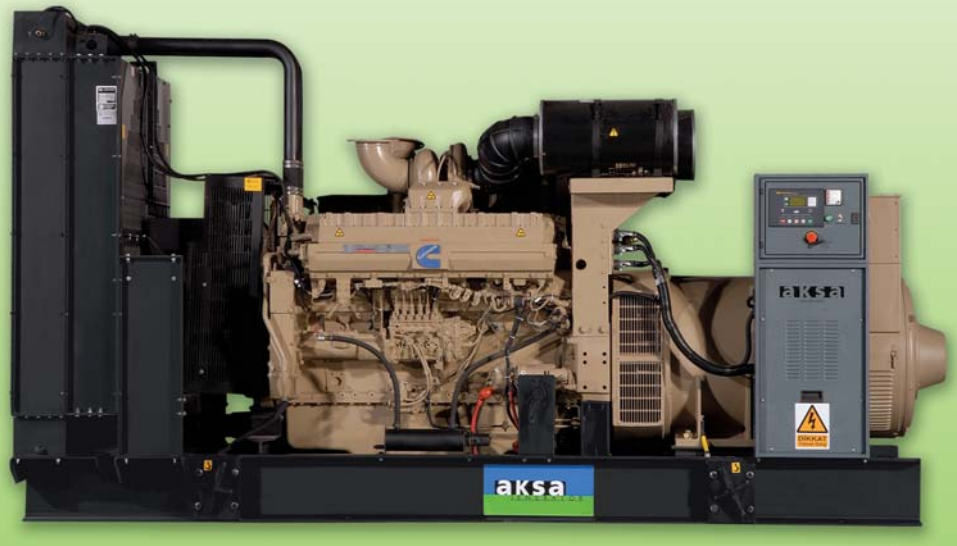
aksa POWER GENERATION

INSTALLATION RECOMMENDATIONS

&

OPERATION MANUAL

OF DIESEL GENERATING SETS



aksa POWER GENERATION

Dear Aksa Generating Set Operator

First of all, we would like to thank you for your choice of Aksa Power Generator.

This operating and maintenance manual is designed and developed to make you familiar with the generator system.

This manual gives general information about mounting, operation and maintenance of the generating set. Tables and diagrams are also available outlining your generating set.

Never operate, maintain or repair your generating set without taking general safety precautions.

CONTENTS

1. INTRODUCTION **1**

2. SAFETY **2**
2.1 General 2
2.2 Installation, Handling and Towing 2
2.3 Fire and Explosion 2
2.4 Mechanical 3
2.5 Chemical 3
2.6 Noise 3
2.7 Electrical 3
2.8 First aid For Electric Shock 4

3. GENERAL DESCRIPTION **6**
3.1 Generating Set Description and Identification 6
3.2 Diesel Engine 6
3.3 Engine Electrical System 6
3.4 Cooling System 6
3.5 Alternator 6
3.6 Fuel Tank and Baseframe 6
3.7 Vibration Isolation 6
3.8 Silencer and Exhaust System 6
3.9 Control System 6

4. INSTALLATION, HANDLING AND STORAGE **8**
4.1 General 8
4.2 Canopies 8
4.3 Location 8
4.4 Moving the Generating Set 8
4.5 Foundation's Vibration Isolation 9
4.6 Combustion Air Inlet 9
4.7 Cooling and Ventilation 9
4.8 Exhaust 10
4.9 Fuel System 16
4.9.1 Day Tank 16
4.9.2 Bulk Storage Tank 16
4.9.3 Fuel Lines 16
4.10 Lubrication Oil 23
4.10.1 Oil Performance Properties 23
4.10.2 Lubrication Recommendations for Cummins Engines 23
4.10.3 Recommended Oil Properties for Perkins Diesel Engines 23
4.10.4 Lubrication Oil Recommendations by Lister Petter 23
4.10.5 Lubrication Oil Recommendations by Deutz 23
4.10.6 Lubrication Oil Recommendations by Volvo Penta 23
4.10.7 Lubrication Oil Recommendations by MTU 23
4.11 Batteries 24
4.11.1 Maintenance Batteries 24
4.11.1.1 First Filling of Acid Water to The Battery 24
4.11.1.2 Battery Maintenance 24
4.11.1.3 Testing the Battery 24
4.11.1.4 Hydrometer Test 24
4.11.2 Maintenance Free Batteries 24
4.12 Electrical Connection 24
4.12.1 Cabling 25
4.12.2 Protection 25
4.12.3 Loading 25
4.12.4 Power Factor 25
4.12.5 Grounding / Earthing Requirements 30
4.12.6 Alternator Reconnection 30
4.12.7 Parallel Running 30
4.12.8 Insulation Test 30
4.13 Acoustic Silencing 30
4.13.1 Exhausts Silencers 30
4.13.2 Canopies 30
4.13.3 Other Sound Attenuation 30
4.14 Engine Jacket Water Heater 30

4.15 Towing (Mobile Generating Sets) 30
4.15.1 Preparing to Low 30
4.15.2 Towing 30
4.15.3 Parking 30
4.16 Storage 30
4.16.1 Engine Storage 31
4.16.2 Alternator Storage 31
4.16.3 Battery Storage 31

5. GENERATING SET MAINTENANCE 31

6. GENERAL PRECATIONS AND CONTROLS WHICH MUST BE DONE BEFORE STARTING UP THE GENERATING SET 31

7. GENERATING SET CONTROL SYSTEMS 32
7.1 Starting with ME 40 Manual Control Panel 32
7.2 Starting with P 500 Automatic Control Panel 32
7.2.1 Manual Operation 32
7.2.2 Automatic Mode of Operation 32
7.3 Starting With P 2010 Autostart Control Panel 33
7.3.1 Manual Operation 33
7.3.2 Automatic Mode of Operation 33
7.4 Starting with P 2020 Automatic Control Panel 34
7.4.1 Manual Operation 34
7.4.2 Automatic Mode of Operation 34
7.4.3 Test Operation 35
8. GENERAL PRECATIONS AND CONTROL WHICH MUST BE DONE AFTER STARTING UP THE GENSET 35
9. STOPPING THE GENERATING SETS 35
9.1 At Manual Models 35
9.2 At Automatic Models 36
10. GENERATING SET CONTROL SYSTEMS 36
10.1 Control Panels 36
10.1.1 Manual Control System ME40 36
10.1.1.1 DSE 701 Module Features 36
10.1.1.2 DSE 701 Module Emergency Led's 36
10.2.1 Automatic Control System P 500 36
10.2.1.1 DSE 704 Module Features 37
10.2.1.2 Status and Fault Conditions Displayed by LED illumination 37
10.3.1 Automatic Control System P 2020 Panel Specification 37
10.3.1.1 DSE 5220 Module Features 37
10.4.1 Autostart Control System P 2010 Panel Specification 38
10.4.1.1 DSE 5210 Module Features 38
10.5. Panel Equipments 39
10.5.1 AC Voltmeter 39
10.5.2 Voltmeter Selector Switch 39
10.5.3 AC Ampermeter 39
10.5.4 Frequencymeter 39
10.5.5 Hoursrunmeter 39
10.5.6 Water Temperature Gauge 39
10.5.7 Oil Pressure Gauge 39
10.5.8 Emergency Stop Pushbutton 39
10.5.9 Alternator Protection 39
11. THE PLACEMENT AND INSTULATION OF TRANSFER SWITCH 41
12. DSE 530 MODEL FULL AUTOMATIC TRANSFER SWITCH CONTROL SYSTEM 42
12.1 Automatic Mode of Operation 42
12.2 Manual Restore Mode of Operation 42
12.3 Manual Operation 42
12.4 Indications 42
13. ALTERNATOR TROUBLESHOOTING 43
14. ENGINE TROBLESHOOTING 44

1. INTRODUCTION

Aksa Generating set is designed to be commissioned, when delivered, as soon as the necessary cooling water, antifreeze, fuel, lubrication oil and fully charged battery are provided.
With its long years of experience, Aksa manufactures efficient, reliable and quality generating set.
This operating and maintenance manual is prepared to assist the operator in operation and maintenance of the generating set. Observing the advices and rules in this manual will ensure that the generating set operates in maximum performance and efficiency for a long time.

Care should be taken to perform more frequent maintenance in dirty and dusty environments in order to keep the generating set in good working condition.
Necessary adjustments and repairs should be made only by authorized and qualified persons.
Each generating set has a model and a serial number indicated on a label on the base frame. This plate also indicates the manufacturing date, voltage, current, power in kVA and kW, frequency, power factor and weight of the generating set. These datas are necessary in spare part orders, for warranty validity and for service calls.

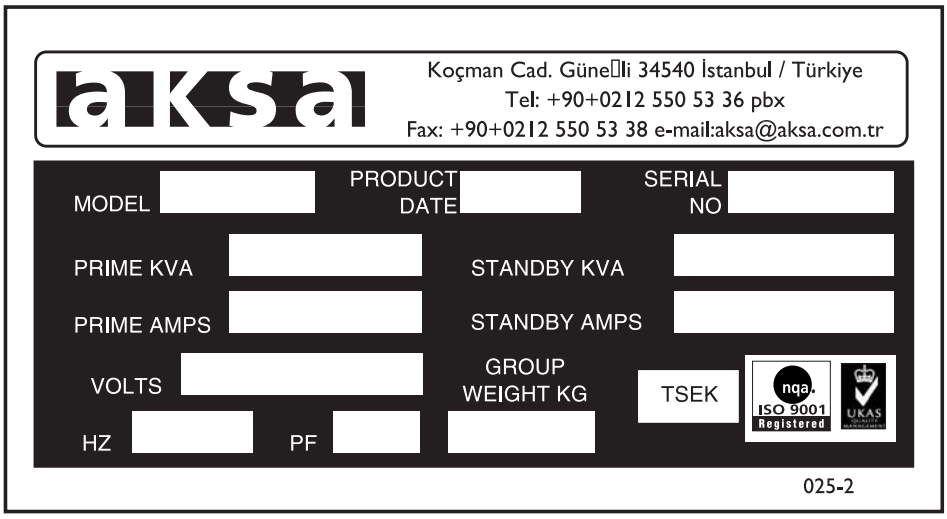


Figure 1.1 AKSA Generating set label

2. SAFETY

2.1 GENERAL

The generating set is designed to be safe when used in the correct manner. However responsibility for safety rests with the personnel who install, use and maintain the set. If the following safety precautions are followed, the possibility of accidents will be minimized. Before performing any procedure or operating technique, it is up to the user to ensure that it is safe. The generating set should only be operated by personnel who are authorized and trained.

WARNING

- ! Read and understand all safety precautions and warnings before operating or performing maintenance on the generating set.
- ! Failure to follow the instructions, procedures, and safety precautions in this manual may increase the possibity of accidents and injuries.
- ! Do not attempt to operate the generating set with a known unsafe condition.
- ! If the generating set is unsafe, put danger notices and disconnect the battery negative (-) lead so that it cannot be started until the condition is corrected.
- ! Disconnect the battery negative (-) lead prior to attempting any repairs or cleaning inside the enclosure.
- ! Install and operate this generating set only in full compliance with relevant National, Local, or Federal Codes, Standards or other requirements.

2.2 INSTALLATION, HANDLING AND TOWING

Chapter 4 of this manuel covers procedures for installation, handling, and towing of generating sets. That chapter should be read before installing, moving and lifting the generating set or towing a mobile set. The following safety precautions should be noted:

WARNING

- ! Make electrical connections in compliance with relevant Electrical Codes, Standards or other requirements. This includes requirements for grounding and ground/earth faults.
- ! For stationary generating sets with remote fuel storage systems, make sure such systems are installed in compliance with relevant Codes, Standards or other requirements.
- ! Engine exhaust emissions are hazardous to personnel. The engine exhaust for all indoor generating sets must be piped outdoors via leak-free piping in compliance with relevant Codes, Standards and other requirements. Ensure that hot exhaust silencers and piping are clear of combustible material and are guarded for personnel protection per safety requirements. Ensure that fumes from the exhaust outlet will not be a hazard.

- ! Never lift the generating set by attaching to the engine or alternator lifting lugs, instead use the lifting points on the baseframe or canopy.
- ! Ensure that the lifting rigging and supporting structure is in good condition and has a capacity suitable for the load.
- ! Keep all personnel away from the generating set when it is suspended.

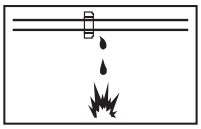
2.3 FIRE AND EXPLOSION

Fuel and fumes associated with generating sets can be flammable and potentially explosive. Proper care in handling these materials can dramatically limit the risk of fire or explosion. However, safety dictates that fully charged BC and ABC fire extinguishers are kept on hand. Personnel must know how to operate them.

WARNING

- ! Ensure that the generating set room is properly ventilated.
- ! Keep the room, the floor and the generating 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.

! Turn off or disconnect the power to the battery chargen before making or breaking connections with the battery.
! To avoiding arcing keep grounded conductive objects (such as tools) away from exposed live electrical parts (such as terminals). Sparks and arcing might ignite fuel or vapours.
! Avoid refiling the fuel tank while the engine is running.
! Do not attempt to operate the generating set with any known leaks in the fuel system.

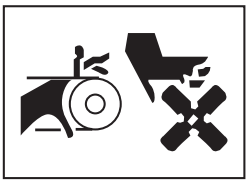


2.4 MECHANICAL

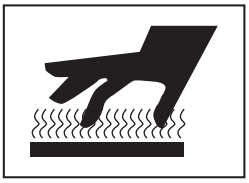
The generating set is designed with guards for protection from moving parts. Care must still be taken to protect personnel and equipment from other mechanical hazards when working around the generating set.

WARNING

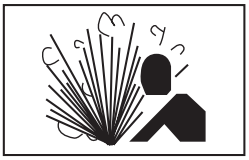
! Do not attempt to operate the generating set with the safety guards removed. While the generating set is running do not attempt to reach under or around the guards to do maintenance or for any other reason.
! Keep hands, arms, long hair, loose clothing and jewellery away from pulleys, belts and other moving parts.



Attention: Some moving parts can not be seen clearly when the set is running.
! If equipped keep access doors on enclosures closed and locked when not required to be open.



! Avoid contact with hot oil, hot coolant, hot exhaust gases, hot surfaces and sharp edges and corners.
! Wear protective clothing including gloves and hat when working around the generating set.



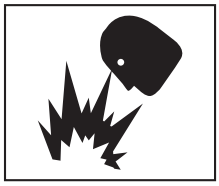
! Do not remove the radiator filler cap until the coolant has cooled. Then loosen the cap slowly to relieve any excess pressure before removing the cap completely.

2.5 CHEMICAL

Fuels, oils, coolants, lubricants and battery electrolyte used in this generating 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, coolant, lubricants 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.



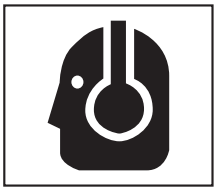
! Do not wear clothing that has been contaminated by fuel or lube oil.
! Wear an acid resistant apron and face shield or goggles when servicing the battery. If electrolyte is spilled on skin or clothing, flush immediately with large quantities of water.

2.6 NOISE

Generating sets that are not equipped with sound attenuating enclosures can produce noise levels in excess of 105 dBA. Prolonged exposure to noise levels above 85 dBA is hazardous to hearing.

WARNING

! Ear protection must be worn when operating or working around an operating generating set



2.6 ELECTRICAL

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

WARNING

! The generating set must be connected to the load only by trained and qualified electricians who are authorized to do so, and in compliance with relevant Electrical Codes, Standards and other requlations.
! Ensure that the generating set, including a mobile set is effectively grounded/earthed in accordance with all relevant regulations priorts operation.

! The generating set should be shutdown with the battery negative (-) terminal disconnected prior to attempting to connect or disconnect load connections.

! Do not attempt to connect or disconnect load connections while standing in water or on wet or soggy ground.

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

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

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

! Keep all electrical equipment clean and dry. Replace any wiring where the insulation is cracked, cut, abraded or otherwise degraded. Replace terminals that are worn, discolored 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 other wise pull the plug or the cable away from the viation.

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

! If victim is breathing, turn thi victim clear of the conductor, preferably using insulated material such as dry wood.

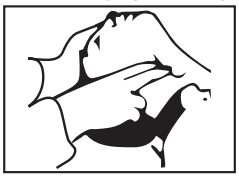
! If victim is breathing, turn the victim into the recovery position described below. If victim is unconscious, perform resuscitation as required:

OPEN THE AIRWAY

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

BREATHING

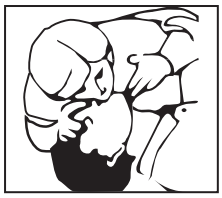
Check that the victim is breathing by looking, listening and feeling for the breath.



CIRCULATION

Check for pulse in the victim's neck.

IF NO BREATHING BUT PULSE IS PRESENT

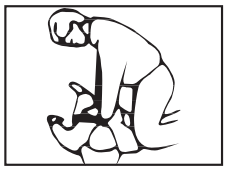


❶ Pinch the victim's nose firmly.
❷ Take a deep breath and seal your lips around the victim's lips.
❸ Blow slowly into the mouth watching for the chest to rise. Let the chest fall completely. Give breaths at a rate of 10 per minute.
❹ If the victim must be left to get help, give 10 breaths first and then return quickly and continue.
❺ Check for pulse after every 10 breaths.
❻ When breathing restarts, place the victim into the recovery position described later in this section.

