

10 KVA-2500KVA

DIESEL GENERATING SETS INSTALLATION RECOMMENDATIONS AND OPERATIONS MANUAL

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INSTALLATION RECOMMENDATIONS
AND
OPERATIONS MANUAL**

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1. INTRODUCTION

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 adjustment 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, frequency, power factor and weight of the generating set. These data are necessary in spare part orders, for warranty validity and for service calls.

laKsa		Gölköyler Cad. 1 Blok. Güneşli Sokak / İstanbul / Türkiye Tel: +90 212 478 69 60 Fax: +90 212 651 60 40 e-mail: aksa@aksa.com.tr http://www.aksa.com.tr	
MODEL	PRODUCT	SERIAL NO	
PRIME KVA		STANDBY KVA	
PRIME A		STANDBY A	
ALTERNATOR		ALTERNATOR	
WIND		WIND	
DIMENSIONS L W H		FUEL TANK CAPACITY L	
VOLTS		GROUP	
HZ	Core	WEIGHT kg	
PHASE	R.P.M		
		E14-003-12	

The generating set is designed to be safe when used in 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.

Only people that have the right skills should be allowed to operate, adjust, perform maintenance or repair on Aksa Power Generation equipment. It is the responsibility of management to appoint operators with the appropriate training and skill for each category of job.

Skill level 1 : Operator

An operator is trained in all aspects of operating the unit with the push- buttons, and trained to know the safety aspects.

Skill level 2 : Mechanical technician

A mechanical technician is trained to operate the unit the same as the operator. In addition, the mechanical technician is also trained to perform maintenance and repair, as describe in the instruction manual, and is allowed to change settings of the control and safety system. A mechanical technician does not work on live electrical components.

Skill level 3 : Electrical technician

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

Skill level 4: Specialist from the manufacturer

This is skilled specialist sent by the manufacturer or its agent to perform complex repairs or modifications to the equipment. In general it is recommended that not more than two people operate the unit, more operators could lead to un safe operating conditions. Take necessary steps to keep unauthorized person away from the unit and eliminate all possible source of danger at the unit.

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

2. GENERAL SAFETY PRECAUTIONS

2.1. GENERAL

1. The owner is responsible for maintaining the unit in a safe operating condition. Unit parts and accessories must be replaced if missing or unsuitable for safe operation.

2. Operate the unit only for the intended purpose and within its rated limits (pressure, temperature, speeds, etc.).

3. Gen-set and equipment shall be kept clean, i.e. as free as possible from oil, dust or other deposits.

4. To prevent an increase in working temperature, inspect and clean heat transfer surfaces (cooler fins, intercoolers, water jackets, etc.) regularly.

5. Take precautions against fire. Handle fuel, oil and anti-freeze with care because they are inflammable substances. Do not smoke or approach with naked flame when handling such substances. Keep a fire-extinguisher in the vicinity.

WARNING

! Read and understand all safety precautions 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 possibility 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 and 12 of this manual 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 base frame 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 vapors are explosive. Hydrogen gas generated by charging batteries is also explosive.

! **Never store flammable liquids near the engine.**

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

Hydrogen gas generated by charging batteries is also explosive.

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

! To avoid arcing keep grounded conductive objects (such as tools) a way from exposed live electrical parts (such as terminals). Sparks and arcing might ignite fuel or vapors.

! Avoid refilling 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 jewelers away from pulleys, belts and other moving parts.



Attention: Some moving parts cannot 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 dB(A). Prolonged exposure to noise levels above 85 dB(A) is hazardous to hearing.



WARNING

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

2.7. ELECTRICAL

Safe and efficient operation of electrical equipment can be achieved only if the equipments 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 regulations.

! Ensure that the generating set, including a mobile

set is effectively grounded/earthed in accordance with all relevant regulations prior 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 victim.

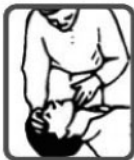
! If this is not possible, stand on dry insulating material and pull the victim clear of the conductor, preferably using insulated material such as dry wood.

! If victim is breathing, turn the 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

● Pinch the victim's nose firmly.

● Take a deep breath and seal your lips around the victim's lips.

● Blow slowly into the mouth watching for the chest to rise.

● Let the chest fall completely.

Give breaths at a rate of 10 per minute.

● If the victim must be left to get help, give 10 breaths first and then return quickly and continue.

● Check for pulse after every 10 breaths. When breathing restarts, place the victim into the recovery position described later in this section.

If no breathing and no pulse

● Call or telephone for medical help.



● Give two breaths and start chest compression as follows:

● Place heel of hand 2 fingers breadth above ribcage/ breastbone junction.



● Place other hand on top and interlock fingers.

● Keeping arms straight, press down 4-5 cm at a rate of 15 times per minute.



● Repeat cycle (2 breaths and 15 compressions) until medical help takes over.

● If condition improves, confirm pulse and continue with breaths.

Check for pulse after every 10 breaths.

● When breathing restarts, place the

victim into the recovery position described below.

2.9. Recovery position

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



WARNING

! Do not give liquids until victim is conscious.

3. GENERAL DESCRIPTION

3.1. Generating Set Description and Identification

Diesel-electric generating sets are independent units for the production of electric power; basically, they comprise a constant voltage synchronous generator driven by an internal - combustion, diesel - cycle engine.

The sets are used for two main purposes:

a-Continuous duty sets,

used to produce electric power for countless requirements (motive power, lighting, heating, etc) in areas where other sources of power are unavailable.

b-Emergency duty sets,

Used during public network failures, when such failures are liable to cause serious trouble to persons or material or financial damage (i.e. in hospitals, industrial plants with non-stop operating cycles, etc) or to meet peak energy demands.

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

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

The sets for use on land can be either :
-stationary sets (fixed installation), or
-mobile sets (mobile installation)

These two types of sets are available in a vast range of versions, for every operating requirement, the main ones being:

- 1.hand control generating sets
- 2.stand-by generating sets

The standard stationary generating set comprises:

- diesel engine
- synchronous generator
- coupling
- metal sub-base with vibration isolators
- starter batteries
- fuel tank within the bed-plate
- instrument panel
- exhaust gas silencer.

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 this 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. AC series generating sets are an Alternating Current generator, built for continuous running at sites where no electricity is available (some models are excepted) or as stand-by in case of interruption of the mains.

The generator operates at 230/220 V in line-to-neutral mode and 400/440 V in line-to-line mode. The AC series generating set is driven by a water-cooled diesel engine.

3.2. Generating Set Main Parts

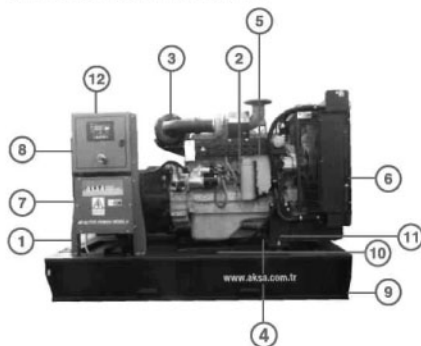


Figure 3.1. Typical generating set configuration

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

3.3.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. The engine cylinder block is cast in one piece cast iron, vertical cylinders inline overhead valves and camshaft in block or V- type, according to the type.

The cylinder heat is made of special cast iron. The thermally loaded flame plate is efficiently water cooled.

The crankshaft is forged in one piece in a high tensile steel.

Lubrication: forced lubrication via gear pump, special paper cartridge -type filters, lubricant cooling via heat exchanger on most versions.

3.4.Engine Electrical System

The engine electrical system is 12 volt 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.

3.5.Cooling System

The engine cooling system is water cooled. The water cooled system is comprised of a radiator (item 6) a pusher fan and thermostat. The alternator has its own internal fan to cool the alternator components.

3.6.Synchronous Alternator

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

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)

3.7.Coupling

Engine and alternator are firmly joined by a coupling cone that guarantees the proper assembly coaxiality Mono-support machines are also used a special flexible disk is used in place of a flexible coupling.

3.8. Fuel tank and Base frame

The engine and alternator are coupled together and mounted on a heavy duty steel base-frame (Item 9). This base frame includes a fuel tank (Item 10) with capacity of approximately 8 hours operation under variable loads. The tank is complete with filling cap and fuel level gauge and is connected by flexible joints to the intake piping and to the overflow piping containing fuel from the injector drain. High power gen-set's fuel tank is separate from gen-set.

3.9. 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 base frame.

Lubrication: forced lubrication via gear pump, special paper cartridge -type filters, lubricant cooling via heat exchanger on most versions.

3.10. Silencer and Exhaust system

Exhaust gases from the turbocharger are discharged toward atmosphere through a silencer. These should be vented as high as possible, and must be prevented from re-entering the engine via the charge air intake, or polluting the radiator fins.

It is important to note that the turbocharger nozzles must be always free of loads. Stainless steel exhaust compensator is delivered with generator set. Exhaust lines of different engines shall not be mixed in a common stack, but routed separately in individual ducts, enclosed in a chimney.

Suitable material is carbon steel sheet, and recommended calculation temperature is 525°C. Rain and condensate permanent draining shall be provided to prevent water entering the silencer and the engine. 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 system reduce the noise emission from engine and can direct exhaust gases to safe outlets.

The exhaust silencer is made of a carbon steel receiver containing sound attenuator and wave de-phasing system made of perforated steel sheet and

heavy rock wool. It is asbestos-free. The exhaust silencer is delivered in two configurations with an industrial attenuation and residential attenuation.

3.11. 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 15 of this manual provides detailed information on these systems and will aid in identification of the control system fitted on the generating set.

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 effective and safe installation of the generating set.

4.2.Canopies

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

4.3.Moving the Generating Set

The generating set base frame 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 base frame directly with fork. Always use wood between forks and the base frame to spread the load and prevent damage.

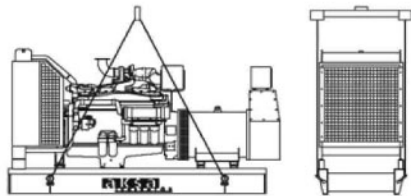


Figure 4.1. Lifting generating set by using a winch

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

In order to start to consider the possible layouts for a site, the following criteria must first be determined:

-The total area available and any restrictions within that area (i.e. buried or overhead services)

-A forced ventilation system is required for the equipment, which draws sufficient cooling and aspiration air into the room at the back of the alternator and discharges the air from in front of the engine. Dependent upon the layout of the building, it may be necessary to install additional ductwork to achieve the airflow required.

-The access into the building, initially for the delivery and installation of the equipment, and afterwards for servicing and maintenance of the equipment.

-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.

-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 around the set and at least 2 meters headroom above the set.

-Access to move the entire generating set into the room. Air inlet and outlet vents can often be made removable 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. Base and Foundation

Note: Special foundation are unnecessary. A level and sufficiently strong concrete floor is adequate. The responsibility for the foundation (including seismic considerations) should be placed with a civil or structural engineer specializing in this type of work.

Major functions of a foundation are to:

Support the total weight of the generating set.

Isolate generator set vibration from surrounding structures.

To support the structural design, the civil engineer will need the following details:

- the plant's operating temperatures

- the overall dimensions of the proposed foundation mass.

- the mounting and fixing arrangements of the generator bed-frame.

Concrete Foundations The foundation will require at least seven days between pouring the concrete and mounting the generating set to cure. It also essential that the foundation should be level, preferably within ± 0.50 of any horizontal plane and should rest on undisturbed soil.

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

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

t = thickness of foundation in m

k = net weight of set in kg

d = density of concrete (take 2403 kg/m³)

w = width of foundation in (m)

l = length of foundation in (m)

The foundation strength may still vary depending on the safe bearing capacity of supporting materials and the soil bearing load of the installation site, therefore reinforced gauge steel wire mesh or

reinforcing bars or equivalent may be required to be used.

Vibration Isolation

Each generating set is build as a single module with the engine and alternator coupled together through a coupling chamber with resilient mounting to form one unit of immense strength and rigidity. This provides both accuracy of alignment between the engine and alternator and damping of engine vibration. Thus heavy concrete foundations normally used to absorb engine vibration are not necessary and all the generator requires is a level concrete floor that will take the distributed weight of the unit.

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 base-frame.

