

# OPERATING MANUAL

## GENERATOR SETS



Dear Zenessis generator set user,

First of all, we would like to thank you for having chosen the Zenessis generator sets.

They are solid, safe and reliable machines, built according to the latest technology.

This operating manual has been designed in order to make you familiar with the generator set.

Please carefully read the instructions in this manual before starting to use your machine.

This manual provides general information about assembly, operation and maintenance of the generator set. Tables and diagrams are also available outlining your generator set.

Never operate, maintain or repair the generator set without taking safety precautions.

The manufacturer does not assume responsibility for possible errors.

The manufacturer reserves the right to make changes without prior notice.


## 1. INTRODUCTION

This operating manual is prepared to assist the operator in the operation and maintenance of the generator set. Observing the advices and rules contained in this manual will ensure the operation of the generator set at maximum performance for a long time.

- In dirty and dusty environments care should be taken to perform more frequent maintenance works in order to keep the generator set in good working condition.

- Necessary adjustments and repairs should be made only by authorized and qualified persons.

- Each generator set has the model and the serial number indicated on a label on the frame. This label also indicates the manufacturing date, voltage, current, power in kVA, frequency, power factor and weight of the generator set. These elements are necessary when ordering spare parts, for warranty validity and for service calls.



The image shows a black rectangular label with white text and input fields. At the top left is the ZENESSIS logo. The label contains the following fields:

MODEL	PRODUCT DATE	SERIAL NO
PRIME KVA	STANDBY KVA	STANDBY KW
PRIME KW	DIMENSIONS	ALTERNATOR TYPE
VOLTS	Hz	FUEL TANK CAPACITY L
PHASE	Cor y	GROUP WEIGHT kg
R.P.M		

At the bottom left, there is contact information for Endress Group Romania: Fagarasului 21, Rucila, Tel: 0250227825, Fax: 0250227828, www.endress-group.ro. At the bottom center is a CE mark, and at the bottom right is a QR code and the text 'SER EN ISO 9001:2001'.

The generator set is designed to be safe when used in the correct manner. However responsibility for safety rests with the personnel who installs, uses and maintains the generator set. If the necessary precautionary measures are taken, the possibility of accidents will be minimized. Before performing any kind of works, it is up to the user to ensure that he is safe.

The generator set should only be operated by personnel properly authorized and trained.

Only people that have the right skills should be allowed to operate, adjust or repair the generator set. It is the responsibility of the management team to give appropriate tasks to operators with the necessary training and skill for that task.

### Skill level 1: Operator

An operator is trained to know the functions of push-buttons, and trained to know the safety aspects.

### Skill level 2: Mechanical technician

A mechanical technician is trained to operate the generator set the same as the operator. In addition, the mechanical technician is also trained to perform maintenance and repair works, as described in the operating manual, and is allowed to change settings of the control and safety systems. A mechanical technician is not allowed to work on live electrical components.

### Skill level 3: Electrical technician

An electrical technician has the same qualifications as both the operator and the mechanical technician. In addition, the electrical technician may carry out electrical repair works within the various enclosures of the generator set. This includes works on live electrical components.

### Skill level 4: Specialist provided by the manufacturer

This is a skilled specialist sent by the manufacturer to perform complex repairs or modifications of the equipment. In general, it is recommended that not more than two people operate the unit, if the operations are carried out by more operators errors could occur. Take necessary measures to keep unauthorized persons away from the generator set and eliminate all possible source of danger near it.

The manufacturer does not accept any liability for any damage arising from the use of non-original parts and for modifications of the generator set made without the manufacturer's approval in writing.

## 2. GENERAL SAFETY PRECAUTIONS

### 2.1. GENERAL

1. The owner is responsible for maintaining the generator set in a safe operating condition. Parts and accessories must be replaced if missing or unsuitable for safe operation.
2. Operate the generator set only for the intended purpose and without exceeding its operating limits (temperature, speed).
3. The generator set shall be kept clean, i.e. as free as possible from oil, dust or other deposits.
4. To prevent an increase of the operating temperature, inspect and clean the heat transfer surfaces (intercooler, water hoses, etc.) regularly.
5. Take precautions against fire. Handle fuel with care because they are inflammable substances. Do not smoke or approach with naked flame when handling such substances. Keep a fire extinguisher in the vicinity.

### WARNING

! Read and understand all safety precautions before operating or performing works on the generator set.

! Failure to follow the instructions and safety procedures in this manual may increase the possibility of accidents and injuries.

! Do not attempt to operate the generator set if you know it is damaged.

! If the generator set is unsafe, place danger notices and disconnect the battery negative terminal (-) so that the generator set cannot be started until the malfunction is corrected.

! Disconnect the battery negative terminal (-) before attempting any repair or maintenance inside the casing.

! Install and operate this generator set only in compliance with applicable local, national legislation or other requirements.

### 2.2. INSTALLATION, HANDLING AND TOWING

Chapters 4 and 12 of this manual cover the procedures for installation, handling and towing of generator set. These chapters should be read before installing, moving, lifting or towing the generator set. The following precautionary measures should be followed:

### WARNING

! Make electrical connections in compliance with the applicable standards and legislation. This includes requirements for grounding and grounding faults.

! For generator sets with storage system outside the casing, make sure such systems are installed in compliance with the applicable legislation and standards.

! Exhaust gas emissions are hazardous to personnel. The exhaust system of the indoor generator sets must be directed outdoors via piping in compliance with the applicable legislation. Ensure that gas silencer and exhaust piping are clear of combustible materials and do not pose any danger to the personnel. Ensure that gases from the exhaust system will not be a hazard.

! Never lift the generator set by attaching to the engine or alternator lifting lugs, instead use the lifting points on the generator set.

! Ensure that the lifting system is in good condition and has a capacity suitable for the load.

! Keep all personnel away from the generator set when it is suspended.



### 2.3. FIRE AND EXPLOSION

Fuel and fumes associated with generator set can be flammable and potentially explosive. Proper care in handling these materials can dramatically limit the risk of fire or explosion. However, safety norms dictate that fully charged BC and ABC fire extinguishers should be kept on hand.

The personnel must know how to operate them.

### WARNING

! Ensure proper ventilation of the location where the generator set is kept.

! Keep the room, the floor and the generator set clean. When spills of fuel, oil, battery electrolyte or coolant occur, they should be cleaned up immediately.

! Never store flammable liquids near the engine.

! Do not smoke or allow sparks, flames or other sources of ignition around fuel or batteries.

Fuel vapours are explosive. Hydrogen gas generated by charging batteries is also explosive.

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! Do not smoke or allow sparks, flames or other sources of ignition around fuel or batteries.

Fuel vapours are explosive.

Hydrogen gas generated by charging batteries is also explosive

! Turn off or disconnect the power to the battery charger before making or breaking connections with the battery.

! To avoiding arcing, keep grounded conductive objects away from exposed live electrical parts. Sparks or arcing might ignite fuel or vapours.

! Avoid refilling the tank while the engine is running.

! Do not attempt to operate the generator set if there are any leaks in the fuel system.



### 2.4. MECHANICAL

The generator set is designed with guards for protection from moving parts. Measures must still be taken to protect personnel and equipment from other mechanical hazards when working around the generator set.

#### WARNING

! Do not attempt to operate the generating set with the safety guards removed. While the generating set is running do not attempt to reach under or around the guards to do maintenance or for any other reason.

! Keep hands, arms, long hair, loose clothing and jewellery away from pulleys, belts and other moving parts.

Attention: Some moving parts cannot be seen clearly when the generator set is running.

! If equipped with access doors, keep them closed when not required to be open.



! Avoid contact with hot oil, hot coolant, hot exhaust gases, sharp edges and corners.

! Wear protective clothing, including gloves and hat when working around the generator set.

! Do not remove the radiator lid until the coolant has cooled. Then loosen the cap slowly to slowly relieve any excess pressure.



### 2.5. CHEMICALS

The fuel, oil, coolant, lubricant and battery electrolyte used in this generator set are typical of the industry. However, they can be hazardous to personnel if not treated properly.

#### WARNING

! Do not swallow or allow skin contact with fuel, oil or battery electrolyte. If swallowed, seek medical treatment immediately. Do not induce vomiting if fuel is swallowed. For skin contact, wash with soap and water.

! Do not wear clothing that has been contaminated by oil or fuel.

! Wear an acid resistant apron and face shield or protective goggles when handling the battery. If electrolyte is spilled on skin or clothing, flush immediately with large quantities of water.



### 2.6. NOISE

Generator sets that are not equipped with sound attenuation casing can produce noise levels exceeding 105 dB(A). Prolonged exposure to noise levels above 85 dB(A) is hazardous to hearing.



#### WARNING

Ear protection must be worn when operating or working around a generator set.

## 2.7. ELECTRICAL

Safe and efficient operation of electrical equipment can be achieved only if the equipment is correctly installed, operated and maintained.

