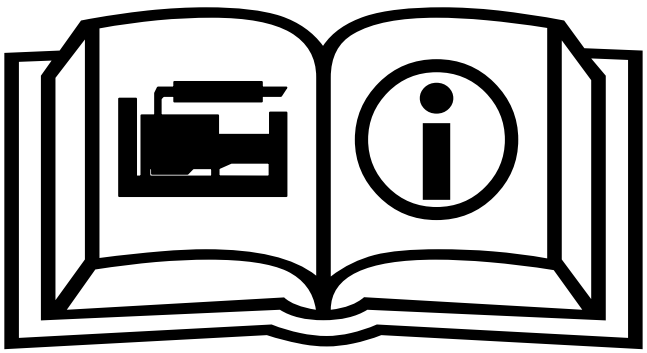
# CAROD DIESEL GENSETS GENERAL MANUAL



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# 1. INTRODUCTION

Thank you very much for purchasing our CAROD generator set.

Please, keep this instruction for the future in a safe place, and ensure that they are available to all users of the system.

It is recommended that all personnel who will operate the generator set read these instructions beforehand. It is also recommended that the equipment will be installed, maintained and repaired by qualified personnel.

All the gensets need to be routinely inspected and maintained, in order to ensure a safe operation and an optimum performance.

It is intended that the content of this manual is adjusted with the maximum precision to the information needs about the equipment, as well as that the data is as actual as possible. However, the manufacturer reserves the right to change, alter or improve this product without prior notice and without incurring obligations.

Make sure you have a clear understanding of the described instructions. Otherwise, please contact us to request additional information in:

**www.carod.es**
+ 34 976 140800 – Carod – Technical Office.

To request spare parts or technical assistance, please contact your nearest CAROD dealer. Be sure you know the model and serial number of the equipment that contains the part you need.

# 2. SAFETY PRECAUTIONS

## 2.1. GENERAL ASPECTS

The equipment must to be operated by qualified personnel only.

There is a need to know that an inappropriate use can result in an accident. To avoid this, before operating, maintaining or repairing the genset, it is important to follow all of these steps.

Perform all the safety inspection and checking operations detailed in this manual, before starting up the genset.

⚠ If an unsafe genset working condition is observed, please shut off and do not start-up the equipment. Then proceed to disconnect the negative terminal of the battery until the safety conditions are restored.

The genset installation and the nature and sizing of the electrical loads is the installer's responsibility and the final Customer. Please, be sure all the work is done according to the local regulations.


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## 2.2. GENERAL CAUTIONS FOR HANDLING AND TRANSPORTATION

The loading, unloading and displacement of the genset should be done by skilled personnel, and under certain conditions of safety.

Make sure that the floor can support the equipment weight.

When lifting the genset, make sure the fuel tank is empty.

Disconnect the battery negative terminal to avoid unexpected start-ups or short circuits.

In case of using a crane, use the lifting eyebolts to lift the group.

In case of using a forklift truck, introduce the forklift toes inside the omegas for lifting. If it's not possible, make sure every toe stays at the same horizontal distance of the lifting eyebolts axis.

## 2.3. GENERAL CAUTIONS IN THE MAINTENANCE

### *2.3.1. MECANICAL RISKS*

A working genset has moving parts that can provoke injuries if they are touched.

Always avoid contact with moving parts of the equipment. Make sure all the guards are correctly fitted. Do not remove guards if the genset is about to work, unless the task is done by a qualified and authorized personnel.

Loose fitting clothing, long hair, pendants, etc. can get caught in machinery and equipment causing accidents and injuries.

Before working in moving parts of the equipment, be sure an unexpected start-up is not possible.

Before realizing electrical or mechanical fixings, disconnect the negative terminal of the battery to prevent unexpected turns of the starter.

Whenever possible, keep doors of enclosed gensets closed and blocked.

Use gloves, safety shoes, safety eyewear and head protection when service parts of the genset.

Internal combustion engines work at high temperatures. Avoid touching engine surfaces when it is working, especially in the exhaust manifold, turbo and exhaust piping in general.

Please, keep in mind that after certain working time, fluids like oil and coolant reach high temperatures. Avoid direct skin contact with these hot fluids.


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### *2.3.2. ELECTRICAL RISKS*

If the group has a TT or TN connection installed, it is very important to connect the group to a reliable earth ground when installing. This is decisive for the electrical protections to work effectively. Otherwise, there is a risk of electrocution when coming into contact with the metal parts of the equipment.

⚠ Never expose or operate an open genset to water or rain.

⚠ Never operate the equipment when your hands are wet.

If the genset catches fire, use fire extinguishers Class BC o ABC. Never use water to try to put out a fire in the immediate area of electrical equipment.

Avoid the contact with electrical terminals and other unseated electrically living components.

In case of going to assist for a person injured by electrocution, proceed as follows:

⚠ First open the main breaker of the circuit that provoked the accident. Do not touch the victim with direct skin until the power source is shutted off.

If this is not possible, move the wire away from the victim using isolating objects, like wooden sticks, ropes, etc. without touching the victim with direct skin.

Check the vital signs and apply cardiopulmonary resuscitation techniques if necessary.

Cover the wounds with preferably sterile bandage (the entrance and exit openings, caused by electricity).

Move the victim to a medical care centre, although the injuries appear to be small. Sometimes late alterations could appear.

### *2.3.3. FIRE AND EXPLOSION*

Generator set fuel is a potentially hazardous substance, which can lead to an explosion. Make sure not to fill the fuel tank completely, especially if it will be exposed to the sun or sources of intense heat. Do not expose or spill fuel on sources of intense heat.

Lubricating oil emit fumes that can become flammable above a certain temperature. Do not expose lubricating oil to sparks or flames.

Starting batteries work with chemical reactions. The resulting vapours are flammable. Avoid the accumulation of vapours in confined or poorly ventilated spaces.

When batteries work in poor conditions, they may cause explosion during the charging process. Make sure the electrolyte level is good, keep them clean and replace them every two years.



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It is necessary to dispose of fire extinguishers close of the genset, class BC or ABC. Make sure they are fully charged and checked.

The genset operation must be carried out by trained and authorized personnel.

The site of the genset installation should have sufficient ventilation to provide a natural draught and avoid for air recirculation and accumulation of toxic fumes.

The genset environment and the site floor must remain clean and free of dirt, in order to keep from spreading in case of fire. Dirt can be absorbed by the fan and get caught on the radiator, clogging the air flow and causing over temperature failure.

### *2.3.4. CHEMICAL RISKS*

Avoid direct skin contact with fuel, oil and coolant. In the case of ingestion, do not induce vomiting. Call local number for medical emergencies and describe the situation. If your clothing gets contaminated with these fluids, take a soapy shower and wear clean clothes.

Avoid entirely direct skin contact with batteries electrolyte. This fluid involves corrosive hazard and direct contact causes burns. In case of direct contact, remove contaminated clothing as fast as possible. Quickly wash your affected skin with large amounts of soap and water for at least 15 minutes.

If the electrolyte comes in contact with your eyes, rinse them open for at least 15 minutes with water and then consult your doctor. In case of accidental ingestion, drink large amounts of water, preferably with bicarbonate, and go to your local hospital or emergency room as soon as possible.

Be careful not to inhale vapours produced by the chemical reaction of the battery if you think they remained concentrated in a small enclosure.

### *2.3.5. NOISE*

⚠ It is very important having earplugs or a headset to wear to help block out the noise from a working genset, in order to prevent hearing damages.

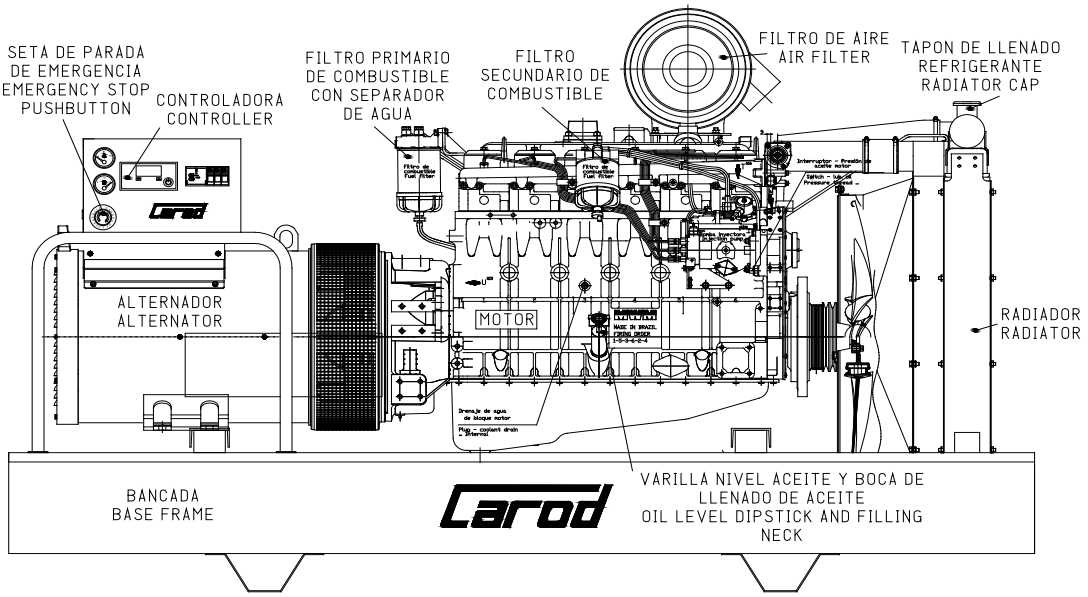
Open gensets, without soundproofed enclosures, generate noise levels that may exceed 105dB.

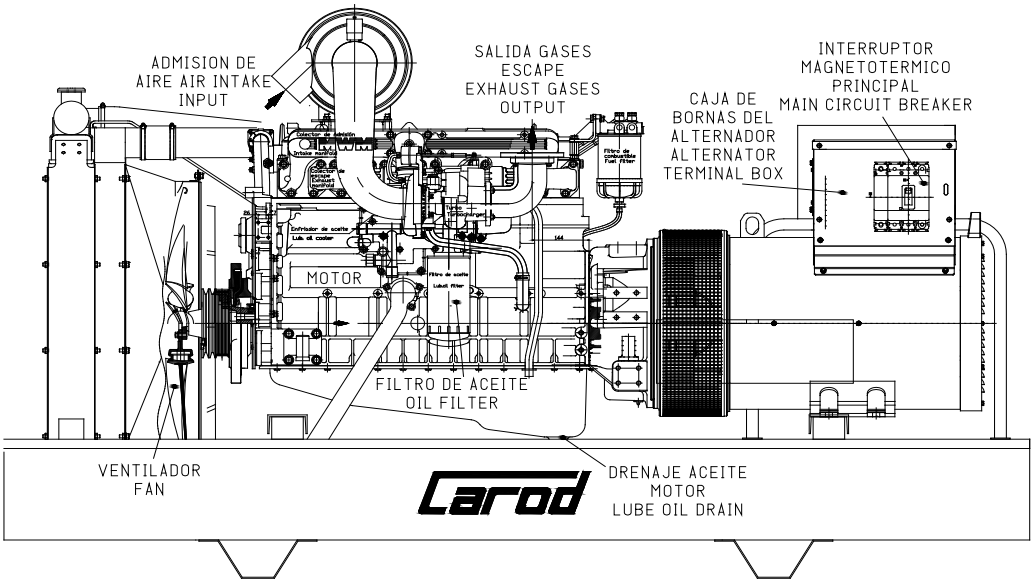
A prolonged exposure to noise levels exceeding 85dB may result dangerous and lead to hearing deficits.

# 3. GENSET SYSTEMS: DESCRIPTION, IDENTIFICATION AND WARNINGS

## 3.1. GENSET DESCRIPTION

This equipment has the purpose of supplying electrical energy autonomously, at the voltage, frequency and number of phases that detail its characteristics.




The major components that compose a genset are engine, alternator, controller and main power breaker.

The engine - alternator set is supported by shock absorbers, fitted on a metallic base frame in which the fuel tank with its accessories is installed.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The function of the engine is turning the alternator rotor, and overcoming resistance created by the alternator magnetic field. The higher generated current, the greater is the resistance to overcome. The turning speed must be constant despite to the supplied current variations.

The function of the alternator is to generate the electrical supply current to the loads. It must be able to keep the voltage constant at the nominal value despite the variation of the load.

The alternator is protected against faults in the supply line by means of a circuit breaker with magnetothermic protection and differential protection or insulation monitoring.

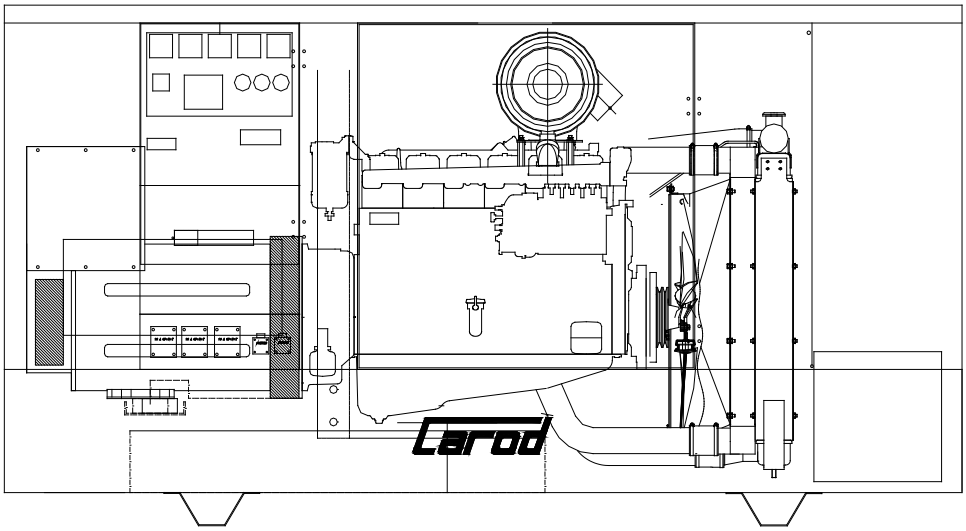
The “brain” of the genset is the controller. It is the user interface for the operator, offering control, information about the status and parameters of the equipment, and protecting against possible failures.

Consult the genset data sheet for performance specifications, minimum air flow necessary for suitable cooling, working autonomy calculation, fuel consumption, capacities for refilling, etc.

### 3.2. GENSET ENCLOSURE

There are several reasons for wrapping the generator set with an enclosure. The main one would be to reduce the level of noise emitted, but there is also its protection against water, dirt, unauthorized access and the simplification of its transport and installation.

⚠ Beware of enclosed gensets doors. If the genset starts with the doors open, they tend to close absorbed by the fan.




Large generators can be mounted inside a intermodal transport container.

⚠ In container mounted gensets, be sure to check out for people inside before locking their doors.

⚠ When the generator set installed in a container is going to operate, the cooling channels must remain open. If it is in autostart mode, they should always be open. In manual mode, remember to open them before starting it.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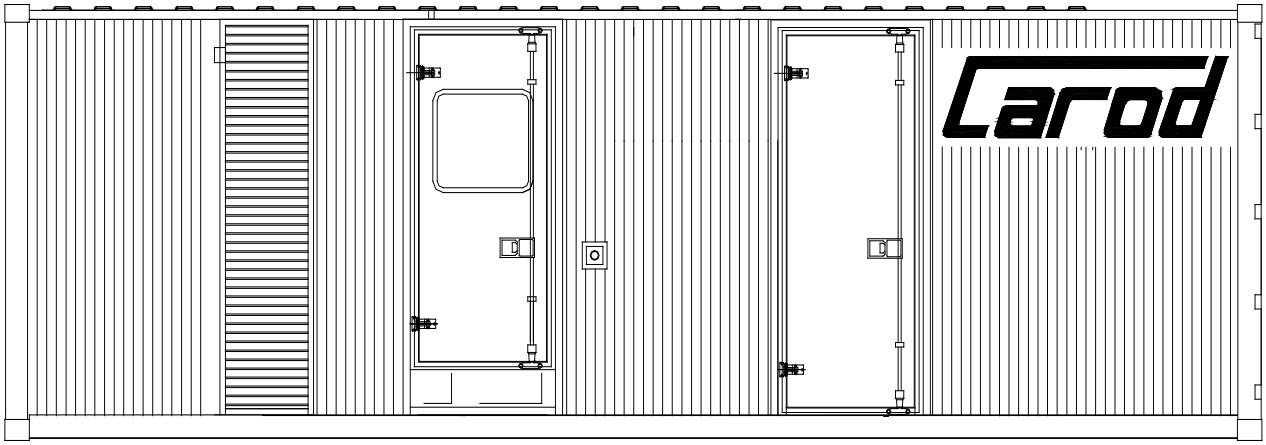
⚠ If opening the air flux ways was forgotten and the genset is already running, turn the generator off before opening. Otherwise they can provoke an accident due to air pressure.




### 3.3. PAINTING

It is possible that a certain amount of smell and smoke from the exhaust manifold is released to burn the paint factory in the early hours of engine operation.

Use only heatresistant special paint to paint the exhaust pipes or turbo.

The standard red color for CAROD equipment is RAL 3000 code.

The frames, tank, muffler are painted satin black powder.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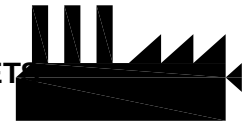
## 3.4. MANUAL APPLICATION GENSETS

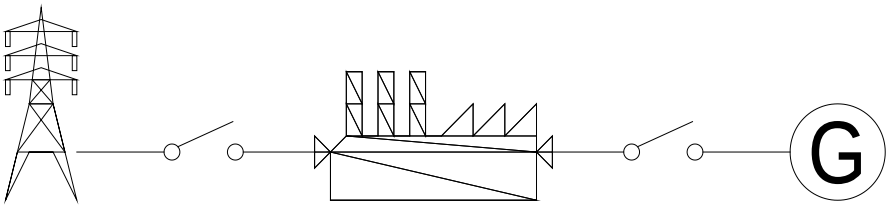
These devices are intended to be operated manually to start and stop. They may also have a voltage free contact to perform that function in remote or timer to do it.

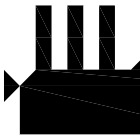

## 3.5. AUTOMATIC MAINS FAILURE APPLICATION GENSET



These gensets are designed to supply power only in case of failure of the mains power supply. They are equipped with a mains watchdog device that analyzes the state of the mains grid supply. If mains source supply becomes defective, the generator will generate power by switching loads from normal (mains) power supply to genset supply.

Installation of such switching is required. It can be set in a separate closet and be done by interlocked contactors, motorized changeover switch or motorized switch interlocked circuit breakers. Is necessary to install power cables and signal cables between the switch and the genset.





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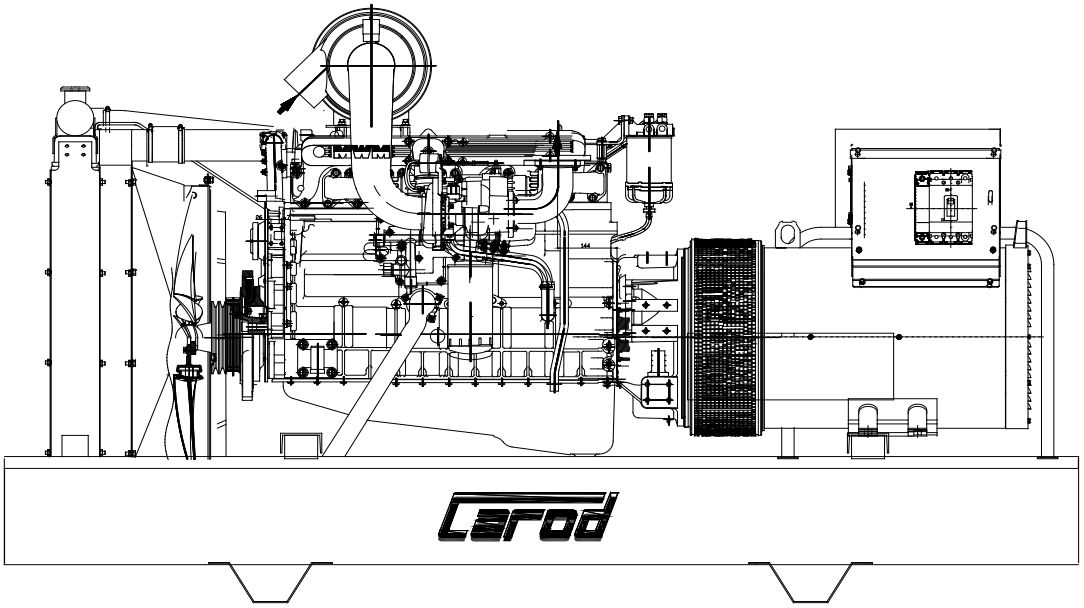
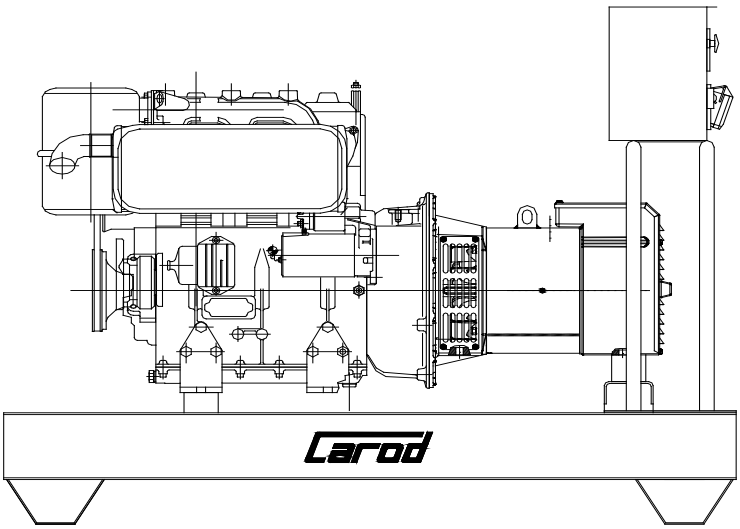
## 3.6. GENERAL OVERVIEW ABOUT ENGINES

The generator is driven by a 4stroke diesel engine. It can be governed by mechanical injection or electronic fuel injection. According to the engine type of governing it can be called mechanical or electronic.