Levelling

A poor foundation may result in unnecessary vibration of the plant.

4.6. Room Design Guidance Notes

4.6.1. Room size allowance

The dimensions as indicated A & B allow for good maintenance /escape access around the generator. Ideally you should allow a minimum distance of 1 meter from any wall, tank or panel within the room.

4.6.2. Inlet and outlet attenuators with weather louvers

The inlet and outlet attenuators should be installed within a wooden frame and are based on 100 mm. Airways with 200 mm. Acoustic modules. The attenuators should be fitted with weather louvers with a minimum 50 % free area, good airflow profile and afford low restriction airflow access.

The weather louvers should have bird/vermin mesh screens fitted on the inside, but these screens must not impede the free flow of cooling and aspiration air. The outlet attenuator should be connected to the radiator ducting flange with a heat and oil resistant flexible connection.

4.6.3. 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.

4.6.4. Exhaust systems

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

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

It is good installation practice for the exhaust system within the generator room to be insulated with a minimum of 50 mm. of high density, high temperature mineral insulation covered by an aluminium over clad. This reduces the possibility of operator burn injury and reduces the heat being radiated to the operating generator room.

4.6.5. Cooling and Ventilation

The engine, alternator and exhaust piping radiate heat which can result in a temperature high enough to adversely affect the performance of the 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.

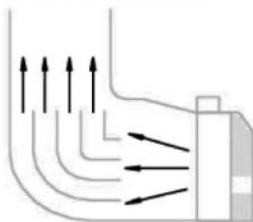


Figure 4.2. Directing the air thrown from the radiator with deviating wings

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.)

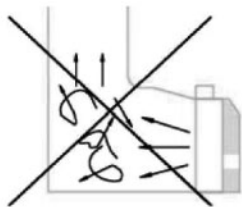


Figure 4.3. Weak ventilation

The air inlet and outlet openings should be large enough to ensure free flow of air into and out of the room. As 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 louvers 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 louvers 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 louvers are movable they must be automatically operated. They should be programmed to open immediately upon starting the engine.

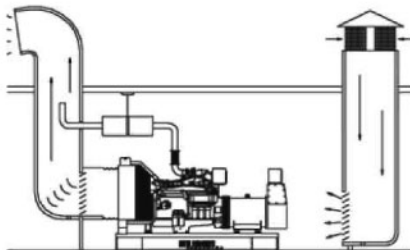


Figure 4.4. Air ventilation

4.6.6. Cable systems

The layout drawings assumes that the change-over, switch-gear is external to the generator room and located in the power distribution room. Specific project requirements can affect this layout.

The power output cables from the generator output breaker to the distribution panel must be of a

flexible construction.

The flexible power cables as installed should be laid up in trefoil, placed on support trays/ladder rack in the trench with the recommended inter-spacing and segregated from the system control cables.

The cables should be correctly supported and rated for the installation/ambient conditions.

The flexible single core power cables when entering any panel must pass through a non-ferrous gland plate.

4.6.7. Change - over panels

Should the change-over panel with in the generator room.

For change-over cubicles up to 400 Amp. rating the wall mounting panel of maximum depth 350mm. can be mounted directly above the cable trench in the side access area without causing too many problems. For change-over cubicles from 800 Amp. and above a floor standing panel is used which needs additional space to allocated. A minimum of 800 mm for rear access should be allowed.

4.6.8. Generator Sets

Up to 680 kVA generators include base fuel tanks. Free standing tanks can be provide but additional room space will required.

Canvas ducting between the radiator and ductwork or attenuator should be a minimum of 300 mm.

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

4.6.9. Doors

Doors should always open outwards. Make allowance for the generator to be moved into the room by using double doors at the attenuator space.

4.6.10. Inlet and outlet louvers

The inlet and outlet weather louvers should be installed within a wooden frame with a minimum 50 % free area, good airflow profile and low restriction airflow access.

The weather louvers should have bird/vermin mesh screens fitted on the inside, but must not impede the free flow of cooling and aspiration air.

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

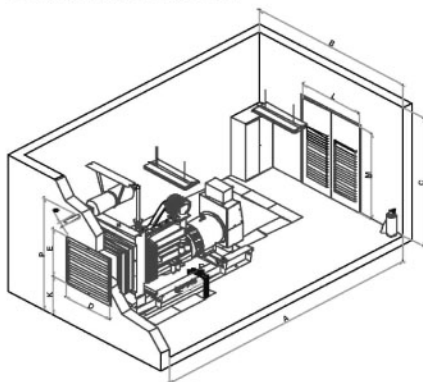


Figure 4.5. Generating set room

4.7 BELLOWS

The purpose of a flexible connection is to allow for engine displacement, to allow for thermal expansion of the system, to facilitate alignment of the engine with the pipes (exhaust, cooler), and prevent vibration transmission.

Some bellows with long bolts is same function, but the long bolts are used for adjusting bellows length and easy connection. For some generator sets, we need disassemble radiator or silencer system for shipment, but please make sure all the long bolts must be removed from generator sets after mounted in site.

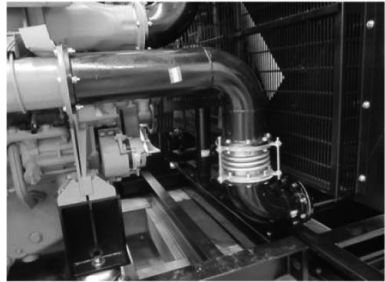

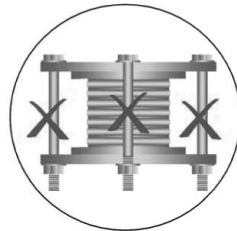


Figure 4.6 Bellows



 After the genset is installed in site, please make sure user must remove all long adjustment bolts of bellows before starting the genset.



Genset		Generating Set Dimensions(m)			Room Dimensions(m)			Radiator Hot Air/Outlet Openings Louvers			Air Inlet Openings Total Area	Room's Door Dimensions (m)		Exhaust	
Model	Stand By Power (KVA)	Length	Width	Height	A Length	B Width	C Height	D	E	K	M2	L	M	Diameter (inch)	P(m)
APD12MA	8.5	1.37	0.82	1.11	3.5	3	2.7	0.7	0.75	0.5	0.8	1.5	2.2	3	2
APD16MA	11	1.56	0.82	1.11	3.5	3	2.7	0.7	0.75	0.5	0.8	1.5	2.2	3	2
APD20MA	16.5	1.94	0.9	1.2	3.5	3	2.7	0.7	0.75	0.5	0.8	1.5	2.2	3	2
APD25MA	20	1.94	0.9	1.2	3.5	3	2.7	0.7	0.75	0.5	0.8	1.5	2.2	3	2
APD33MA	25	1.94	0.9	1.2	3.5	3	2.7	0.7	0.75	0.5	0.8	1.5	2.2	3	2
APD12A	11.5	1.37	0.82	1.11	3.5	3	2.7	0.7	0.75	0.5	0.8	1.5	2.2	3	2
APD16A	15.5	1.56	0.82	1.11	3.5	3	2.7	0.7	0.75	0.5	0.8	1.5	2.2	3	2
APD20A	20	1.94	0.9	1.2	3.5	3	2.7	0.7	0.75	0.5	0.8	1.5	2.2	3	2
APD25A	25	1.94	0.9	1.2	3.5	3	2.7	0.7	0.75	0.5	0.8	1.5	2.2	3	2
APD33A	33	1.94	0.9	1.2	3.5	3	2.7	0.7	0.75	0.5	0.8	1.5	2.2	3	2
APD40A	40	1.73	0.9	1.4	3.5	3	2.7	0.7	0.8	0.5	0.8	1.5	2.2	3	2
APD50A	50	1.73	0.9	1.4	3.5	3	2.7	0.75	0.8	0.5	0.8	1.5	2.2	3	2
APD70A	70	1.86	0.9	1.8	3.5	3	2.7	0.75	0.8	0.5	1	1.5	2.2	3	2
APD90A	93	2.15	1	1.58	4	3	2.7	0.8	0.9	0.5	1	1.5	2.2	3	2.2
APD125A	125	2.15	1.1	1.65	4	3	2.7	1.1	1	0.6	1	1.5	2.2	3	2.2
APD150A	150	2.15	1.1	1.65	4	3	2.7	1.1	1	0.6	1	1.5	2.2	3	2.2
APD250A	250	2.98	1.22	2.04	5	3.3	3	1.25	1.2	0.7	1.5	1.5	2.2	4	2.2
APD30C	30	1.86	0.9	1.25	3.5	3	2.7	0.75	0.8	0.5	0.8	1.5	2.2	3	2
APD43C	43	1.86	0.9	1.38	3.5	3	2.7	0.75	0.8	0.5	0.8	1.5	2.2	3	2
APD66C	66	1.86	0.9	1.45	3.5	3	2.7	0.75	0.8	0.5	0.8	1.5	2.2	3	2
APD119C	110	2.15	1	1.46	4	3	2.7	0.8	0.9	0.5	1	1.5	2.2	3	2.2
APD145C	145	2.27	1	1.46	4	3	2.7	0.8	0.9	0.5	1	1.5	2.2	3	2.2
APD175C	175	2.3	1.1	1.68	4	3	2.7	1.1	1	0.6	1.3	1.5	2.2	4.5	2.2
APD209C	200	2.3	1.1	1.68	4	3	2.7	1.1	1	0.6	1.3	1.5	2.2	4.5	2.2
APD220C	220	2.3	1.1	1.68	4	3	2.7	1.1	1	0.6	1.3	1.5	2.2	4.5	2.2
APD275C	275	2.9	1.15	1.97	5	3.3	3	1.25	1.2	0.7	1.5	1.5	2.2	4.5	2.3
APD339C	330	2.9	1.15	1.97	5	3.3	3	1.25	1.2	0.7	1.5	1.5	2.5	6	2.5
APD350C	350	2.9	1.15	1.97	5	3.3	3	1.25	1.2	0.7	1.5	1.5	2.5	6	2.5
APD385C	385	2.9	1.15	1.97	5	3.3	3	1.25	1.2	0.7	1.5	1.5	2.5	6	2.5
APD412C	412	2.9	1.15	1.97	5	3.3	3	1.6	1.8	0.5	3.6	1.5	2.5	6	2.5
APD440C	440	2.9	1.15	1.97	5	3.3	3	1.6	1.8	0.5	3.6	1.5	2.5	6	2.5
APD500C	500	3.4	1.6	1.97	5.5	3.5	3	1.6	1.8	0.5	3.6	1.7	2.6	6	2.5
APD550C	550	3.4	1.6	1.97	5.5	3.5	3	1.6	1.8	0.5	3.6	1.7	2.6	6	2.5
ACD550	550	3.4	1.6	1.97	5.5	3.5	3	1.6	1.8	0.5	3.6	1.7	2.6	6.5	2.5
APD610C	610	3.62	1.7	2.39	5.5	3.5	3.3	1.6	1.8	0.5	3.6	1.7	2.6	6	2.6
APD688C	688	3.62	1.7	2.39	5.5	3.5	3.3	1.6	1.8	0.5	3.6	1.7	2.6	6	2.6
AC703	700	3.62	1.7	2.39	5.5	3.5	3.3	1.6	1.8	0.5	3.6	1.7	2.6	2*6	2.6
APD825C	825	4.37	2.06	2.2	6.5	4	3.5	2.2	2	0.3	5	2.5	3	2*6	3
AC825	825	4.37	2.06	2.2	6.5	4	3.5	2.2	2	0.3	5	2.5	3	2*6	3
ACD881	880	4.37	2.06	2.2	6.5	4	3.5	2.2	2	0.3	5	2.5	3	2*6	3
APD888C	888	4.37	2.06	2.2	6.5	4	3.5	2.2	2	0.3	5	2.5	3	2*6	3
APD1000C	1000	4.37	2.06	2.2	6.5	4	3.5	2.2	2	0.3	5	2.5	3	2*6	3
APD1100C	1100	4.37	2.06	2.2	6.5	4	3.5	2.2	2	0.3	5	2.5	3	2*6	3
ACD1100	1100	4.37	2.06	2.2	6.5	4	3.5	2.2	2	0.3	5	2.5	3	2*6	3
APD1250C	1250	4.37	2.06	2.2	6.5	4	3.5	2.2	2	0.3	5	2.5	3	2*6	3
APD1375CS	1375	4.9	2.06	2.4	7.5	6	3.5	2.2	2	0.3	6	2.5	3	2*6	3
APD1375C	1375	4.9	2.06	2.4	7.5	6	3.5	2.2	2	0.3	6	2.5	3	2*6.5	3
AC1410	1410	4.9	2.06	2.4	7.5	6	3.5	2.2	2	0.3	6	2.5	3	2*6.5	3

