INSTALLATION GUIDE

MTU Range

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HIMOINSA
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INTRODUCCIÓN
By means of this handbook we intend to provide the basic instructions and information for a proper Installation, use and maintenance of the generator set. All activities involving the internal functioning of the generating set, must be carried out by specialized personnel, with experience in Diesel engines and mechanical and hydraulic installations as well as in electricity generation. This handbook and all the other reference documentation are indispensable in order to train these specialists. At HIMOINSA we think of you, that is why it is essential that you read all safety regulations and warnings thoroughly before you start the generator set. Only by doing this we can assure you an optimal service in perfect reliability and safety conditions. HIMOINSA advises that the validity of the information in this handbook refers to the date when it was issued, since several aspects such as the technological developments, new regulations or updates and improvements of the models oblige us to make changes without notice, which may not appear in the current handbook. This handbook and the rest of the reference documentation are parts of the generator set that you have purchased and must be kept and protected against any agents that may damage them. This documentation must accompany the equipment whenever it is leased to any other users or new owners. Although all the information in this handbook has been thoroughly verified, HIMOINSA refuses any responsibility for any spelling, typographic or transcription errors. In accordance with directive 85/374/EEC and its subsequent modification 99/34, HIMOINSA will not be deemed responsible for defective installations, improper uses of the machine and non-fulfillment of the regulations of this handbook.
1. SAFETY REGULATIONS

Before operating the machine, read the following safety regulations carefully, and find out about the local requirements in safety.

The installation, operation, maintenance and repairs must be carried out only by authorized and competent personnel.

The owner is responsible for maintaining the generating set in good safety conditions. The parts and accessories must be replaced if they are not in good working conditions.

1.1. General safety precautions.

- Do not allow non-authorized people to access the plant.
- Do not allow people with pacemakers to access the plant, as it may cause electromagnetic interferences on these devices.
- Do not approach the G.S. if you are wearing loose clothes or objects that may be attracted by the airflow or by the mobile parts of the engine.
- It is forbidden to dismantle or disable any safety devices.
- It is forbidden to lean on the G.S. or to leave objects on it.

For automatic action generating sets:

- Place a red light that switches on when the unit is working in a visible place.
- Place a warning sign alerting of the possibility that an unexpected automatic startup of the machine may occur.
- Place an obligation sign stating: “All maintenance operations must be carried out with the generator in the LOCK position”.
- For the emergency stop of the group, press the “emergency stop” button, located in the group, or the emergency push button to be installed outside the engine room.

1.2. Safety at delivery, storage and unpacking.

- Once you receive the lighting tower, check that the received goods correspond to those on the delivery note and that all the goods are in perfect conditions.
- In order to lift and transport the Tower, lifting machines of the appropriate capacity must be used. All loose and pivoting parts must be safely fixed before lifting it.
- When moving the G.S., and especially when lifting it, it is highly recommendable to use the available points for this purpose. (1-2)
• It is totally forbidden to use any other lifting points located over the engine, alternator or other components.
• If the G.S. is damaged for any reason during its transportation, storage, and/or mounting, it must not be started up before being verified by our specialized personnel.
• If you want to store the Tower until its utilization, it is highly recommendable to have a warehouse properly protected against any chemical agents that may damage its components.
• Unpacking must be carried out carefully, avoiding causing any damages to the goods during such operation, especially when using levers, saws or any other metallic tools.

1.3. Safety during installation and initial start-up
• The installation of the generator set and its respective accessories must be carried out by specialized personnel. In the event of any difficulties during the installation, consult with the Technical Department at Himoinsa.
• You must be familiar with the emergency procedures concerning the installation to be followed.
• Always wear a safety helmet, footwear and safety gloves, protective goggles and dry, tight clothes.
• Do not modify the original protections, located on all rotary parts on display, hot surfaces, air intakes, belts and live parts.
• Do not leave dismantled parts, tools or any other accessories on the engine, near the engine or in the area where the generator set is located.
• Do not leave any flammable liquids or rags soaked in flammable liquids near the generator set, electrical devices or any other parts of the electrical installation (including lamps). Take extreme caution to avoid risks of fulguration; make sure there is a grounding installation and that it has been fitted according to the regulations.
• Place a sign stating: “DO NOT PERFORM MANOUVERS” in all sectioning parts that separate the areas of the installation where you are to work.
• Install all the necessary protective measures required for safety in the parts that complete the installation.
• Insulate all connections and wires that are disconnected. Do not leave any terminals of the generator sets unprotected.
• Plug all connection points concerning the generator set and its accessories into the grounding installation.
• Verify and make sure the electrical power connections and the auxiliary services connections are correctly made.
• Check that the cyclical direction of the phases matches the one of the power supply.
• Isolate the position of the emergency stop switches, quick-stop fuel valves, switches and other incidental emergency systems existing in the installation.
• Verify the perfect functionality of the stop devices of the set, especially those in the following devices (in case they are standard supplies): overspeed stop, low oil pressure stop, high water temperature in the engine stop, and the user-installed emergency stop switch, which is usually outside the premises.
• Check the correct ventilation of the premises so that the exhaust gases can be released to the atmosphere, to the exterior of the premises, and verify that they are in a safe position away from doors, windows and air intakes.
• Check that pipes and silencers are installed in a correct way. They must have expansion joints and be protected against accidental contact.
• Make sure there are no losses or leaks in the oil and fuel pipes.
• Before the starting-up, make sure the generator set has the right amount of lubricant oil, cooling liquid and fuel.
• Single out the position of the fire extinguishers and other protective and emergency devices, and learn how they work.
• Single out the sources of dangers, such as fuel leaks, lubricant oil, acid solutions, condensed drippings, high pressures and other dangers.
• Check that the set is clean and the surrounding area and escape routes are clear and free of obstacles. Check that there are no obstructions on grilles, intakes and outlets.
• Check that there are staff members working at other nearby sets, and that those tasks are not dangerous and may affect the operation of the system.

