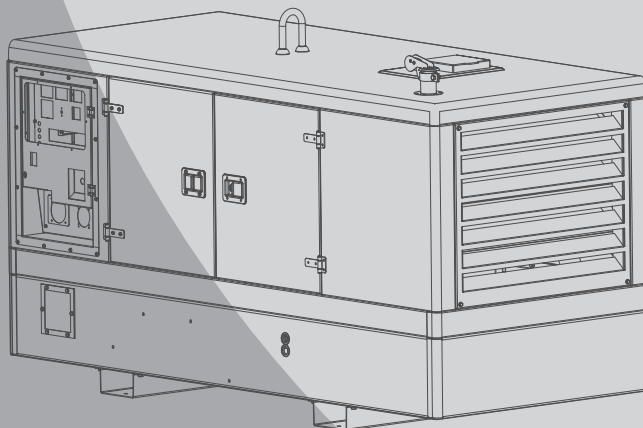
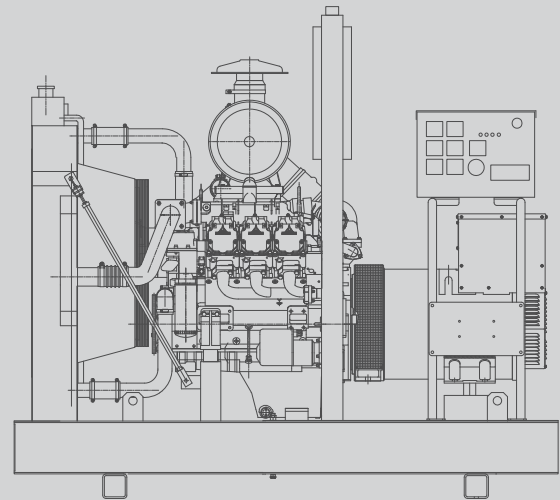


*GENERAL INSTALLATION
AND OPERATION MANUAL*



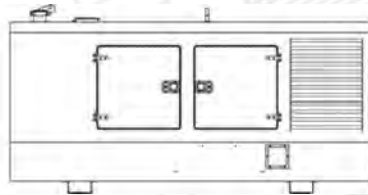
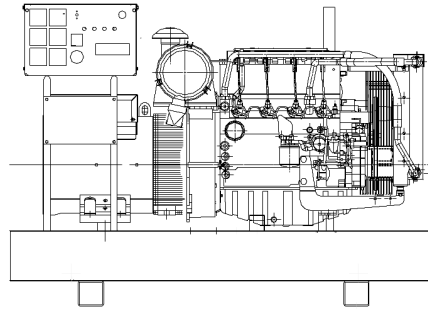
SOUND PROOF GEN SETS



OPEN GEN SETS



GENERAL INSTALLATION AND OPERATION MANUAL



**OPEN GEN SETS
SOUND PROOF GEN SETS**

!CAUTION!



THIS MANUAL IS AN INTEGRAL PART OF THE DELIVERED EQUIPMENT AND SHOULD BE KEPT CLOSE TO THE GENSET



DO NOT START TO ASSEMBLE, INSTALL, OPERATE OR PERFORM MAINTENANCE WORK ON THE GEN SET WITHOUT HAVING STUDIED THIS MANUAL.



THIS MANUAL SHOULD BE STUDIED BY ANY OPERATOR, USER, INSTALLER OR MAINTENANCE TECHNICIAN BEFORE DOING ANY OPERATIONS.

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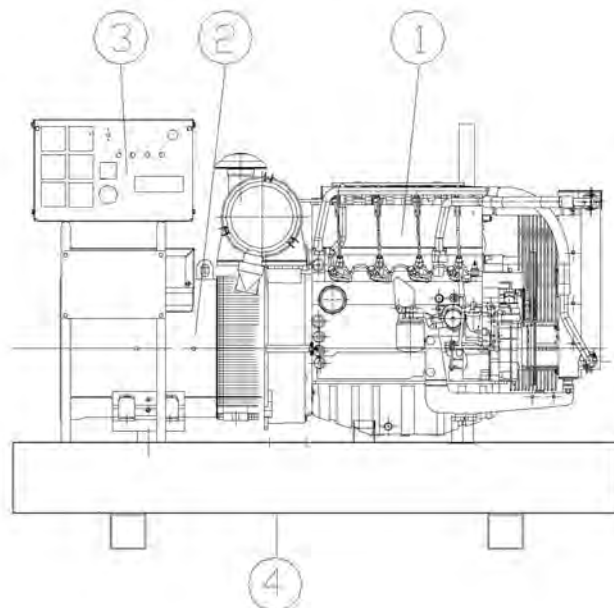
NOTE.- The manufacturer does not assume any responsibility if the user does not follow these instructions and if non original spare parts are used.

1. GEN SET DESCRIPTION/TECHNICAL SPECIFICATIONS

1.1 Open Standard gen sets.

The Gen set consists of an engine – alternator bolted together forming a mono-bloc that is mounted on an electro welded base-frame covered with polyester epoxy powder paint. The gen set is equipped with a control cubicle that is mounted above the alternator in a steel cabinet.

The monobloc and the control cubicle are mounted on the base-frame with rubber anti-vibration dampers.



The fuel system is integrated in the base frame.

1. Engine (for data please see the engine Manual)
2. Alternator, (for data please see the alternator manual)
3. Manual control cubicle(if the control is automatically the cubicle is meant for wall mounting)
4. Base-frame

1.2 Soundproofed gen sets.

The Gen set is assembled with a starting battery and together with the Gen set is delivered a kit for connection to Earth. It is very important and necessary for the proper functioning of the Gen set that it is connected to Earth in a proper way.

When installed in a machine room it is very important for the proper function of the Gen set that an adequate ventilation- and escape-system is installed.

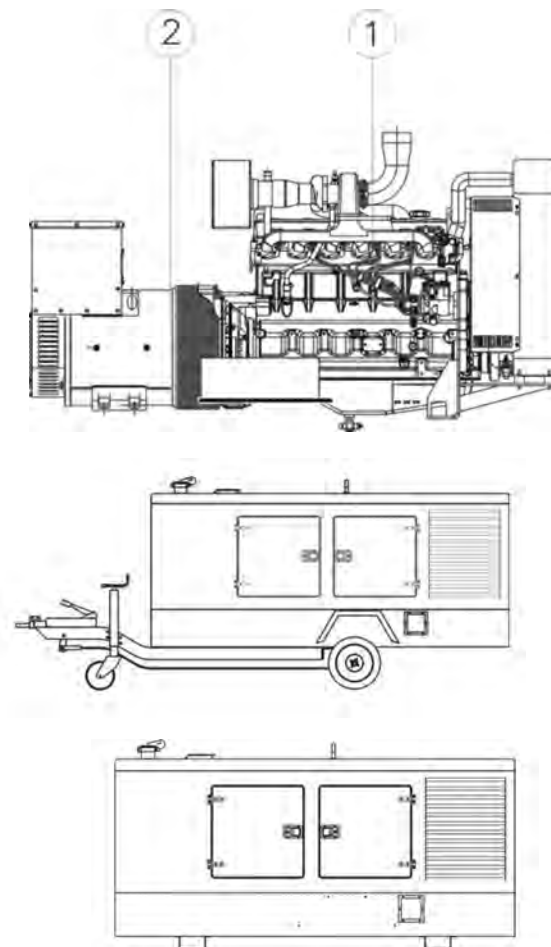
1.2 Soundproofed gen sets.

Denomination: Sound proof Gen sets. These gen sets are used as static as well as mobile units.

The Gen set consists of an engine – alternator bolted together forming a mono-bloc (fig.1), which is mounted inside a sound proofed canopy manufactured of steel sheet panels covered with polyester epoxy powder paint and with sound dampening material attached to the inside. The canopy may be stationary (fig. 2) or may be mounted on a trailer (fig. 3).

The Gen set is assembled with a starting battery and together with the Gen set is delivered a kit for connection to Earth. It is very important and necessary for the proper functioning of the Gen set that it is connected to Earth in a proper way.

When installed in a machine room it is very important for the proper function of the Gen set that an adequate ventilation- and escape-system is installed.

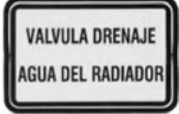
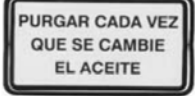


SYMBOL	PLACEMENT	MEANING
	At the circuit breakers and Earth fault relays.	Breaker open or closed
	At the rear of the cubicle	Earth wire connecting point
	Control cubicle	Danger of electrocution
	Gen set base frame	Indicates the common earthing point
	Control cubicle	230 V & 400 V voltage
	Close to the radiator cap	Indicates that care has to be taken while opening the radiator cap, the coolant is hot and may be under pressure with risks of scalding.