IF NO BREATHING AND NO PULSE

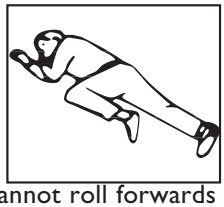
❶ Call or telephone for medical help.
❷ Give two breaths and start chest compresion as follows:
❸ Place heel of hand 2 fingers breadth above ribcage/breastbone junction.

❹ Place other hand on top and interlock fingers.
❺ Keeping arms straight, press down 4-5 cm (1.5-2 inch) at a rate of 15 times per minute.



❻ Repeat cycle (2 breaths and 15 compressions) until medical help takes over.
❼ If condition improves, confirm pulse and continue with breaths. Check for pulse after every 10 breaths.
❽ When breathing restarts, place the victim into the recovery position described below.

RECOVERY POSITION



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

WARNING

! Do not give liquids until victim is conscious.

3. GENERAL DESCRIPTION

3.1. GENERATING SET DESCRIPTION AND IDENTIFICATION

Aksa Generating Set has been designed as a complete package to provide superior performance and reliability.

Figure 3.1 identifies the major components. This figure is of a typical generating set. However, every set will be slightly different due to the size and configuration of the major components. This section briefly describes the parts of the generating set. Further information is provided in later sections of thi manual.

Each generating set is provided with a Rating Label (item 1) generally fixed to the base frame. This label contains the information needed to identify the generating set and its operating characteristics. This information includes the model number, serial number, output characteristics such as voltage and frequency, output rating in kVA and kW, product date and weight.

The model and serial numbers uniquely identify the generating set and are needed when ordering spare parts or obtaining service or warranty work for the set.

3.2. DIESEL ENGINE

The diesel engine powering the generating set (Item 2) has been chosen for its reliability and the fact that it has been specifically designed for powering generating sets. The engine is of the heavy duty industrial type with 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 (item 3) and a mechanical or an electronic engine speed governor.

3.3. ENGINE ELECTRICAL SYSTEM

The engine, electrica system is 12 volts or 24 volts DC, negative ground/earth. This system includes an electric engine starter, a battery (item 4) and a battery charging alternator (item 5). For 12 volts electrical system one battery is given. For 24 volt system two lead-acid batteries are given. Other types of batteries may be fitted if they were specified.

3.4. COOLING SYSTEM

The engine cooling system is either air cooled or water cooled. The air cooled system consists of a high capacity fan to pull cool air across the engine to cool it. The water cooled system is comprised of a radiator (item 6), a pusher fan and a thermostat. The alternator has its own internal fan to cool the alternator components.

3.5. ALTERNATOR

The output electrical power is normally produced by a screen protected and drip-proof, self-exciting, self-regulating, brushless alternator (item 7) fine tuned to the output of this generating set. Mounted on top of the alternator is a sheet steel terminal box (item 8)

3.6. FUEL TANK AND BASEFRAME

The engine and alternator are coupled together and mounted on a heavy duty steel bareframe (item 9). This baseframe includes a fuel tank (item 10) with a capacity of approximately 8 hours operation at full load.

3.7. VIBRATION ISOLATION

The generating set is fitted with vibration isolators (item 11) which are designed to reduce engine vibration being transmitted to the foundation on which the generating set is mounted. These isolators are fitted between the engine/alternator feet and the baseframe.

3.8 SILENCER AND EXHAUST SYSTEM

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

3.9 CONTROL SYSTEM

One of several types of control systems and panels (item 12) may be fitted to control the operation and output of the set and to protect the set from possible malfunctions. Section 7 of this manual provides detailed information on these systems and will aid in identification of the control system fitted on the generating set.

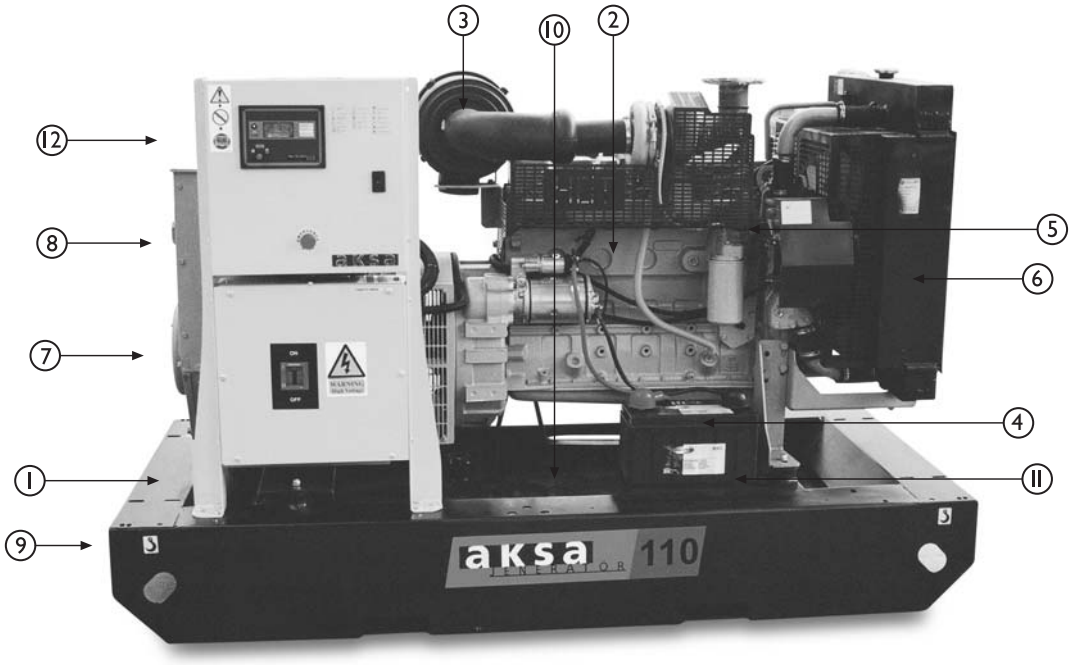


Figure 3.1 Typical generating set configuration

No.	Description	No.	Description	No.	Description
1	Aksa generating set rating label	5	Battery charging alternator	9	Baseframe
2	Diesel engine	6	Radiator	10	Fuel tank (inside the baseframe)
3	Air filter	7	Alternator	11	Vibration isolators
4	Battery	8	Terminal box	12	Control panel

4. INSTALLATION, HANDLING AND STORAGE

4.1 GENERAL

Once the size of the generating set and any associated control systems or switchgear have been established, plans for installation can be prepared. This section discusses factors important in the effective and safe installation of the generating set.

4.2 CANOPIES

Installation and handling is greatly simplified when the generating set has been equipped with a canopy. The canopy also gives protection from the elements and protection from unauthorized access.

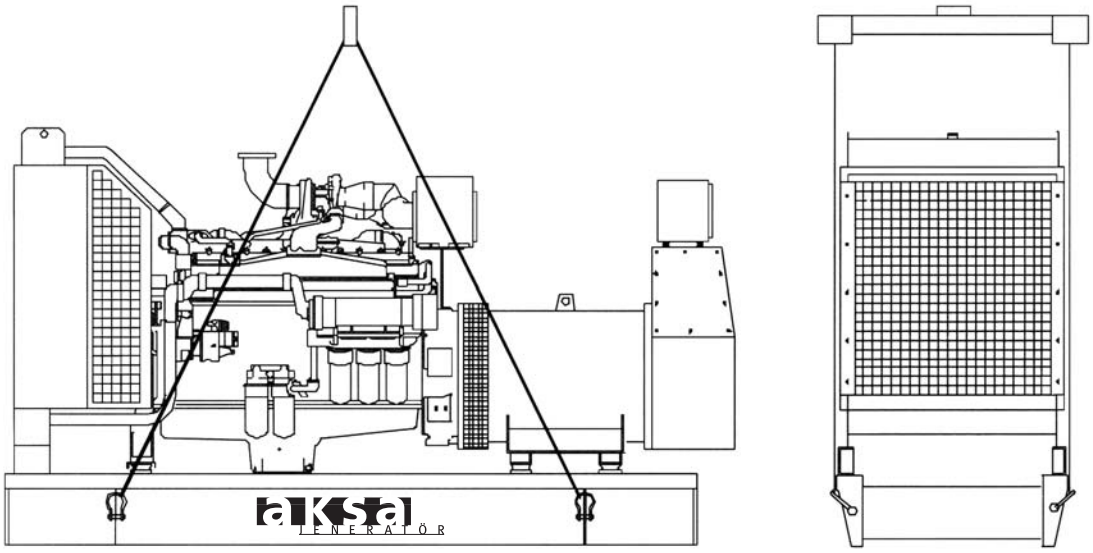


Figure 4.1 Lifting generating set by using a winch

4.3 MOVING THE GENERATING SET

The generating set baseframe is specifically designed for ease of moving the set. Improper handling can seriously damage components. Using a forklift, the generating set can be lifted or carefully pushed/pulled by the baseframe. If pushing, do not push the baseframe directly with fork. Always use wood between forks and the baseframe to spread the load and prevent damage.

WARNING

! Never lift the generating set by attaching to the engine or alternator lifting lugs.
! Ensure the lifting rigging and supporting structure is in good condition and is suitably rated.
! Keep all personnel away from the generating set when it is suspended.
! If the generating set is going to be lifted, it should be lifted by the lifting points fitted on canopied sets and most open sets.

4.4 LOCATION

Selecting a location for the generating set can be the most important part of any installation procedure. The following factors are important in determining the location:

- Adequate ventilation.
- Protection from the elements such as rain, snow, sleet, wind driven precipitation, flood water, direct sunlight, freezing temperatures. or excessive heat.
- Protection from exposure to airborne contaminants such as abrasive or conductive dust, lint, smoke, oil mist, vapors, engine exhaust fumes or other contaminants.
- Floor of generating set room must be smooth and strong.
- Protection from impact from falling objects such as trees or poles, or from motor vehicles or lift trucks.

- Clearance around the generating set for cooling and access for service: at least 1 meter (3.3 feet) around the set and at least 2 meters (6.6 feet) headroom above the set.
- Access to move the entire generating set into the room. Air inlet and outlet vents can often be made removeble to provide an access point. Limited access to unauthorized personnel.

- If it is necessary to locate the generating set outside of the building, the generating set should be enclosed in a canopy. A canopy is also useful for temporary installations inside or outside the building.

4.5. FOUNDATION'S VIBRATION ISOLATION

The generating set is shipped assembled on a rigid baseframe that precisely aligns the alternator and engine and needs to be bolted down only to a suitably prepared surface. Foundation

A reinforced concrete pad provides a rigid support to prevent deflection and vibration. Typically the foundation should be 150 mm to 200 mm (6 to 8 inches) deep and at least as wide and long as the generating set. The ground or floor below the foundation should be properly prepared and should be structurally suited to carry the weight of the foundation pad and the generating set. (If the generating set is to be installed above the ground floor the building structure must be able to support the weight of the generating set, fuel storage and accessories). If the floor may be wet from time to time such as in a boiler room, the pad should be raised above the floor. This will provide a dry footing for the generating set and for those who connect, service or operate it. It will also minimize corrosive action on the baseframe.

4.6. COMBUSTION AIR INLET

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

4.7. 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 generating set. It is therefore important that adequate ventilation is provided to keep the engine and alternator cool. Proper air flow, as shown in Figure 4.4, requires that the air comes in at the alternator end of the set, passes over the engine, through the radiator and out of the room via a flexible exhaust duct. Without the ducting of the hot air outside the room, the fan will tend to draw that hot air around and back through the radiator, reducing the cooling effectiveness.

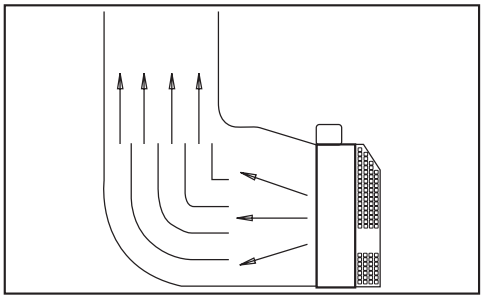


Figure 4.2 Directing the air thrown from the radiator with deviating wings

Sharp corners on the radiator, hot air outlet channel or its chimney must be avoided. Some rearrangements to turn thrown air should be done (Figure 4.2 and 4.3).

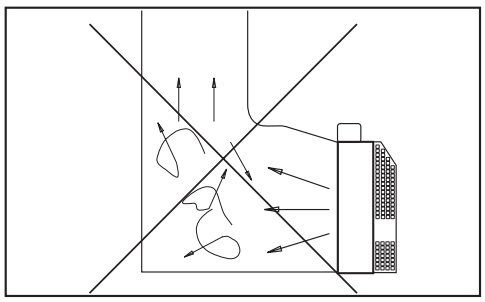


Figure 4.3 Weak ventilation installation

The air inlet and outlet openings should be large enough to ensure free flow of air into and out of the room. As a rough guide the openings should each be at least 1.5 times the area of the radiator core.
Both the inlet and outlet openings should have louvres for weather protection. These may be fixed but preferably should be movable in cold climates so that while the generating set is not operating the louvres can be closed. This will allow the room to be kept warm which will assist starting and load acceptance. For automatic starting generating sets. If the louvres are movable they must be automatic-ally operated. They should be programmed to open immediately upon starting the engine.

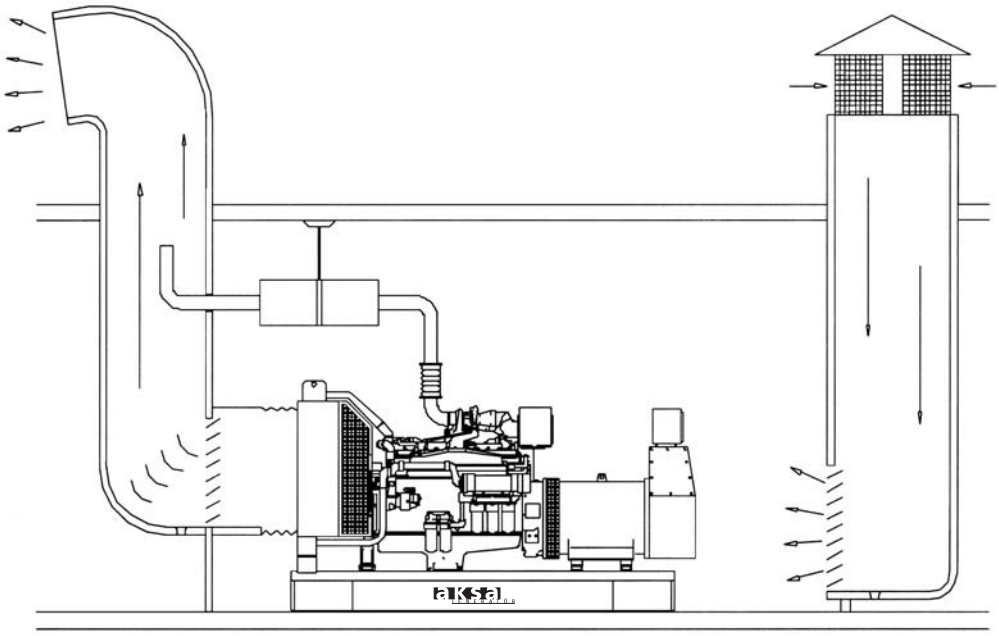


Figure 4.4 Air ventilation

4.8 EXHAUST

The purpose of the engine exhaust system is to direct the exhaust outside to a location and height where the fumes and odors will not become an annoyance or hazard, and to reduce noise. A suitable exhaust silencer must be incorporated into the exhaust piping to reduce the noise level from the engine. (See Figure 4.4-4.5)

WARNING:

! Engine exhaust emmissions are hazardous to personnel. The engine exhaust for all indoor generating sets must be piped outdoors via leak-free piping in compliance with relevant Codes, Standards and other requirements.

Ensure hot exhaust silencers and piping are clear of combustible material and are guarded for personnel protection per safety requirements.
Ensure that fumes from the exhaust outlet will not be a hazard.

In designing an exhaust system, the primary consideration is to not exceed the allowable back pressure permitted by the engine manufacturer. Excessive back pressure seriously affects engine output, durability and fuel consumption. To limit the back pressure the exhaust piping should be as short and straight as possible. Any required bends should have a curve radius of at least 1.5 times the inside diameter of the pipe.

Other exhaust design criteria are as follows:

- A flexible connection between the exhaust manifold and the piping system should be used to prevent transmission of engine vibration to the piping and the building and to allow for thermal expansion and any slight misalignment of the piping. (See Figure 4.4)
- The exhaust gas pipes should be supported by the building in order to prevent the dead weight carried by the engine manifold and turbocharger. For that, stretching, elements should be used. (See Figure 4.5)
- Exhaust system components located within the generator room should be insulated to reduce heat radiation and noise levels. Pipes and the silencer, whether located inside and outside the building, should be located well clear of any combustible material.
- The outer end of the exhaust pipe, if horizontal, should be cut at 60° to the horizontal or should be fitted with a rain hood or cap, if vertical, to prevent rain or snow from entering the exhaust system.
- The exhaust pipe must not be connected to exhausts from other generating sets.
- Exhaust pipes must be made up of black iron pipe.