The engine is specially designed to run on generators. Cooling, depending on the model, can be performed by water (with some additives) or air.



Above: Water cooled engine. Below: Aircooled engine.





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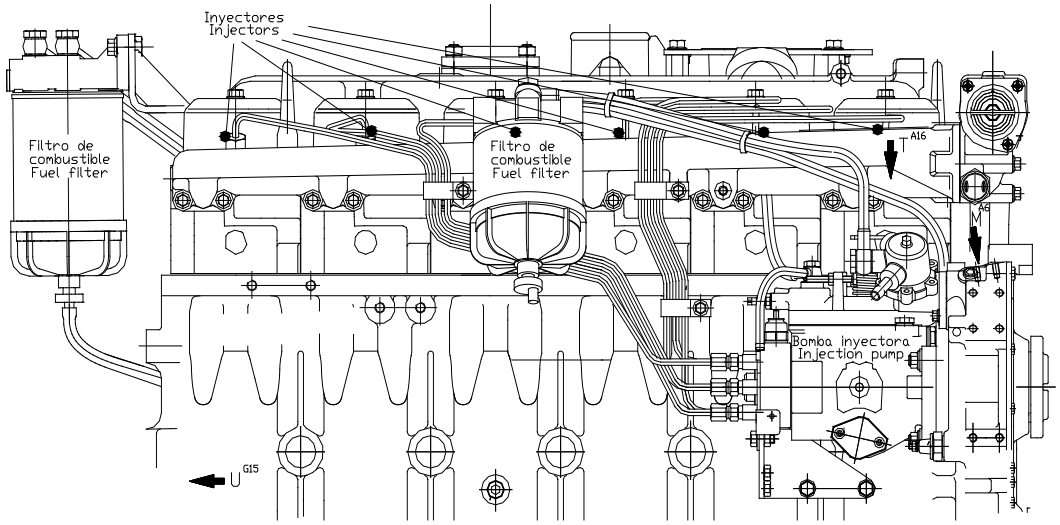
### *3.6.1. FUEL SYSTEM*

Diesel engines require a continuous supply of clean fuel. They ensure fuel cleaning, depending on the characteristics of the engine, with one or two fuel filters. These filters must be replaced periodically as often as the engine oil is replaced.

If the engine is equipped with a water separator, it will be necessary to drain the water every certain number of operating hours indicated by the engine manufacturer.



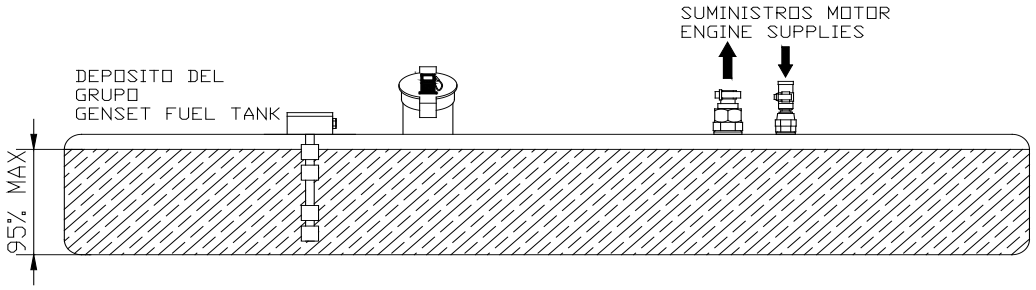

The generator set is equipped with a fuel tank (called “daily use”) that is normally installed inside the frame. It has a suction pipe, a return pipe, a level indicator sender, a breather and a filler neck.

⚠ The tank must have 5% free space so that the fuel can expand when heated.

⚠ Refuel the tank with the engine stopped. Do not do it while smoking or in the presence of sources of intense heat. Make sure there is ventilation during the maneuver.

⚠ It is convenient to drain and clean inside the fuel tank every 4-5 years.

⚠ Remember that the shelf life of stored fuel can be 1.5-2 years before degradation depending on the storage conditions.





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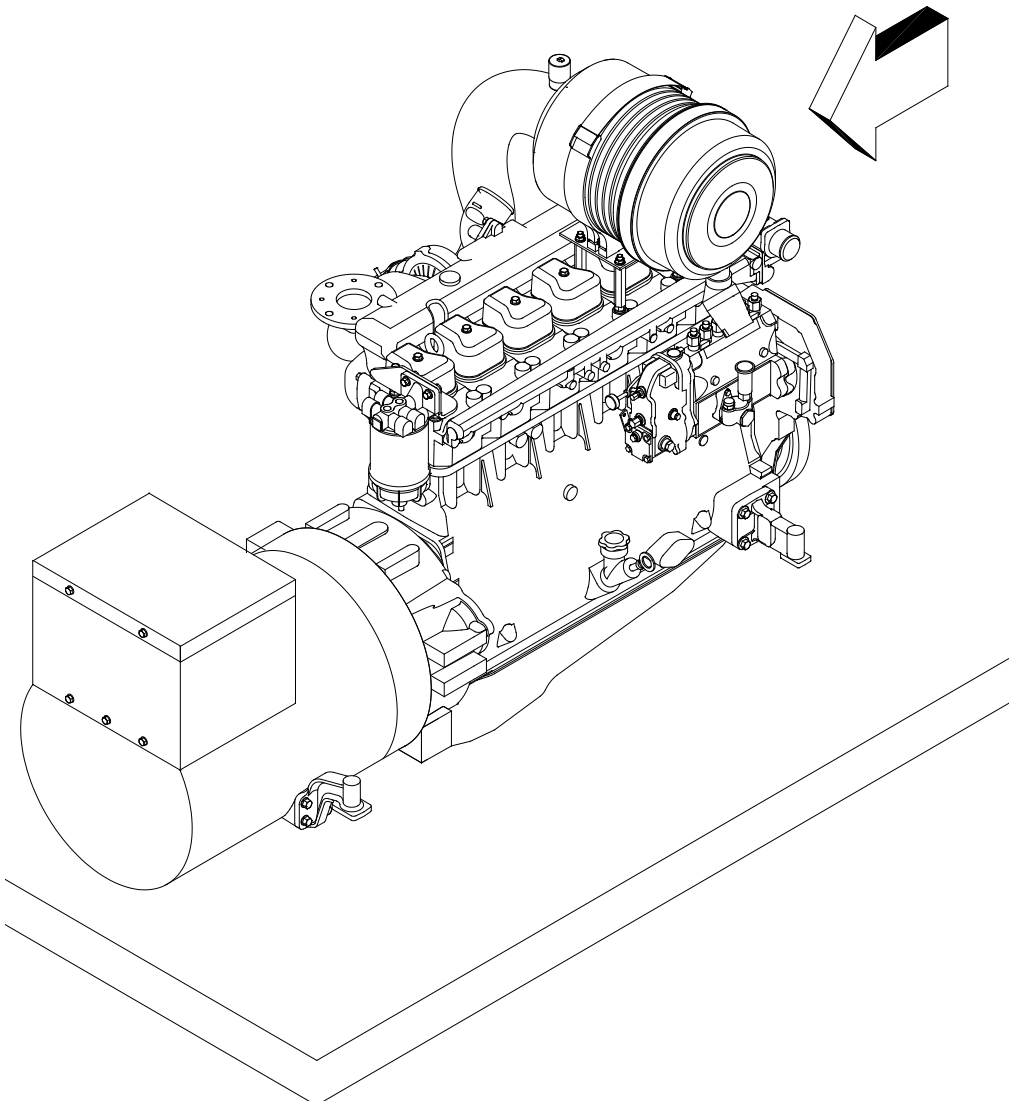
### *3.6.2. AIR INLET SYSTEM*

The engine needs to draw in clean air for its operation. To do this, the engine draws in through an air filter.

The air filter is an element that must be replaced according to the manufacturer's recommendations, according to a number of hours of operation or according to an elapsed time, whichever comes first.



Many air filters is fitted with an air restriction indicator. It can be optical or electronic. You have to replace the filter immediately if the indicator points out.

⚠ Never run/operate the engine without the air filter installed. Otherwise, dust and dirt could get into the motor, acting as abrasives and destroying it in a short time.



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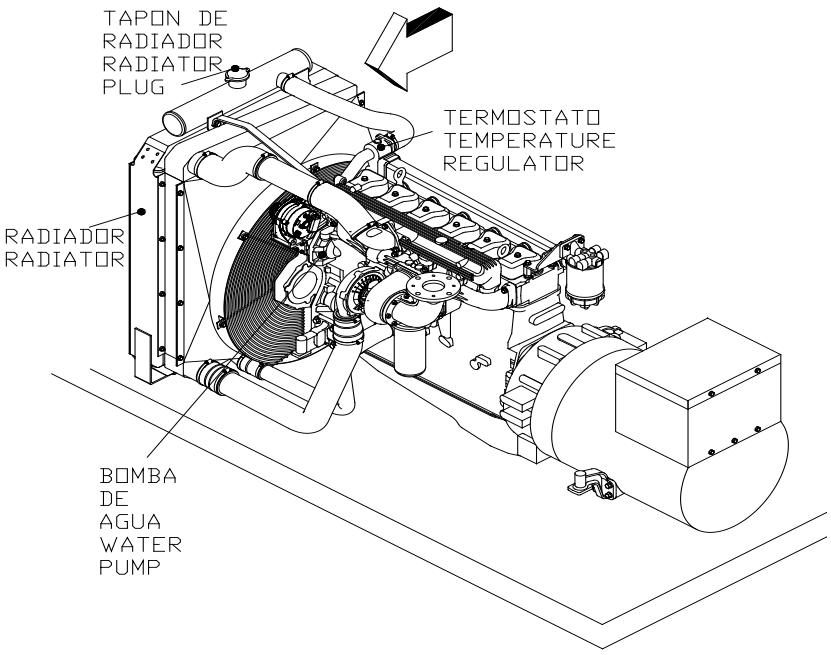
### *3.6.3. COOLING SYSTEM*

In liquid cooled engines, the coolant flow through the radiator is controlled by a thermostat. A fan, driven by the engine, forces air from the side of the engine to the radiator, cooling the liquid in its path.

The “water pump” circulates the coolant to the fan and is driven by the engine's distribution system.




The thermostat allows the engine to work in a suitable temperature range for operation, opening and giving to the coolant way to the radiator when engine is hot, and closing when engine is cold.

Coolant is essentially water with special additives to protect the engine against corrosion, freezing and avoid cavitation of the cylinder liner. Coolant must be replaced according to the manufacturer's recommendations, according to a number of hours of operation or as an elapsed time, whichever occurs first. Otherwise they may appear serious longterm damage.

⚠ Use coolants recommended by the engine manufacturer. Sometimes generator sets are equipped with severe duty engines, and automotive coolants do not have the necessary additives.

⚠ Do not use tap water to top up the coolant. The lime may be deposited inside the circuit and cause a malfunction. If urgent filling, use distilled water, but remember that a low concentration of additives promotes corrosion, freezing and erosion of the circuit.

⚠ Remember that the radiator incorporates a fan on the engine side, which may not be visible when running. Avoid approaching it with the engine running. Do not remove the protective grid from it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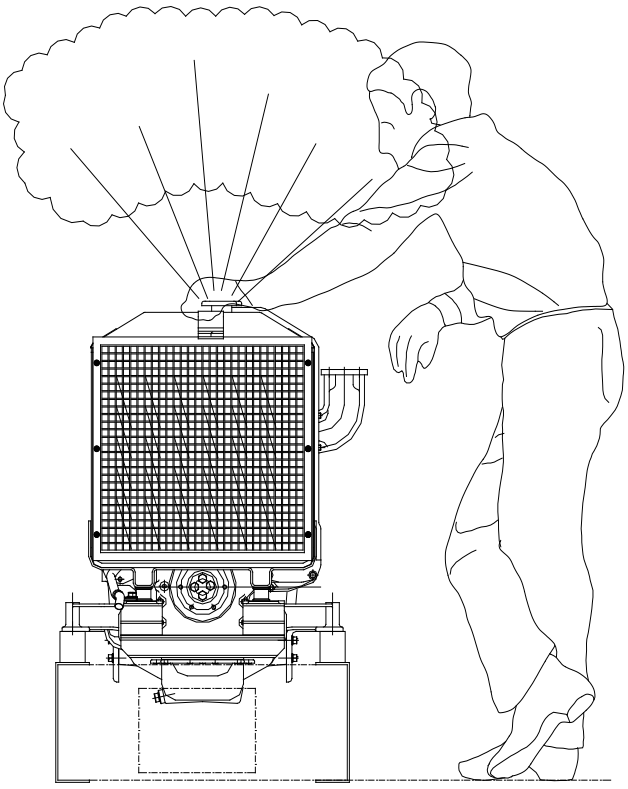
⚠ Do not mix refrigerants with different chemical composition. The mixture may be corrosive to some components of the circuit.

⚠ Do not open the radiator cap when the coolant is hot, hot liquid can jump and cause burns, especially on the face and hands.



If you are going to change the coolant, The best way to do it is with the engine cold. Pouring large amounts of cold coolant into a hot engine can cause damage.

When the circuit is empty and after installing the sealed drain plug, fill the circuit again. Do not pour the refrigerant too quickly to avoid bubbles in the circuit.

Normalize the level and start the engine 30 seconds to see how the level stays. If necessary, fill the circuit up to the level established in the engine manual.

To clean the radiator, open the drain plug and store the old coolant in a suitable container. Feed a hose through the filler cap until the water runs clear. If the antifreeze appears very dirty, it may be necessary to run the unit for a while with the cooling circuit filled with a mixture of water with special detergent.

Dispose of the coolant and cleaning water at an authorized waste manager.

See engine manual for details.



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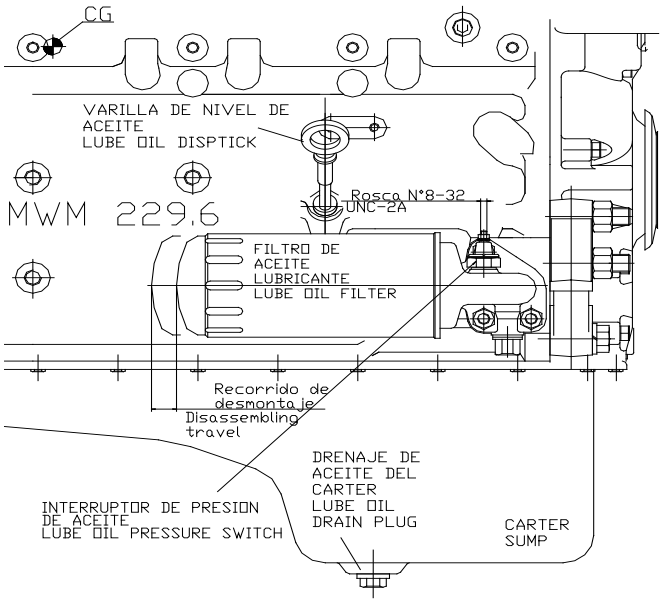
### *3.6.4. LUBE SYSTEM*

The engine needs oil to avoid friction between its metal components. Without it, friction would originate that would raise the temperature until the metal melted, destroying the engine.

The oil, with use, absorbs dirt from combustion and metal residues derived from wear. That is why it must be kept clean by continuously passing it through one or more filters. Filters, in general, accumulate dirt and deteriorate over time.

Oil also degrades with temperature and in combination with oxygen. From all this derives the loss of its properties over time and the operation of the engine..

*It is necessary to replace the oil and filters according to the manufacturer's recommendations, according to a number of hours of operation or according to an elapsed time, whichever comes first. Otherwise the engine will rapidly deteriorate to a point of uselessness. Use filters and oil of the characteristics recommended by the manufacturer.*




The first oil change should be carried out after 100 hours of engine operation. This is due to the fact that during the settling of the pieces in the first hours, many metallic particles accumulate in the oil and they must be removed..

It is normal for the engine to consume a certain amount of oil during operation (usually between 0.25 and 1% of fuel consumption). This amount will increase the higher the load and wear on the engine..

It is necessary to check that the oil level inside the engine is kept in the proper range. For this, there is a metal rod marked with the maximum and minimum acceptable levels, with the tip immersed in the crankcase. It is necessary to verify IN COLD that the level is correct before each start of the engine. If the level is abnormally high, contact technical service.

If the oil level is abnormally low, it would be necessary to study the situation to see wether this indicate a fault or simply is due to a normal consumption.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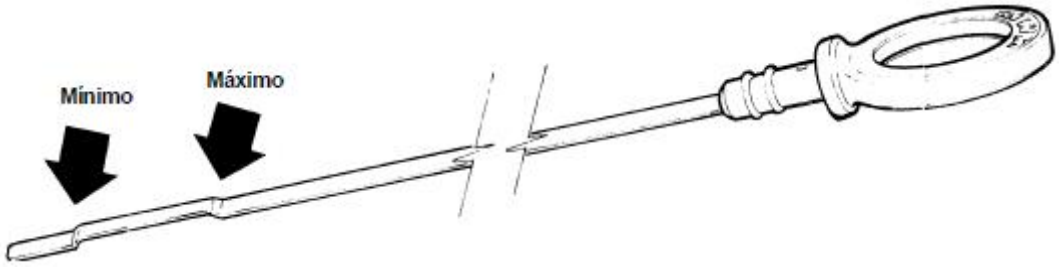


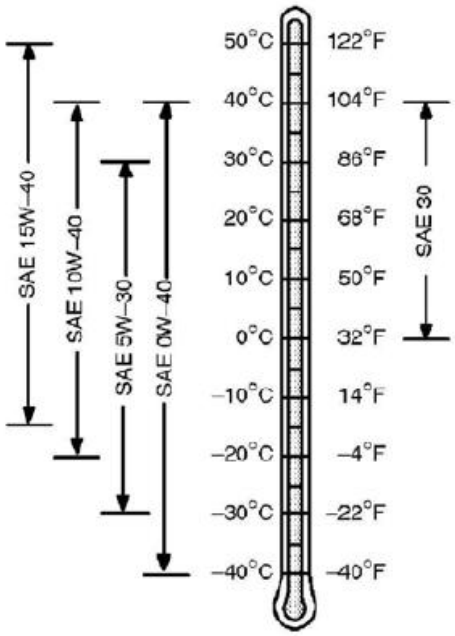

⚠ If you replace the oil by yourself, make sure that the level is within the range marked by the rod. Let the mid range level, start the engine a few seconds, turn it off and wait 10 minutes. Observe the oil level until it reaches midrange of the rod. Remember that the correct level is observed when the engine is stopped and cold.

⚠ Never mix synthetic oil with mineral oil. The mixture can be corrosive to engine gaskets. If you know the nature of the engine oil, consult the manufacturer or replace everything, including the filters.

⚠ Change oil when hot. Be sure to wear thick waterproof gloves to prevent burns when handling.

⚠ Before installing the new filter, wet the gasket with the same oil that you are going to use. Do not use tools to tighten the new filter. Clean the metal shavings from the magnetic drain plug. Before reinstalling, apply liquid Teflon or tape to thread to seal. Replace the drain plug gasket

Dispose of used oil and filters at an authorized waste manager.
See engine manual for details.




## Oil specifications

The engine is mainly shipped with 20W50 viscosity multigrade mineral oil from the factory. Consult the specifications recommended by the manufacturer in each particular motor case..

Adapt the oil viscosity according to the typical temperature of the genset operating area.

Consult the data sheet corresponding to the model of your generator set or the engine manual for the specifications that the lubricating oil must meet.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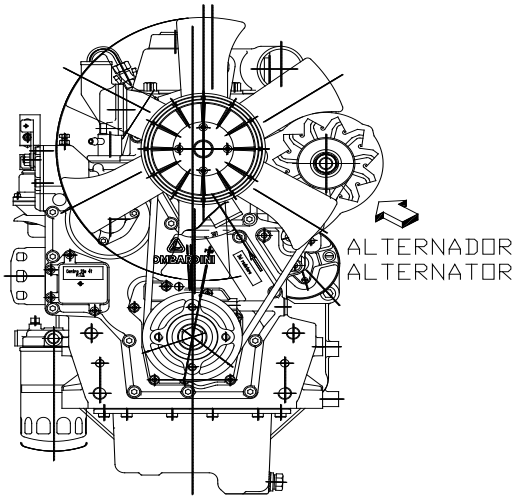
### *3.6.5. BATTERY CHARGER ALTERNATOR*




Some engines, all from a certain size, are equipped with a battery charging alternator. This is usually self-regulating and self-excited. It only works with the engine running, driven by a belt that must remain in good condition and with acceptable mechanical stress.

See the engine manual for instructions on belt tensioning.

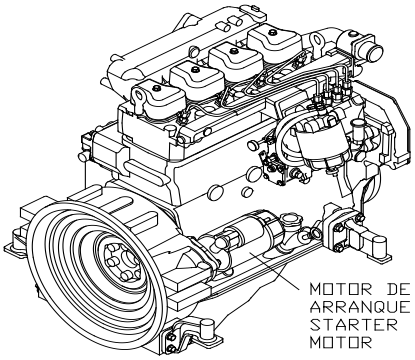
### *3.6.6. MAGNETIC DISC AND BATTERY CHARGER REGULATOR*

In small motors, the battery can be charged by means of a magnetic disc inside the engine that feeds a regulator which in turn charges the battery. It works with the engine running only.

### *3.6.7. STARTER*

It is a DC motor whose mission is to turn the engine crankshaft and compress the mixture in the cylinders chambers to start combustion.

It is moved by the engine batteries. The nominal system voltage (12V, 24V in large gensets), when it turns, engages a pinion in a concentric ring to turn the crankshaft assembly.




After the engine has started, the starter must be deactivated. Normally, the generator frequency signal and the battery charging signal are used for this. On some engines, the signal from the oil pressure contact will be used.

It is important to know that the starter motor can only work for a limited time. If its time of use is prolonged, its temperature rises until its destruction.

