Users guide and and maintenance manual

SDMO

All generating sets

General considerations
Safety instructions
Installation
Special maintenance advice

MUE SD (C_5_EN) 33522903401_5_1

1. Preface

1.1.Introduction

1.1.1 General recommendations

Thank you for choosing an electrical generating set from our company.

This manual has been designed to help you operate and maintain your electrical generating set correctly.
The information contained in this manual is taken from technical data available at the time of print. In the intention of permanently improving the quality of our products, this information may be amended without warning.

We are interested in your comments!
This manual is updated regularly. We are interested in your comments and suggestions as they enable this document to be made increasingly more useful.
You can contact us with any comments or suggestions at:

- fax: technical documentation department, number: + 00 33 (0)2 98 41 15 55
- by e-mail: doctech@sdmo.com

Read the safety instructions carefully in order to prevent any accident, incident or damage. These instructions must always be followed.

You are likely to encounter several warning symbols in this manual.

 Danger	This symbol indicates a definite risk to the health and life of people. Not following this instruction may seriously affect the health of people or prove fatal.

 Warning	This symbol draws attention to the potential risk to the health and life of people. Not following this instruction may seriously affect the health of people or prove fatal.

 Warning	This symbol indicates a dangerous situation if the warning is not heeded. Not following this instruction could result in non-serious injury or damage.

In order to obtain optimum efficiency and the longest possible life for the electrical generating sets, maintenance operations must be carried out according to the periods indicated in the attached preventative maintenance tables. If the electrical generating set is used under dusty or unfavourable conditions, some of these periods will be shorter.

Ensure that all adjustments and repairs are carried out by personnel who have received the appropriate training. The dealers are suitably qualified and can answer all of your questions. They can also supply you with spare parts and other services.

The left and right sides can be seen from the back of the electrical generating set (the radiator is at the front).

Our electrical generating sets have been designed so that damaged or worn parts can be replaced by new or reconditioned parts thereby reducing the out of action period to a minimum.
For all parts replacement, contact your nearest dealer representing our company who will have the necessary equipment and properly trained and informed staff to carry out maintenance, parts replacement and even total reconditioning of generating sets.

Contact your local dealer for the available repair manuals and to make the necessary arrangements for training personnel in implementation and maintenance.

 Warning	Some user manuals and maintenance manuals that come with the generating sets have instrument units and show the starting and stopping procedures for the engines. For the generating sets fitted with command and control boxes that are specific to the sets, only the information that appears in the documentation for the sets' boxes should be taken into consideration. Based on this and depending on the manufacture criteria for the generating sets, some engines may be fitted with specific electric cables different from those described in the engine's documentation.

1.1.2 Description of the reference material

The reference material supplied with the generating sets gives all the user and maintenance procedures for the generating set or power station.
This reference material enables you to get to know the equipment, operate it and maintain it, both on a daily basis and periodically. The reference material for the engines and alternators fitted to the sets consists of engine user and maintenance manuals (from the manufacturer) alternator user and maintenance manuals (from the manufacturer).

The reference material contains:

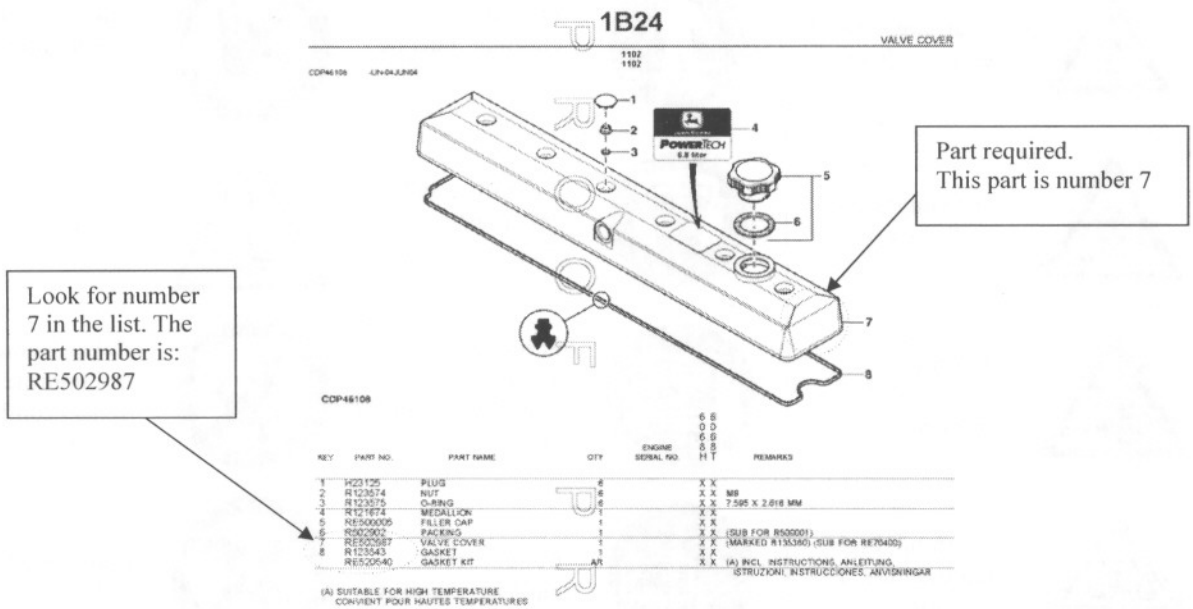
- ✓ the user and maintenance manual, containing among other things:
  - o general recommendations and safety regulations to be adhered to
  - o general recommendations for installing generating sets
  - o general instructions for preparing generating sets before putting them into operation
  - o tables of capacities (lubricants and coolants) and fuel tanks for different engines that may be fitted to the sets according to their configurations
  - o specific maintenance instructions
  - o descriptions and/or maintenance instructions for certain optional equipment.
- ✓ the user manual for the control unit (if fitted)
- ✓ wiring diagrams (these diagrams are supplied with the reference material or delivered with the generating set)
- ✓ the user and maintenance manual for the engine fitted to the set
- ✓ the maintenance manual for the alternator fitted to the set

The reference material may also include:

✓ the spare parts catalogue for the engine fitted to the set which enables a qualified user to identify a part and order it.

Layout: nomenclature (number, description, reference) and illustrations (with numbers).

These parts catalogues are generally only available in English, regardless of the engine manufacturer. Nevertheless, parts can still be identified for the purposes of ordering. A part can be identified from the illustrations in these catalogues and a part number can be found in the corresponding nomenclature for ordering (see the following example).



✓ the workshop/repair manual which contains information necessary for major maintenance work on a generating set or power station and which allows an experienced user to carry out a repair after a fault or damage of some description.

The manual includes: Illustrated text (e.g. labels, notes, procedures, operation time, skills prerequisites) and a list of tooling.

This reference material is generally written in English regardless of the engine manufacturer.

1.2.Pictograms and their meanings

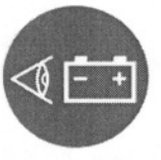
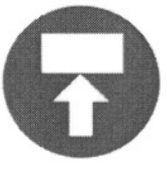
 Warning danger	 Publications delivered with the generating set must be referred to	 Warning, risk of explosion
 Warning, risk of electric shock	 Protective clothing must be worn	 Entry prohibited to non-authorised persons
 Warning, toxic materials	 Your eyes and ears must be protected	 Earth
 Warning, pressurised liquids	 Periodic maintenance must be carried out	 Naked flames and unprotected lights prohibited. No smoking
 Warning, high temperature, risk of burns	 Battery level must be checked	 Extinction by water prohibited
 Warning, rotating or moving parts (risk of getting caught in the machinery)	 Lifting point required	 When on a trailer, earth the set before starting it
 Warning, corrosive product	 Stacking point required	 Emergency cut-out

Diagram 1.1 : . Pictograms and their meanings

1.3.Instructions and safety regulations

THESE SAFETY GUIDELINES ARE IMPORTANT

If you do not understand or have any questions about any point in this manual, contact your dealer who will explain it to you or give you a demonstration. A list of risks and precautionary measures to take follows. You should also refer to any local and national regulations that apply in accordance with your own jurisdiction.

KEEP THIS MANUAL

This manual contains important instructions which must be followed when installing or carrying out maintenance on a generating set or batteries.

1.3.1 General advice

- Read and understand the manuals provided with the generating set in full.
- Do not wear loose clothing and do not go near the machines when operating. Note that the fans are not clearly visible when the engine is running.
- Warn all people present to keep well back during operation.

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- The generating set should always be controlled by an experienced person.
- Always test the generating set from the control panel.
- Follow the maintenance table and its directions.
- Never let anyone else use the generating set without having first given them the necessary instructions.
- Do not start the generating set without first removing the protection cover and closing all of the openings.
- Engine with turbocharger: never start the engine without fitting the air filter. The rotating compressor wheel in the turbocharger can cause severe physical injury. Foreign objects in the intake duct can cause mechanical damage.
- Engine with air preheating (starter components): never use starter aerosol or similar product as starter assistance.
  When it comes into contact with the starter component, an explosion may occur in the inlet manifold and lead to physical injury.
- Never let a child touch the generating set, even when not in use. Avoid using the generating set in the presence of animals (can distress the animal).
- Never start the engine without an air filter or exhaust.
- Always follow current local regulations regarding generating sets and use of fuel (petrol and gas) before using your generating set.
- Never use sea water or any other electrolitic or corrosive product in the coolant circuit.

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- Disconnect the battery and pneumatic starter (if there is one) before carrying out any repair, to prevent the engine from starting accidentally. Fit a panel over the controls to prevent any attempt at starting.
- Do not modify the engine.
- Only use the correct techniques for turning the crankshaft to rotate the crankshaft manually. Do not try to rotate the crankshaft by pulling or exerting force on the lever on the fan. This method can cause serious physical or material harm or damage the fan blade (s), leading to premature breakdown of the fan.
- Always use tools in good condition. Check that you have understood how to use them before starting a procedure.
- Only fit original spare parts.
- Use tools that correspond to the work being carried out.
- Clean all traces of oil or coolant with a clean cloth.
- Never use petrol or other flammable substances to clean parts. Use only approved cleaning solvents.
- Do not use a high-pressure cleaner for cleaning the engine and fittings. The radiator, hoses, electrical components etc. could be damaged.
- Avoid accidental contact with parts that reach high temperatures (exhaust manifold, exhaust)
- Engage the parking brake when the generating set on its trailer is installed on the operating site.

- When setting on a slope; check that no-one is behind the trailer.
- Goggles should be worn when carrying out maintenance operations and watches, bracelets etc. should be removed.

1.3.2 Risks related to feed gas (concerns gas sets)

Danger	The gas is explosive. It is forbidden to smoke, go near or create sparks when the tank is being filled and near to the generating set.

- Request the user technical notes and LPG or NG safety data sheets from your gas supplier.

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- Gas installations must be installed, maintained and repaired by recognised specialists.
- Do not attempt to open, unseal or intervene in gas supply pressure relief valves and on the gas line in general.

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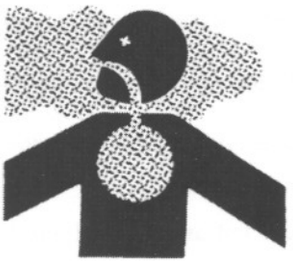
- Gas supply procedures must be carried out in fresh air (outside) in accordance with local regulations, in an area well away from fire, people or animals.

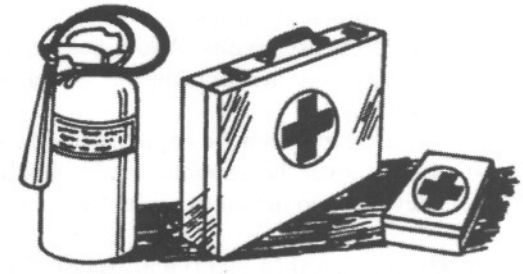
1.3.3 Risks related to exhaust gases and fuels

Danger	Generating sets should not be operated in unventilated



- Always follow the local regulations in force regarding generating sets and use of fuel (petrol, diesel and gas) before using your generating set.
- Fuel filling should be carried out when the engine is stopped (except for sets with an automatic filling system)
- Engine exhaust gases are toxic: do not operate the generating set in non ventilated areas. When installed in a ventilated area, the additional requirements for protection against fire and explosions must be observed.
- If a burnt gas exhaust leaks, the generating set may become more noisy. In order to be sure of its efficiency, you should periodically examine the burnt gas exhaust.
- Pipes must be replaced as soon as their condition requires it.

1.3.4 Risks related to toxic products

 Warning	The corrosion inhibitor contains alkali. This substance should not come into contact with the eyes. Avoid any prolonged or repeated contact with skin. It should not be swallowed. In the event of skin contact, wash thoroughly with water and soap. In the event of contact with eyes, rinse immediately with plenty of water for at least 15 minutes. CALL A DOCTOR IMMEDIATELY. KEEP THE PRODUCT OUT OF THE REACH OF CHILDREN. The anti-rust product is toxic and dangerous if absorbed. Avoid any contact with skin or eyes. Read the instructions on the packaging.	Glycol is a toxic product and dangerous if absorbed. Avoid any contact with skin or eyes. Read the instructions on the packaging. 

- Never expose the equipment to liquid splashes or rainfall, and do not place it on wet ground.
- Always use the recommended fuels. Using low quality fuels risks damaging the engine and altering performance
- The battery electrolyte is harmful to skin and especially eyes. If splashes get into eyes, rinse immediately with running water and/or a 10% diluted boric acid solution.
- Wear protective eyewear and strong base resistant gloves for handling the electrolyte .

1.3.5 Risk of fire, burns and explosion

 Danger	The engine should not be operated in areas containing explosive products. There is a risk of sparks forming where all electrical and mechanical components are not shielded.




- Beware of creating sparks or flames and do not smoke near batteries as the electrolyte gases are highly flammable (especially when the battery is being filled). Their acid is also harmful to the skin and particularly the eyes.
- Never clean, lubricate or adjust an engine when it is in operation (unless you are qualified to do so, in which case extreme care must be taken to avoid accidents)
- Never make adjustments that you are not familiar with.
- Never cover the generating set with any material while it is working or just after it stops (wait until the motor cools down)
- Do not touch hot components such as the exhaust pipe and do not put combustible material on them.
- Keep all flammable or explosive products (petrol, oil, cloth, etc.) well away when the set is running.
- Good ventilation is required for your generating set to work properly. Without ventilation, the engine will quickly reach an excessive temperature that could lead to accidents or damage to the equipment and surrounding items.
- Do not take off the radiator cap when the engine is hot and the coolant is pressurised due to risk of burns.

- Depressurise the air, oil and coolant circuits, before removing or disconnecting any unions, ducts or connected components. Be aware of any possible pressure that might be present when disconnecting a device from a pressurised system. Do not look for pressure leaks manually. High pressure oil can cause physical accidents.
- Some preservative oils are flammable. Also, some are dangerous to inhale. Check that ventilation is good. Use a protective mask.
- Hot oil causes burns. Avoid contact with hot oil. Check that the system is no longer pressurised before carrying out any procedures. Never start or run the engine when the oil filling cap is off as oil may be ejected.
- Never start or run the engine when the oil filling cap is off as oil may be ejected.
- Never cover the generating set with a fine layer of oil for anti-rust protection.
- Never fill up the oil or coolant when the generating set is running or when the engine is hot.

1.3.6 Risks related to electrical networks

- The electrical equipment supplied with the generating set complies with standard NF C15.100 or the standards of the relevant countries
- Read the manufacturer's identification plate carefully. The values for voltage, power, current and frequency are shown. Check that these values match the supply use.
- Never accidentally touch naked wires or disconnected connections.
- Never handle a generating set with wet hands or feet.
- Keep electrical wires and connections in good condition. Using equipment in poor condition can lead to electrocution and damage to equipment.

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- Operations should only be carried out on the generating set when the installation or the equipment is switched off.
- Electrical connections must be made in accordance with the standards and regulations in force in the country where the equipment is to be used.
- Do not use faulty, poorly insulated or temporarily connected wires.
- Do not invert the positive and negative terminals of batteries when connecting them. This could cause severe damage to the electrical equipment. Follow the wiring diagram supplied by the manufacturer.
- The generating set should not be connected to any other power sources, such as the public distribution network. In specific cases where there is provision for a reserve connection to existing electrical networks, this must only be carried out by a qualified electrician, who should take the operating differences of the equipment into account, according to whether the public distribution network or generating set is being used.
- Protection against electric shocks is ensured by an assembly of specific equipment. If the assembly needs to be replaced, it should be replaced by components with identical nominal values and specifications.
- If protection plates (blanking covers) need to be removed for cable routing, the plates must be put back into place after the work has been carried out.
- Due to strict mechanical specifications you should only use flexible resistant rubber sleeved cables or equivalent wires which comply with CEI 245-4.

1.3.7 Dangers presented by electric currents (first aid)

First aid
In the event of an electric shock, cut off the voltage immediately and activate the set's emergency stop. If the voltage has not yet been cut off, move the victim out of contact with the live conductor as quickly as possible. Avoid direct contact both with the live conductor and the victim's body. Use a dry plank of wood, dry clothes or other non-conductive materials to move the victim away. The live wire may be cut with an axe. Take extreme care to avoid the electric arc that results from this.