2.1.- Meaning and placement of the symbols

SYMBOL	PLACEMENT	MEANING
	At engine escape collector and other hot parts.	Indicates zones that should not be touched during operation and not before a cooling down period. Risk for burns.
	At the gen set manual holder	Indicates that the manuals should be read before installing and operating the gen set.
	Close to the fuel tank cap.	Indicates where to fill up fuel.
	Close to engine oil dip stick.	Indicates the engine oil dip stick position.
	At the base frame lifting points.	Indicate where to put the fork lift forks when lifting and transporting the gen set.
	At the radiator draining valve.	Indicates where to drain the coolant liquid.

SYMBOL	PLACEMENT	MEANING
	At the circuit breakers and Earth fault relays.	Breaker open or closed
	At the rear of the cubicle	Earth wire connecting point
	Control cubicle	Danger of electrocution
	Control cubicle	Indicate the power connection plinths for Phase 1,2,3 and Neutral.
	Control cubicle	230 V & 400 V voltage
	Close to the radiator cap	Indicates that care has to be taken while opening the radiator cap, the coolant is hot and may be under pressure with risks of scalding.
	At engine escape collector and other hot parts.	Indicates zones that should not be touched during operation and not before a cooling down period. Risk for burns.
	At the gen set manual holder	Indicates that the manuals should be read before installing and operating the gen set.

SYMBOL	PLACEMENT	MEANING
	Close to the fuel tank cap.	Indicates where to fill up fuel.
	Close to engine oil dip stick.	Indicates the engine oil dip stick position.
	At the base frame lifting points.	Indicate where to put the fork lift forks when lifting and transporting the gen set.
	At the radiator draining valve.	Indicates where to drain the coolant liquid.
	At the crankcase ventilation oil separator.	Indicating that the crankcase ventilation oil trap should be drained when changing the engine oil.
	At the top of the canopy close to the lifting hook.	Indicate where to lift the gen set.
	At the gen set canopy doors.	Indicates that the doors should always be closed during operation.

3. OPERATORS RESPONSIBILITIES.

The Gen set should be operated by one only operator, who should assure the proper commissioning and use of the Gen set.

The operator should be well aware of the function of the Gen set and pay maximum attention when operating it, as well as electrical hazards there are also the hazards of fuels, lubrication oils, escape gases, rotating machine parts and hot surfaces.

4. SECURITY CHAPTER

ATTENTION!!

**In this chapter you will find a number of advices and instructions
for the safe operation of this gen set.**

4.1 Transport of the Gen set:

- When transporting the Gen set use slings and other adequate lifting equipment, take **EXTREME** care, and **NEVER** place any part of your body under the Gen set during lifting or when suspended. Make sure that all loose parts are secured before lifting the Gen set.

Attach lifting equipment to the points indicated for this use.

4.2 Placement of the Gen set and installation:

- The installation of the Gen set should be made by specialised personnel well experienced in the procedures of emergency during the installation. If in doubt please contact the Technical Dept. of INMESOL.

- Exhaust gas system:
 - A proper system for evacuation of exhaust gases to the exterior have to be installed.

REMEMBER that the exhaust gases are poisonous.

 - The pre-assembled parts of the exhaust system are protected against accidental contacts. The installer should insulate and/or protect the completing parts, like the exhaust tubes to the exterior and extra silencers delivered loos, etc.
- In the case of Gen set with automatic control, it is necessary to:
 - Mount a red light, well visible, that lights up when the Gen set is automatically started.
 - Mount a WARNING sign which indicates that the Gen set may start automatically at any moment.
- The Gen set should have an ADEQUATE VENTILATION SYSTEM to prevent over heating, keep the distance between the walls of the machine room and other equipment at a minimum of 1 meter during its operation. The heat generated during operation may cause FIRE. Avoid keeping inflammable materials close to the Gen set.
- Make sure that there is sufficient illumination installed at the control cubicle, in case of operation at precarious conditions.

4.2 Placement of the Gen set and installation

- NEVER start the Gen set if it is humid (rain, snow, condense) and NEVER operate the Gen set with wet hands. THERE IS A HAZARD OF ELECTROCUTION.
- The Gen set and the Load should be connected to EARTH according to the existing norms. One of the protective devices that are included in the Gen sets is the Earth Fault Relay that secures the protection against accidental contact with live parts, automatically cutting the electric supply. This device needs a good connection to Earth for its proper function. For this purpose each Gen set is delivered with an Earthing rod.
- The connection of the gen set has to be made by authorised personnel (electrician) and in accordance with existing norms and regulations. It is necessary to control that all power connections as well as all auxiliary connections are made correctly and that the sense of rotation is the same for both the mains and the Gen set. A faulty connection may cause circulating currents and DANGER OF ELECTROCUTING for anyone working on the mains.
- Any disconnected wires should be insulated. The power plinths of the alternator should always be covered.

4.3 Operators protection.

- An open Gen set is noisy and should be installed in a machine room with acoustic insulation, and personnel that are working around it should wear ear protection against the noise.
- Don't use head phones to listen to music or radio when working with the Gen set. The secure operation of the Gen set requires MAXIMUM ATTENTION of the operator.
- The protective clothes of the operator should be close fitting and elastic. Avoid loose fitting clothes and use proper security gear for each type of work.
- Use protective gloves or hand protective cream when handling fuels and lubrication oils.
- Don't use wet or humid clothes and avoid materials that have been in contact with oils.

4.4 Before commissioning.

- Use the Gen set only for applications for which it is designed. Don't change the specifications of the Gen set.
- Don't permit anyone to use the Gen set that is not familiar with its function. The operator should be trained.

- Make sure that the engine is controlled only from the control cubicle.
- ALWAYS make the necessary controls of fuel, lubricating oil and coolant which are indicated in the manual before starting up the Gen set. Watch out for losses or leaks.
- Make sure that air inlet and outlets are free from any type of obstacles.
- Learn to know the placement and function of the control cubicle, circuit breakers, emergency stops and other systems of security present in the installation.
- Avoid unforeseen starts of the engine. Don't start the engine by jumper connection.
- Don't modify the original protection devices. Don't start the Gen set with any protection device disassembled.

4.5 During operation

- STOP the Gen set at any minor sign of malfunction. Make sure that the problem is solved before starting up again.
- Don't touch, lean or sit on the Gen set during operation.

- Don't touch the engine or the escape system during operation or until the Gen set is cooled down. It may cause severe burns.
- Don't touch cables or connections of the alternator during operation, they are now live.
- Keep away from any moving parts of the engine when it is running.

4.6 Maintenance

- Post a warning sign at the gen set with the text: All maintenance operations on the Gen set shall be made with the Gen set STOPPED and in Locked position.
- ALWAYS make sure that the Gen set is STOPPED and let the engine and escape system cool down before making any maintenance operations. and
- If the Gen set has an automatic control system, disconnect the negative battery pole before working on the engine to avoid that the engine starts automatically when working on it.
- Familiarise yourself with the maintenance procedures and don't make any adjustments unless you know how to make them.
- Protect the Gen set from humidity and dust, and if that is not possible dry and clean the Gen set regularly.

- All components should be in good repair and correctly installed. Any damage should be repaired immediately. Replace worn out or broken components with original spare parts.
- Regularly inspect all cables and electric components of the Gen set. If you find any damaged parts immediately stop the Gen set and change the damaged parts before you restart the Gen set.

To make any kind of work on any component of the electrical installation the authorized personnel should take the following precautions:

- Put the control cubicle in BLOCKED position..
 - Disconnect the battery terminals before making any kind of operations on the electrical system.
 - If present disconnect any connections to the MAINS.
-
- Chemical products like coolants, lubrication oils etc. should be handled with great care.
 - When changing the lubricating oil you should wash your hands afterwards, as used engine oil may cause cancer in the skin if in prolonged or very frequent contact.

- Transfer used engine oil and other residual liquids in hermetic enclosures. Don't use barrels or bottles used for food or beverages to avoid serious errors. Don't throw any residues in the drains, rivers, dams or lakes.
- Handle batteries with outmost care:
 - Keep batteries away from sparks open fire or cigarettes. The vapours emitted from the batteries are inflammable and there is a hazard of explosion.
 - Make sure there is good ventilation when charging or using batteries in closed areas. Skin or eye contact with sulphuric acid may cause serious burns. In case of accidental contact with the skin wash with water. In case of accidental contact with the eyes wash with water during 15 min and procure medical aid immediately.
 - The electrolyte is poisonous. If you accidentally drink it, drink great quantities of water or milk and follow up with vegetable oil and procure medical aid immediately.
 - Use only distilled water for the batteries, tap water is shortening the life time of the battery. Don't over fill the battery, electrolysis will overflow and cause corrosion on affected parts. Clean up immediately any leaking electrolysis.
 - Take great care not to connect the battery with inverted polarity, it will short circuit the battery charging system and the circuit breaker.
- Take outmost care when making emergency repairs in adverse conditions.