⚠ Do not manipulate the electrical system to force the starter. It could be destroyed.

⚠ If the starter has made many starting attempts and a high temperature is detected, let it cool for 15 minutes before to re activate it.

⚠ The generator is programmed to run a limited number of start attempts. If after this number of attempts it has failed to start, a start failure alarm will appear and will be indicated on the control panel. This is to avoid the starter overheating.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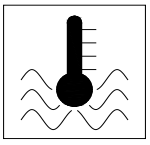
## *3.6.8. ENGINE PROTECTIONS*

### *Low oil pressure protection*

Low oil pressure in the engine lubrication channels may be indicative of a serious and imminent breakdown. The value of the oil pressure should be controlled so that the motor stops when the value is low.

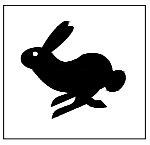
This is achieved by means of a calibrated mechanical pressure switch that changes state when the pressure falls below a certain value. In mechanical engines, when the oil pressure is low, the contact usually closes to negative (ground). In electronic engines it is an electronic signal that goes to the control ECU and is indicated via the bus.

### *High coolant temperature protection*



A low coolant temperature indicates an engine malfunction. The value of the temperature must be controlled so that the motor stops when hot.

This is achieved by means of a calibrated thermistor, which modifies its resistance value with temperature. In mechanical motors, this resistance is read by the control board. In electronics, a temperature transducer is used. The engine-ECU reads this value, stopping the engine if it goes over a limit. Temperature senders are usually located in the top of the engine near the thermostat.



### *Overspeed protection*

In the case of certain malfunctions, the engine can be accelerated until its destruction. This can be avoided with an over speed protection.

In mechanical engines, the pump regulator is calibrated so that it cannot exceed a set value of engine speed.

In the case of electronically controlled engines, overspeed protection is performed by reading the speed value, either through a magnetic sensor in the engine or through the frequency value of the generator alternator. If we exceed the limit, the ECU will cut the injection and stop the engine.



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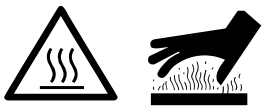
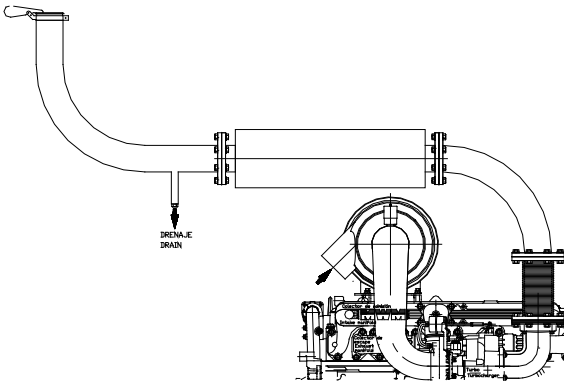
### *3.6.9. EXHAUST SYSTEM*

The engine produces hot and toxic exhaust gases. It is necessary to evacuate them outside the premises in a safe way and through pipes designed in such a way that they do not hinder their exit.



⚠ Avoid contact with the of exhaust manifold , turbo and exhaust pipe surfaces.



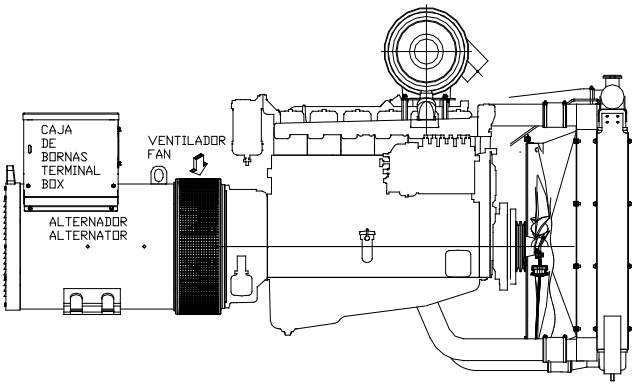

In open gensets, the exhaust muffler is fitted apart. It's mission is to reduce the noise coming from the exhaust during normal engine operation.

For large gensets, periodically drain the condensed water in the exhaust circuit with the plugs fitted for that purpose.

## 3.7. GENERATING ALTERNATORS OVERVIEW

Its function is to produce the electrical power supplied by the genset. Need rotated at a constant speed, stay clean, dry and not overheat. The voltage value is controlled by means of a voltage regulator, which also guarantees the stability of its value.

The alternator is air cooled by an internal fan.




After giving the shutdown command, the genset is prepared to open its ouput contactor and run with no load some time after release loads. The purpose of this is cooling the generator alternator. Otherwise, the latent heat from the windings could end up damaging the insulation.

⚠ Do not stop the engine with the emergency mushroom or other immediate stop method after the alternator has run under a high load. The alternator could be damaged.

⚠ Do not allow entering water inside the alternator. If you install equipment in a wet room, you must heat the alternator.



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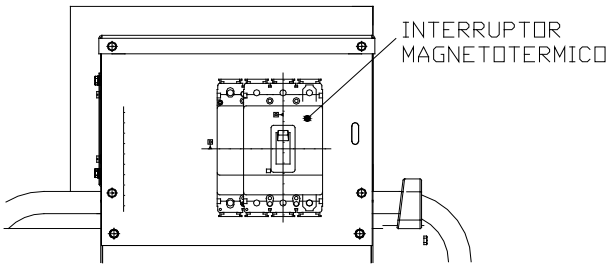
### *3.7.1. MAGNETOTHERMIC AND EARTH LEAKAGE PROTECTIONS*

The power output of the generating set is protected by a magnetothermic circuit breaker, the value of which is calculated for each application.



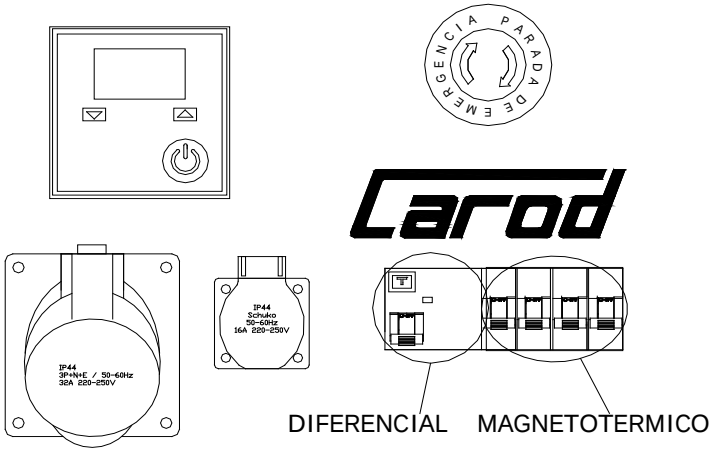

In certain equipments, the differential protection will be provided by an electronic relay with a separate leakage current detection toroid. For small power groups, the differential protection will be in charge of a differential switch. For groups with isolated IT ground systems, protection is carried out by means of an Isolation Monitoring Relay.

⚠ To prevent the consequences of a possible coincidence of failures, it is necessary to protect each of the loads with their respective magnetothermic protections.

⚠ If you leave the lever of the circuit breaker or differential protection switch lowered, the electric current will not reach the loads.

⚠ If when raising a protection switch lever with the equipment running, it lowers again, it is because there is a fault in the line.

⚠ It is necessary to differentiate if it is due to a short circuit, an overload or a ground leakage and solve the problem (see electrical diagram).




⚠ Never bypass a protection switch. Repair the defect that causes it to trip. Otherwise, it could lead to a serious breakdown or a major accident.



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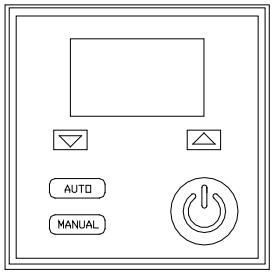
## 3.8. GENSET CONTROLLER USE OVERVIEW

The control interface of the generator set is a panel, normally installed on the outer surface of the control electrical panelboard.

Its mission is to act as a computer to control the genset operation (start, stop, operating mode, timings), protect, and indicate their status depending on their sophistication, a number of operating parameters of the genset.

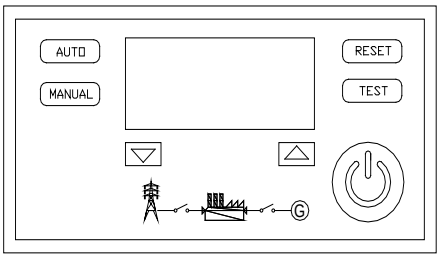
⚠ If any failure warning comes up, do not ignore it, fix the problem as soon as possible.

In general, we can find controllers that have modes MANUAL and AUTOMATIC operation.




In both manual application equipment and emergency application equipment, the manual mode will be used to start or stop the group directly from the pushbuttons on the card, START and STOP pushbuttons.

In manual application groups, the automatic mode is used to start or stop by means of the voltage-free contact, remotely or programmed.




In the emergency application equipment, the automatic mode will serve for the equipment to remain monitoring the state of the mains lines and start and switch in case of failure of the same.

⚠ In gensets with manual or emergency application, keep in mind to leave the controller in AUTO before leaving the installation. Otherwise, the control card will not start the genset when needed.

The controller cards have a certain amount of programmable parameters, which vary depending on the application and the nature of the motor.

⚠ If is necessary to install a replacement controller in a generator, first make sure that it has been conveniently wired and programmed for that equipment.

All groups have a red emergency button in the shape of a mushroom. Its actuation will immediately stop the group. In addition, the control card monitors a series of security parameters. If these values are not correct the group will stop automatically

⚠ Do not use this button to stop the genset habitually. This form of stop inhibits the cooling period and could provoke an overheat in the alternator.

Turn off the group by pressing the normal STOP button. The group will continue to idle to cool down before stopping for a programmed time.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In the event of a fault, the controller will indicate the type of fault and will prevent the group from starting until it is corrected. Once the problem is corrected, it will be necessary to reset the controller. To do this, the controller (depending on the model) will have to be turned “OFF”, “RESET”, or “POSITION 0” and then put it back in MANUAL or AUTO mode, as needed..

### *3.8.1. COMMON ALARMS*

We can find, according to the sophistication of the controller, a certain amount of alarm types. The most common are:

- Low oil pressure.
- Coolant overtemperature.
- Overspeed.
- Failure to start (the engine fails to complete the start).
- Generator alternator failure. Incorrect voltage or frequency.
- Generator overload.
- Stop button actuated / emergency.
- Low battery voltage / failure battery charging system.
- Low fuel level.

### *3.8.2. TIMINGS*

We can find different timings in controllers. The most common are:

- Duration engine preignition (if required ).
- Duration of cooling time or idle before stopping.
- Service required. Maintenance need notification.
- Delay of frequency fault alarm action.
- Delay of actuation voltage fault alarm action.
- Duration of the alarm siren.
- Scheduled genset autotest period duration.
- Delay between mains failure and genset running (EMERGENCY gensets).
- Delay of output contactor closing.
- Delay between mains recovery and stop genset order.

Refer to the controller manual for specific details of management.

## 3.9. BATTERIES

Some batteries require maintenance. This means that its electrolyte evaporates during the normal charging process and its level must be checked and replenished.

Fill all glasses with distilled water up to the mark indicated by the manufacturer. If there is no such mark, fill 15mm above the plates.

⚠ Electrolyte vapor concentrates hydrogen, which is flammable. Do not check the electrolyte level of batteries in the light of a live flame. Avoid sparks near or inside the battery receptacle.

⚠ Batteries accumulate hydrogen, the pressure of which must be released by a safety valve. If the batteries get clogged in the pressure release hole, or the electrolyte level is low, or a vessel is communicated internally, they can explode and project acid.

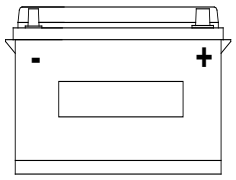
⚠ The electrolyte is corrosive. Wear antacid gloves and goggles to check the level and replenish it.

If you detect that a battery has exploded, neutralize the sulfuric acid with baking soda or slaked lime.

Replace batteries every 2 years for safety. Keep them clean and maintained.

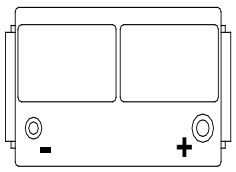
Ventilate the receptacle (if any) where the batteries are housed before working on them.

Remember that the positive is the thick terminal and is marked in red. The negative terminal is thinner and is marked with black. Never reverse the polarity of the battery connections. It can seriously damage electrical equipment.




When connecting the copper terminals around the terminals, tighten them firmly, but remember that overtightening can break the arc of the terminal.

If you are relocating the batteries for any reason, remember that they should be as close to the starter as possible.




Temperature affects battery performance.

A low temperature helps the battery to accumulate more charge, but makes it difficult for it to release energy. The consequence is that, in cold days, they have less starting capacity. High temperature can damage batteries. It can be dangerous to carry out charging operations if the battery is over 45ºC.

⚠ Never tip the batteries. There may be an acid spill.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⚠ Try to preserve the batteries from direct sun. This favors its self-discharge.

Keep the terminals clean. Cover them with a thin layer of dielectric petroleum jelly to prevent corrosion.

If a lead-acid battery is deeply discharged, it will not regain its normal charge capacity.

If you have a 24Vdc system remember to connect the batteries IN SERIES. If the system is 12Vdc with several batteries, connect them IN PARALLEL.

Choose batteries based on the COLD START AMPS (CCA) value recommended by the generator set manufacturer. This is the important parameter for these teams.

Do not connect batteries of very different performance together.

⚠ Never disconnect or connect the batteries with the engine running.

### 3.10. JUMP STARTING

If the battery has been discharged enough that it is not possible to start the generator, it can be helped by starting with pliers.

⚠ Do not attempt to jump start a battery pack with frozen or frosted electrolyte. Heat the assembly to at least 5ºC before carrying out this operation.

The ideal way would be to do it in the following way:

Remove the caps from the discharged battery (if maintenance is required) to ensure that there is no built-up electrolyte vapor pressure in the battery. Do not allow foreign bodies to enter the vessels.

Check the battery electrolyte level. It should be at a suitable level.

Use a system of the same voltage for rescue. Do not try to rescue a 12Vdc system with a 24Vdc system or vice versa. The rescue battery must be equal to or greater than the one to be rescued.

If starting from a vehicle, do so with the vehicle's engine running. Do not allow the metal of the vehicle to touch the group.


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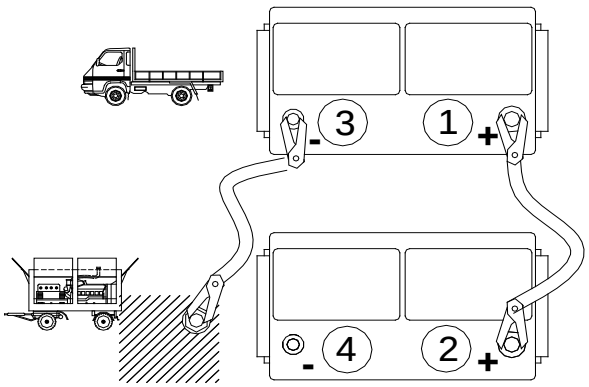
The sequence of connecting the wires of the grippers is:




1 Red wire to + Rescue battery
2 Red wire to + rescued battery
3 black wire to Rescue Battery
4 screw black GROUND Cable, away from the battery and genset fuel lines.

Let the generator charge the battery for a while. Then disconnect the cables from the clamps in reverse order of connection.

## 3.11. BATTERY CHARGERS

In emergency application gensets (automatic mains failure) is needed to compensate the natural self discharge of the battery by connecting them automatic battery charger. This can be mounted in the control panel of the same genset or externally. A 230Vac power supply network is needed for its operation.

Once connected to the network, the amount of charging current will depend on the capacity of the battery in Ampere-Hours, the conditions of the same and the level of charge present. The charge current will decrease as the charge level increases and its voltage level increases.

If you will choose yourself a battery charger, adjust its performance to the need for batteries.

Do not install the battery charger outdoors or in damp places.

If the battery charging voltage is too high, the electrolyte will evaporate faster.

Turn off the battery charger if you find that the battery is very hot.

⚠ Always turn off the battery charger before disconnecting the battery. Otherwise it may damage it.

In case of connecting a very discharged battery to a battery charger, we may find that the charger protects itself from an overcurrent by inhibiting charging. You can connect a battery of the same performance charged in parallel with the discharged one to the charger to make the charger work.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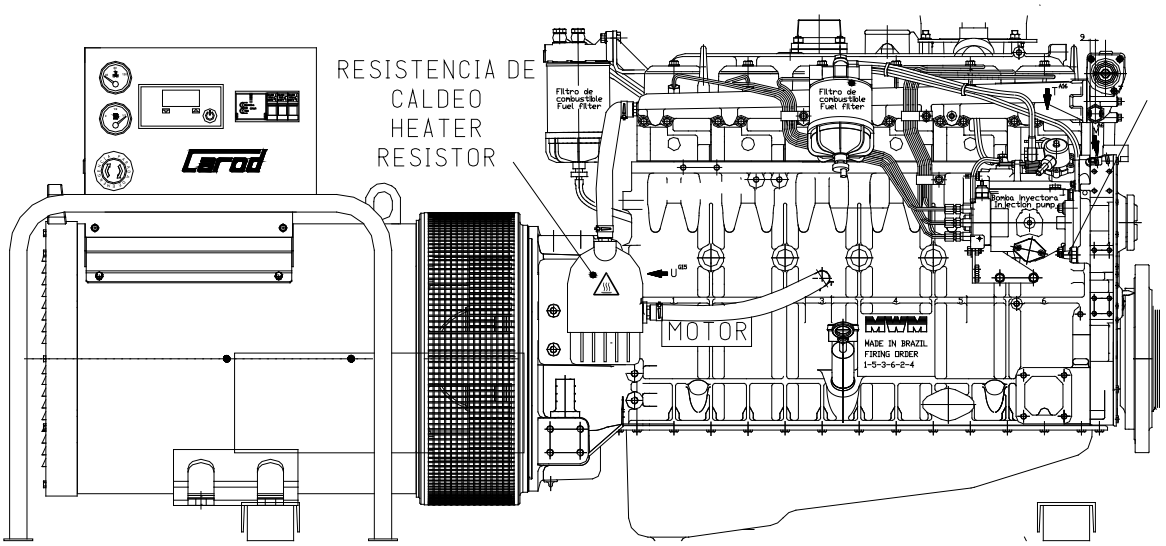
## 3.12. COOLANT HEATER

The emergency gensets are usually equipped with some system for keeping warm coolant. The reason is engine works at full load few moments after startup.




If the engine runs at full load when cold, undergoes a significant wear that shorten its life. It also avoids starting problems when the engine is very cold.

The refrigerant is heated by a heating element submerged in the liquid.

It is generally powered by a voltage supply of 230Vac. It is controlled by a thermostat so that the temperature does not exceed a limit.

The ideal coolant temperature, with the engine stopped but waiting, should be between 40 and 45ºC.

The system works by thermosyphon effect. As the liquid heats up, it rises upwards, allowing the cooler liquid to enter below the resistance.

⚠ Do not relocate the heating element to a higher position. The water should flow through the hose flowing upwards from the bottom.

⚠ Do not operate the heating element dry. It is designed to operate submerged in the fluid.

⚠Do not adjust the temperature with the thermostat set too high. It shortens coolant life and accelerates evaporation.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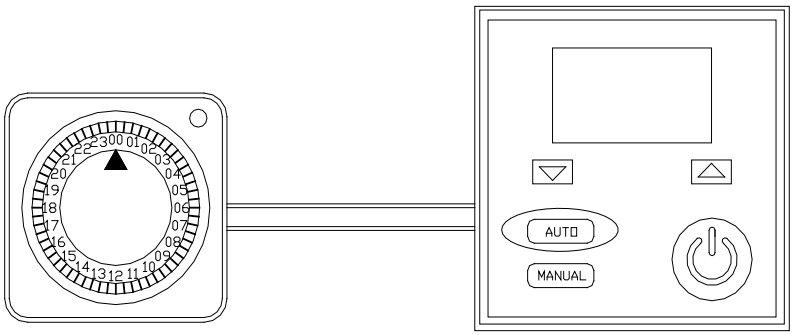
## 3.13. TIME SCHEDULER (START/STOP CLOCK)

Preferably in manual application groups, the controller card usually includes an automatic operating mode, where by changing the state of a voltage-free contact we order the group to start or stop.

The time programmers can be analog or digital and are used to program when the group should operate.




⚠ Be very careful when installing the timer, carefully follow the diagram provided and connect the timer contact only to the indicated terminals. In case of doubt, consult qualified personnel.

Depending on the control card model, this scheduler timers can be carried out by the control card itself, without having to place an external clock on it.