Begin emergency procedures

Resuscitation
If breathing has stopped, begin artificial respiration at once in the same place the accident took place unless the victim or operator's life could be endangered by this.
In the event of cardiac arrest, carry out cardiac massage.

1.3.8 Risks related to moving the set

- Use lifting units to lift the generating set. Always make sure that the lifting equipment is in good condition and has a sufficient lifting capacity.
- In order to work in complete safety and prevent the components fitted to the top of the engine from being damaged, the engine should be lifted with an adjustable boom. All chains and cables should be parallel to one another and as perpendicular as possible to the top of the set.
- If other equipment fitted to the generating set alters its centre of gravity, special lifting devices may be required to maintain the correct balance for working in total safety.
- Never carry out work on a generating set that is suspended on a lifting device only.

1.3.9 Recommendation for the operator and environment

- Operating personnel should be aware of the safety and operating instructions. These will be regularly updated.
- Operating should be monitored, directly or indirectly, by someone designated by the operator who is familiar with the installation and dangers and problems regarding products stored and used in the installation.
- No-one from outside the establishment should be able to access the installations freely, unless designated by the operator.
- The user should check the service pressures of the different pressure stages, making sure that they are in accordance with the prescribed operating requirements. The user is also responsible for making the apparatus adjustments according to the manufacturer's instructions and should check that the apparatus is operating correctly.
- The user should create or obtain a document describing modifications and showing alterations made to the installations in relation to the original document.

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- Manufacturers' notes should be available to technical staff, on site if possible.
- The internal network diagram should be displayed as close as possible to the access points showing all the individual points. Internal and external network information can be contained in a single distribution diagram.
- A sign on the door identifies and gives details of the operating company and includes the telephone number for the gas supplier emergency department.
- Personnel should be aware of the layout of the premises and they should be identified on site to simplify procedures. In the event of a problem, this type of knowledge about installations is crucial when poor identification of the premises might make a situation worse.

- Written operating instructions must be available for operations that involve dangerous handling procedures and driving installations. In particular, these instructions prescribe:
  - ✓ Operating modes
  - ✓ Frequency of testing for safety devices and devices for handling pollution and other harmful substances generated by the installation
  - ✓ Methods for maintenance, checking and use of adjustment equipment and safety devices.

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- The operator should make the necessary arrangements to satisfy site aesthetic requirements. The whole site must be kept clean and in good condition.
- The premises must be kept clean and cleaned regularly with in order to avoid piles of dangerous or pollutant material or dust that could be susceptible to catching fire or causing an explosion. The cleaning equipment must be adapted to accommodate the risks presented by such products and dust.
- The presence of dangerous or combustible materials on premises where combustion apparatus is sheltered is limited to what is required for the operation.
- The installations must be operated under the constant supervision of a qualified person. This person should periodically check that the safety devices are working properly and ensure the correct fuel supply to the combustion apparatus.
- Apart from combustion apparatus, flames in any form are prohibited. This should be displayed in bold on a sign.
- Residual water, mud and waste spray is prohibited.
- The fuels to be used should correspond to the ones in the declaration file and the specifications prescribed by the combustion apparatus manufacturer.
- The fuel is considered as being in the physical state that is introduced into the combustion chamber.
- Burning waste in the open air is prohibited.
- Except for where a specific agreement has been made, once the gas supply main unit has been closed, it can only be reopened by the gas distributor. However the user may conditionally have access to it. Check for each site.
- Always protect your hands when detecting leaks. Pressurised fluids can enter body tissues and cause severe harm. Risk of blood poisoning.
- Drain and discard engine oil in a designated container (the fuel distributors can collect your used oil).

1.4.Generating set features

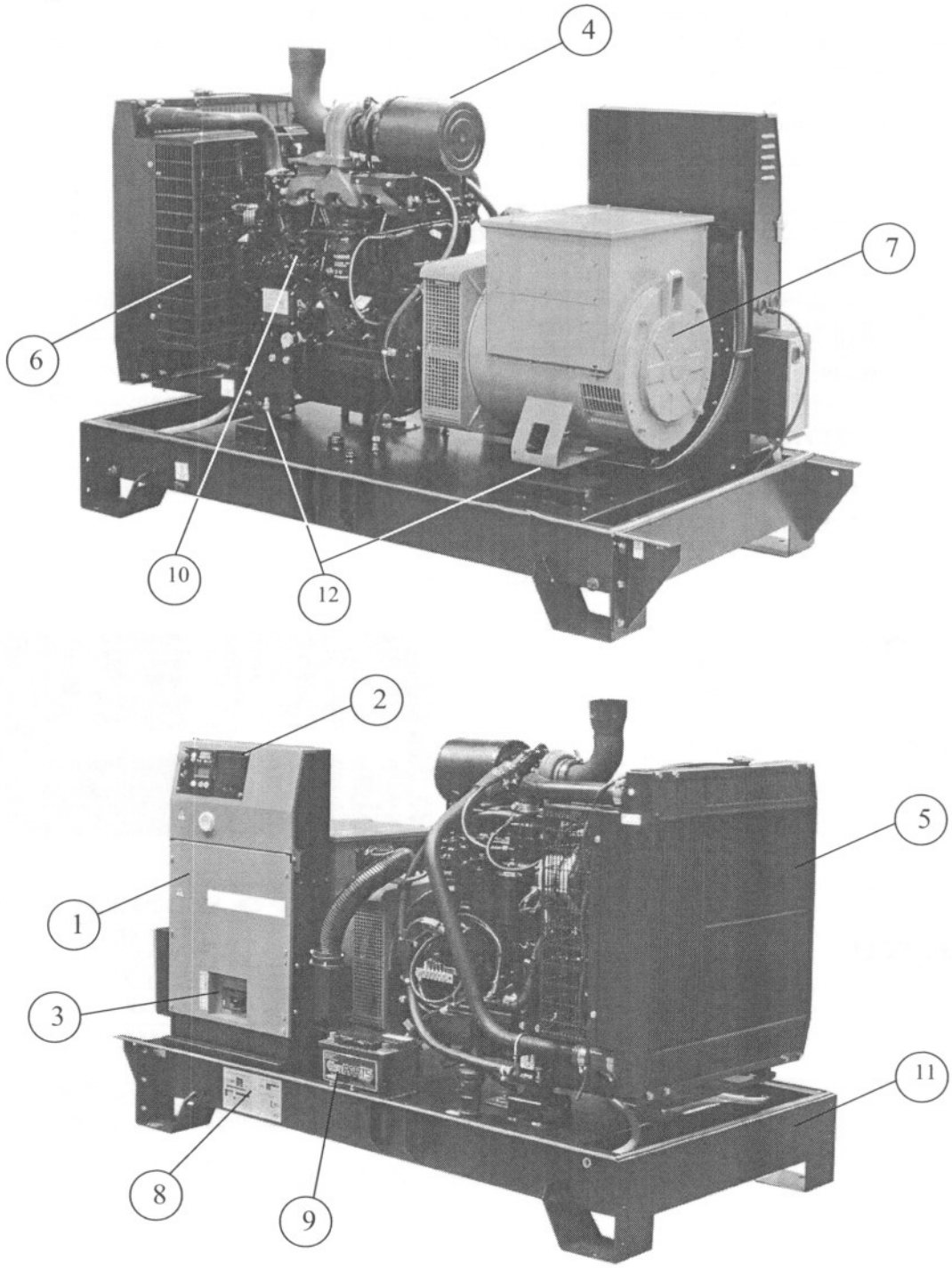


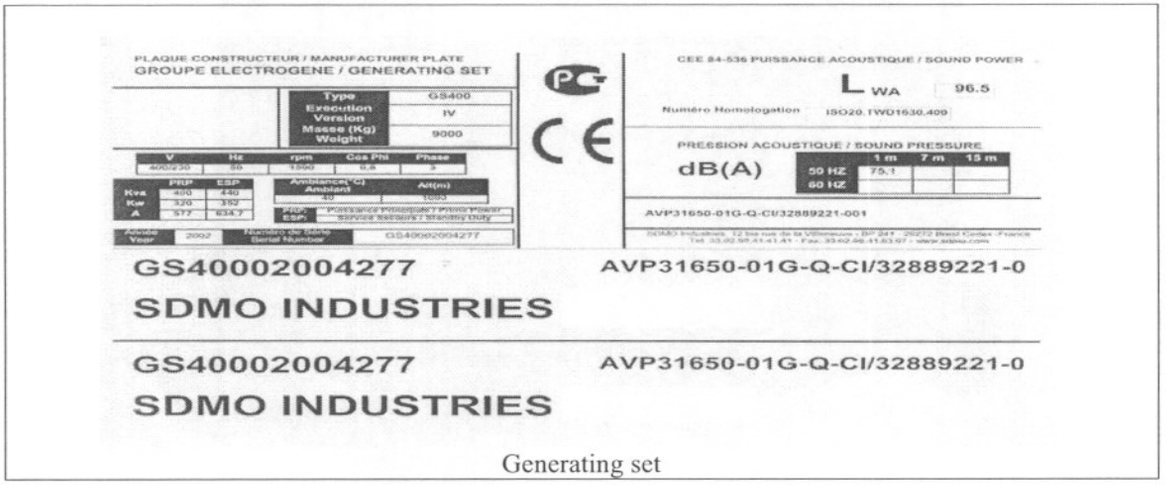
Figure 1.4.: Main features of a generating set

1	Console	5	Radiator	9	Starter battery
2	Control unit	6	Protective grille for rotating parts	10	Engine
3	Circuit breaker	7	Alternator	11	Chassis
4	Air filter	8	Identification plate	12	Suspension mounts

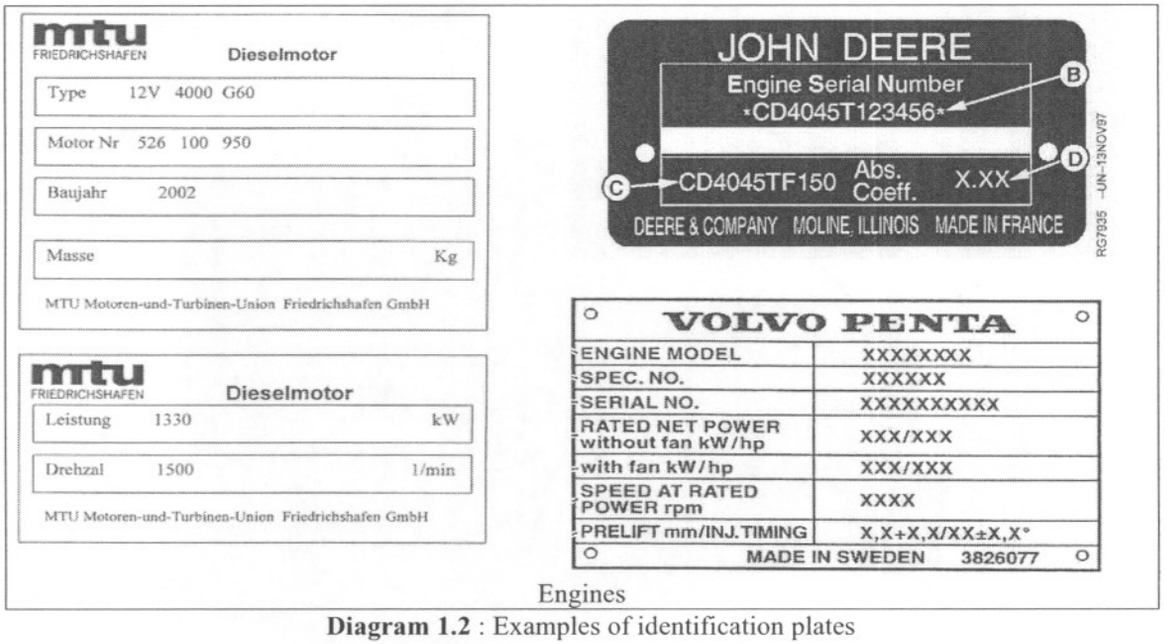
1.5.Identifying sets

Generating sets and their components are identified by means of identification plates.
The precise rules for identifying each major component (engine, alternator etc.) are set out in each manufacturer's documents contained in this manual.

Examples of identification plates

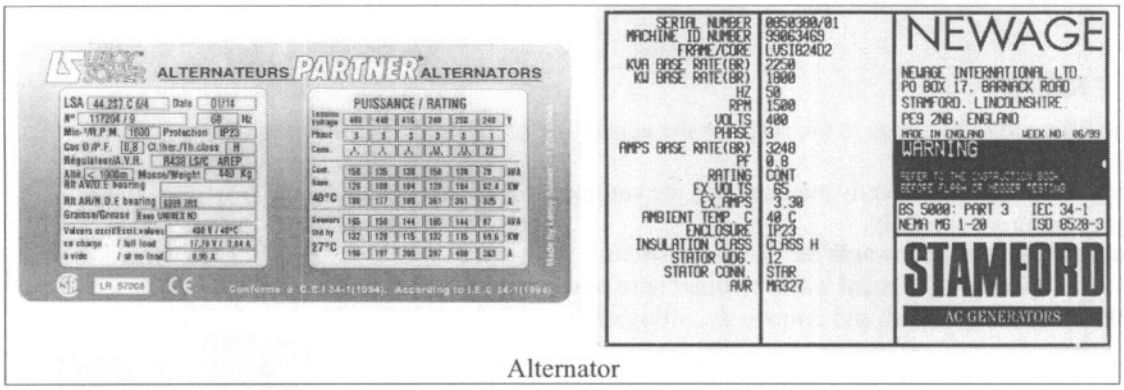


Generating set



Engines

Diagram 1.2 : Examples of identification plates



Alternator

Designation : ARMOIRE DE 400KVA
A0217010
Cde : AVP31650-01C
Reference SOREEL : 371562.03
No OF : 02280753

Cabinet

Diagram 1.3 : Examples of identification plates

2. Installation

⚠ Warning	Sections 3, 4 and 5 contain only general recommendations. It is recommended that you use a professional to ensure correct installation and start-up. The company cannot be held responsible for breakdowns related to the conditions of installation.

2.1.Unloading

2.1.1 Safety during unloading

In order to unload generating sets from their transport mountings, under optimum conditions of safety and efficiency, you should check that the following points are being followed correctly.

- Suitable lifting vehicles or equipment for the work.
  - Slings positioned in the rings provided for this procedure or lifting arms resting fully underneath the frame cross beams.
- Suitable ground to accommodate the load of the set and lifting vehicle, without strain (if not, put down sufficiently strong and stable boards).

Remove the set as close as possible to its place of use or transport, in a clear space with free access.

2.1.2 Example of equipment used

- crane, slings, lifting beam, safety hook, shackles.
- fork lift truck.

2.1.3 Instructions for unloading

2.1.3.1. Slings

- attach the lifting vehicle slings to the rings on the generating set designed for this procedure.
- hang the slings carefully.
- check that the slings are correctly attached and the equipment is solid.
- lift the generating set carefully.
- direct and stabilise the set towards the chosen position.
- carefully set down the equipment while continuing to position it.
- release the slings, then detach and remove the lifting rings.

⚠ Warning	The slings must be perpendicular to the frame in order not to interfere with the set (no rubbing).

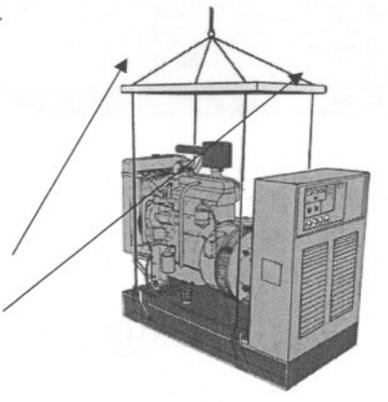


Diagram 2.1 : Hoisting a generating set

2.1.3.2. Fork lift truck

- position the arms of the fork lift under the frame, making sure that only the cross beams are resting on the arms.
- lift and handle the equipment carefully.
- set down the generating set in its unloading position.

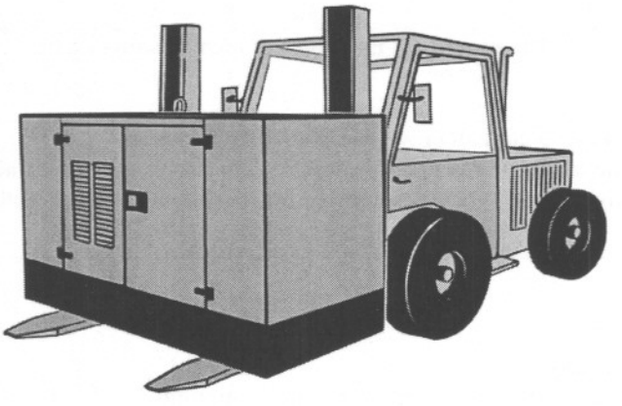


Diagram 2.2 : Transporting a generating set on a fork-lift truck

2.2.Handling instructions

- carefully lift the edge on the engine side with 2 jacks then slide 3 pipes under the frame
- leave the frame under the pipes then move the set by pushing manually.
- while the set is being moved, use the freed pipes by sliding them one after another under the frame.
- when it has reached the desired location, position the set then lift it up using jacks to support it.
- remove the pipes and put down the set checking that it is in the correct position, then remove the jacks.