1.4. Safety during operation

• Do not allow people or animals to access the operating area of the G.S..
• Do not touch the generator set, especially wires and connections to the alternator when the set is operating, since they are live.
• Do not touch any parts in motion, until the generator set has stopped completely.
• When the G.S. is in operation, some parts of the engine, conduit(s) and exhaust reach high temperatures. Avoid touching them until they have cooled down completely.
• Always wear ear protectors when the generator set is in operation, in order to avoid ear damage.
• The labels concerning safety must be kept clean and on the locations designated by the manufacturer.
• Fuels and lubricants may be flammable, toxic, explosive and corrosive. We recommend keeping them in their original containers and storing them in protected areas.

1.5. Safety during maintenance

• All checks and/or maintenance of the generator set must be always carried out by specialized personnel.
• Maintenance operations must be done when the engine is not working.
• Before operating any components of the electrical installation, disconnect the poles from the battery.
• Before opening the electrical panel, specialized personnel must take the following precautions:
  o Stop the generator set if it is in operation, and set the electric panel in the LOCK position.
  o Disconnect the battery/batteries from the generator set.
  o Disconnect the power input.
  o Periodically check both the tightness and insulation of connections.
• The different operations and/or maintenance procedures which are not specifically indicated in the user handbooks must be notified to the manufacturer for their approval.
• Do not carry out modifications of the product without having the knowledge and exclusive authorization by our technical department.
• Follow the recommended manufacturer’s directions concerning oil changes and fuel replacements. Do not use oils or fuels that are not specified by the manufacturer.
• Spare parts must conform to the manufacturer’s standards. Use original spares only. For spares, contact original spare suppliers only, or workshops in the HIMOINSA assistance network. For a correct determination of the spare parts always refer to the data indicated on the plate of the set, the type of engine and/or alternator and their respective registration numbers.
• Periodically control the condition of the different components of the G.S., especially of antivibration components, the origin of eventual vibrations and/or the increase in noise.
• Periodically check if there are any water, oil, fuel and/or acid leaks in the battery/batteries.
• Do not modify the engine or other components of the generator set to obtain performances different from those specified by the manufacturer.
• Do not operate the fuel tank or fuel supply conduits when the engine is hot or in operation.
• Wear protective gloves and goggles:
  o When using pressurized air;
  o During battery maintenance;
  o During the supply of inhibitors or antifreeze products;
  o During the replacement or supply of lubricant oil (hot engine oil can cause scalds during emptying). Allow the oil to cool below 60º C.
• Wear protective helmets when operating in an area with suspended loads or equipment at head level.
• Always wear safety footwear and tight clothes.
• When working with parts that may be live, always make sure that your hands and feet are dry. We recommend the use of insulating flooring to perform maneuvers.
• Wet clothes must be replaced immediately.
• Keep used rags in containers that are anti-flammable or indicated for such effect.
• Do not leave rags on the engine.
• When starting up an engine that has been repaired, take precautions in order to prevent air suction in case there is an excess in revolutions during the start up.
• Always keeps the engine clean, removing eventual oil stains, gas oil and/or other cooling liquids.
• Never start up the engine when the fan speed regulator lever has been dismantled.
• Do not carry out tasks that need the presence of several people if you are alone, especially when moving or operating parts such as switches, section switches, fuses and/or other live devices.

**Engine cooling circuit**

• Never add coolant to a hot engine; allow the engine to cool down first.
• Periodically check the level of the coolant, and if necessary, add product until the appropriate level is reached. Only use liquids that are recommended in the use and maintenance handbook.
• Remove the radiator cap gently. The cooling conduits are usually pressurized, and therefore the hot liquid may spout if pressure is released very quickly.
• Periodically check the tightness and level of wearing of pump belts/fan.
Lubrication circuit.
- Periodically check the level of the oil in the crankcase, with a cool engine, and add oil whenever necessary, according to the directions found in the use and maintenance handbook.
- Do not smoke or light fires during the oil supply.

Fuel circuit
- Do not smoke or light fires during the fuel supply.
- Do not smoke during the fuel replacement, and be careful not to spill fuel on the generator set.

Exhaust circuit
- Watch the exhaust circuit, and in the event that any eventual gas leaks are detected, repair immediately. These are possible fire sources.
- Warning: very hot surfaces. Pre-assembled installation parts are protected against accidental contacts. The installer must insulate and/or protect any other additional parts, gas evacuation pipes, the silencer which is supplied separately, etc.

Electric start system
- Disconnect the negative pole from the battery/batteries before operating the engine, in order to prevent the automatic start system of the engine from starting while being operated.
- Keep joints tight and check that the insulation of the wires is satisfactory.
- We recommend connecting first the positive pole to the battery, and next the negative pole (usually grounding), in order to prevent the formation of electrical arches.

Synchronous Generator.
- Do not manipulate the generator when it is in operation. Before manipulating, set the generator to the position of LOCK.
- Ensure the air intakes for the ventilation of the generator are clean, and in some models, lubricate the bearings. Also, make sure that the tightness and the position of the electrical connections are correct.

Control panel
- Before operating the control panel, disconnect the power input and set the generator to the position of LOCK.
- Electrical control panels, as all electrical devices, are damp and dusty. Verify that the anticondensation heaters, if available, are in good working order and that the air ventilation intakes are clean.
- Periodically check that the bolts that fix electrical connections are securely screwed.

1.6. Environmental safety.
- Do not start a G.S. in closed premises, where there is no exhaust installation with outlets.
- Exhaust gases are harmful and may be lethal.
- Follow the rules and other regulations concerning acoustic installations.
- Replace the exhaust and/or silencer of the engine if the humming level is louder than the allowed by the respective regulation.
- Maintenance operations (oil replacements, fuel tank cleaning, radiator cleaning, washing, battery/batteries replacements, etc.), storage and waste disposals will be
carried out according to the existing regulations in the country where they are being used.