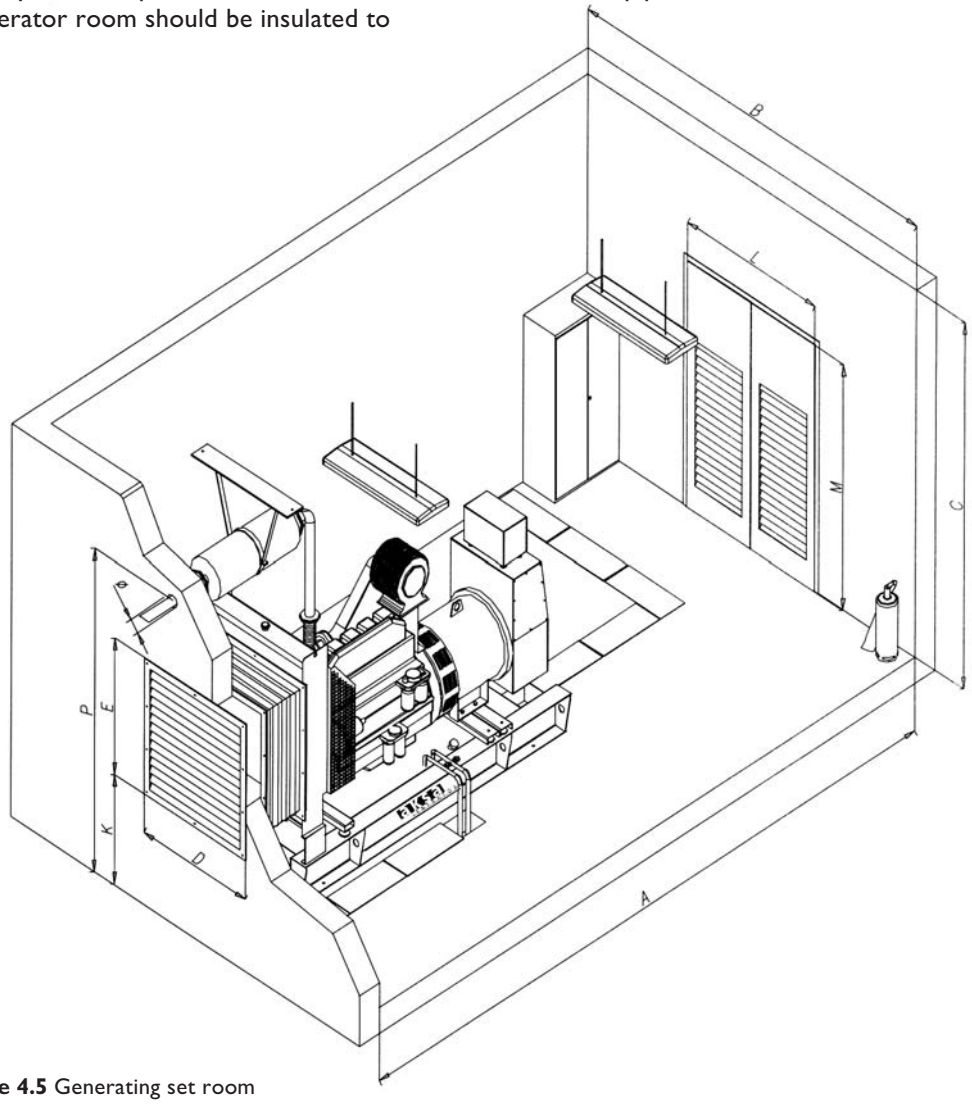


Figure 4.5 Generating set room

Generating Sets		Dimensions (m)			Room Dimensions (m)			Radiator Hot Air Outlet Openings Louvers (m)			Air Inlet Openings Total Area (m^2)	Room's Door Dimensions (m)		Exhaust	
Model	Standby Power (kVA)	Length	With	Height	Length	With	Height	D	E	K		L	M	Diameter (inch)	P (m)
ALP 8	8.5	1.37	0.75	0.97	3	3	2.5	0.55	0.4	0.4	0.5	1	2.2	2	1.5
ALP 12	12	1.45	0.8	1.04	3	3	2.5	0.55	0.5	0.4	0.5	1	2.2	2	1.6
ALP 15	15	1.37	0.75	0.97	3	3	2.5	0.55	0.4	0.4	0.5	1	2.2	2	1.5
ALP 18	17.5	1.45	0.8	1.04	3	3	2.5	0.55	0.5	0.4	0.5	1	2.2	2	1.6
ALP 22	22	1.45	0.8	1.04	3	3	2.5	0.55	0.5	0.4	0.5	1	2.2	2	1.6
ALP 30	30	1.45	0.8	1.04	3	3	2.5	0.55	0.5	0.4	0.5	1	2.2	2	1.6
ADZ 110	110	2.15	1	1.53	5	3	3	0.55	0.75	0.56	0.5	1.2	2.2	3.5	2.1
ADZ 175	175	2.46	1.1	1.62	5	3	3	0.75	0.8	0.46	1	1.3	2.2	4	2.2
ADZ 360	360	2.96	1.37	2.1	5	3	4	0.85	1.05	0.45	1.5	1.6	2.5	2x4	2.6
ADZ 400	400	2.96	1.37	2.1	5	3	4	0.85	1.05	0.45	1.5	1.6	2.5	2x4	2.6
ADZ 490	490	3.2	1.43	2.07	6	3	4	1.5	1.6	0.25	2	1.8	2.5	2x4	2.6
ADZ 538	538	3.2	1.43	2.07	6	3	4	1.5	1.6	0.25	2	1.8	2.5	2x4	2.6
ADZ 550	550	3.2	1.43	2.07	6	3	4	1.5	1.6	0.25	2	1.8	2.5	2x4	2.6
AP 500	500	3.6	1.22	2.1	6	3	4	1.3	1.4	0.4	2	1.8	2.5	6	2.7
AP 550	550	3.6	1.22	2.1	6	3	4	1.3	1.4	0.4	2	1.8	2.5	6	2.7
AVP 515	515	3.6	1.3	1.96	6	3	3.5	1.35	1.35	0.4	1.5	1.5	2.5	6	2.5
AVP 550	550	3.6	1.3	1.96	6	3	3.5	1.35	1.35	0.4	2	1.5	2.5	6	2.5
AKMTU 720	720	4	1.58	1.9	6	5	4	1.6	1.3	0.4	2.5	2.2	2.7	2x6	2.7
AKMTU 780	780	4.1	1.58	2	7	5	4	1.6	1.3	0.4	2.5	2.2	2.7	2x6	2.8
AKMTU 925	925	4.38	1.58	2	7	5	4	1.6	1.55	0.3	3	2.2	2.7	2x6	2.8
AKMTU 1030	1030	4.38	1.76	2.2	7	5	4	2.2	2	0.25	4.5	2.4	3	2x6	3
AKMTU 1500	1500	3.85	1.8	2.3	7	5	4	Remote Radiator			*	2.4	3	2x12	3.1
AKMTU 1700	1700	3.85	1.8	2.3	7	5	4	Remote Radiator			*	2.4	3	2x12	3.1
AKMTU 2050	2050	4.55	1.8	2.33	8	5	4	Remote Radiator			*	2.4	3	2x12	3.1
AKMTU 2250	2250	4.55	1.8	2.33	8	5	4	Remote Radiator			*	2.4	3	2x12	3.1

Table 4.1.1 Aksa open type diesel (look figure 4.5 genset room) gen-sets dimensions, room dimensions, air inlet and outlet openings dimensions and exhaust pipe dimensions.
Please contact us for gen-sets which have remote radiator system.

Generating Sets					Room Dimensions (m)			Radiator Hot Air Outlet Openings Louvres (m)			Air Inlet Openings Total Area (m^2)	Room's Door Dimensions (m)		Exhaust	
Model	Standby Power (kVA)	Dimensions (m) Length	With	Hight	A Length	B With	C Height	D	E	K		L	M	Diameter (inch)	P (m)
AC 39	39	1.86	0.9	1.3	3.5	3	2.5	0.7	0.75	0.45	0.8	1.5	2	3	2
AC 55	55	1.86	0.9	1.3	3.5	3	2.5	0.8	0.85	0.4	0.8	1.5	2	3	2
AC 66	66	1.86	0.9	1.3	3.5	3	2.5	0.75	0.8	0.5	0.8	1.5	2	3	2
AC 70	70	1.86	0.9	1.3	3.5	3	2.5	0.75	0.8	0.5	0.8	1.5	2	3	2
AC 90	90	1.86	0.9	1.3	3.5	3	2.5	0.75	0.8	0.5	0.8	1.5	2	3	2
AC 115	115	2.15	1	1.67	4	3	2.5	0.8	0.9	0.45	1	1.5	2	3	2
AC 150	150	2.31	1.1	1.6	4	3	2.5	1.1	1	0.55	1.3	1.5	2	4	2
AC 160	160	2.15	1.1	1.67	4	3	2.5	0.8	0.9	0.45	1	1.5	2	3	2
AC 200	200	2.31	1.1	1.6	4	3	2.5	1.1	1	0.55	1.3	1.5	2	4	2
AC 250	250	2.53	1.1	1.6	4	3	2.5	1.1	1	0.55	1.3	1.5	2	4	2
ACL 250	250	2.9	1.15	1.73	5	3.3	3	2.5	1.2	0.45	1.5	1.5	2	6	2.2
AC 275	275	2.9	1.15	1.73	5	3.3	3	2.5	1.2	0.45	1.5	1.5	2	6	2.2
AC 350	350	3.23	1.15	2	5	3.3	3	1.25	1.2	0.7	1.5	1.5	2.5	6	2.5
AC 400	400	3.23	1.15	2	5	3.3	3	1.25	1.2	0.7	1.5	1.5	2.5	6	2.5
AC 500	500	3.4	1.3	2.1	5.5	3.5	3	1.5	1.5	0.52	3	1.7	2.6	6	2.5
ACQ 515	515	3.6	1.3	2	5.5	3.5	3	1.5	1.5	0.4	3	1.7	2.6	6	2.5
AC 550	550	3.43	1.3	2.1	5.5	3.5	3	1.5	1.5	0.5	3	1.7	2.6	6	2.5
ACQ 550	550	3.6	1.3	2	5.5	3.5	3	1.5	1.5	0.4	3	1.7	2.6	6	2.5
AC 650	650	3.6	1.3	2	5.5	3.5	3	1.5	2.5	0.4	2.5	1.7	2.6	6	2.5
AC 703	703	3.9	1.4	2.13	5.5	3.5	3.3	1.6	1.5	0.5	3.6	2	2.6	2x6	2.6
ACQ 720	720	4.2	1.7	2.2	6	3.7	3.5	1.8	1.8	0.3	4	2.5	2.7	8	2.7
AC 825	825	3.9	1.4	2.13	5.5	3.5	3.3	1.6	1.5	0.5	3.6	2	2.6	2x6	2.6
ACQ 830	830	4.2	1.7	2.2	6	3.7	3.5	1.8	1.8	0.3	4	2.5	2.7	8	2.7
ACQ 881	880	4.2	1.7	2.2	6	3.7	3.5	1.8	1.8	0.3	4	2.4	2.7	8	2.7
AC 1030	1030	4.3	1.8	2.4	6.5	4	3.5	2.2	2	0.3	5	2.5	3	2x6	3
ACQ 1030	1030	4.23	1.8	2.35	6.5	4	3.5	2.3	2	0.3	5	2.5	3	2x6	3
AC 1130	1130	4.35	1.8	2.35	6.5	4	3.5	2.2	2	0.3	5	2.5	3	2x6	3
ACQ 1130	1130	4.4	2	2.3	6.5	4	3.5	2.3	2	0.3	5	2.5	3	2x6	3
AC 1435	1435	4.95	2.15	2.3	7	4.5	3.5	2.5	2	0.3	5	2.7	3	2x8	3
AC 1675	1675	5.5	2.15	2.9	7.5	4.5	4	2.5	2	0.3	6	2.7	3.4	2x8	3.5
ACQ 2100	2100	6.05	2.5	3.22	8	5	4.5	3	3	0.3	9	3	3.5	2x12	4
ACQ 2250	2250	6.05	2.5	3.22	8	5	4.5	3	3	0.3	10	3	3.5	2x12	4

Table 4.1.2 Aksa open type 50 Hz diesel gen-sets dimensions, room sizes, air inlet and outlet openings dimensions (look figure 4.5. genset room) Without acoustic treatment. Single sets.

Generating Sets					Room Dimensions (m)			Radiator Hot Air Outlet Openings Louvers (m)			Air Inlet Openings Total Area (m^2)	Room's Door Dimensions (m)		Exhaust	
Model	Standby Power (kVA)	Dimensions (m)													
		Length	With	Height	Length	With	Height	D	E	K		L	M	Diameter (inch)	P (m)
ALP 10-6	10	1.38	0.77	0.98	2.5	3	2.5	0.55	0.4	0.4	0.5	1	2.2	2	1.5
ALP 15-6	15	1.45	0.82	1.04	2.5	3	2.5	0.55	0.5	0.4	0.5	1	2.2	2	1.6
ALP 21-6	21	1.45	0.82	1.04	2.5	3	2.5	0.55	0.5	0.4	0.5	1	2.2	2	1.6
AP 616-6	616	3.6	1.3	2.1	5.5	3.5	3	1.5	1.5	0.4	3	1.8	2.6	6	2.5
AP 693-6	693	3.6	1.3	2.1	5.5	3.5	3	1.5	1.5	0.4	3	1.8	2.6	6	2.5

Table 4.1.3 Aksa 60 Hz, open type diesel gen-set dimensions, air inlet and outlet openings dimensions and exhaust pipe dimensions. (look figure 4.5. genset room) Without acoustic treatment. Single sets.

Generating Sets					Room Dimensions (m)			Radiator Hot Air Outlet Openings Louvers (m)			Air Inlet Openings Total Area (m^2)	Room's Door Dimensions (m)		Exhaust	
Model	Standby Power (kVA)	Dimensions (m)			A	B	C	D	E	K		L	M	Diameter (inch)	P (m)
		Length	With	Height	Length	With	Height								
AC 44-6	44	1.86	0.9	1.3	3.5	3	2.5	0.7	0.75	0.45	0.8	1.5	2.2	3	2
AC 66-6	66	1.86	0.9	1.3	3.5	3	2.5	0.8	0.85	0.4	0.8	1.5	2.2	3	2
AC 77-6	77	1.86	0.9	1.3	3.5	3	2.5	0.75	0.8	0.5	0.8	1.5	2.2	3	2
AC 100-6	100	1.86	0.9	1.3	3.5	3	2.5	0.75	0.8	0.5	0.8	1.5	2.2	3	2
AC 135-6	135	2.15	1	1.67	3.5	3	2.5	0.8	0.9	0.45	1	1.5	2.2	3	2
AC 165-6	165	2.31	1.1	1.6	4	3	2.5	1.1	1	0.55	1.3	1.5	2.2	4	2
AC 225-6	225	2.31	1.1	1.6	4	3	2.5	1.1	1	0.55	1.3	1.5	2.2	4	2
AC 275-6	275	2.9	1.15	1.73	5	3.3	2.5	1.1	1.2	0.45	1.5	1.5	2.2	6	2.1
AC 350-6	350	3.23	1.15	2	5	3.3	3	1.25	1.2	0.7	1.5	1.5	2.5	6	2.5
AC 383-6	383	3.23	1.15	2	5	3.3	3	1.25	1.2	0.7	1.35	1.5	2.5	6	2.5
AC 450-6	450	3.23	1.15	2	5	3.3	3	1.25	1.2	0.7	1.35	1.5	2.5	6	2.5
ACQ 498-6	498	3.6	1.3	2	5.5	3.5	3	1.5	1.5	0.4	3	1.7	2.6	6	2.5
AC 550-6	550	3.43	1.3	2.1	5.5	3.5	3	1.5	1.5	0.5	3	1.7	2.6	6	2.5
AC 616-6	616	3.43	1.3	2.1	5.5	3.5	3	1.5	1.5	0.5	3	1.7	2.6	6	2.5
ACQ 616-6	616	3.6	1.3	2	5.5	3.5	3	1.5	1.5	0.4	3	1.7	2.6	6	2.5
AC 754 –6	754	3.9	1.4	2.13	5.5	3.5	3.3	1.6	1.8	0.5	3.6	2	2.6	2 x 6	2.6
ACQ 758-6	758	4.2	1.7	2.2	6	3.7	3.5	1.8	1.8	0.3	4	2.4	2.7	8	2.7
ACQ 935-6	935	4.2	1.7	2.2	6	3.7	3.5	1.8	1.8	0.3	4	2.4	2.7	8	2.7
ACQ 1030-6	1030	4.2	1.7	2.2	6	3.7	3.5	1.8	1.8	0.3	4	2.4	2.7	8	2.7
ACQ 1025-6	1025	4.23	1.8	2.35	6.5	4	3.5	2.3	2	0.3	5	2.5	3	2x6	3
AC 1150-6	1150	4.3	1.8	2.4	6.5	4	3.5	2.2	2	0.3	5	2.5	3	2 x 6	3
ACQ 1160-6	1160	4.23	1.8	2.35	6.5	4	3.5	2.3	2	0.3	5	2.5	3	2 x 6	3
ACQ 1232-6	1232	4.4	2	2.35	6.5	4	3.5	2.3	2	0.3	5	2.5	3	2 x 6	3
AC 1450 –6	1450	4.95	2.15	2.3	7	4.5	3.5	2.5	2	0.3	5	2.7	3	2 x8	3
AC 1590-6	1590	4.95	2.15	2.35	7	4.5	3.5	2.5	2	0.3	5	2.7	3	2 x 8	3
AC 1930-6	1930	5.5	2.15	2.9	7.5	4.5	4	2.5	2	0.3	6	2.7	3.4	2 x 8	3.5
ACQ 2200-6	2200	6.05	2.5	3.22	8	5	4.5	3	3	0.3	9	3	3.5	2 x 12	4
ACQ 2500-6	2500	6.05	2.5	3.22	8	5	4.5	3	3	0.3	10	3	3.5	2 x 12	4

Table 4.1.4 Aksa 60 Hz, open type diesel gen-set dimensions, room sizes. air inlet and outlet openings dimensions and exhaust pipe dimensions. (look figure 4.5. genset room) Without acoustic treatment. Single sets.