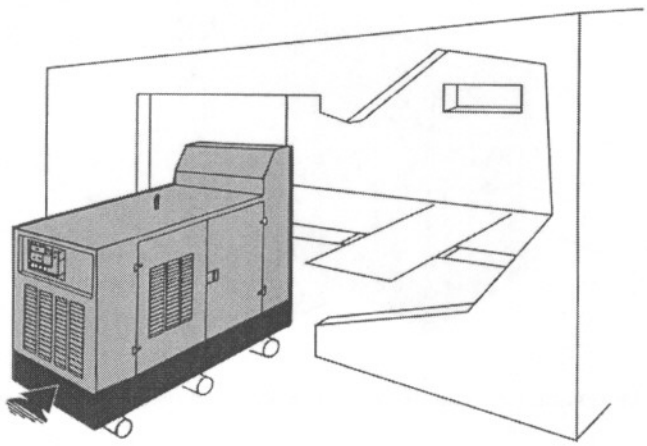


Diagram 2.3 : Handling a generating set using rollers

It is recommended to use a fork lift truck with arms that are longer than the width of the frame

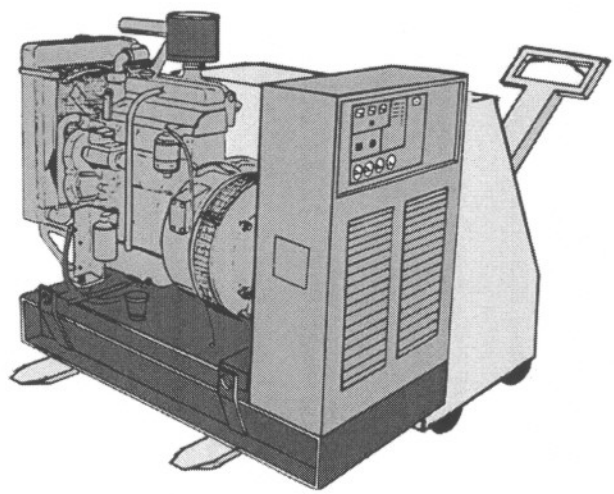


Diagram 2.4 : Handling a generating set with a pallet truck

If you are using a rail or crab once it is in position, continue in the same way as described in the "slings" paragraph

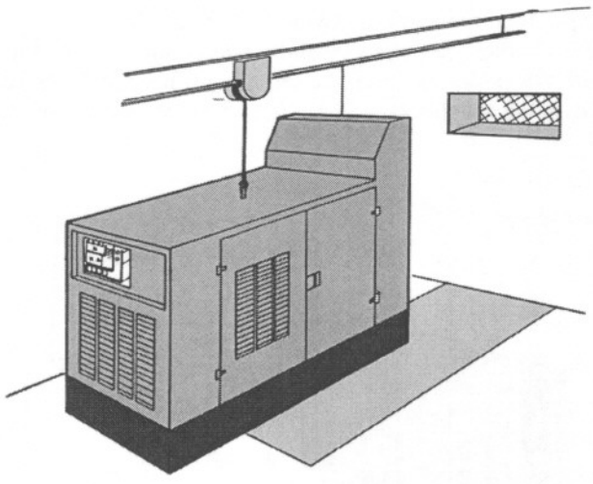


Diagram 2.5 : Handling a generating set using a mobile winch

2.3.Installation of fixed sets

NOTE
If you do not follow the basic principles, the installation assembly will suffer damage and abnormal wear. The procedure described gives the main requirements for installing a "conventional" generating set made up of a heat engine, a generator and electric panel. These requirements are general principles to be observed. For any specific applications or if you have any doubts, our technical departments will advise you and look at your specific conditions of installation. The current regulations, provisions and laws in installation locations must be adhered to.

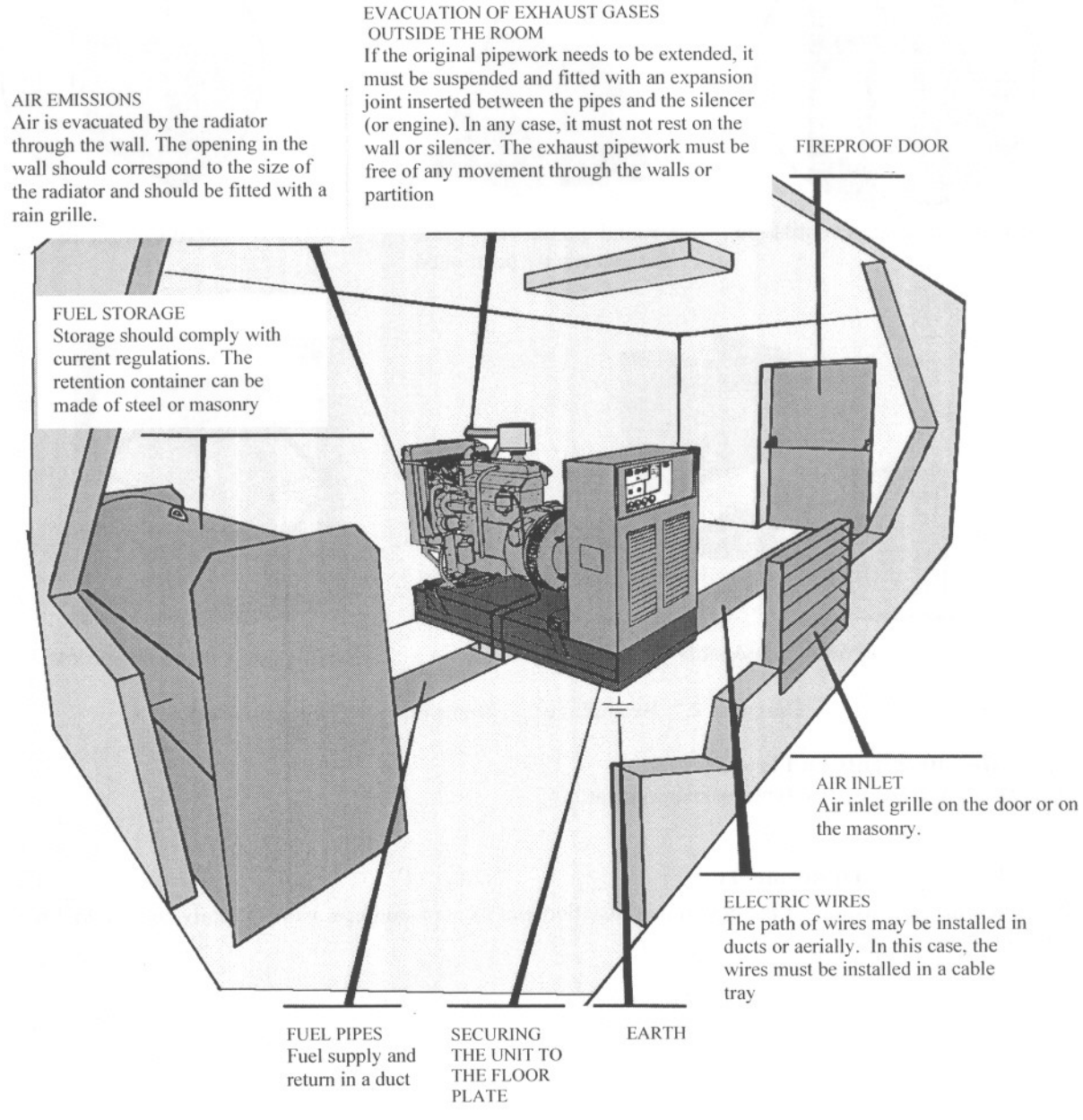
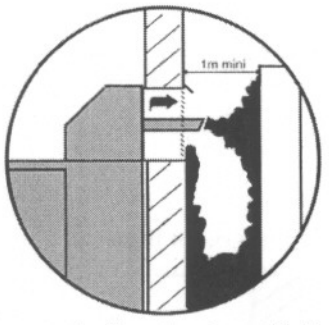


Diagram 2.6 : Example of a generating set site

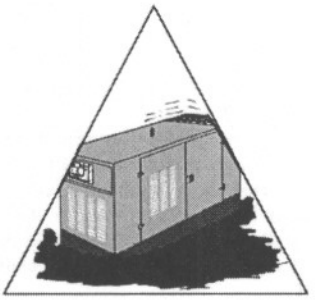
2.3.1 Position

It should be determined on the basis of use. There are no specific rules governing the choice of location, other than proximity to the electric distribution panel and disturbances caused by the noise. However, fuel supply, burnt gas evacuation, and the direction of these gases and the noises emitted should be taken into account.
The choice of its position will be based on carefully considered compromise!

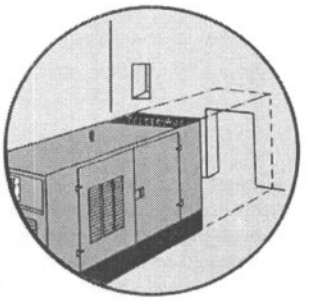
Examples of problems that may be encountered:



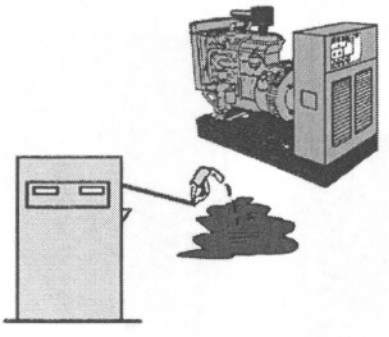
Incorrect exhaust and ventilation



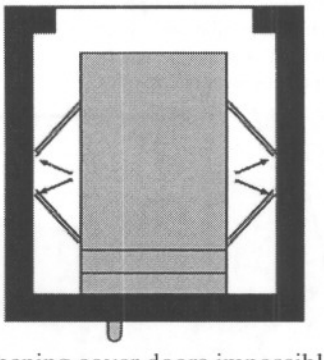
Ground too uneven or soft.
Set incorrectly positioned



Reduced access



Fuel filling impossible



Opening cover doors impossible

Diagram 2.7: Examples of problems that may be encountered

2.3.2 Measurements and layout

These are governed by two types of requirement:

2.3.2.1. Static requirements

These are the dimensions of the equipment installed and its surroundings, namely: daily service fuel tank, cabinet, silencer, batteries etc.

2.3.2.2. Dynamic requirements

These are the measurements to be adhered to between each piece of equipment to allow for refitting and possible removal.
About a 1 metre space around the set is considered the minimum required for carrying out problem-free maintenance. This will give enough space to check that the doors of covered sets open fully, that equipment can be accessed for maintenance and that integral removal of the set can be carried out.

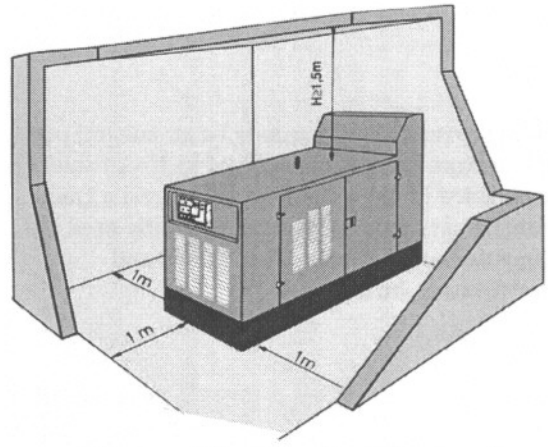


Diagram 2.8 : Example of the size of a covered generating set site

2.3.2.3. Construction

All sorts of shelters can be designed to house a generating set.
If noise level and speed of starting are not the main considerations in your choice, it can be installed under a basic shelter to protect it from bad weather (rain, snow, storms, etc.).
If a low noise level and fast start are important criteria, (e.g.: emergency set or noise sensitive area), particular attention will be given and the room will be built of framing concrete or solid concrete blocks 20 cm minimum, covered in absorbent fireproof and insulating material.

Warning	The fire test should comply with current legislation according to the type of building.

2.3.2.4. Base of the set

An operating generating set generates a certain amount of vibratory energy. This vibratory energy makes its way to the floor plate via the frame. As a rule, our generating sets do not require a specific floor plate as they are fitted to elastic mountings. However, the floor plate will be sufficiently strong and detached from the rest of the construction. It will also be level, smoothed by the flow and unshackled.
If there is a risk of vibrations being transmitted, the set can be mounted on a vibration-mounted floor plate insulated if necessary by a resilient material.
This solution is mainly used with very powerful generating sets.

2.3.2.5. Openings

The room should include a certain number of openings which are required for it to operate:
- a door, giving access to the generating set and its accessories, preferably in line with the set's floor plate
- ventilation openings (fresh air inlet and hot air outlet) located so that scavenging takes place in the direction from the alternator towards the engine. Their surfaces depend on the power of the generating set being installed, general atmospheric conditions, the cooling system selected and the soundproofing procedure.

2.3.2.6. Lifting

The lifting system should usually be an integral part of the construction. It is made up of an H or I steel rail, embedded in the walls and ceiling, and a crab. It should be easy to handle and is generally used on top along the longitudinal axis of the set and directed towards the exit.

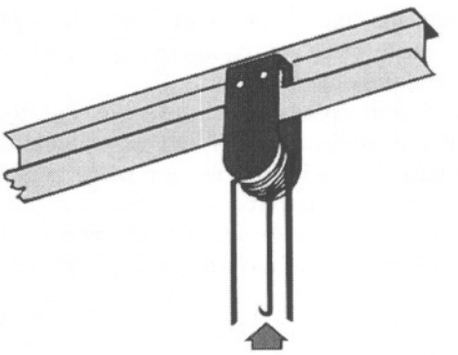


Diagram 2.9 : Example of a lifting system

2.3.2.7. Soundproofing

The room is soundproofed using two procedures:

Insulation:

This prevents the noise from crossing the walls, and in this case, it is the weight then thickness of the wall that is important.

Absorption:

These are materials that absorb sound energy and this procedure will be used on ventilation openings. As a result of this, the air inlet and outlet sections are increased.

The internal lining of the room can also be covered with absorbent material designed to lower the sound level in the room, and consequently through the walls, ventilation openings and door.

General arrangements

- building structure made from framing concrete or solid concrete blocks, 20 cm thick minimum
- anti-vibrating floor plate under the generating set when adjoining sensitive areas.
- ceiling and walls covered if necessary with absorbent materials
- choice of adapted exhaust silencer(s).
- soundproofed door for access to the room and, if required, to the pressure lock, for a very low sound level.
- sound traps fitted to the air inlet and outlet sleeves.

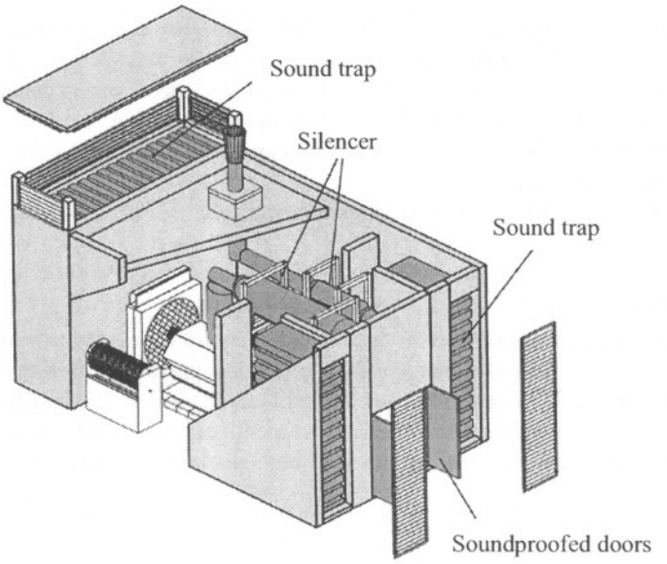


Diagram 2.10 : Example of an installation

2.3.2.8. Ventilation

A heat engine generates a certain amount of heat, which must be evacuated outside the room to ensure the set works properly.
The heat released by the set originate from different sources:
- cylinder cooling
- radiation from the engine unit and exhaust duct
- alternator cooling.

Also the room must be fitted with air inlet and outlet openings suitable for the conditions of use and cooling system. As you know, insufficient ventilation will cause the atmospheric temperature to rise and lead to problems ranging from, at least, a loss of engine power to the set stopping altogether.
Air must flow through the set room from alternator ⇨ engine ⇨ radiator.
This solution also supplies the quantity of fresh air needed for combustion. The openings should be of ample size.
Air intake and emission will be as direct as possible. The cooling system will be connected to a sealed emission sleeve or cover to prevent hot air from being recycled. The air inlet and emission openings should not be located close to one another.

 Warning	Crankcase ventilation The vapours from the crankcase should preferably be removed outside the room in which the generating set is located, to prevent these vapours from being deposited on the radiator, causing it become dirty and thereby reducing its cooling capability.