4.7 Fuel:

- Keep the Gen set in a stable and horizontal position, otherwise the fuel may spill over.
- Fill the fuel tank with the engine stopped and with good ventilation, diesel fuel is flammable.
- Don't over fill the fuel tank and make sure you replace the fuel cap in a proper and secure way. If fuel is spilling over dry it up and make sure all fuel is cleaned up and wait some time for any fuel vapours to ventilate before re-starting the Gen set.
- KEEP FUEL OUT OF THE REACH OF CHILDREN!
- Don't smoke and don't permit the presence of open fire or sparks close to the place where you refuel or store fuel.
- If you are hit by fuel jets under high pressure procure medical aid immediately.

4.8 Other security measures:

- Be prepared in case of fire. Keep a fire extinguisher and a first aid box close at hand. Take note of telephone numbers to medical aid, ambulance and fire brigade and post it close to the telephone.
- When the Gen set shall be decommissioned contact specialised personnel for the proper recycling of all material.

5. GEN SET WORKING CONDITIONS.

- • **Reference ambient conditions:**

Engines:

The power for static applications is referring to the following ambient conditions according to the ISO 3046/10 Norms:

- Air temperature: 25 ° C
- Air pressure: 100 kPa (750 mmHg)
- Relative humidity: 30%

Alternators:

The power for static applications is referring to the following ambient conditions according to the IEC 34-I, ISO 8528-3 y CEI 2-3 Norms:

- Air temperature: 40 ° C
- Altitude above sea level 1000m (674 mm/Hg)

For conditions different from the ones mentioned above a loss of power, de-rating should be applied both for the engine and the connected alternator and consequently for the electric power delivered by the Gen set.

Therefore it is very important to know the ambient conditions of the site where the Gen set will operate:

- a) Maximum and minimum air temperature.
- b) Altitude above sea level.
- c) Relative humidity at maximum air temperature.
- d) Other circumstances:
 - Dusty air
 - Excessive chemical pollution.
 - Vibrations not caused by the Gen set.
 - Etc.

The nominal gen set power is established according to the standard ambiental conditions.

6.1.- Gen set foundation.-

For the correct installation of the Gen set in the place where it will operate it is necessary to take into account that the type of foundation is sufficiently strong to be able to support the weight and forces of the Gen set.

6.1.1 Assembly and foundation.

The simplest way of installing the Gen set is to fix it rigidly to the foundation or support. It is very important to have a perfectly level surface on top of the platform or concrete foundation.. The rigid fixation should have adequate characteristics to assure a normal function of the gen set and to assure that the assembly of Gen set and concrete foundation will not enter into resonance.

The foundation on which the Gen set will be installed is very important because it should:

1. Support the static weight of the Gen set and resist any type of forces or vibrations.
2. Be sufficiently rigid to avoid any distortions that could affect the line up of the Gen set.
3. Absorb the vibrations caused by the rotating parts of the Gen set.

The soil on the place where the Gen set will be installed should support the weight of the Gen set plus the weight of the concrete foundation on which the Gen set is mounted. If in doubt of the characteristics of the site contact a civil engineer to elaborate the adequate design of the concrete foundation.

6.1.2 The concrete block

6.1.2 The concrete block.-

The fixed concrete block is a tested and preferred method in many circumstances. In this case the base frame of the Gen set is firmly fixed by the anchor bolts to the concrete block. Recommendable dimensions of the block are presented in Fig.1.

The upper level of the concrete block is normally raised above the earth level ($h=20-100\text{mm}/\text{Fig.1/}$). The height of the concrete block is calculated with the following formula:

$$D = \frac{W}{d \times B \times L}$$

Where D = Height of the concrete block (m)

W = Total weight of the Gen set (kg)

d = Density of the concrete (kg/m^3);

NOTE: Use $d = 2400 \text{ kg}/\text{m}^3$ for standard concrete

B = Width of the concrete block (m).

L = Length of the concrete block (m)

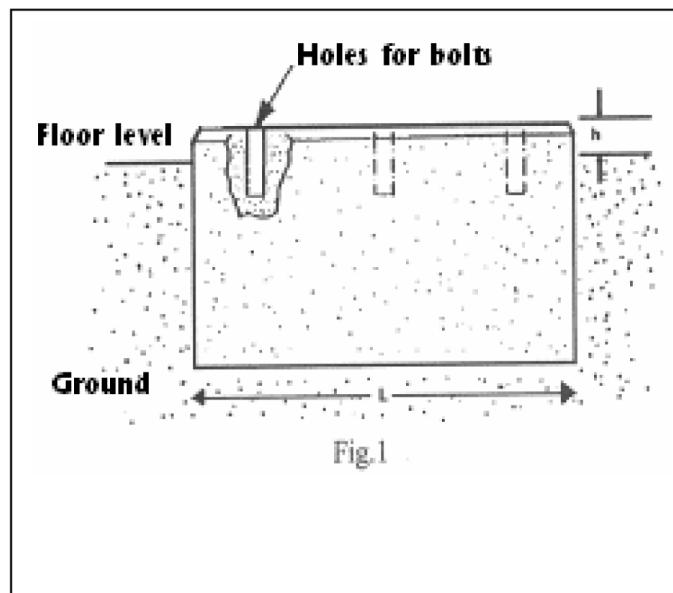


Fig.1

After calculating the height of the concrete block it is necessary to make sure that the soil of the site will support the total weight of the assembly concrete block – Gen set.

Sometimes it is not possible to reach firm soil, compact sand or rock without excavating to unreasonable depths. In these cases the weight of the Gen set assembly has to be distributed over a more complex construction designed by a qualified civil engineer.

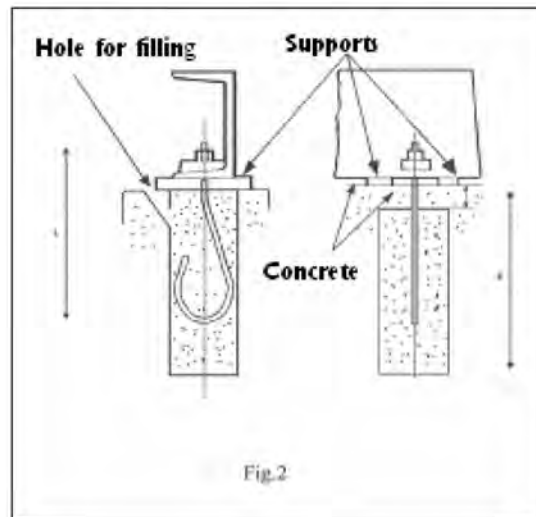
6.1.3 Procedure for the installation of a concrete block.

In a concrete block holes must be Made for the anchor bolts (for example the anchor bolts in Fig.2). To create such holes blocks of wood is placed in the wet concrete.

The dimensions of the blocks should correspond to the anchor bolts that shall be used. When the concrete is reasonably firm the blocks should be removed. The upper surface of the block should be level and smooth.

After the removal of the wooden blocks the concrete block should be left 5 – 7 days to cure before mounting the Gen set.

The design of the concrete block should take into consideration the cables to and from the Gen set: Power cables should be placed in cable ditches. For cables of great dimension with a great bending radius it might be necessary to cut out parts of the block to create an adequate cable way.



6.2.- Connection to earth

6.2.- Connection to earth.-

The installation of an earth connection system should be made by qualified personnel.

The Gen set should be provided with a system of earth connection that secures that, in case of insulation faults or other causes, no voltage is appearing in the metallic masses of the installation.

Both the gen set and the control cubicle are provided with Earth connecting plinths. A copper cable of adequate dimensions should be connected between these plinths and the earth rod or earth electrode. The value of the resistance in this connection should be low to allow that in case of a short circuit a sufficient current is flowing to blow fuses or trip other protection devices as circuit breakers.

In the place of the earth connection a sign should be posted reading:

ATTENTION!!!!: "EARTH CONNECTION - DO NOT DISCONNECT".

Gen sets with manual control:

The earth system of the gen set should be independent of any other earth system. it is considered that earth systems are independent when a maximum fault current in one of them is not causing more than 50 V of voltage raise compared to the reference earth in any other earth system.

In an installation of this type, connecting to Earth of the alternator neutral or the metallic bodies of the installation should be made according to one of the systems shown in ITC BT 08 the “Reglamento Electrotécnico de Baja Tensión (esquemas de distribución TT, TN ó IT)”.

In case that two or more gen sets are working in parallel, the neutrals of the alternators should be connected to the same point of Earth.

Gen sets with automatic control:

When the mains has its neutral connected to Earth it is considered a TT system and metallic masses and out let sockets in the system should be connected to an independent Earth from the one connected to the Mains neutral.

In case that it is technically impossible to create an independent Earth from the one connected to the mains neutral, the same earth may be used if previously agreed with the controlling authorities.

When supplying a load alternatively with the Mains and a local gen set the commutator between the sources should have a pole connecting the Neutral of the load to the Neutral of the source of supply and thereby changing the Earth connection.

6.3.- Lay out of the machine room ,Open Standard Gen Sets (basement, hut etc.):**6.3.1 General precautions****6.3.- Lay out of the machine room ,Open Standard Gen Sets (basement, hut etc.):**

Open standard gen sets are NOT suitable for operating outdoors, and should always be operated indoors or under cover.