### WARNING

! The generator set must be connected to power consumers only by trained and qualified electricians who are authorized to do such works, and in compliance with the applicable legislation and with other imposed regulations.

! Ensure that the generator set, including a mobile set is effectively grounded in accordance with all relevant regulations prior operation.

! The generator set should be shutdown with the battery negative terminal (-) disconnected before attempting to connect or disconnect the power consumer to/from the generator set.

! Do not attempt to connect or disconnect consumers while the generator set stands in water or on wet or soggy ground.

! Do not touch electrically energized parts of the generator set and/or the interconnecting cables or conductors with any part of the body or with any non-insulated conductive object.



! Place the generator set terminal box cover as soon as connection or disconnection of the cables is complete. Do not operate the generator set without the terminal box cover securely in place.

! Connect the generator set only to consumers or electrical systems that are compatible with its electrical characteristics and that are within its rated capacity.

! Keep the electrical equipment clean and dry. Replace any conductors where the insulation is worn or cut. Replace terminals that are worn, discoloured or corroded. Keep terminals clean and tight.

! Insulate all connections and disconnected wires.

! Use only Class BC or Class ABC extinguishers on electrical fires.

## 2.8 FIRST AID FOR ELECTRIC SHOCK

### WARNING

! Do not touch the victim's skin with bare hands until the source of electricity has been turned off.

! Switch off power if possible, otherwise pull out the cable from the socket and away from the victim.

! If this is not possible, stand on insulating material and move the victim clear of the conductor, preferably using an insulated material such as dry wood. If victim is breathing, move the victim clear of the conductor, preferably using an insulated material.

! If victim is breathing, turn the victim into the recovery position described below. If victim is unconscious, perform resuscitation as required.

#### *Open the airway*

Tilt the victim's head back and lift the chin upwards. Remove objects from the mouth or throat (including false teeth, chewing tobacco or chewing gum).



#### *Breathing*

Check that the victim is breathing by looking, listening and feeling for the breath.



#### *Circulation*

Check for pulse in the victim's neck.

#### *If no breathing but pulse is present*

- Gently pinch the victim's nose.
- Take a deep breath and seal your lips around the victim's lips.
- Blow slowly into the mouth watching for the chest to rise.
- Let the chest fall completely.



Give breaths at a rate of approx. 10 per minute.

- If the victim must be left to get help, give 10 breaths first and then return quickly and continue.
- Check for pulse after every 10 breaths. When breathing restarts, place the victim into the recovery position described later in this section.

If no breathing and no pulse

- Call or telephone for medical help.
- Give two breaths and start chest compression as follows:



- Place heel of hand and 2 fingers above ribcage junction.
- Place other hand on top and interlock fingers.



- Keeping arms straight, press down 4-5 cm at a rate of 15 times per minute.
- Repeat cycle (2 breaths and 15 compressions) until medical help takes over.
- If condition improves, confirm pulse and continue with breaths. Check for pulse after every 10 breaths.
- When breathing restarts, place the victim into the recovery position described below.



### 3.6. Recovery position

- Turn the victim onto the side.
- Keep the head tilted with the jaw forward to maintain the open airway.
- Make sure the victim cannot roll forwards or backwards.
- Check for breathing and pulse regularly. If either stops, proceed as above.



### WARNING

! Do not give liquids until victim is conscious.

## 3. GENERAL DESCRIPTIONS

### 3.1. Generator set description and identification

Diesel generator sets are independent units for the production of electric power; basically, they comprise an alternator driven by an internal combustion, diesel engine.

The generator sets are used for two main purposes:  
*a- Continuous generation of electric power*, used to produce electric power (for lighting, heating, engine start, etc.) in areas where other electric power supply sources are unavailable.

*b- Emergency generators*, used during public network failures, when such failures can cause accidents, material or financial damage (in hospitals, industrial plants with non-stop operating cycles, etc.) or to meet peak energy demands.

According to their application, the sets are further divided into:

- set for use on land
- set for use at sea

The sets for use on land can be either:

- stationary sets or
- mobile sets

These two types of sets are available in a wide range of versions, the main ones being:

1. with manual startup
2. with automatic startup

The stationary generator set is composed of:

- diesel engine
- synchronous generator
- coupling
- metal base with vibration isolators
- starter batteries
- fuel tank in metal frame
- instrument panel
- exhaust silencer.

The Zenessis generator set has been designed as a complete unit to provide superior performance and reliability. Figure 3.1. identifies the major components. This figure shows a typical generator set. However, every set will be slightly different due to the size and configuration of the various components. Further information is provided in later sections of this manual.

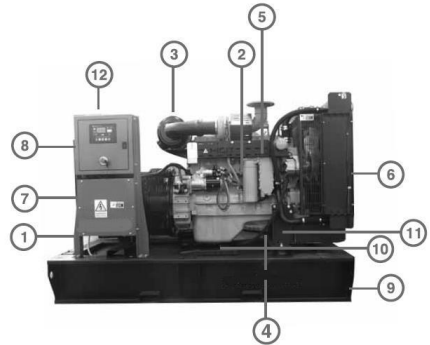
Each generator set is provided with an identification label, generally fixed to the frame base. This label contains the information needed to identify the generator set and its operating characteristics. This information includes the model, serial number, output voltage, frequency, power in kVA and kW, manufacturing date and weight.

The model and serial number uniquely identify the generator set and are needed when ordering spare parts or requesting service or warranty works for the set.

AC series generator sets are Alternating Current generators, designed for continuous running at sites where no electricity is available (some models are excepted) or as alternative electric power source in case of interruption of the mains.

The generator provides 230/220 V in line-to-neutral mode and 400/440 V in line-to-line mode. The AC series generator sets are driven by a water-cooled diesel engine.

### 3.2. Main parts of the generator set



**Figure 3.1.** Typical generating set configuration

1. Zenessis tag
2. Diesel engine
3. Air filter
4. Battery
5. Battery charging alternator
6. Radiator
7. Alternator
8. Terminal box
9. Metal frame
10. Fuel tank (inside the metal frame)
11. Vibration isolator
12. Control panel

### 3.3. Diesel Engine

The diesel engine powering the generator set has been chosen for its reliability and the fact that it has been specifically designed for powering generator sets. The engine is of the heavy duty industrial type, 4-stroke, compression ignition and is fitted with all accessories to provide a reliable power supply. These accessories include, among others, a cartridge type dry air filter and a mechanical or an electronic engine speed governor. The engine block is cast in one piece cast iron, with vertical cylinders, valves and cam shaft in-line or V-shaped, according to the type.

The cylinder heat is made of special cast iron. The crank shaft is forged in one piece in a high tensile steel.

Lubrication: forced lubrication via gear pump, oil cartridge, with lubricant cooling via heat exchanger on almost all versions.

### 3.4. Engine electrical system

The engine electrical system is 12 volt or 24 volts DC, with grounding. This system includes a starter motor and a battery charging alternator. For the 12 volts electrical system one battery is given. For the 24 volt system two lead-acid batteries are given. Other types of batteries may be fitted if requested.

### 3.5. Cooling system

The engine cooling system is water cooled. The water cooled system is comprised of a radiator, a fan and thermostat. The alternator has its own internal fan to cool the alternator components.

### 3.6. Synchronous alternator

Horizontal axle alternator (synchronous three-phase), on rolling bearings, self-ventilated, with low-loss silicon-sheet bundle, copper winding with class H insulation.

The output electrical power is produced by a screen protected and drip-proof, self-regulating, self-exciting, brushless alternator. Fine tuned to the output of the generator set. Mounted on top of the alternator is a sheet steel terminal box.

### 3.7. Coupling

Engine and alternator are firmly joined by a coupling that guarantees the proper coaxiality. At mono-support machines, a special flexible disk is used instead of a flexible coupling.

### 3.8. Fuel tank and base frame

The engine and alternator are coupled together and mounted on a heavy duty steel frame. This frame includes a fuel tank to ensure the operation of the generator set for approximately 8 hours under variable loads. The tank is fitted with a filling cap and fuel level gauge and is connected by flexible hoses to the engine intake and with a return hose. The fuel tank of the high power generator set is separate from the generator set itself.

### 3.9. Vibration isolators

The generator set is fitted with vibration isolators which are designed to reduce engine vibration being transmitted to the foundation on which the generator set is mounted. These isolators are fitted between the engine/alternator and the base of the frame.

### 3.10. Exhaust silencer and exhaust system

Exhaust gases from the engine are discharged in the atmosphere through an exhaust silencer. These should be exhausted as high as possible, and must be prevented from re-entering the engine via the intake, or polluting the radiator. It is important to note that the quick intake nozzles must be always free. Stainless steel exhaust element is delivered together with the generator set. Exhaust systems of different engines shall not be mixed in a common stack, but routed separately on individual paths.