Genset		Generating Set Dimensions(m)			Room Dimensions(m)			Radiator Hot Air Outlet Openings Louvers			Air Inlet Openings Total Area	Room's Door Dimensions (m)		Exhaust	
Model	Stand By Power (KVA)	Length	Width	Height	A Length	B Width	C Height	D	E	K	M2	L	M	Diameter (inch)	P(m)
APD1650C	1650	5.6	2.1	2.86	8	6	4	2.5	2	0.3	6	3	3.5	2×6.5	3
APD1675C	1675	5.6	2.1	2.86	8	6	4	2.5	2	0.3	6	3	3.5	2×6.5	3
AC1675	1675	5.6	2.1	2.86	8	6	4	2.5	2	0.3	6	3	3.5	2×6.5	3
ACQ2250	2250	5.95	2.55	3.1	10	8	5	2.5	2.5	0.3	12	6	4	2×10.5	3.5
APD10MM3	7.5	0.9	0.6	0.9	3.5	3	2.7	0.7	0.75	0.5	0.8	1.5	2.2	3	2
APD12MM	8.6	1.05	0.6	0.9	3.5	3	2.7	0.7	0.75	0.5	0.8	1.5	2.2	3	2
APD16MM3	11.5	1.05	0.6	0.9	3.5	3	2.7	0.7	0.75	0.5	0.8	1.5	2.2	3	2
APD16MM	12.1	1.15	0.6	0.9	3.5	3	2.7	0.7	0.75	0.5	0.8	1.5	2.2	3	2
APD21MM3	16.5	1.05	0.6	0.9	3.5	3	2.7	0.7	0.75	0.5	0.8	1.5	2.2	3	2
APD23MM	17.2	1.38	0.6	1	3.5	3	2.7	0.7	0.75	0.5	0.8	1.5	2.2	3	2
APD27MM3	22	1.15	0.6	0.9	3.5	3	2.7	0.7	0.75	0.5	0.8	1.5	2.2	3	2
APD33MM	25	1.48	0.7	1	3.5	3	2.7	0.7	0.75	0.5	0.8	1.5	2.2	3	2
APD10M3	10	0.9	0.6	0.9	3.5	3	2.7	0.7	0.75	0.5	0.8	1.5	2.2	3	2
APD12M	11.5	1.05	0.6	0.9	3.5	3	2.7	0.7	0.75	0.5	0.8	1.5	2.2	3	2
APD16M3	16	1.05	0.6	0.9	3.5	3	2.7	0.7	0.75	0.5	0.8	1.5	2.2	3	2
APD16M	16	1.15	0.6	0.9	3.5	3	2.7	0.7	0.75	0.5	0.8	1.5	2.2	3	2
APD21M3	21	1.05	0.6	0.9	3.5	3	2.7	0.7	0.75	0.5	0.8	1.5	2.2	3	2
APD23M	23	1.38	0.6	1	3.5	3	2.7	0.7	0.75	0.5	0.8	1.5	2.2	3	2
APD27M3	27	1.15	0.6	0.9	3.5	3	2.7	0.7	0.75	0.5	0.8	1.5	2.2	3	2
APD33M	33	1.48	0.7	1	3.5	3	2.7	0.7	0.75	0.5	0.8	1.5	2.2	3	2
APD42M	42	1.48	0.7	1	3.5	3	2.7	0.75	0.8	0.5	0.8	1.5	2.2	3	2
APD680M	680	3.55	1.5	1.65	5.5	3.5	3	1.6	1.8	0.5	3.6	1.7	2.5	9	2.6
APD737M	737	3.55	1.5	1.65	5.5	3.5	3	2.2	2	0.3	5	2.5	3	9	2.6
APD825M	825	3.95	1.715	2	6	3.5	3.3	2.2	2	0.3	5	2.5	3	9	3
APD1100M	1100	4.45	1.75	2.41	6.5	3.5	3.3	2.2	2	0.3	5	2.5	3	9	3
APD1425M	1425	4.67	1.9	2.5	9	5.5	4.2	2.5	2	0.3	7.5	3.5	3	12.5	3
APD1540M	1540	4.67	1.9	2.5	9	5.5	4.2	2.5	2	0.3	7.5	3.5	3	12.5	3
APD1650M	1650	4.92	2.19	2.5	9	5.5	4.2	2.5	2	0.3	7.5	3.5	3	12.5	3
APD1915M	1915	5.31	1.82	2.5	9	5.5	4.2	3	2.5	0.3	7.5	3.5	3	14	3
APD2100M	2100	5.65	2.25	2.5	9	5.5	4.2	3	2.5	0.3	7.5	3.5	3	14	3
APD2250M	2250	5.7	2.25	2.5	9	5.5	4.2	3	2.5	0.3	7.5	3.5	3	14	3
APD10MP	7.5	1.15	0.62	0.9	3.5	3	2.7	0.7	0.75	0.5	0.8	1.5	2.2	3	2
APD14MP	11	1.15	0.62	0.9	3.5	3	2.7	0.7	0.75	0.5	0.8	1.5	2.2	3	2
APD22MP	16.5	1.5	0.9	1.174	3.5	3	2.7	0.7	0.75	0.5	0.8	1.5	2.2	3	2
APD33MP	25	1.5	0.9	1.284	3.5	3	2.7	0.7	0.75	0.5	0.8	1.5	2.2	3	2
APD10PE	10	1.15	0.62	0.9	3.5	3	2.7	0.7	0.75	0.5	0.8	1.5	2.2	3	2
APD14PE	14	1.15	0.62	0.99	3.5	3	2.7	0.7	0.75	0.5	0.8	1.5	2.2	3	2
APD22PE	22	1.5	0.9	1.174	3.5	3	2.7	0.7	0.75	0.5	0.8	1.5	2.2	3	2
APD33P	33	1.5	0.9	1.284	3.5	3	2.7	0.7	0.75	0.5	0.8	1.5	2.2	3	2
APD50P	50	1.73	0.9	1.188	3.5	3	2.7	0.75	0.8	0.5	0.8	1.5	2.2	3	2
APD66P	66	1.73	0.9	1.188	3.5	3	2.7	0.75	0.8	0.5	0.8	1.5	2.2	3	2
APD72P	72	1.86	0.9	1.285	3.5	3	2.7	0.75	0.8	0.5	1	1.5	2.2	3	2
APD88P	88	1.86	0.9	1.285	3.5	3	2.7	0.8	0.9	0.5	1	1.5	2.2	3	2.2
APD110P	110	2.15	1	1.387	4	3	2.7	0.8	0.9	0.5	1	1.5	2.2	3.5	2.2
APD110PE	110	1.86	0.9	1.318	4	3	2.7	0.8	0.9	0.5	1	1.5	2.2	3	2.2
APD150P	150	2.296	1	1.466	4	3	2.7	1.1	1	0.6	1.3	1.5	2.2	3.5	2.2
APD165P	165	2.296	1	1.466	4	3	2.7	1.1	1	0.6	1.3	1.5	2.2	3.5	2.2
APD200PE	200	2.356	1.1	1.6	4	3	2.7	1.1	1	0.6	1.3	1.5	2.2	3.5	2.2

Genset		Generating Set Dimensions(m)			Room Dimensions(m)			Radiator Hot AirOutlet Openings Louvers			Air Inlet Openings Total Area	Room's Door Dimensions (m)		Exhaust	
Model	Stand By Power (KVA)	Length	Width	Height	A Length	B Width	C Height	D	E	K	M2	L	M	Diameter (inch)	P(m)
APD220PE	220	2.6	1.25	1.774	5	3.3	3	1.25	1.2	0.7	1.5	1.5	2.2	3.5	2.3
APD250PE	250	2.6	1.25	1.774	5	3.3	3	1.25	1.2	0.7	1.5	1.5	2.2	3.5	2.3
APD275PE	275	2.6	1.25	1.774	5	3.3	3	1.25	1.2	0.7	1.5	1.5	2.2	3.5	2.3
APD330PE	330	3.13	1.15	1.563	5	3.3	3	1.25	1.2	0.7	1.5	1.5	2.2	6	2.5
APD385PE	385	3.22	1.15	1.563	5	3.3	3	1.25	1.2	0.7	1.5	1.5	2.2	6	2.5
APD440PE	440	3.22	1.15	1.563	5	3.3	3	1.6	1.8	0.5	3.6	1.5	2.5	6	2.5
APD500PE	500	3.428	1.42	2.133	5.5	3.5	3	1.6	1.8	0.5	3.6	1.5	2.5	6	2.5
APD550PE	550	3.428	1.42	2.133	5.5	3.5	3	1.6	1.8	0.5	3.6	1.7	2.5	6	2.5
APD660P	660	3.4	1.536	2.161	5.5	3.5	3	1.6	1.8	0.5	3.6	1.7	2.5	8.5	2.6
APD715P	715	3.4	1.536	2.161	5.5	3.5	3	2.2	2	0.3	5	2.5	3	8.5	2.6
APD800P	800	4	1.8	2.3	6	3.5	3.3	2.2	2	0.3	5	2.5	3	2*6.5	2.6
APD900P	900	4	1.8	2.3	6	3.5	3.3	2.2	2	0.3	5	2.5	3	2*6.5	3
APD1100P	1100	4.655	2.05	2.3	6.5	3.5	3.3	2.2	2	0.3	5	2.5	3	2*6.5	3
APD1400P	1400	4.8	1.7	2.55	9	5.5	4.2	2.5	2	0.3	7.5	3.5	3	2*10	3.5
APD1650P	1650	5	2.2	2.55	9	5.5	4.2	2.5	2	0.3	7.5	3.5	3	2*10	3.5
APD1875P	1875	5	2.2	2.55	9	5.5	4.2	2.5	2	0.3	7.5	3.5	3	2*10	3.5
APD2250P	2250	5.8	2.25	2.9	9	5.5	4.2	3	2.5	0.3	7.5	3.5	3	2*10	3.5
APD2500P	2500	5.8	2.25	2.9	9	5.5	4.2	3	2.5	0.3	7.5	3.5	3	2*10	3.5
APD33L	33	1.5	0.9	1.284	3.5	3	2.7	0.75	0.8	0.5	0.8	1.5	2.2	3	2
APD47L	47	1.73	0.9	1.188	3.5	3	2.7	0.75	0.8	0.5	0.8	1.5	2.2	3	2
APD50L	50	1.5	0.9	1.188	3.5	3	2.7	0.75	0.8	0.5	0.8	1.5	2.2	3	2
APD80L	80	1.73	0.9	1.3	3.5	3	2.7	0.8	0.9	0.5	1	1.5	2.2	3	2
APD101L	101	2.15	1	1.387	4	3	2.7	0.8	0.9	0.5	1	1.5	2.2	3	2.2
APD110L	110	2.15	1	1.387	4	3	2.7	0.8	0.9	0.5	1	1.5	2.2	3	2.2
APD154L	154	2.296	1	1.466	4	3	2.7	1.1	1	0.6	1.3	1.5	2.2	3	2.2

5. FUEL SYSTEM

5.1.General

Dependent upon the specific site layout, the fuel can be supplied to the engine either from:

1. Directly from sub-base fuel tank located under the generating set.
2. An intermediate daily service tank located within the plant room or generator enclosure, which is automatically refilled from a bulk storage tank.
3. Directly from the bulk storage tank, provided that the outlet connection from this tank is at least 500 mm higher than the base on which the generator is mounted.

It is very important that the fuel oil purchased for use in any engine be as clean and water-free as possible. Dirt in fuel the fuel can clog injector outlets and ruin the finely machined precision parts in the fuel injection system. Water in the fuel will accelerate corrosion of these parts.