When installing a gen set in a machine room, space must be reserved for maintenance, inspection and repair work on the following parts:

- Cylinder head
- Water pump
- alternator
- escape compensator
- air, oil and fuel filters
- engine oil dip stick
- radiator filling cap
- Crankcase ventilation.

6.3.1 General precautions

1. Avoid using plastic materials for the fuel lines.
2. Place the fuel lines away from the exhaust system
3. Insulate the exhaust tubes.
4. Place a fire extinguisher in the machine room close to the entrance door.
5. Install adequate illumination.
6. Install a system for the draining of the coolant.
7. Install all necessary protections.
8. Ensure adequate ventilation and cooling air.

6.3.2 Initial installation conditions

For the proper design of the gen set layout in the machine room you have to take the following aspects into consideration.

1. The machine room should have room enough for the gen set and its maintenance and operation, sufficient ventilation and a floor that can carry the weight of the equipment.
2. The air filters and escape silencers should be placed inside the machine room without causing overheating or diminish the performance of the gen set..
3. If the machine room does not have ventilation openings, such openings have to be constructed.
4. The mechanical noise may be attenuated by installing sound dampening material in the machine room.

6.3.3 Gen set lay out.

6.3.3 Gen set lay out.

Typical gen set lay out and equipment disposition for an open gen set in a machine room.

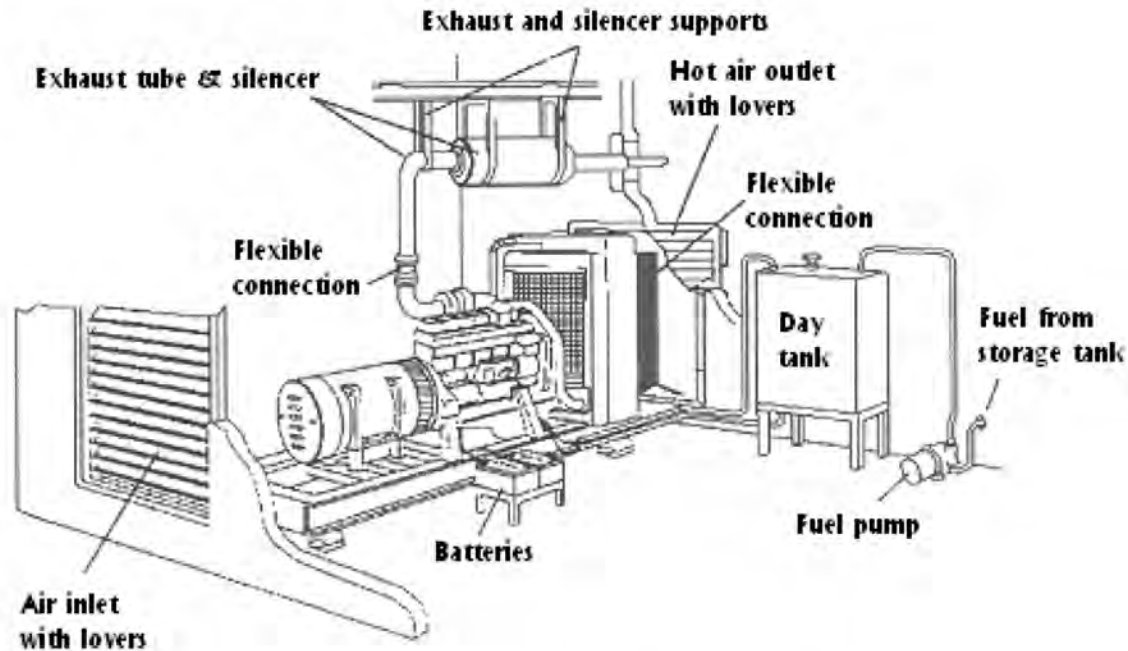


Fig.3

It is necessary to prevent air from the radiator out let from being sucked into the cooling and combustion air inlet, as this may cause engine over heating.

The silencer should be fixed to the sealing by supports that permit thermal movements. The exhaust tubing should be designed with a minimum of curves to avoid back pressure build up.(please see engine manual for permitted back pressure). If this is not possible increase the escape tube diameter.

For cooling and combustion air, use only fresh air. Never let escape gases or hot air from the radiator to be absorbed in the fresh air inlet. Avoid any restrictions for the free flow of cooling air.

The gen sets are provided with a fuel tank built into the base frame which permits an autonomy that varies between 8 and 12 hours depending on the power of the gen set. If the gen set operating time is planned to be of longer duration an auxiliary fuel tank may be installed as shown in the drawing above. (Please see fuel tank section of this manual.)

If the gen set is not to be used for a prolonged period, the gen set batteries should be charged, unless the gen set is provided with a built in battery charger.

6.4 Ventilation

6.4 Ventilation:

When a gen set is built into a machine room it's very important to extract all hot air from the machine room and let fresh air from the outside come in with a minimum of recirculation.

The following picture shows the best lay out of a gen set in the relation to the walls of the building. The free openings for the entrance and outlet of cooling air should be 25% larger than the radiator area and have the same rectangular form.

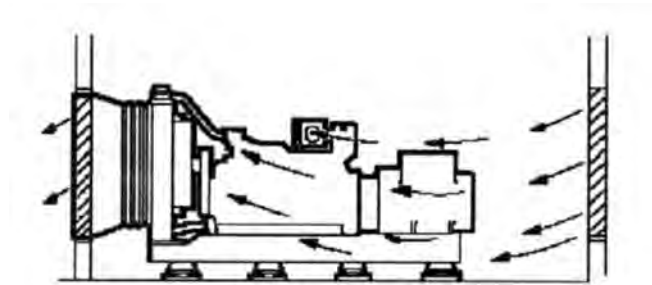
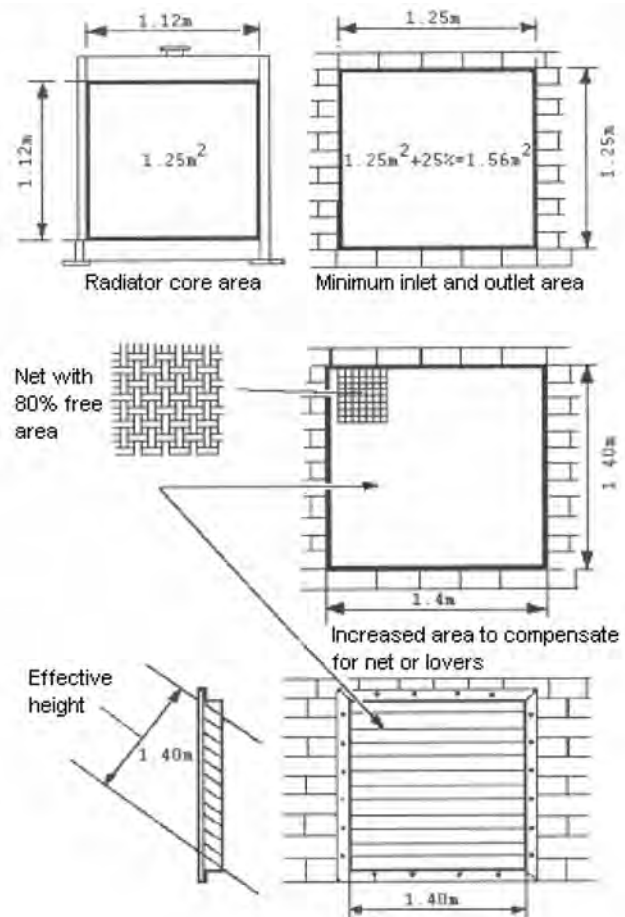


Fig.4

The outlet air channel made of metal sheet or plastic should be fixed at the wall outlet and connected to the radiator by a flexible section./Fig.4/ Lovers, grids, channels and sound dampening baffles are usually installed and are all adding to the air flow resistance and the area should be increased to compensate.

E AMPL.-

For a radiator area of $1,25 \text{ m}^2$ the section of the cooling air inlet/outlet openings in the wall should be $1,56 \text{ m}^2$. If a grid is installed the section should be increased to $1,95 \text{ m}^2$, as can be seen in the figure below.



.The large quantity of air that is moved by the radiator fan is usually sufficient for the machine room ventilation. There should be no restrictions for the free flow of hot air at the outlet of the radiator.

6.4 Ventilation

The fig. 6 shows an air inlet placed high up on the wall, this is ACCEPTABLE if the incoming air is directed at the alternator air intake and its advantage is that it prevents hot air build up under the roof.

The fig. 7 shows an air inlet placed high up on the wall and at the side of the gen set. This is NOT CORRECT as it will direct the air flow away from the alternator and the combustion air filter which may cause overheating of the gen set.