Suitable material is sheet metal, and calculated temperature is 475°C. Rain and condensate have to be drained in order to prevent water entering the engine.

An exhaust silencer is provided loose for installation with the generator set. The exhaust silencer and exhaust system reduce the noise emission from the engine and the exhaust system directs exhaust gases to safe outlets.

The exhaust silencer is made of steel, containing a sound attenuator and a filtering system made of perforated steel sheet and mineral wool; it is asbestos-free. The exhaust silencer is delivered in two configurations: with an industrial attenuator and a residential attenuator.

### 3.11. Control system

One of the several types of control systems and control panels may be fitted to control the operation and output of the generator set and to protect the set from possible malfunctions. Section 15 of this manual provides detailed information about these systems and facilitates the identification of the control systems mounted on the generator set.

## 4. INSTALLATION, HANDLING AND STORAGE

### 4.1. General

Once the size of the generator set and any associated control systems have been established, plans for installation can be prepared. This section presents the main factors to be observed for a quick and effective installation of the generator set.

### 4.2. Sound attenuation casing

Installation and handling is simplified when the generator set has been equipped with a casing. The casing also provides protection from the elements and protection against unauthorized access.

### 4.3. Moving the generator set

The generator set frame is specifically designed for ease of moving the set. Improper handling can seriously damage components.

Using for a forklift, the generator set can be carefully lifted or pushed/pulled by the base directly with the forks. Always use wood between forks and the base frame to spread the load and prevent damage.

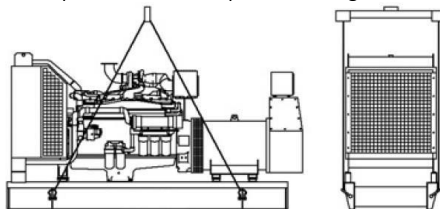


Figure 4.1. Lifting the generator set by using a winch

### WARNING

- ! Never lift the generator set by attaching to the engine or alternator lifting lugs.
- ! Ensure the lifting equipment is in good condition and is able to hold the load of the generator set.
- ! Keep all personnel away from the generator set when it is suspended.
- ! If the generating set is going to be lifted, it should be lifted by the lifting points fitted on generator sets with or without casing.

### 4.4. Location

In order to start to consider the possible mounting locations, the following criteria must be determined:

- The total area available and any possible restrictions within that area (i.e. buried or overhead services).
- A forced ventilation system is required for the equipment to provide enough air for the engine aspiration. Depending on the layout of the building, it may be necessary to install additional duct work to achieve the airflow required.
- The access to the site, initially for the delivery and installation of the equipment, and afterwards for the maintenance or repair works carried out at the generator set.
- Protection from the elements such as rain, snow, flood water, direct sunlight, freezing temperatures or excessive heat.

- Protection from exposure to airborne contaminants such as abrasive or conductive dust, smoke, oil mist, engine exhaust gases or other contaminants.
- Protection from impact with falling objects such as trees or poles, or with motor vehicles or forklifts.
- Clearance around the generator set for cooling and access has to be at least 1 meter around the set and at least 2 meters headroom above the set.
- Possibility to move the entire generator set in the room. Air inlet and outlet vents can often be removable to provide an access point. Limited access to unauthorized personnel.
- If it is necessary to move the generator set outside of the building, the generator set should be enclosed in a sound attenuation casing. A casing is also useful for temporary installations inside or outside the building.

#### 4.5. Foundation and support base

Note: A special foundation is not necessary. A levelled and sufficiently strong concrete floor is adequate. The responsibility for the foundation should be placed with a civil or structural engineer specializing in this type of work

Major functions of a foundation are to:

Support the total weight of the generator set.

Isolate the generator set vibration from surrounding structures.

The civil engineer will need the following details:

- the operating temperature of the generator set
- the overall dimensions of the foundation
- the mounting and fixing arrangements of the generator components.

#### Concrete foundations

The foundation will require at least seven days between pouring the concrete and mounting the generating set to cure.

It also essential that the foundation should be level, preferably within  $\pm 0,5^\circ$  of any horizontal plane and should be poured on solid soil.

The following formula may be used to calculate the minimum foundation depth:

$$t = \frac{k}{d \times w \times l}$$

t = thickness of foundation in m

k = net weight of set in kg

d = density of concrete (2403 kg/m<sup>3</sup>)

w = width of foundation in m

l = length of foundation in m

The foundation **strength** may vary depending on the bearing capacity of supporting materials and the soil type where the foundation will be placed, therefore reinforced concrete may be required to be used.

### **Vibration isolation buffers**

Each generator set is built as a single module with the engine and alternator coupled together through a coupling in order to form one unit of high strength and rigidity. This provides both accuracy of alignment between the engine and alternator and reduces engine vibration. Thus, a heavy concrete foundation normally used to absorb engine vibration is not always necessary, if the generator set is placed on a concrete floor that will bear the distributed weight of the generator set.

### **Foundation**

A reinforced concrete foundation provides a rigid support to prevent any deflection and vibration of the generator set. Typically, the foundation should be 150 mm to 200 mm deep and at least as wide as the generator set. The ground or floor below the foundation should be properly prepared and should be able to bear the weight of the foundation and of the generator set.

If the generating set is to be installed above the ground floor, the building structure must be able to bear the weight of the generator set, of the fuel storage and of the other accessories.

If the floor becomes wet from time to time (such as in a boiler room), the support base should be raised above the floor level. This will provide a dry footing for the generator set and for those who connect, service or operate it. It will also minimize corrosive action on the frame base.

### **Levelling**

A poor foundation may result in unnecessary vibration of the generator set.

### **Connections**

All hoses and electrical connections should be flexible to prevent damage during movement of the generator set. All fuel lines and exhaust pipes can transmit vibrations at long distances.

## **4.6. Room design guidance notes**

### **4.6.1. Room size allowance**

The dimensions indicated as A and B allow for sufficient working space around the generator set.

Ideally you should allow a minimum distance of 1 meter from any wall, tank or panel within the room.

### **4.6.2. Attenuator inlets and outlets with louvers**

The attenuator inlets and outlets should be installed within a wooden frame with a 100 mm base. The attenuators should be fitted with louvers with a minimum 50% free area, good airflow profile and in order to allow restriction of airflow when necessary.

These louvers should have mesh screens fitted on the inside, but these screens must not impede the free flow of cooling and aspiration air.

The attenuator outlet should be connected to the radiator flange with a heat and oil resistant flexible connection.

### **4.6.3. Engine inlet**

Air necessary for engine combustion must be as clean and cool as possible. Normally this air can be drawn from the area surrounding the generator set via the air filter. However, in some cases due to dust, dirt or heat, the air around the set is unsuitable. In these cases an air inlet duct should be fitted. This duct should run the air from outside the building, or from another room to the air filter mounted on the engine. Do not remove the air filter and mount it at a remote location, as this can increase the possibility of dirt leaking through the duct and into the engine inlet.

### **4.6.4. Exhaust system**

The exhaust system shown on the layout drawing is supported from the ceiling. Should the building construction be unable to support the exhaust system, a floor standing steel stand exhaust system will be needed. Exhaust pipes should terminate at least 2-3 m above floor level to make it reasonable safe for anyone passing or accidentally touching it.

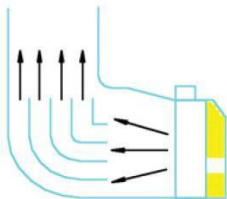
It is recommended that stainless steel bellows be fitted to the engine exhaust system, followed by rigid pipe work to the exhaust silencer.

It is recommended that the exhaust system within the generator room be insulated with a minimum of 50 mm layer of high temperature mineral insulation covered by an aluminium layer.

This reduces the possibility of operator burn injury and reduces the heat being radiated to the room where the generator set is located.

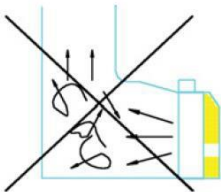
#### 4.6.5. Cooling and ventilation

The engine, alternator and exhaust piping radiate heat which can result in a temperature high enough to adversely affect the performance of the generator set. It is therefore important that adequate ventilation is provided to keep the engine and alternator cool. A proper air flow, as shown in Figure 4.4., requires that the air comes in at the alternator, passes over the engine, through the radiator and out of the room via a flexible inlet/outlet ducting. Without this inlet/outlet ducting, the hot air from the room will be drawn back through the radiator, reducing the effectiveness of the cooling system.



**Figure 4.2.**  
Directing the air thrown from the radiator with deviating wings

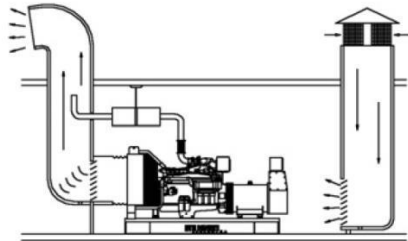
Sharp corners on the radiator hot air outlet must be avoided.