5.2.Fuel Oil Recommendations

The following fuel oil specification is typical
Fuel oil Recommended Physical Properties Specifications.

Viscosity (ASTM D445)	1.3 to 5.8 centi strokes (1.3 to 5.8 mm per second) at 40°C (104°F)
Cetane Number (ASTM D613)	40 Minimum above 0°C (32°F) 45 Minimum below 0°C (32°F)
Sulphur Content (ASTM D129 or 1552)	Not to exceed 0.5 mass percent
Water and Sediment (ASTM D1796)	Not to exceed 0.05 volume percent
Density (ASTM D287)	42 to 30° API gravity at 60°F (0.816 to 0.876 g/cc at 15°C)
Cloud Point (ASTM D287)	6°C (10°F) below lowest ambient temperature at which the fuel is expected to operate
Ash (ASTM D482)	Not to exceed 0.02 mass percent (0.05 mass percent with lubricating oil blending)
Acid Number (ASTM D664)	Not to exceed 0.1 Mg KOH per 100 ML
Lubricity	3100 grams or greater

Diesel Fuel Property Definition

Ash - Mineral residue in fuel. High ash content leads to excessive oxide build up in the cylinder and/ or injector. Cetane Number - Ignitability of fuel. The lower the cetane number, the harder it is to start and run the engine. Low cetane fuels ignite later and burn slower. This could lead to explosive detonation by having excessive fuel in the chamber at the time of ignition. In cold weather or with prolonged low loads, a higher cetane number is desirable.

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

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

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

Viscosity - Influences the size of the atomized droplets during injection. Improper viscosity will lead to detonation, power loss and excessive smoke. Fuels that meet the requirements of ASTM or 2.0 diesel fuels are satisfactory with fuel systems.

5.3. Base Fuel Tank

Up to 680 kVA generating sets can be supplied with or without base fuel tanks. and the room height allows for this feature.

Recommended room layout drawings incorporate base fuel tanks on the generators.

This provides a self contained installation without the additional of external fuel lines, trenches and fuel transfer pumps. Generators with base tanks are delivered fully connected and ready to run.

5.4. Bulk Storage Tanks

The purpose of the fuel-supply system is to store an adequate quantity of fuel to suit the application for which the system is intended. The bulk storage tanks should be sized accordingly.

The filling of the tanks will be by means of a fill connection housed in a suitable lockable cabinet located so as to permit easy access by delivery tanker. This cabinet may also house a contents gauge and an overfill alarm connected to the float switch inserted into a manhole on the tank.

5.5. Without Intermediate Fuel Tank (Fig. 5.1.)

The simplest arrangement would be to supply the engine directly from the bulk storage tank and return the injector spill directly to this tank. A typical arrangement for this is shown in Fig. 5.1. The principle limitations of this method are: In order to gravity feed the engine, the outlet from the bulk storage tank must be a minimum of 600 mm above the generator plinth level; The pressure drop of the spill return pipe must not exceed that detailed in the Engine Data sheet. The supply pipe work from the bulk storage tank to the engine must be sized to allow the total volume of fuel required by the engine to flow under gravity.

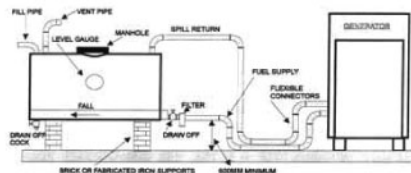


Fig. 5.1. Without Intermediate Fuel Tank

5.6. With Intermediate Fuel Tank (Fig. 5.2)

Where, due to site constraints, it is not possible to supply the engine direct from the bulk tank an intermediate tank can be located within the plant room/generator enclosure which supplies fuel directly to the engine.

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

1. An automatic duplex fuel transfer pump and primary filter system arranged to start the standby pump should the duty pump fail. The transfer pump(s) must be sized to cater for the total fuel required by the engine, i.e. fuel consumed and the spill return volumes (Fig. 5.2.);

2. A fusible link operated dead weight drop valve designed to cut off the supply of fuel to the intermediate tank and to transmit a signal in the vent of fire;

3. A fusible link operated dump valve, arranged to dump the contents of the local tank back into the bulk tank in the event of a fire within the generator enclosure.

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

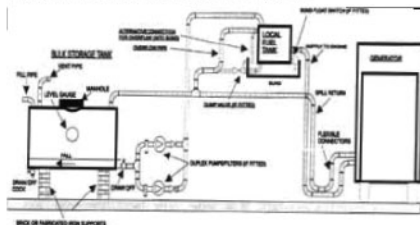


Fig. 5.2. With Intermediate Fuel Tank

5.7. Daily Service Fuel Tank

Separate daily service tank can be 500 litres, 1250 litres or 2000 litres and a transfer system arranged to automatically feed from the bulk storage tank electric motor driven pump(s) operating from signals from a level sensing float switch. Fuel tanks should not be made from galvanized iron as diesel fuel oil reacts against zinc.

A vent pipe should be extended to the highest point of the fuel system installation. The diameter of the pipe should at least match that of the fill connection. Provision should be made to prevent the ingress of dirt. The overflow from the daily service intermediate tank can either be:

1. Piped directly back to the bulk storage tank;
2. Piped into the bund of the intermediate tank with a bund level alarm system arranged to cut off the fuel transfer pump system on detection of a spillage;
3. Piped to overflow into the bunded area.

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

5.8. Determining Pipe Sizes

Minimum pipe sizes are determined by the size of the inlet to the fuel transfer pump. The pipe inner diameter must be at least as large as the transfer pump inlet. If the piping must carry the fuel over long distances, the pipe size must be increased. An auxiliary transfer pump at the tank outlet may also be needed to avoid high suction pressure within the piping. In all cases, excessive fuel line suction pressures must be avoided. At high suction pressures the fuel vaporize in the piping and the fuel supply to the engine will be decreased. When sizing piping, always remember to account for pressure drop across filters, fittings and restriction valves. A flex connector must be added to isolate the engine vibration from the fuel

piping. If this vibration is not isolated, the piping could rupture and leak. The flexible connector must be as close to the engine transfer pumps as possible. Any expanse of exposed piping must be properly supported to prevent piping ruptures. Use pipe hangers to isolate vibration from the system. Exposed fuel piping must never run near heating pipes, furnaces, electrical wiring or exhaust manifolds. If the area around the piping is warm, the fuel lines should be insulated to prevent the fuel and piping from picking up any excess heat. All pipes should be inspected for leaks and general condition, including cleanliness before installation. Back flush all lines to the tank before start-up to avoid pulling excess dirt into the engine and fuel piping system. After installation, the air should be bled from the fuel system. A petcock should included at some high point in the system to allow air removal.

Use plugged tees, not elbows, to make piping bends. This will allow for cleaning by removing the plugs and flushing out the lines. All threaded pipe fittings must be sealed with a suitable paste.

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

5.9. Fuel Return Lines

Fuel return lines take the hot excess fuel not used in the engine cycle a way from the injectors and back to either the fuel storage tank or the day tank. The heat from the excess fuel is dissipated in the tank.

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

The fuel return lines should always enter the storage or day tank above the highest fuel level expected. This statement is true for all Cummins powered engines with the PT fuel system (NT, K range). However with sets using the B series, C series engines drain lines for fuel will cause siphoning back through the supply line and result in hard starting if installed above the fuel level. The fuel return line should never be less than one pipe size smaller than the fuel supply line.

WARNING!

- The fuel must be clean and must not contain any water.

-Fuel pipes must best made of black pipe, not galvanized pipe.

-When the engine stops, there should not be any gravitational free flow in the fuel pipes towards of the engine.

-The fuel 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.

- In fuel system line, using the water filter separators will prevent the injectors and fuel pump and it is useful for healthy working of the engine.

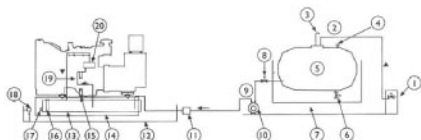


Figure 5.3. Typical fuel installation using a base tank fed from a bulk tank

1. Fill cabinet with overflow alarm and gauge
2. Tank fill line
3. Vent line
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. Electrical fuel shut off valve
12. Optional band
13. Day tank incorporated in base frame
14. Float Control switches
15. Manuel fill and vent
16. Level gauge
17. Drain
18. Leakage alarm unit (optional)
19. Fuel filter
20. Engine fuel pump

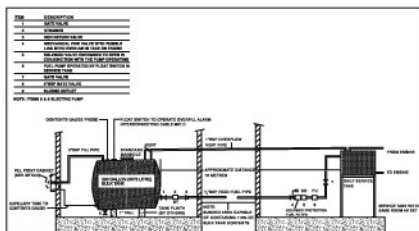


Figure 5.4. Suggested Installation for Bulk and Set Tanks

Generating Set Stand by Power	Maximum Fuel Pipe Length (m)	Maximum Vertical Height (m)	Maximum Pipe Fittings Quantity (m)	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"

Table 5.1 Recommendations for fuel piping

6. WATER TREATMENT

6.1.General

The engine cooling system is subject to rust and cavitation attacks. To minimize the severity of this condition an anti-corrosive agent can be added to totally clean and limpid coolant water.

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

6.2.Engine Coolant

Water for coolant should be clean and free from any corrosive chemicals such as chlorides, sulphates and acids. It should be kept slightly alkaline with a pH value in the range 8,5 to 10,5. Generally, any water which is suitable for drinking can be used, with treatment as described below. Protection against corrosion Supplemental Coolant Additive is required to protect the cooling system from fouling, solder blooming and general corrosion.

The use of antifreeze is also recommended as DCA4 concentrations are dependent upon the presence of antifreeze. Antifreeze also interacts with DCA4 to provide greater corrosion and cavitation protection.

Procedure for Treating Coolant

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

Cold Weather Protection

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

A 50% antifreeze / 50 % water mixture is recommended because DCA4 concentrations are dependent upon the presence of antifreeze. The dosage of DCA4 must be increased to higher

concentration if antifreeze is not added to the coolant. A low- silicate antifreeze is recommended.

6.3. Engine Warming

Where thermostatically controlled immersion heaters operating from the mains supply are fitted in cooling system these maintain the temperature of the coolant in cold weather.

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

7. EXHAUST SYSTEM

7.1.Sizing

An exhaust system should be designed to dispel the exhaust gases to atmosphere at the nearest convenient point in an installation. The length of the run and the number of changes in direction should be kept to a minimum to avoid exceeding optimum. The calculation of the effect on the back pressure is based upon the restriction through the straight lengths of pipe, the bends and the silencers. The smaller the bore of the pipe, the greater its length and the more times it changes its direction, the greater is its resistance to flow.

The back pressure limit for most Cummins engines is 3 ins Hg (76 mm Hg) Take an estimate of the size of the pipe by starting with the bore of the exhaust flange off the manifold and increasing the size by 1" for each 20 ft length or 3 x 90° bends.

7.2.Routing

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

A flexible bellows unit must be fitted on the engine connection to allow the engine to move on its mountings; If the silencer is to be located within the plant room, due to its physical size and weight need to be supported from the floor;

It may be necessary to install expansion joints at each change of direction to compensate for the thermal growth in the pipe during operation;

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

The primary silencer should be mounted as close as possible to the engine;

The termination point should not be directed at combustible materials/structures, into hazardous atmospheres containing flammable vapors, where there is a danger that the gases will re-enter the plant room through the inlet air vent, or into any opening to other buildings in the locality.

All rigid pipe work should be installed in such a manner that the engine's exhaust outlet is not stressed.

Pipes should be routed so that they are supported by fixtures to the building fabric or by existing structural steelwork where such methods are acceptable;

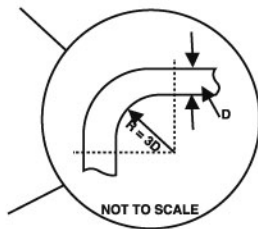


Fig. 7.1. Exhaust bend and radius

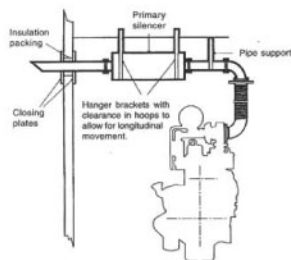


Figure 7.2. Exhaust System

8. LUBRICATING OIL

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

8.1. 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.