4.9 FUEL SYSTEM

The fuel system for the generating set must be capable of delivering a clean and continuous supply of fuel to the engine. For most installations this will include a small day tank, a bulk storage tank and fuel lines.

WARNING:

! For stationary generating sets with remote fuel storage systems, make sure such systems are installed in compliance with relevant Codes, Standards or other requirements.

! Do not smoke or allow sparks, flames or other sources of ignition around fuel. Fuel vapours and oil vapours are explosive.

4.9.1 Day tank: Day tanks provide a readily available supply of fuel directly to the generating set and should therefore be located within the generator room. The baseframe is designed to contain a day tank up to 700 kVA.

4.9.2 Bulk Storage Tanks: For extended operation. a separate bulk fuel storage tank is required. The bulk tank should generally be located outside the building where it will be convenient for refilling, cleaning and for inspection. It should not, however, be exposed to freezing weather because fuel flow will be restricted as viscosity increases. The tank may be located either above or below ground.
A vent must be installed on the bulk tank to relieve the air pressure created by filling the tank or created by evaporation and expansion. It will also prevent a vacuum as the fuel is consumed. The base of the tank should have a slope, so the water and the sediment can be collected. A sludge drain valve should be installed at the low point to allow removal of water and sediment on a regular basis.

4.9.3 Fuel Lines: The fuel lines can be of any fuel compatible material such as steel pipe or flexible hoses that will tolerate environmental conditions.

Flexible piping should be used to connect to the engine to avoid damage or leaks caused by engine vibration.

The fuel delivery line should pick up ful from a point no lower than 50 mm (2") from the bottom at the high end of the tank (away from the drain plug).

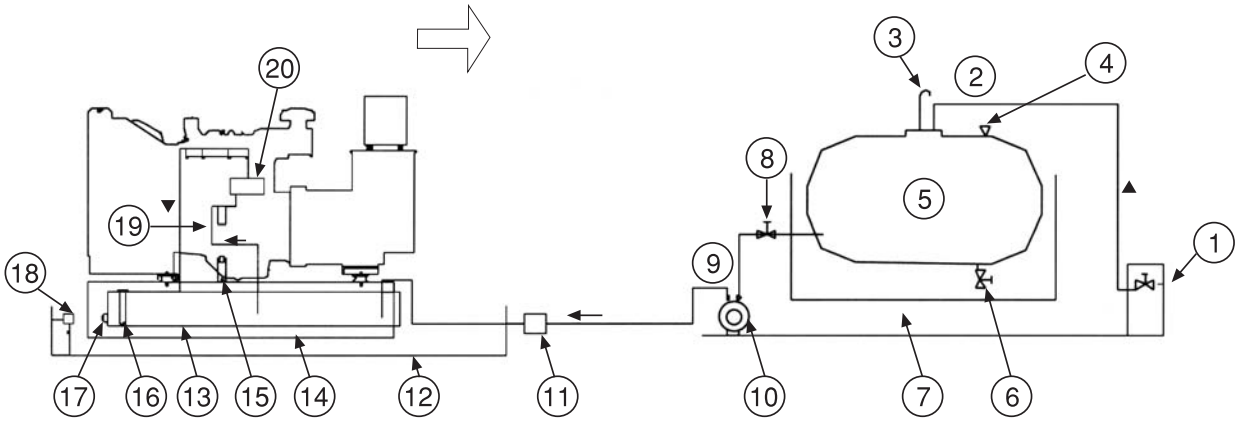


Figure 4.6.1 Typical fuel installation using a base tank fed from a bulk tank

1. Fill cabinet with overfill alarm and gauge
2. Tank fill line
3. Vent
4. Contents gauge
5. Bulk storage tank
6. Sludge drain
7. Bund tank
8. Outlet valve
9. Supply line to day tank
10. Electric fuel transfer pump
11. Electric fuel shutoff valve
12. Optional band
13. Day tank incorporated in baseframe
14. Float Control switches
15. Manual fill and vent
16. Level gauge
17. Drain
18. Leakage alarm unit (optional)
19. Fuel filter
20. Engine fuel pump

RECOMMENDATIONS FOR FUEL PIPING				
Generator Stand-By Power (kVA)	**Maximum Fuel Pipe Length (m)**	**Maximum Vertical Height (m)**	**Maximum Pipe Fittings Quantity**	**Recommended Pipe Diameter (inch)**
40-800	6	0,9	6	1"
800-1500	6	0,9	6	1 1/2"
1500-2200	6	0,9	6	2"

Figure 4.6.2 Recommendations for fuel piping

WARNING

! The fuel must be clean and must not contain any water or any erasive liquids.
! 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 temperature is a critical factor for appropriate working conditions of the engine. Fuel temperature above 71°C, due to expansion of the fuel, will decrease the engine output power.
! The connection pipe from the bulk storage tank to the day tank must be equal or greater than the daily feed pipe.
In fuel system line, using the water filter seperators will prevent the injectors and fuel pump, and it will be usefull for healthy working of the engine.
! In the simplest tank settlement, the fuel level should not be above the injectors and should not be lower than the fuel pump for more than 1.8 m, see Figure 4.7.

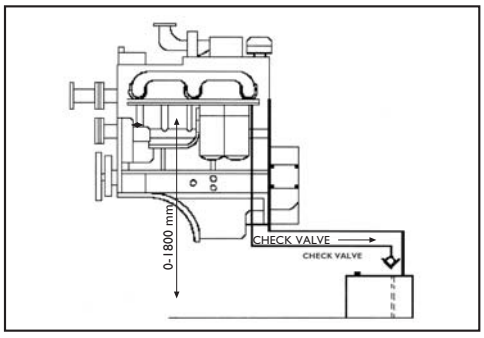


Figure 4.7 Typical fuel drawing of a fuel tank placed below the engine

If the fuel tank is set 1.5 meters above injectors, two check valves must be connected like in Figure 4.8 in order to prevent the engine from hydraulic lock. The protection capacity of these valves is 0 to 1.5 meters in elevation. If fuel tank will be mounted at an elevation and at a distance, Figure 4.10 shows a tank mounted below the engine level and at a distance.

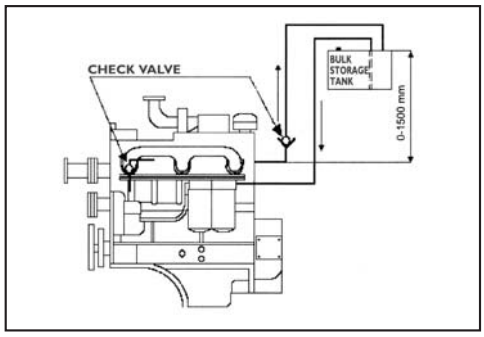


Figure 4.8 Fuel tank which is put 1500 mm above the fuel conversion

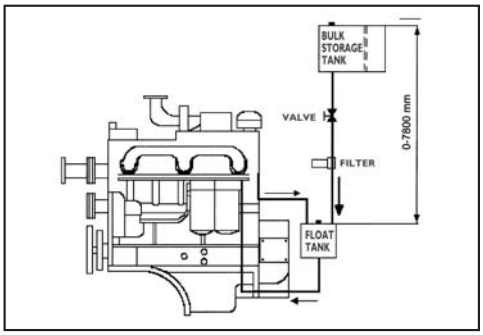


Figure 4.9 Float tank used with elevated fuel tank

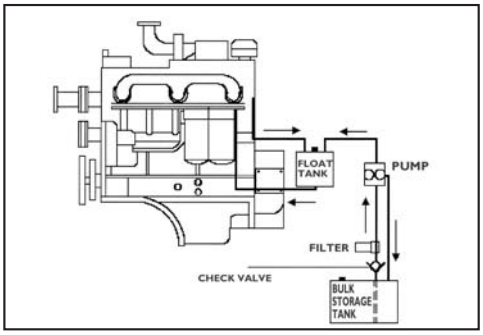


Figure 4.10 Fuel tank which is put below 1500 mm

Generating Sets				Fuel Consumption at Full Load	Fuel Tank Capacity	Coolant Capacity	Oil Capacity	Oil Specifications
Engines	Model	Stand by Power (kVA)	Engine Model	L/h	Lt	Lt	Lt	Not: Lubricating oil viscosity level will be chosen from Table 4.3 according to the ambient temperature
Lister Petter	ALP 8	8.5	LPW 2	1.9	80	5.5	3.2	Lister Petter: Recommends API CC at first use Heavy load conditions and below 25 °C temperatures. At other conditions recommends API CD lubricating oil
	ALP 12	12	LPW 3	2.8	90	6.5	4	
	ALP 15	15	LPW 2	3.9	80	5.5	3.2	
	ALP 16	16.5	LPW 4	3.8	90	7.5	5.8	
	ALP 22	22	LPW 3	5.9	90	6.5	4	
	ALP 30	30	LPW 4	7.8	90	7.5	5.8	
Deutz	ADZ 110	110	BF4M 1013 EC	23.8	140	22	13	Deutz: Recommends API CF, API CG-4, API CH-4, ACEA E1-96, ACEA E3-96, ACEA E4-98 Lubricating oils
	ADZ 175	175	BF6M 1013 EC	34	270	28	20	
	ADZ 360	360	BF6M 1015 C	67.6	500	57	38	
	ADZ 400	400	BF6M 1015 C	68.6	1000	57	38	
	ADZ 490	490	BF8M 1015 C	88.5	1000	77	38	
	ADZ 538	538	BF8M 1015 C	88.5	1000	77	38	
	ADZ 550	550	BF8M 1015 CP	101	1000	77	38	
Perkins	AP 500	500	2806C-E16TAG1	97	665	50	68	Perkins: Recommends API CG4
	AP 550	550	2806C-E16TAG2	108	665	50	68	
Volvo	AVP 515	515	TAD1630GE	96.1	520	64	64	Volvo: Recommends API CD, API CE, API CF, API CF4, CCMC D4 CCMC D5 lubricating oils
	AVP 550	550	TAD1631GE	107	520	64	64	
MTU	AKMTU 720	720	12V2000G23	132	1000	180	82	MTU; Recommends API CG-4 ACEA E2-96 ACEA E3-96 lubricating oils
	AKMTU 780	780	12V2000G63	147	1500	180	82	
	AKMTU 925	925	16V2000G23	169	1500	205	110	
	AKMTU 1030	1030	16V2000G63	187	1500	205	110	
	AKMTU 1500	1500	12V4000G21	275	2000	815	260	
	AKMTU 1700	1700	12V4000G61	305	2000	870	260	
	AKMTU 2050	2050	16V4000G21	362	2000	910	290	
	AKMTU 2250	2250	16V4000G61	400	2000	970	290	

Table 4.2.1 Coolant and oil capacities and lubricating oil specifications (50 Hz, Gen-sets).

	Generating Sets			Fuel Consumption at Full Load	Fuel Tank Capacity	Coolant Capacity	Oil Capacity	Oil Specifications Not: Lubricating oil viscosity level will be chosen from Table 4.5 according to the ambient temperature
	Model	Stand by Power (kVA)	Cummins Engine Model	L/h	Lt	Lt	Lt	
CUMMINS ENGINE	AC 39	39	4B3.3-G1	8.4	132	12	7.5	API CH API CI-4 API CF4
	AC 55	55	4BT3.3-G2	11.5	132	15	8	
	AC 66	66	4BT3.9-G4	14	132	19	11	
	AC 70	70	4BT3.9-G4	15	132	19	11	
	AC 90	90	4BTA3.9-G3	18	132	20	11	
	AC 115	115	6BT5.9-G6	24	220	23	16.4	
	AC 150	150	6CT8.13-G2	30	370	36	23.8	
	AC 160	160	6BTA5.9-G2	31	220	26	16.4	
	AC 200	200	6CTA8.3-G2	40	370	36	23.8	
	AC 250	250	6CTAA8.3-G2	51.3	370	32	23.8	
	ACL 250	250	LTA10-G2	48.4	420	37	36	
	AC 275	275	LTA10-G3	51	420	37	36	
	AC 350	350	NT855-G6	69	420	70	38.6	
	AC 400	400	NTA855G4	76	420	70	38.6	
	AC 500	500	KTA19-G3	97	550	92	50	
	ACQ 515	515	QSX15-G6	95.9	620	90	91	
	AC 550	550	KTA19-G4	107	550	92	50	
	ACQ 550	550	QSX15-G8	105	620	90	91	
	AC 650	650	KTA19-G8	135	750	130	50	
	AC 703	703	VTA28-G5	140	920	176	83	
	ACQ 720	720	QSK23-G1	134	600	120	103	
	AC 825	825	VTA28-G6	164	920	176	83	
	ACQ 830	830	QSK23-G2	151	600	120	103	
	ACQ 881	881	QSK23-G3	161	600	120	103	
	AC 1030	1030	KTA38-G3	198	1250	280	135	
	ACQ 1030	1030	QST30-G3	184	1250	175	154	
	AC 1130	1130	KTA38-G5	209	1250	280	135	
	ACQ 1130	1130	QST30-G4	202	1250	342	154	
	AC 1435	1435	KTA50-G3	261	2000	315	177	
	AC 1675	1675	KTA50-GS8	309	2000	375	204	
	ACQ 2100	2100	QSK60-G3	363	2000	380	280	
	ACQ 2200	2200	QK60-G4	394	2000	380	280	

Table 4.2.2 Fuel consumption and coolant, fuel and lubricating oil capacities (50 Hz, Gen-sets).

Generating Sets				Fuel Consumption at Full Load	Fuel Tank Capacity	Coolant Capacity	Oil Capacity	Oil Specifications
Engines	Model	Stand by Power (kVA)	Engine Model	L/h	Lt	Lt	Lt	Not: Lubricating oil viscosity level will be chosen from Table 4.3 according to the ambient temperature
Lister Petter	ALP 10-6	10	LPW 2	2,3	80	5,5	3,2	Recommends API CC at first use Heavy load conditions and below 25 °C temperatures. At other conditions recommends API CD lubricating oil
	ALP 15-6	15	LPW 3	3,4	96	6,5	4	
	ALP 21-6	21	LPW 4	4,6	96	7,5	5,8	
Perkins	AP 616-6	616	2806C-E16TAG1	117	665	50	68	Recommends API CG4
	AP 693-6	693	2806C-E16TAG2	127	665	50	68	

Table 4.2.3 Coolant and oil capacities and lubricating oil specifications (60 Hz, Gen-sets).

	Generating Sets			Fuel Consumption at Full Load	Fuel Tank Capacity	Coolant Capacity	Oil Capacity	Oil Specifications Not: Lubricating oil viscosity level will be chosen from Table 4.5 according to the ambient temperature
	Model	Stand by Power (kVA)	Cummins Engine Model	L/h	Lt	Lt	Lt	
CUMMINS ENGINE	AC 44-6	44	4B 3,3-G1	9.7	132	12	7.5	API CH API CI - 4 API CF4
	AC 66-6	55	4BT 3,3-G2	13.4	132	15	8	
	AC 77-6	77	4BT 3,9-G4	17	132	19	11	
	AC 100-6	100	4BTA 3,9-G3	22	132	20	11	
	AC 135-6	135	6BT 5.9-G6	29	220	23	16.4	
	AC 165-6	165	6CT 8.3-G2	37	370	36	23.8	
	AC 225-6	225	6CTA 8.3-G2	48	370	36	23.8	
	AC 275-6	275	LTA 10-G2	56.4	420	37	36	
	AC 350-6	350	NT 855-G6	74	420	70	38.6	
	AC 383-6	383	NTA 855-G2	79	420	70	38.6	
	AC 450-6	450	NTA 855G3	87	420	70	38.6	
	ACQ 498-6	498	QSX 15-G6	97.6	620	90	91	
	AC 550-6	550	KTA 19-G3	111	620	90	50	
	AC 616-6	616	KTA 19-G4	122	550	92	50	
	ACQ 616-6	616	QSX 15-G9	117.8	620	90	91	
	AC 754-6	754	VTA 28-G5	154	920	176	83	
	ACQ 758-6	758	QSK 23-G1	137	1000	120	103	
	ACQ 935-6	935	QSK 23-G2	176	1000	120	103	
	ACQ 1030-6	1030	QSK 23-G3	189	1000	120	103	
	ACQ 1025-6	1025	QST 30-G2	197	1250	175	154	
	AC 1150-6	1150	KTA 38-G3	217	1250	280	135	
	ACQ 1160-6	1160	QST 30-G3	207	1250	175	154	
	ACQ 1232-6	1232	QST 30-G4	240	1250	342	154	
	AC 1450-6	1450	KTA 50-G3	265	2000	315	177	
	AC 1590-6	1590	KTA 50-G3	291	2000	315	177	
	AC 1930-6	1930	KTA 50-G9	330	2000	375	204	
	ACQ 2200-6	2200	QSK 60-G5	400	2000	380	280	
	ACQ 2500-6	2500	QSK 60-G7	471	2000	380	280	

Table 4.2.4 Coolant and oil capacities and lubricating oil specifications (60 Hz, Gen-sets).