The voltage-free contact can also be used to switch the group on and off remotely (e.g. a remote control, a programmable inverter output, etc ...)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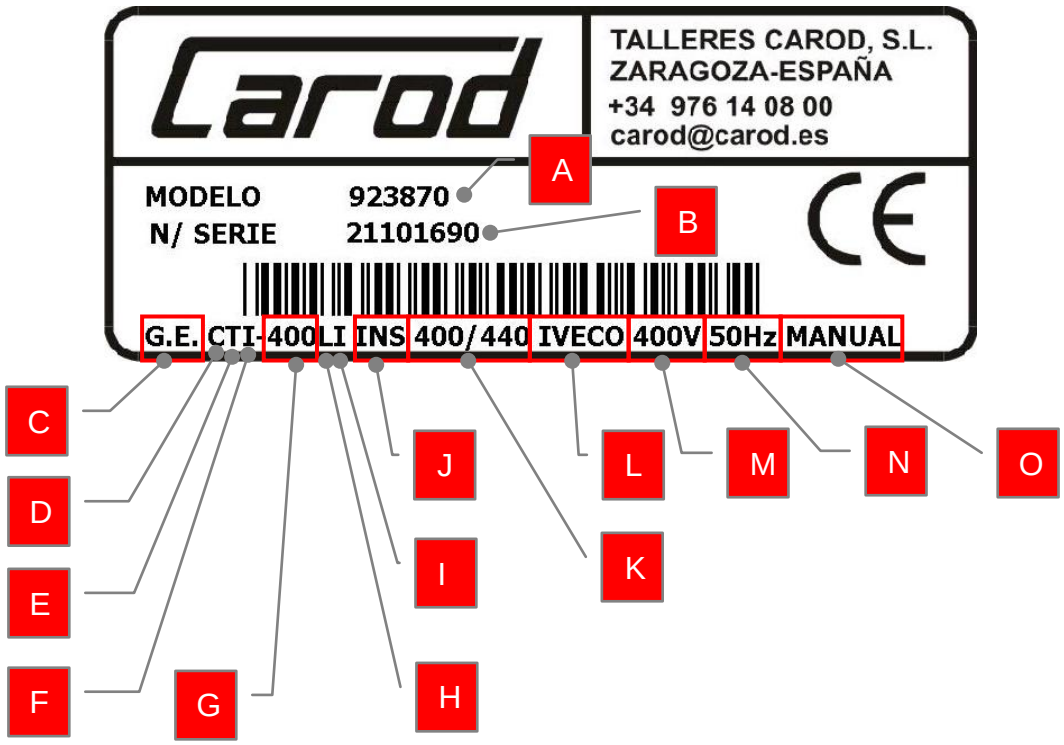
# 4. EQUIPMENT IDENTIFICATION LABEL

All generator has affixed a label printed in black on silver background as detailed in the drawing. Please make sure that you have your serial number of the equipment when ordering replacement parts or technical assistance.




A: CAROD machine model coding.
B: Serial number.
C: G. E. : Generator.
D: C means " Carod ".
E: “T” = Three phase / "M" = Single phase
F: Coding of the engine manufacturer (M : MWM, L : Lombardini, I: Iveco... ).
G: Number associated with the segment of rated power in kVA where the equipoment fits.
H: L = Genset operating at 1,500 rpm. No letter: 3,000 rpm
I: If there is an "I" is that the team is soundproof.
J: "INS " means "soundproof".
K: Values of nominal continuous power and power in standby.
L: Engine Manufacturer.
M: Voltage.
N: Nominal frequency.
O: Manual start-stop application (MANUAL) or automatic mains failure (FTR ).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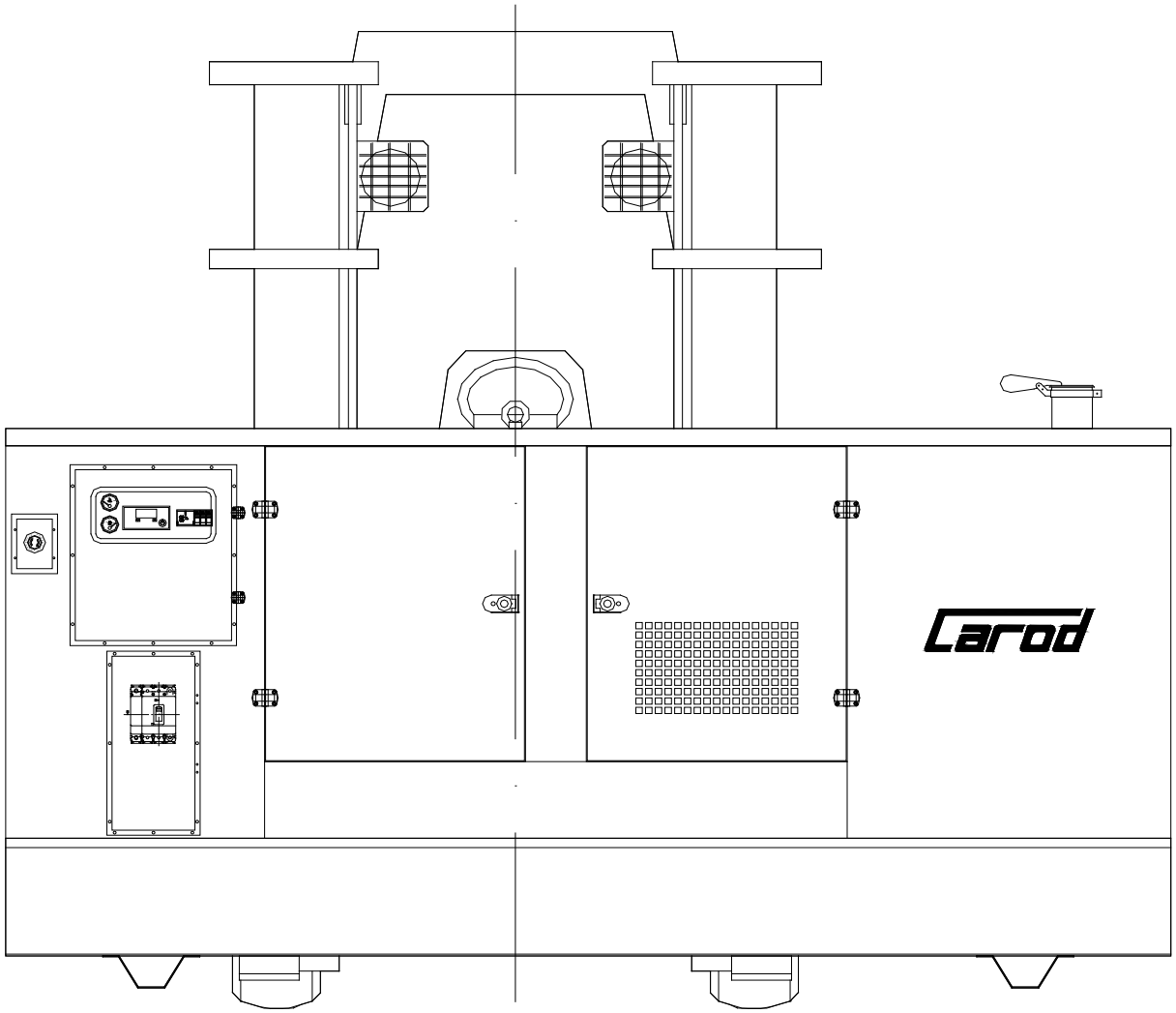
# 5. GENSET TRANSPORT

## 5.1. LIFTING THE GENSET WITH FORKLIFT

Place the nails inside the "omega" shaped genset legs. If not possible, place the nails equidistant to the genset central lifting eye bolt.

Drive with the genset at the lowest possible height.



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## 5.2. LIFTING THE GENSET BY CRANE

Leave this task to experienced staff.

Check the condition of the slings, chains, or towropes before lifting. Make sure the lines are suitable for lifting the equipment weight.

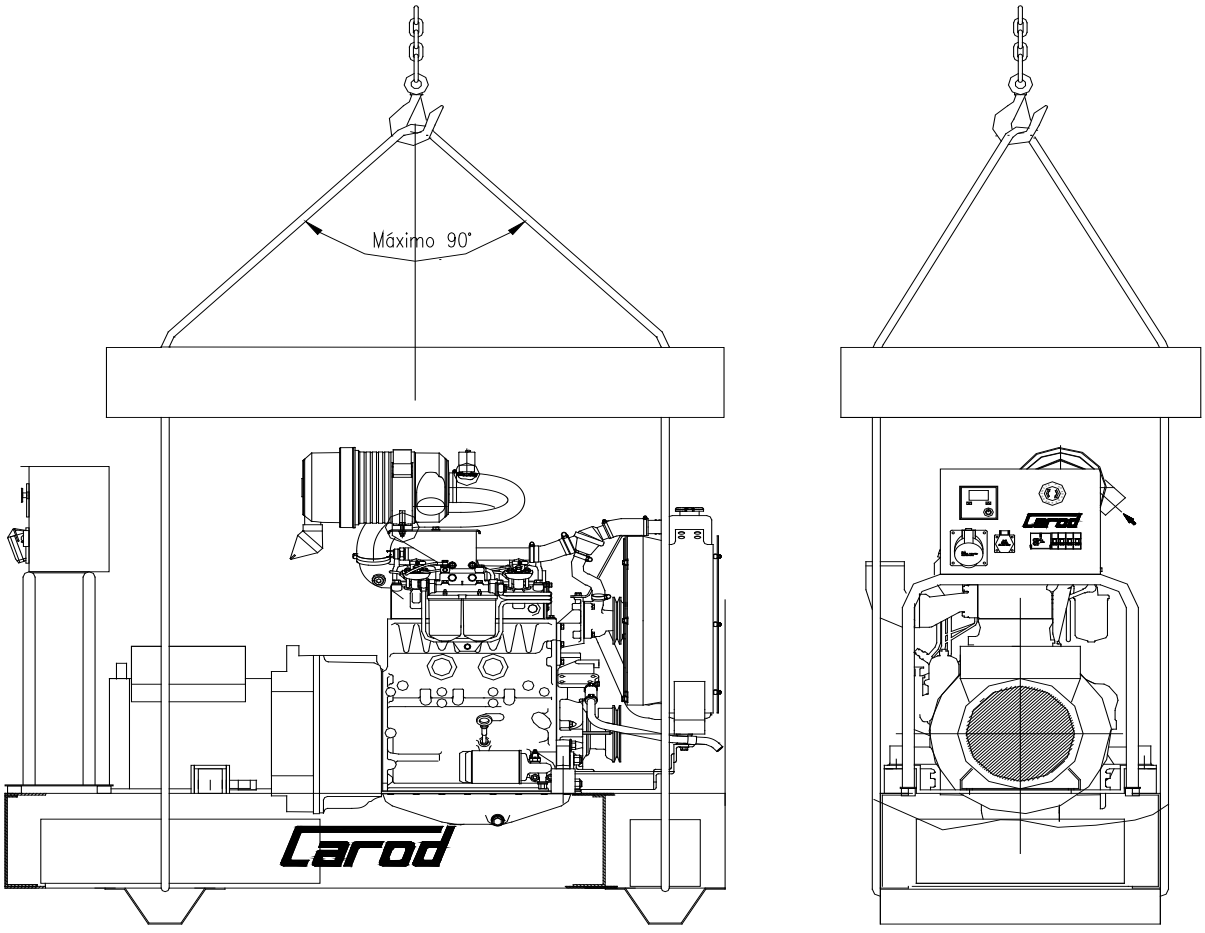
Use appropriate hooks to pass by the lifting lugs.

Before lifting, take one lap around the genset to verify that the lifting tools are secure.

Try lifting lines remain as perpendicular to the ground as possible to prevent damage to tighten.

Do not allow any person to go under the equipment when lifting.

⚠ This maneuver can result in serious or fatal accident if all safety rules are not observed



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## 5.3. PREPARING TO TRANSPORT

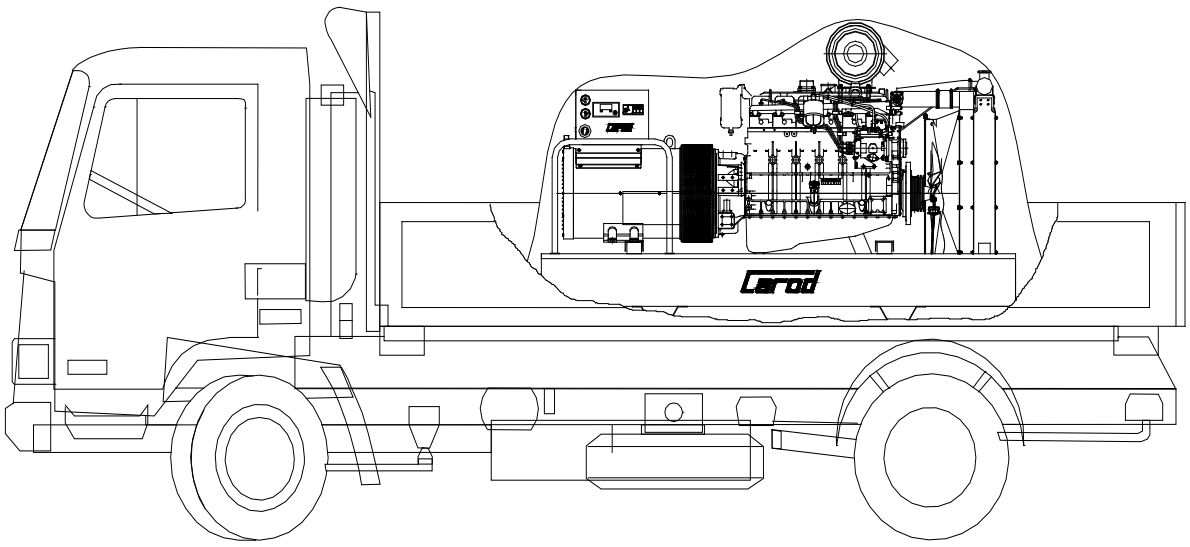
Before hiring a truck, please have the data size and weight of the equipment to make them available to the carrier.

When an open genset is transported, make sure you cover the exhaust port of the turbo, to prevent it from running dry in the wind.

Place the radiator to the rear to prevent insect fills during transport and to reduce wind resistance.

Attach the fan to prevent its tendency to rotate during transport.

Make sure the genset is tied up and secured to the truck by qualified personnel.





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## 5.4. TOWING (GENSETS IN TRAILER)

### *5.4.1. TRAILER COUPLING*

Attach the trailer hook only to a compatible link.

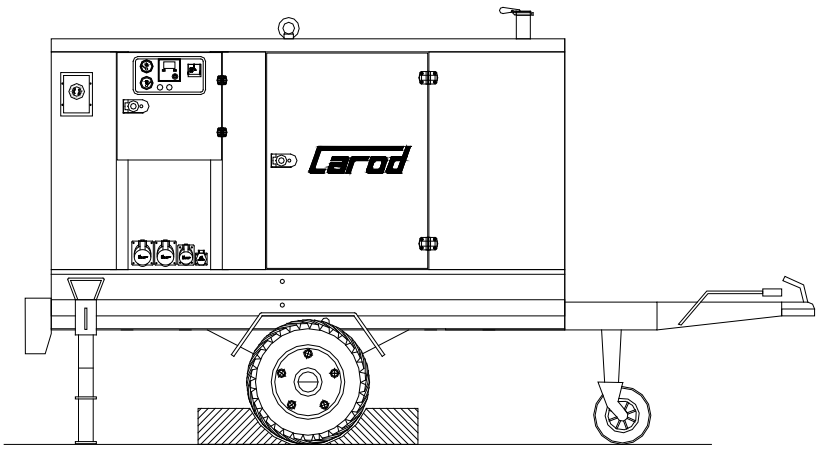
Do not link a trailer to a device no designed for it.

Check the condition of the hook, and the operation of the locking system.

To attach, first block the wheels to prevent movement. Raise and block rear supports. Release the parking brake.

Proceed to engage the latch. Remove the shims and press the handle to raise the jockey wheel support.

Connect the electrical circuit.




### *5.4.2. CHECKING BEFORE TOWING*

- ☑ Check the tires pressure on the trailer. Check if chocks are removed. Observe the tightening of the wheels screws. Make sure the hitch has blocked well.
- ☑ Make sure the enclosure doors are closed and locked.
- ☑ Make sure the parking brake is released.
- ☑ See if the rear jack stands and jockey wheel are rised.
- ☑ Connect light signaling connector. Try all the light indicators before running the trailer.

When the trailer is new, check every 20 kilometers the tightening the wheel bolts. At first, the heating of the brake drums and hubs may tend to loosen the screws.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### *5.4.3. DRIVING WITH A TRAILER, NON APPROVED FOR ROAD USE*

These trailers may not be equipped with a service brake, not being able to stop when running. Attention to the maximum speed permitted by the tire. It could be that they were not prepared to run at more than 27km/h.

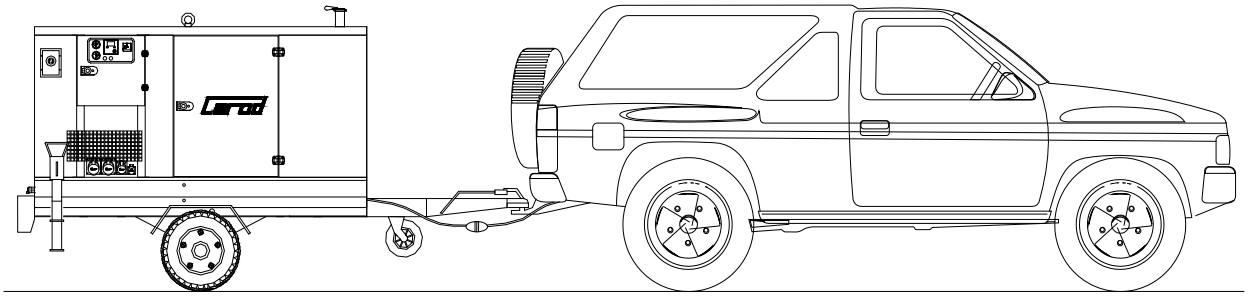
Remember the movement of such vehicles on the road is not allowed by law.

### *5.4.4. DRIVING WITH A TRAILER, APPROVED FOR ROAD USE*

Adapt your speed of movement to the rules established in the Highway Code by type of road, type of vehicle and trailer driving situation.

Adapt the driving speed according to weather conditions, road conditions, visibility and behavior of the trailer.

If you travel long distances with the trailer, periodically check the heating of the trailer tires. If you notice excessive heat, let it cool 30 minutes in the shade.



### *5.4.5. TRAILER UNCOUPLING*

- ☑ Find a level area for the release.
- ☑ Chock the wheels.
- ☑ Operate the crank to lower the small front wheel (jockey wheel).
- ☑ Disconnect the electrical circuit.
- ☑ Unlock the latch.
- ☑ Press the handle that extends the small wheel to climb out of the ring and hook.
- ☑ Move the tractor vehicle forward.
- ☑ Apply the trailer parking brake.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### *5.4.6. LAYING TRAILED GENSET IN ORDER TO BE INSTALLED*

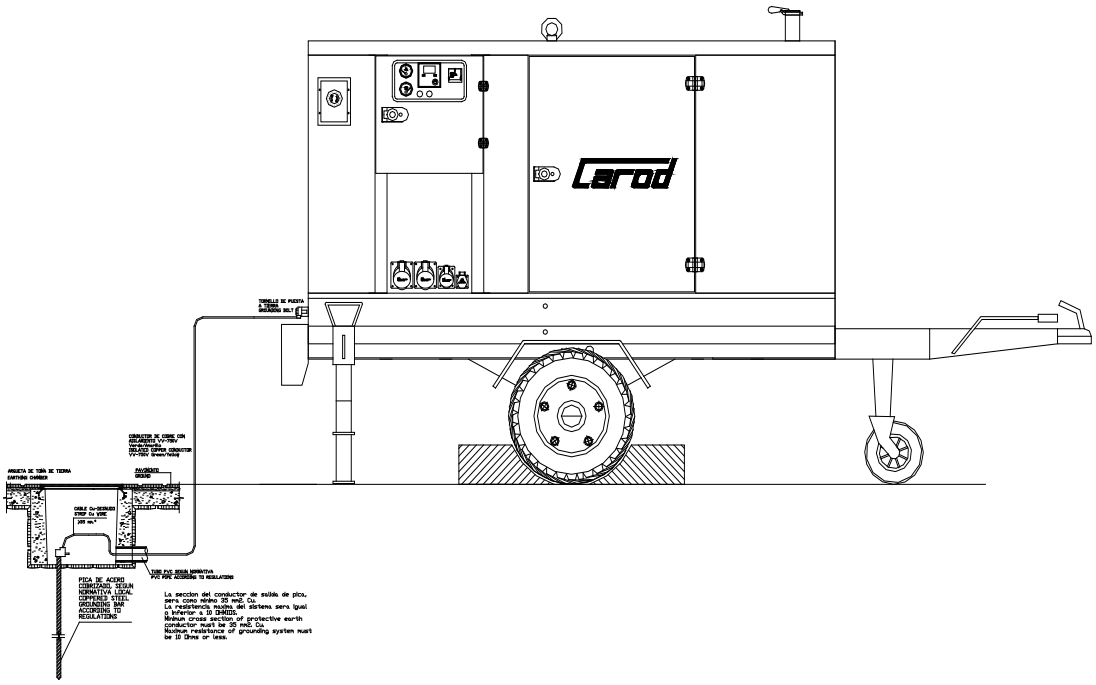
Find a suitable place. (See section "TEMPORARY INSTALLATION OF THE GROUP").

Apply the parking brake.

For installation, do not forget to level the group by extending or retracting the small wheel.

Lower the rear supports to the ground and lock them.

⚠ If the group has a Relay / Differential Switch (TN Union), connect the group to an effective earth ground. If the group has an Isolation Watchdog Relay (IT Union), the group MUST NOT be connected to any ground.



# 6. TEMPORARY GENSET INSTALLATION

Some tips for generators that are temporarily installed are outlined.

If you plan to frequently change the location of the generator set, it is advisable to choose a model protected by enclosure.

Locate the group where it cannot receive damage from vehicles, does not obstruct the passage and away from sources of dust, other gases or vapors or fumes from other fixed equipment.

Seat the group on a firm, level surface. Make sure that this surface supports the weight of the equipment plus that of the machine that has to handle it. Consider that the equipment during operation transmits certain vibrations to the ground.

Position the group so that it can be refueled easily.

⚠ If the group has a Differential Protection relay (TN Union), make sure to always connect the group to an effective Earth Ground. The opposite implies risk of electrocution.

⚠ If the group has an Insulation Monitoring relay (IT Union), <u>the group must not be connected to an Earth Ground</u>.

⚠ Protect the drop cables from the group to the load. If they run on the ground, cover them with a sturdy surface to prevent damage and accidents.

If you temporarily install the equipment indoors, make sure it is well ventilated. Always channel the exhaust gas through pipes to the outside. Do not do it through tubes that are too narrow, or with constrictions and avoid sharp bends. A restricted exhaust pipe will greatly reduce the performance of the equipment.

⚠ Be aware that exhaust smoke is dangerous and can be blown into inhabited areas by the wind.

Read the PERMANENT INSTALLATION OF THE GROUP section to find out about the equipment needs.