1.7. Safety stickers and information.
There are some safety stickers and information all over the generator. Next you can find a brief explanation of their locations and information on each of them:

<table>
<thead>
<tr>
<th>PICTURE</th>
<th>LOCATION</th>
<th>INFORMATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>![Warning]</td>
<td>Located on the connections from the alternator to the engine. Whenever there are timing belts or transmission shafts.</td>
<td>They warn of the danger in case an alien object collides with the timing belts or with the components in motion that they connect.</td>
</tr>
<tr>
<td>![Temperature]</td>
<td>Located on the parts of the genset that heat up during operation.</td>
<td>They indicate those areas which must not be touched while the set is in operation or shortly after having stopped.</td>
</tr>
<tr>
<td>![Warning]</td>
<td>Placed on the coolant tank cap.</td>
<td>They warn of the precautionary measures to be taken when opening this cap. The liquid is hot and may spout and cause scald.</td>
</tr>
<tr>
<td><img src="hook" alt="Lift" /></td>
<td>Located on the bonnet and next to the lifting eye.</td>
<td>It indicates the point by which the set must be lifted in order to move it.</td>
</tr>
<tr>
<td><img src="diesel" alt="Fuel" /></td>
<td>Located next to the fuel cap. Depending on the model, it can be either on the bedplate or next to the engine.</td>
<td>It indicates the location of the fuel tank. Tank filling cap.</td>
</tr>
<tr>
<td>![Warning]</td>
<td>Located on both sides of the bedplate skids.</td>
<td>It indicates the advisable area to move the set by means of a fork-lift truck.</td>
</tr>
<tr>
<td>![Warning]</td>
<td>Located next to the oil fill dipstick and oil fill cap.</td>
<td>Indicates the location of the oil fill dipstick.</td>
</tr>
<tr>
<td>DIBUJO</td>
<td>UBICACIÓN</td>
<td>INFORMACIÓN</td>
</tr>
<tr>
<td>--------</td>
<td>-----------</td>
<td>-------------</td>
</tr>
<tr>
<td><img src="image1" alt="Grounding Protection" /></td>
<td>Next to the derivations of the grounding protections.</td>
<td>They are the parts by means of which the genset is protected against possible electric shocks.</td>
</tr>
<tr>
<td><img src="image2" alt="Thermal-Magnetic Switches" /></td>
<td>Next to the protective thermal-magnetic switches of the genset.</td>
<td>They protect the genset against possible overcurrent that may occur during charge.</td>
</tr>
<tr>
<td><img src="image3" alt="Emergency Stop" /></td>
<td>On the emergency stop.</td>
<td>It indicates the location of the emergency stop button which allows the simultaneous stop of the genset.</td>
</tr>
<tr>
<td><img src="image4" alt="Warning" /></td>
<td>Located on the control panel.</td>
<td>They warn of electric shock hazard.</td>
</tr>
<tr>
<td><img src="image5" alt="Prohibition" /></td>
<td>Always located on the thermal-magnetic switch.</td>
<td>They indicate the prohibition of manipulating the genset when the switch is on.</td>
</tr>
</tbody>
</table>
2. INADEQUATE USE WARNINGS

The Generator Set that HIMOINSA supplies is aimed at the production of electrical energy according to the conditions and environmental and operating limits established or agreed in this contract. All amendments of such conditions and limits must be notified directly to the manufacturer or made via authorised workshops in order to achieve an optimal performance and, if necessary, to perform modifications and/or new calibrations of the generator.

The Generator Set is a machine that transforms potential thermal energy, contained in the fuel, into electrical energy, and is aimed at supplying distribution installations that must be carried out by specialists according to existing regulations. Although the power in use is much lower than that of a public supply network, the danger of electrical energy is the same. The generator set is a production plant that, apart from the existing dangers of electrical source from a public supply network, also adds other risks derived from the existence of flammable substances (the fuel itself or lubricant oils) of rotatory parts and secondary waste products (exhaust gases and irradiation and cooling heats).

Although it is possible to take advantage of the heat contained in the exhaust gases and the cooling system in order to boost the thermal efficiency of the process, this application must be fitted by specialized technicians to achieve a reliable installation and safe for people and things, and to prevent the expiration of the warranty.

Any other uses that have not been previously agreed with HIMOINSA shall be considered as of improper use and, therefore, they are not acceptable.

3. WORKING CONDITIONS

3.1 Standard environmental conditions for reference

- Diesel engine.
  Important: the power of Diesel engines, for stationary applications, refers to the following environmental conditions, according to the ISO 3046/1 standard:
  - Room temperature: 25º C
  - Room air pressure: 1000 Mbars (750 mm/Hg.)
  - Relative humidity: 30%

- Synchronous generator
  The environmental conditions used as a reference for alternators, stationary applications, according to the directives IEC 34-I, ISO 8528-3 and CEI 2-3, are the following:
  - Room temperature: 40ºC (30ºC according to NEMA)
  - Altitude: 1000m ASL (674 mm/Hg)

3.2. Derating for operative environmental conditions.

For environmental conditions of installation and operation different from those above specified, it is necessary to foresee an eventual loss of power, or 'derating', not only in the engine, but also in the generator that is fitted into it, and therefore, in the electric power provided by the generator.

The user/customer must clearly establish the effective environmental conditions in which the Generator Set will operate when placing the order. Therefore, the derating and declassification must be fixed at the time of signing the agreement, so that both the engine and the generator are correctly sized.
Particularly, the user/customer must report on the following environmental conditions in which the generator set will operate:

- The upper and lower room temperature limits.
- The altitude above sea level or, preferably the minimum and maximum values of barometric pressure in the installation area; in case of mobile sets, the upper and lower limits of altitude above sea level.
- The humidity values in relation to the temperature and air pressure within the installation, paying special attention to the humidity value with respect to the maximum temperature.
- The maximum and minimum temperatures of the cooling water, only in those generators that are equipped with water-water interchangers (under special request) instead of a radiator.
- Any other environmental conditions that may require special solutions or shorter maintenance cycles, such as:
  - Dusty and/or sandy environments
  - Maritime environments
  - Environments with the possibility of chemical pollution
  - Environments with existence of radiations.
  - Operating conditions with the presence of great vibration (e.g. earthquake-prone areas, or subject to external vibrations caused by nearby machines).

When the effective conditions are not specified in the contractual base, the power of the generator is interpreted according to the Standard conditions for Diesel engines, as established.

If the effective environmental conditions change subsequently, it will be necessary to contact HIMOINSA, in order to calculate the new power losses and to carry out the necessary calibrations.