2.3.2.9. Fuel

Since the fuel is classed as a "dangerous product", certain regulations for storage and distribution must be followed. It is also necessary to consult current laws when carrying out the installation.
It is usual to fit fixed installations with a daily service tank and storage tank. These two tanks can be joined into one if the generating set consumption is low.

Warning	Do not used galvanised receptacles or brass coated receptacles for storing fuel.

Manual filling tank
Solution for a manual starting generating set that is visually monitored. This tank is often part of the frame and has a mechanical gauge, filler neck and drain port.

Automatic filling tank located in the room
Solution for automatic starting generating sets. The tank is automatically filled by an electric drawing pump in a main storage tank.
This type of installation is subject to regulations. Moreover, it should be fitted with a retention container capable of collecting leaks with a capacity at least equal to that of the tank. There must be an overflow pipe going back to the main tank. Its section should be at least twice that of the supply pipes.
To prevent unpriming, the tank is fitted slightly filled in relation to the diesel engine (except in covered parking areas).
This tank must also be fitted with a shut-off valve for which the control must be located outside the room.

1 - Double lined storage tank
2 - Leak testing cell
3 - Filling port
4 - Shut-off valve control unit
5 - Safety valve control unit
6 - 600 L retention container
7 - 500 L daily service tank
8 - Gauge with level switch
9 - Manual pump
10 - Electric pump
11 - generating set
12 - Vent
13 - Safety valve
14 - Shut-off valve
15 - Earthing
16 - Electric fuel level gauge
17 - Anti-return valve with strainer
18 - Concrete floor plate
19 - Anchoring belt (1/m)
20 - Pits
21 - Pipe passage
22 - Access plug
23 - Drains
24 - Min hole: 0.70 x 0.70
25 - Type and capacity label

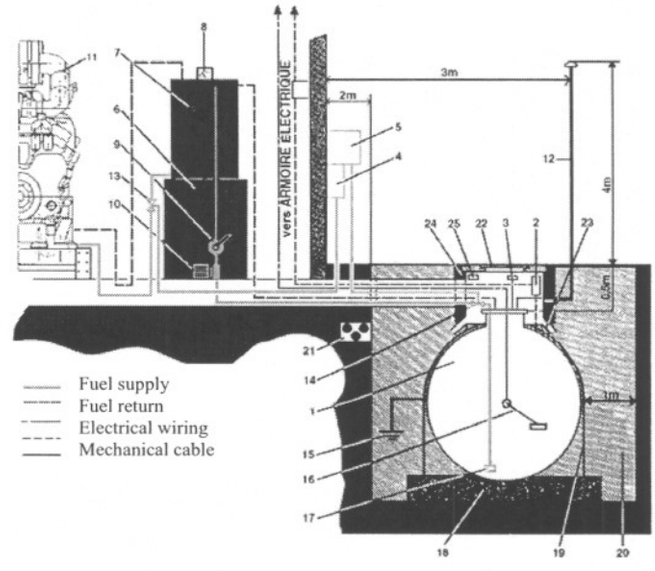


Diagram 2.11 : Example of an installation

2.3.2.10. Burnt gas exhaust : general information

Studying the evacuation of burnt gases by a generating set should not be seen as a minor detail due to the fact that a pipe can always be installed, even in the most inaccessible areas. In fact, there are a certain number of constraints to be considered such as drops in pressure caused by the exhaust, insulation, suspension, noise level and air pollution. It should be noted that the more complicated a circuit, the more it causes drops in pressure and consequently, its diameter will be large and heavy and its supports and silencers expensive.

NOTE
Generating sets with a silencer fitted in the enclosure must be fitted with an exhaust compensator. This compensator or hose will be fitted to the exhaust outlet in the cover.

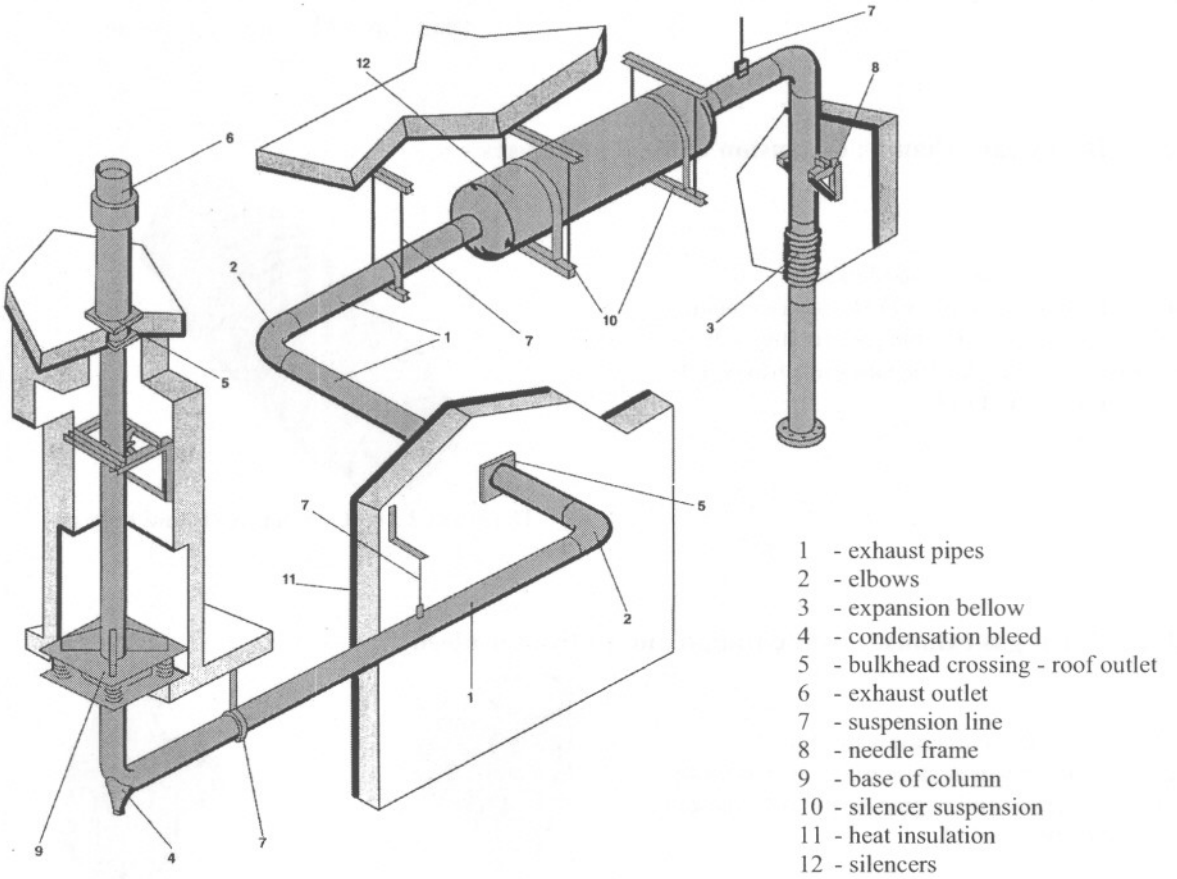


Diagram 2.12 : Example of an installation

The installer must check that all the components installed on the exhaust pipe do not cause pressure drops greater than the engine's admissible pressure.

2.3.2.11. Burnt gas exhaust : pipes

Figure 1 : Pipes
It is recommended that you use seamless pipes. However, for weight reasons, rolled steel pipes can be used. In any event, welded "bars" inside the duct are to be avoided.

Figure 2: elbows
The elbow should have a minimum curve radius of 2D if possible in a single component. If the elbow is made of welded steel, check that it includes at least 3 sectors for 90° elbows.

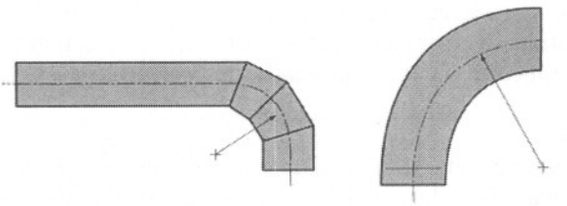


Diagram 2.13 : Pipes and unions

2.3.2.12. Burnt gas exhaust : expansion bellows and hoses

Figure 3: expansion bellows and hoses
- expansion bellow : absorbs sideways movements due to expansion (approx 1mm/metre/100° C).
- hose: allows for considerable sideways travel, but low longitudinal amplitude.

Diagram 2.14 : Compensators and hoses

2.3.2.13. Burnt gas exhaust : condensation and rainwater bleed

Figure 4 : condensation and rainwater bleed
Allowed for in the lower section of the installation, to protect the silencer and engine or for any changes in horizontal/vertical travel.

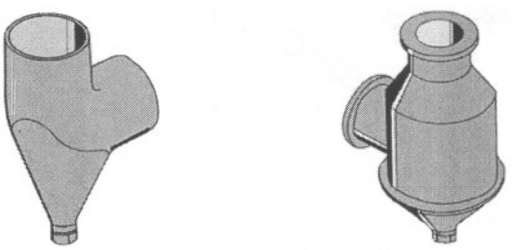


Diagram 2.15 : Bleed valves

2.3.2.14. Burnt gas exhaust : bulkhead crossing - roof outlet

Figure 5 : bulkhead crossing - roof outlet
For each bulkhead passage and roof outlet.

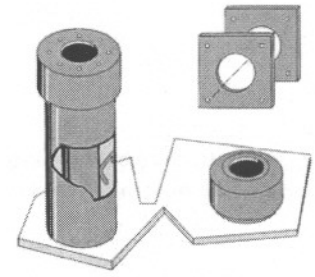


Diagram 2.16 : Bulkhead connectors

2.3.2.15. Burnt gas exhaust : exhaust outlet

Figure 6: exhaust outlet
The exhaust outlets disperse the gases in the atmosphere and protect the inner section of the pipes from bad weather.

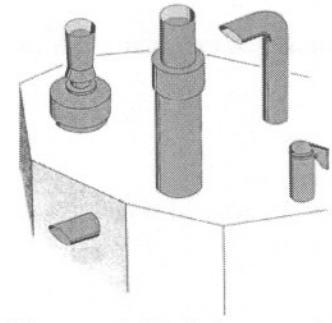


Diagram 2.17 : Exhaust outlet

2.3.2.16. Burnt gas exhaust : suspension line

Figure 7: suspension line
Generally made up of a flat iron ring attached to the ceiling. The suspension line enables the pipes to expand freely.

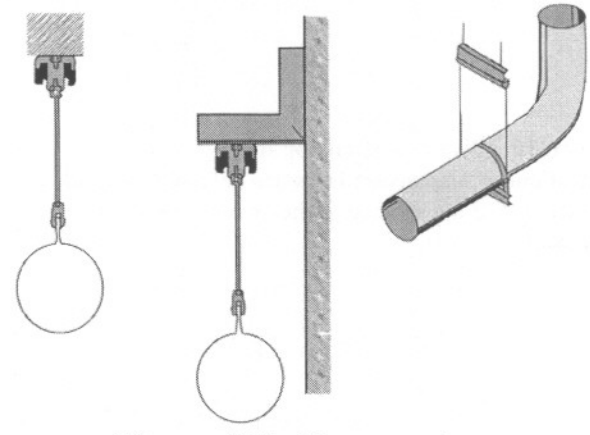


Diagram 2.18 : Pipe suspensions

2.3.2.17. Burnt gas exhaust : needle frame

Figure 8: needle frame
Used for vertical sections, the needle frame allows the pipes to expand while holding them laterally.

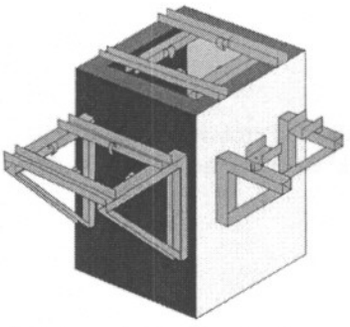


Diagram 2.19 : Needle frame

2.3.2.18. Burnt gas exhaust : column base

Figure 9: column base
The column base is designed to hold the weight of the vertical pipes.

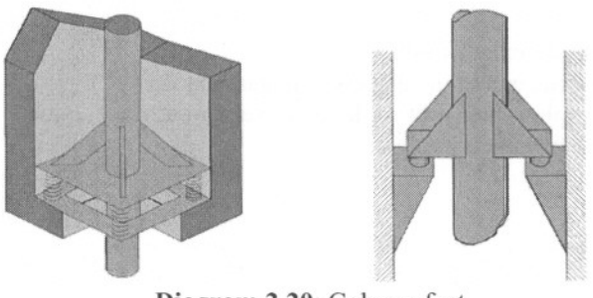


Diagram 2.20: Column feet

2.3.2.19. Burnt gas exhaust : silencer suspension line

Figure 10: silencer suspension line
The silencer suspension lines are designed to hold the weight of the silencers, they can be vertical or horizontal.

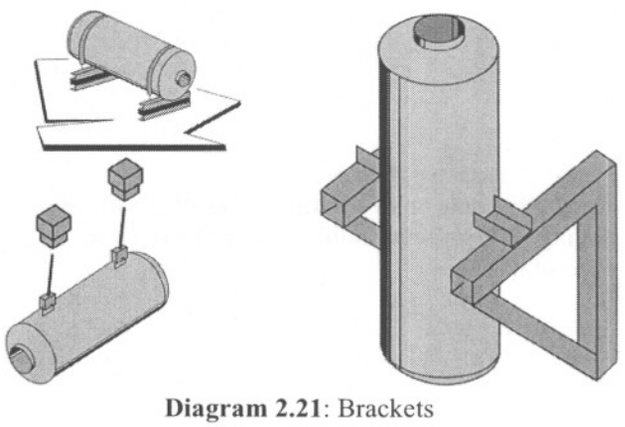


Diagram 2.21: Brackets

2.3.2.20. Burnt gas exhaust : heat insulation

Figure 11: heat insulation
Depending on the type of installation, you may have to insulate the heat released in the room.
Once it has been insulated, the surface temperature should not exceed 70 °C. The recommended material is rock wool (excluding asbestos) and eventually it can be recovered with aluminium sheets to improve the look of the installation and the thermal insulation.
50 mm thick glass wool should be considered a minimum requirement.

2.3.2.21. Burnt gas exhaust : silencers

Figure 12: silencers
These reduce noise by absorbing or causing phase differences in the sound wave. An exhaust should be effectively suspended, the supports should never rest on the set (except for original fittings). An exhaust compensator will be fitted to the engine outlet. The pipes will never have a diameter less than the set (refer to us about vermin) and be directed so that gas cannot return to the room.
The pipes should be fixed so that their weight is not supported by the compensator.
It should be perfectly straight (any misalignment could lead to a rupture).

"Adapted" silencer
The "adapted" silencer is fitted directly to the set or cover. It is an absorption type silencer.
A compensator is fitted between the engine and exhaust in the covered version'.

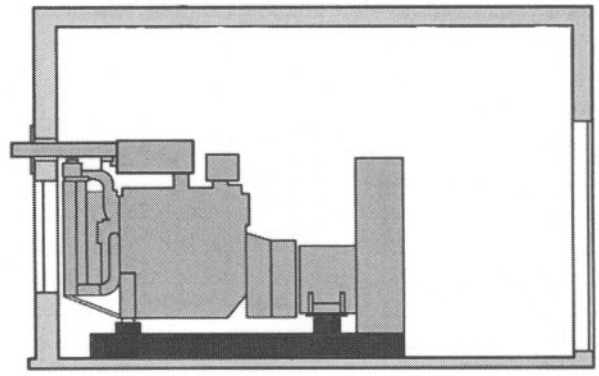


Diagram 2.22: Adapted silencer

Absorption silencer
The gas passes through a sound proof duct made of acoustic high efficiency absorbent material protected by a perforated metal sheet.

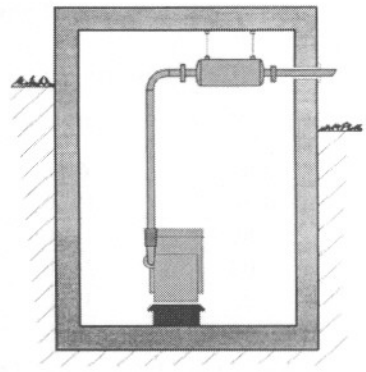


Diagram 2.23: Absorption silencer

Absorbent reactive silencer
The gas enters an expansion chamber lined with absorbent material, supported by perforated metal sheets then into an absorbent sound proof duct.

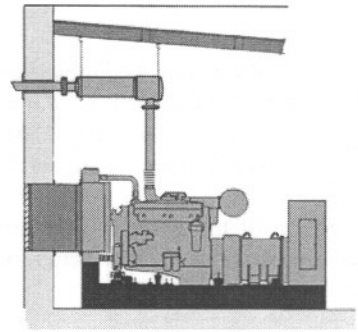


Diagram 2.24 : Absorbent reactive silencer

2.3.2.22. Electricity

a) Connections - general information

In the same way as for low voltage electrical installations, running and maintenance are subject to NF C 15.100 standard rules or the standards of the relevant country.