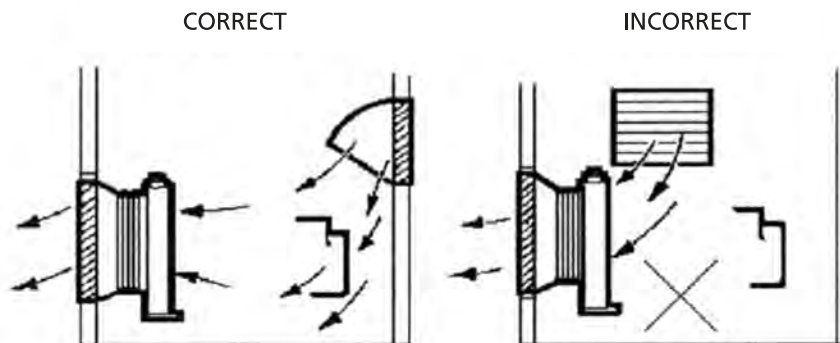


Fig.6

Fig.7

6.5 Air inlet:

The air inlet should be placed so that it obtains as clean air as possible and so that it prevents recirculation of hot air and exhausts from the gen set. The entrance of the air inlet should be designed so that it prevents water, snow and dust to enter. The channels should have curves with big radius and be smooth on the inside.

The maximum temperature in the machine room should not be higher than 60° C. If the temperature is becoming higher it will disturb the normal function of the gen set and a forced ventilation system has to be installed. Ventilation for other machines and equipment installed in the same machine room as the gen set has to be included in the dimensioning of the ventilation system.

6.6 Installation of protection for prevailing winds:

When installing the air outlet, it is necessary to take into account the direction of the prevailing winds. If the prevailing wind is blowing against the direction of the air flow from the radiator it will add to the air flow resistance and the air flow from the radiator fan will decrease. Therefore it will be necessary to direct the air outlet in another direction.

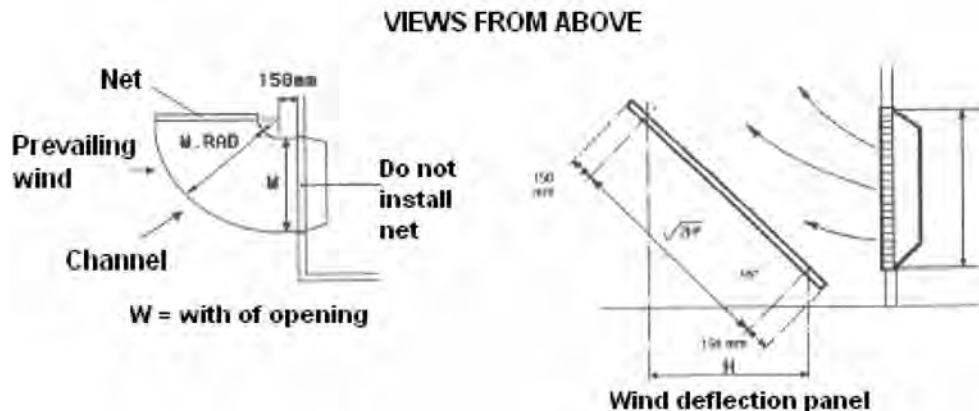
If it is not possible to change the position of the air outlet the below methods could be used.

1. The air outlet could be formed as a curve directing the air flow away from the prevailing wind. (see Fig.8)
2. Install a deflector panel (The panel should be 30-40% larger than the section of the air outlet.) (See Fig. 9).

6.6 Installation of protection for prevailing winds

6.7 Escape system

6.7.1 Considerations to take into account when designing the escape system.



6.7 Escape system:

6.7.1 Considerations to take into account when designing the escape system.

The exhaust system should be planned at the beginning of the installation. The principle objectives are:

- To make sure that the resistance (back pressure) of the system is not bigger than what the engine manufacturer permits.
- Properly designed supports.
- To take into account thermal expansion.
- To reduce the noise level.

The figures are showing typical installations:



Fig. 11

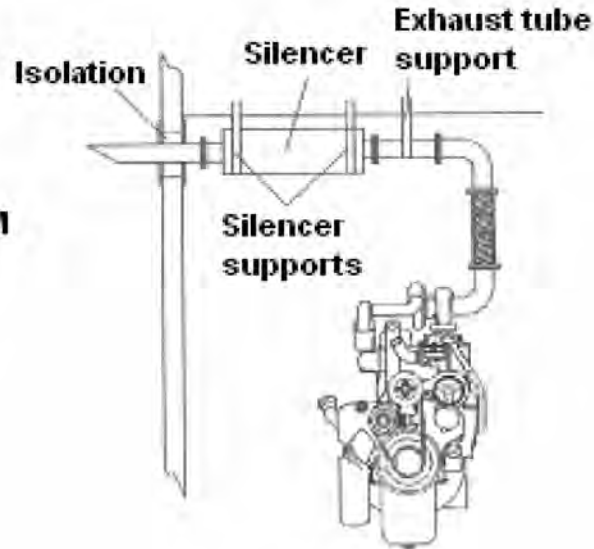


Fig.12

6.7.2 Exhaust system back pressure.

The escape gases are passing the tubes and through the silencer to reduce the noise level. These elements are causing a resistance to the gas flow in the system that should not be higher than allowed. The total resistance is composed by the resistance in the tubes the curves and the silencers.

Excessive back pressure may cause:

- Loss of power.
- High exhaust temperature.
- High fuel consumption.

These conditions are causing over heating and smoke in the installation and reduce the life time of the engine valves and the turbo charger. Please consult the engine manual for the allowed back pressure.

6.7.3 Installation

• Flexible connections

The exhaust tubes should be separated from the engine by a flexible connection that should be mounted close to the engine escape collector and have the following functions:

- a) Isolate the engine vibrations and take away the weight of the tubes from the engine.
- b) Compensate for thermal movements.
- c) Take up the lateral movements of the engine when starting and stopping.

The flexible tube can absorb small radial vibrations but not axial vibrations and it should not be bent. The flexible tube may be installed in several positions but it is preferable to mount it vertically.

The supports should be made as close as possible to the tubes to avoid excessive vibrations.

The thermal expansion should be planned so that it is not causing excessive loads on the supports. The expansion of 1 m of tube for 100°C temperature raise is approximately 1.2 mm: Long tubing should be separated by flexible sections.

- **Position of the escape tube outlet**

The exhaust tube outlet should be placed so that rain is not coming into the tube and so that the escape gases are not returning back into the machine room.

6.8.- Fuel system

If the gen set needs an auxiliary fuel tank you should take the following into consideration: The delicate nature of the fuel injection system of Diesel engines requires that the supplied fuel is clean without air or water and with the correct pressure. There should always be sufficient fuel available at the fuel injection pump to guarantee perfect starts and delivery of nominal power from the engine. Air and fuel vapour in the fuel system difficult the start, disturbs the running and causes miss-firing.

Therefore the tank and fuel lines should be well designed and of sufficient dimensions..

6.8.1 Fuel tank.

Install a fuel tank with sufficient capacity for the normal operation of the gen set. The tank should be manufactured of SAE1010 steel and it should not be painted or galvanized on the inside, this may disturb the injection system.

6.8.1 Fuel tank

The tank should have sufficient ventilation and be equipped with:

- breather
- fuel filling neck with cap
- fuel level indicator
- draining
- fuel suction tube (the tube should end 50 mm above the bottom of the tank to avoid suction of water or debris into the system)
- fuel return tube
- Earthing connection.

When the fuel tank is installed precaution should be taken so that the level of the entrance in the suction tube in the tank is not lower than 2 m. below the fuel injection pump.

If the fuel tank has to be situated so that the suction height is more than 2 m or the distance from the gen set is very long it is recommended to install a day tank in the machine room close to the gen set. Usually the day tank is filled up from the storage tank by an electric fuel transfer pump as can be seen in the below figure.