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# 7. PERMANENT GENSET INSTALLATION

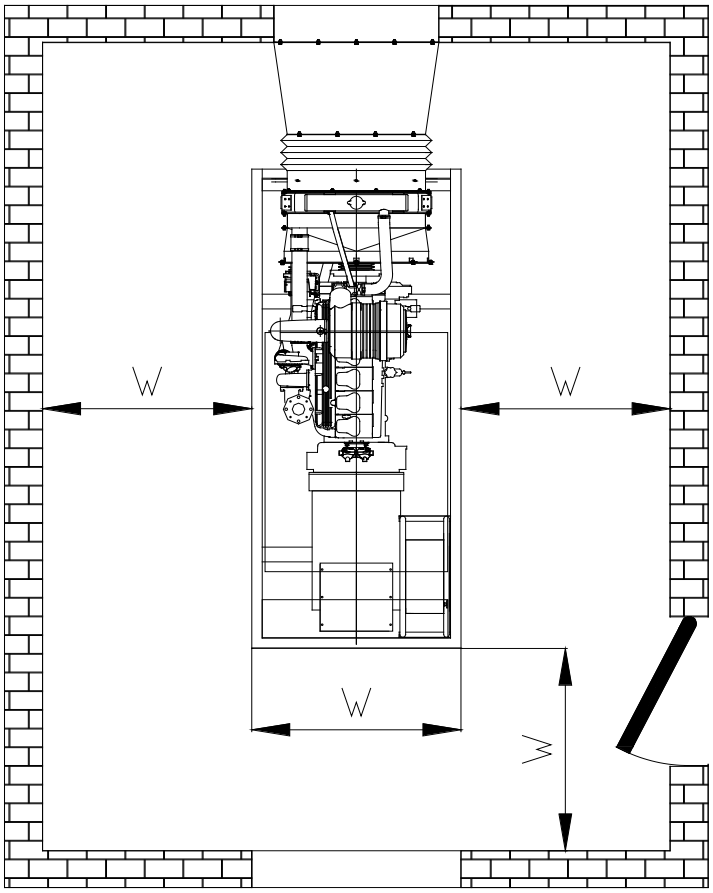
## 7.1. NECESSARY ROOM

The premises enabled for the generator set must be dedicated only to the generator set and related systems.

To correctly install a generator set (or several) in a permanent location, a space equal to or greater than the width of the group must be left around it to facilitate its operation, repair and maintenance. It will also help your ventilation.

If you are going to design the genset location, count on more space-occupying elements, such as switchboard, ducting and exhaust silencer, auxiliary fuel tank with its transfer pump, bellows and air ducting hopper. outdoor cooling, power cables, control cables (with their trays etc.).

In the case of large groups, the height of the room depends on how we install the exhaust silencer. In these cases it is expected that about 3 meters of height will be needed.




It must be remembered that for a good cooling of the group or groups, one of the walls of the room should have an air inlet or inlets located in the lower part, of sufficient section, and another wall opposite to this with the air outlet or outlets. , also of the appropriate section. It must be such that the air current circulates from the generator to the radiator.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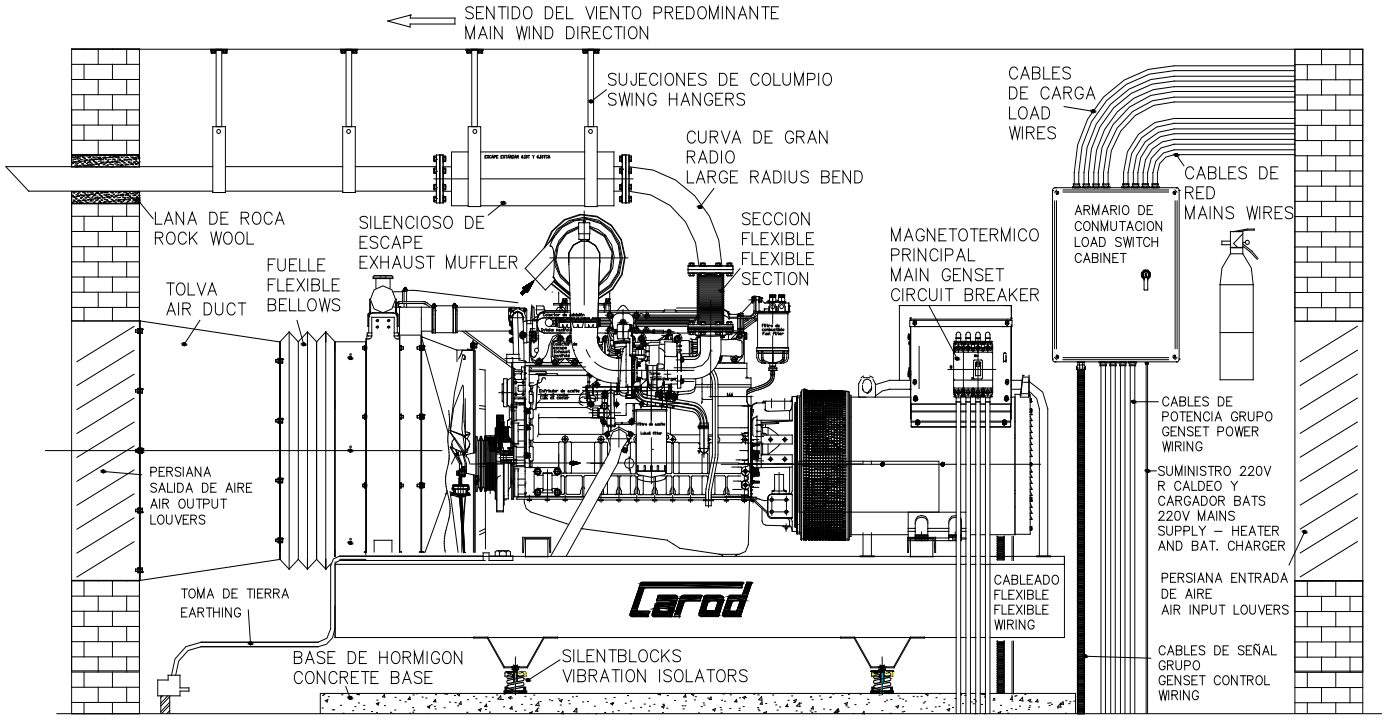


Above: Example of permanent automatic mains failure genset installation.

## 7.2. ROOM PREPARATION FOR GENSET MAINTENANCE TASKS

Consider that during the genset life, it can get seriously damaged, become small for its application, or get out of regulations.

Note that some time it may be necessary perform replacement works, and may be necessary handling bulky and heavy parts that need to be mounted on a carriage for movement. Design the premises close of an elevator or with an exit to the street or a garage where you can enter a large van.

Avoid installing generators in premises accessible by stairs only, narrow passages and obstacles.


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## 7.3. ACCESORIES AND CONSUMABLES STORAGE

During the genset life, there will be fluid consumptions. It is necessary to check their level weekly and replenish them to the right level periodically.

The fluids to replenish are coolant, oil and depending on the batteries nature, distilled water in sufficient amount.

It will be necessary to set a place, outside the genset room (depending on the local regulations), to keep that fluids and other materials. Is advisable having an industrial paper roll, cloths or other absorbent materials on hand, in order be ready to clean oil leaks. Container trays, baked soda or slaked lime in order to neutralize acid spills, hearing protection systems, work clothes, anti-acid gloves, safety glasses, different size funnels, cleaning stuff, spare parts as considered, a flashlight with charged cells, teflon tape, gaskets and o-rings, a first-aid kit and basic tools.

There must be a well visible and reachable place to keep a maintenance tasks log, where all the servicing must to be written down, with date and time and related genset working hours.

## 7.4. WARNING INDICATIONS

⚠ Indicate in a clearly visible and close to the equipment the emergency generator may start in any time without notice.

Notice the access to the genset room is restricted to authorized personnel only.

Indicate on the room door the escape route in case of fire and what is the emergency exit.

Indicate smoking is banned in the genset room.

If the genset is not soundproofed, notice on the door of the room that is required to use hearing protection if the equipment operates.

Make sure that the genset warning stickers remain in place.

## 7.5. FIRE EXTINGUISERS

Beside each room access, is necessary to place registered, revised and loaded extinguisher, Class BC or ABC. Their presence must be indicated with a luminescent panel.



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## 7.6. FIREPROOF ROOM PREPARATION

Under certain regulations, a fire resistance capacity of the local of at least 1 or 2 hours must be required. Genset room could be considered fire protection sector from the rest of the building enclosures. For example, the doors must be fireproofed. Check local regulations.

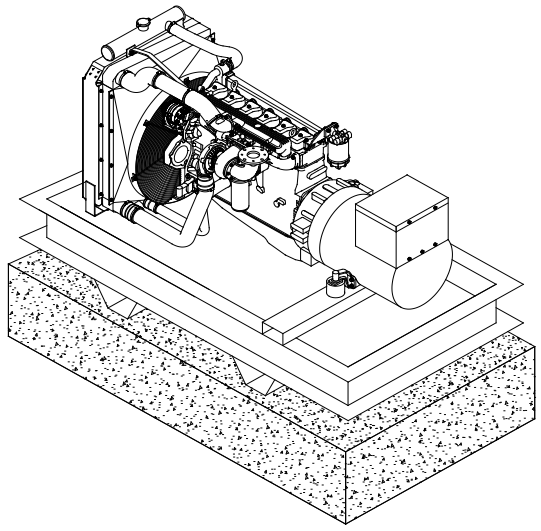
## 7.7. ENTRANCE AND EXITS IN THE GENSET ROOM

If the genset room area is bigger than the minimum area specified by the rules, you must have more than one access, one of them being the emergency exit, which must be maintained and operational indicated. ( Check local regulations ).

Doors should be fireproof and must open inwards, to overcome the negative pressure of the fan to move air out of the room. When are installed to open outwards, there is a risk that the doors get closed with violence when genset starts and will be difficult to open them.

## 7.8. LAYING OF THE GENSET AND VIBRATIONS ISOLATION

The first and foremost thing is to know the weight of the equipment and the capacity of the building structure to support it. Make sure the structure can support the weight of the generator set plus its accessories.



In the installations of emergency groups in basements, it is good to design a reinforced concrete base that acts as a support base and tends to isolate the vibrations of this equipment during its operation..

In order to function successfully, this base should weigh at least 2 times the weight of the complete set of the group that it will support.

The plinth must be a rectangle that contains the width and length dimensions of the group, protruding 150mm around.

It should also be raised 150mm from the ground and separated from the pavement along its entire height by an elastic material that isolates vibrations (rubber, polystyrene, fiberglass).

The concrete weighs about 2300 kg/m$^3$. These data should be used to calculate the height of the plinth foundation.

For installation over a roof, it is convenient to isolate the vibrations of the genset ground by shock absorbers or silent blocks suitable for the application.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## 7.9. EMERGENCY LIGHTING

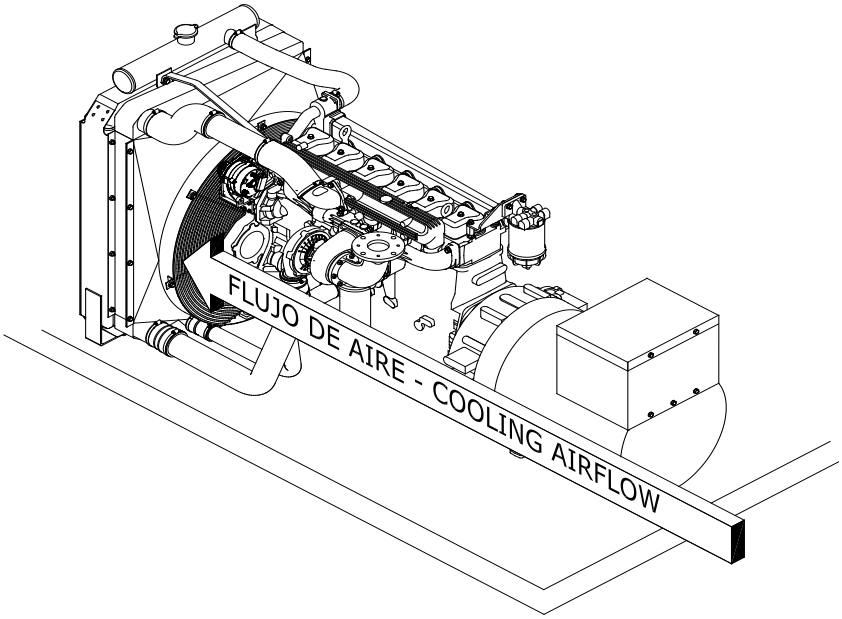
The generator's room must have emergency lighting.

## 7.10. ROOM AND EQUIPMENT VENTILATION

Proper ventilation is essential for the life and performance of the generator set.

If it is poorly ventilated, power losses and abnormal operation will occur, causing premature engine wear and possible destruction.

The engine needs to force-air cool the radiator, generator, and engine surfaces. It must be foreseen that a large volume of air is required for this.




The proper way to cool a generator set is by ensuring a flow of fresh air that runs along the sides and upper part of the unit from the generator to the radiator, longitudinally.

For this reason, the group fans are all impulsion fans, taking the air from the engine and driving it towards the radiator.

The ideal place for this should have in one wall an air inlet or inlets located in the lower part, of sufficient section, and another opposite wall with the air outlet or outlets, also of the appropriate section. The inlet air section must be 150% of the outlet air section.

If this is not the case and too much vacuum is created in the room, the intake air intake of the engine can be impaired. This would lower the performance, increase the consumption and the temperature of the exhaust.

If the design of the available room is not conducive to this, you can have baffles to direct the air.

It is necessary to install a metal hopper on the external surface of the radiator with an elastic bellows that absorbs the vibrations of the engine that channels the hot air to the outside of the room. In this way, the hot air from the radiator is prevented from re-entering the room, damaging the intake of air for combustion, which must be as cool as possible.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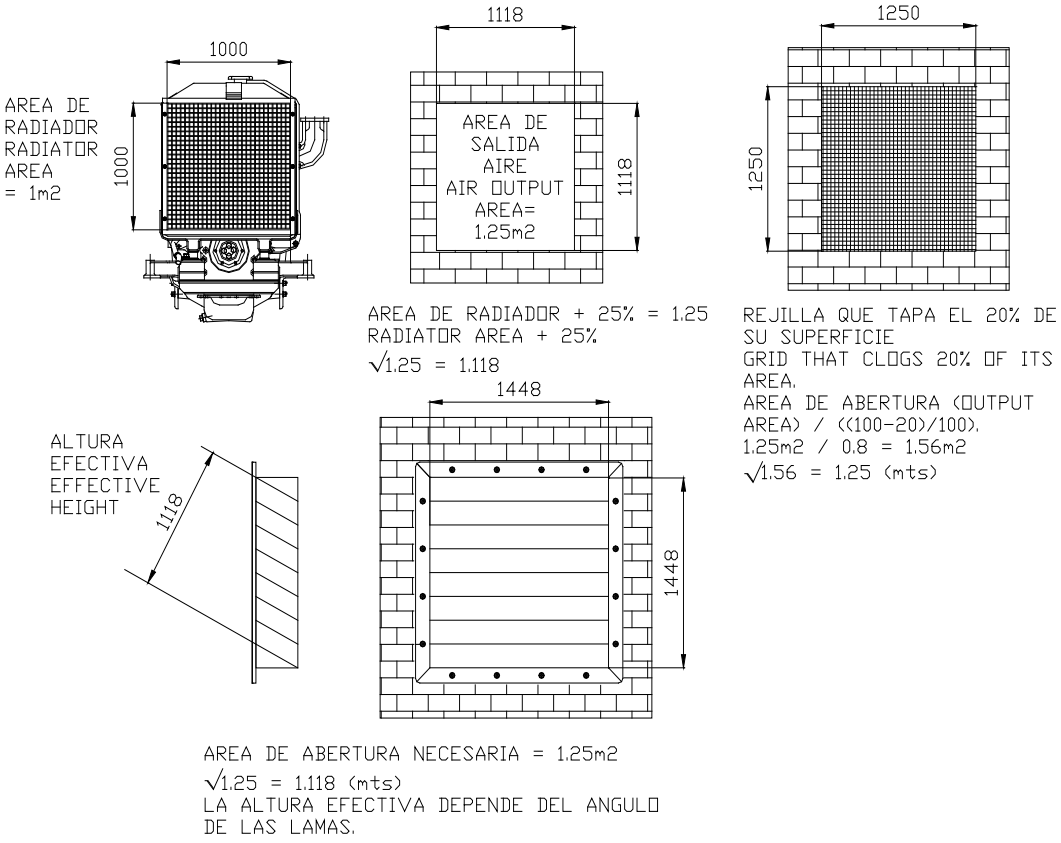


The hopper area on the wall side must be 125% of the area on the radiator side. The smallest section of the hopper or bellows must be greater than the section of the radiator.

If we install rain shutters at the outlet, the hopper section must be increased by 25%. If we install fine screens, the section of the hopper must be 40% larger than that of the radiator.

The air inlet area to the premises must also be 125% of the radiator surface, although it is preferable that it be larger.

It must be borne in mind that the fan tends to drain the room. Ideally, doors and windows should open inward or be sliding. Otherwise, when starting the group will tend to close them with violence.

Make designs that facilitate air circulation. If the ventilation ducts must be very long (in basements etc), consider the need for a forced ventilation system.

Please note that noise will come out through the ventilation holes during unit operation. Raise the need for silencers at the inlet and outlet of the ventilation.

The higher the installation altitude, the lower the air density and the lower cooling capacity. We can compensate for this by adding 10% more airflow for every 765 m increase in height above sea level.


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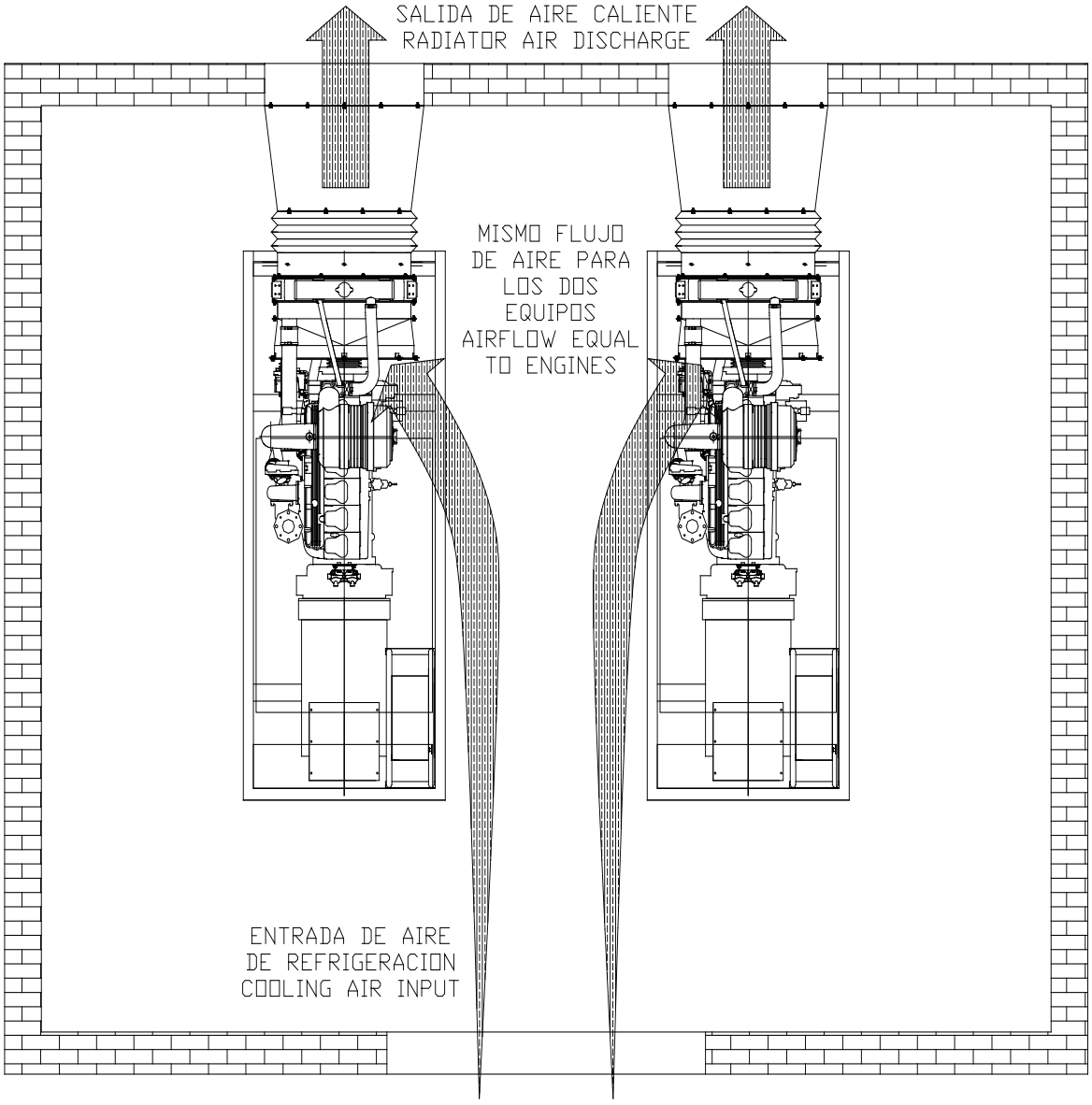
### *7.10.1. COOLING A ROOM WITH GENSETS OPERATING IN PARALLEL*

Airflow must always run longitudinally, as shown in the next drawing.