They must also comply with the NF C 15.401 application guide rules or with the standards of the relevant countries.

b) Power cables

These can be single-pole or multi-pole, according to the generating set output.

The power cables will be installed in a raceway or a specially provided cable run.

The cable sizes and number of cables should be determined according to the cable type and the standards in force in the country of installation.

Drain current (A)	Cable lengths		
	0 – 50 metres	51 – 100 metres	101 – 150 metres
6	1.5 mm^2	1.5 mm^2	2.5 mm^2
8	1.5 mm^2	2.5 mm^2	4.0 mm^2
10	2.5 mm^2	4.0 mm^2	6.0 mm^2
12	2.5 mm^2	6.0 mm^2	10.0 mm^2
16	2.5 mm^2	10.0 mm^2	10.0 mm^2
18	4.0 mm^2	10.0 mm^2	10.0 mm^2
24	4.0 mm^2	10.0 mm^2	16.0 mm^2
26	6.0 mm^2	16.0 mm^2	16.0 mm^2
28	6.0 mm^2	16.0 mm^2	16.0 mm^2

Table 2.1. – cable sizes - 50 Hz

Drain current (A)	Load in watts		Maximum length of cables			
	at 120 Volts	at 240 Volts	# 10 AWG (5.27 mm^2)	# 12 AWG (3.31 mm^2)	# 14 AWG (2.08 mm^2)	# 16 AWG (1.31 mm^2)
2.5	300	600	1000 ft.	600 ft.	375 ft.	250 ft.
5	600	1200	500 ft.	300 ft.	200 ft.	125 ft.
7.5	900	1800	350 ft.	200 ft.	125 ft.	100 ft.
10	1200	2400	250 ft.	150 ft.	100 ft.	
15	1800	3600	150 ft.	100 ft.	65 ft.	
20	2400	4800	125 ft.	75 ft.	50 ft.	
WARNING: a voltage which is too low can damage the equipment. AWG: American Wire Gauge.						

Table 2.2. – cable sizes - 60 Hz

c) Battery cables

Install the battery or batteries in the immediate vicinity of the electric starter motor. The cables will be connected directly from the battery terminals to the starter motor terminals.

The first instruction to follow is to check that the polarities of battery and starter motor correspond. Never reverse the positive and negative battery terminals when fitting them. This could cause severe damage to the electrical equipment.

The minimum section of the wires is 70 mm^2. It varies according to the power of the starter motor but also the distance between the batteries and the generating set (voltage drops on the line).

d) Safety guidelines

References: NFC 15-100:2002 - CEI : 60364-5-54

The generating set must be earthed. To do this, use a minimum 25 mm^2 stripped copper wire and a 16 mm^2 insulated cable, connected to the generating set earth connection and a galvanised steel earthing rod embedded vertically into the ground.

The resistance value of this earthing rod must correspond with the values indicated in the following table.

Note: use the highest differential setting from the installation as a guideline.

The resistance value is calculated in the following wa $R = \frac{Vl}{I\Delta n}$

Maximum resistance value of the earth connection R (Ω) depending on the operating current of the differential device (trigger time not exceeding 1 second)

I Δn differential	R Earth (Ω) Vl: 50 V	R Earth (Ω) Vl: 25 V
≤ 30 mA	500 A	> 500
100 mA	500	250
300 mA	167	83
500 mA	100	50
1 A	50	25
3A	17	8
5A	10	5
10A	5	2.5

The V1: 25 V value is required for worksite installations and rearing buildings, for example.

For example

For a default voltage of 25 V and default current of 30mA:

Nature of ground	Length of rod in metres	
Rich arable land, moist compact ballast	1	
Bare arable land, Bare arable land, Gravel, Coarse ballast	1	
Bare, stony ground, dry sand, impermeable rocks	3.6	To obtain an equivalent length, you can use more than one earthing rod connected in parallel and set apart by a distance which is at least their length. Example: 4 interconnected 1-metre rods separated by 1 metre.

Note: For the US (reference: National Electrical Code NFPA-70)

The generating set must be earthed. To do this, use a minimum 13.3 mm^2 copper wire (or AWG 6 at most), connected to the generating set earth socket and a galvanised steel earthing rod fully embedded vertically into the ground.

This rod fully embedded in the ground must have a minimum length of 2.5 m (8 ft).

2.3.2.23. Cooling

Three types of heat production must be dissipated:
- heat from the engine cooling circuit(s)
- heat radiating from the engine and exhaust
- ventilation air from the room
- exhaust gases

The systems described below evacuate and pipe the heat produced by the engine cooling circuit.

a) Ventilated radiator
The engine cooling circuit is connected to a tubular ribbed radiator at the end of the frame in order to implement this procedure. This radiator is cooled by the fan controlled directly by the engine.
In all cases the air is blown in the direction from fan ⇨ radiator.
Cooling is ensured by the circulation of air across the room.
An expansion vase can compensate for the variations in the volume of coolant fluid according to the temperature.

b) Air recooler
The engine cooling circuit is connected to an air recooler located inside or outside the room in order to implement this procedure.
When located in the room, it operates in the same way as a ventilated radiator. The fan is either attached to the diesel engine or run by an electric motor. If the air recooler is moved outside, on the roof or in another room, the coolant pipes are extended and cooling ventilation is supplied from another room. In these installations the degassing conditions should be considered even more carefully than for a radiator.
In all cases, the air cooler is cooled by the fan.

For cooling by radiator or air cooler in the room, the increase in temperature due to heat radiation for the sizing of the installation should be taken into account.

c) Lost water exchanger
This type of cooling consumes a non negligible degree of water and hence there is an operating cost to be taken into account. This the solution when local provisions ensure the flow of water and do not allow the ventilation provisions to be made for cooling by a ventilated radiator or air recooler.

These lost water installations consist essentially of an exchanger, with one of its circuits fitted with an expansion receptacle, connected to the engine cooling circuit. The latter's water pump ensures circulation. The second exchanger circuit, known as raw water is connected between the building's water supply and the drain. A valve fitted upstream of the exchanger can enable and cut off circulation. With automatic sets, this valve should also come with an electric control (solenoid valve).
This system's heat exchange ensures engine cooling. The room needs a ventilations system and this type of installation requires a detailed study.

d) Ventilation of the room
Extractor fans and/or air blowers can evacuate heat radiation from the engine and supply fresh air to the room and equipment in the case of external air coolers or lost water exchangers.
If fans are being used, more fans, rather than one large one, can regulate the temperature.
Ventilation of the premises requires a detailed study and should take into account the atmospheric air temperature and loss of pressure of components located in the air inlet and outlet (grilles, sound traps etc.) in particular

2.3.2.24. Special arrangements

Generating sets are not fitted with protection against power surges caused by drops in atmospheric pressure or manoeuvring.
The company does not accept any responsibility regarding damage caused by these occurrences.
However, lightning conductors can be installed, on the understanding that this does not give total protection.

3. Installation of mobile site sets

3.1.General information

Besides the advice and rules given for fixed sets, certain arrangements must be made for "site" sets.

3.2.Specific arrangements

An area will be reserved to install the generating set. Its should be flat and strong enough so that the generator does not sink into it. It could be made of concrete or even large planks fitted together.
It should be noted that a generating set that does not rest correctly on its base (frame or trailer) will be subject to vibrations that could cause damage to all the equipment.
The location of the set on site should be chosen for ease of fuel supply and distribution of current to the users.
Access to the set's doors should be available at all times for safety and maintenance reasons.
Ventilation of the generating set should not be affected if there are different objects close by. It will cause abnormal heating and reduced power.
Burnt gas evacuation will take place in such a way that there is no reaspiration into the air filter or cooling system.
The generating set's neutral speed must be used to protect people.
The generating set will need to be earthed. To do this, use a minimum 25 mm^2 stripped copper wire and a 16 mm^2 insulated cable, connected to the generating set earth socket and a galvanised steel earthing rod embedded vertically into the ground.
These sets are to be covered or protected from bad weather by a suitable construction (see previous sections).

4. Road trailer

4.1.Trailer linkage

Before attaching the trailer, check the trailer hook on the tow vehicle; it should fit the trailer ring perfectly.

Warning	Trying to tow a trailer with a non-matching device (bar, wires, cords, etc.) could lead to serious accidents. Also check: - no incipient fractures or excessive wear on the hitching system. - locking system is operating properly.

To hitch the trailer, proceed as follows:
- lock the wheels to stop the trailer from moving
- lift up the rear trailer supports and lock them
- release the parking brake
- release the locking levers for the draw bar arms and adjust the ring to the same height as the vehicle hook
- hitch the trailer, remove the locks on each side of the wheels then lift up the front wheel fully using its handle
- connect the electrical circuit of the trailer to that of the tow vehicle
- hook the handbrake safety wire onto the hook on the tow vehicle.

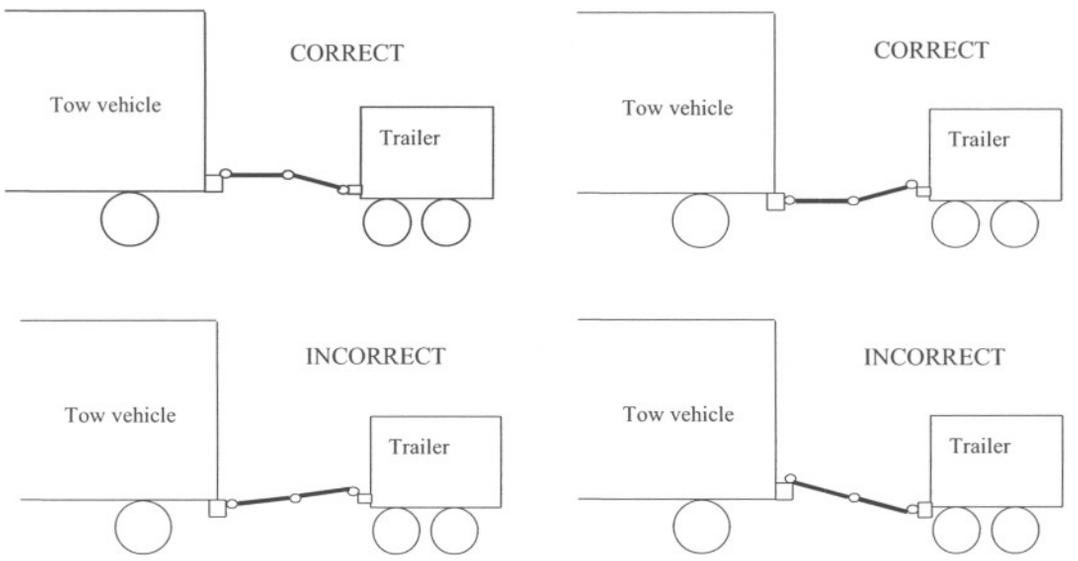


Diagram 4.1 : Coupling a trailer

4.2.Check before towing

Before towing carry out the following checks:
- wheel torquing
- lock trailer hook
- tyre pressure
- light signals working
- cover doors closed
- parking brake off
- front wheels and rear supports lifted.
- tightening and fixing the draw bar arms locking levers
- brake test for "road" type trailers
- fitting brake safety cable.

4.3.Driving

"On-site" type trailer

These trailers are not fitted with a main brake and so cannot brake when operating; the tyres are designed for a speed of 17 mph (27 Km/h). Therefore, it is absolutely forbidden to exceed this speed .

"Road" type trailer

The driving speed should be adapted to road conditions and the trailer handling.
Driving at sustained speed causes tyres to heat up; therefore it is important to stop from time to time to check them. Excessive heating can lead to a blow out and hence a serious accident. When reversing, do not forget to lock the overrun brake.

 Warning	Particular attention must be paid to wheel torquing on new vehicles. Indeed, during the first few miles, heat build-ups on the wheel hubs and brake drums lead to reduced wheel torquing. It is therefore essential to check the torquing every 6 miles (10 kilometres) until no further loosening is noted. The torque test should nevertheless be carried out before towing.

4.4.Unhitching the trailer

This operation should be carried out on horizontal, flat, stable ground.
- lock the wheels
- lower the front wheel
- disconnect the road signals wire
- refit the hitch using the wheel to release the hook ring from the tow vehicle,
- release the tow vehicle
- engage the handbrake.

4.5.Implementation for installation

Procedures to be carried out:
- check that the ground is strong enough for the assembly not to sink into it
- using the front wheel, position the set as horizontally as possible
- engage the handbrake.
- lower the rear trailer supports and lock them

5. Installation of electrical generating sets in containers

Danger	When the generating set is working in automatic start mode, the air evacuation doors must be open.

Danger	When the generating set is working in **manual** start mode, the air evacuation doors **must be open before** it starts.

Danger	When the generating set has been started and the doors have remained closed, they are **formally prohibited** from being opened (very severe risk of injury owing to sudden opening of doors).

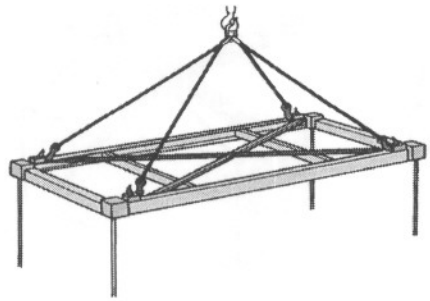
Warning	Before beginning handling procedures, you must ensure that the operating personnel has the necessary qualifications. All handling procedures must be carried out under the instruction of one co-ordinator only. It is essential to use an adapted lifting vehicle (lifting and travel limit, etc.) fitted with a lifting beam to ensure that the container is moved correctly.

5.1.Handling, transport and positioning of the containers

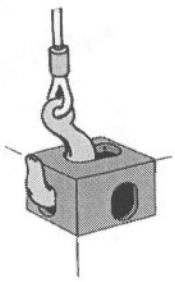
5.1.1 Handling instructions

- attach the lifting vehicle slings to the handling rings on the container .
- carefully stretch the slings without lifting the container.
- check that the sling hooks are correctly attached and the equipment is solid.
- lift the container carefully and without jerking
- direct and stabilise the container towards its final position.
- position the container, while still lifted, in accordance with its final position.
- carefully set down the container without jerking while continuing to position it.
- once the container is on the ground and in the correct position, release the slings, check that the container is stable and correct it if not
- detach the slings and remove them from the lifting rings.
- earth the generating set. To do this, use a minimum 25 mm^2 stripped copper wire and a 16 mm^2 insulated cable, connected to the generating set earth socket and a galvanised steel earthing rod embedded vertically into the ground.
- the procedure has been completed when the container is in position.

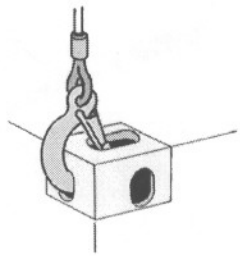
Examples of equipment and handling



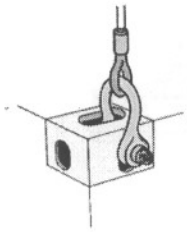
Example of container lifting using a lifting beam fitted with hooks, shackles or manually coupled locks.