For Diesel engines, these deratings are determined by the manufacturers of the respective engine. In order to become familiar with them, contact the technical department at HIMOINSA, or ask your regular supplier.

The alternator derating is not as important as the one of Diesel engines; therefore, the general derating of the generator generator matches the derating of the engine.

**Chart 4** is a merely indicative way of determining the derating of alternators. For a higher precision, you must refer to the supplier’s documentation.

<table>
<thead>
<tr>
<th>Room temperature °C</th>
<th>30</th>
<th>35</th>
<th>40</th>
<th>45</th>
<th>50</th>
<th>55</th>
<th>60</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction coefficient K1</td>
<td>1.05</td>
<td>1.03</td>
<td>1.00</td>
<td>0.96</td>
<td>0.92</td>
<td>0.88</td>
<td>0.84</td>
</tr>
<tr>
<td>Altitude - metres above sea level (m ASL)</td>
<td>1000</td>
<td>1500</td>
<td>2000</td>
<td>2500</td>
<td>3000</td>
<td>3500</td>
<td>4000</td>
</tr>
<tr>
<td>Reduction coefficient K2</td>
<td>1.00</td>
<td>0.97</td>
<td>0.95</td>
<td>0.92</td>
<td>0.89</td>
<td>0.86</td>
<td>0.83</td>
</tr>
</tbody>
</table>

**CHART 4**

Coefficients that indicate the reduction in power of an IP21 air-cooled, self-ventilated alternator, depending on the different environmental conditions. Both K1 and K2 coefficients must be applied to the nominal power of the generator in order to obtain the power in environmental conditions that are different from the standard ones.
3.3. Operational limits.

At the stage of placing the order, the user/customer must report on all the operative conditions that may affect the working order of the generator. Along with the environmental conditions stated above, special attention must be paid to the characteristics of the loads the generator is going to feed, the power, voltage and power factor. The connection sequence of the loads must be determined and indicated with high accuracy.

⇒ Power

The power of the generator is the active power (expressed in kW), supplied on generator terminals, to the voltage and nominal frequency and for the specified environmental conditions. Below their respective definitions can be found:

The specified features, with a ± 3% tolerance, are net and can be obtained after 50 hours of operation.

Continuous Power (COP)

It is the continuous power that the generator set can produce continuously for a limited number of hours per year, performing the maintenance intervals described by the manufacturer and in the specified environmental conditions.

Prime Power (PRP)

It is the maximum power available, for a cycle with variable power, that the generator set can produce for a limited number of hours per year, performing the maintenance intervals described by the manufacturer and in the specified environmental conditions. The average power produced for a period of 24 hours must not exceed 80% of the PRP.

A 10% overload is allowed for 1 hour out of 12 operating hours.
**Stand By Power (SBY)**

It is the maximum power which, in the established environmental conditions, the generator can produce for a maximum period of 500 hours per year. The load factor must not exceed 90% of the SBY.

Overloads are not allowed.

⇒ **Rate**

HIMOINSA generators are prepared to work at 1,500 rpm or 1,800 rpm at a rate of 50 or 60 Hz, respectively.

Low-power engines are equipped with a mechanical rpm regulator, installed in the injection pump; this is normally adjusted so that motionlessness is 5% and therefore the output rate is 52.5 Hz with no load, and 50 Hz at full load.

In static conditions, the mechanical rpm regulator usually provides an accuracy of ± 0.5%.

⇒ **Voltage**

The voltage regulator is usually ELECTRONIC with features that can control the voltage of the terminals.

For supercharged engines, it is possible to apply an instant voltage equivalent to 80% of the nominal voltage with a transitory fall in speed within 10%.

The specified values, for both naturally aspirated engines and supercharged engines, may vary, as usual, depending on the type of speed regulator and the generator used.

⇒ **Power factor**

The power of generators is the active power, expressed in kW, produced by the terminals of the generator. The nominal power factor is cos =0.8; therefore, the apparently nominal power will be 1.25 times the Nominal Active Power.

The power factor is a piece of information that depends on the characteristics of the load; HIMOINSA generators, equipped with an alternator, can produce both the active power and the reactive power required by the load but, whereas the active power is produced by the Diesel engine (transforming mechanical power into electric power by means of the generator), the reactive power is produced by the alternator.

Therefore, for a performance with values different from cos =0.8 we must consider:

**Cos 0.8 <> 1 load.**

The alternator works perfectly at active nominal power with the cos values between 0.8 and 1. In order to prevent engine overload, it is required not to exceed the active nominal power.

**Cos < 0.8 load.**

The alternator, for a certain plate value with reference cos = 0.8, overloads more when the cos value comes closer to 0. Therefore, the reactive power to be produced increases as the cos decreases. The generator reduces its power according to the directions provided by the manufacturer. Results In these conditions the Diesel engine generally in an exuberant power.

For reference purposes, Chart 5 is presented so as to determine these reductions in power. For a higher accuracy refer to the documentation provided by the generator’s manufacturer.
Single-phase loads
The generators may be supplied with unbalanced loads that can reach the nominal current of each phase. This means that between two phases (for example, L1 and L2) you cannot insert more than 0.58 of the three-phase nominal power of the set: similarly, between one phase and the neutral (e.g., L3 and neutral) you cannot insert more than 1/3 (that is, 33%) of the three-phase power of the plate.
It is necessary to take into consideration that during the single-phase operation, or with unbalanced loads, the voltage regulator cannot hold the expected voltage tolerances.

Charge intakes
When a charge is applied to a generating set, a series of transitory variations of voltage and frequency occur. The scope of such variations depends on the value of the power, both active (kW) and reactive (kVAR) of the variations of the load, depending on the characteristics of the diesel engine and alternator.

When charge intake capacity constitutes an important requirement, the customer/user must clearly specify it and must provide HIMOINSA with all the necessary information related to the different loads to feed, its possible distribution in groups and the connection sequence. The former is necessary to obtain the best dimensions of the generator and to prevent low-profit oversized generators or dangerously downsized ones.