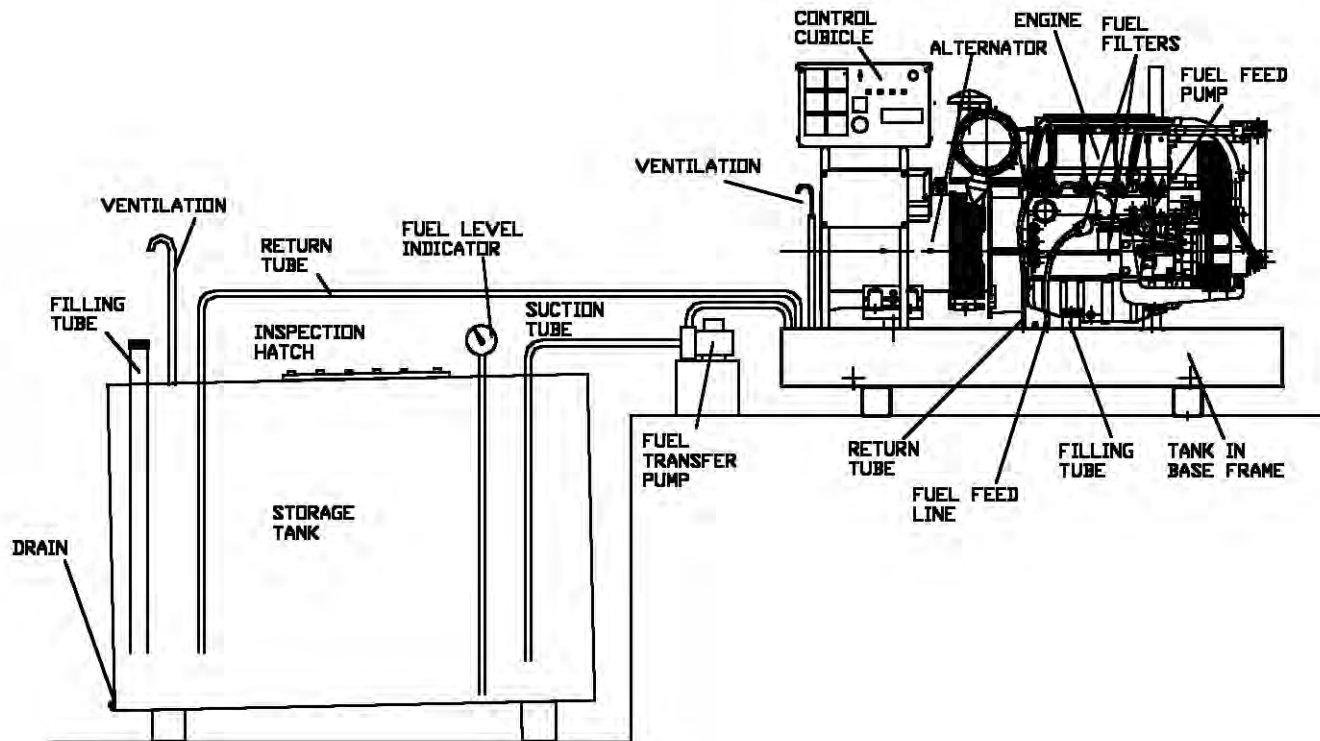


Fig. 15

6.8.1 Fuel tank**6.8.2 Fuel lines**

If the fuel tank has to be installed so that the level of the fuel is more than 3,5 m above the fuel injection pump, a pressure reduction valve should be installed in the fuel line between the tank and the fuel injection pump, to avoid damage on the injection pump. The valve should be closed when the engine is not running.

The tank should be inclined 3 to 5 ° away from where the suction is placed and with a draining valve in the lowest point so that condensed water can be removed. (See the below fig.)

6.8.2 Fuel lines.

Fuel lines should be installed so that excessive heating of the fuel by the engine is avoided.

ATTENTION!!!
MAXIMUM ALLOWED FUEL TEMPERATURE IS 60°C at the fuel injection pump inlet.

Above this temperature it is not possible to guarantee a good function of the engine as it is formed bubbles of fuel fumes in the fuel that is causing engine miss-fire.

It is important that radiated heat from the engine or the escape system is not causing a warming up of the fuel tank and the fuel. The fuel suction and return tubes should not have any leaks.

Fuel line with a length of up to 6 m should have an internal diameter of 8 mm minimum, for longer tubes the internal diameter should be 10 mm minimum. The tube diameter should be calculated so that fuel flow is lower than 0,8 m/sec calculating with a maximum flow of 3 times the fuel consumption at full load.

ATTENTION!!
THE FUEL RETURN LINE SHOULD NEVER BE CONNECTED TO THE
SUCTION TUBE.

If the fuel tank is placed above the level of the fuel injection pump the return fuel line should be placed above maximum fuel level. If the fuel tank is deeper than 1,5 m or the tank is placed below the level of the fuel injection pump the return fuel line should be placed at the lowest level of the tank.

6.8.3 Fuel filters**6.8.4 Fuel storage**

ATTENTION!!
MAKE ALWAYS SURE THAT THE FUEL IN THE TANK IS FREE FROM
WATER.

6.8.3 Fuel filters

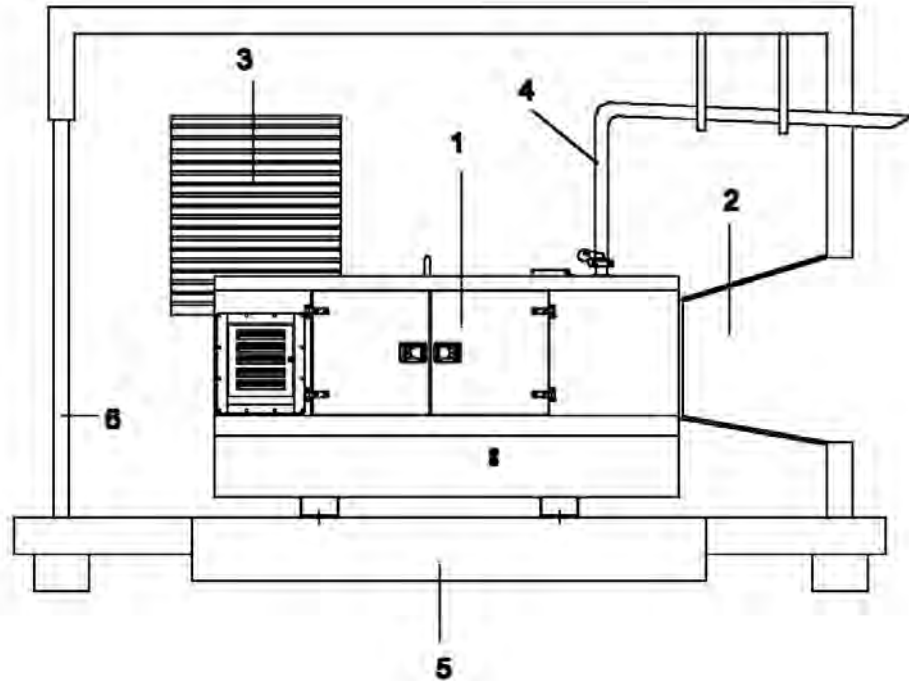
Fuel filtering is made by the engine fuel filters. It is advisable to install a pre-filter to protect the fuel feed pump and to prolong the life time of the engine fuel filters.

6.8.4 Fuel storage.

Correct storing of the fuel is of vital importance. Use clean vessels for the storing and transfer of fuel. Drain water and sediments from the bottom of the fuel tank regularly. Store fuel on a suitable place far away from buildings. Avoid storing of fuel for long periods.

6.9.- Lay out of the machine room Sound Proof Gen Sets:

- 1. Gen set
- 2. Hot air outlet
- 3. Fresh air inlet
- 4. Exhaust tube
- 5. Concrete block
- 6. Entrance door



6.9.- Lay out of the machine room Sound Proof Gen Sets:

It is VERY IMPORTANT to take into account that:

- The Machine room should have space enough for the gen set and allow easy access to its components for maintenance and eventual repair work and to have suitable floor and illumination.
- The placement of the gen set should be made so that the escape system will have a minimum of elbows.
- The channelling of the out going air should be adequate. It is very important to avoid recycling of hot air as it could cause over heating of the engine.
- Only fresh air should be used as cooling or combustion air. Hot air or exhaust gases should never be allowed to be absorbed. Avoid all kinds of obstacles in the in and outgoing cooling air channels.
- The exhaust tube should be suspended so that thermal movements are allowed.

7. BEFORE STARTING UP PLEASE CONSIDER THE FOLLOWING:**7.1 General considerations.-**

- DO NOT MODIFY the gen set specification: Engine speed, gen set cabling, etc. this will immediately invalid the gen set Warranty..
- Do not charge the batteries via the DC sockets.

ATENCIÓN!!!

Learn to know the characteristics of the loads that will be supplied by the gen set and consider the following:

- Make sure that the installation that shall be connected to the gen set is CONNECTED TO EARTH.
- Do not connect any equipment that does not correspond to the voltage and frequency of the gen set.

7.1 General considerations

- Avoid over loads. The gen set has a circuit breaker for its protection. If the circuit breaker is tripping, reduce the load before connecting the gen set again. For the correct function of the gen set take into account that:
 - The sum of the rated power of all equipment connected to the gen set at the same time may not be greater than the rated power of the gen set.
 - Some equipment (electric motors, compressors etc.) are absorbing a much higher power when starting up than the rated power.
 - The rated current of each outlet socket should not be exceeded. If a welding transformer is connected to the gen set, the peak currents caused by the welding may OVER LOAD THE ALTERNATOR. (Please consult the manufacturer.)
- This gen set is not recommended for connection of television sets, Hi Fi sound equipment, computers etc..
- All liquid levels like FUEL, LUBRICATION OIL and COOLANTS, should be correct. Fill up if necessary.
- Never top up coolant on a hot engine, let it cool down before filling up coolant.
- Lubrication oil level should be checked on a cool engine.

IMPORTANT!!!

An engine operations and maintenance manual, where all specifications related to the actual engine are listed, is delivered with the gen set, together with this and other manuals.. That manual as well as this manual should be followed when operating or maintaining the gen set.