4.10 LUBRICATION OIL

Oil system of diesel engine is one of the most important elements of the engine. Correctly made engine overhaul (this subjet includes oil change periods, filter change periods, paying attention about selecting the true type of oil) prolongs the life of the engine and it decreases the life cycle cost of the engine.

4.10.1 Oil Performance Properties

The American Petroleum Institute (API) the American Society for Testing and Materials (ASTM) and Society of Automotive Engineers (SAE) has developed and preserved a system in order to classify the lubrication oils for their performance categories.

4.10.2 Lubrication Recommendations for Cummins Engine

Cummins recommends that high quality multi grade SAE 15W/40 high service engine oil in diesel engines are used. At ambient temperatures above -15 °C is 15W 40. The minimum API oil quality levels recommended for use is CH / CI-4, CH or CI/4 oil can be used in areas where CF4 oil is not yet available, but the oil change interval must be reduced API CA, CB, CC, CD, CE, CG4 categories not recommended, do not use.

4.10.3 Recommended Oil Properties for Perkins Diesel Engines

Recommended lubriation oil specifications for Perkins Diesel Engines:
If the ambient temperature of the engine is above -15°C, use lubricating oil as SAE 15W/40. If ambient temperature is above -15°C and below 25°C, 10W/30 grade lubricating oil is recommended. API CH-4 classification is required to neet Perkins oil change intervals.

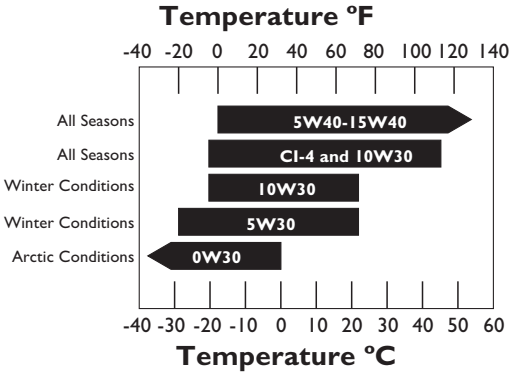


Figure 4.3 Recommended SAE Oil Viscosity Grades vs. Ambient Temperatures

4.10.4 Lubricating oil recommendations by Lister Petter

To help assist engine running, all engines are dispatched with an initial fill lubricating oil which must be changed after 100 hours. Lister Petter engine manufacturer recommends the following oils;
• API CC • Def2101 D • MIL-L-46152 B
• MIL-L-2104 B

4.10.5 Lubricating oil recommendations by Deutz

Deutz engine manufacturer recommends the following oils.
For turbocharged engines:
• API CF-4, API CG-4, API CH-4
• ACEA E1-E3-96 + E4-98

4.10.6 Lubricating oil recommendations by Volvo

Volvo engine manufacturer recommends the following oils.
For turbocharged engines:
• API American Petroleum Institue
API CE, CF, CF-4, CG-4
• CCMC Commitee of Common Market Automobile Constructors
CCMC D4, D5
• VDS Volvo Drain Specification
VDS, VDS-2, VD5-3
• ACEA (European automobile manufacturers association)
ACEA E1, E2, E3

4.10.7 Lubricating oil recommendations by MTU

MTU engine manufacturer recommends the following oils, for 2000 and 4000 series engines. The luboil will be monograde specification.
• API CG-4
• ACEA E2-96 + E3-96

4.11BATTERIES

4.11.1 MAINTENANCE 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 goggles when servicing the battery. If electrolyte is spilled on skin or clothing, flush immediately with largequantities of water.
! Take out the metalic things in your wrist and protect your wrist and hand.
! Disconnect the battery negative (earth) lead first and reconnect last.
! Always ensure that battery charging is carried out in a well ventilated area.
The starting batteries should be located as close as possible to the generating set while still being accessible for servicing. This will prevent electrical losses from long cale that could impact on the engine starting capability of the batteries.

4.11.1.1 First filling of Acid Water to the battery

1. Take out the protective cover above the taps and tear down the air outlet taps.
2. Fill the battery with a clean accumulator acid having a density of 1.280 at 20 °C until the point 15 mm. above plates. Battery an acid teperature must above 10 °C.
3. Let the battery to stand still 15 minutes. After that point battery pockets will start to become heated and gas bubbles will rise at the surface of electrolyte.
4. Attach the air outlet taps to their place.
5. After waiting at least 15 min. control the battery with a hydrometer.
6. Minimum charge time is 6 hours. If the charge voltage and electrolyte level does not increase in at least one hour period that means battery has been charged.
7. Control the electrolyte level after two hours from the charge and if necessary add distilled water so that it is 10 mm. above plates.

4.11.1.2 Battery Maintenance

1. Keep the top of the battery and its terminals clean.
2. Cover the battery terminals and its connections with vaseline.
3. Tighten the terminals but not tighten it hardly.
4. Control the electrolyte level periodically. It must be 10 mm. above the plates.
5. Control the abrasion in the charge alternator belt and check periodically the belt tension according to the producer's recommendation.
6. Ensure that your battery is not uncharged.

4.11.1.3 Testing The Battery

Conduct an inspection every time before testing the battery.

1. A white powdered element causes abrasion to the pole-heads, its surroundings and the connections. Remove the connections and wash them with hot water to purify the axidation. Reconnect it and coat with vaseline.
2. Check if any untightened connections exist.

4.11.1.4 Hydrometer Test

Sulphuric acid density and its charge situation has been determined by using a hydrometer.

1. Don't add distilled water.
2. Keep the barrel part of the equipment in the vertical position and pull on the sufficient amount of electrolyte. Inside the tube there must be a free float and it should be readable at the eye level.
Evaluation is as the following;
Between 1.270 and 1.280 density level is fully charged,
Between 1.220 and 1.230 density level is half charged,
Between 1.150 and 1.220 density level is low charged

4.11.2 Maintenance Free Batteries

Ensure that all battery connections are correct and batteries are always charged. After that there is not any procedure for this batteries.

4.12 ELECTRICAL CONNECTION

Only fully qualified and experienced electrical technicians should carry out electrical installation, service and repair work.

WARNING:

! Make electrical connections in compliance with relevant Electrical Codes, Standards or other requirements.

4.12.1 Cabling: Due to movement of generating sets on their vibration mounts, the electrical connection to the set should be made with flexible cable.
The cable should be protected by laying it in a duct or cable tray.
The cable must be suitable for the output voltage of the generating set and the rated current of the set. In determining the size, allowances should be made for ambient temperature. method of installation, proximity of other cables. etc.
All connections should be carefully checked for integrity.
Current carrying capacity of power cables that will be used for generator has been given in table 4.4. and the cable cross sections which must be used according to the generator powers has been given in table 4.5.1-4.5.2
On the other hand, there is a one more important point while cable cross sections are being selected. If the distance between load and generator is too length, voltage falling at the load side can be too much at the transient current duration. In this case you should calculate the cable cross sections with electrical formula which has been given below.

$e = \sqrt{3} \times L \times I \times (R \cos\varnothing + X \sin\varnothing)$

e : Voltage falling (volt)
L : Cable length (meter)
I : Current (Amper)
R : Resistance of cable (ohm/m)
x : Reactance of cable (ohm/m)

4.12.2 Protection: The cables connecting the generating set with the distribution system are protected by means of a circuit breaker to automatically disconnect the set in case of overload or short circuit. (Manual models only).

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

4.12.4 Power Factor: The power factor (cosø) of the connected load should be determined. Power factors below 0.8 lagging (inductive) can overload the generator. The set will provide its kilowatt rating and operate satisfactorily from 0.8 lagging to unity power factor (1.0). Particular attention must be given to installations with power factor correction equipment such as capacitors to ensure that a leading power factor is never present. This will lead to voltage instability and may result in damaging overvoltages. Generally whenever the generating set is supplying the load any power factor correction equipment should be switched off.

PVC - ISOLATED CABLES YVV (NYY) SUITABLE TO 0.6/1KV VDE NORMS AND TS

Wire Section (mm^2)	0,6/1 KV,YVV type Cable Current Capacity				
	Soil	%25°C @ Air	%40°C @ Air		
	Multiple Core	Multiple Core	Multiple Core	Single Core	HO7RN-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	8/8
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 4.4: Current carrying capacity of power cables PVC insulated conductors in accordance with VDE 0298

GENERATING SETS			Full Load Current U=400 Vac Cosφ: 0,8	Current Capacity of Cable at Air (Ampere)	Cable Section YVV 25°C (mm)
	Model	Stand by Power (kVA)			
Cummins Engine	AC 39	39	57	80	4 x 16
	AC 55	55	80	105	3 x 25 / 16
	AC 66	66	95	130	3 x 35 / 16
	AC 70	70	101	130	3 x 35 / 16
	AC 90	90	130	160	3 x 50 / 25
	AC 115	115	166	200	3 x 70 / 30
	AC 150	150	216	245	3 x 95 / 50
	AC 160	160	230	285	3 x 120 / 70
	AC 200	200	288	325	3 x 150 / 70
	AC 250	250	360	400	2 x (3 x 70 / 30)
	AC 250	250	360	400	2 x (3 x 70 / 30)
	AC 275	275	396	400	2 x (3 x 70 / 30)
	AC 350	350	504	570	2 x (3 x 120 / 70)
	AC 400	400	576	650	2 x (3 x 150 / 70)
	AC 500	500	720	855	3 x (3 x 120 / 70)
	ACQ 515	515	744	855	3 x (3 x 120 / 70)
	AC 550	550	792	855	3 x (3 x 120 / 70)
	ACQ 550	550	792	855	3 x (3 x 120 / 70)
	AC 650	650	939	1140	4 x (3 x 120 / 70)
	AC 703	703	1015	1140	4 x (3 x 120 / 70)
	ACQ 720	720	1040	1140	4 x (3 x 120 / 70)
	AC 825	825	1192	1300	4 x (3 x 150 / 70)
	ACQ 830	830	1199	1300	4 x (3 x 150 / 70)
	ACQ 881	881	1267	1425	5 x (3 x 120 / 70)
	AC 1030	1030	1483	1625	5 x (3 x 150 / 70)
	ACQ 1030	1030	1483	1625	5 x (3 x 150 / 70)
	AC 1130	1130	1627	1710	6 x (3 x 120 / 70)
	ACQ 1130	1130	1627	1710	6 x (3 x 120 / 70)
	AC 1435	1435	2066	2275	7 x (3 x 150 / 70)
	AC 1675	1675	2412	2600	8 x (3 x 150 / 70)
	ACQ 2100	2100	3024	3250	10 x (3 x 150 / 70)
	ACQ 2250	2250	3251	3575	11 x (3 x 150 / 70)

Table 4.5.1: Recommended cable cross sections (50 Hz, Gen-sets). **Note**: PVC isolated cables YVV suitable 0,6/1kV VDE norms and TSE

GENERATING SETS			Full Load Current U=400 Vac Cosφ: 0,8	Current Capacity of Cable at Air (Ampere)	Cable Section YVV 25 °C (mm^2)
	Model	Stand by Power (kVA)			
Lister Petter	ALP 8	8	12	25	4 x 2.5
	ALP 12	12	17	25	4 x 2.5
	ALP 15	15	21	25	4 x 2.5
	ALP 16	16.5	23	34	4 x 4
	ALP 22	22	31	34	4 x 4
	ALP 30	30	43	60	4 x 10
Perkins	AP 500	500	720	855	3 x (3 x 120 / 70)
	AP 550	550	792	855	3 x (3 x 120 / 70)
Volvo	AVP 515	515	742	855	3 x (3 x 120 / 70)
	AVP 550	550	792	855	3 x (3 x 120 / 70)
MTU	AKMTU 720	720	1036	1140	4 x (3 x 120 / 70)
	AKMTU 780	780	1123	1300	4 x (3 x 150 / 70)
	AKMTU 925	925	1332	1425	5 x (3 x 120 / 70)
	AKMTU 1035	1035	1490	1625	5 x (3 x 150 / 70)
	AKMTU 1500	1500	2160	2275	7 x (3 x 150 / 70)
	AKMTU 1700	1700	2448	2600	8 x (3 x 150 / 70)
	AKMTU 2050	2050	2952	3250	10 x (3 x 150 / 70)
	AKMTU 2200	2200	3168	3250	10 x (3 x 150 / 70)
Deutz	ADZ 110	110	158	200	3 x 70 / 30
	ADZ 175	175	252	285	3 x 120 / 70
	ADZ 360	360	518	570	2 x (3 x 120 / 70)
	ADZ 400	400	576	650	2 x (3 x 150 / 70)
	ADZ 490	483	695	735	3 x (3 x 95 / 50)
	ADZ 538	534	768	855	3 x (3 x 120 / 70)
	ADZ 550	550	792	855	3 x (3 x 120 / 70)

Tablo 4.5.2 Recommended cable cross sections (50 Hz, Gen-sets).

Note: PVC isolated cables YVV suitable to 0,6/1kV VDE norms and TSE

GENERATING SETS			Full Load Current U=400 Vac Cosφ: 0,8	Current Capacity of Cable at Air (40°C ambient temperature) (Ampere)	Cable Section (NYY) Single core for each phase (mm^2)
	Model	Stand by Power (kVA)			
Lister Petter	ALP 10-6	10	14.4	22	2.5
	ALP 15-6	15	21.6	30	4
	ALP 21-6	21	30	38	6
Perkins	AP 616-6	616	890	1068	4x120
	AP 693-6	693	1001	1068	4x120

Table 4.5.3 Recommended cable cross sections (60 Hz, Gen-sets).
Note : PVC isolated cables YVV suitable to 0,6/1 kV , VDE norms and TSE

GENERATING SETS			Full Load Current U=400 Vac Cosφ: 0,8	Current Capacity of Cable at Air (40°C ambient temperature) (Ampere)	Cable Section (NYY) Single core for each phase (mm^2)
	Model	Stand by Power (kVA)			
Cummins	AC 44-6	44	63,5	76	16
	AC 66-6	66	95	123	35
	AC 77-6	77	111	155	50
	AC 100-6	100	144	191	70
	AC 135-6	135	195	228	95
	AC 165-6	150	238	267	120
	AC 225-6	225	325	382	2x70
	AC 275-6	275	397	456	2x95
	AC 350-6	350	505	534	2x120
	AC 383-6	383	553	610	2x150
	AC 450-6	450	650	800	3x120
	ACQ 498-6	483	698	800	3x120
	AC 550-6	550	794	915	3x150
	AC 616-6	616	890	1068	4x120
	ACQ 616-6	616	890	1068	4x120
	AC 754-6	754	1089	1220	4x150
	ACQ 758-6	758	1095	1220	4x150
	ACQ 935-6	935	1351	1525	5x150
	ACQ 1030-6	1030	1488	1525	5x150
	ACQ 1025-6	1025	1481	1525	5x150
	AC 1150-6	1150	1661	1830	6x150
	ACQ 1160-6	1160	1676	1830	6x150
	AC 1232-6	1232	1780	1830	6x150
	ACQ 1450-6	1450	2095	2135	7x150
	AC 1590-6	1590	2297	2440	8x150
	AC 1930-6	1930	2789	3050	10x150
	ACQ 2200-6	2200	3179	3355	11x150
	ACQ 2500-6	2500	3612	3660	12x150

Table 4.5.4 Recommended cable cross sections (60 Hz, Gen-sets).
Note : PVC isolated cables YVV suitable to 0,6/1 kV , VDE norms and TSE

4.12.5 Grounding/Earthing Requirements: The frame of the generating set must be connected to an earth ground. Since the set is mounted on vibration isolators, the ground connection must be flexible to avoid possible breakage due to vibration.

Ground connection cables or straps should have at least full load current carrying capacity and meet applicable regulations.

4.12.6 Alternator Reconnection: Most alternators can be reconnected to suit different output voltages. Ensure that all other components such as circuit breakers, current transformers, cables and ammeters are suitable before operating at a different voltage.

4.12.7 Parallel Running: Extra equipment must be fitted for the standard generating sets to be operated in parallel with other generating sets or with mains power.

4.12.8 Insulation Test: Before starting the generating set after installation, test the insulation resistance of the windings. The Automatic Voltage Regulator (AVR) should be disconnected and the rotating diodes either shorted out with temporary links or disconnected. Any control wiring must also be disconnected.

A 500V Megger or similar instrument should be used. Disconnect any earthing conductor connected between neutral and earth and megger an output terminal to earth. The insulation resistance should be in excess of 1MΙ to earth. Should the insulation resistance be less than 1MΙ the winding must be dried out.