Start-up of asynchronous engines
The start-up of asynchronous engines by means of a generator set poses some problems, as engines with squirrel cage motors have start-up voltages that are 8 times higher than the normal intensity of the generator (I_{arr} = 8 \times I_n), and a low power factor.

In these conditions, the current that is absorbed by the asynchronous engine (or by the engines that start simultaneously) during the start-up, must not exceed the maximum current that the generator can produce in short times, taking into account a tolerable fall in voltage and without exceeding overheat limits.

In order to avoid this excessive oversize of the generator, the following systems can be used: Several engines: distribute them in several groups each, according a pre-set sequence, at time intervals of 30-60 seconds.

<table>
<thead>
<tr>
<th>Power factor cos</th>
<th>1</th>
<th>0.8</th>
<th>0.7</th>
<th>0.6</th>
<th>0.5</th>
<th>0.3</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coefficient of reduction</td>
<td>1.00</td>
<td>1.00</td>
<td>0.93</td>
<td>0.88</td>
<td>0.84</td>
<td>0.82</td>
<td>0.80</td>
</tr>
</tbody>
</table>

Chart 5. Coefficients that indicate the reductions in power for a generator in a cos function.
One engine: whenever the operating machine that is fitted allows it, by using a startup system with reduced voltage (star/triangle or self-transformer), or, for higher powers, single-coil rotor engines and rheostat starters. For star/triangle startups, the voltage of each phase turns out to be reduced and the startup voltage \( l_{arr} \) decreases in the same proportion.

\[
1 / \sqrt{3} = 0.58
\]

It is evident that, in the case of an engine with \( l_{arr}=6 \times \text{In} \) in direct startup, with a star/triangle startup, it reduces approximately up to \( 3.5 \times \text{In} \), and as a consequence there is a power request to the generator which is lower than a \( 6/3.5 \) ratio. In all cases, both direct startup and reduced voltage startups, it is necessary to control the devices and equipment that are connected to the circuit in use in order to avoid failures (eg. the opening of contractors) due to a transitory fall in voltage at the time of startup.

4. GENERAL DESCRIPTION

The sets are used for two main types of services:

Continuous service sets: Used for the production of electrical energy in areas where there is no other source of production and application for several purposes (motion force, lighting, heating, etc.)

Emergency service sets: They are used to solve energy interruptions that may cause serious problems to people, physical and/or financial damage (hospitals, industrial facilities, airports, etc.) or to face consumption peaks.

Depending on the assigned destination, the sets are subdivided into:

- Sets for terrestrial use
- Sets for maritime use

The sets for terrestrial use, depending on the use they are aimed at, have been provided with two types:

- Static sets (for fixed installations)
- Mobile sets (for mobile installations)

Both types can be subdivided at the same time into a wide range of models depending on their variety and user demands:

- Manual operation generators
- Automatic operation generators
- Continuity sets

4.1. Diesel engines

They operate with a four-stroke diesel cycle, naturally aspirated direct injection, turbocharged and/or aftercooled. The layout of the cylinders depends on the engine model, and it can be in-line or V-type. It is a water-cooled type of engine.
4.2. Monopolar alternator
Generator with a horizontal shaft, synchronous without brushes, auto excited and auto regulated. The alternator has an automatic voltage regulator. This regulator has got potentiometers in order to adapt the functioning to the different conditions in which the set is used.

4.3. Coupling joint
It is possible to use two-bearing alternators upon request. The engine and the alternator are joined by means of elastic coupling and through a hood coupling in order to guarantee a correct coaxial position of the assembly. For standard assemblies it is possible to use single-bearing alternators, and the connection is made by means of flexible disks that are fixed directly to the engine wheel.

4.4. Support bedplate
The support bedplate or base consists of a folded metal sheet with a suitable stiffness, which holds the generator set by means of elastic supports (silentblocks) that remove the transmission of vibrations to it, and therefore, to the ground. The fitting to the foundations is usually made by means of long bolts with nothing in between. The fuel tank is located on this support bedplate which, depending on the model, is equipped with a filling hole, a flow meter (one or two signals), an emptying hole and a vent, and it is connected to the aspiration pipes of the injection pump by means of flexible elements, and fuel returns from the injection pump and the injectors drain. Due to the specific needs of our customer, we can supply high capacity tanks separately. However, in this handbook we shall only describe the fuel tanks that are fitted into the supporting base. Moreover, inside the supporting base it is possible to find a suitable housing for the battery/batteries with its respective fixing iron fittings.

4.5. Soundproof bonnet
Depending on our customers’ demands and applications, the generator may be equipped with a protective soundproof bonnet. Such bonnet is made of steel sheets of a suitable thickness, accordingly treated in order to allow a perfect finish. The bonnet is internally covered with a fireproof, sound-absorbing material classified as M-0 material. In air intakes and outlets, the bonnet is equipped with its respective piping, designed for driving air without producing the logical reverberations of a forced air drive. The engine exhaust is silenced using a high-performance noise-reduction silencer that guarantees a correct noise reduction level. The bonnet is equipped with perfectly soundproof doors covered with fireproof fiber. The locks are supplied with keys that prevent an improper use by unauthorized personnel, even in the control area of the generator.

4.6. Electrical panel with manual start
The HIMOINSA electrical panel is designed to bring together the electrical control equipment, the general protections of the engine and alternator, the alarms and measure and control equipment.
4.7. Electrical panel with automatic start
The automatic panels are connected to the power supply and to the set. When the electrical supply is suitable the power supply contactors are locked and the supply to the sets comes from the power supply. When the electric supply is poor the power supply contactors unlock and the generator starts automatically. The generator contactors detect voltage in the terminals and switch in order to make use of the generator.

Please contact our commercial department to find out about the possibilities that our control systems can offer.