8.2. Lubrication Recommendations for Engine

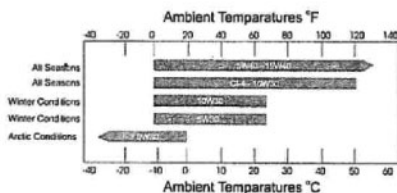
Aksa recommends that high quality multi grade SAE 15W/40 high service engine oil in diesel engines are used. At ambient temperatures above -15°C is 15W40.

The minimum API oil quality levels recommended for use is CH / CI-4, CH or CI-4 can be used in areas where CF4 oil is not yet available, but the oil interval must be reduced API CA, CB, CC, CD, CE, CG4 categories not recommended, do not use.

8.3. Lubricating oil replace

Normally lubricating oil changes according maintenance chat, but for new engine or overhauled engine, lubricating oil including oil filter need to be changed after running 50 hours.

Figure:8.1.Recommended SAE Oil Viscosity Grades v s Ambient Temperatures.



Genset			Fuel Consumption at full load (L/H)	Fuel Tank Capacity (L)	Coolant Capacity (L)	Oil Capacity (L)	Oil specification
Model	StandBy Power (KVA)	Engine Model					
APD12MA	8.5	A3CRX14	3.4	35	7	4.5	API CH/API CI-4/API CF4
APD16MA	11	A4CRX18	4.1	35	9	5	API CH/API CI-4/API CF4
APD20MA	16.5	A4CRX22	4.5	95	10	10	API CH/API CI-4/API CF4
APD25MA	20	A4CRX25	5.5	95	11	10	API CH/API CI-4/API CF4
APD33MA	25	A4CRX25T	6.75	95	11	10	API CH/API CI-4/API CF4
APD12A	11.5	A3CRX14	3.4	35	7	4.5	API CH/API CI-4/API CF4
APD16A	15.5	A4CRX18	4.1	35	9	5	API CH/API CI-4/API CF4
APD20A	20	A4CRX22	4.5	95	10	10	API CH/API CI-4/API CF4
APD25A	25	A4CRX25	5.5	95	11	10	API CH/API CI-4/API CF4
APD33A	33	A4CRX25T	6.75	95	11	10	API CH/API CI-4/API CF4
APD40A	40	A3CRX32T	10.0	145	16.5	14	API CH/API CI-4/API CF4
APD50A	50	A4CRX47	10.8	145	25	14	API CH/API CI-4/API CF4
APD70A	70	A4CRX46T	14.9	145	18	14	API CH/API CI-4/API CF4
APD90A	93	A4CRX46Ti	18.5	195	26	14	API CH/API CI-4/API CF4
APD125A	125	A6CRX65Ti	29.9	195	26	16	API CH/API CI-4/API CF4
APD150A	150	A6CRX69Ti	32.6	195	26	16	API CH/API CI-4/API CF4
APD250A	250	A6CRX98Ti	52.9	525	54	24	API CH/API CI-4/API CF4
APD30C	30	4B3.9-G2	6.7	145	19.2	10.9	API CH/API CI-4/API CF4
APD43C	43	4BT3.9-G2	9.3	145	19.2	10.9	API CH/API CI-4/API CF4
APD66C	66	4BTA3.9-G2	12.9	145	19.9	10.9	API CH/API CI-4/API CF4
APD110C	110	6BT5.9-G2	22	195	32.9	16.4	API CH/API CI-4/API CF4
APD145C	145	6BTA5.9-G2	30	195	34.4	16.4	API CH/API CI-4/API CF4
APD175C	175	6CTA8.3-G2	40	320	35.3	23.8	API CH/API CI-4/API CF4
APD200C	200	6CTA8.3-G2	40	320	35.3	23.8	API CH/API CI-4/API CF4
APD220C	220	6CTA8.3-G2	45.4	320	41.3	23.8	API CH/API CI-4/API CF4
APD275C	275	NTA11-G2A	53	420	42.9	39	API CH/API CI-4/API CF4
APD330C	330	NTA855-G1A	61	420	60.6	38.6	API CH/API CI-4/API CF4
APD350C	350	NTA855-G1B	68	420	60.6	38.6	API CH/API CI-4/API CF4
APD385C	385	NTA855-G2A	72	420	60.6	38.6	API CH/API CI-4/API CF4
APD412C	412	NTA855-G7	86	420	60.6	38.6	API CH/API CI-4/API CF4
APD440C	440	NTA855-G7A	100	420	60.6	36	API CH/API CI-4/API CF4
APD500C	500	KTA19-G3	111	850	66	50	API CH/API CI-4/API CF4
APD550C	550	KTA19-G4	122	850	75	50	API CH/API CI-4/API CF4

Genset			Fuel Consumption at full load (L/H)	Fuel Tank Capacity (L)	Coolant Capacity (L)	Oil Capacity (L)	Oil specification
Model	StandBy Power (KVA)	Engine Model					Not,Lubricating oil viscosity level will be chosen from table 8.1 according to the ambient temperature
ACQ 550	550	QXS 15 -G8	103	850	65.9	91	API CH/API CI-4/API CF4
APD610C	610	KTA19-G5	108	850	N/A	N/A	API CH/API CI-4/API CF4
APD688C	688	KTAA19-G6A	113	850	95	50	API CH/API CI-4/API CF4
AC 703	700	VTA 28 -G5	140	1000	166	83	API CH/API CI-4/API CF4
APD825C	825	KTA38-G2	167	1000	280	114	API CH/API CI-4/API CF4
AC 825	825	VTA 28 -G6	180	1000	166	83	API CH/API CI-4/API CF4
ACQ 881	880	QSK 23 -G3	161	1000	103	95.5	API CH/API CI-4/API CF4
APD888C	888	KTA38-G2B	125	900	199.5	135.1	API CH/API CI-4/API CF4
APD1000C	1000	KTA38-G2A	191	1000	280	114	API CH/API CI-4/API CF4
APD1100C	1100	KTA38-G5	209	1000	280	114	API CH/API CI-4/API CF4
ACQ 1100	1100	QST 30 -G4	202	1000	302	154	API CH/API CI-4/API CF4
APD1250C	1250	KTA38-G9	256	1000	336	135	API CH/API CI-4/API CF4
APD1375CS	1375	KTAA38-G9A	274	1000	210	114	API CH/API CI-4/API CF4
APD1375C	1375	KTA 50 -G3	261	1000	340	177	API CH/API CI-4/API CF4
AC 1410	1410	KTA 50 -G3	261	1000	340	177	API CH/API CI-4/API CF4
APD1650C	1650	KTA 50 -G8	290	1000	345	204	API CH/API CI-4/API CF4
APD1675C	1675	KTA 50 -G8	309	1000	345	204	API CH/API CI-4/API CF4
AC 1675	1675	KTA 50 -GS8	309	1000	315	204	API CH/API CI-4/API CF4
ACQ 2250	2250	QSK 60 -G4	394	1000	454	280	API CH/API CI-4/API CF4
APD10MM3	7.5	L2E-63SGH	2.7	30	1.2	2.9	API CH/API CI-4/API CF4
APD12MM	8.6	S3L2-63SG	3.1	38	1.8	4.2	API CH/API CI-4/API CF4
APD16MM3	11.5	L3E-63SGH	4.2	30	1.8	3.6	API CH/API CI-4/API CF4
APD16MM	12.1	S4L2-63SG	4.7	45	2.5	6	API CH/API CI-4/API CF4
APD21MM3	16.5	S3L2-63SGH	5.8	38	1.8	4.2	API CH/API CI-4/API CF4
APD23MM	17.2	S4Q2-63SG	6.1	80	4	6.5	API CH/API CI-4/API CF4
APD27MM3	22	S4L2-63SGH	7.8	45	2.5	6	API CH/API CI-4/API CF4
APD33MM	25	S4S-63SG	8.6	80	5.5	10	API CH/API CI-4/API CF4
APD10M3	10	L2E-63SGH	2.7	30	1.2	2.9	API CH/API CI-4/API CF4
APD12M	11.5	S3L2-63SG	3.1	38	1.8	4.2	API CH/API CI-4/API CF4
APD16M3	16	L3E-63SGH	4.2	30	1.8	3.6	API CH/API CI-4/API CF4
APD16M	16	S4L2-63SG	4.7	45	2.5	6	API CH/API CI-4/API CF4
APD21M3	21	S3L2-63SGH	5.8	38	1.8	4.2	API CH/API CI-4/API CF4
APD23M	23	S4Q2-63SG	6.1	80	4	6.5	API CH/API CI-4/API CF4
APD27M3	27	S4L2-63SGH	7.8	45	2.5	6	API CH/API CI-4/API CF4
APD33M	33	S4S-63SG	8.6	80	5.5	10	API CH/API CI-4/API CF4
APD42M	42	S4S-DT-63SG	10.4	80	5.5	10	API CH/API CI-4/API CF4
APD660M	660	S6R-PTA	90	890	50	100	API CH/API CI-4/API CF4
APD737M	737	S6R2-PTA	101.5	890	55	100	API CH/API CI-4/API CF4
APD825M	825	S6R2-PTAA	116.9	1000	55	94	API CH/API CI-4/API CF4
APD1100M	1100	S12H-PTA	161.2	1000	100	200	API CH/API CI-4/API CF4
APD1425M	1425	S12R-PTA	194.4	1000	125	180	API CH/API CI-4/API CF4
APD1540M	1540	S12R-PTA2	207.0	1000	125	180	API CH/API CI-4/API CF4

Genset			Fuel Consumption at full load (L/H)	Fuel Tank Capacity (L)	Coolant Capacity (L)	Oil Capacity (L)	Oil specification
Model	StandBy Power (KVA)	Engine Model					Not.Lubricating oil viscosity level will be chosen from table 8.1 according to the ambient temperature
APD1650M	1650	S12R-PTAA2	229.8	1000	125	180	API CH/API CI-4/API CF4
APD1915M	1915	S16R-PTA	254.2	1000	170	230	API CH/API CI-4/API CF4
APD2100M	2100	S16R-PTA2	286.1	1000	170	230	API CH/API CI-4/API CF4
APD2250M	2250	S16R-PTAA2	301.2	1000	170	230	API CH/API CI-4/API CF4
APD11MP	7.5	403D-11G	2.6	35	5.2	4.9	API CH
APD15MP	11	403D-15G	6.8	35	6	6	API CH
APD22MP	16.5	404D-22G	5.3	95	7	10.6	API CH
APD33MP	25	1103A-33G	7.1	82	10.2	8.3	API CH
APD10PE	10	403D-11G	2.6	35	5.2	4.9	API CH
APD14PE	14.4	403D-15G	6.8	35	6	6	API CH
APD22PE	22	404D-22G	5.3	95	7	10.6	API CH
APD33P	33	1103A-33G	7.1	82	10.2	8.3	API CH
APD50P	50	1103A-33TG1	10.7	82	10.2	8.3	API CH
APD66P	66	1103A-33TG2	13.9	82	10.2	8.3	API CH
APD72P	72	1104A-44TG1	14.8	145	13	8	API CH
APD88P	88	1104A-44TG2	18.7	145	13	8	API CH
APD110P	110	1006TG2A	21.8	195	27.7	16.1	API CH
APD110PE	110	1104C-44TAG2	22.6	145	12.6	8	API CH
APD150P	150	1006TAG	31.5	195	37.22	19	API CH
APD165P	165	1006TAG2	41	195	37.22	19	API CH
APD200PE	200	1106C-E66TAG44	40.2	320	21	16.5	API CH
APD220PE	220	1306C-E87TAG3	45.2	500	37.2	28.3	API CH
APD250PE	250	1306C-E87TAG4	48.5	500	37.2	28.3	API CH
APD275PE	275	1306C-E87TAG6	56.9	500	37.2	28.3	API CH
APD330PE	330	2206C-E13TAG2	84	525	47	68	API CH
APD385PE	385	2206C-E13TAG2	84	525	51.4	68	API CH
APD440PE	440	2206C-E13TAG3	92	525	51.4	68	API CH
APD500PE	500	2506C-E15TAG1	99	890	58	62	API CH
APD550PE	550	2506C-E15TAG2	106	890	58	62	API CH
APD660P	660	2806A-E18TAG1A	123	890	61	62	API CH
APD715P	715	2806A-E18TAG2	132	890	61	55.5	API CH
APD800P	800	4006-23TAG2A	161	1000	105	113.4	API CH
APD900P	900	4006-23TAG3A	172	1000	105	113.4	API CH
APD1100P	1100	4008TAG2A	226	1000	149	153	API CH
APD1400P	1400	4012-46TWG2A	266	1000	240	177.6	API CH
APD1650P	1650	4012-46TAG2A	342	1000	198	177.6	API CH
APD1875P	1875	4012-46TAG3A	380	1000	198	177.6	API CH
APD2250P	2250	4016TAG2A	447	1000	316	214	API CH
APD2500P	2500	4016-61TRG3A	473	1000	316	214	API CH
APD33L	33	1003G	7.2	82	17	8.1	API CH/API CI-4/API CF4
APD47L	47	1004G	11.2	82	21	8.1	API CH/API CI-4/API CF4
APD50L	50	1003TG	11.4	82	17	8.1	API CH/API CI-4/API CF4