4.13 ACOUSTIC SILENCING

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

WARNING

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

4.13.1 Exhaust Silencers: As discussed in Section 4.8 the exhaust silencer will decrease sound levels from the engine.

4.13.2 Canopies: Section 4.2 discusses sound attenuating canopies that lower the noise level of the entire generating set.

4.13.3 Other Sound Attenuation: For installations in buildings there are other types of equipment such as acoustic louvers, splitter vents and fan silencers, as well as sound absorbing wall coverings, that can be used to reduce the noise levels of generating sets.

4.14 ENGINE JACKET WATER HEATER

Jacket water heater is used in order to startup the generating set more easily and to take the load. In automatic generating sets jacket water heater is standard. In manual type generating sets it is an option. Heater warms up the jacket water of the engine when the generating set is not working.

4.15. TOWING (Mobile Generating Sets)

4.15.1 Preparing to Tow: Inspect all components of the coupling equipment on the towing vehicle and the generating set for defects such as excessive wear, corrosion, cracks, bent metal, or loose 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.

4.15.2 Towing: Whenever towing a mobile generating set, remember that manoeuvra-bility and stopping distance will be affected by the weight of the trailer.

WARNING

! When towing mobile generating set, observe all Codes, Standards or other regulations and traffic laws. These include those regulations specifying required equipment and maximum and minimum speeds.

! Do not permit personnel to ride on the mobile generating set. Do not permit personnel to stand or ride on the drawbar or to stand or walk between the generating set and the towing vehicle.

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

! Ensure the area behind and under the mobile set is clear before reversing.

4.15.3 Parking: Park the set on a dry level area that can support it's 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 set on grades exceeding 15°.

4.16 STORAGE

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

4.16.1 Engine Storage: The engine should be put through an engine "preservation" procedure that includes cleaning the engine and replacing all the fluids with new or preserving fluids.

4.16.2 Alternator Storage: When an alternator is in storage, moisture tends to condense in the windings. To minimize condensation, store the generating set in a dry storage area. If possible use space heaters to keep the windings dry.
After removing the generating set from storage, perform an insulation Check as discussed in 4.12.8.

4.16.3 Battery Storage: While the battery is stored, it should receive a refreshing charge every 8 weeks up to a fully charged condition.

5. GENERATING SET MAINTENANCE

A good maintenance program is the key to long generating set life. The recommended maintenance program is provided on the Periodic Maintenance Chart. This chart is given with all generating sets.
Maintenance and service should only be carried out by qualified technicians. The maintenance and service which are done must be recorded to the Maintenance Record Form. In General, the generating set should be kept clean. Do not permit liquids such as fuel or oil film to accumulate on any internal or external surfaces. Wipe down surfaces using an aqueous industrial cleaner.

6. GENERAL PRECAUTIONS AND CONTROLS WHICH MUST BE DONE BEFORE STARTING UP THE GENERATING SET

- Make a general visual inspection on the engine and alternator. Check if there is any breakage, crack, indentation, leakage or looseness. Never operate the generating set before removing any fault, if any.
- Take out foreign materials such as keys, tools, cleaning wool, papers etc. on the engine and the alternator.
- Check the fuel level in the day tank. Refill with fuel if it is low.
- Check the engine oil level on the dip stick. Refill with an appropriate oil if it is low. Oil level normally must be close to the maximum level line.
- Look at the water level by opeing the radiator tap. If it is inadequate add more water. Water level must be 30 mm. lover than the water filling neck.
- Engine cooling water must include antifreeze according to the coolest weather conditions in the area. A mixture of 50% antifreeze and 50% water provides a good protection in all area.
- Inspect the radiator air outlet hood, open if clogged and clear away all obstructions in front of the air outlet.
- Check the air filter gauge. Clean or replace the air filter, if necessary.
- Keep the inlet opening open.
- Make sure that the generating set can easily take air from te environment.
- Check the battery connection cables. Take care to tighten the loosened battery terminals with spanner and, cover with special substance and keep clean in order to avoid oxidation.
- Open the battery caps and check the liquid level in the cells. Add distilled water, if necessary, so as to be 1 cm higher than the separation. Never fill the cells with tap water, acid water or acid.
- Check if the circuit breaker outlet switch is in OFF position.
- Make sure that the emergency stop button is not pressed.

7. GENERATING SET CONTROL SYSTEMS

To control and monitor the generating set, an electronic control system has been used. Depending on the requirements of the set, one of several different standard control systems may be fitted. These include ME 30, ME 40 model Manual Control Systems, P 500 Automatic Control Systems (with AMF), P 2010 Auto start Control System and P 2020 Automatic Control System (with AMF). Control panel provides a means of starting and stopping the generating set, monitoring its operation and output and automatically shutting down the set in the event of a critical condition arising such as low oil pressure or high engine temperature.

7.1 Starting with ME 30 or ME 40 Manual Control Panel

- Check the precautions and controls before starting up the generating set
- To start the generating set, turn the key switch to the hand position, which will power up the unit (DSE 701 module)
- Pressing start button (1) will energise the Fuel solenoid, then the starter motor. The button should be pressed for the duration of the crank period.
- When the engine fires, the starter motor is disengaged and locked out at 20 Hz measured from the alternator output.
- After the starter motor has disengaged, safety on timer is activated (which is fixed at 12 seconds), allowing oil pressure, high engine temperature and charge fail to stabilise without triggering the fault.
- If the generator has not started when the start button has been released or generator fails once it is running, the key switch must be turned to stop (0) and then back to hand position before another start cn be invoked.
- Check the alternator output voltage and frequency and engine oil pressure, engine temperature.
- The gen set should run 2-3 minute no load
- When the engine warm after alternator output circuit breaker sholud be ON position.

Figure 7.1
Model DSE 701 module

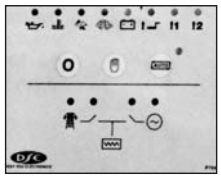


Figure 7.2
Model DSE 704 module

7.2. STARTING WITH P500 AUTOMATIC CONTROL PANEL (with AMF)

7.2.1 Manual Operation

- Check the precautions and controls starting up the generating set.
- To initiate a start sequence in MANUAL, press the push button and the start sequence is initiated.
- After fuel solenoid is energised, then the starter motor is engaged.
- Engine cranked for a 10 second period, If the engine fails to fire during this cranking attempt then the starter motor is disengaged for a 10 second period. Should this sequence continue terminated and fail to start ! fault will be illuminated.
- When the engine fires, the starter motor is disengaged and locked out at 20 Hz measured from the Alternator output.
  After the starter motor has disengaged, the Safety On timer is activated, allowing Oil pressure, High Engine Temperature, Under -speed, Charge Fail and any delayed Auxiliary fault inputs to stabilise without triggering the fault. The generator will run off load, unless the mains supply fails or Remote start on load signal is applied, at which point the load will be transferred to the generator. If Auto mode is selected, and the mains supply is healthy with the remote start on load signal not active, then the Remote Start Delay Timer begins, after which, the load is disconnected. The generator will then run off load allowing the engine a cooling down period.
- Selecting STOP de-energises the fuel solenoid, bringing to stop.

7.2.2 Automatic Mode Of Operation

- This mode is activated by pressing the AUTO pushbutton. An LED indicator beside the button confirms this action. Whether the start sequence is initiated by mains (utility) failure or remote input, the following sequence is followed: After Start Delays the Fuel Solenoid is energised, then one second later, Starter Motor is engaged. The engine is cranked for 10 second period. If the engine fails to fire during this cranking attempt then the starter motor is disengaged for a 10 second rest period. Should this sequence continue beyond the 3 starting attempts, the start sequence will be terminated and Fail to Start ! fault will be illuminated. When the engine fires, the starter motor is disengaged and Safety On timer activated.
  If the remote start is being used and has been configured to Remote start is on load or the mains has failed, the load will be transferred to the generator.
  On the return of mains supply, (or removal of the Remote Start signal if the set was started by remote signal), the Stop delay timer is initiated. Once it has timed out, the load is transferred back to the mains (utility). The Cooling timer expires the Fuel Solenoid is de -energised, bringing the generator to a stop.

7.3 Starting with P2010 Autostart Control Panel

7.3.1 Manual Operation

- Check the precautions and controls starting up the generating set.
  NOTE: If a digital input configured to panel lock is active, the LCD will display the icon. When in panel lock, changing modules will not be possible.
  Viewing the instruments and event logs is not affected by panel lock.
- To initiate a start sequence in MANUAL press the pushbutton. When the controller is in the manual button), pressing the START (I) button will initiate the start sequence. NOTE: There is no Start Delay in this mode of operation.
- The Fuel Solenoid is energized, then the Starter Motor is engaged. The engine is cranked for a preset time period. If the engine fails to fire during this cranking attempt then the starter motor is disengaged for the preset rest period. Should this continue beyond the set number of attempts, the start sequence will be terminated and fail to start fault will be displayed accompanied by a flashing shutdown indicator.
- When the engine fires, the starter motor disengaged and locked out at a pre-set frequency from the Alternator output. Rising oil pressure can also be used to disconnect the starter motor, however it cannot be used for under speed or over speed detection.
- The generator will run off load, unless a Remote Start signal is applied, and if Load Transfer has been selected as a control source, the appropriate auxiliary output selected will active.
- If the Remote Start signal is removed, the generator will continue to run On load until Auto mode is selected. The Remote Stop Delay Timer will time out, the load is then disconnected. The generator will then run off load allowing the engine a cooling down period.
- Selecting STOP (0) de-energises the Fuel Solenoid, bringing the generator to a stop.

7.3.2 Automatic Mode of Operation

NOTE: If a digital input configured to panel lock is active, the LCD will display the icon. When in panel lock, changing modules will not be possible.
Viewing the instrument and event logs is not affected by panel lock.

- This mode is activated by pressing the AUTO push button. An LED indicator beside the button confirms this action.
  When a Remote Start signal is applied to the remote start input, the following sequence is initiated:
  The Remote Start Active indicator illuminates (if configured)
  To allow for false signals the Start Delay timer is initiated.
- After this delay the Fuel Solenoid is energized, then one second later, the Starter Motor is engaged. The engine is cranked for a pre-set time period. If the engine fails to fire during this cranking attempt then the strter motor is disengaged for the pre-set period. Should this sequence continue beyond the set number of attempts, the start sequence will be terminated and Fail to Start fault will be displayed accompanied by a flashing shutdown symbol.
- When the engine fires, the starter motor disengaged and locked out at a pre-set frequeny from the alternator output. Rising oil pressure can also be used to disconnect the starter motor, however it cannot be used for under speed or over speed detection.
- If an auxiliary output has been selected to give a load transfer signal, this would then active.
- On removal of the Remote Start signal, the stop delay timer is initiated, once it has timed out, the Load Transfer is de-energise, removing the load. The cooling timer is then initiated, allowing the engine a cooling down period off load before shutting down. Once the Cooling timer expires the Fuel Solenoid is de-energised, bringing the generator to a stop.
- Should the Remote Start signal be re-activated during the cooling down period, the set will return on load.

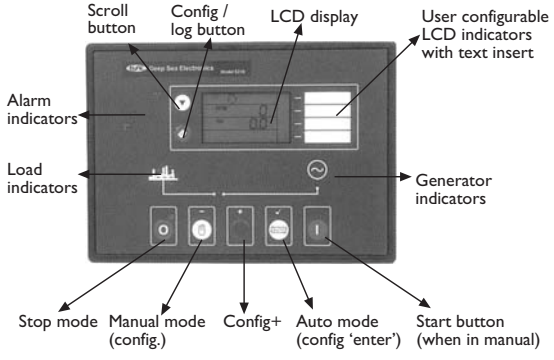


Figure 7. 3 Desription of Controls on DSE5210 module

7.4 Starting with P 2020 Automatic Control Panel (with AMF)

7.4.1 Manual Operation

- Check the precautions and controls starting up the generating set.
  NOTE: If a digital input configured to panel lock is active, the LCD will display the icon. When in panel lock, changing modules will not be possible.
  Viewing the instruments and event logs is not affected by panel lock.
- To initiate a start sequence in MANUAL press the pushbutton. When the controller is in the manual button), pressing the START (I) button will initiate the start sequence. NOTE: There is no Start Delay in this mode of operation.
- The Fuel Solenoid is energized, then the Starter Motor is engaged. The engine is cranked for a preset time period. If the engine fails to fire during this cranking attempt then the starter motor is disengaged continue beyond the set number of attempts, the start sequence will be terminated and fail to start ! fault will be displayed accompanied by a flashing shutdown indicator.
- When the engine fires, the starter motor disengaged and locked out at a pre-set frequency from the Alternator output. Rising oil pressure can also be used to disconnect the starter motor, however it cannot be used for under speed or over speed detection.
- The generator will run off load, unless a Remote Start signal is applied, and if Load Transfer has been selected as a control source, the appropriate auxiliary output selected will active.
- If the Remote Start signal is removed, the generator will continue to run On load until Auto mode is selected. The Remote Stop Delay Timer will time out, the load is then disconnected. The generator will then run off load allowing the engine a cooling down period.
- Selecting STOP (0) de-energises the Fuel Solenoid, bringing the generator to a stop.

7.4.2 Automatic Mode of Operation

NOTE: If a digital input configured to panel lock is active, the LCD will display the icon. When in panel lock, changing modules will not be possible.
Viewing the instrument and event logs is not affected by panel lock.

- This mode is activated by pressing the AUTO push button. An LED indicator beside the button confirms this action.
  When a Remote Start signal is applied to the remote start input, the following sequence is initiated:
  The Remote Start Active indicator illuminates (if configured)
  To allow for false signals the Start Delay timer is initiated.
- After this delay the Fuel Solenoid is energized, then one second later, the Starter Motor is engaged. The engine is cranked for a pre-set time period. If the engine fails to fire during this cranking attempt then the starter motor is disengaged for the pre-set period. Should this sequence continue beyond the set number of attempts, the start sequence will be terminated and Fail to Start ! fault will be displayed accompanied by a flashing shutdown symbol.
- When the engine fires, the starter motor disengaged and locked out at a pre-set frequency from the alternator output. Rising oil pressure can also be used to disconnect the starter motor, however it cannot be used for under speed or over speed detection.
- If an auxiliary output has been selected to give a load transfer signal, this would then active.
- On removal of the Remote Start signal, the stop delay timer is initiated, once it has timed out, the Load Transfer is de-energise, removing the load. The cooling timer is then initiated, allowing the engine a cooling down period off load before shutting down. Once the Cooling timer expires the Fuel Solenoid is de-energised, bringing the generator to a stop.
- Should the Remote Start signal be re-activated during the cooling down period, the set will return on load.

7.4.3 Test Operation

NOTE: If a digital input configured to panel lock is active, the LCD will display the icon. When in panel lock, changing modules will not be possible.

Viewing the instruments and event logs is not affected by panel lock.

To initiate a start sequence in TEST, press the pushbutton. When the controller is in the test mode (indicated by an LED indicator beside the button), pressing the START (I) button will initiate the start sequence. NOTE: There is no Start Delay in this mode of operation.

The Fuel Solenoid is energized, then the Starter Motor is engaged. The engine is cranked for a preset time period. If the engine fails to fire during this cranking attempt then the starter motor is disengaged for the pre-set rest period. Should this sequence continue beyond the set number of attempts, the start sequence will be terminated and Fail to Start ! fault will be displayed accompanied by a flashing shutdown indicator.

The generator will continue to run on load regardless of the state of the mains supply or remote start input until the Auto mode is selected. If Auto mode is selected, and the mains supply is healthy with the remote start on load signal not active, then the Remote Stop Delay Timer begins, after which, the load is disconnected. The generator will then run off load allowing the engine a cooling down period.

Selecting STOP (0) removes the Close Generator output (if configured) and de-energises the Fuel Solenoid, bringing the generator to a stop.

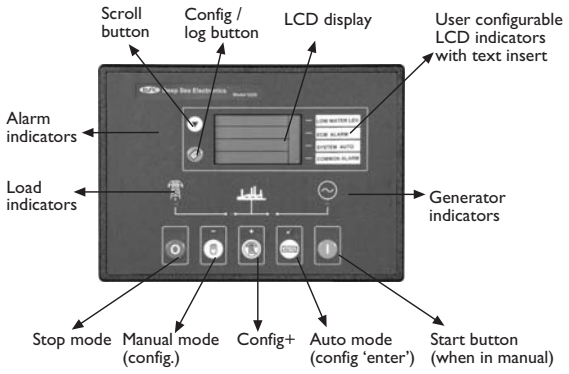


Figure 7. 4 Desription of Controls on DSE5220 module

8. GENERAL PRECAUTIONS AND CONTROLS WHICH MUST BE DONE AFTER STARTING UP THE GENERATING SET

- Check for any abnormal noise or vibration on the generating set.
- Check if the exhaust system has any leakage.
- Monitor the generating set operation by means of the gauges on the control panel. Check the engine temperature and oil pressure by means of the gauges on the panel. Oil pressure must reach the normal value 10 seconds after the generating set operation.
- Monitor the generating set outlet voltage and frequency by means of the gauges on the panel. Check on the voltmeter, if the voltage between phases is 400 V and between phase and neutral is 230 V. Check that the frequency at idle is 51-52 Hz (for 50 Hz operation or 61-62 Hz for 60 Hz operation) on generating sets with mechanical governors and 50 Hz or 60 Hz on generating sets with electronic governors. Outlet voltage is adjusted ex-factory. Adjustments should be done only by authorized personnel.
- If an engine block water heater is not available, put the generating set under load after warming with a 10 minute idle run (manual models).
  Putting the generating set under load must be done as follows:
- Set the alternator outlet switch on the panel to ON position.
- Set the load switches (or fuses) on the distribution panel to ON position one by one. This way, the generating set cannot be suddenly put under full load. Otherwise, the engine stalling or alternator winding insulation deformation or burning can occur.
- Set the alternator outlet switch on the circuit to OFF position before you stop the generating set.
- Continue to run the unloaded diesel engine for the purpose of cooling for 5 minutes and then stop.
- Never operate the generating set before removing any fault, if any.