**Figure 4.3.** Insufficient ventilation

The air inlet and outlet openings should be large enough to ensure free flow of enough air into and out of the room. The openings should each be at least 1.5 times the area of the radiator.

Both the inlet and outlet openings should have louvers for weather protection. These may be fixed, but preferably should be movable in cold climates so that while the generator set is not operating the louvers can be closed. This will allow the room to be kept warm, which will assist starting the generator set. If the louvers are movable, they must be manually operated. They should be opened immediately upon starting the engine.



**Figure 4.4.** Air ventilation

#### 4.6.6. System cabling

The cable layout drawing assumes that the load change-over board is located outside of the room where the generator set is located. Specific project requirements can affect this layout.

The cables from the generator output to the switch panel must be of a flexible construction.

The installed flexible power cables have to be properly mounted, keeping the recommended inter-spacing from the system control cables.

The cables should be correctly dimensioned to resist the installation and operating conditions. The flexible cables when entering any panel must pass first through a gland fitting.

#### 4.6.7. Load transfer panels

Should the load transfer panel be mounted within the room where the generator set is located.

For change-over panels up to 400 amperes, wall mounted at a maximum depth of 350 mm: they can be mounted directly above the side access area without causing too many problems. For change-over panels from 800 amperes and above, a floor standing panel is used which needs additional space to be allocated. A minimum of 800 mm for rear access should be allowed.

#### 4.6.8. Generator sets

Up to 680 kVA, generator sets include fuel tanks inserted in the frame. For standing tanks additional room space will be required.

Air inlet should be at rear of the alternator to allow adequate circulation.

#### 4.6.9. Access doors

Doors should always open outwards. Ensure that there is sufficient space around the generator set for the doors to allow access to the generator set.

#### 4.6.10. Air inlet and outlet louvers

The attenuators should be installed with at least 50% free areas, good airflow profile and in order to allow restriction of airflow when necessary.

These louvers should have mesh screens fitted on the inside, but these screens must not impede the free flow of cooling and aspiration air.

The attenuator outlet should be connected to the radiator flange with a heat and oil resistant flexible connection.

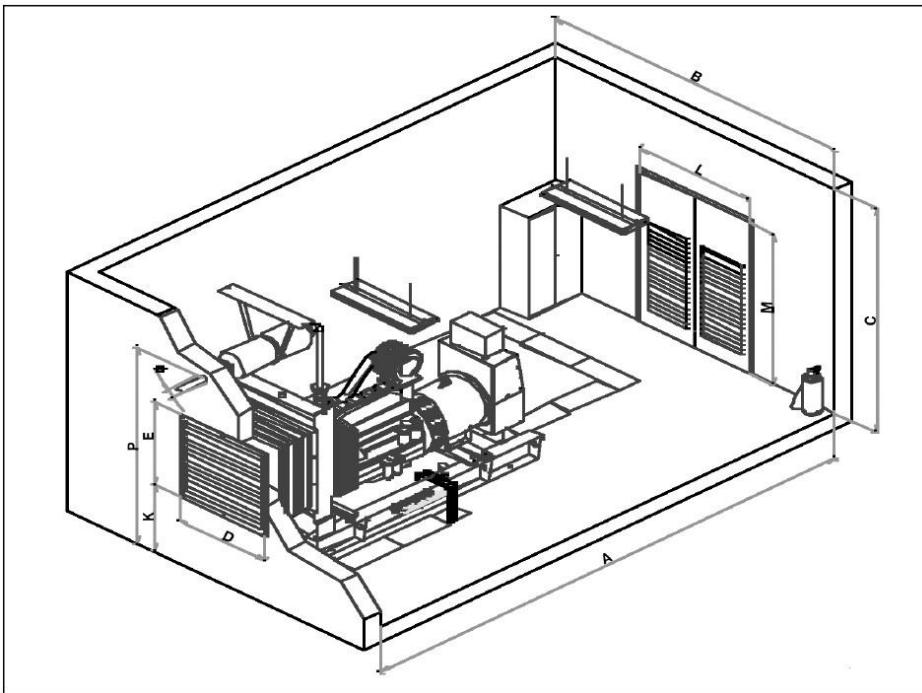


Figure 4.5. Generator set room

## 5. FUEL SYSTEM

### 5.1. General

Depending on the specific site layout, the fuel can be supplied to the engine either:

1. Directly from the fuel tank located under the generator set.
2. From an intermediate tank located within the room, which is automatically refilled from a bulk storage tank.
3. Directly from the bulk storage tank, provided that the outlet connection from this tank is at least 500 mm higher than the support base on which the generator set is mounted.

It is very important that the fuel oil which is used to operate the engines be as clean and water-free as possible. Dirt in fuel the fuel can clog injector outlets and ruin the precision of the fuel injection system. Water in the fuel will accelerate corrosion of the parts.

### 5.2. Recommended fuel

The following fuel specifications are typical

Physical properties of recommended fuel  
Specifications

Viscosity (ASTM D445)	1.3 to 5.8 (1.3 to 5.8 mm per second) at 40°C (104°F)
Octane Number (ASTM D613)	40 Minimum above 0°C (32°F) 45 Minimum below 0°C (32°F)
Sulphur content (ASTM D129 or 1552)	Not to exceed 0.5%
Water and sediment (ASTM D1796)	Not to exceed 0.5%
Density (ASTM D287)	42 to 30° API at 60° (0.816 to 0.876 g/cc at 15°C)
Cloud Point (ASTM D287)	6°C (10°F) below lowest ambient temperature at which the fuel is expected to operate

Ash (ASTM D482)	Not to exceed 0.02% (0.05% with lubricating oil)
Acid Number (ASTM D664)	Not to exceed 0.1 Mg KOH per 100 ML
Lubricity	3100 grams or greater

### Diesel fuel property definition

**Ash** - Mineral residue in fuel. High ash content leads to excessive oxide build up in the cylinder and injector.

**Octane Number** - Ignitability of fuel. The lower the octane number, the harder it is to start and run the engine. Low octane fuels ignite later and burn slower. This could lead to strong explosion by having excessive fuel in the chamber at the time of ignition. In cold weather, a higher octane number is desirable.

**Cloud and pour points** - The pour point is the temperature at which the fuel will not flow. The cloud point is the temperature at which the wax crystals separate from the fuel.

The pour point should be at least 6°C (10°F) below the ambient temperature to allow the fuel to move through the lines. The cloud point must be no more than 6°C (10°F) above the pour point, so the wax crystals will not separate from the fuel and clog the filtration system.

**Sulphur** - Amount of sulphur residue in the fuel. The sulphur combines with the moisture formed during combustion to form sulphuric acid.

**Viscosity** - Influences the size of the atomized droplets during injection. Improper viscosity will lead to explosion, power loss and excessive smoke. Fuels that meet the requirements of ASTM or 2.0 diesel fuels are appropriate as required fuels.

### 5.3. Integrated fuel tank

Up to 680 kVA generator sets can be supplied with or without integrated fuel tanks, if the room size allows for this feature.

The recommended room layout allows the inclusion of fuel tanks in the generator set.

This provides a self contained installation without any additional external fuel lines or transfer pumps. Generators with integrated tanks are delivered fully connected and ready to run.

#### 5.4. Bulk storage fuel tank

The role of the fuel supply system is to store an adequate amount of fuel to operate the system. This fuel tank can be sized as necessary.

Filling of the fuel tank is done using a fuel supply hose, kept in a closed enclosure, located so as to allow access to the fuel tank. This enclosure also has a level gauge and an alarm, in case of overfilling, connected to a switch which stops the fuel supply.

#### 5.5. Without intermediate fuel tank (Fig. 5.1.)

The simplest arrangement would be to supply the engine directly from the bulk storage tank and the return be sent directly to this same tank. A typical arrangement for this is shown in Fig. 5.1.

The main limitations of this method are:

In order to gravity feed the engine, the bulk storage tank must be a minimum of 600 mm above the engine level. The pressure drop of the return pipe work must not exceed the values mentioned in the engine manual. The supply pipe from the fuel tank to the engine must be sized to allow the total volume of fuel required by the engine to flow under gravity.

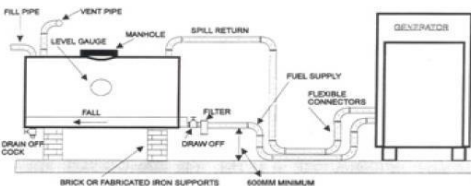
#### 5.6. With intermediate fuel tank (Fig. 5.2.)

Where, due to site constraints, it is not possible to supply the engine directly from the bulk tank, an intermediate tank can be placed within the generator set room to supply fuel directly to the engine.