Genset			Fuel Consumption at full load (L/H)	Fuel Tank Capacity (L)	Coolant Capacity (L)	Oil Capacity (L)	Oil specification
Model	StandBy Power (KVA)	Engine Model					Not: Lubricating oil viscosity level will be chosen from table 8.1 according to the ambient temperature
APD80L	80	1004TG	16.7	145	22.2	8.5	API CH/API CI-4/API CF4
APD101L	101	1006TG1A	20.9	195	27.7	16.1	API CH/API CI-4/API CF4
APD110L	110	1006TG2A	23.5	195	27.7	16.1	API CH/API CI-4/API CF4
APD154L	154	1006TAG	29	195	37.22	19	API CH/API CI-4/API CF4

Table 8.1. Fuel consumption and coolant, fuel and lubricating oil capacities and lubricating oil specifications.

9. ELECTRIC STARTING SYSTEMS

Electric starting systems are generally used on all gen-sets. The power source for electric starting systems is a 12 or 24 VDC battery system. The starting voltage is determined by engine size, 24 VDC being used for larger engines to reduce starting current and hence cable size. Control of starting is via a start solenoid which is controlled by the gen-set control system.

9.1. Battery Systems

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

9.2. 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 large quantities of water.

–Take out the metallic 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.

9.3. Battery Maintenance

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

9.4. 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.

9.5.Starting Aids

It is customary to maintain coolant temperatures above 40oC min. To promote quick starting on an emergency generating plant. Thermostatically controlled immersion heaters, deriving their supply from the primary source of power are fitted in the engine cooling system to provide this heating.

10. ELECTRICAL CONNECTION

Only full 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.

10.1. 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 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 given in table 10.1 and the cable cross sections which must be used according to the generating set power has been given in table 10.2. 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. The voltage drop across a cable can be determined as follows:

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

e = Voltage drop (V)

I = Rated current (A)

L = Length of conductors (m)

R = Resistance (Ω/km to VDE 0102)

X = Reactance (Ω/km to VDE 0102)

10.2.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)

10.3.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 over heating in the alternator windings, imbalance in the 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 existing distribution system, it may be necessary to reorganize the distribution system to ensure these loading factors are met.

10.4.Power Factor

The power factor (Cosφ) of the connected load should be determined. Power factors below 0,8 lagging (inductive) can over load 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 over voltages. Generally whenever the generating set is supplying the load any power factor correction equipment should be switched off.

Cable Section mm ²	Soil	25°C at Air		40°C at Air	
	Multiple Core	Multiple Core	Multiple Core	Multiple Core	HO07RN-F
2.5	36	25	22	25	21
4	46	34	30	33	28
6	58	44	38	42	36
10	77	60	53	57	50
16	100	80	71	76	67
25	130	105	94	101	88
35	155	130	114	123	110
50	185	160	138	155	138
70	230	200	176	191	170
95	275	245	212	228	205
120	315	285	248	267	245
150	355	325	283	305	271
185	400	370	322	347	310
240	465	435	380

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

10.5. 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.

10.6. 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 500 V Megger or similar instrument should be used.

Disconnect any earthing conductor connected between neutral and earth and megger an output terminal to earth.

Genset		Standby load Current at 400V (A)	Cable current capacity at 40°C (A)	Cable section Y V V Single core for each phase (mm2)
Model	StandBy Power (KVA)			
APD12MA	8.5	37	42	6
APD16MA	11	47.8	57	10
APD20MA	16.5	71.7	76	16
APD25MA	20	87	123	35
APD33MA	25	108.7	123	35
APD12A	11.5	16.6	25	2.5
APD16A	15.5	22.4	25	2.5
APD20A	20	28.9	23	4
APD25A	25	36	42	6
APD33A	33	47.6	57	10
APD40A	40	57.7	76	16
APD50A	50	72.2	76	16
APD70A	70	101	123	35
APD90A	93	134.2	155	50
APD125A	125	180.4	228	95
APD150A	150	216.5	267	120
APD250A	250	361	456	2*95
APD30C	30	43.3	57	10
APD43C	43	62	76	16
APD66C	66	95.3	123	35
APD110C	110	158.8	191	70
APD145C	145	209.3	267	120
APD175C	175	252.6	305	150
APD200C	200	288.6	382	2*70
APD220C	220	317.6	382	2*70
APD275C	275	396.9	456	2*95
APD330C	330	476.3	534	3*70
APD350C	350	505	610	2*150
APD385C	385	555.6	684	3*95
APD412C	412	594.6	684	3*95
APD440C	440	635.1	684	3*95
APD500C	500	721.6	915	3*150
APD550C	550	793.8	915	3*150
ACQ 550	550	793.8	915	3*150
APD610C	610	880.5	1068	4*120
APD688C	688	993.1	1220	4*150
AC 703	700	1010.2	1220	4*150
APD825C	825	1190.6	1335	5*120
AC 825	825	1190.6	1335	5*120
ACQ 881	880	1270	1525	5*150
APD888C	888	1281.8	1525	5*150
APD1000C	1000	1443.4	1830	6*150
APD1100C	1100	1587.8	1830	6*150

Genset		Standby load Current at 400V (A)	Cable current capacity at 40°C (A)	Cable section Y V V Single core for each phase (mm ²)
Model	StandBy Power (KVA)			
ACQ 1100	1100	1587.8	1830	6*150
APD1250C	1250	1804.3	2440	8*150
APD1375C	1375	1984.7	2440	8*150
APD1375CS	1375	1984.7	2440	8*150
AC 1410	1410	2035.2	2440	8*150
APD1650C	1650	2381.6	2745	9*150
APD1675C	1675	2417.7	2745	9*150
AC 1675	1675	2417.7	2745	9*150
ACQ 2250	2250	3247.7	3600	12*150
APD10MM3	7.5	32.6	42	6
APD12MM	8.6	37	42	6
APD16MM3	11.5	50	57	10
APD16MM	12.1	52.6	57	10
APD21MM3	16.5	72	76	16
APD23MM	17.2	75	123	35
APD27MM3	22	95.7	123	35
APD33MM	25	108.7	123	35
APD10M3	10	14.4	25	2.5
APD12M	11.5	16.6	25	2.5
APD16M3	16	23	25	2.5
APD16M	16	23	25	2.5
APD21M3	21	30.3	42	6
APD23M	23	33.2	42	6
APD27M3	27	39	42	6
APD33M	33	47.6	57	10
APD42M	42	60.6	76	16
APD660M	660	952.5	1220	4*150
APD737M	737	1063.6	1220	4*150
APD1000M	1000	1443.2	1830	6*150
APD1100M	1100	1587.7	1830	6*150
APD1425M	1425	2056.6	2440	8*150
APD1540M	1540	2222.5	2745	9*150
APD1650M	1650	2381.3	2745	9*150
APD1915M	1915	2763.7	3600	12*150
APD2100M	2100	3030.7	3600	12*150
APD2250M	2250	3247.7	3600	12*150
APD11MP	7.5	33	42	6
APD15MP	11	48	57	10
APD22MP	16.5	72	76	16
APD33MP	25	109	123	35
APD10PE	11	16	25	2.5
APD14PE	14.4	21	25	2.5
APD22PE	22	32	42	6

Genset		Standby load Current at 400V (A)	Cable current capacity at 40°C (A)	Cable section Y V V Single core for each phase (mm ²)
Model	StandBy Power (KVA)			
APD33P	33	48	57	10
APD50P	50	72	76	16
APD66P	66	95	123	35
APD72P	72	104	123	35
APD88P	88	127	155	50
APD110P	110	159	191	70
APD110PE	110	159	191	70
APD150P	150	217	267	120
APD165P	165	238	305	150
APD200PE	200	289	382	2*70
APD220PE	220	318	382	2*70
APD250PE	250	361	456	2*95
APD275PE	275	397	456	2*95
APD330PE	330	476	534	3*70
APD385PE	385	556	684	3*95
APD440PE	440	635	684	3*95
APD500PE	500	722	915	3*150
APD550PE	550	794	915	3*150
APD660P	660	953	1220	4*150
APD715P	715	1032	1220	4*150
APD800P	800	1155	1335	5*120
APD900P	900	1299	1525	5*150
APD1100P	1100	1588	1830	6*150
APD1400P	1400	2021	2440	8*150
APD1650P	1650	2382	2745	9*150
APD1875P	1875	2706	3012	10*150
APD2250P	2250	3248	3600	12*150
APD2500P	2500	3609	4270	14*150
APD33L	33	47.6	57	10
APD47L	47	67.8	76	16
APD50L	50	72.2	76	16
APD80L	80	115.5	123	35
APD101L	101	145.8	155	50
APD110L	110	158.8	191	70
APD154L	154	222.3	267	120

Table 10.2. Recommended single core cable cross

The insulation resistance should be in excess of 1MΩ to earth. Should the insulation resistance be less than 1MΩ winding must be dried out.

11. ACOUSTIC SILENCING

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

WARNING!

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

11.1.Exhaust Silencers:

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

11.2.Canopies:

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

11.3.Other Sound Attenuation:

For installation 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 reduced the noise levels of generating sets.

12.TOWING (Mobile Generating Sets)

12.1.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.

12.2.Towing:

Whenever towing a mobile generating set, remember that manoeuvrability and stopping distance will be affected by the e trailer.

WARNING

! When 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 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 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.

12.3.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 tent to roll downhill. Do not park the set on grades exceeding 158 .

13.STORAGE

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

13.1. 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.

13.2. 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 Section 10.6.

13.3. Battery Storage:

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

13.4. Generator sets

Long-term storage

The following describes how to store the genset in a non-operable condition for three months or more and in an operable condition for three months or more. If the engine has been left unattended for three months or more, the internal engine parts can rust that may cause damage to the engine. When storing the engine for an extended period of time, be sure to follow the directions below.

Storing genset in non-operable condition for 3 months or more Preparation for storage

1. Drain engine oil, and pour in rust-preventive oil into the engine.
2. Prepare a fuel mixture containing 50% rust-preventive oil, and fill the fuel tank with it.
3. Operate the genset at rated speed for 5 to 10 minutes under no load.
4. Immediately before stopping the engine, spray volatile.
5. With the genset stopped, drain the fuel mixture from the fuel tank.
6. Apply rust-preventive oil liberally on the exposed sections of the genset.
7. Seal air inlet, exhaust outlet, breather and other openings with an adhesive cloth tape.

8. Loosen V-belt of engine.

9. Disconnect cables from the battery terminals, and charge the battery. Clean the terminals, apply a thin coat of grease to the terminals, and store the battery in a cool and dry room.

10. Cover the entire genset.

Note:

- (a) Store the genset in a well-ventilated indoor area, and keep free of salty air which can cause rusty on mechanical parts easily.

- (b) No need to drain coolant since it contains LLC. (Add LLC to increase the concentration between 30 and 60%.)

- (c) Post a sign at an easily noticeable place to warn that the rust-preventive oil in the engine must be replaced with engine oil, and the fuel tank must be filled with fuel before operation the engine.

Maintenance during storage

Charge the battery once a month.