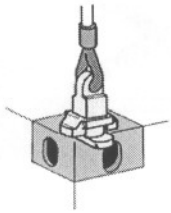
Example of grip by an ordinary hook



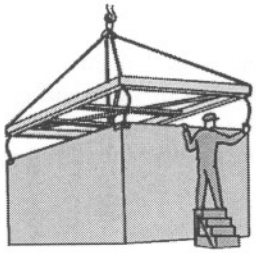
Example of grip by a safety hook



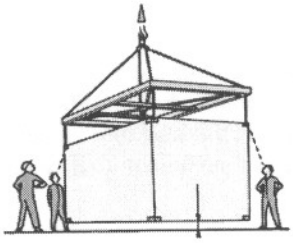
Example of shackle grip



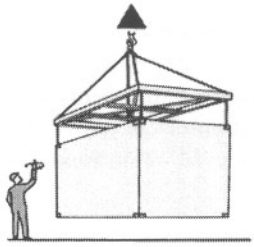
Example of grip by a manually coupled lock



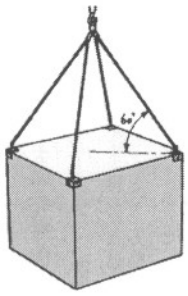
Attachment of lifting device



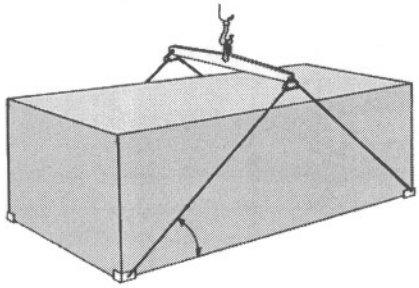
Checking the attachment when the container is still on the ground



lifting



Example of lifting



Example of a container lifted by four parts in the bottom corners

Diagram 5.1 : Examples of handling equipment

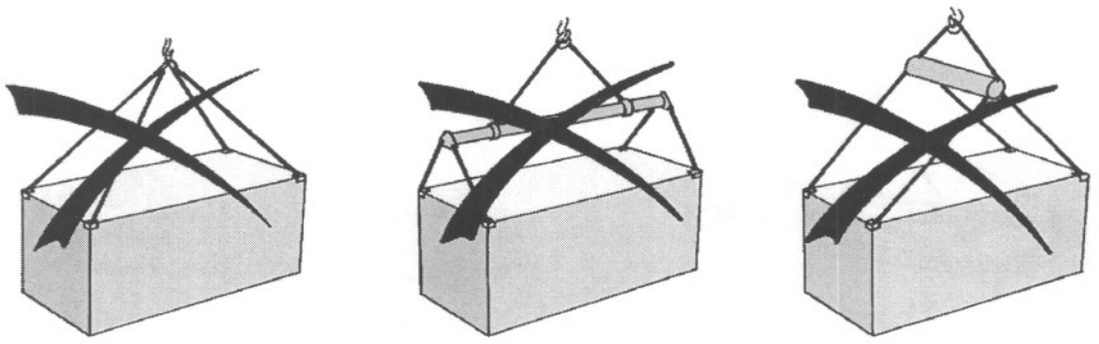


Diagram 5.2 : Examples of lifting methods which should not be used

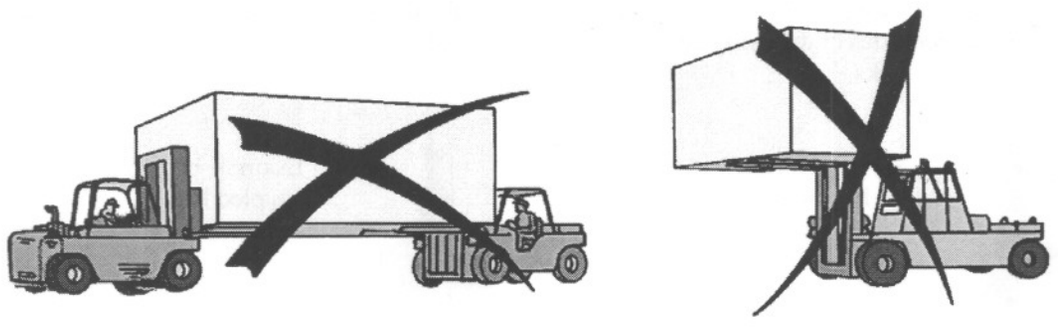


Diagram 5.3 : Examples of handling methods which should not be used

5.1.2 Transport

The transport of containers should be in accordance with the highway code (for the relevant countries).
The transport equipment (trailer, semi-trailer, container holder, etc.) should be suitable for this use and provide all safety guarantees in terms of its capacity to support the load and the attachment devices.
Driving should be on roads suitable for vehicles of sufficient quality not to damage the equipment stored inside the container.

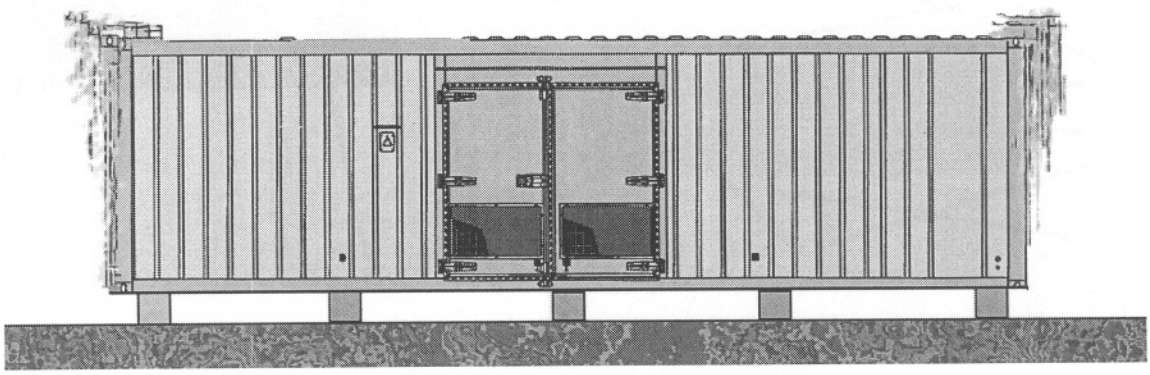
Maritime transport approval (CSC)
Our containers are available in 4 different versions.

	CSC approval	
Version	YES	NO
CIR 20		X
EUR 20		X
ISO 20	X	
ISO 40	X	

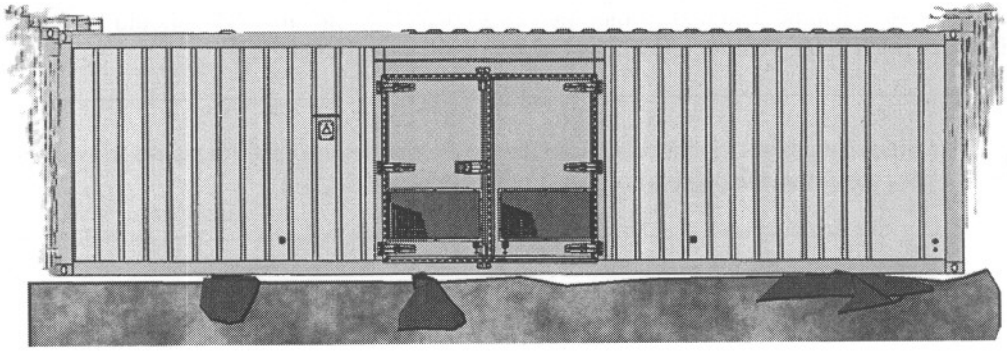
Warning	Our CIR 20 and EUR 20 containers cannot carry additional loads (no stacking).

5.1.3 Installation - positioning

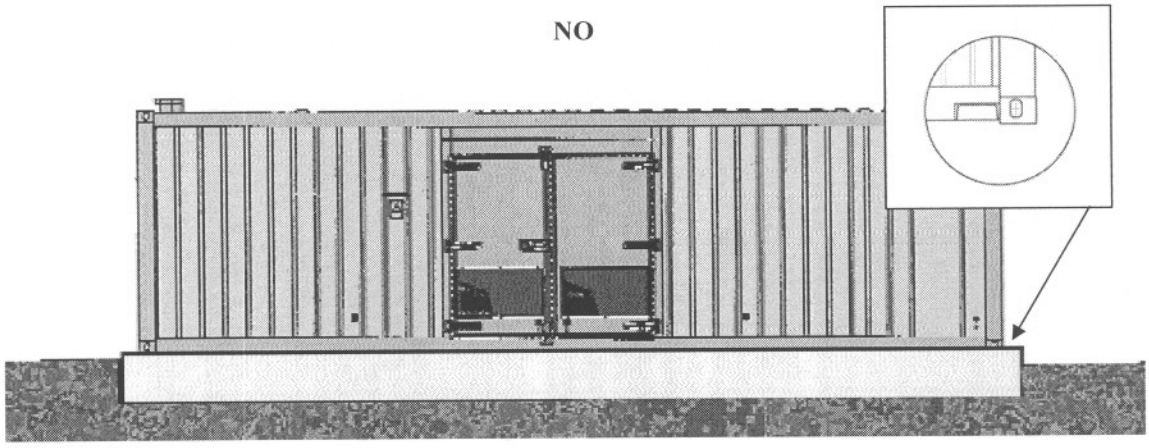
The position should first be considered in relation to the electricity distribution centre, fuel storage, the general environment and type of ground before the equipment can be accommodated.
The installation area should be flat enough for the frame to rest level on it and strong enough so that the container does not sink down.
If the container(s) are being installed definitively, a concrete foundation must be constructed, for which the calculations and execution must be performed by a specialist .



NO



NO



YES

Diagram 5.4 : Positioning containers

The environmental impact should also be analysed so that the disturbances to be caused by the equipment will not affect those living close by.
Therefore, it is essential to be aware of the regulations in force, in order not to be vulnerable to future legal action.
On this subject, the sound level of the set and reverberation effects on buildings must be taken into account .

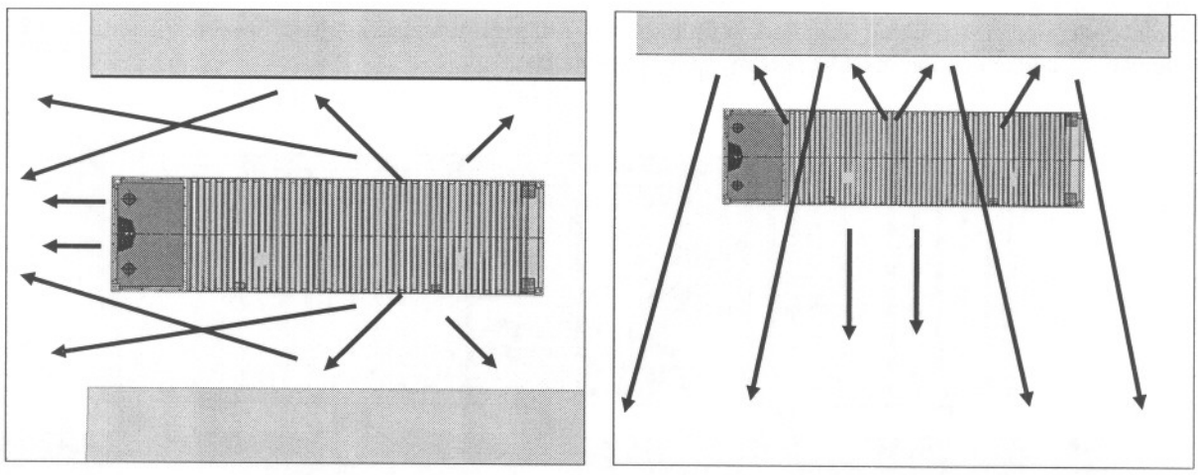


Diagram 5.5 : Examples of increase in sound level caused by reverberations and the sound directivity.

The equipment should also be installed so that the vents controlling the air intake should be opposite so that there are no difficulties in difficult weather conditions (intake of air, snow, sand etc.).

Warning	Remove the blanking piece(s) from the exhaust outlet(s) (used for transporting it) and replace them with the extension cable(s) supplied with the generating set.

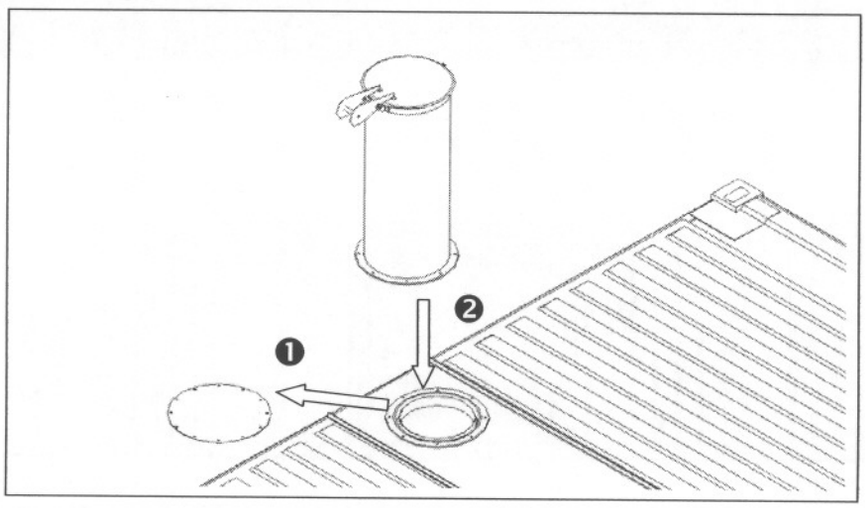


Diagram 5.6 : Removing the blanking piece

5.2.Maintenance

- lubricate the hinges and locks regularly
- lubricate the joints with silicone grease
- wash and clean the bodywork using products designed for car bodywork
- check the condition of the bodywork and retouch any scratches straight away (to prevent the start of corrosion).

6. Preparation before operating the set

 Warning	The inspections referred to in this section enable the electrical generating set to operate. Specific skills are required to carry out these operations. They must only be entrusted to personnel with the necessary skills. **Failure to follow these instructions in any way could lead to incidents or very serious accidents.**

 Warning	Generating sets fitted with MTU engines of the 4000 series : it is essential to dismount the flywheel blocking device (for protection of the crankshaft during transport) at set commissioning (**before first start-up**).

6.1.Installation checks

- check that the general recommendations from the installation section (ventilation, exhaust, fluids etc.) are followed
- check the levels (oil, water, diesel, battery)
- ensure the generating set earth socket is earthed

6.2.Connection checks

- check the remote controls by section and number (sector, accessories, low voltage central control panels etc.)
- apply voltage to the accessories to check the following components (non comprehensive list) :
  - fuel pump (consumption and direction of rotation)
  - water preheating (intensity and voltage)
  - battery charger
  - etc.

6.3.Starting the generating set

- carry out the mechanical checks (oil pressure, water temperature, absence of noise etc.)
- carry out the electrical checks (voltage and frequency)
- carry out the safety checks (emergency stop, oil pressure, water temperature etc.)

6.4.Load test on installation

- check the rotary field
- check the voltage, frequency and intensity
- check normal/emergency switching or coupling.

7. Special maintenance advice

7.1.Maintenance plans

The maintenance plans (periodic maintenance tables) are outlined in the relevant reference material (maintenance manual) for engines, alternators and certain accessories. As a general rule, these plans distinguish between continuous operation and emergency operation.
They take into account the types of consumables used, for example: the sulphur content of diesel or the grade of lubricating oil.
These maintenance plans must be studied in order to determine the service intervals to apply. This should be carried out when a generating set is first received and the types of consumables (mentioned above) should be taken into account.

In addition to following the maintenance plans outlined above, it is recommended that the following checks are conducted (these checks should be undertaken by experts):

- ✓ Mechanical:
  - mechanical checks (mechanical adjustments, belt tension, etc.)
  - cooling system checks
  - tightening checks on equipment mountings, retightening of nuts and bolts.
- ✓ Electrical:
  - electrical checks on machines and safety devices
  - checks on electrical control devices
  - alternator insulation check
  - retightening of alternator bus bars
  - auxiliary insulation and current consumption check
  - starter battery charging systems check
  - battery check.

These checks must be carried out at the following recommended points (or according to manufacturers' recommendations):

- ➢ generating set emergency operation (≤ 100 hours per year): once per year
- ➢ generating set emergency operation (≤ 500 hours per year): 3 times per year
- ➢ generating set continuous operation:
  - mechanical checks: during oil changes
  - electrical checks: every 6 months.

7.2.Cover sealing

A seal is used between the cover and the chassis, and between the chassis and the retention cover to ensure leaktightness. This seal must always be replaced whenever the cover is removed.

7.3.Trials with load and with no load

Notes on no load operation and operation with low load:
When operating at no or low load < than 30%, the operating conditions are such that the engine cannot be used at its optimum level. The main reasons for this are:

- ✓ a small volume of burnt fuel in the combustion chamber means that full combustion cannot be attained; the thermal energy resulting from the combustion is not great enough for the engine's optimum operating temperature to be reached.
- ✓ supercharged engines have lower compression ratios, which are required for full load, and are not suited to good combustion at low load.

The combination of these factors leads to engine clogging and, in particular, piston ring and valve clogging which results in:

- ✓ a greater rate of wear and glazing of the cylinder wall
- ✓ reduced leaktightness of the mating faces, with valve rod movement sometimes becoming less efficient.

GENLUB TDX 15W-40

Top-of-the-range lubricant recommended for diesel engines: for generating sets used under severe conditions.

USES:

- ✓ Particularly suited to more modern engines with or without turbochargers, *intercoolers*, or sophisticated injection systems (e.g. ***HEUI***, injector-pumps)
- ✓ **All types of use**: can cope with the most demanding applications
- ✓ **Depolluted engines:** complies with EURO 2 and EURO 3 technology and can be used with all types of diesel fuel, especially ecological diesel with low sulphur content.

PERFORMANCE:

ACEA E3

API CH-4

- ✓ Meets level E3 of the specifications defined by European manufacturers in the ACEA standards 98 edition.

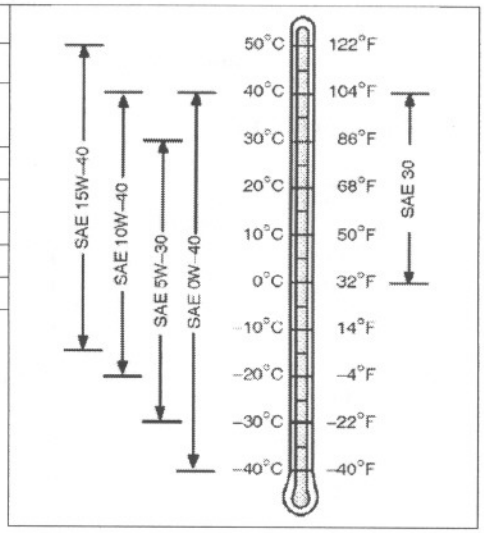
ADVANTAGES:

- ✓ **Less frequent oil services**: this product has been put to the test during thousands of hours of use on worksites under varying conditions, demonstrating its high quality.
- ✓ **Conformity with new environmental legislation**: adherence to new anti-pollution standards required for new EURO 2 and EURO 3 engines.