4.8. Control and protection controller
Specific handbooks and electric diagram are supplied belong each control panel.

5. INSTALLATION

5.1. Important warnings:
Control of material.
When the generator is delivered it is advisable to check that the received material matches the order, and to compare it with the delivery note that is enclosed with the set. Also, check that the material is not damaged. Proceed to open the packagings. In case any flaws are detected, you must contact the shipping company immediately in order to report the incident to the insurance company.
“Himoinsa specifies that all deliveries are made at the customer’s complete risk”
Operations prior to the installation of the automatic G.S.
During the operations prior to the installation of the automatically-driven generators, or when connecting the electrical connections, or in order to avoid unfortunate startups, etc. the following precaution measures must be taken:
- Battery/batteries must be disconnected.
- The control panel switch must be set to the OFF position.
Safety rules for diesel G.S.
The engine room and installations of the set (foundations, air intake, gas exhaust) must match the “Safety rules” that exist in the country where the generator will be installed.

Installation
For stationary generators, two types of installation can be considered:
- Outdoors assembly
- Indoors assembly

5.2. Outdoor installations.
The generators which are assembled outdoors (excluding soundproof sets, that are intended for such applications), must be located in a place which must be as protected against weather conditions, dust, etc. as possible.
For temporary installations, the generator can rest on a well-levelled surface. For long-time installations, it is advisable to build a concrete base.
5.3. Indoor installations

- Generator room
  
  For the correct installation of a generator in closed premises, the size of the room must allow:

  - The regular operation of the generator.
  - An easy access to its components for maintenance and possible repairs.
  - The possibility of introducing the generator using the available means of transport. The door through which the generator will be introduced must be centred, so that the set remains centred once it is inside, and there is no need of moving it.
  - The existence of holes that allow oil replacement.
  - The installation of the exhaust pipe with the minimum possible number of pipe elbows.
  - The generator to be placed in the middle of the premises, with respect to perimeter walls, in order to facilitate access.
  - The layout of the command panel (in case it is an automatic set) to be in a position that allows the operator to have complete visibility over the instruments when operating it.

The recommended room dimensions are displayed in the following pictures:

**ENCLOSED GENERATOR**

2. Control panel.
3. Air intake gap.
4. Air outlet tunnel.
5. Cable wire way.
6. Access door.
8. Exhaust pipe.
10. Exhaust silencer.

* May vary depending on the function of the outlet section of the model (see plans of the specific model to be installed).

The dimensions showed are in millimeters.
OPEN SET GENERATOR

2. Control panel.
3. Air intake gap.
4. Air outlet tunnel.
5. Cable wire way.
6. Access door.
8. Exhaust pipe.
10. Exhaust silencer.

* May vary depending on the function of the outlet section of the model (see plans of the specific model to be installed).

The dimensions showed are in millimeters.

The basic elements to be considered are:
- Foundations
- Exhaust installations
- Ventilation
- Fuel installation.
- Electrical connections
- Grounding.
- Heating

⇒ Foundations
The foundations must be calculated and dimensioned by experts in civil engineering. They must prevent the transmission of vibrations and noise to other parts of the building. The surface on which the set will be placed must be leveled in order to allow its correct operation. For cleaning reasons, it is recommended that the foundations are approximately 10cm above the floor level, and covered with gres industrial sandstone tiles.

⇒ Exhaust installation
Exhaust outlet pipes
The outlet pipes for exhaust gases are usually made of flat steel, with no welding, or in other special cases, with asbestos-concrete pipes.
The pipes must evacuate the gases to those areas where they cause no danger or damage, and must end with a protection cap to protect them from water entry, or with a similar system. (1) and (2)

In the part where they run through the walls, it is recommended to perform a thermal insulation of the pipes, in order to prevent heat expansion to the walls. (3) The joints between the different pipe stretches must be perfectly sealed, so that there are no gas leaks. The connection between flange and gasket is the most ideal one. It is also recommended to place a condensation collector, with faucet, on the bottoms point of the pipelines.
The connection between the engine’s collector outlet (or the turbo blower exhaust for supercharged types) and the pipe must be made by means of a stretch of flexible tube, so that the actions induced by the engine and the thermal expansions of the pipe are absorbed by the engine without damaging any elements.

The use of flexible element also demands the placement of flanges in the exhaust pipe, independent of the generator. Therefore, the pipelines must be fixed to the walls or ceiling of the engine room, with supports that can bear the weight of the pipe to the engine outlet, so that it does not rest on the parts of the engine (collector, turbo blower), and allow its expansion.

When dealing with very long pipes, it is necessary to insert expansion joints made of sealed flexible elements.

When establishing the trajectory of the exhaust pipe, it is necessary that the pipe is not near the engine air filters, in order to prevent the machine from drawing in hot air. Otherwise, it will be necessary to insulate it.

Whenever there are several generators, it is advisable that all exhausts do not converge on a common pipe, as there can be problems when some generators are in operation and others are not. The produced exhaust gases can penetrate in the conduits of the sets that are not in operation and may cause damage.

A. Exhaust pipes measurement for Standard Static Generators

The engine’s exhaust backpressure has a remarkable influence on the produced power and on the thermal charge.

Excessive backpressure values (measured at the exhaust collector outlet for turbocharged engines, and at the turbine outlet in case of supercharged engines) cause reductions in power, rise in temperature of exhaust gases, fumes, high fuel consumption, cooling water overheat, lubricant degradation, and the ensuing consequences on the engine parts.

The limits that must not be exceeded (referred to the delivery conditions of maximum power at fullthrottle) in HIMOINSA genets must be consulted in the factory.
Such limits can be observed considering the dimensions that are suitable for the exhaust installation, that is, the diameter of the pipe and type of silencer.

The pipes must be as short as possible, and with as few pipe elbows as possible. Whenever these are essential, they must be used with a very wide angle of curvature (from 2.5 to 3 times the diameter of the pipe). Solutions with bends of angles lower than 2.5 times the diameter pose difficulties so they must be avoided.