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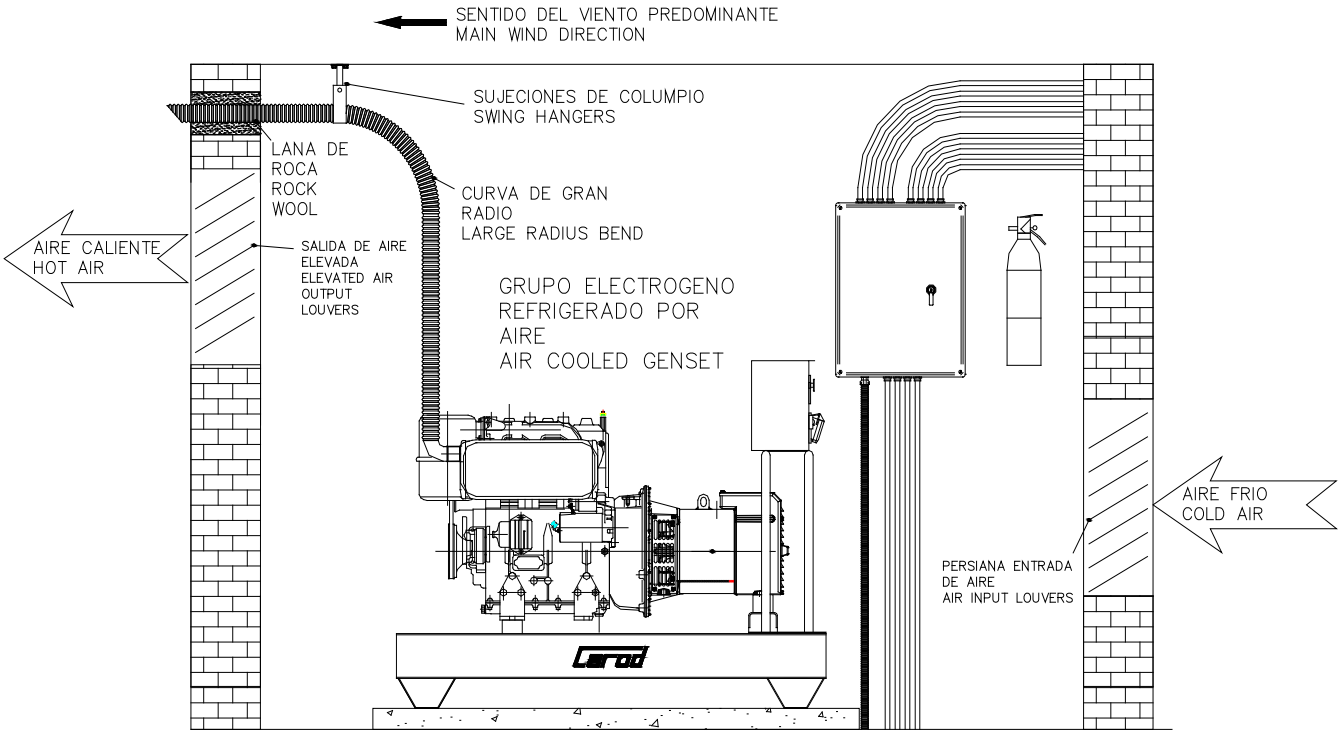
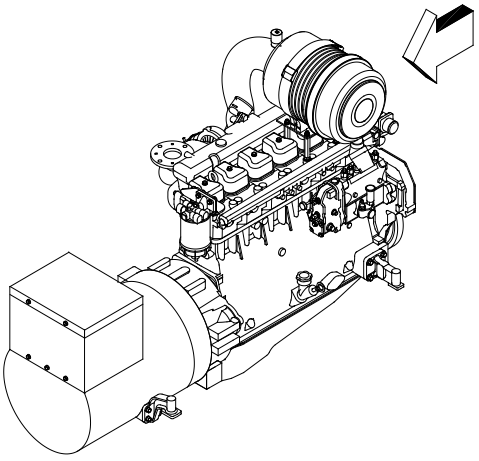
*7.10.2. COOLING A ROOM WITH AN AIR COOLED GENSET OPERATING*




In this type of facilities it is especially important having a great amount of air flow. The cold air intake should be at the bottom at one end of the room, in the arrangement shown in the drawing. The hot air outlet should be located in a opening on the upper part of the wall of the other end of the room, as heat tends to build up above. Forced ventilation is recommended.

## 7.11. INTAKE AIR INLET



A minimum flow of intake air must be ensured to enable a proper engine operation (see data sheet).

This air must be clean and fresh to ensure performance and equipment life. Usually taken from the same local genset. If the place is usually very hot, will be necessary to take air from outside.

Make sure the air intake is away from dusty, polluted or very hot environments.

The engine must be installed in a way the air intake doesn't suction the exhaust gases. The exhaust gas recirculation may result in a serious malfunction.



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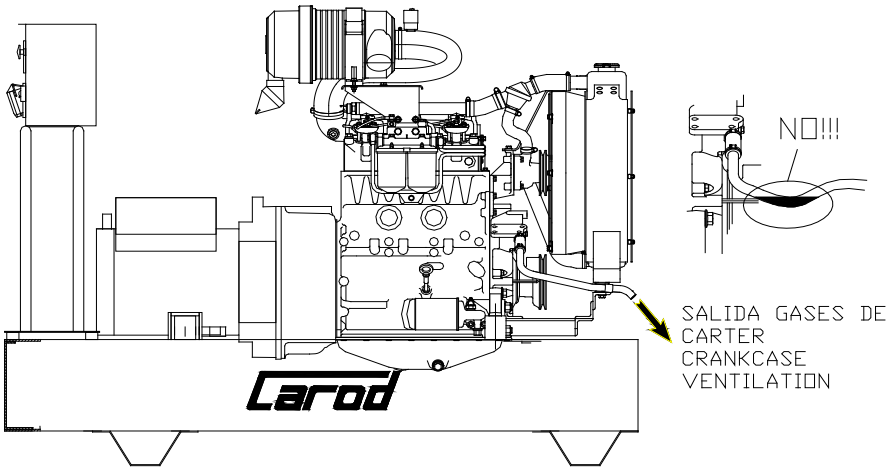
## 7.12. CRANKCASE VENT GASES

Diesel engines have a conduit to release the crankcase gases that come from the combustion chamber through the piston rings. That conduit prevent excessive pressure buildup inside the crankcase. If not released, it would tend to cause leakage of oil.




In the case of well ventilated rooms, it is not necessary to channel the crankcase gases outside, since the flow of these is small.

⚠Over time, the oil can arise crankcase gases. Never drive off crankcase gases to the exhaust gases circuit, since its high temperature could ignite the crankcase gases.

For rooms with poor ventilation or where a more intensive use of the application to normal emergency engines is expected, it should be necessary to extend the crankcase gases piping outside of the room.

In many cases, the crankcase gas outlet is guided to the air intake of the engine, making it not going outside.

## 7.13. EXHAUST GASES CHANNELING

The exhaust system must be designed to facilitate the escape of exhaust gases in order to the maximum value of "back pressure in the exhaust" established by the engine manufacturer is not exceeded. Excessive restriction in the circuit results in a rise in fuel consumption, exhaust temperature normally high, with excess related breakdowns and black smoke.

The circuit can be built exhaust pipes in black or stainless steel. Flexible connections between the engine and the exhaust pipe are required to avoid breaking the vibration tubes. These flexible joints should never be forced.

Build the curves radius of the tubes as large as practical to improve the output.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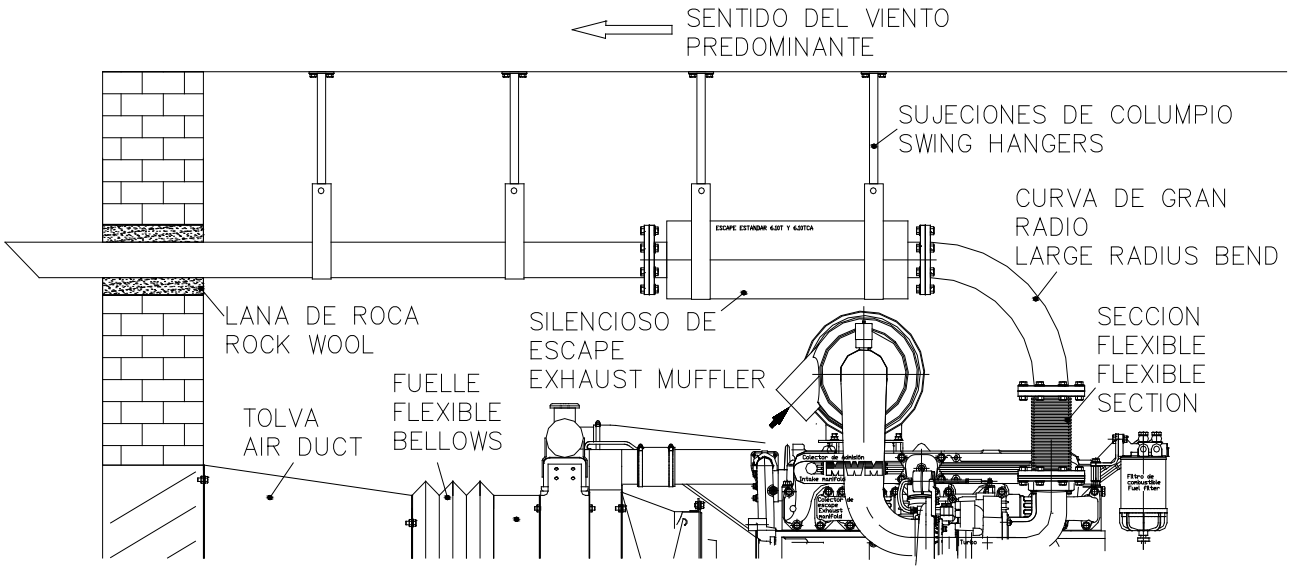
The diameter of the exhaust must be greater than the engine exhaust outlet, but not too large because condensation would occur. It is necessary to calculate according to the length and angles of the installation.

Install the silencer near the engine to warm up quickly and no water to condense. Preferably make exhaust sections hang from the ceiling to prevent it to be touched, do it using metal "swings", never with rigid supports.




Do not allow weight of the exhaust pipe to rest on the output of the engine or on the flexible. In a medium term it will damage the turbo or exhaust manifold.

Note that the exhaust expands. Install expansion joints, in long runs and in changes of direction of the tube.

If is necessary to pass walls or ceilings, don't formwork the tube in the wall or ceiling. Make a through hole of about 60mm larger than the radius of the tube and fill the gap around the pipe with fireproof rock wool.

If is necessary to isolate a section of exhaust to avoid contact burns, do it, but do not wrap either the exhaust manifold or the turbo. It could increase its temperature until it's destruction.

Do not direct the exhaust outlet where it's gases can be reabsorbed by ventilation or admission. Do not head the exhaust outlet towards the usual wind incoming direction (leeward).

Remember the accumulation of exhaust gases is dangerous and generates high noise. Ideally, take the exit at the highest and as away from people as possible place.

On small devices, the exhaust pipe must be installed with a slope that leads the water that condenses in the combustion to outside, to prevent moisture buildup in the tube.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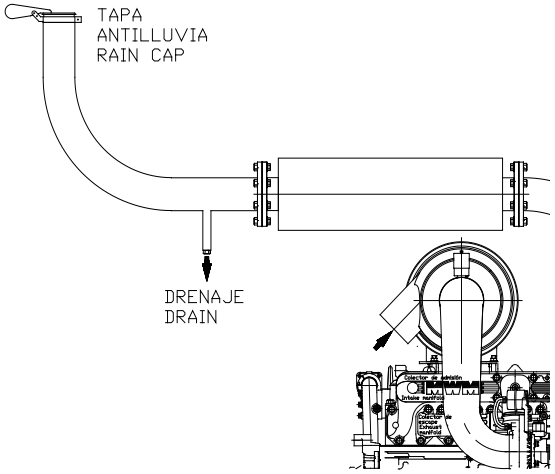
In large equipments, the exhaust circuit can have a plug to drain the condensed water. Drainage is necessary to include in the maintenance program.

Prevent rain entering through the vertical leakage through rainproof covers.

Cut the tube bevel horizontally, so as to prevent the entry of rain and cover it with a fine wire mesh to prevent animals from nesting inside exhaust output.




### *7.13.1. EXHAUST CIRCUIT BACKPRESSURE CALCULATOR*

The value of pressure in the exhaust circuit is the result of adding the backpressure in the tubes plus the backpressure in the muffler.

Typical values of pressure in the muffler of the equipment (open gensets) should usually be 1kPa (1000Pa). In the soundproof equipment, it could be 3kPas (3000Pa). Check each model for more accuracy.

The formula for calculating an approximate value of backpressure in the exhaust pipes would be this:

$$P = 6{,}32\frac{L \times Q^2}{D^5} \times \frac{1}{T + 273}$$

where :
P = back pressure (Pa)
L = total equivalent length of straight pipe (m)
Q = Flow exhaust (m3/s)
D = Diameter of pipe (m)
T = temperature of the exhaust gas (ºC)

If elbows in the exhaust system are used, we must transform each elbow on a straight stretch of equivalent length, for these equivalences:

Elbow at 90 : L = 0.033 D
90 ° elbow radio > 150% D: L = 0.02 D
Square Elbow: L = 0.066 D
Elbow 45 ° : L = 0.015 D

That equivalent distances must to be added to the straight run up to figure out the total equivalent length.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## 7.14. BULK FUEL TANK INSTALLATION

In gensets deployed in fixed installations, it may be necessary a remote fuel tank with larger capacity than the daily tank. When genset detects the fuel level is low, it transfers fuel from the bulk tank to the daily tank.

For gensets with remote fuel tank, it is important to install and manipulate them by following the specific rules on "Storage facilities for fuel consumption in the facility itself". Try not to expose the fuel to spark or flame, as it is flammable.

⚠ Never use copper or galvanized piping to channel fuel. These materials tend to react with the diesel releasing particles and clogging the filters.

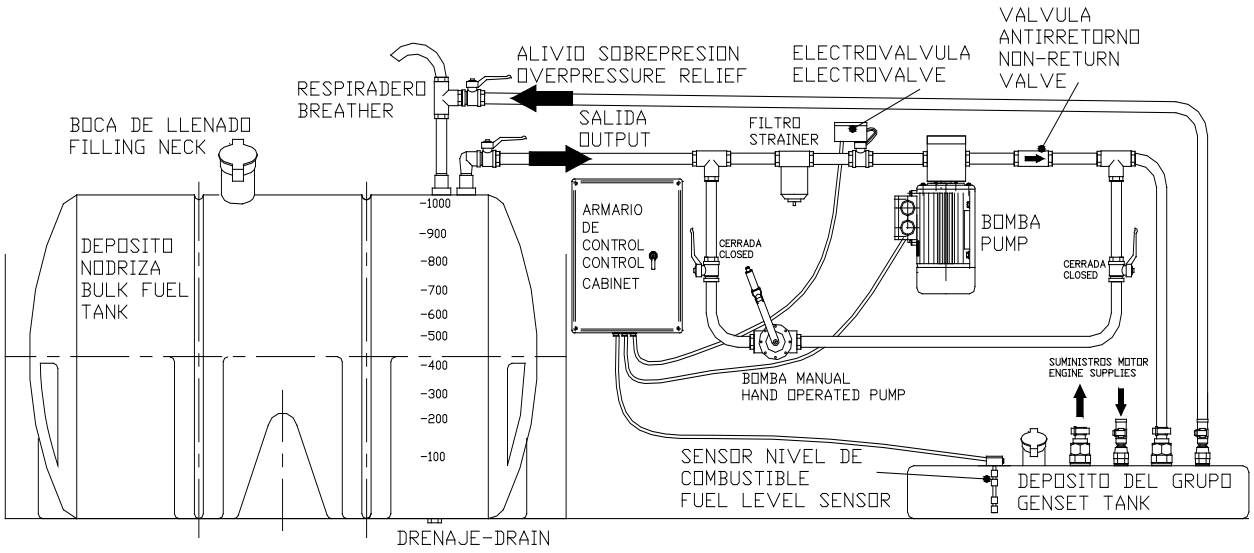
⚠ Do not use porous materials for fuel channeling.

⚠ Use fuel channels with flexible links as they pass around the genset to absorb vibration thereof.

⚠ Check the internal cleaning of piping before installation.

⚠ Do not run pipes near electrical wires or hot spots.

Remember to install shutoff valves at strategic locations to make repairs without draining the fuel tank.




It is desirable that the fuel tank of the generator set is metallic for these applications. It is also interesting to seal the fuel level sensors and indicators and hermetically seal the manual fill cap of the group's tank.

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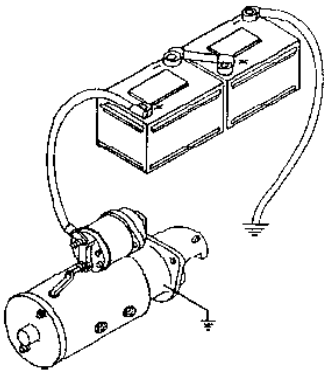
## 7.15. BATTERIES INSTALLATION



If you relocate the battery for some reason, remember they should be as closest as possible to the starter.

The temperature affects the battery performance.

A low temperature favors the battery accumulate more charge, but it hinders release of energy. The consequence is that they have less cold start capability. .

A high temperature can damage the batteries. It could be not recommended to charge the battery if its environment temperature is very high. Consult battery specifications.

⚠ Try to preserve the batteries from direct sun. This favors their self-discharge.

⚠ Electrolyte vapor concentrates hydrogen, which is flammable. Try not to install the batteries in a closed receptacle where electrolyte vapor can accumulate.

## 7.16. BATTERY CHARGERS INSTALLATION

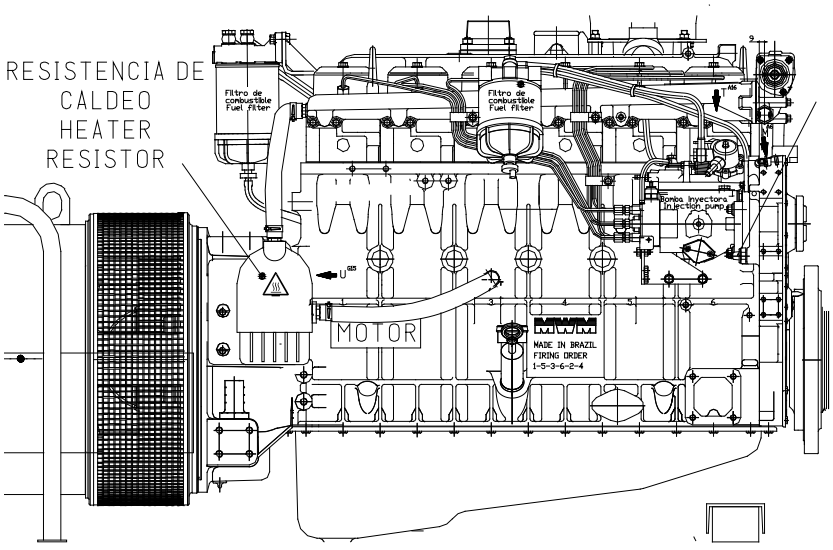
Do not install the battery charger outdoors or in damp places.

## 7.17. COOLANT HEATER INSTALLATION

In emergency application gensets, the coolant is heated by a heating element that is submerged in the liquid.

The system works by means of thermosiphon effect. As the liquid is heated, rises, allowing cooler liquid enters from below the resistance.

⚠ Do not relocate the heating element to a higher position. The water must flow through the upper hose always ramping from bottom to top for it to work.



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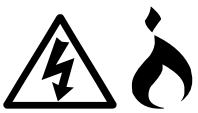
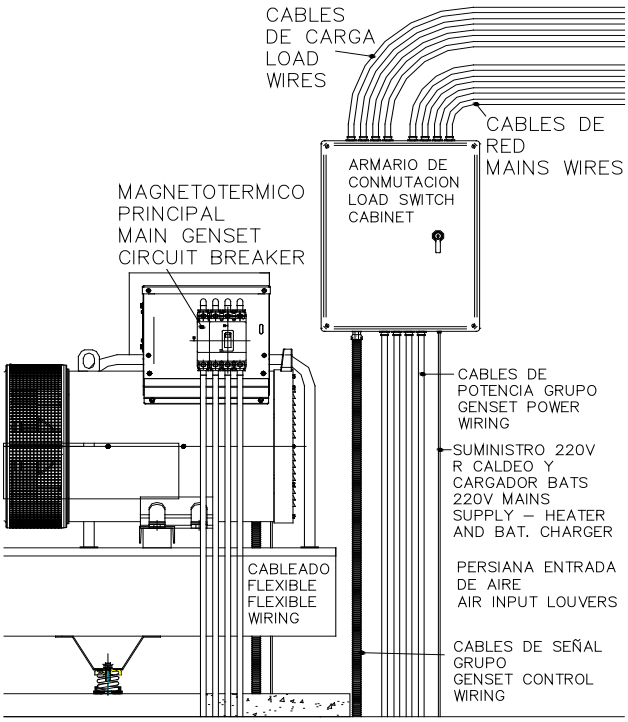
## 7.18. ELECTRICAL CONNECTIONS FOR PHASES, NEUTRAL, CONTROL AND EARTH

Use conductors of the nature and section prescribed by the current Low Voltage Regulations, according to the nature of their conductive material, their insulating material and the maximum current that they will withstand plus a 10% overload, ambient temperature, voltage drop, the installation method (if recessed, overhead ...).

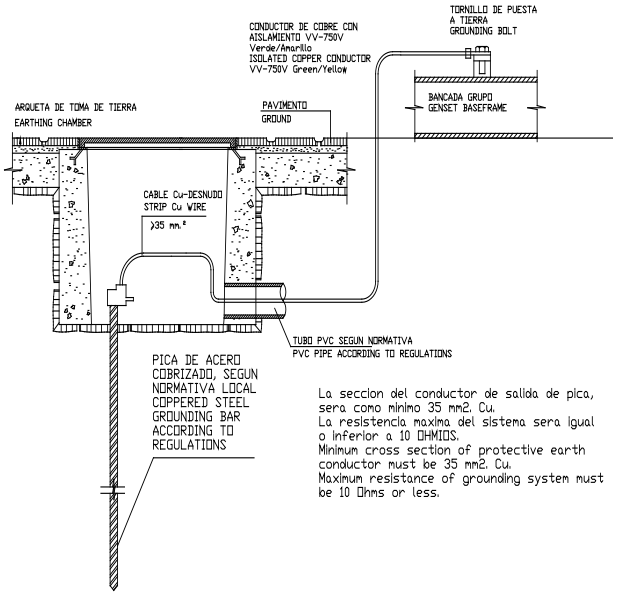
The connection terminals must be of the correct dimensions and well crimped to the connection cables.