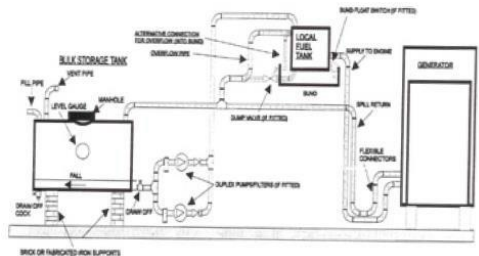
This type of system can be further enhanced by adding the following optional items of equipment:

1. An automatic duplex fuel transfer pump and a primary filter set to start as standby pump should the duty pump fail. The transfer pump must be chosen to ensure the total fuel required by the engine (Fig.5.2.)
2. A valve designed to cut off the supply of fuel to the intermediate tank and to transmit a signal in the event of fire;
3. A fusible valve, arranged to empty the contents of the intermediate tank back into the bulk storage tank in the event of a fire within the generator set enclosure.

The connection details for these additional items of equipment are indicated. See Fig. 5.2.



**Fig. 5.1.** Without intermediate fuel tank



**Fig. 5.2.** With intermediate fuel tank

#### 5.7. Daily checks of the fuel tank

Separate tanks can have a capacity of 500 litres, 1250 litres or 2000 litres and a transfer system arranged to automatically feed from the main tank/bulk storage tank through an electric motor driven pump operating from signals received from level sensors. Fuel tanks should not be made from galvanized steel, as diesel fuel oil reacts against zinc.

A vent pipe should be extended to the highest point of the fuel supply system. The diameter of this pipe should at least match that of the fill connection.

Measures should be taken to prevent the ingress of dirt. The fuel coming from the return line can either be:

1. Piped directly back to the main tank;
2. Piped back into the intermediate tank with an alarm system arranged to cut off the fuel transfer pump system on detection of an overflow;
3. Piped to flow back to the specified overflowing area.

The feed connection on the tank should not be lower than 600 mm above the level on which the engine sits in order to maintain a gravity feed to the engine. When the intermediate tank is located at a lower level than the bulk storage tank, it is essential that a solenoid valve be incorporated into the transfer line. All final connections to the engine should be made with flexible hoses to restrict vibration transmission through the pipes.

### Determining Pipe Sizes

Minimum pipe sizes are determined by the size of the inlet to the fuel transfer pump. The pipe inner diameter must be at least as large as the transfer pump inlet. If the piping must carry the fuel over long distances, the pipe size must be increased. An auxiliary transfer pump may be needed to avoid high suction pressure within the piping. At high suction pressures the fuel vaporizes in the piping and the fuel amount supplied to the engine will be decreased. When sizing piping, always remember to account for pressure drop caused by filters, fittings and restriction valves. A flexible connector must be added to isolate the engine vibration from the fuel piping. If this vibration is not isolated, the piping could rupture and leak. The flexible connector must be positioned as close to the pumps as possible.

Any expansion of exposed piping must be properly supported to prevent piping ruptures. Use pipe hangers to isolate vibration from the system. Exposed fuel piping must never run near heating pipes, electrical wiring or exhaust ducts.

fuel from heating. All pipes should be inspected for cracks or leaks, including cleanliness. Before start-up to avoid pulling excess dirt into the engine flush the piping. After installation, the air should be removed from the fuel system. A discharge cock should be mounted at a high point in the system to allow air removal.

Use tees to make piping bends. This will allow for cleaning by removing the plugs. All threaded pipe fittings must be sealed with a suitable paste.

Caution: Do not use tape to seal fuel line fittings. Pieces of tape could shear off and jam in the pump or injectors.

### Fuel Return Lines

Fuel return lines take the hot excess fuel not used in the engine and send it back to the tank. The heat from the excess fuel is dissipated in the tank.

Caution: Never run a fuel return line directly back to the engine fuel supply lines because the fuel will overheat and break down.

The fuel return lines should always enter back into the tank above the highest fuel level possible. This measure is true for all Cummins powered engines with the PT fuel system. However, using the B series, C series drain lines will cause siphoning back through the supply line and result in hard starting of the engine if installed above the fuel level.

The fuel return line should never be less than one inch smaller than the fuel supply line.

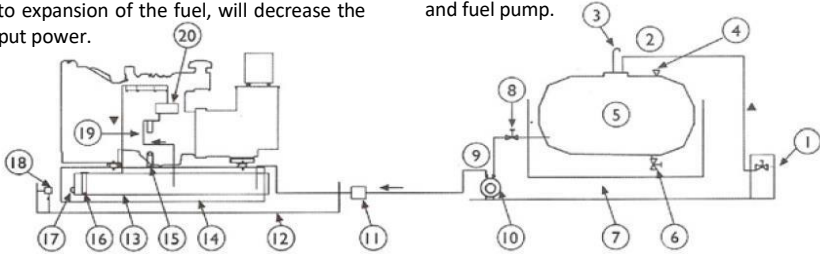
### WARNING!

- The fuel must be clean and must not contain any water.
- Fuel pipes must best made of black pipe, not galvanized pipe.
- When the engine stops, there should not be any gravitational free flow in the fuel pipes towards of the engine.

The fuel lines should be insulated to prevent the

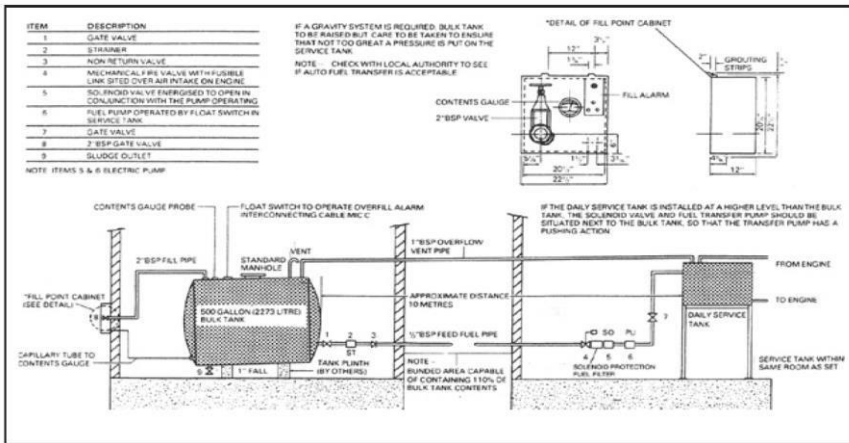
- The fuel temperature is a critical factor for the operation of the engine. Fuel temperature above 71°C, due to expansion of the fuel, will decrease the engine output power.

- Using the water separator in fuel supply system will ensure the proper operation of the engine, injectors and fuel pump.



**Figure 5.3.** Typical fuel supply system using an integrated tank fed from a bulk tank

- |  |                                   |
|--|-----------------------------------|
| 1. Fill receptacle with overflow alarm and gauge | 11. Electrical shut off valve     |
| 2. Tank fill system                              | 12. Optional band                 |
| 3. Vent line                                     | 13. Integrated tank               |
| 4. Contents gauge                                | 14. Float control switch          |
| 5. Bulk storage tank                             | 15. Fill and vent holes           |
| 6. Sludge drain                                  | 16. Level gauge                   |
| 7. Connected tank                                | 17. Drain outlet                  |
| 8. Outlet valve                                  | 18. Leakage alarm unit (optional) |
| 9. Supply lines to integrated tank               | 19. Fuel filter                   |
| 10. Electric fuel transfer pump                  | 20. Engine fuel pump              |



**Figure 5.4.** Suggested installation of the main tank and the generator set

Generator set Active power	Maximum length of pipes (m)	Maximum vertical height (m)	Maximum number of pipe fittings (m)	Recommended pipe Diameter (inch)
40 - 800	6	0.9	6	1"
800 - 1500	6	0.9	6	1 1/2"
1500 - 2250	6	0.9	6	2"

**Table 5.1** Recommendations for fuel piping

## **WATER TREATMENT**

### **General**

The engine cooling system has a high level of rusting. To minimize the severity of this condition, an anti-corrosive agent can be added for protection purposes.

An antifreeze solution is required to prevent freezing of the coolant in the cold weather.

### **Engine Coolant**

Water and coolant should be clean and free from any corrosive chemicals such as sulphates, chlorides and acids. It should be kept slightly alkaline with a pH value in the range 8.5 to 10.5.

Generally, any water which is suitable for drinking can be used, with treatment as described below.

### **Protection against corrosion**

A additional coolant additive is required to protect the cooling system from general corrosion and residue build-up.

The use of antifreeze is recommended as DCA4 concentrations are dependent upon the presence of antifreeze. Antifreeze also interacts with DCA4 in order to provide greater protection against corrosion and sulphate build-up.

### **Procedure for treating the coolant**

1. Add the required amount of water into the mixing container and dissolve in the required quantity of DCA.
2. Add the required amount of antifreeze, if used, to the water solution and mix.
3. Add the coolant to the cooling system.

### **Cold Weather Protection**

Antifreeze must be added to the coolant where there is any possibility of freezing to protect the engine from damage due to coolant freezing.