SPECIFICATIONS:

SAE Grade	15W-40	
Density at 15°C	0.883	
Cinematic viscosity at 40 °C	105	mm2/s (cSt)
Cinematic viscosity at 100 °C	14.1	mm2/s (cSt)
Viscosity index	140	
Dynamic viscosity at -15 °C	3000	mPa.s(cP)
Pour point	- 30	°C
Flash point	220	°C
Sulphated ash content	1.4	% weight

(Values given as examples only)



8.1.2 Specifications of coolants

Engine			
Make	Type	Make	Type
Cummins	All	SDMO	GENCOOL PC -26°C
John Deere	All	SDMO	GENCOOL PC -26°C
MTU	All	SDMO	GENCOOL PC -26°C
MITSUBISHI	All	MITSUBISHI	LLC
		SDMO	GENCOOL PC -26°C
Perkins	All	SDMO	GENCOOL PC -26°C
Volvo	All	SDMO	GENCOOL PC -26°C

Consequently, using any supercharged engine at low load (< 30%) can only have negative implications for engine operation and service life. Maintenance will have to be stepped up in order to cope with the severe operating conditions. Reducing the time between oil changes will allow for oil with a tendency to clog with unburned residue and to pollute fuel, to be replenished more frequently. The main purpose of attaching a charging bank is to reduce periods of low load operation and to enable full load to be reached periodically, which is necessary to unclog the engine.
Finally, when operation is taking place under load we recommend that you pay close attention to the oil venting system, especially for engines whose sump air vent is located at the turbocharger inlet (risk of oil or oil vapour uptake and engine racing).

Tests under load:
It is recommended that the generating set be tested every month under load for approximately 1 hour after conditions have stabilised.
The load should be over 50% (ideally 80%) to ensure the engine is de-coked and to give a reliable indication of the operation of the generating set.

Off-load test (without load):
This test is not recommended; it should not last longer than 10 minutes and should not be repeated without the monthly test under load. This test serves only to check that the engine starts correctly. It does not check that the generating set is operating correctly.

8. Fuel and consumables

The capacities stated in this section apply to standard generating sets.
All specifications (product features) are given in the motor and alternator maintenance manuals attached to this manual.
In addition, we recommend the consumables to be used in the "specifications" section.

8.1.Specifications

8.1.1 Oil grades

Engine			
Make	Type	Make	Type
Cummins	All	SDMO	GENLUB TDX 15W40
John Deere	All	John Deere	John Deere PLUS-50
		SDMO	GENLUB TDX 15W40
MTU	396/2000/4000	SDMO	GENLUB TDX 15W40
	183	SDMO	GENLUB TDX 15W40
MITSUBISHI	All	SDMO	GENLUB TDX 15W40
Perkins	Fuel	SDMO	GENLUB TDX 15W40
	Gas	MOBIL	PEGASUS 705
Volvo	All	SDMO	GENLUB TDX 15W40

GenCOOL PC -26

High-protection coolant, approved by manufacturers.

GenCOOL PC -26 is a ready-to-use, highly protective coolant which is produced from an antifreeze recommended by the majority of European manufacturers.

- It is made from antifreeze and G 48 inhibitors.
- It protects up to -26°C.
- It is free from nitrates, amines and phosphates.
- It is a clear, fluorescent orange liquid.

REFERENCES/APPROVALS (for the antifreeze):

HEAVY GOODS VEHICLE	LIGHTER VEHICLES
Approved by MTU, MERCEDES BENZ, MAN, KHD, GENERAL MOTORS	Approved by BMW, VOLKSWAGEN, MERCEDES, PORSCHE
Conforms with VOLVO, IVECO, VAN HOOL and STAYR TRUCK specifications	Conforms with VOLVO, OPEL, SEAT and SKODA specifications

Conforms with the NF R 15.601 standard

REINFORCED ANTI-CORROSION FEATURES:

- Protects **against high-temperature corrosion** by oxidisation of ethylene (cylinder head protection).
- Protects **against high-temperature cavitation** (top of cylinder and coolant pump protection)
- Non-corrosive for seals and hoses.
- Improves the **efficiency and longevity of the cooling system.**
- **GenCOOL PC -26** is especially recommended for engines fitted with aluminium or light alloy radiators.

HIGH TEMPERATURE SUITABILITY:

- Provides good conditions for thermal exchange.
- Perfect stability at high temperatures.
- **GenCOOL PC -26** is specially adapted for engines with high power densities.

LONG LASTING PROTECTION:

- High alkaline reserve/stability and longevity of corrosion inhibitors
  - Maintains its technical properties during prolonged use at high temperatures (neutralisation of acids).
- Ensures maximum heat transfer without the build up of deposits in the cooling system
- **GenCOOL PC -26** ensures optimum protection against overheating and corrosion in extreme conditions of vehicle use.

PACKAGING/STORAGE:

- **GenCOOL PC -26** is supplied in 210 l metallic barrels with smooth interior linings.
- It can be stored for 2 years in its original container and packaging.
- Avoid zinc coated containers.

RECOMMENDATIONS FOR USE:

- Compatible with the original fluid.
- It is recommended that the cooling system is completely drained when replacing the fluid.

SPECIFICATIONS	UNITS	SPECIFIED VALUES	TRIAL METHODS
Density at 20°C	kg/m^3	**1,059 +/- 3**	R 15-602-1
pH	pH	**7.5 to 8.5**	NF T 78-103
Alkalinity reserve	ml	**>=10**	NF T 78-101
Boiling point	°C	**105 +/- 2**	R 15-602-4
Freezing point:	°C	**-26 +/- 2**	NF T 78-102
Glassware corrosion : (test with antifreeze)	mg/test piece		R 15-602-7
- Copper		**+/- 2.6**	
- Weld		**+/- 0.5**	
- Brass		**+/- 2.3**	
- Steel		**+/- 1.6**	
- Cast iron		**+/- 0.8**	
- Cast aluminium		**+/- 1.0**	
Corrosion on warm plate (test with antifreeze)	$mg/(cm^2 week)$	**+/- 0.17**	R 15-602-8

8.2.Circuit capacities - Volvo engines

ENGINES / CIRCUIT AND TANK CAPACITY		TWD 740	TAD 740	TAD 941	TAD 1241	TAD 1242	TAD 1640	TAD 1641	TAD 1642
LUBRICATION (in litres)		29	29	33	35	35	48	48	48
COOLING (in litres)		41,9	36,9	41	44	44	60	60	60
FUEL (in litres)	EX II	390	390	470	470	470	500	500	610
	ENCLOSURE M 227	390	390						
	ENCLOSURE M 228			470	470	470			
	ENCLOSURE M 229						500	500	
	ENCLOSURE M 230								610

8.3.Circuit capacities - Mitsubishi engines

ENGINES / CIRCUIT AND TANK CAPACITY	L3-SD (série L)	L3-SDH (série L)	S3L2-SD (série SL)	S3L2-SDH (série SL)	S4L2-SD (série SL	S4L2-SDH (série SL)	S4Q2 (série SQ)	S4S (série SS)	S12R (sérei SR)	S16R (série SR)
LUBRICATION (in litres)	4.1	4.1	4.2	4.2	5.9	5.9	6.5	10	180	230
COOLING (in litres)	3,7	3,7	4,2	4,2	4,9	4,9	8,1	8,9	300	345
FUEL (in litres)	50	50	50	50	100	100	100	100	ISO 20 500	ISO 40 500

8.4.Circuit capacities - John Deere engines

CIRCUIT AND TANK CAPACITY \ ENGINES		3029DF120	3029TF120	3029TF270	4045DF120	4045DF270	4045HF120	4045HF150	4045TF120	4045TF270	4045TF220	4045TF250	4045HF275	6068HF120 (153kW @ 1500 rpm)	6068HF120 (183 kW @ 1500 rpm)	6068HF150 (187kW @ 1800 rpm)	6068TF220	6068HF475	6068TF250	6068HF150 (210kW @ 1800 rpm)	6068HF275 (187kW @ 1800 rpm)	6081 HF 001	6081HF070 (318kW @ 1800 rpm)	6081HF070 (260kW @ 1800 rpm)	6125HF070 (387 kW @ 1500 rpm)
LUBRICATION (in litres)		6	6	6	13,5	13,5	13,5	13,5	13,5	13,5	13,5	13,5	13,5	21,5	31,5	21,5	21,5	33	21,5	31,5	33	32	32	32	42
COOLING (in litres)		16,1	16,1	16,1	18,9	18,9	20,2	20,2	23,6	23,6	23,6	23,6	20,2	25,8	25,8	25,8	27,3	30	27,3	25,8	25,8	40	40	40	43,8
FUEL (in litres)	EX II	100	100	100	180	180	190	190	180	180	180	180	340	340	340	340	340	340	340	340	340	390	390	390	470
	ENCLOSURE M 128				180	180			180	180	180	180						340							
	ENCLOSURE M 129						190	190																	
	ENCLOSURE M 107	100	100	100																					
	ENCLOSURE M 226												340	340	340	340	340	340	340	340	340				
	ENCLOSURE M 227																					390	390	390	
	ENCLOSURE M 228																								470

8.5.Circuit capacities - MTU engines

CAPACITY OF CIRCUITS AND TANKS \ ENGINES		12V2000G23E	12V2000G23F	12V2000G43	12V2000G63E	12V2000G63F	12V2000G83	16V2000G23	16V2000G43	16V2000G83	18V2000G23	12V4000G21	12V4000G61	12V4000G81	16V4000G21	16V4000G61	16V4000G81
LUBRICATION (in litres)		82	82	82	82	82	82	110	110	110	130	260	260	260	290	290	290
COOLANT (in litres)		180	180	180	212	180	212	261	261	261	268	200	200	200	215	215	215
FUEL (in litres)	ISO 20	500	500	500	500	500	500	500	500	500							
	CIR 20	500	500	500	500	500	500	500	500	500	500						
	CIR 20 with fuel option	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020						
	ISO 40										500	500	500	500	500		
	EUR 40											500	500	500	500	500	500
	CAPOT M 127	930	930	930	930	930	930	930	930	930	930						

8.6.Circuit capacities - GMC engines (Nevada)

ENGINES / CIRCUIT AND TANK CAPACITY	GMC 430	GMC 643	GMC 857	GMC 874 T	GMC 881	GMC 881 T
LUBRICATION (in litres)	4.3	4.76	5.24	8.1	8.1	8.1
COOLING (in litres)	3.78	6.9	6.9	13.7	20.6	20.6

8.7.Circuit capacities - Perkins engines

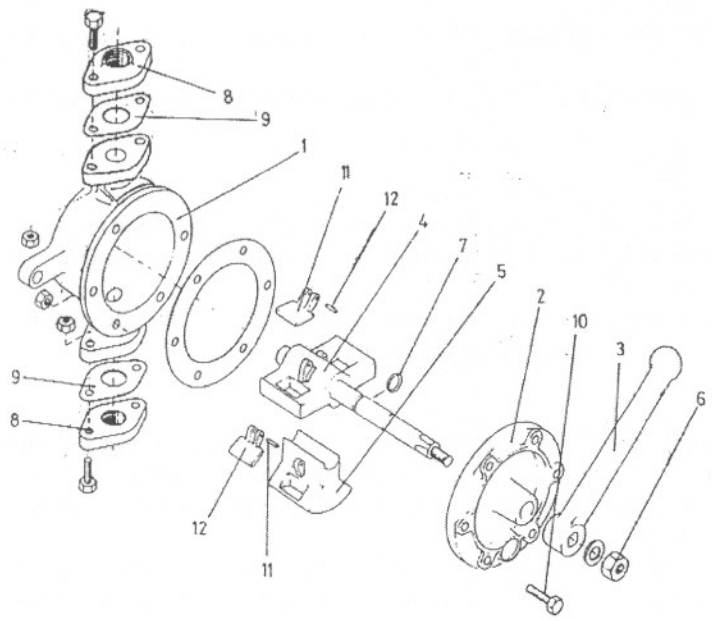
ENGINES / CIRCUIT AND TANK CAPACITY	2806 E16 TAG2	2806 E18 TAG2	3012 TAG	4006 TAG3	4012 TAG
LUBRICATION (in litres)	68	55,5	73.8	113,4	178
COOLING (in litres)	50	61	122.7	105	*4012 TAG* 200 *4012TAG2* 231
FUEL (in litres)	500 ENCLOSURE M229	610 ENCLOSURE M230		930 ENCLOSURE M427	

9. Maintenance of optional equipment

9.1.Japy pumps for clear fluids

9.1.1 Technical specifications

Type	Use	Composition
EZ 254	Diesel and petrol	Base block Zamak piston, seat and valves Steel shaft – against mounting clamps and lugs O ring
HT 254	Hydrocarbons Max viscosity 300 cst	Base block Brass piston, seat and valves Steel shaft– against mounting clamps and lugs O ring



1 Pump body.
2 Cover.
3 Lever.
4 Piston.
5 Seat.
6 Lever nut.
7 O ring
8 Suction or discharge clamp.
9 Clamp joint.
10 Screw with nut for cover or bracket (to be specified).
11 Piston valve.
12 Seat valve.
13 Valve split pin.

Diagram 9.1 : Pump components

9.1.2 Description

Suction:
Suction capacity is completely independent of the size of the pump.
These pumps can attain 7m to 7.50m of pressure suction with cold water at sea level.
The suction pipes should always face on an upwards slope from the fluid suction pump to the pump installation point with no top section and with as few bends as possible with a large radius.
For any suction over 2 metres, a foot valve must be installed (suction valve) to hold the fluid in the pipes which should have no cracks or leaks.
The suction "manometric height" should not be confused with the vertical distance of the expanse of water to the pump.
Losses of pressure are inevitable and are related to:
- the length and diameter of the pipes used according to the flow,
- the presence of a non-return valve or elbows in the pipes.

A non-return valve or elbow causes a loss of pressure equivalent to what 5 metres of straight pipes would give.
When there is a certain length of pipework or high suction (or discharge), a larger diameter pipe than usual should be used.

Discharge:
The pumps have been tested at a pressure of 1,500 kg to 2 kg and can therefore handle a 15m discharge. However, the force developed by the person handling the pump, will increase according to the flow and elevation height (suction + discharge). Therefore with a low flow, the fluid can be raised higher than with a large flow pump.

Draining:
A small tap or bolt, about 0.70m above the pump is indispensable.

Fitting:
The pump should be installed on a strictly vertical plane, with Japy marque on the discharge side. Check that the mounting has a flat surface and that the nuts are tightened moderately and alternately to prevent distortion of the body.

9.1.3 Maintenance and repair

Faults:

The pump no longer sucks or discharges.
- there is air intake - check all the seals and the suction pipes.
- the foot valve (suction valve) no longer works, there is probably dirt or some waste under the valve that it stopping it from resting on its seat, check it.
- there is dirt inside the pump blocking the valves; remove the cover, clean inside and check that the valves move freely.

Cable gland leak:
- tighten the two cable gland bracket nuts alternately by one or two turns. Otherwise, remove this bracket, take out the cable gland which is located in its housing. Clean this housing and remove the residual lining. Replace it with graphite braiding.
- if it is a pump without cable gland, model 254, remove the cover, replace the O-ring checking that the piston axis is not oxidised. If it is, clean it carefully. Also reline the groove with graphite braiding.

Frost:
The draining bolt is inefficient, and the Japy pump has not been supplied by it for a long time except for special requests using the control. On the other hand, it is indispensable if the pump is exposed to frost to use a small draining tap on the suction pipes about 0.75m above the pump. In any case, the pipes must be fitted with a foot valve. This device is necessary for draining the pump.
If there is a threat of frost, do not forget to open this tap while checking that the discharge port is free to let air in.
Draining should take place normally, but for increased safety, after the water has flowed out pull the lever two or three times to complete the draining.
If the body or cover is cracked by frost, do not try to repair it by autogenous welding as this would distort the part

Extended lack of use:
If the pump is not used for a while, it is recommended:
- if frost is not likely, to check that the pump chamber is always full of pumped fluid.
- if frost is likely, to:
  - drain and, if possible, pull the lever a few times to prevent the internal components from becoming blocked by oxidation, if not:
  - drain and add liquid paraffin, by spraying if possible, to prevent oxidation and the internal components from becoming blocked.

In the event of oxidation and blocking, never force the lever as this risks breaking the piston. Remove the cover, carefully clean the inside of the pump with an oiled cloth but never with abrasive material. Lightly oil before refitting.
The Japy pump does not normally require any lubrication.
After several years of service or after use for water or fluids that are full of impurities or slightly acidic, it becomes necessary to replace the main internal components. This procedure must be carried out by a mechanic.

