,90	0,88
1100	88,8	1,15	1,10	1,07	1,05	1,02	1,00	0,98	0,96	0,93	0,91	0,89	0,88
1200	87,7	1,14	1,09	1,06	1,04	1,01	0,99	0,97	0,95	0,92	0,90	0,89	0,87
1300	86,7	1,13	1,08	1,05	1,03	1,00	0,98	0,96	0,94	0,92	0,90	0,88	0,86
1400	85,6	1,12	1,07	1,04	1,02	0,99	0,97	0,95	0,93	0,91	0,89	0,87	0,85
1500	84,5	1,11	1,06	1,03	1,01	0,98	0,96	0,94	0,92	0,90	0,88	0,86	0,84
1600	83,5	1,10	1,05	1,02	1,00	0,97	0,95	0,93	0,91	0,89	0,87	0,85	0,83
1700	82,4	1,09	1,04	1,01	0,99	0,96	0,94	0,92	0,90	0,88	0,86	0,84	0,82
1800	81,5	1,08	1,03	1,00	0,98	0,96	0,93	0,91	0,89	0,87	0,85	0,83	0,82
1900	80,5	1,07	1,02	0,99	0,97	0,95	0,92	0,90	0,88	0,86	0,84	0,83	0,81
2000	79,5	1,06	1,01	0,98	0,96	0,94	0,92	0,89	0,87	0,86	0,84	0,82	0,80
2200	77,6	1,04	0,99	0,96	0,94	0,92	0,90	0,88	0,86	0,84	0,82	0,80	0,79
2400	75,6	1,02	0,97	0,95	0,92	0,90	0,88	0,86	0,84	0,82	0,80	0,79	0,77
2600	73,7	1,00	0,95	0,93	0,90	0,88	0,86	0,84	0,82	0,80	0,79	0,77	0,75
2800	71,9	0,98	0,93	0,91	0,89	0,87	0,85	0,83	0,81	0,79	0,77	0,75	0,74
3000	70,1	0,96	0,91	0,89	0,87	0,85	0,83	0,81	0,79	0,77	0,76	0,74	0,72
3200	68,4	0,94	0,89	0,87	0,85	0,83	0,81	0,79	0,77	0,76	0,74	0,72	0,71
3400	66,7	0,92	0,88	0,86	0,83	0,81	0,80	0,78	0,76	0,74	0,73	0,71	0,69
3600	64,9	0,90	0,86	0,84	0,82	0,80	0,78	0,76	0,74	0,73	0,71	0,69	0,68
3800	63,2	0,88	0,84	0,82	0,80	0,78	0,76	0,74	0,73	0,71	0,69	0,68	0,66
4000	61,6	0,87	0,82	0,80	0,78	0,76	0,75	0,73	0,71	0,70	0,68	0,66	0,65

*Note: Environmental conditions of  $T=298\text{ K}$  y  $P=100\text{ kPa}$ .*

*Intercooler reference conditions:  $T=330\text{ K}$ ,  $T_c=300\text{ K}$  y  $P=70\text{ kPa}$ .*

*In order to know the particular engine power rating derating, refer to manufacturer technical specifications.*

### 16.3. DERATING OF ENGINE POWER RATING OF NATURALLY ASPIRED ENGINES:

Altitude from sea	Barometric pressure	Humidity: 30%											
		Temperature (°C)											
		-10	0	5	10	15	20	25	30	35	40	45	
0	101,30	1,14	1,10	1,09	1,07	1,05	1,03	1,02	1,00	0,98	0,97	0,95	
100	100,00	1,12	1,09	1,07	1,05	1,03	1,02	1,00	0,98	0,97	0,95	0,93	
200	98,90	1,11	1,07	1,05	1,04	1,02	1,00	0,99	0,97	0,95	0,94	0,92	
400	96,70	1,08	1,04	1,03	1,01	0,99	0,98	0,96	0,94	0,93	0,91	0,90	
600	94,40	1,05	1,01	1,00	0,98	0,96	0,95	0,93	0,92	0,90	0,88	0,87	
800	92,10	1,02	0,98	0,97	0,95	0,93	0,92	0,90	0,89	0,87	0,86	0,84	
1000	89,90	0,99	0,95	0,94	0,92	0,91	0,89	0,88	0,86	0,85	0,83	0,82	
1200	87,70	0,96	0,92	0,91	0,89	0,88	0,86	0,85	0,83	0,82	0,80	0,79	
1400	85,60	0,93	0,90	0,88	0,87	0,85	0,84	0,82	0,81	0,79	0,78	0,76	
1600	83,50	0,90	0,87	0,85	0,84	0,82	0,81	0,80	0,78	0,77	0,75	0,74	
1800	81,50	0,87	0,84	0,83	0,81	0,80	0,79	0,77	0,76	0,74	0,73	0,72	
2000	79,50	0,85	0,82	0,80	0,79	0,77	0,76	0,75	0,73	0,72	0,71	0,69	
2200	77,60	0,82	0,79	0,78	0,76	0,75	0,74	0,72	0,71	0,70	0,68	0,67	
2400	75,60	0,79	0,76	0,75	0,74	0,72	0,71	0,70	0,69	0,67	0,66	0,65	
2600	73,70	0,77	0,74	0,73	0,71	0,70	0,69	0,67	0,66	0,65	0,64	0,62	
2800	71,90	0,74	0,72	0,70	0,69	0,68	0,66	0,65	0,64	0,63	0,62	0,60	
3000	70,10	0,72	0,69	0,68	0,67	0,65	0,64	0,63	0,62	0,61	0,59	0,58	
3200	68,40	0,70	0,67	0,66	0,64	0,63	0,62	0,61	0,60	0,59	0,57	0,56	
3400	66,70	0,67	0,65	0,63	0,62	0,61	0,60	0,59	0,58	0,57	0,55	0,54	
3600	64,90	0,65	0,62	0,61	0,60	0,59	0,58	0,57	0,55	0,54	0,53	0,52	
3800	63,20	0,62	0,60	0,59	0,58	0,57	0,56	0,55	0,53	0,52	0,51	0,50	
4000	61,50	0,60	0,58	0,57	0,56	0,55	0,53	0,52	0,51	0,50	0,49	0,48	

*Note: Environmental conditions of  $T=298\text{ K}$  y  $P=100\text{ kPa}$ . Relative humidity 30%  
In order to know the particular engine power rating derating, refer to manufacturer technical specifications.*











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