First, check the battery electrolyte for correct level and then charge the battery.

Using genset after storage

1. Remove the cover from the genset.
2. Connect a fully charged battery.
3. Adjust the tension of V-belt.
4. Remove sealing tapes from the openings of the engine.
5. Drain rust-preventive oil, and pour in appropriate engine oil.
6. Fill the fuel tank with fuel, and bleed the fuel system.
7. Inspect the entire genset.
8. Remove the rocker covers, and lubricate the valve mechanisms.

9. Shut off the fuel supply and crank the engine for about 10 seconds, and repeat this cranking 3 times at intervals of about 1 minute.

CAUTION

To crank the engine, shut off the fuel supply to the engine and operate the starters.

10. Make sure the engine oil pressure rises.

11. Start the engine.

12. Apply load and increase the engine speed to the rated speed.

Storing genset in operable condition for 3 months or more

When the genset is not operated during storage of three months or more, internal engine parts can rust and lose oil film. As a result, the engine can seize when it is started after storage. To prevent such a risk, the genset must be operated periodically during storage.

Operating genset for maintenance purpose

Operate the genset for maintenance purpose at least once a month as described below.

1. With fuel shut off (press the stop button in order to shut off fuel injection), operate the starters twice at intervals of about 15 seconds and check to see if the engine oil pressure increases.

2. After the genset starts, operate under no load for 5 to 10 minutes.

14. 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 day tank. Refill with fuel if it is low.

- Check the oil level on the dipstick. 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 opening the radiator tap. If it is inadequate add more water. Water level must be 30 mm lower than the water filling neck.

- Engine cooling water must include antifreeze according to the 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 air filter, if necessary.

- Keep the inlet opening open.

- Make sure that the generating set can easily take air from the 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 for maintenance type battery. 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.

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.

15. GENERATING SET CONTROL SYSTEMS




To control and monitor the generating set, an electronic control system has been used. DSE6020 model control system is fitted from 10 kVA to 250 kVA. DSE7320 control system is fitted from 250 kVA to 2500 kVA. 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 critical condition arising such as low oil pressure or high engine temperature.


15.1. DSE6020, Control System with Automatic Mains Failure

DSE, model 6020 module controls generating set system. Module has been designed to monitor the mains (utility) supply.


15.1.1. Operation

Manual Mode of Operation

This mode activated by pressing the  push button. A LED indicator beside the button confirms this action. Press the button  to begin the start sequence (There is no Start Delay in this mode of operation). After the fuel solenoid is energized, then the starter motor is engaged. The engine is cranked for 10 sec. If the engine fails to fire during this cranking attempt then the starter motor is disengaged for 10 sec. This sequence should continue beyond the 3 cranking attempts, the start sequence will be terminated and Fail to Start  fault will be displayed. When the engine fires, the starter motor is disengaged and locked out. Delayed alarms (under speed, low oil pressure etc) will be monitored after the end of the Safety On delay.


The generator will continue to run on load regardless of the state of the mains supply. If Auto mode is selected, and the mains supply is healthy then the Remote Stop Delay Timer begins, after which the load is transferred to the mains. The generator will then run off load allowing the engine a cooling down period. Selecting stop  de-energises the fuel solenoid, bringing the generator to a stop.

Automatic Mode of operation


This mode is activated by pressing the  push button. A LED indicator beside the button confirms this action.

Should the mains (utility) supply fail outside the configurable limits for longer than the period of the delay start timer, the mains healthy indicator will extinguish.

Additionally, while in AUTO mode, the remote start input is monitored. Whether the start sequence is initiated by mains failure or by remote start input, the following sequence is followed: To allow for short term mains supply transient conditions or false remote start signals, the start delay timer is initiated. After the Fuel Solenoid is energized, then 1/2 second later, the starter motor is engaged.




The engine is cranked for 10 second. If the engine fails to fire during this cranking attempt than the starter motor is disengaged for 10 second. Should this sequence continue beyond the 3 cranking attempts, the start sequence will be terminated and Fail to Start  fault will be displayed. When the engine fires, the starter motor is disengaged and locked out. Delayed alarms (under speed, low oil pressure etc) will be monitored after the end of the Safety On Delay.

If the remote start is being used and has been configured to Remote Start is on load, or the mains failed, the load will be transferred to the generator.

On the return of the mains supply, the Stop delay timer is initiated, once it has timed out, the load is transferred back to the mains (utility). The cooling timer is then initiated, allowing the engine a cooling down period (180 sec) off load before shutting down. Once the cooling timer expires the fuel solenoid is de-energised, bringing the generator to a stop. Selecting Stop  de-energises the fuel

solenoid, bringing the generator to a stop.

Test Mode of Operation

This mode is activated by pressing the  push button. A LED indicator beside the button confirms this action. Press the  button to begin the test sequence. After the Fuel Solenoid is energised, then 1/2 second later, the Starter Motor is engaged. The engine is cranked for 10 second. If the engine fails to fire during this cranking attempt then the starter motor is disengaged for 10 second. Should this sequence continue beyond the 3 cranking attempts, the start sequence will be terminated and Fail to Start!  fault will be displayed.

When the engine fires, the starter motor is disengaged and locked out. Delayed alarms (under speed, low oil pressure etc) will be monitored after the end of the Safety On delay. The load will be transferred to the generator and the set will run on load until Auto mode is selected or Stop is pressed.


Selecting Stop  de-energises the fuel solenoid, bringing the fuel solenoid, bringing the generator to a stop.








Figure 15.1. DSE model 6020 Control Module

15.2. DSE7320, Control System with Automatic Mains Failure



DSE, model 5220 module controls generating set system. Module has been designed to monitor the mains (utility) supply.

15.2.1. Operation Manual Mode of 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  not affected by panel lock.

To initiate a start sequence in Manual press the  pushbutton. When (the controller is in manual button) pressing the Start  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.




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 stabilize without triggering the fault.


The generator will run off load, unless the mains supply fails or a Remote Start signal is applied.

If Close generator has been selected as a control source, the appropriate auxiliary output will then activate.

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  bringing the generator to a stop.

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 instruments  and event logs  is not affected by panel lock.


This mode is activated by pressing the  push button. A LED indicator beside the button confirms this action.


Should the mains (utility) supply fall outside the configurable limits for longer than the period of the mains transient delay timer, the mains (utility) available Green indicator LED extinguishes. Additionally, while in AUTO mode, the remote start input (if configured) is monitored. If active, the Remote Start Active indicator illuminates (if configured)

Whether the start sequence is initiated by mains (utility failure) or by remote start input, the follow sequence is followed:

After the start 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.



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.

If an auxiliary output has been selected to give a load transfer signal, this would then activate.



On the return of the 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 Transfer signal is de-energised, removing the load. The Cooling timer expires the Fuel Solenoid is de-energised, bringing the generator to a stop.

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  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.

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 continue to run on load regardless of the state of the mains supply or remote start input until the Auto mode is selected.


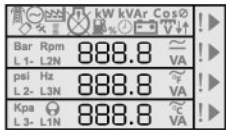
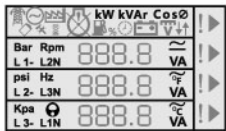
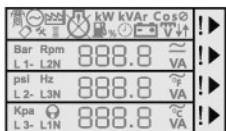
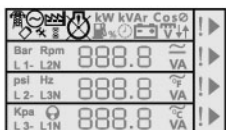
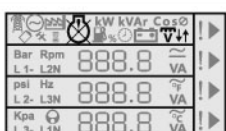








If Auto mode is selected, and the mains supply is healthy with the remote start on load signal not active, then the Remote Stop Delay Timer begins, after which the load is disconnected. The generator will then run off load allowing the engine a cooling down period. Selecting Stop  de-energises the fuel solenoid, bringing the generator to a stop.



Figure 15.2. Description of Controls on DSE 7320 Control Module

15.2.2 LCD Display Areas

Instruments Values	Instruments Values		
Display information units of measure	Display information units of measure		
User Configurable icons	User Configurable icons		
Status icons	Status icons		
Alarm icons	Alarm icons		
Manually Selecting an Instruments	Initial display (Hz/RPM)		 Rpm 1500  Hz 50.0
	Pressing the DOWN button the LCD will then show (Generator L-N voltages)	▼	 L1- N 229.2 V  L2- N 231.5 V  L3- N 235.7 V
	Pressing the DOWN button the LCD will then show (Generator L-L voltages)	▼	 L1- L2 397.0 V  L2- L3 401.0 V  L3- L1 408.3 V

15.3. ICONS and LCD IDENTIFICATION

15.3.1. Push Buttons

Display	Description	Display	Description	Display	Description
	Stop/Reset		Configure		Atue mode
	Scroll		Test mode		Start (when in Manual or Test mode)
			Manual mode		

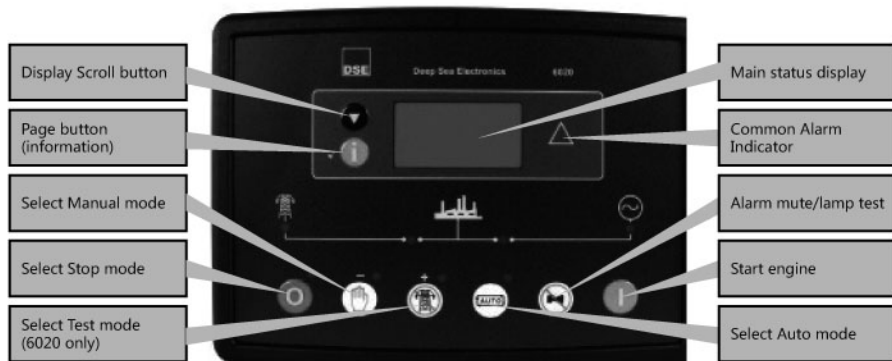
15.3.2. Starts/Masurement Units

Display	Description	Display	Description	Display	Description
L1	Phase	L2	Phase	L3	Phase
L1 - N	Phase-Neutral	L2 - N	Phase-Neutral	L3 - 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 Rum	~	AC		Generator
	Timer in progress		DC		Mains (Utility)
	Configuration mode active		Fuel level		Event log
	Panel locked by configurable input				

15.3.3. Alarm Indications

Display	Description	Display	Description	Display	Description
	Warning Alarm		Shutdown Alarm		Electrical Trip
	Fuel		Low Oil Pressure		High Current Warning
	Charge Fail		High Coolant Temperature		Over Voltage(AC)
	Emergency Stop		Fail to start(Over-crank)		Under Voltage(AC)
	Over Voltage (DC)		Over-speed		Over frequency
	Under Voltage(DC)		Under-speed		Under frequency
	Auxiliary Indication		Auxiliary Alarm (Warming or Shutdown)		

DSE6020



DESCRIPTION

DSE6020 is an Auto Mains (Utility) Failure Control Module for single gen-set applications. Both modules have been designed to work with electronic and non electronic engines providing advanced engine monitoring and protection features.

The modules include a backlit LCD display which clearly shows the status of the engine at all times. They monitor, speed, frequency, voltage, current, oil pressure, coolant temperature and fuel level.

The modules have also been designed to display the warning and shutdown status of the engine.

Both modules include seven inputs and six outputs. Four outputs are configurable on the magnetic pick-up version and six are configurable on the CANbus version. The modules can either be programmed using the front panel or by using the DSE Configuration Suite PC software.

CONFIGURATION

The modules can be configured using the front panel or by remote PC using a USB connection lead and the DSE Configuration Suite PC software.

FEATURES

- CAN and magnetic pick-up versions (specify on ordering)
- PC and front panel configurable
- 4digital inputs/3 analogue inputs
- 6outputs(4 configurable on Magnetic Pick-Up, 6 configurable on CANbus version)
- 3Phase generator and mains (utility) voltage monitoring (mains on DSE6020 only)
- Event log (5) events
- Configurable timers
- Automatic shutdown or warning when fault conditions are detected
- Remote start on or off load
- Engine pre-heat
- Advanced metering capability

- Engine hours counter
- Red LED indicator for warning or shutdown
- Icon LCD Display
- Protected Solid State Outputs(PSS)

BENEFITS

- Transfer between mains (utility) and generator power (DSE6020) only
- Hours counter provides accurate information for monitoring and maintenance periods
- User-friendly set-up and button layout
- Multiple engine parameters are monitored simultaneously
- Module can be configured to suit individual applications
- Wide range of engines can be specified
- Uses the DSE Configuration Suite PC Software for simplified programming
- IP65 rating offers advanced resistance to water ingress when gasket is filled
- License free PC software

OPERATION

Manual Mode

- The engine is started using the HAND button and the Start button on the front of the module.
- Once pressed the module instructs the engine to initiate its pre-heat sequence and then start the engine.
- To stop the engine the stop button on the front of the module is pressed.