In order to calculate the total length of the pipe (which is crucial for the exhaust’s backpressure), the following considerations must be taken into account:

The rectified length of the pipe elbows must be determined according to the chart and pictures:

<table>
<thead>
<tr>
<th>Interior diameter of the exhaust pipe (mm)</th>
<th>40</th>
<th>50</th>
<th>65</th>
<th>80</th>
<th>100</th>
<th>125</th>
<th>150</th>
<th>200</th>
<th>250</th>
<th>300</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equivalent rectified length $L_0$</td>
<td>0.5</td>
<td>0.7</td>
<td>0.9</td>
<td>1.2</td>
<td>1.7</td>
<td>2.2</td>
<td>2.8</td>
<td>4.0</td>
<td>5.4</td>
<td>6.7</td>
</tr>
</tbody>
</table>

The backpressure values due to the exhaust silencers may vary within a wide range, depending on the type of building, dimensions and noise abatement characteristics:
- If it is the one supplied by HIMOINSA, the length must be multiplied by a coefficient of safety, so that the total length to be considered due to backpressure will be: $L=2xl$.
- If it has been provided by another supplier, it is recommended to check the value of backpressure derived from the silencer with the supplier.

**Example:** The exhaust pipe consists of the following parts:
- 5 metres of straight pipe stretches.
- Two pipe elbows type a)
- Three pipe elbows type c)
- A 1m long silencer.

If the inner diameter of the engine exhaust is 80mm, the total length of the exhaust pipe is calculated as follows:

a) for the inner diameter 80mm, according to the chart, $l=1.2m$.

b) total length of the pipe elbows type a) is, $1Xl=1X1.2=1.2m$, as there are two pipe elbows, $2 \times 1.2=2.4m$.

c) the total length of the pipe elbows type c) is $5 \times 1=5 \times 1.2=6m$, as there are three pipe elbows, $3 \times 6=18m$.

d) the total length of the exhaust silencer is $L=2X1=2m$.

e) the total length of the exhaust pipe is: $5+2.4+18+2=27.4$ metres
In order to calculate the diameter of the exhaust gases pipe it is possible to use the normogram that can be found below:

- For calculation purposes, in this normogram we will use the following backpressure values:
  - 800 mm H2O, for aspirated engines.
  - 400 mm H2O, for supercharged engines.
- Exhaust gases airflow in kg/h. In order to convert into m3/h, the data must be divided by the exhaust gases density. Request these data to the manufacturer.
# Example: If we take the exhaust pipe from the previous example, with a total length of 27.4 metres (taking into account the rectified length of the pipe elbows and the length equivalent to the exhaust silencer). From the following data of the installation:

- 5 pipe elbows at 90º (2x type A and 3x type C).
- Set model: HhW-210
- Working rate: 50 Hz
- Motor: 8361 SRI 26 (supercharged).
- Insulated pipe.

a) Start from the lower part, with a total pipe length of 27.4 m (straight stretches + rectified elbow length), until crossing the straight line relative to the total number of pipe elbows in the installation (5 elbows).

b) Continue and follow a horizontal direction to the right until crossing again the straight line relative to the number of pipe elbows (5 elbows).

c) Continue upwards until crossing the straight line relative to the flow of the exhaust gases, which according to the chart is 1120 kg/h. To convert kg/h into m³/h divide the flow expressed in kg/h by the density of the exhaust gases. As a first approximation we can take the density of the exhaust gases with a value of 0.42 kg/m³

\[ 1120 \times 0.42 = 2667 \text{ m}^3/\text{h} \]

d) Continue horizontally to the left. After crossing the straight line, continue upwards until crossing the straight line relative to the overpressure of the pipe, 400 mmH₂O.

e) Continue upwards until crossing the straight line.

f) Continue to the right until the straight line relative to the insulated pipe. After crossing this last straight line, the pipe diameter, 122 mm, is determined on the right top part. The commercial diameter right above is the one to be considered.

The exhaust pipe cannot have a lower diameter than the collector pipe of the engine exhaust, and also, the straight stretches must have a slight inclination in order to prevent the return of condensates, as shown on the location plan of the generator in the room.

When the diameter of the pipe is higher, the engine joint must have a conic connection element with a conicity below 30º in order to avoid excessive load losses.

**B. Exhaust pipes measuring for Soundproof Static Generators**

Check with the HIMOINSA engineering department. There is backpressure in the outlet of the generator which is caused by the internal pipes. It is necessary to know this value so as not to exceed the recommended backpressure when designing the rest of the installation.

⇒ **Exhaust silencer**

The exhaust silencer is usually attached to the stretch of pipe that remains inside the room where the generator is located. Whenever possible, it can be separated from the generator. The silencer used in industrial applications performs a 15 to 20 decibels noise reduction. In order to reduce the noise caused by the resonances of gas pulses in pipes, the position of the silencer can be altered, by reducing the length of the tube that goes into the engine. For example, for a 10m long pipe, the optimal position would be half-way through the distance in relation to the outlet.

In the cases of private installations, such as hospitals or residential areas, where a higher noise reduction is required, special silencers can be used, with a reduction of 25 to 30 decibels, and whenever possible, using special quiet chambers.
Ventilation
The ventilation of the engine room where the G.S. is installed is of vital importance for a correct operation and durability of the generator.
The engine room must have the following features:
- Allow the disipation of the heat produced when the generator is in operation by irradiation and convection.
- Guarantee the correct supply airflow, and in the right amount for the engine combustion.
- Allow the engine cooling by means of the radiator, keeping the operating room temperature within the safety limits in order to guarantee a good aspiration of the supply air.

A good ventilation solution applicable to most cases is the one indicated in the charts of the sections of the installation, in which the engine fan draws in the cooling air from the engine room, whereas the hot air is expelled through the expulsion tunnel placed between the radiator and the room window.
The expulsion window must have a bigger or same size as the radiator in case of standard static generators, and bigger or same as the expulsion grid in case of soundproof sets.
We must prevent the radiator exhaust hot air from coming back to the engine room, making sure the expulsion conducts are leak-proof. Therefore, the air in the engine room is constantly renovated, and the dimensions of intake grilles must be big enough for the cooling and combustion.
In order to achieve a correct air flow, the cool air must be introduced through the grilles that are located on the lower part of the engine room wall. This wall should be the one located opposite the radiator, so that the air flows all over the set before being expelled through the fan.
Make sure there are no areas in the engine room where the air is deposited. This usually happens in rooms with several engines. In those cases, and whenever possible, each group should have its own air intake grille.
In case you need more details about the air flow required for the different types of HIMOINSA generators, please refer to the manufacturer.
For safety reasons, in those premises where there are sets in continuous operation, or in those areas where the room temperature is high, it is advisable to use an auxiliary extractor fan that has enough power to achieve suitable ventilation. Such extractor fan must be located on top of the room, as close to the radiator as possible.