In general, when pistons and seats need to be replaced we recommend a standard replacement pump.
To remove the lid and to check inside, begin by unscrewing the 6 bolts that attach the lid to the chamber . Then, to undo the lid, hit it preferably with a piece of wood, alternately on the discharge and suction manifolds, while keeping the other hand on the piston rod and the valve gland clamp. Do not carry out these removal procedures often.
Before refitting, carefully clean the whole of the inside with a cloth, lightly lubricate the internal parts of the chamber with liquid paraffin, put the piston back in place by pushing down slowly with a semicircular motion.
Check that the suction seat is held in place and that the felt pad is properly positioned.
Put the bolts back in position, retighten the blocks moderately and alternately until the cover is locked down.

9.2.Japy pump kit

9.2.1 Technical data

- max. flow: 37 L/man
  max. pressure: 2.2 bars (with water)
- rotation speed: 2800 rpm
- max.suction height: 6 m
- fitted with a by-pass
- operation with discharge cut-off 2 to 3 ins Mx
- PI 55 protection.

9.2.2 Electrical data

- power: 0.37 kW
- engine made for continuous work

- JEV 10/658 single phase: 50 Hz 220V – 2.4 A – 240V – 2.1 A
- JEV 10/658 single phase: 60 Hz 208V – 3.7 A – 277V – 3.3 A

- JEV 11/661 three phase: 50 Hz 380V – 0.8 A – 415V – 1 A
- JEV 11/661 three phase: 50 Hz 200V – 1.5 A – 240V – 1.6 A

- JEV 11/661 three phase: 60 Hz 380V – 0.9 A – 480V – 1.4 A
- JEV 11/661 three phase: 50 Hz 208V – 1.8 A – 240V – 2 A

 Danger	The engines are not flame proof. Do not use them in locations where there may be flammable vapours.

9.2.3 Suitable fluids

- water, fuel, diesel & light oil
- maximum viscosity of 10 cst at atmospheric temperature.

9.2.4 Prohibited fluids

Fluids	Corresponding dangers
Petrol	Fire, explosion
Flammable fluids with PM below 55 degrees C	Fire, explosion
Supply fluids	Pollution of the fluids
Corrosive chemical fluids	Pump corrosion
Solvents	Damage to linings and joints

9.2.5 Maintenance

The pumps do not require any specific maintenance.
Possible checking for leaks at the joints.

9.2.6 Faults and repairs

The engine does not work	
Possible causes	**Actions**
No electric current	Check the connections
Blocked rotor	Take apart the engine pump. Look for a possible foreign body
No flow or insufficient pressure	
Possible causes	**Actions**
Suction height too high	Move the pump nearer to the fluid to be pumped
Blocked foot valve	Clean or replace
Blocked filter	Clean the filter
Considerable losses of pressure	Increase the diameter of the pipes
Blocked by-pass valve	Clean or replace
Air in the suction pipes	Check that they are sealed
Fluid leak	Check the pipe connections. Replace the seals

9.3.REN-RAB automatic oil auxiliary adjuster

9.3.1 Use

The RAB 101 -70 REN regulator regulates oil levels for all engine outputs. The RAB 101 -70 REN regulator maintains a correct oil level in the engine sump. It is adjusted to the engine operating oil level and it regulates the level as oil is consumed.

9.3.2 Composition

The majority of models are equipped with a low level threshold alarm or stop feature to warn operators of a low supply of oil, a drop in the oil level in the sump and possibly an overflow of oil.
A built-in oil level threshold triggers an alarm or stops the engine to warn the user of a low supply of oil. The engine still consumes oil.

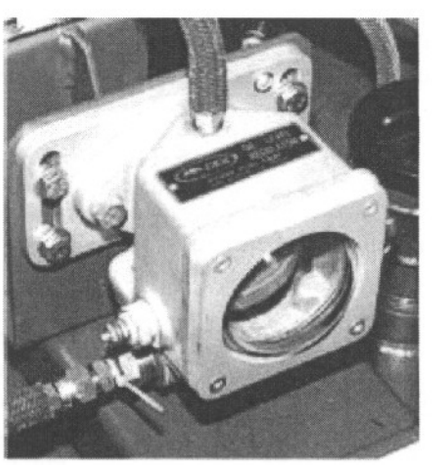


Figure 9.2 - general view of regulator

9.3.3 Operation

When the oil level falls in the sump, the float moves down and opens a valve.
When the valve opens, oil can flow from the tank into the sump via the regulator.
As the sump fills, the float moves up and eventually closes the valve when the required oil level is reached, preventing oil from flowing into the sump.
The valve is designed to be able to clean itself and consequently cannot become clogged.
A 3 mm hole in the regulator is wide enough to enable the sump to be filled effectively.

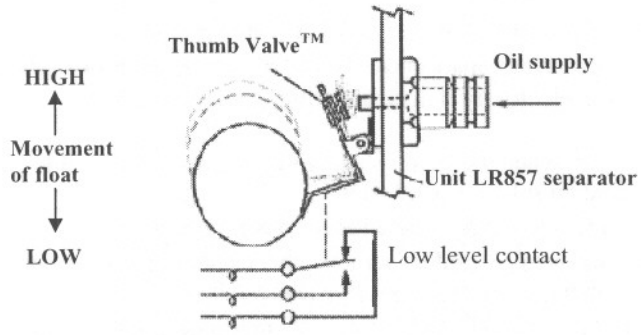


Figure 9.3 - simplified diagram of valve operation

9.3.4 Settings

After having fitted the unit as illustrated below, manually fill the engine to the "low" or "add" mark on the oil gauge, without starting the engine. Position the oil level regulator so that the oil level is in the centre of the front inspection window. Give the system some time to balance out the oil level between the regulator and the sump before the sump is finally fixed into position. This level depends on the level of use. Start the engine and wait a while for the regulator to replenish the measured oil circulating in the sump. When the engine is switched off, the return of oil from the engine causes the oil level to rise and this can be seen through the front inspection window on the regulator. This is normal and as soon as the engine is switched on again the oil level will return to the level required for use previously mentioned.

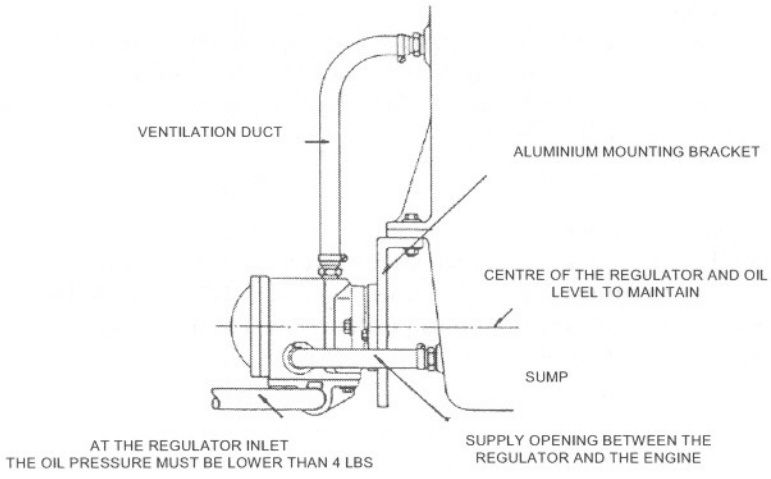


Figure 9.4 - oil make-up regulator

9.4.Battery maintenance

9.4.1 General information - Safety

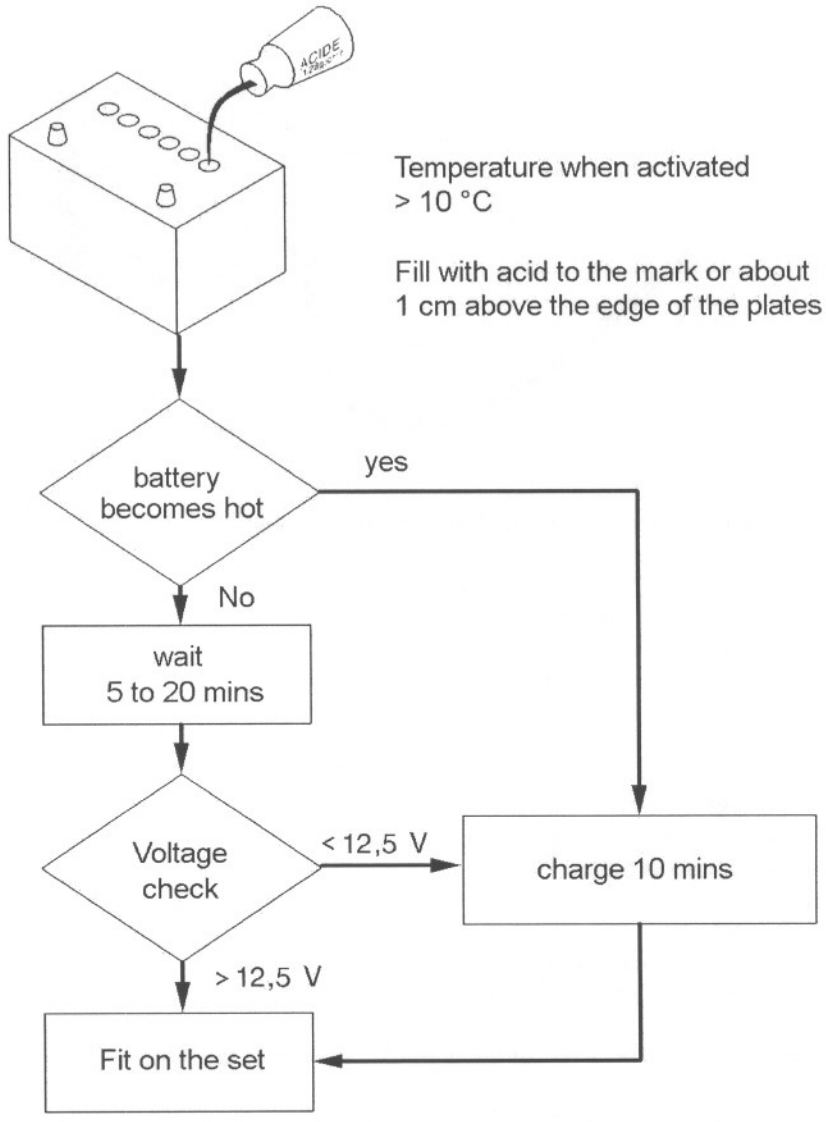
 Danger	Fit the battery so that it is properly ventilated. Maintenance should only be carried out by a qualified person. If replacing the batteries, use the same type of batteries. Only use insulated tools (the operator should not be wearing a watch, bracelet or any metal object) Never use sulphuric acid or acid water to top up the electrolyte level. Batteries release oxygen and hydrogen gas, which are flammable Never use flames or generate sparks near the battery since flames or sparks can cause an explosion. Discharge any static electricity before handling the batteries by first touching an earthed metal surface. Do not use the battery when the fluid is below the minimum required level. Using a battery with a low electrolyte level could result in an explosion. Do not short the battery terminals with a tool or other metal object. When disconnecting battery cables, remove the cable from the negative (-) terminal first. When reconnecting the battery, connect the positive lead (+) first. Charge the battery in a well-ventilated area, with all filling hole plugs removed. Make sure the cable clamps are correctly secured to the battery terminals. A loose cable clamp can cause sparks that could result in an explosion. Before servicing electrical components or performing electric welding, set the battery switch to the [OFF] position or disconnect the battery negative cable (-) to cut off the electrical current. Electrolyte contains dilute sulphuric acid. Careless handling of the battery causing contact with sulphuric acid could damage your eyesight or cause burns. Wear safety goggles and rubber gloves when working with the battery (topping-up fluid, charging, etc.) If electrolyte comes into contact with your skin or clothes, wash it off immediately with plenty of water. Then wash thoroughly with soap. If electrolyte comes into contact with your eyes, rinse immediately with plenty of water and see a doctor as soon as possible. Should you accidentally swallow electrolyte, gargle with plenty of water, then drink lots of water. Consult a doctor immediately. Large quantities of electrolyte should be rinsed off using a neutralising agent. A common method is to use a solution of 500g of bicarbonate of soda diluted in 4 litres of water. The bicarbonate of soda solution should be added until the reaction has finished (lather). The remaining liquid should be rinsed off with water and left to dry.

9.4.2 Storage and transport

- Dry batteries do not need any maintenance
- Batteries ready to use must be stored in a cool dry place (frost free) protected from the sun (self-discharge).
- Batteries ready for use must be recharged at the latest when the acid density drops below 1.20.
- Batteries must be transported and stored in the vertical position (risk of acid escaping)
- Leave the terminal cover on the positive terminal

9.4.3 Commissioning

- Batteries filled with acid have a density of 1.28 g/ml and are charged.
- In the case of dry batteries, fill each battery cell with acid up to the maximum level mark or to 15 mm above the plates. Let the battery rest for 20 minutes.
- Before fitting the battery, stop the engine and any power consumer, clean the terminals and give them a light coating of grease. When connecting, connect the positive terminal (+) first, and then the negative terminal (-).



9.4.4 Checks

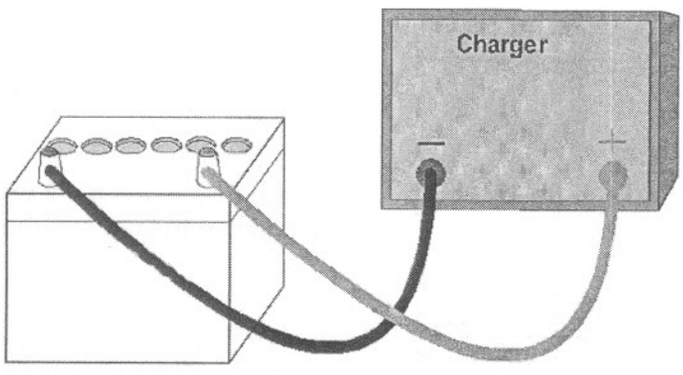
Acid density	Charge status	Voltage when idle	
1.27	100%	Above 12.60 V	
1.25	80%	12.54 V	
1.20	60%	12.36 V	**From 50 % recharge**
1.19	40%	12.18 V	**Risk of sulphation**
1.13	20%	Under 11.88 V	**Unusable**

9.4.5 Recharging batteries

- Very discharged or sulphated batteries (formation of whitish lead sulphate deposit on the plates which becomes hard and insoluble in acid; this deposit reduces the active surface of the plates and increases their internal resistance) can no longer regenerate or charge in a set.

⚠ Warning	A discharged battery should be recharged immediately otherwise it will suffer irreparable damage.

Battery charge



When several batteries are connected together, the following points should be checked:

Are the batteries connected in series ?
Is the voltage chosen exact? 1 x 12 V battery, 3 x 36V batteries
Adjust the charge current to the lowest battery.
The power difference between the batteries must be as low as possible.

Example of charge:

- Battery 12V 60 Ah = charging current 6 A
- Charge status: 50% (acid density 1.21/voltage when idle 12.30V)
- Battery lacks 30 Ah, recharging required
- Charge factor: 1.2
- Ah x 1.2 = 36 Ah to be recharged
- Charging current: 6A around 6 hours charging required.

Recharging is complete when the battery voltage and the acid density stop increasing.

→ The charging current must always be $1/10^{th}$ of the nominal capacity of the battery

- The power of the charger must be suitable for the battery to be charged and the charging time available.
- You need to use an automatic charger able to provide a sufficient voltage and charging current, as well as a compensation voltage to handle spontaneous battery discharge.

9.4.6 Fault finding

Fault observed	Probable origin	Measures or observations
The acid heats up when a new battery is filled	- Incorrect composition - Incorrect storage - Prolonged storage in a damp place	- Cool - Charge - Check the acid density
The acid escapes through the filler holes	- Battery overflow during filling	- Reduce the battery fluid level
Acid level too low	- Battery tray not leaktight - Significant gas formation caused by too high a charging voltage	- Replace the battery - Check the charger and repair if necessary.
Acid level too low Incorrect operation from start-up	- Insufficient charge - Short circuit in the current circuit - Consumption fault	- Recharge - Check the electrical installation
Acid density too high	- The battery has been filled with acid instead of water	- Reduce the acid level and fill with distilled water. Repeat the operation if need be.
Starting problems Starting test incorrect	- Battery empty - Battery used up or faulty - Capacity too low - Battery sulphated	- Recharge the battery - Fit a new battery
Battery terminals melted	- Incorrect electrical connection - Incorrect battery wiring	- Tighten the ends of the battery cables, or replace them if necessary
One or two cells release a lot of gas at high charge	- Cell(s) faulty	- Fit a new battery
The battery discharges very quickly	- Charge status too low - Short circuit in the current circuit - High self-discharge (for example: through electrolyte contamination) - Sulphation (storage of discharged battery)	- Check the charge - Replace the battery
Short service life	- Incorrect battery part no. - Too many repeated deep discharges - Battery stored too long without charge	- Define the correct battery part no. for the recommended use - Think about charging the battery using a regulator
High water consumption	- Overload - Charging voltage too high	- Check the charger (voltage regulator)
The battery explodes	- Spark after battery charging - Short circuit - Connection or disconnection during charging - Internal fault (for example: interruption) and low electrolyte level	- Replace the battery (beware of fire and sparks) - Ensure there is sufficient ventilation