7.2.- Fuel, lubrication oil and coolant specifications.-**FUEL**

Diesel fuels conforming to EN 590 or ASTM D975 are recommended. In any case the Diesel fuel should comply with the following specifications:

- Minimum Cetane number 40.
- A Cold Filter Plugging Point (CFPP) lower than the lowest anticipated ambient air temperature or a Cloud point at least 5°C (9°F) lower than the lowest anticipated ambient air temperature when operating.
- The Lubricity of the fuel should be at least 3100 grams of load according to the BOCLE scuffing test.
- Sulphur content.
 - Should not exceed 0,5% Sulphur content lower than 0,05% is recommended.
 - In case that fuel with sulphur content higher than 0,5% is used, the service periods should be reduced to 50%.
 - DO NOT use Diesel fuel with more than 1,0% sulphur content.

Bio Diesel fuels may be used but ONLY if they comply with the DIN 51606 specification or equivalent.

DO NOT mix diesel fuel with engine oil or any other lubricant.

7.2.- Fuel, lubrication oil and coolant specifications

LUBRICATION OIL

Running in engine oil: The following engine oils are recommended:

Diesel engine lubrication oil according to the following specifications:

- Service class API CE.
- Specification ACEA E1.

IMPORTANT!!

Do Not use engine oil according to Service Class API CG4, API CF4 and ACEA E3 or ACEA E2 specifications during the first 100 hours of operation of new or repaired engines.

Suchs engine oils are not suitable for running in of engines.

Once the running in period is finished , use engine oils recommended below.

Diesel engine oil.

Engine oil with the correct viscosity for the temperature should be selected.

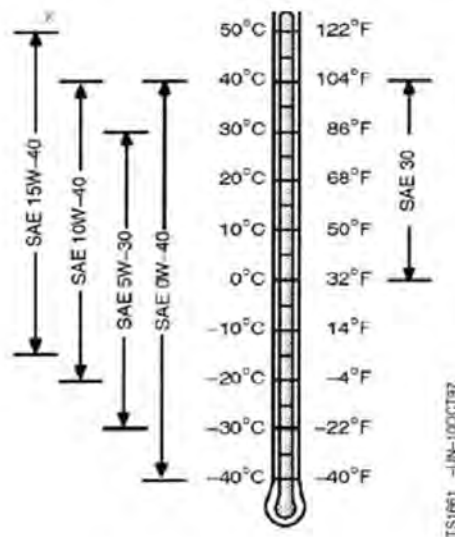
See the engine manual for engine oils recommended by the engine manufacturer:

Other types of engine oils may also be used as long as they comply with the below specifications:

- Service Class API CG-4.
- Service Class API CF-4.
- Specification ACEA E3
- Specification ACEA E2

It is recommended to use multi grade engine oil.

Avoid mixing engine oils of different brands and types as it may reduce the efficiency of the additives and the quality of lubrication.



COOLANT.

It is recommended to use an antifreeze/anticorrosion additive to obtain protection against corrosion and wear of the cylinder sleeves during the whole year and protection against freezing down to -37°C (-34°F).

For maintenance original coolant from the engine manufacturer is recommended.

If this coolant is not available it is recommended to use a solution of 50% low silicate ethylene glycol and 50% pure water of high quality, (to protect the gen set against freezing down to -37°C). For the efficiency of the cooling system it's recommended to use de-ionized and de-mineralized water to mix with the concentrated coolant/antifreeze.

IMPORTANT!!

Do not add any radiator sealing additive to the coolant and do not use any antifreeze additive containing radiator sealing additives.

7.3.- Battery connections.

First connect the positive (+) pole cable of the battery to the starter motor solenoid terminal. Then connect the negative (-) pole cable to a suitable bolt on the engine block as close to the starter motor as possible.

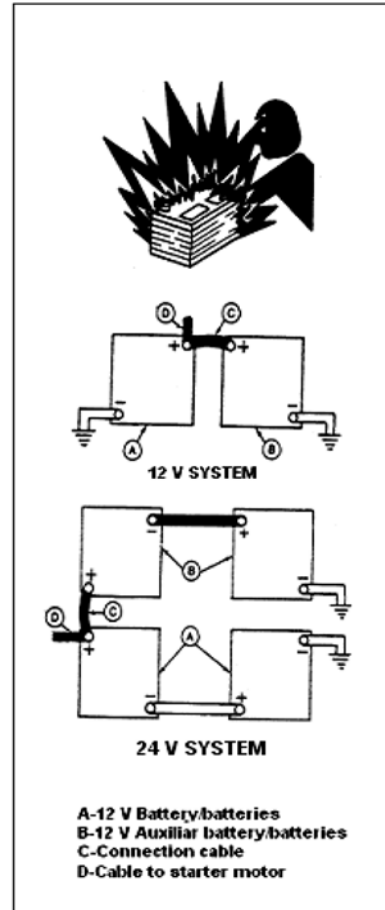
The cable connections should be well tightened and free from corrosion. Eliminate any sign of corrosion from terminals or cables and cover the terminal and cable end with grease.

How to use an auxiliary battery.

In cold weather it is possible to connect an extra 12V battery in parallel with the gen set battery to aid the starting of the engine.

Always use connection cables of adequate section. This is the procedure:

1. Connect the auxiliary battery so that it produces the necessary voltage for the electrical system.



7.3.- Battery connections

NOTE: To avoid sparks, do not let the cable terminals touch the engine or any metal parts.

2. Connect a cable to positive (+) pole of the auxiliary battery.
3. Connect the other extreme of the cable to the positive (+) pole of the battery connected to the starter motor.
4. Connect another cable to the negative (-) pole of the auxiliary battery.
5. ALWAYS complete the circuit by connecting the other extreme of the negative (-) pole to the engine block well away from the battery.

8. START.

For starting procedure and other operations please see the Condensed Manual and the Manufacturers Controller Manual for the Controller actually mounted in the gen set.

9. Function and stopping of the engine

9 FUNCTION AND STOPPING OF THE ENGINE.

For function description, programming etc. please see the Condensed Manual and the Manufacturers Controller Manual for the Controller actually mounted in the gen set.

10.- MAINTENANCE**ATTENTION!!!**

Stop the engine and let it cool down 15 minutes before doing any maintenance work.

To follow a good maintenance program is essential to be able to obtain a good efficiency and a long service life of the gen set. Follow the program in this manual and consult as well the instruction manuals for the engine and the alternator.

10.1.- Daily controls:

- 1.- Check any parts that has caused problems during previous operation.
- 2.- Gen set checks:
 - Leaks of water or engine oil.
 - Check engine oil level¹⁾.
 - Check and clean the radiator externally.
 - Check the air filter. 1,2,3).
 - Check the fuel level.
 - Check the coolant level.
 - Watch out for broken parts or missing bolts or nuts.
 - Check the engine for leaks.

10.- Maintenance

- 1) In continuous duty, the engine oil level should be checked every 8 hours.
- 2) The air filter should be substituted when the indicator is showing a red field once the engine is stopped.
- 3) When operating in extremely dusty environment special air filters should be used.

3.- Controls before starting:

- Check the correct functioning and cleanliness of all instruments displays and indicator LED's.
- Check that all indicator lamps are functioning..

4.- Controls during operation:

- Watch the colour of the engine smoke during start up.
- Watch out for any strange noise from the engine.

ATTENTION!!!

Drain the engine oil trap in the crankcase ventilation system every time the engine oil is changed.

Even if a table for a maintenance program is presented below it is necessary to follow as well the instructions presented in the engine manual as it contains more information and instructions on how to do the different operations.

10.2.- Maintenance program:

Operation	10 H / daily	500 H	1000 H/ 1 year	2000 H/ 2 years	2500 H/ 3 years	when necessary
Check engine oil and coolant level.	X					
Check the air filter indicator ¹	X					
Change engine oil and filter ²		X				
Change fuel filter.		X				
Check the fan belt tension or automatic tensioner ³		X	X			
Control valve rocker play ⁴			X	X		
Clean the crankcase ventilation tube.			X			
Clean all hoses and connections and the air inlet system.			X			
Check the engine vibration damper (6 cylinders.) ⁵				X		
Check the engine running and the speed governor stability.				X		
Drain and clean the cooling system ⁶				X	X	
Clean the fuel filter for any sediments and water						X
Clean the air filter ¹						X
Check the thermostat and the injectors (contact your service workshop) ⁷						X

10.2.- Maintenance program

- 1 Clean the air filter when the indicator is showing red. Change the filter after to have cleaned it 6 times or annually.
- 2 Change the engine oil and filter after the first 100 hours of operation, then every 500 hours. Change the engine oil and filter at least once a year.
- 3 Check the fan belt tension every 500 hours on engines with manual belt tensioner. Check the automatic tensioner every 1000 hours engines with this device.
- 4 Let your Service work shop adjust the valve rocker play
- 5 Drain and clean the cooling system every 2500 hours/3 years if original engine coolant is used, if else every 2000 hours/ 2 years.
- 6 If you suspect that the injectors or the thermostat are faulty, let your Service Workshop replace them. Change injectors every 5000 hours and the thermostat every 10000 hours.

11.- TRANSPORT / STORAGE

Transport.-

Before transporting the gen set make sure that the battery is disconnected. The gen set should not contain any fuel when transported.