A 50% antifreeze / 50% water mixture is recommended because DCA4 concentrations are dependent upon the presence of antifreeze. The dosage of DCA4 must be increased to a higher concentration if antifreeze is not added to the coolant. A low-silicate antifreeze is recommended.

### **Engine warming**

Where thermostatically controlled immersion heaters controlled from the operating panel are fitted in the cooling system, these maintain the temperature of the coolant at low temperatures.

A heater alone, fitted in the radiator will not be adequate for starting the engine or preventing freezing, so a water-antifreeze mixture should be used.

## **EXHAUST SYSTEM**

### **Sizing**

An exhaust system should be designed to dispel the exhaust gases into the atmosphere at the most convenient point in an installation. The length of the system and the number of changes in direction should be kept to a minimum to maintain the efficiency of the system.

The calculation of the effect on the back pressure is based upon the restriction related to the straight lengths of pipe, the bends and the exhaust silencer. The smaller the diameter of the pipe, the greater its length and the more times it changes its direction, the greater is its resistance to flow.

The back pressure limit for most Cummins engines is 3 ins Hg (76 mm Hg).

Take an estimate of the size of the pipe by starting with the diameter of the exhaust flange and increasing the size by 1 inch for each 6 meters or after 3 x 90° bends.

### **Routing the exhaust system**

Once the final size and route of the piping and the location of the exhaust silencer have been established, the exhaust route can be determined, taking into account the following factors:

A flexible joint must be fitted between the engine and the exhaust pipes in order to allow the engine to move on its buffers.

If the silencer is to be located within the generator set room, due to its physical size and weight it has to be supported from the floor.

It may be necessary to install expansion joints at each change of direction to compensate for the thermal expansion of the pipe caused by heat during operation.

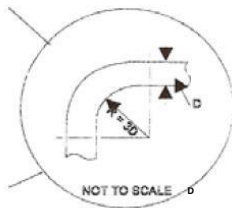
The inner radius of pipe at 90° bends should be 3 times the diameter of the pipe; Fig. 7.1.

The primary exhaust silencer should be mounted as

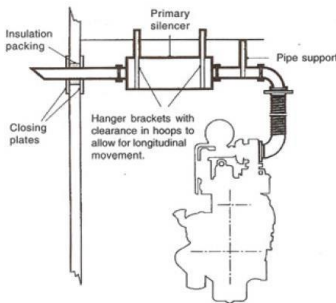
close as possible to the engine.

The termination point should not be directed towards combustible materials/structures, into hazardous atmospheres containing flammable vapours or where there is a danger that the discharged gases will re-enter the generator set room through the vent system or through any opening of the building or in its vicinity.

All rigid piping should be installed in such a manner that the engine's exhaust outlet is not stressed. Pipes should be routed so that they are supported by fixtures to the building or by an existing steel structure which supports such operations.



**Fig. 7.1.** Exhaust bend and radius



**Fig. 7.2.** Exhaust system

## 8. LUBRICATING OIL

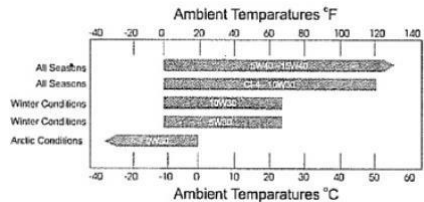
The diesel engine oil is one of the most important elements of the engine. Correctly made engine overhaul (this subject includes oil changes, filter changes and correctly selecting the type of oil) prolongs the life of the engine.

### 8.1. Oil performance properties

The American Petroleum Institute (API), the American Society for Testing and Materials (ASTM) and the Society of Automotive Engineers (SAE) have developed and preserved a system to classify the lubrication oils according to their performances.

### 8.2. Lubrication recommendations for engine

The manufacturer recommends that high quality SAE 15W/40 oils be used. At ambient temperatures above -15 °C the 15W40 oil is recommended. The minimum API oil quality levels recommended for use is CH / CI-4, CH or CI-4 can be used in areas where CF4 oil is not available or when the oil interval must be reduced. API CA, CB, CC, CD, CE, CG4 oil categories are not recommended, do not use these.



**Fig.8.1.** Recommended SAE oil viscosity Categories according to temperatures

### **ELECTRIC STARTING SYSTEM**

The electric starting system is generally used on all generator sets. The power source for the electric starting system is a 12 or 24 V battery system. The starting voltage is determined by engine size, 24 V being used for larger engines in order to reduce the necessary starting current. Control of starting is done via a start solenoid which is controlled by the control system of the engine.

### **Batteries**

Batteries are of two types - lead acid and NiCad. Lead acid batteries are generally used, being the least expensive. NiCad batteries are used where longer life, etc., is required.

### **Maintenance of batteries**

#### **Warning**

- Do not smoke or allow sparks, flames or other sources of ignition around batteries. Hydrogen gas generated by charging batteries is explosive.
- Wear an acid resistant apron and face shield or protective goggles when handling the battery. If electrolyte is spilled on skin or clothing, flush immediately with large quantities of water.
- Take out the metallic objects from your hand and protect your hand and wrist.
- Disconnect the battery negative terminal (-) first and reconnect last.
- Always ensure that battery charging is carried out in a well ventilated area.

The battery should be located as close as possible to the generator set, while still being accessible for servicing. This will prevent electrical losses.

### **Battery maintenance works**

- Keep the top of the battery and its terminals clean.
- Cover the battery terminals and its connections with vaseline.
- Tighten the terminals but do not tighten too strong.
- Check the electrolyte level periodically. It must be 10 mm above the plates.
- Check periodically the abrasion of the alternator belt and the belt tension according to manufacturer's recommendation.
- Ensure that your battery is not uncharged.

### **Maintenance-free batteries**

Ensure that all battery connections are correct and batteries are charged. There are not any other procedures for this type of batteries.

### **Starting aids**

You can choose to maintain the coolant temperature above 40°C, to ensure a quick startup of the emergency generator sets. Thermostatically controlled heaters, deriving their supply from the primary source of power are immersed in the engine cooling system to provide this temperature.

### **ELECTRICAL CONNECTIONS**

Only full qualified and experienced electrical technicians should carry out electrical installation, repair works and servicing.

#### **Warning:**

- Make electrical connections in compliance with applicable standards and regulations.

### **Cabling**

Due to movement of generator sets, the electrical connections to the set should be made with flexible cables.

The cables must be suitable for the output voltage and rated current of the generator set. In determining the size, clearances should be kept for temperature changes.

All connections should be carefully checked for integrity. On the other hand, there is a one more important point while cable cross sections are being selected. If the distance between the consumer and the generator is too long, voltage drop at the consumer side can be too much during the transient current period. The voltage drop across a cable can be determined as follows:

$$e = \frac{\sqrt{3} \times L \times I \times (R \cos \phi + \sin \phi)}{1000}$$

e = Voltage drop (V)

I = Rated current (A)

L = Length of conductors (m)

R = Resistance (Ω / km to VDE 0102)

X = Reactance (Ω/ km to VDE 0102)

### Protection

The cables connecting the generator set with the distribution system are protected by means of an automatic circuit breaker which disconnects the generator set in case of overload or short circuit. (for manual versions)

### Consumers

When planning the electrical distribution system, it is important to ensure that a balanced load at the generator set. If loading on one phase is substantially higher than the other phases, this will cause overheating of the alternator windings, imbalance in the output voltage and possible damage to sensitive 3-phase equipment connected to the generator set. Ensure that no individual phase exceeds the current rating of the generator set. For connection to an existing distribution system, it may be necessary to reorganize the distribution system to ensure these loading factors are met.

### Power factor

The power factor (Cosφ) of the connected load should be determined. Power factors below 0.8 can overload the generator. The generator set will provide its rated output and operate satisfactorily at a power factor between 0.8 up to 1. Particular attention must be given to installations with power factor correction equipment, such as capacitors, to ensure that a high power factor is never present. This would lead to voltage instability and may result in damaging the overvoltage protection devices. Generally, whenever the generator set is supplying the consumer any power factor correction equipment should be switched off.

Cable Selection mm <sup>2</sup>	Soil	Air at 25°C	Air at 40°C		
	Multiple wires	Multiple wires	Multiple wires	Multiple wires	H07RN-F
2.5	36	25	22	25	21
4	46	34	30	33	28
6	58	44	38	42	36
10	77	60	53	57	50
16	100	80	71	76	67
25	130	105	94	101	88
35	155	130	114	123	110
50	185	160	138	155	138
70	230	200	176	191	170
95	275	245	212	228	205
120	315	285	248	267	245
150	355	325	283	305	271
185	400	370	322	347	310
240	465	435	380	....	....