Fuel installation
Generator sets supplied by HIMOINSA include a complete fuel installation, since the fuel tank is located on the bedplate of the generator.
The fuel tank is connected through flexible tubes in order to guarantee their operating durability, depending on the model. For longer durability, and in order to satisfy special demands, it is necessary to use a special tank that is fitted separately. It will be necessary to connect the engine to the new tank, and previously perform the placing of the flexible connections and new suitable pipes that must be firmly fixed. The new fuel tank must be located according to the following criteria, so that the engine injection pump is able to draw in fuel from the new tank:
- Closer than 20m from the engine, in case they are both at the same level.
- Less than 5m deep.
The usual connections are:
• For fuel injections to the engine injection pump.
• For fuel excess returns from the injection pump.
• For drain return of the injectors.

The pipes must not have any welds. They can be made of steel, iron or cast iron. Galvanized steel pipelines must not be used.
Flexible connections must be fitted in order to isolate the static parts of the plant from the new fuel tank, in order to avoid the possible vibrations caused by the engine. Depending on the type of engine, these can be made using the following:
**Stretches with a suitable length made of reinforced rubber pipes with flexible insertions that are resistant to gas oil. For the connections with the terminal rubber holders with edges and screw clamps.**
**Flexible low-pressure type tubes, suitable for gas oil, protected with metal mesh and with screwed terminals for tightly-sealing.**
Synthetic resins must be avoided.
In complementary areas of the plant, maximum attention must be paid to the following issues:
- Fix pipes by means of holders, at regular intervals in a way that vibrations and inflexions caused by pipes weight are avoided, especially those made of copper tube.
- Couplings must be avoided. In case of using them they must be tightly-sealed, especially in depression conditions parts (fuel aspiration intake), in order to avoid air filtrations that make the startup more difficult.
- Aspiration pipes below the fuel level must be placed at a distance of 20-30mm from the bottom, in order to avoid a possible deactivation of the circuit due to air insufflations. Also, these must be conveniently separated from each other, in a way that the fuel return flow does not block the supply due to the gas oil impurities from the bottom of the tank or mixed air.
- Thorough cleaning of the used pipes.
- Avoid abrupt variations in the tube section and the use of elbows with wide angles in pipes.

⇒ **Electrical connections**
The generators are ready for user connections.
When making the connections, you must comply with the conditions specified in the diagrams enclosed with the generator.
**Generator of manual intervention**
The user cables must be connected to the line terminals which, for standard static generators, are located inside the electrical panel, on the rail terminals or at the bottom of the magnetothermal switch, either inside the panel or in the moldeada box (check the electrical diagrams included in the manual of the panel). For soundproofsets, the connection to the grounding terminals is easily accessible, as they are prepared for such effect and protected with a methacrylate sheet.

**Generator of automatic intervention**
The cables that come from the generator, the external power supply and user shall be connected to their respective terminals, located in the command panel. The power cables of the generator shall be connected directly to alternator terminals of the generator.
The connection to auxiliary services between the set and the command panel shall be made with a multiple cable and using the multiple connectors plugs provided with the set.

Cable dimensions
The choice and dimensions of the cables is responsibility of the person who carries out the installation.

Cable positioning
Power cables, for both manual and automatic sets, must be placed in suitable channelling, tunnels or protective conduct-holder. Do not include 400V and 12V (or 24V) cables in the same channelling.

⇒ Grounding
Metal parts of installations which are exposed to human contact, and due to an insulation flaw or other reasons, may get in contact with voltage, must be connected to land-dispersion device. The generators and panels have been equipped with their respective grounding terminals. The connection of these to the land-dispersion must be made with bare copper wires conductors with a minimum section of 16mm², or if not available, galvanized iron with a 50 mm² section. The resistance of such conductor, including the contact resistance, must not exceed 0.15 Ohm.

⇒ Heating
For automatic start generators, the engine room where they are installed must be conveniently conditioned during the cold season, in a way that the room temperature is not below 10-15° C, a required condition for a quick engine start.
Electric heaters with thermostatic controls ranging from 500 to 1500W, depending on the generator, have also been supplied with those sets. They maintain the water temperature within acceptable values in case a sudden start or power input may damage the engine.
6. BEFORE OPERATION

These operations must be performed in the following situations:

- Before the startup.
- After the installation of the set.
- After a general check.
- If maintenance operations have been carried out.
- If the set has been idle for a long time.

**During these operations, make sure the set cannot be started.**

Water level in the radiator
In case the radiator needs water, it must be refilled with a mix containing at least 50% of anticoolant liquid/corrosion inhibitor Paraflu II type, and the rest with clean water.

**Oil lubricant level in the crankcase**

The type of oil to be used is: ACEA E3/API CF4/MIL L2104E/F for supercharged engines, and ACEA E2/API CJ4/MIL L2104E/F for aspirated engines. Fill up the crankcase with oil, up to the top mark of the graduated dipstick, but without exceeding it. With the cool engine, and after a short time in operation, recheck the lubricant oil, and if necessary, add the amount that is missing.

**Fuel tank level**
If the fuel level is below the minimum required for the startup of the generator, it is necessary to add fuel until the tank is full.

**Electrical regulations**
Before starting up the generator, all electrical connections, startup batteries and earth connections must be checked. The terminals must be firmly connected and all switches must be set to their unlocked positions.

**Cyclical direction of the phases**
For generators intervention automatic or in those auxiliary, hand-operated ones for external production lines, make sure the cyclical direction of the alternator phases matches the phases of the external producer in order to avoid reversals in rotation and other inconveniences.

**Air filter check-up**
It must not have obstructions or porosities that prevent a good air filtering. In case of showing deterioration you must proceed with the maintenance operations of the air filter.

**Radiator/intercooler (air/air) check-up**
Verify that the surface of the radiator air intake is clean.

**Checkup of the liquid level in batteries**
Once the batteries are settled and cool, check that the level of liquid is between the maximum and minimum levels.