To lift the gen set use certified textile lifting slings marked with an adequate lifting capacity. When transporting the gen set put the fuel valve in the closed position and keep the gen set in a level position.

Prolonged storage.-

If the gen set shall be out of service for a longer time take the following precautions:

- Store the gen set in a dry and clean place.
- If the gen set shall be stored more than 6 months drain the engine oil and dismantle the filter. When the gen set shall be commissioned again fill oil and assemble a new filter.
- Pull out the injectors and put a small quantity of oil in each cylinder via the injector holes.
- Turn the engine crank shaft manually if possible to distribute the oil evenly.
- Disconnect the batteries.

In this way the gen set will be ready to use again when needed.

12.1.- Diagnosis chart for engine faults.

12.- TROUBLESHOOTING

12.1.- Diagnosis chart for engine faults.

Fault	Cause	Remedy
The engine turns around by the starter motor but does not start	Wrong starting procedure	Check the starting procedure
	Lack of fuel	Check fuel level and fuel valve
	The exhaust is blocked	Check the exhaust system for obstructions
	The fuel filter is blocked or full of water	Change fuel filter or drain the water
	Fuel is not reaching the fuel pump or the system is full of air	Check that fuel is running freely and purge the system from air.
	Fuel pump or injectors are faulty	Contact an authorised service workshop

Fault	Cause	Remedy
The engine starts badly or does not start	The engine is starting loaded	Disconnect the load
	Wrong starting procedure	Check the starting procedure
	Lack of fuel	Check fuel level and fuel valve
	The fuel system is full of air	Purge the system from air
	Cold weather	Start the engine by using the cold start aid system
	Low starter motor speed	See the engine manual
	The engine oil is too dense	Drain and refill the engine with appropriate engine oil

12.1.- Diagnosis chart for engine faults.

TROUBLESHOOTING

Fault	Cause	Remedy
The engine starts badly or does not start	Wrong type of fuel	Check with the fuel supplier and use the adequate fuel for the working conditions
	Water, dirt or air in the fuel lines	Clean and refill the fuel system with fuel.
	The fuel filter is blocked	Change fuel filter
	The fuel injectors are dirty or faulty	Let your authorized service workshop overhaul the injectors
	The fuel pump is deactivated	Turn the starting key to OFF and back to ON
The engine is knocking	Low engine oil level	Fill engine oil to correct level
	The fuel pump is out of adjustment	Contact your authorized service workshop

Fault	Cause	Remedy
The engine is knocking	Low engine temperature	Check the engine thermostat
	Engine overheating	See the engine manual
The engine is running irregularly or is frequently stopping	Low engine temperature	Check the engine thermostat
	The fuel filter is blocked	Change fuel filter
	Water, dirt or air in the fuel lines	Clean and refill the fuel system with fuel.
	The fuel injectors are dirty or faulty	Let your authorized service workshop overhaul the injectors
Low engine temperature	The engine thermostat is faulty	Check the engine thermostat

12.1.- Diagnosis chart for engine faults.

TROUBLESHOOTING

Fault	Cause	Remedy
Low engine temperature	The engine temperature gauge or sensor is faulty	Check the engine temperature gauge or sensor
Lack of engine power	Overload	Reduce the load
	Combustion air inlet is obstructed	Clean air filter
	Fuel filter is obstructed	Clean fuel filter
	Wrong type of fuel	Check with the fuel supplier and use the adequate fuel for the working conditions
	Engine overheating	See the engine manual
	Too low engine temperature	Check the engine thermostat

Fault	Cause	Remedy
Lack of engine power	The engine valve clearance is wrong	Let your authorized service workshop adjust the valve clearance
	The fuel injectors are dirty or faulty	Let your authorized service workshop overhaul the injectors
	The fuel pump is out of adjustment	Contact your authorized service workshop
	The turbo compressor does not work	Let your authorized service workshop overhaul the turbo compressor
	The exhaust collector is leaking	Contact your authorized service workshop
	The aneroid control tubing is faulty	Contact your authorized service workshop
	Fuel lines are obstructed	Clean or change fuel lines

12.1.- Diagnosis chart for engine faults.

Fault	Cause	Remedy
Lack of engine power	Maximum speed limit is faulty	Contact your authorized service workshop
Low oil pressure	Check the engine oil level	Add engine oil
	Wrong type of engine oil	Drain and refill the engine with appropriate engine oil
Too high consumption of engine oil	The engine oil has too low density	Drain and refill the engine with appropriate engine oil
	Engine oil leaks	Check the engine for oil leaks
	The crankcase ventilation tube is blocked	Clean the crankcase ventilation system
	Faulty turbo compressor	Contact your authorized service workshop

Fault	Cause	Remedy
The engine is emitting white smoke	Wrong type of fuel	Check with the fuel supplier and use the adequate fuel for the working conditions
	Too low engine temperature	Warm up the engine to correct temp. Check the engine thermostat
	The engine thermostat is faulty	Check the engine thermostat
	The fuel injectors are dirty or faulty	Let your authorized service workshop overhaul the injectors
	The engine valve clearance or the fuel pump setting is wrong	Let your authorized service workshop adjust the valve clearance
The engine is emitting grey or black smoke	Wrong type of fuel	Check with the fuel supplier and use the adequate fuel for the working conditions
	Fuel filter is obstructed	Clean fuel filter

12.1.- Diagnosis chart for engine faults.

Fault	Cause	Remedy
The engine is emitting grey or black smoke	Overload	Reduce the load
	The fuel injectors are dirty or faulty	Let your authorized service workshop overhaul the injectors
	The engine valve clearance or the fuel pump setting is wrong	Let your authorized service workshop adjust the valve clearance
	Faulty turbo compressor	Contact your authorized service workshop
Engine overheating	Overload	Reduce the load
	Low coolant level	Fill the radiator and check for coolant leaks
	Faulty radiator cap	Lat a mechanic check the radiator cap

Fault	Cause	Remedy
Engine overheating	Fan belts stretched or broken	Check the automatic belt tensioner and the belts Change belts if necessary
	Low engine oil level	Check the engine oil level and add oil if necessary.
	Dirty cooling system	Clean the cooling system
	The engine thermostat is faulty	Check the engine thermostat
	The engine temperature gauge or sensor is faulty	Check the engine temperature gauge or sensor
	Wrong type of fuel	Check with the fuel supplier and use the adequate fuel for the working conditions
Too high fuel consumption	Wrong type of fuel	Check with the fuel supplier and use the adequate fuel for the working conditions

12.1.- Diagnosis chart for engine faults.

TROUBLESHOOTING

Fault	Cause	Remedy
Too high fuel consumption	Combustion air inlet is obstructed	Clean air filter
	Overload	Reduce the load
	The engine valve clearance is wrong	Let your authorized service workshop adjust the valve clearance
	The fuel injectors are dirty or faulty	Let your authorized service workshop overhaul the injectors
	The engine valve clearance or the fuel pump setting is wrong	Let your authorized service workshop adjust the valve clearance
	Faulty turbo compressor	Contact your authorized service workshop
	Too low engine temperature	Warm up the engine to correct temp. Check the engine thermostat

12.2.- Diagnosis chart for electric system faults.

Fault	Cause	Remedy
Low battery loading capacity	Battery overload because of too many electrical accessories	Disconnect accessories or install a bigger charge alternator
	Engine over speed	Set the engine speed
	Faulty connections of battery , starter motor or negative cables	Check, clean and/or tighten as necessary
	Faulty battery	Check the battery substitute if necessary
	Faulty charge alternator	Check the battery charging system
The battery is consuming too much water	Battery box is broken	Check the battery substitute if necessary
	Battery faulty	Check the battery substitute if necessary

12.2.- Diagnosis chart for electric system faults.

TROUBLESHOOTING

Fault	Cause	Remedy
The battery is consuming too much water	Battery overloaded	Disconnect accessories or install a bigger charge alternator
The battery does not accept charge	Battery connections loose or oxidised	Disconnect accessories or install a bigger charge alternator
	Battery sulphated or worn out	Check, clean and/or tighten as necessary Contact your authorized service workshop
	Fan belts stretched or broken	Check the automatic belt tensioner and the belts Change belts if necessary
The starter motor does not function	The engine is starting loaded	Disconnect the load
	Battery connections loose or oxidised	Check, clean and/or tighten as necessary
	Battery voltage is low	Contact your authorized service workshop

Fault	Cause	Remedy
The starter motor does not function	The starter motor relay is faulty	Contact your authorized service workshop
	Blown fuse	Change fuse
The starter motor runs slowly	Battery voltage is low	Contact your authorized service workshop
	The engine oil is too dense	Drain and refill the engine with appropriate engine oil
	Battery connections loose or oxidised	Check, clean and/or tighten as necessary
The complete electrical system	Battery connections loose or oxidised	Check, clean and/or tighten as necessary
	Battery sulphated or worn out	Contact your authorized service workshop
	Blown fuse	Change fuse



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