**Table 10.1.** Current carrying capacity of power cables (PVC-insulated YVV, NYY, 0.6/1 kV, VDE and TSE norms)

### Grounding requirements

The frame of the generator set must be connected to an earth ground. Since the set is mounted on vibration isolators, the ground connection must be flexible in order to avoid possible breakage due to vibration. Ground connection cables should have at least half of the consumer current carrying capacity and meet applicable requirements in the field.

### Insulation Test:

Before starting the generator set, test the insulation resistance of the windings. The automatic voltage regulator (AVR) should be disconnected and the diodes either shortened or disconnected during the test. Any control wiring must also be disconnected. A 500 V megohmmeter or similar instrument should be used. Disconnect the earthing conductor connected from neutral and connect a megohmmeter output to the earthing. The insulation resistance should be in excess of 1MΩ to the earthing.

**TOWING (mobile generator sets)****Preparing to tow**

Inspect all components of the coupling equipment on the trailer and towing vehicle and the generator set for possible defects, rust or missing bolts. Inspect tyres for condition and proper inflation. Check that all tail lights, if equipped, are operating properly and that all reflectors are clean and functional.

**Towing**

Whenever towing a mobile generator set, remember that manoeuvrability and stopping distance will be affected by the weight being towed.

**WARNING!**

When transporting mobile generator set, observe all applicable traffic rules. These include the required equipment and the maximum and minimum speeds.

Do not allow anyone to ride on the mobile generator set. Do not allow personnel to stand on the drawbar or to stand or walk between the generator set and the towing vehicle.

Avoid gradients, potholes, rocks or other obstructions and soft or unstable terrain.

Ensure the area behind and under the trailer is clear before reversing.

**Parking:**

Park the generator set on a dry levelled area that can support its weight. If it must be located on a slope, park it across the grade so that it does not tend to roll downhill. Do not park the generator set on grades exceeding 15°.

**STORAGE**

Long storage periods can have detrimental effects on both the engine and alternator. These effects can be minimized by properly preparing the generator set.

**Engine Storage**

The engine should be put through a special engine "preservation" procedure that includes cleaning the engine and replacing all the fluids with new ones or preserving the old fluids.

Control of generator set noise is becoming very important in most installations. There is wide range of components available to control the noise level.

**WARNING!**

Ear protection must be worn when working around an operating generator set.

**Exhaust Silencers:**

As discussed in Section 3.10, the exhaust silencer will decrease sound level of the engine.

**Sound attenuation casings:**

Section 4.2 describes sound attenuation casings that lower the noise level of the entire generator set.

**Other sound attenuation methods:**

For installation in buildings there also exist other types of equipment, such as vent holes and fan silencers, as well as sound absorbing walls. All these can be used to reduce the noise levels produced by the generator set.

**ACOUSTIC SILENCING**

**Alternator storage:**

When an alternator is in storage, moisture tends to condense in the windings. In order to minimize condensation, store the generator set in a dry storage area.

If possible, use space heaters to keep the windings dry. After removing the generator set from storage, perform an insulation check as discussed in Section 10.6.

**Battery storage:**

When the battery is stored, it should be fully charged at approximately every 8 weeks.

**GENERAL PRECAUTIONS AND CONTROLS WHICH MUST BE DONE BEFORE STARTING UP THE GENERATOR SET**

- Make a general visual inspection on the engine and alternator. Check if there are any cracks, indentations, leakages or loosened bolt nuts. Never operate the generator set before removing any fault, if any.
- Keep foreign materials such as keys, tools, papers etc. away from the engine and the alternator.
- Check the fuel level in day tank. Refill with fuel if necessary.
- Check the oil level on the dipstick. Refill with an appropriate oil if it is low. Normally, oil level must be close to the maximum level line.
- Check the water level in the radiator by opening the lid. If the level is inadequate add more water. Water level must be 30 mm lower than the water filling neck.
- Engine cooling water must include antifreeze according to the temperatures recorded in the area. A mixture of 50% antifreeze and 50% water provides a good protection in all areas.
- Inspect the vent holes on the casing, clear away all obstructions in front of them.
- Check the air filter. Clean or replace air filter, if necessary.
- Keep the inlet opening open.
- Make sure that the generator set can easily take air from the environment.
- Check the battery connection cables. Take care to tighten the loosened battery terminals using a spanner and cover with special substance to keep them clean and to avoid oxidation.
- Open the battery lids and check the liquid level in the batteries requiring maintenance. Add distilled water, if necessary, so as to be approximately 1 cm higher than the plates. Never fill the battery with tap water, acid water or acid.
- Check if the circuit breaker switch is in OFF position.
- Make sure that the emergency stop button is not pressed.

**GENERAL PRECAUTIONS AND CONTROLS WHICH MUST BE DONE AFTER STARTING UP THE GENERATOR SET**

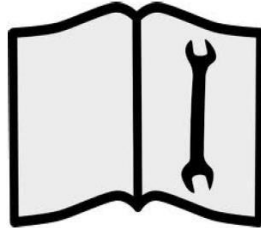
- Check for any abnormal noise or vibration at the generator set.
- Check if the exhaust system has any leakage.
- Monitor the operation of the generator set by means of the control module LCD display. Check the engine temperature and the oil pressure. Oil pressure must reach the normal value 10 seconds after the generator set startup.
- Monitor the generator set outlet voltage and the frequency by means of the control module display. Check whether the voltage between phases is 400 V and between phase and neutral is 230 V. Check whether the frequency is 51 - 52 Hz at generator sets with mechanical governors and 50 Hz at generator sets with electronic governors.
- If a water heater is not available, run the generator set at no-load for 8 minutes and when the engine has warmed up apply on load (for manual versions).

Apply load to the generator set as follows:

- Set the alternator circuit breaker on the panel to ON position.
- Set the load circuit breakers (or fuses) on the distribution panel to ON position one by one. This way, the generator set cannot be suddenly put under full load. Otherwise, engine stalling or alternator winding insulation damage or even burning can occur.
- Set the alternator circuit breaker on the circuit to OFF position before stop the generator set.
- Continue to run the engine at no-load period for 5 minutes for purpose of cooling and then stop.
- Never operate the generator set before removing any fault, if any.

**17. CONTROL PANELS**

Control, supervision and protection panels are mounted on the generator set base frame.



- Battery capacity too low
- Bad electrical connection
- Faulty in starter motor
- Wrong type of lubrication oil is used

**The engine does not start or difficult to start:**

- Starter motor turns engine too slowly
- Fuel tank empty
- Faulty fuel supply pump
- Clogged fuel supply pipe
- Faulty fuel control solenoid
- Dirty fuel filter
- Air in fuel supply system
- Faulty atomisers
- Cold start system used incorrectly
- Faulty cold start system
- Clogging of fuel tank vent
- Wrong type of fuel is used
- Clogged exhaust pipe

**Engine does not have enough power:**

- Clogged fuel supply pipe
- Faulty fuel supply pump
- Dirty fuel filter
- Air in fuel supply system
- Clogged air filter
- Clogged exhaust pipes
- Faulty atomiser or atomiser of an incorrect type
- Clogging of fuel tank vent
- Wrong type of fuel is used
- Restricted movement of speed control unit
- Engine temperature is too low or too high

**Misfire**

- Clogged fuel supply pipe
- Faulty fuel supply pump
- Dirty fuel filter
- Air in fuel supply system
- Faulty atomiser or atomiser of an incorrect type
- Faulty cold start system
- Incorrect valve clearances
- Engine temperature is too high

**The pressure of the lubrication oil is too low:**

- Wrong type of oil is used
- Not enough lubrication oil in sump
- Defective gauge
- Dirty lubrication oil filter

**High fuel consumption:**

- Clogged air filter
- Faulty atomiser or atomiser of an incorrect type
- Faulty cold start system
- Wrong type of fuel is used
- Restricted movement of speed control unit
- Clogged exhaust pipes
- Engine temperature is too low
- Incorrect valve clearances

**Black exhaust smoke:**

- Clogged air filter
- Faulty atomiser or atomiser of an incorrect type
- Faulty cold start system
- Wrong type of fuel is used
- Clogged exhaust pipes
- Engine temperature is too low
- Incorrect valve clearances
- Engine overload

**Blue or white exhaust smoke**

- Wrong type of oil is used
- Faulty cold start system
- Engine temperature is too low

**The engine knocks:**

- Faulty fuel supply pump
- Faulty atomiser or atomiser of an incorrect type
- Wrong type of oil is used
- Faulty cold start system
- Engine temperature is too high
- Incorrect valve clearances

**The engine runs erratically:**

- Faulty fuel supply system
- Clogged fuel supply system
- Faulty fuel supply pump

- Dirty fuel filter
- Clogged air filter
- Air in fuel supply system
- Faulty atomiser or atomiser of an incorrect type
- Faulty cold start system
- Clogged fuel tank vent
- Restricted movement of speed control element
- Engine temperature is too high
- Incorrect valve clearances