⚠ A bad connection of the power cables can generate an electric arc and with it a fire.




Size the neutral cable preferably of the same section as the power cables, especially if you plan to connect loads with a high content of harmonics (large battery chargers, welding machines, large groups of gas discharge lamps ...).




If you foresee that the loads are going to be balanced and mostly resistive and linear, the section of the neutral conductor must be equal to the section of the power conductors up to 16mm$^2$. If they have 25 or 35mm$^2$, they could be 16mm$^2$. If they are more than 35mm$^2$, they can be half the section of the power conductors, at least up to 400mm$^2$.

This last sizing rule is applicable to the grounding conductor. The maximum resistance of the earth conductor should be 25Ω (Ohms).

⚠ Always connect the group chassis to an effective earth ground. Otherwise, there may be a danger of electrocution when coming into contact with the metallic masses of the equipment.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In special cases, the grounding of the group must be independent from that of the installation. Check that the grounding point of the alternator (s) complies with the grounding regulations in one of the following three systems: TT (neutral to ground and ground to ground with independent grounds); TN (neutral and masses to the same ground); IT (isolated neutral and earthed). Usually the TT system is used.

⚠ If the group has an Insulation Surveillance relay (IT Union), the group must not be connected to a Grounding, therefore the indications on the previous page regarding Grounding should not be considered.

The signal and control wiring must go in a separate tray from the rest of the wiring. The alternating current wiring, even for control, must always be separated from the direct current wiring.

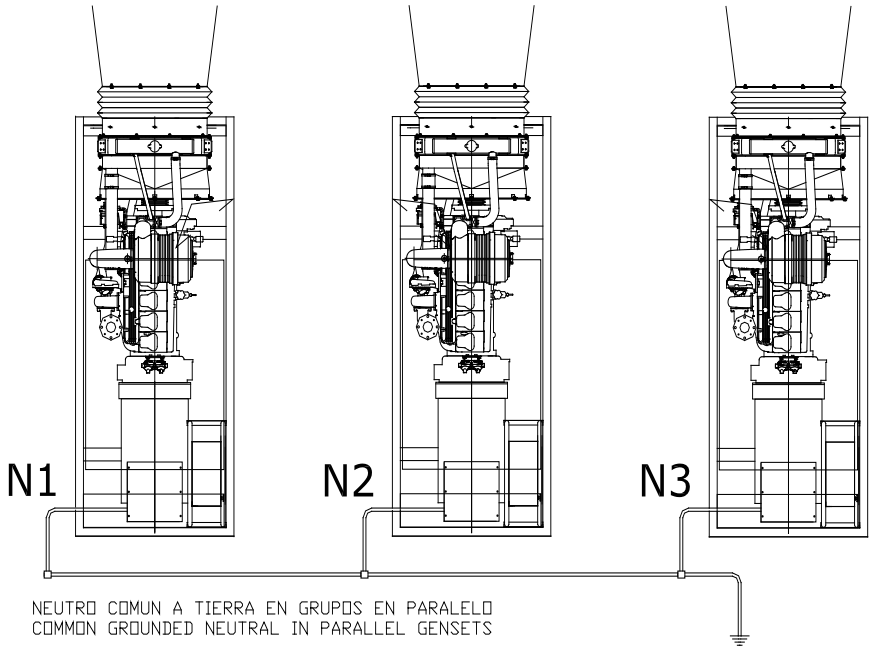
The control wiring tray must be separated a minimum of 30 centimetres from any other tray with AC or power wiring.

The signal and control wiring will have a minimum section of 1.5 $mm^2$, unless a higher section is required due to a very long distance.

Do not forget to consult and comply with the current regulations.

### *7.18.1. PARTICULARIDADES DE LOS GRUPOS EN PARALELO*

The REBT indicates that when several groups work in parallel, the union of the neutrals of all generators must be grounded at a single point.




The best way to do this is to go to the group junction busbar and connect the neutral bar to earth. The neutral circuit of these equipments cannot be opened. That is why its circuit breakers are three-pole, cutting only the phases.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# 8. STORAGE

If leaving the genset out of order for longer than six months is required, it is recommended to follow some guidelines for easy availability of operation when is needed to reuse the equipment.

- Start the engine until the oil reaches over 70 º C.
- Turn off the genset, leave it in "OFF" mode.
- Drain crankcase oil and remove the oil filter. Protect the filter hole. Disconnect the battery negative. If you can, use it in another application.
- Press the emergency stop to avoid possible unexpected new startup.
- Drain the fuel tank.
- Remove and empty the fuel filter or filters. Protect bare holes.
- Remove the injectors and pour a small amount of oil into the cylinders through the holes. Then turn around the crankshaft manually to distribute the oil.
- Do not store the equipment in damped, dusty or cold places.
- Cover the equipment with plastic during the downtime.

When returning to service, reinstall new filters and oil. Connect operative batteries, fill the tank with fresh and clean fuel. Prime the fuel supply circuit. Unlock the emergency mushroom.

# 9. GENSET LOADS

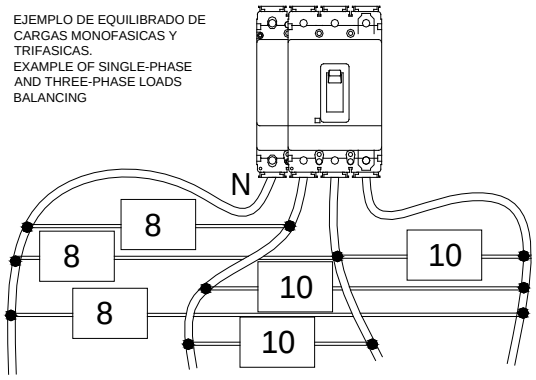
The dimensioning of the power loads to be fed is the responsibility of the buyer. It is recommended to leave a minimum margin of 10% calculated on the required power for the generator to do not operate at 100 % of capacity. If the load is expected to be constant, it is recommended to charge 75-80 %.

Avoid having the motor working with a load smaller than 60%, since it not reach its operating temperature, crankcase oil would rise up, getting out of the exhaust manifold gaskets and suffering the engine premature wear. Be sure to buy the generator size you need.

It is advisable to protect the loads powered by the generator by means of circuit breakers in a way that avoids a possible breakdowns overlapping.

When singlephase loads are connected in a threephase genset is very important to distribute these loads evenly between the three phases. Otherwise, we could overload one of the lines and generate a problem.

EJEMPLO DE EQUILIBRADO DE CARGAS MONOFASICAS Y TRIFASICAS.
EXAMPLE OF SINGLE-PHASE AND THREE-PHASE LOADS BALANCING




There are certain types of loads including solid state switches (welders, battery chargers, large sets of gas discharge lamps...) that generate lots of harmonics. In these cases a more than usual oversized generator is required, to avoid excessive heating of the magnetic cores of electric machines and neutral wire overload. Oversizing burdens in the case of frequent starting of motors is also necessary.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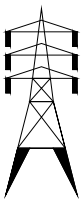
# 10. SWITCHING SYSTEMS FOR AUTOMATIC MAINS FAILURE GENSETS



The voltage monitoring module (which may be incorporated into the controller card) analyzes the state of the parameters of the mains.

In "AUTO" mode, when a mains fault is detected, the controller sends a command to start the genset. When this value reaches the proper voltage and frequency, the order to switch the loads that are fed by the genset is given. To do this, is necessary to open some contacts and close others.

When the mains power is restored, the genset, after a programmed security time, switch again for loads and they get fed by the normal mains.

After loads get released, the genset will operate with no load to cool the alternator during the programmed cooling time. Once this time has elapsed, the stop command is activated.

Please, keep in mind when the network fails, there will be a time of no power for several seconds while the genset get started, stabilizes and switching occurs.

In the case of a critical load that can't afford this lack of supply, we must combine the genset with a UPS (Uninterruptible Power Supply). You can also use a system of preventive start with a parallel connection to the network in some applications.

See the wiring diagram to see how switching to the genset connects.



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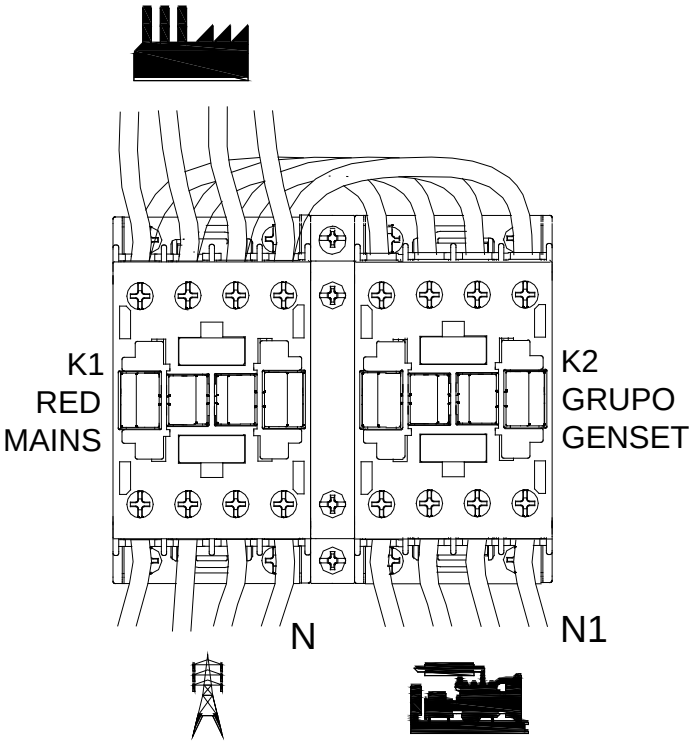
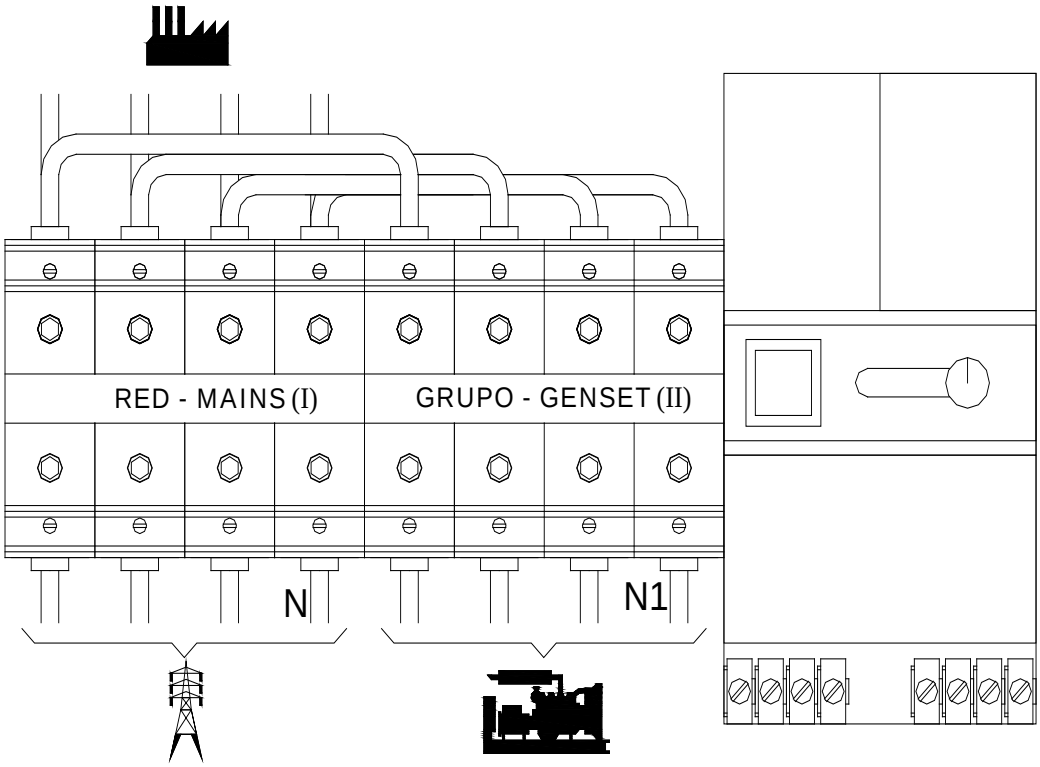
## 10.1. TYPE OF TRANSFER SWITCHINGS

We can find made by switching contactors with interlocks (typically up to 100A), motorized mains transfer switching device or motorized circuit breakers switch interlocks.




Left: Contactors genset mains switching.
Down: Motorized genset mains transfer switching





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# 11. CONSIDERATIONS ABOUT GENSETS COMISSIONNING

## 11.1. GENERALITIES

Either the the generator set initial operation as startup or starting after a complex repair should be done by a qualified technician with knowledge about these equipments.

Before starting the genset, make sure you know the management of the controller and you have read and understood the instructions in this manual.

It is convenient to make the first start with MCB breaker lever down. If it appears that the electrical parameters of the genset are correct, raise the lever and observe the values for a while.

See instructions of the controller to learn how to operate the genset.

## 11.2. INSPECTION BEFORE STARTING (TO BE DONE ALWAYS)

Before starting, check the oil levels, coolant and if equipped with maintenance need batteries, the electrolyte level of the batteries.

⚠ See "Lubrication System", "Cooling System" and "Batteries" for methodology and risks of this practice.

## 11.3. AFTER STARTING

Whenever the computer is booted up, it is advisable to go to observe the parameters values at least for initial moments of the operation.

Have occasionally a look to the controller just in case it indicates an abnormality during the operation.

The parameters must be within the range specified in the specifications section of the engine and the alternator.

The controller should not indicate malfunction warning during normal operation.



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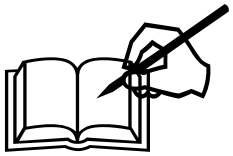
# 12. GENERAL GENSETS MAINTENANCE

## 12.1. GENERALITIES

Maintenance and inspection must only be carried out by qualified technicians. Correctly following the maintenance program indicated in the manual of your engine is the key to a long life of the generator.



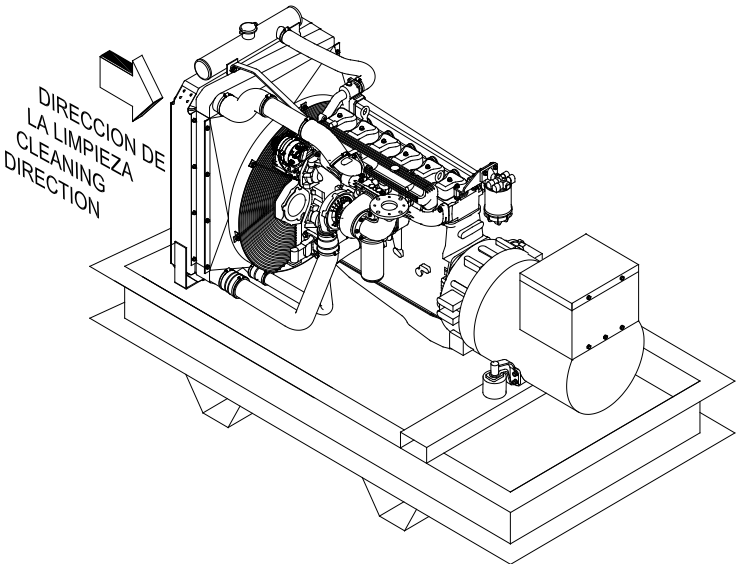
It is convenient to record these maintenance tasks in a format where the interventions and revisions are noted, with the date and working hours of the group corresponding to the moment in which they are carried out.


Before carrying out any maintenance or repairs on the group, make sure that it cannot start unexpectedly.

## 12.2. CLEANING

Pay attention to cleaning the radiator. This can be sifted by lint, dust, insects, etc. so that its cooling capacity is reduced.

To clean it, water can be used, although preferably compressed air or steam jet. If necessary, we can apply detergent.




You have to direct the steam jet from the outside of the radiator towards the side of the fan, so that we tend to descale the residues and not the other way around. Move the jet in the direction of the radiator fins and not perpendicularly. Otherwise it could deform them.

You can clean the exterior of the motor-generator set with a degreasing spray cleaner (in moderate doses) and rags. Prevent the liquid from falling into parts of the electrical circuit.

Prevent the floor of the premises from being filled with dirt that can be absorbed by the radiator or help spread a possible fire.

Cover the motor-generator set and the electrical panel box with plastic to prevent water from entering when cleaning the radiator. Lower the group breaker lever.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⚠ Prevent water from entering the generator. Also inside the electrical panel. If you suspect that water has entered any of these components, disconnect the negative from the battery and apply a stove in the direction of the areas to be dried until necessary.

⚠ Avoid climbing on top of the engine. It could damage the wiring, sensors, or other delicate items.

⚠ Do not clean the generator set while it is running.

⚠ Make sure it cannot start unexpectedly while you are cleaning it. Leave it in "STOP". If in doubt, disconnect the negative from the battery.

⚠ Do not use flammable solvents for group cleaning.

Keep the cooling channels of the group enclosure and the installation room clear and clean.

### 12.3. GENSET SCHEDULED TEST

In generating sets, especially emergency ones (mains failure), periodic operation is necessary to check their integrity and for the oil to impregnate certain internal components of the engine, avoiding their corrosion or seizure.

It is good that the group works weekly, preferably with load until it reaches the maximum coolant temperature and stabilizes.

Do not run the group for more than 10 minutes without load.

It is noted that if the engine is not working for more than a month, internal corrosion may appear, shortening its useful life. If fuel breaks down inside the injection pump, it will seize up and require repair.

In the network failure controller cards there is the possibility of programming this periodic test, with or without switching the load.

### 12.4. OIL AND FILTERS REPLACEMENT

Every certain number of hours of operation, it is required to replace the lubricating oil, oil filters and fuel filter of the engine. This task is carried out every 250h or every 500h. Consult the engine manual to verify the number of hours of the interval between changes.


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## 12.5. DAILY CHECKLIST

- ☑ Visually inspect the entire genset, looking for for signs of leakage from the fuel system, cooling system or gaskets and o-rings that retain lubricating oil.
- ☑ Check with the stick the oil level has neither risen nor fallen out of bounds.
- ☑ Check the coolant level in the radiator is right.
- ☑ Check fuel level in the tank.
- ☑ Check the voltage and appearance of the batteries (see "Batteries" section).
- ☑ See if the genset is in automatic mode.
- ☑ Note that no objects or debris may obstruct ventilation openings, alternator, radiator, or can be caught in any belt or fan of the genset.
- ☑ Verify that no dirt is likely to be absorbed by the fan near the genset if it becomes operational.
- ☑ Check if the heating element works properly (in emergency gensets).
- ☑ Check if the control panel shows the data normally.
- ☑ Note if there is any failure warning light on the control panel.
- ☑ If the genset runs daily in dusty environment, shake the dust from the air filter and apply patterns for weekly review daily.
- ☑ If the genset is equipped with a primary filter and water separator, drain separator if it runs daily.

Correct if the anomalies detected. Write them down in the maintenance log.

## 12.6. WEEKLY CHECKLIST

- ☑ Check the cleanliness of radiator and cooling pipes of the premises. Observe the exhaust circuit integrity. Note the integrity of the engine wiring harnesses.
- ☑ We measure a value equal battery voltage between 12,5V and 14V. If the system is 24V should be between 24,5V and 27V. If we exceed the charging voltage, it will evaporate the battery electrolyte quickly.
- ☑ Run genset 5-10 minutes every week preventively, preferably under load, but if not possible, run it with no load.
- ☑ Check the air filter restriction indicator with the genset running. If the restriction is excessive is indicated, replace the air filter.
- ☑ The parameters must be within the range specified by the motor and alternator manual.
- ☑ The generated voltage value should not be more than 5% from the nominal. It must be stable.
- ☑ The frequency may be about 50-52Hz at no load.
- ☑ The genset controller should perform normally and does not indicate malfunction warning during operation.
- ☑ If the genset is equipped with a primary filter and water separator, drain it if the genset runs daily.
- ☑ If the genset generator alternator is equipped with brushes, check their possible wear ( see section "Alternator").


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## 12.7. MONTHLY CHECKLIST

Observe the electrolyte level of the batteries. Replenish if necessary.

- ☑ Check the condition and alternator and fan belts tension (if any) in the genset in STOP mode, and never with the hands.
- ☑ Make sure the genset can't start unexpectedly while checking the belt tension.
- ☑ Run genset with load for at least one hour.
- ☑ Check when starting the battery voltage value goes up at the genset starting. That's a way to know if the charging alternator works.

Remember to check the proper working condition of the engine speed governor and alternator voltage regulator. The genset should work with load to check it properly.

Oil pressure is normalized in 10 seconds after starting and running the engine. It goes down as the engine approaches its normal operating temperature to stabilize. The low oil pressure alarm shouldn't come up.

The coolant temperature should go up until the thermostat opens and stabilizes. Engines typically work between 80 and 100°C when it is stabilized.

It is better to check this parameter when the engine is loaded. In cold environment and at no load, the thermostat may not get opened.

If values of operating temperature, oil pressure, voltage, frequency etc are registered, wait for the engine to reach normal operating temperature and stabilize before write them down. Take the values then.

The frequency may be about 52Hz at no load and 48Hz at full load, depending on the engine speed governor.

If tested with load, the electrical current must not exceed the maximum value corresponding to the nominal power of the genset. If so protection systems should act.

## 12.8. EVERY 6 MONTHS OR EVERY 250 HOURS

- ☑ Clean battery terminals and apply dielectric vaseline to protect.
- ☑ Verify the connecting the power cables terminal screws are securely tightened.
- ☑ Make sure the exhaust circuit screws are securely tightened.
- ☑ In emergency application gensets, simulate a mains failure to test the switching and automatic start of the genset (when it is possible).
- ☑ Perform maintenance operations as described in the engine and alternator operator manual.