9. STOPPING THE GENERATING SET

9.1 At Manual Models:

- Before stopping the generator, alternator output, circuit braker should be OFF position.
- The genset should run 2-3 minute with no load.
- To stop the generator turn the key switch to the STOP "O" position, de-energises key switch the fuel solenoid, bringing the generator to a stop.

9.2 At Automatic Models:

- The genset should run 2-3 minute with no load.
- Selecting **STOP "O"** position, de-energises the fuel solenoid, bringing the generator to a stop.

10. GENERATING SET CONTROL SYSTEMS

To control and monitor the generating set, an electronic control system has been used. Depending on the requirements of the set, one of several different standard control systems may be fitted. These include ME 40 Model Manual Control panel or P 500, P2020 Auto Mains Failure panel and 2010 Autostart Panel Control panel provides a means of starting and stopping the generating set, monitoring its operation and output, and automatically shutting down the set in the event of a critical condition arising such as low oil pressure or high engine temperature.

10.1 CONTROL PANELS

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

10.1.1 MANUAL CONTROL SYSTEM - ME 40

- Control with DSE 701 Module
- 3 Ammeters
- 1 Hours run meter
- 1 Volt - Frequencymeter (by LED) and selector switch
- Engine oil pressure gauge
- Engine coolant temperature gauge
- Emergency stop push button
- 3 pole alternator circuit braker

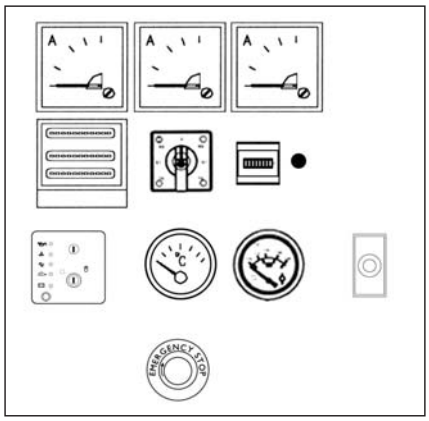


Figure 10. 1 ME 40 Manual Control Panel

10.1.1.1 DSE 701 MODULE FEATURES

- Engine supervision and protection
- Key switch operation on the fron panel

10.1.1.2 DSE 701 MODULE EMERGENCY LED's

- High engine temperature, shutdown
- Low oil pressure, shutdown
- Over speed, shutdown
- Charge failure, warning

Figure 10.2 DSE 701 Manuel Control Module

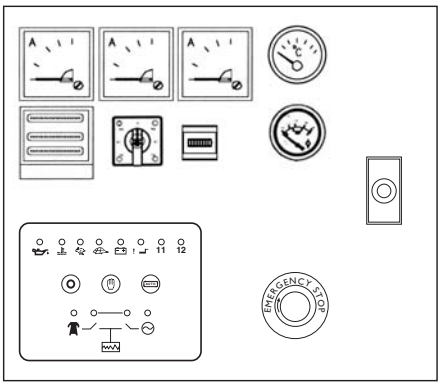


Figure 10.3 P500 Automatic Control Panel

10.2.1 AUTOMATIC CONTROL SYSTEM P 500 PANEL SPECIFICATION

- Control with DSE 704 module
- 3 Ammeters
- 1 Hours run meter
- 1 Volt-Frequencymter (by LED) and selector switch
- Engine oil pressure gauge
- Engine coolant temperature gauge
- Emergency stop push button
- Static battery charger
- Thermally delayed overload protection
- Engine water heater control

10.2.1.1 DSE 704 MODULE FEATURES

- Three phases mains sensing
- Engine protection
- Automatic engine starting and stopping
- Simple push button controlled operation Stop-Reset/Manual/Auto
- Micro processor based design
- Configurable via front panel
- Configurable timer setting
- Adjustable mains fail voltage level
- Mains/Generator, change-over contactor control
- External remote start input

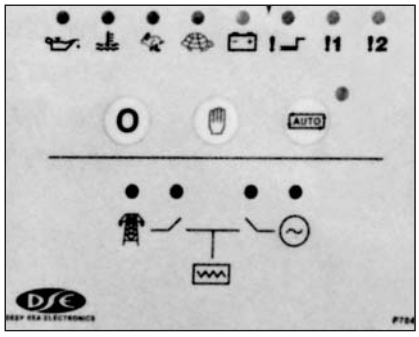


Figure 10.4 DSE 704 Automatic Start and Control Module

10.2.1.2 FAULT CONDITIONS DISPLAYED BY LED ILLUMINATION

- High engine temperature, shutdown
- Low oil pressure, shutdown
- Over speed, shutdown
- Charge eltarnator fault, warning
- Start failure, shutdown

10.3.1 AUTOMATIC CONTROL SYSTEM P 2020 PANEL SPECIFICATIONS

- Control with DSE 5220 Full Automatic Mains Failure Module
- Static Battery Charger
- Emergency stop shutdown push button

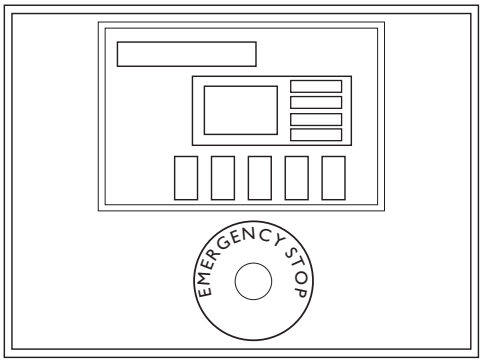


Figure 10.5 P 2020 Automatic Control Panel

10.3.1.1 DSE 5220 MODULE FEATURES

- Monitoring AC mains supply
- Automatic controls generating set, start and shutdown
- Provides signal to change over switch gear
- Remote communication via RS 232 port or RS 485 "modbus" output.
- Front panel programming of the module settings
- Scrolling digital LCD display
- Event logging of shutdown alarms
- Easy pushbutton control
- Stop/Reset, Auto, Manual, Test

Metering via LCD display

- Generator volts (F-F/F-N)
- Generator amperes (L1, L2, L3)
- Generator frequency (Hz)
- Generator kVA
- Generator kW
- Generator Cosφ
- Engine oil pressure (PSI & Bar)
  Engine temperature (°C & °F)
- Engine speed RPM
- Engine hours run
- Mains volts (F-F / F-N)
- Mains frequency (Hz)
- Plant battery volts

Figurel 10. 6 DSE 5220 AMF Control Module

Multiple Alarms

- Under/over generator volts; Pre-Alarm and Shutdown
- Under/over generator frequency; Pre-Alarm and Shutdown
- Under/over mains volts
- Under/over mains frequency
- Over current; Shutdown
- Low oil pressure; Pre-Alarm and Shutdown
- High engine temperature; Pre-Alarm and Shutdown
- Under/over speed; Shutdown
- Low coolant level; Shutdown
- Fail to start; Shutdown
- Fail to stop; Warning
- Low/High Battery volts; Warning
- Charge fail; Warning
- Emergency stop; Shutdown
- Can Data Fail; Shutdown
- Can ECU Fail; Pre-Alarm and Shutdown

The Event Log

5220 control module maintains a log of the last 15 shutdown alarms to enable the operator or engineer to view the past alarms history.

10.4.1 AUTOSTART CONTROL SYSTEM P2010 PANEL SPECIFICATIONS

• Control with DSE 5210 Autostart Module
• Emergency stop shutdown push button

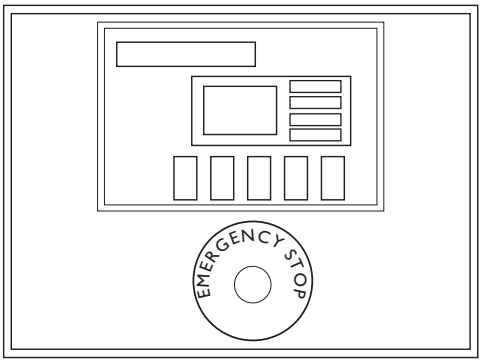


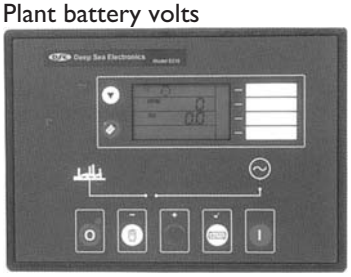
Figure 10.7 P 2010 Autostart Control Panel

10.4.1.1 DSE 5210 MODULE FEATURES

- Automatic start and stop the genset Provides signal to Load Transfer
- Remote communication via RS 232 port or RS 485 "modbus" output.
- Front panel programming of the module settings
- Scrolling digital LCD display
- Event logging of shutdown alarms
- Easy pushbutton control
- Stop/Reset, Auto, Manual, Test

Metering via LCD display with the following instrumentation displays

- Generator volts (F-F / F-N)
- Generator amperes (L1, L2, L3)
- Generator frequency (Hz)
- Generator kVA
- Generator kW
- Generator Cosφ
- Engine oil pressure (PSI & Bar)
- Engine coolant temperature (°C&°F)
- Engine speed RPM
- Engine hours run
- Plant battery volts



Figurel 10. 8 DSE 5210 Autostart Control Module

Multiple Alarms

- Under/over generator volts; Pre-Alarm and Shutdown
- Under/over generator frequency; Pre-Alarm and Shutdown
- Over current; Shutdown
- Low oil pressure; Pre-Alarm and Shutdown
- High engine temperature; Pre-Alarm and Shutdown
- Under/over speed; Shutdown
- Low coolant level; Shutdown
- Fail to start; Shutdown
- Fail to stop; Warning
- Low / High Battery volts; Warning
- Charge fail; Warning
- Emergency stop; Shutdown

The Event Log

5220 control module maintains a log of the last 15 shutdown alarms to enable the operator or engineer to view the past alarms history.

10.5 Panel Equipments

Before starting or running the generating set, the operator should become fully acquainted with the instruments and controls. The instuments should be observed from time to time while the generating set is running so that any abnormal readings can be detected before problems arise. Some of our standard manual and automatic control panels are shown in figures 10.1, 10.3, 10.5 and 10.7. In addition optional equipment items can be added to the panel so the panel fitted on the generating set may be slightly different from the typical ones shown.

10.5.1 Ac Voltmeter

A voltmeter that indicates the AC voltage generated at the alternator output terminals. The reading indicated on the voltmeter will vary depending on the connections made inside the alternator terminal box, the setting of the voltage regulator and the position of the voltmeter selector switch.

10.5.2 Voltmeter Selector Switch

A selector switch allowing the operator to select voltage reading between phases.

10.5.3 AC Ammeter

An ammeter that indicates the AC electrical current being delivered which is dependend on the connected load. There are three ammeters.

10.5.4 Frequency Meter

A meter that indicates the output frequency of the generating set. The engine maintain a relatively constant speed under governor control so as to provide the proper operating frequency of 50 Hz or 60 Hz when the generating set is operating at full load. In practice, if the generating set has a manual governor control system, no load frequencies of approximately 52 62 Hz for 50 Hz and 60 Hz respectively, are considered. The frequencies will fall, as the set is loaded, to 50 Hz and 60 Hz at full load.

10.5.5 Hours Run Meter

A meter that indicates the total number of hours of generating set operation to aid in maintenance.

10.5.6 Water Temperature Gauge

A temperature gauge connected to a sensor in the engine to monitor engine coolant temperature. Normal level of the engine coolant temperature is approximately 85°C (185°F).

10.5.7 Oil Pressure Gauge

A gauge to monitor engine oil pressure from the moment the engine is cranked. On cold engines the oil pressure will be significantly higher until the engine warms up.

10.5.8 Emergency Stop Pushbutton

A red lockdown pushbutton that immediately shut dow the generating set and will inhibit start until the pushbutton has been released by turning it.

10.5.9 Alternator Protection

In our standard production, the alternators in automatic operation generating sets are protected with a thermic protector against overload (with P 500 control panel). In our standard production of manual operated generating sets, the alternators are protected against overload and short circuit by a thermic magnetic switch and then the generating set is given load.

10.9 ICONS AND LCD IDENTIFICATION ON DSE 5210 and DSE 5220 MODULE

10.9.1 PUSH BUTTONS

Display	Description	Display	Description	Display	Description
	Stop / Reset		Auto mode		Manual mode
	Configure / log		Start (when in manual mode)		Scrool

10.9.2 STATUS / MEASUREMENT UNITS

Display	Description	Display	Description	Display	Description
L1	Phase	**L2**	Phase	**L3**	Phase
L1 - N	Phase - Neutral	**L1 - N**	Phase-Neutral	**L1 - N**	Phase-Neutral
L1 - L2	Phase - Phase	**L2 - L3**	Phase-Phase	**L3 - L1**	Phase-Phase
BAR	Pressure	**Kpa**	KPa Oil Pressure Units	**PSI**	Pressure
V	Voltage	**□F**	Temperature	**Hz**	Frequency
A	Amperes	**□C**	Temperature	**RPM**	Speed
kW	KiloWatts	**kVA**	Apparent Power	**Cosφ´**	kW divided by kVA
	Hours Run		AC		Generator
	Timer in progress		DC		Factory (load)
	Configuration mode active		Fuel Level		Event log
	Panel locked by configurable input				

10.9.3 ALARM INDICATIONS

Display	Description	Display	Description	Display	Description
	Warning Alarm		Shutdown Alarm		Electrical Trip
	Fuel		Low Oil Pressure	**A** ↑	High Current Warning
	Charge Fail		High Coolant Temperature	**V** ↑	Over Voltage (AC)
	Emergency Stop		Fail to start (Over-crank)	**V** ↓	Under Voltage (AC)
	Over Voltage (DC)		Over-Speed	**Hz** ↑	Over Frequency
	Under Voltage (DC)		Under-speed	**Hz** ↓	Under Frequency
	Auxiliary Indication		Auxiliary Alarm (Warning or Shutdown		

11. THE PLACEMENT AND INSTALLATION OF TRANSFER SWITCH

- The placement of the transfer switch and its mountings:
- Position the transfer switch near the emergency power panel.
- Locate the transfer switch in a place where it is clean, not over-heated, and having a good ventilation. If the environment temperature is above 40 °C, fuses and breakers will open more easily. There must be enough working place around the transfer switch.
- Having a fuse or breaker between the generating set and the transfer switch is optional. (Connection cables used in transfer switch). Currents from the generating set must be distributed equally to the three phase if possible.
- Current from one phase should not exceed the nominal current.
- Current from one phase should not exceed the nominal current. Two different power cables, which will be used between the generating set and the transfer switch is on the generating set. (Main supply cable and power cable for emergency power panel)
- If the transfer switch panel is apart from the generating set, transfer switch must be placed as close as possible to the distributor panel. In this case power cables are drawn from generating set, mains panel and emergency power panel. Furthermore 8 x 2.5 mm control cable must be drawn from the generating set control panel.

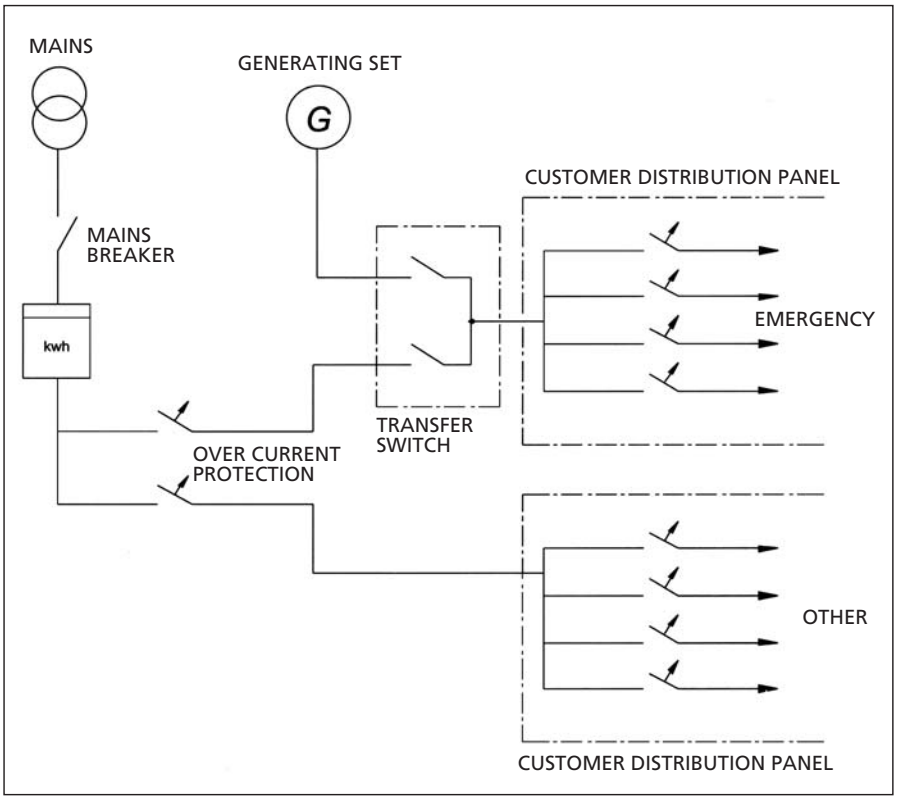


Figure 11 Typical emergency power system installation

12. DSE 530 MODEL FULL AUTOMATIC TRANSFER SWITCH CONTROL SYSTEM

Control of the DSE 530 module is by a four position rotary key-switch, mounted on the front of the module with Auto, Auto with Manual Restore and Manual Run On Load and Off-Load position.