**Vibration**

- Faulty atomiser or atomiser of an incorrect type
- Restricted movement of speed control element
- Engine temperature is too high
- Fan is damaged
- Faulty flywheel or engine mounting

**The engine temperature is too high:**

- Clogged air filter
- Faulty atomiser or atomiser of an incorrect type
- Faulty cold start system
- Clogged exhaust piping
- Fan is damaged
- Too much lubrication oil in sump
- Restriction in air or water passage through radiator
- Insufficient coolant

**Motor crankcase pressure:**

- Clogged breather pipe
- Exhaust pipes leak or are faulty

**Bad compression:**

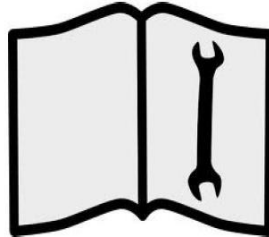
- Clogged air filter
- Incorrect valve clearances

**The engine starts and stops:**

- Dirty fuel filter
- Clogged air filter
- Air in fuel supply system

**The engine shuts down after approximately 15 seconds:**

- Bad connection towards oil pressure switch/  
coolant temperature switch



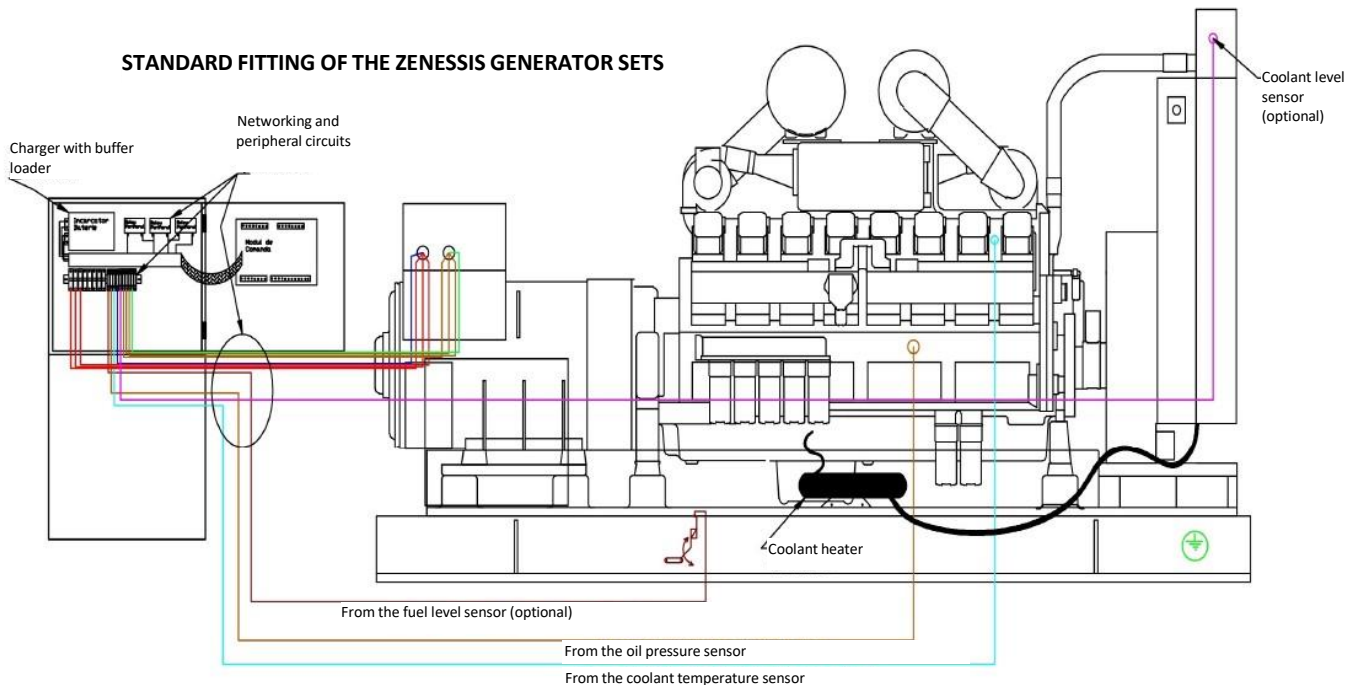
**GENERAL PRECAUTIONS ABOUT WARRANTY**

DEAR ZENESSIS GENERATOR SET OPERATOR,

PLEASE TAKE INTO CONSIDERATION TO THE FOLLOWING IN ORDER TO PREVENT THE GENERATOR SET WARRANTY TO BECOME INVALID BEFORE THE TERMINATION OF THE WARRANTY PERIOD AND TO ENSURE TROUBLE-FREE OPERATION OF THE GENERATOR SET FOR A LONG PERIOD!

- MAINTENANCE AND REPAIR WORKS WILL NOT BE COVERED BY THE WARRANTY IF THE WARRANTY CERTIFICATE, INVOICE OR DELIVERY CERTIFICATE OF THE GENERATOR SET IS NOT SUBMITTED.
- THE WARRANTY OF THE GENERATOR SET WILL BECOME INVALID IN CASE OF ANY INTERVENTION OF ANY PERSON WHO IS AUTHORIZED BY THE MANUFACTURER OR WITHOUT THE PRIOR WRITTEN APPROVAL FROM THE MANUFACTURER IN THIS RESPECT.
- MAINTENANCE WORKS AND CHECKS INDICATED IN THE OPERATING MANUAL MUST BE CARRIED OUT COMPLETELY AND TIMELY. THE FAILURES DUE TO INCOMPLETE OR UNTIMELY MAINTENANCE WORKS ARE NOT COVERED BY THE WARRANTY.
- THE GENERATOR SET SHOULD BE MOUNTED AS INDICATED IN THE OPERATING MANUAL. OTHERWISE, THE PROBLEMS WHICH ARE LIKELY TO OCCUR WILL NOT BE COVERED BY THE WARRANTY. THE CUSTOMER IS RESPONSIBLE FOR THE FAILURES WHICH ARE LIKELY TO OCCUR IN CASE THAT THE FUEL USED CONTAINS DIRT OR WATER.
- THE OIL TYPE INDICATED IN THE OPERATING MANUAL SHOULD BE USED IN THE ENGINE. OTHERWISE, THE FAILURES WHICH ARE LIKELY TO OCCUR WILL NOT BE COVERED BY THE WARRANTY.
- BATTERIES WILL NOT BE COVERED BY THE WARRANTY IF THEY ARE SUBJECTED TO BREAKAGE, EXCESSIVE ACID FILL OR HAVE BEEN LEFT DISCHARGED OVER LONG TIME PERIODS.
- AT GENERATOR SETS WITH MANUAL STARTUP, NEVER START OR STOP THE ENGINE WHEN THE GENERATOR SET IS UNDER LOAD. THE ENGINE SHOULD BE STARTED AND STOPPED AFTER LOAD IS DISCONNECTED. OTHERWISE, THE VALVES CAN BE SEIZED, THE VOLTAGE REGULATOR, TRANSFORMER AND DIODES CAN BE BROKEN AND THESE CONDITIONS ARE NOT COVERED BY THE WARRANTY.
- THE MANUFACTURER DOES NOT ASSUME THE RESPONSIBILITY FOR THE DAMAGES ON THE MAINS SUPPLY CONTACTOR OF THE AUTOMATIC GENERATOR SETS DUE TO OVERCURRENTS, LOW OR HIGH VOLTAGES.
- NEVER REMOVE THE BATTERY TERMINALS WHILE THE GENERATOR SET IS IN USE. EVEN A MOMENT OF DISCONNECTION CAN DAMAGE THE ELECTRONIC CLOSING RELAY OF THE CHARGING ALTERNATOR AND OF THE ELECTRONIC ENGINE SPEED CONTROL CIRCUIT. THESE CONDITIONS ARE NOT COVERED BY THE WARRANTY.
- FAILURES DUE TO OVERLOAD AND UNBALANCED LOAD IN EXCESS OF THE GENERATOR SET POWER, SUCH AS ALTERNATOR AND CONTACTOR FAILURES, ARE NOT COVERED BY THE WARRANTY.
- WHEN THE MANUALLY OPERATED GENERATOR SET IS STARTED UP, IT SHOULD BE WARMED BY OPERATING AT IDLE FOR 5 MINUTES. WHEN STOPPING THE DIESEL ENGINE, IT SHOULD BE UNLOADED AND THEN CONTINUED TO BE OPERATED FOR 10 MINUTES FOR COOLING BEFORE STOPPING. OTHERWISE PROBLEMS WHICH ARE LIKELY TO OCCUR WILL NOT BE COVERED BY THE WARRANTY.
- WARRANTY PERIOD IS 1 YEAR, BEGINNING FROM THE SHIPMENT DATE.

### STANDARD FITTING OF THE ZENESSIS GENERATOR SETS



### STANDARD AND OPTIONAL FITTING OF THE ZENESSIS GENERATOR SETS