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## 12.9. ANNUAL CHECKLIST

- ☑ Inspect alternator.
- ☑ Observe belts. Inspect, adjust, replace if necessary.
- ☑ Inspect the crankshaft vibration damper.
- ☑ Inspect or replace air filter, depending on its condition.
- ☑ Clean crankcase gases vent.
- ☑ Supports lift motor and alternator. Inspect.
- ☑ Change engine oil and filter if engine has not worked the number of hours required to change them before.
- ☑ Change engine fuel filter if engine has not worked the number of hours required to change it before.
- ☑ Lubricate fan bearing (if applicable). This task is done every 250 work hours in continuous use.
- ☑ Check the operation of the engine protection systems.
- ☑ Inspect starter condition, noise and performance.
- ☑ Observe possible coolant leaks in water pump seal.
- ☑ Observe possible oil leaks in crankshaft seals.
- ☑ Observe possible exhaust gas leaks in turbo.
- ☑ Check for the equipment cleanliness.
- ☑ Clean the radiator if needed.

## 12.10. EVERY 2 YEARS

- ☑ Replace the batteries with others with identical features and size.
- ☑ Replace the air filter if it was never replaced before.

## 12.11. EVERY 3 YEARS

- ☑ Replace the coolant.
- ☑ Replace the coolant circuit hoses and clamps.
- ☑ Replace the thermostat.

Remember that generators operating in very intensive applications often require more testings.

Applying a checklist does not release any other overlapped checklist application if its deadline has been met.


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| **MAINTENANCE SCHEDULE (Set down the vaules when enine is running and the maximal coolant temperature is reached.** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EQUIPMENT SERIAL NUMBER: | | | | | | | | | | | | |
| TECHNICAL | | | | | | | | | | | | |
| DATE | | | | | | | | | | | | |
| ENGINE HOURS | | | | | | | | | | | | |
| **Stopped engine checklist** | | | | | | | | | | | | |
| Room temperature | | | | | | | | | | | | |
| Batteries voltage | | | | | | | | | | | | |
| Batteries OK | | | | | | | | | | | | |
| Coolant heater works ok | | | | | | | | | | | | |
| Oil level OK | | | | | | | | | | | | |
| Coolant level OK | | | | | | | | | | | | |
| Fuel level OK | | | | | | | | | | | | |
| Fuelwater separator drained | | | | | | | | | | | | |
| Room cleanliness OK | | | | | | | | | | | | |
| Radiator cleanliness OK | | | | | | | | | | | | |
| **Engine running checklist** | | | | | | | | | | | | |
| Air filter restriction | | | | | | | | | | | | |
| Frequency at no load | | | | | | | | | | | | |
| No load genset voltage | | | | | | | | | | | | |
| Loaded genset frequency | | | | | | | | | | | | |
| Load genset voltage | | | | | | | | | | | | |
| Load genset current | | | | | | | | | | | | |
| Max. coolant temperature | | | | | | | | | | | | |
| Oil pressure (if indicated) | | | | | | | | | | | | |
| Exhaust manifold temperature | | | | | | | | | | | | |
| T | | | | | | | | | | | | |

REVISION AB

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# 13. TROUBLESHOOTING

Note: for any electrical repairs, disconnect the negative of the battery first to prevent unexpected startings.

Below, it is a guide to the identification and resolution of potential failures in the genset. If does not meet the qualification needed to follow directions safely, require the assistance of a technical expert in generators.

**DIESEL ENGINE DOESN'T START**

**Starter doesn't rotate**

- ❑ Check wether or not battery voltage is OK. If it is wrong, charge or replace the batteries. Check for the genset could have a faulty battery charger.
- ❑ Check wether there are open breakers in the electrical panel.
- ❑ Check wether there are fused fuses in the electrical panel.
- ❑ Check wether some active failure indicator came up on the screen. Reset failures if necessary.
- ❑ Loose battery terminals.

With the electrical schematic:

- ❑ Check power source and the starter relay integrity.
- ❑ Inspect the electrical harnesses and connectors looking for loose connections.
- ❑ Check starter solenoid, brushes status, continuity and isolation of windings. Look af the bendix pinion status.
- ❑ Faulty controller.
- ❑ Faulty starter relay.

**Starter rotates but engine doesn't start.**

- ❑ Check for fuel in the tank.
- ❑ Prime the fuel circuit.
- ❑ Check if fuel reaches the fuel filters and they are not clogged.
- ❑ Extremely cold engine. Check if the coolant heater works and the preheating system works also.
- ❑ Seized stop solenoid. Check if the electrovalve sounds with a "click" when it's voltage changes. Pay attention to a possible controller malfunction.
- ❑ Starter failure. Check if there is the right voltage in its terminals.
- ❑ Fuel in bad condition.
- ❑ Clogged fuel filter, either by dirt or by water.
- ❑ Check wether electronic speed governor has voltage
- ❑ If white smoke comes out from the exhaust pipe, indicates the engine receives fuel but it has a hard starting. Read the engine manual.
- ❑ Dirty fuel tank breather.
- ❑ Engine valves breakdown.Seized valves.
- ❑ Wrong engine compression.
- ❑ Seized injector
- ❑ clogged tank breather

**ENGINE STARTS HARDLY**

- ❑ Very cold engine. Check coolant heater (if installed) Check wether preheating works properly.
- ❑ Lack of fuel flow.
- ❑ Clogged filter.
- ❑ Damaged pinion in starter.

**GENSET STOPS BY ALARM**

**Engine overheating**

- ❑ Check carefully if the indicated temperature is real.
- ❑ If the high temperature is true, check for the radiator cleanliness and fan performance. Check for the status and tension of the belt.
- ❑ Check enough air enters and exits the genset room.
- ❑ Make sure temperature doesn't exceed 40ºC in the genset room. On the contrary, improve the ventilation.
- ❑ If overtemperature is not real, check for deviation in the termoswitch circuit. If it is OK, replace termoswitch.
- ❑ Check for oil level.

**Low oil pressure**

- ❑ Check for oil level and refill if necessary.
- ❑ Look for any leakage in the pressure switch circuit. If it's ok, proceed to replace the pressure switch.
- ❑ Check with a manometer if the oil pressure is within the normal range.

- ❑ Worn rodcrankshaft bearings..
- ❑ Worn oil pump.
- ❑ Oil suction tube is obstructed of fallen down.
- ❑ Oil pressure regulation valve wrongly regulated or blocked..
- ❑ If the oil pressure is really low, call to the technical assistance.
- ❑ Remember if the genset is found stopped and the low oil pressure indicator came up on the screen, it could be due to the engine ran out of fuel and stopped suddenly.

**Engine overspeed**

- ❑ The engine burns oil that enters the combustion chambers, either through an excessive level or fault in the turbo seal or because oil mist enters through the crankcase breather channeled to the intake due to wear.
- ❑ Unwanted fuel leak entering the combustion chamber.
- ❑ Fuel gas inlet through engine breather

**Engine underspeed**

- ❑ If speed is abnormally low, check the power connected to the alternator is not above the nominal. Check for the current and try to reduce its value if it's too high.
- ❑ If the engine is not overloaded, we could have a faulty speed governor. Please call to the technical assistance.

**Fuel level**

- ❑ Check the fuel level is enough.
- ❑ If it's OK, check the level sensor performance.

**Genset voltage failure.**

- ❑ Check for breakers and fuses in electrical panel.
- ❑ Check the loads are balanced.
- ❑ Check the status of the alternator diodes.
- ❑ Failure in the alternator voltage regulator.
- ❑ Check the voltage regulator fuse.
- ❑ If loads have power semiconductors, disconnect loads and check if voltage gets back to it's normal value.
- ❑ Faulty voltage detector in controller.

**Overcurrent**

- ❑ Check if the power value of the load is within the range the alternator was made for. If it carries too much current, disconnect loads.
- ❑ The genset can be protected against overloads by means of a thermical breaker and controller reading. Depending on the limit current value set in the controller, this could order the genset stopping.

**Leakage**

- ❑ If the genset is equipped with this, the earth leakage relay will indicate to the controller earth leakage failures when they come up. In this case, the controller will stop the genset. Check for the schematic to determine what alarm will come up on the screen.
- ❑ In other models, the earth leakage relay acts on the circuit breaker trip coil of the circuit breaker. An auxiliary contact this indicate to the controller that has been shot with the same alarm due to overload, short circuit or shunt. This alarm will stop the genset, being necessary to see the witness protection differential relay for the occasion.

**Communication failure**

- ❑ Check wiring of the data bus and the power of the receivers.

**Emergency stop button activated**

- ❑ Check that the emergency stop button is pressed and locked. Release and reset the alarm.

**Failure of battery charging**

- ❑ Check that the alternator belt is good and proper tension.
- ❑ Check that the alternator is charging battery properly primed by terminal D +.
- ❑ Check charging alternator.
- ❑ In motors with magnetic plate, check that the AC voltage reaches the magnetic plate and the positive after ignition when needed.
- ❑ If everything is correct and systems do not generate load signal, replace the component if necessary..


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**THE MOTOR STOPS BY APPARENTLY NO REASON.**

❑ Unprimed, air in the fuel circuit. Prime again.
❑ Emergency not indicated because of controller malfunction.

**GENSET DOESN'T STOP, BUT WARNING ALARMS COMES UP**

**Low fuel level.**

❑ Check fuel level.
❑ If fuel level is OK, check fuel level sender.

**Low battery voltage**

❑ Check fuses and circuit breakers in the electrical panel that powers the charger (in gensets for emergency).
❑ Ensure that the battery charger is supplied at 220V.
❑ Check that the batteries are not more than 2 years.
❑ Check that the batteries have a correct level of electrolyte.
❑ Ensure that the charger is working properly fed with a 220V battery in good condition. Otherwise, replace or repair the charger..

**THE GENSET DOES NOT STOP AT A STOP ORDER**

❑ Check if the genset has just released loads and is cooling.
❑ Check the electromagnet or solenoid fuel feed (or stop , or "stop " ) reacts when excited.
❑ If always remains open despite the change in state of tension action , we must
❑ dismantle and revise or replace.
❑ If the genset is to break contact and have a voltage value that does not stop solenoid or electromagnet fuel supply , check the appropriate circuit.
❑ Faulty controller card.
❑ Remember that we can stop the genset closing the stopcock overall fuel supply.
❑ Do not operate the fuel pump. Request the assistance of qualified personnel in diesel injection for it..

**ENGINE TURNS ERRATICALLY**

❑ Failure of the injection system.
❑ Irregular fuel supply. It may be low fuel.
❑ Air in the fuel system. Priming the circuit well. fuel filter clogging.
❑ excessive oil level. Check level. Speed governor rack is seized.

**ENGINE OVERHEATS**

❑ Check coolant level circuit (DANGER ). If it is hot , the fluid can skip to loosen the radiator cap causing burns. Observe correct potential losses and also correcting the level.
❑ Check radiator cleaning. Keep it clean.
❑ Ensure that the computer has sufficient cooling air flow ( see local cooling ) and hot air is not recirculated exhaust or radiator.
❑ Check condition of fan and belts (with engine stopped).
❑ Check that the air filter is not clogged. Change filter if it is suspected. Ensure that there are no obstructions in the circuit of the engine air intake.
❑ If all is well and the engine warms up , maybe the temperature controller is stiff.
❑ Replace regulator.
❑ According smoke escape, we may need to do an overhaul of the injection pump.

**ENGINE STOPS UNDESIRABLY**

❑ Check there is enough fuel level in the tank.
❑ Check wether there is a justified alarm stop.
❑ Clogged air filter.
❑ Check that the stop solenoid is not shutting undesirably.
❑ Check the fuel circuit gets no air.
❑ Ensure the fuel is not dirty.
❑ Ensure that the engine load is not excessive.
❑ Failure of the control board.
❑ Electronic malfunction (electronic governor engines).
❑ Fuel tank vent is clogged.
❑ If none of this works, you have to check the injection system (injection pump and injectors).


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**ENGINE TURNS SLOW AND DOESN'T ACCELERATE**

- ❑ Excessive load.
- ❑ The fuel filter is clogged
- ❑ Air in fuel circuit. Bleed air.
- ❑ Broken governor spring.
- ❑ Seized governor rack.
- ❑ Wrong injection timing.

**WHITE OR LIGHT GREY EXHAUST SMOKE**

- ❑ Very cold engine.
- ❑ The engine does not start often.
- ❑ Operation excessively prolonged with no load.
- ❑ The engine is very new.
- ❑ Worn rings or liners.
- ❑ Excessive oil level.
- ❑ Injection system faulty.
- ❑ Check timing, regulate or adjust injector pump. Remove and calibrate.
- ❑ Excessive oil consumption. Observe the condition of engine wear.
- ❑ Defective Turbo. Observe if accompanied by a loss of power and a change in sound. Repair or replace .

**BLUISH EXHAUST SMOKE**

- ❑ Excessive oil consumption. Check the wear condition of the engine and check the oil level.

**EXHAUST SMOKE BLACK OR DARK GREY**

- ❑ Clogged air filter. Replace or shake.
- ❑ Excessive load.
- ❑ Carbon deposits in engine and exhaust, due to work with low load.
- ❑ Seized injector. Pay attention to the r.p.m. stability and the engine sound.
- ❑ Incorrectly adjuste injector pump. Check and calibrate.
- ❑ Faulty compression in the engine. Check out for a possible excessive wear.
- ❑ Fuel in bad condition. Drain, clean and replace fuel.

**OIL GETS OUT OF EXHAUST MANIFOLD**

- ❑ Very long time working with no load or low load.
- ❑ Oil level very high. Check oil level.

**ENGINE POWER LOSS**

- ❑ Fuel fiters clogged with water.
- ❑ Very dirty air cleaner.
- ❑ Fuel transfer pump dirty of worn. Damaged pipe. Check out wether much white smoke can be seen around the exhaust pipe.
- ❑ Engine out of tune. Check and adjust valve clearance, injectors adjustment and fuel pump calibration.

**COMMUTATION BETWEEN MAINS/GENSET DOESN'T GET PERFORMED**

- ❑ Check out the condition of the genset contactor. DANGER: Don't try to force a commutation contactor to close. It could be mains grid and genset power sources get toguether.
- ❑ In the case of motorized commutation, check if this change its position when the bridge between the suitable terminals is made.
- ❑ In the case of commutation with motorized breakers, check out if they are in good condition.
- ❑ Failure of genset controller, or failure in voltage watchdog device (if installed).
- ❑ If mains doesn't supply power to load, check mains contactor of mains breaker in the same way.

**VERY HIGH VOLTAGE WITH NO LOAD**

- ❑ Too high engine speed.
- ❑ Voltage potentiometer in the alternator voltage regulator is not properly adjusted.
- ❑ Failure in the voltage regulator in the alternator.
- ❑ In single phase generators, too big capacitor size.

**LOW VOLTAGE WITH NO LOAD**

- ❑ Very low engine speed.
- ❑ Voltage potentiometer in the alternator voltage regulator is not properly adjusted.
- ❑ Failure in the voltage regulator in the alternator.
- ❑ Alternator winding has a leakage.
- ❑ Broken diode in the excitation rectifier.
- ❑ Faulty varistor.
- ❑ In single phase generators, too small capacitor size.


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**VOLTAGE IS OK WITH NO LOAD, BUT VERY LOW UNDER LOAD**

- ❑ Too high load. Reduce genset load if frequency is lower than 48Hz.
- ❑ Failure in the alternator AVR.
- ❑ Short circuited excitation rectifier diode.

**ALTERNATOR DOESN'T GENERATE**

- ❑ Check wether the main breaker switch lever is up.
- ❑ The alternator has lost the remnant magnetism. Follow the alternator instructions to magnetize the iron core again.
- ❑ Blown rectifier diode in the alternator.
- ❑ Destroyed rectifier varistor in the alternator.
- ❑ Voltage regulator failure in the alternator.
- ❑ Cut or leaking alternator winding.
- ❑ Very slow rotation speed in the engine.
- ❑ Destroyed capacitor (in single phase alternators).
- ❑ Worn brushes or broken brush holder (in brushed alternators).

**UNSTABLE VOLTAGE**

- ❑ Unstable engine speed. Speed governor failure in the engine.
- ❑ Voltage regulator with inproperly regulated stability potentiometer.
- ❑ Defective voltage regulator in the alternator.
- ❑ Improperly connected load. It could losing contact due to vibrations.

**LOW GENERATOR VOLTAGE WITH NO LOAD**

- ❑ Voltage with no load is 20% of nominal voltage. Regulating the potentiometer doesn't produce results.
- ❑ Blown fuse in the voltage regulator.
- ❑ Exciter winding is broken.
- ❑ Defective power supply to the voltage regulator.

**LOW ALTERNATOR VOLTAGE**

- ❑ Voltage value between 50% en 70% of the nominal value.
- ❑ Check alternator frequency. If it's found low, it indicates equipment overload or engine speed governor is defective. Try to remove some alternator loads.
- ❑ Voltage potentiometer in the AVR is not properly regulated.
- ❑ Blown fuse in the AVR.
- ❑ AVR malfunction.

**ABNORMAL NOISE IN ALTERNATOR**

- ❑ Worn bearing (or bearings).
- ❑ Loose coupling.
- ❑ High level of harmonic distortion in the load.

**ALTERNATOR OVERHEATS**

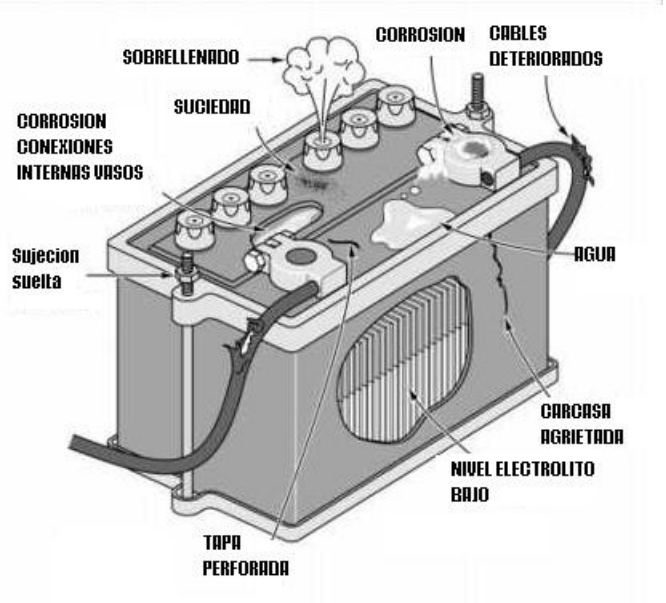
- ❑ Overheated alternator.
- ❑ Lack of ventilation in the room.
- ❑ Dirt is clogging the alternator air inlet.

**CONTROLLER DISPLAYS ALL THE LED INDICATORS LIT**

- ❑ Low battery voltage.
- ❑ Controller malfunction.

**TROUBLESHOOTING ON BATTERIES**

⚠ Danger. Batteries contain a sulfuric acid solution , highly corrosive . This fluid should not leak under any circumstances. It should be handled with special gloves or protective eyewear antacid and eye mask .




See the " Batteries " section for information on the risks.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This section applies to batteries that require maintenance.

**The acid exits the fill holes.**

❑ Battery too full of electrolyte.Remove and neutralize the excess.
❑ Bicarbonate electrolyte. Replace only distilled water to the indicated mark.

**The low level of electrolyte too quickly.**

❑ The charging voltage is very high. Set the battery charger or install power diodes in series with the circuit to reduce voltage.

**The battery has poor starting performance**

❑ Low battery.
❑ Check if the battery is more than 2 years.
❑ If the battery is new, check if you have the recommended services.
❑ Review the search for short circuit or shunt positive.
❑ Electrolyte level too low.
❑ Electrical connection in bad condition. Check out for loose connections in terminals.

**Terminal is found molten**

❑ Loose connection in terminals.
❑ Broken terminal ring.
❑ Excessive current.

**Batteries get discharged too fast**

❑ Old battery. Sulphatation.
❑ Too small battery for the application.
❑ Too many deep discharges. Every deep discharge, battery loses load capacity.
❑ Dirty electrolyte.


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# 14. WARRANTY TERMS

CAROD guarantees all new equipment manufacture either for a period of one year since its comissioning or 2000h, whatever comes earlier. Such commissioning shall be communicated in written notice within a period of 60 days from the invoice date. Without this communication, the effective start of the warranty period will be the date of the invoice.

The warranty covers the replacement or repair of defective parts for proven manufacturing defect or assembly. Not cover damage due to improper use or application, negligent use, wear, unauthorized design alterations, or causes beyond the normal operation.

Failure to comply or failure to follow instructions for installation, use and maintenance contained in the instruction manual will be sufficient for the loss of the security team cause.

Travel expenses, per diem and travel for personnel performing security services to be provided by the customer, including the cost of installation, removal, and accessibility to equipment.

CAROD reserves the right to require the recovery of damaged equipment or item under warranty, the cost of transport of both equipment and its defective parts will be replaced if by the customer.

The decision to grant or deny a security corresponds to CAROD. In the event of breakdowns, components not manufactured by CAROD are subject to the warranty of their manufacturer.

The repair or replacement of materials or equipment not renew prolong the duration of your warranty period.

If any provision of collateral described does not meet the established laws in a country from which you are importing the equipment, the importer is required to notify CAROD before making the purchase  sale.

Compliance with this manual is intended as a guide to aid and does not exempt compliance with current regulations. Carod not be liable for any dispute that may arise between what is written here and binding rules.

*This manual is intended to be a help guide and does not exempt from compliance with current regulations. CAROD is not responsible for any discrepancy that may arise between what is written here and the mandatory regulations.*

Revision n$^{er}$ AB – Dated June 2021

<u>OTHER DOCUMENTS AVAILABLE:</u>

- Declaration of conformity
- Electrical and interconnection diagrams with switchboard
- Technical sheet (capacities and benefits)
- Control card manual and specifications
- Specifications and engine operation and maintenance manual
- Specifications and operation and maintenance manual of the alternator


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# NOTES

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