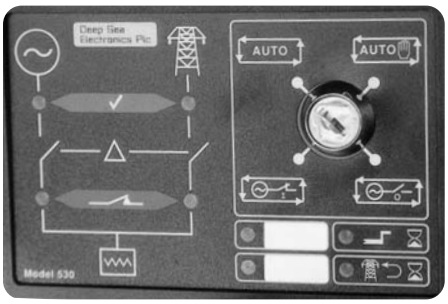


Figure: 7.10 DSE 530 Automatic Transfer Switch Control Module

12.1 Automatic Mode Of Operation

If the module is placed in AUTO mode, it will monitor the incoming mains supply. Should the incoming mains supply fail, the following sequence will occur. The module will start its "Start Delay" timer, this is used to ensure that the start event is really required and the failure is notjust a momentary dip in the supply. Once this timer has expired the module will continue with its normal sequence. If the mains supply returns to within limits during the start delay timer the unit will retun to a standby state.

The start and run generator output relay is de-energised and the relay contacts close, giving a "Remote Start" signal to the engine starting controller.

The engine starting controller (DSE 560, etc.) will now start the generator, the 530 module monitor the generator voltage and frequency (and an optional generator ready input) and once the monitored values are above a pre-set "Loading" level the generator will become available. This is indicated by the illumination of the appropriate LED on the mimic diagram.

As soon as the generator is available the transfer timer is initiated (3 second). Once the transfer timer has expired, the generator close signal will be supplied and run on load.

On return of the mains supply to within limits, the mains return delay timer is initiated, once the timer expires the generator close signal is removed, removing the load. The cooling timer is then initiated, allowing the engine a cooling down period off load before shutting down.

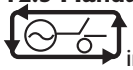
Should the mains fall out of limits during the cooling down period, the set will return on load after the start delay timer has expired.

12.2 Manual Restore Mode Of Operation

If the module is placed in "Manual Restore" mode, it will monitor the incoming mains supply. Should the incoming mains supply fail (or fall outside of pre-set limits), the following sequence will occur like automatic mode until the generator close signal will be supplied and run on load.

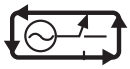
On return of the mains supply to within limits, the mains return delay timer is initiated, once the timer expires the 530 module will wait for a manual restore to mains. This is achieved by placing the keyswitch control into the auto position, the sequence will then continue as described in auto mode of operation.

12.3 Manual Operation



To initiate a start sequence in manual, turn the selector switch to "Start and Run Generator Off Load". The start and run generator output relay is de-energised and the relay contacts close, givin a "Remote Start" signal to the engine starting controller.

The engine stating controller should now start the generator, the 530 module will monitor the generator voltage and frequency and on the monitored values are above a pre-set "Loading" level the generator will become available.



To transfer the load from the mains supply to the generator, turn the selector switch to "Start and Run generator On Load".

To stop the generator return the selector switch to the Auto position. The sequence will then continue as described in auto mode of operation.

12.4 INDICATIONS

The module status is indicated by front panel LED's.

Mains Available LED: Indicates that the incoming AC mains supply is within limits and available o supply the load.

Generator Available LED: Indicates that the generator output voltage and frequency are within acceptable limits and available to supply the load.

Generator On Load LED: Indicates that the generator close signal has been supplied. Alternatively it can be configured to give true indication of load switching device status

Mains On Load LED: As above but with respect to the mains.

Auxiliary LED's: Use PC808 software to configure function.

Start Delay Active LED: Indicates that the 530 internal start delay timer is running. Once expired the start signal will be given to the generator controller.

Mains Return Timer Active LED: Indicates that the 530's internal mains return timer is running. Once expired the load will be transferred back to the mains supply.

13. ALTERNATOR TROUBLESHOOTING

Symptom	Possible Cause	Corrective Action
Alternator does not excite	Blown fuse Insufficient residual voltage No residual voltage Connections are interrupted	Replace fuse Increase speed by 15% For an instant apply on the (+) and (-) terminals of the electronic regulator a 12 V battery voltage with 30 ohm resistor in series respecting the polarities.
After being excited alternator does no excite	Connections are interrupted	Check connection cables as per attached drawings.
Low voltage at no load	Voltage potentiometer out of setting Intervention of protection Winding failure	Reset voltage Check engine speed Check wingings
High voltage at no load	Voltage potentiometer out of setting Failed regulator	Reset voltage Substitude regulator
Lower than rated voltage at load	Voltage potentiometer out of setting Intervention by protection Failed regulator Rotating bridge failure	Reset voltage potentiometer Current to high, power factor lower than 0.8; Speed lower than 4% of rated speed Substitude regulator Check diodes, disconnect cables
Higher than rated voltage at load	Voltage potentiometer out of setting Failed regulator	Reset voltage potentiometer Substitude regulator
Unstable voltage	Speed variation in engine Regulator out of setting	Check regularity of rotation Regulate stability of regulator by acting on stability potentiometer

14. ENGINE TROUBLESHOOTING

The starter motor turns the engine too slowly:
- Battery capacity to low
- Bad electrical connection
- Fault in starter motor
- Wrong grade of lubrication

The engine does not start or difficult to start:
- Starter motor turns engine too showly
- Fuel tank empty
- Fault in fuel control solenoid
- Restriction in a fuel pipe
- Fault in fuel lift pump
- Dirty fuel filter element
- Air in fuel system
- Fault in atomsers
- Cold start systems used incorrectly
- Fault in cold start system
- Restriction in fuel tank vent
- Wrong type or grade of fuel used
- Restriction in exhaust pipe

Not enough power:
- Restriction in a fuel pipe
- Fault in fuel lift pump
- Dirty fuel filter element
- Air in fuel system
- Restriction air filter/cleaner or induction system
- Fault in atomisers or atomisers of an incorrect type
- Restriction in exhaust pipe
- Restriction in fuel tank vent
- Wrong type or grade of fuel used
- Restricted movement of engine speed control
- Engine temperature is too high or low

Misfire:
- Restriction in a fuel pipe
- Fault in fuel lift pump
- Dirty fuel filter element
- Air in fuel system
- Fault in atomisers or atomisers of an incorrect type

The pressure of the lubriation oil is too low:
- Wrong grade of lubrication
- Not enough lubrication oil in sump
- Defective gauge
- Dirty lubrication oil filter element

High fuel consumption:
- Restriction air filter/cleaner or induction system
- Fault in atomisers or atomisers of an incorrect type
- Fault in cold start system
- Wrong type or grade of fuel used
- Restricted movement of engine speed control
- Restriction in exhaust pipe
- Engine temperature is too low
- Incorrect valva tip clearances

Black exhaust smoke:
- Restriction air filter/cleaner or induction system
- Fault in atomisers or atomisers of an incorrect type
- Fault in cold start system
- Wrong type or grade of fuel used
- Restriction in exhaust pipe
- Engine temperature is too low
- Incorrect valva tip clearances
- Engine over load

Blue or white exhaust smoke:
- Wrong grade of lubrication
- Fault in cold start system
- Engine temperature is too low

The engine knocks:
- Fault in fuel lift pump
- Fault in atomisers or atomisers of an incorrect type
- Wrong type or grade of fuel used
- Fault in cold start system
- Engine temperature is too high
- Incorrect valve tip clearances

The engine runs erractically:
- Fault in fuel control
- Restriction in a fuel system
- Fault in fuel lift pump
- Dirty fuel filter element
- Restriction air filter/cleaner or induction system
- Air in fuel system
- Fault in atomisers or atomisers of an incorrect type
- Fault in cold start system
- Restriction in fuel tank vent
- Restricted movement of engine speed control
- Engine temperature is too high
- Incorrect valve tip clearances

Vibration:
- Fault in atomisers or atomisers of an incorrect type
- Restricted movement of engine speed control
- Engine temperature is too high
- Fan damaged
- Fault in engine mounting or flywheel housing

The pressure of the lubrication oil is too high:
- Wrong grade of lubrication oil
- Defective gauge

The engine temperature is too high:
- Restriction air filter/cleaner or induction system
- Fault in atomisers or atomisers of an incorrect type
- Fault in cold start system
- Restriction in exhaust pipe
- Fan damaged
- Too much lubrication oil in sump
- Restriction in air or water passages of radiator
- Insufficiant coolant system

Crankcase pressure:
- Restriction in breather pipe
- Vacuum pipe leaks or fault in exhauster

Bad compression:
- Restriction air filter/cleaner or induction system
- Incorrect valve tip clearances

The engine starts and stops:
- Dirty fuel filter element
- Restriction air filter/cleaner or induction system
- Air in fuel system

The engine shuts down after approximately 15 seconds:
- Badconnection towards oil pressure switch/coolant temperature switch

GENERAL PRECAUTIONS ABOUT WARRANTY

DEAR AKSA GENERATING SET OPERATOR

PLEASE TAKE CARE TO THE FOLLOWING IN ORDER TO PREVENT THE GENERATING SET WARRANTY TO BECOME INVALID BEFORE THE TERMINATION OF THE WARRANTY PERIOD AND TO ENSURE TROUBLE-FREE OPERATION OF THE GENERATING SET WITH A LONG LIFE!...

- MAINTENANCE AND REPAIR WORKS WILL NOT BE COVERED BY THE WARRANTY UNLESS THE WARRANTY CERTIFICATE, INVOICE OR DELIVERY CERTIFICATE OF THE GENERATING SET IS SUBMITTED.
- THE WARRANTY OF THE GENERATING SET WILL BECOME INVALID IN CASE OF ANY INTERVENTION OF ANY PERSON OTHER THAN AUTHORIZED AKSA SERVICES OR BY PRIOR WRITTEN APPROVAL FROM AKSA POWER GENERATION ON THE GENERATING SET FOR ANY REASON.
- CONTROL AND MAINTENANCE WORKS INDICATED IN THE PERIODICAL MAINTENANCE SCHEDULE AND THE OPERATING MANUAL MUST BE CARRIED OUT COMPLETELY AND TIMELY. THE FAILURES DUE TO INCOMPLETE OR UNTIMELY MAINTENANCE ARE NOT COVERED BY THE WARRANTY.
- GENERATING 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.
- CUSTOMER IS RESPONSIBLE FOR THE FAILURES WHICH ARE LIKELY TO OCCUR IN CASE THAT THE DIESEL OIL 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 HARDENING BY LEAVING UNCHARGED.
- ON MODEL KSD 501 MANUAL GENERATING SETS WITH START PANEL, THE IGNITION KEY SHOULD BE RELEASED IMMEDIATELY AFTER THE ENGINE IS STARTED-UP. IN CASE THAT THE ENGINE DOES NOT START UP, THE STARTING SEQUENCE SHOULD NOT BE APPLIED MORE THAN 3 TIMES EACH WITH 10 SECOND INTERVALS. OTHERWISE, STARTING GEAR CAN BE BROKEN OR STARTER MOTOR CAN BURN. THESE CONDITIONS ARE NOT COVERED BY THE WARRANTY.
- ON MANUAL GENERATING SETS, NEVER START OR STOP THE DIESEL ENGINE WHEN THE GENERATING SET IS UNDER LOAD. ENGINE SHOULD BE STARTED AND STOPPED AFTER LOAD IS DISCONNECTED AND THE GENERATING SET IS AT IDLE CONDITION. OTHERWISE, THE VALVES CAN BE SEIZED, THE VOTAGE REGULATOR, TRANSFORMER AND DIODES CAN BE BROKEN DOWN. THESE CONDITIONS ARE NOT COVERED BY THE WARRANTY.
- OUR COMPANY DOES NOT TAKE THE RESPONSIBILITY OF THE DAMAGES ON THE MAINS SUPPLY CONTACTOR OF THE AUTOMATIC GENERATING SETS DUE TO OVERCURRENT, LOW OR HIGH VOLTAGE.
- NEVER REMOVE THE BATTERY TERMINALS WHILE THE GENERATING SET IS IN USE. EVEN A MOMENT OF DISCONNECTION CAN CAUSE A DAMAGE ON THE ELECTRONIC CLOSING RELAY OF THE CHARGE ALTERNATOR AND ON 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 GENERATING SET POWER (SUCH AS ALTERNATOR AND CONTACTOR FAILURES) ARE NOT COVERED BY THE WARRANTY.
- FAILURES DUE TO OVERLOAD AND UNBALANCED LOAD IN EXCESS OF THE GENERATING SET POWER (SUCH AS ALTERNATOR AND CONTACTOR FAILURES) ARE NOT COVERED BY THE WARRANTY.
- WHEN THE MANUAL GENERATING 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 COOLING FOR 10 MINUTES BEFORE STOPPING. OTHERWISE, PROBLEMS WHICH ARE LIKELY TO OCCUR WILL NOT BE COVERED BY THE WARRANTY.
- WARRANTY PERIOD IS 1 YEAR BEGINNING FROM THE PURCHASE DATE.

aksa POWER GENERATION

HEAD OFFICE

Aksa Jeneratör Sanayi A.Ş.
Gülbahar Caddesi 1. Sokak 34212
Güneşli, İstanbul - Turkey
Tel: +90 212 478 66 66
Fax: +90 212 657 55 16
E-mail: export@aksa.com.tr

FACTORIES

TURKEY
Gülbahar Caddesi 1. Sokak 34212
Güneşli, İstanbul - Turkey
Tel: +90 212 478 66 66
Fax: +90 212 657 55 11

TURKEY
Taşocağı Yolu No: 22 Mahmutbey
Bağcılar, İstanbul - Turkey
Tel: +90 212 446 43 01
Fax: +90 212 446 43 00

UNITED KINGDOM
Lister Petter Industrial Estate,
Church Road Cam
Dursley Glos, GL11 5PY - United Kingdom
Tel: +44 1453 549 223
Fax: +44 1453 549 227

BRANCH OFFICES & WAREHOUSES

ALGERIA
Aksa Algeria
20, Rue D'Anjou Hydra, Alger
Algeria
Tel : +213 21 60 81 48
Fax : +213 21 48 41 44
E-mail : aksaalgerie@aksa.com.tr

CHINA
Aksa China (Suzhou)
Zhongxin City, 128 Donghuan Road,
Room 706 Suzhou China 215021 P.R. China
Tel : +86 512 6725 1137
Fax : +86 512 6725 1317

DUBAI
Aksa Middle East
Post Box No 18167, Warehouse
No. RA08/LC07 Jebel Ali Free Zone, Dubai
United Arab Emirates
Tel : +971 4883 3292
Fax : +971 4883 3293
E-mail : sales@aksa.ae

IRAQ
Aksa Iraq
Sahet Al-Wathik, Al Wahda St. 909 Baghdad,
Iraq
Tel : +88 216 333 05 108
+88 216 677 42 506
E-mail: aksa_baghdad@yahoo.com

IRAN
Aksa Iran
Apartment 22, the 6th. Floor
Dasto Building, No: 1421 Vali-e-Asr Ave.
Tehran, Iran
Tel : +98 21 205 4212
+98 21 201 6502
Fax : +98 21 201 8921
E-mail : aksa@aksatehran.com

KYRGHYZISTAN
Aksa Central Asia Ltd.
40 Manas Str. Bishkek, Kyrghyz Republic
Tel : +996 312 21 17 79
Fax : +996 312 66 23 23
E-mail : aksaasia@elcat.kg

KAZAKHISTAN
Aksa Central Asia Kazakhstan Ltd.
111/48 Furmanova Str. Almaty, Kazakhstan
480091
Tel : +732 72 50 67 31 / 41
Fax : +732 72 50 67 91
E-mail : aksa@arna.kz

NIGERIA
Aksa Generators (W.A) Ltd.
90, Oduduwa Crescent,
Ikeja Gra, Lagos, Nigeria
Tel : +234 1 481 3121
Fax : +234 1 320 5681
E-mail : aksanigeria@yahoo.com

SINGAPORE
Aksa Far East Pte. Ltd.
94 Tuas Avenue 11 Singapore 639103
Tel : +65 6863 2832
Fax : +65 6863 0392 - 6863 2956
E-mail : aksafe@aksafareast.com.sg

UNITED KINGDOM
Aksa International (UK) Ltd.
Lister Petter Industrial Estate, Church Road Cam
Dursley Glos, GLII 5PY / United Kingdom
Tel : +44 1453 549 223
Fax : +44 1453 549 227
E-mail : sales@aksa-uk.com

www.aksa.com.tr