Automatic Mode

- The Auto button is pressed to put the unit in Auto Mode.
- The module start sequence is initiated by the activation of the remote start input or mains failure.

●The pre-heat sequence is then initiated and the engine is started.

●To stop the engine the remote start signal is removed or the Stop button on the module is pressed .

●AMF function.

16. 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 control module LCD display. Check the engine temperature and oil pressure. 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 control module LCD display. Check the voltage , if the voltage between phases is 400 V. and between phase and neutral is 230 V. Check that the frequency is 51 - 52 Hz on generating sets with mechanical governors and 50 Hz on generating sets with electronic governors.

●If an engine block water heater is not available, run the generating set at no-load for 8 minutes and when the engine warm then apply on load (for manual models)

Apply load to the generating set as follows:

●Set the alternator outlet circuit breaker on the panel to ON position.

●Set the load circuit breakers (or fuses) on the distribution panel to ON position one by one. This way, the generating set cannot be suddenly put under full load. Otherwise, the engine stalling or alternator winding insulation of formation or burning can occur.

●Set the alternator outlet circuit breaker on the circuit to OFF position before stop the generating set.

●Continue to run the unloaded engine for purpose of cooling period for 5 minutes and then stop.

●Never operate the generating set before removing any fault, if any.

WARNING

Attention:

Our genset cannot run under less than 25% load for a long time. because inside engine, some parts use pressure for seal, such as between cylinder liner and piston and piston ring, between supercharger and supercharger rotor axle. For this kind of seal, when engine has about 1/3 load, which will fully come into play. And under this load, there will be followed failures:

1.Seal between piston and cylinder liner is poor, oil will go up and into combustor, and exhaust will emit blue smoke.

2.As for supercharged diesel gen-sets, because of under low load, no load, low supercharging pressure, it will easily cause the sealing effect(using pressure to seal) of supercharger oil seal(non-contact) to decrease, then oil will go into supercharging chamber and then goes into cylinder together with inlet air.

3.A part of oil which goes into cylinder will take part in combustion, another part of oil cannot combust fully and will form carbon deposit at air valve, air inlet passage, piston top, piston ring and other places. And other part of oil will go out with exhaust air and form carbon deposit at exhaust pipe. When accumulated oil and carbon deposit are to some extent, they will drip from connector of exhaust manifold.

4.When oil in supercharging chamber of supercharger is accumulated to some extent, it will leak form junction of supercharger.

5.If gen-set runs under load for a long time, it will cause its moving parts to have serious abrading and engine combustion environment will worsen, finally it will cause overhaul ahead of time. So overseas diesel gen-set manufacturers always emphasize to make gen-set not to run under low load or no load as less time as possible. And it is ruled that the smallest load cannot be less than gen-set rated power 25% - 30%.

17. CONTROL PANELS

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

17.1. Control System DSE 6020 Panel Specifications

Equipments:

- DSE 6020, Automatic Mains Failure module
- Static battery charger
- Emergency stop push button

DSE 6020 Module Features

- To monitoring AC mains supply
- Automatic controls generating set, start and stop
- Provide signal to change over switch
- Scrolling digital LCD display
- Front panel configuration of timers and alarm trip points
- Easy push button control

STOP/RESET - MANUAL - AUTO - TEST - START

Metering via LCD display

- Generator Volt (L - N)
- Generator Ampere (L1, L2, L3)
- Generator Frequency (Hz)
- Mains Volt (L - L / L - N)
- Engine cooling temperature
- Engine oil pressure
- Engine speed
- Engine hours run
- Engine battery volt

Alarms

- Over current
- Over speed
- Under / Over mains volt
- Under / Over mains frequency
- Low oil pressure
- High engine temperature
- Low battery volt

- Charge fail
- Start failure
- Emergency stop

LED indication

- Mains available
- Mains on load
- Generator available
- Generator on load

17.2. Control System DSE 7320

Equipments:

- DSE 7320, Automatic Mains Failure module
- Static battery charger
- Emergency stop push button

DSE 7320 Module Features

- To monitoring AC mains supply
 - Automatic controls generating set, start and stop
 - Provide signal to change over switch
 - Scrolling digital LCD display
 - Remote communication via RS232 port or RS 485 mod bus output.
 - Event logging of shutdown alarms.
 - Front panel configuration of timers and alarm trip points
 - Easy push button control
- STOP/RESET - MANUAL - AUTO - TEST - START

Metering via LCD display

- Generator Volts (L-L / L - N)
- Generator Ampere (L1, L2, L3)
- Generator Frequency (Hz)
- Generator kVA
- Generator kW
- Generator Cos
- Mains Volt (L - L / L - N)
- Mains Frequency (Hz)
- Engine cooling temperature (°C & °F)
- Engine oil pressure (PSI & Bar)
- Engine speed (RPM)
- Engine hours run
- Plant battery volt

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

7320 control module maintains a log the last 15 shutdown alarms to enable the operator or engineer to view the past alarms history.

18. THE PLACEMENT AND INTALLATION 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, breakers will open more easily. There must be enough working place around the transfer switch.
- Having breaker between the generating set and the transfer switch is optional. Current from the generating set must be distributed equally to the three phase if possible.
- Current from one phase should not exceed the nominal current.

- If the transfer switch panel is apart from the generating set, transfer switch must be placed as close possible to the distributor panel.
- In this case power cables are drawn from generating set, mains panel and emergency power panel. Furthermore 8x2,5 mm² control cable must be drawn from the generating set control panel.

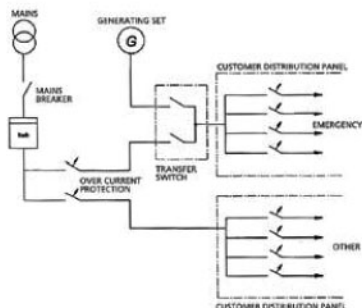


Figure 18.1 Typical emergency power system installation

19. ENGINE TROUBLESHOOTING

The star ter motor turns the engine too slowly:

- Battery capacity to low
- Bad electrical connection
- Faulty in starter motor
- Wrong grade of lubricating oil

The engine does not start or difficult to start:

- Starter motor turns engine too slowly
- Fuel tank empty
- Faulty in fuel control solenoid
- Restriction in a fuel pipe
- Faulty in fuel lift pump
- Dirty fuel filter element
- Air in fuel system
- Faulty in atomisers
- 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
- Faulty in fuel lift pump

- Dirty fuel filter element
- Air in fuel system
- Restriction air filter/cleaner or induction system
- Restriction in exhaust pipe
- Fault in atomisers or atomisers of an incorrect type
- 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
- Faulty in fuel lift pump
- Dirty fuel filter element
- Air in fuel system
- Fault in atomisers or atomisers of an incorrect type
- Fault in cold start system
- Engine temperature is too high
- Incorrect valve tip clearances

The pressure of the lubrication 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 valve 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
- In correct valve 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:

- Faulty 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
- In correct valve tip clearances

The engine runs erratically:

- Fault in fuel control
- Restriction in a fuel system
- Faulty 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
- In correct 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
- Faulty in engine mounting or flywheel housing

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 passage of radiator
- Insufficient 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:

- Bad connection towards oil pressure switch/coolant temperature switch

20. MAINTENANCE CHART

SYSTEM	MAINTENANCE MODEL	MAINTENANCE CONTENTS	DAILY or every 20 hours	WEEKLY	MONTHLY	3 MONTHS or 100 hours	6 MONTHS or 200 hours	12 MONTHS or 800 hours	24 MONTHS or 2000 hours
Lubrication system *	Check	Any leakage	✓	✓	✓	✓	✓	✓	✓
		Lube-oil level	✓	✓	✓	✓	✓	✓	✓
	Replace	Engine oil pressure	Every 12 months						
		Lube-oil filter					✓	✓	✓
		Lube-oil and Lube-oil filter	Oil and oil filter need to be changed for first 50 hours for new or overhauled engine						
Cooling System	Check	Breather of crankcase	Every 12 months						
		Any leakage	✓	✓	✓	✓	✓	✓	✓
		Any blocks of radiator			✓	✓	✓	✓	✓
		Pipes and connectors			✓	✓	✓	✓	✓
		Coolant level		✓	✓	✓	✓	✓	✓
		Antifreeze and anticorrosive			✓	✓	✓	✓	✓
		Strap and it's degree of tightness				✓	✓	✓	✓
		Fan Driver and water pump				✓	✓	✓	✓
	Add	Belt and fan driver of radiator (Optional for Remote pulley type radiators)	Every 250 hours						
		Lubricator of fan driver (Optional for Remote pulley type radiators)	500 hours						
Air induction system	Check	Coolant	Every 12 months						
		Cooling system	Every 12 months						
		Air induction			✓	✓	✓	✓	✓
	Replace	Air filter		✓	✓	✓	✓	✓	✓
		Pipes and connectors			✓	✓	✓	✓	✓
Fuel system	Check	Air filter core				✓	✓	✓	✓
		Any leakage	✓	✓	✓	✓	✓	✓	✓
		Fuel level		✓	✓	✓	✓	✓	✓
		Nozzle of fuel pump				✓	✓	✓	✓
	Clean	Pipes and connectors				✓	✓	✓	✓
		Fuel pump			✓	✓	✓	✓	✓
	Adjust	Drain fuel tank			✓	✓	✓	✓	✓
Exhaust system	Check	Drain water separator				✓	✓	✓	✓
		Fuel filter				✓	✓	✓	✓
		Nozzle and valves				✓	✓	✓	✓
Electrical system	Check	Fuel injection timing	Every 12 months						
		rocker and valve				✓	✓	✓	✓
		Any leakage			✓	✓	✓	✓	✓
		Exhaust restriction			✓	✓	✓	✓	✓
		Exhaust bolting			✓	✓	✓	✓	✓
		Charger alt. strap and it's degree of tightness			✓	✓	✓	✓	✓
Others	Check	Battery		✓	✓	✓	✓	✓	✓
		Specific gravity of electrolyte		✓	✓	✓	✓	✓	✓
		Switch and alarm		✓	✓	✓	✓	✓	✓
		Connector of start motor				✓	✓	✓	✓
		Starter	Every 12 months						
Operate the gen-set under no load for 5 minutes (Optional for Standby Gensets)	Check	Alternator	Every 12 months						
		Vibration is normal or not		✓	✓	✓	✓	✓	✓
		Turbocharger bearing clearance						✓	✓
		Turbocharger compressor wheel and diffuser						✓	✓
		Tightening degree with baseframe						✓	✓
Operate the gen-set with more than 1/2 load for 15 minutes (Optional for Standby Gensets)	Check	gen-set					✓	✓	✓
		Ease of starting		✓					
		Color of exhaust smoke		✓					
		Abnormal vibration		✓					
		Abnormal noise		✓					
Operate the gen-set with more than 1/2 load for 15 minutes (Optional for Standby Gensets)	Check	Abnormal smell		✓					
		Parameter indication		✓					
		Ease of starting				✓	✓	✓	✓
		Color of exhaust smoke				✓	✓	✓	✓
		Abnormal vibration				✓	✓	✓	✓
Operate the gen-set with more than 1/2 load for 15 minutes (Optional for Standby Gensets)	Check	Abnormal noise				✓	✓	✓	✓
		Abnormal smell				✓	✓	✓	✓
		Parameter indication				✓	✓	✓	✓
		Ease of starting				✓	✓	✓	✓
		Color of exhaust smoke				✓	✓	✓	✓

*For the engines with manual added lubricant for fuel pump:

Lubricant of fuel pump need to be checked once in every month; and the Lubricant shall be replaced once in each three months.

21. 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 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 VOLTAGE 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.

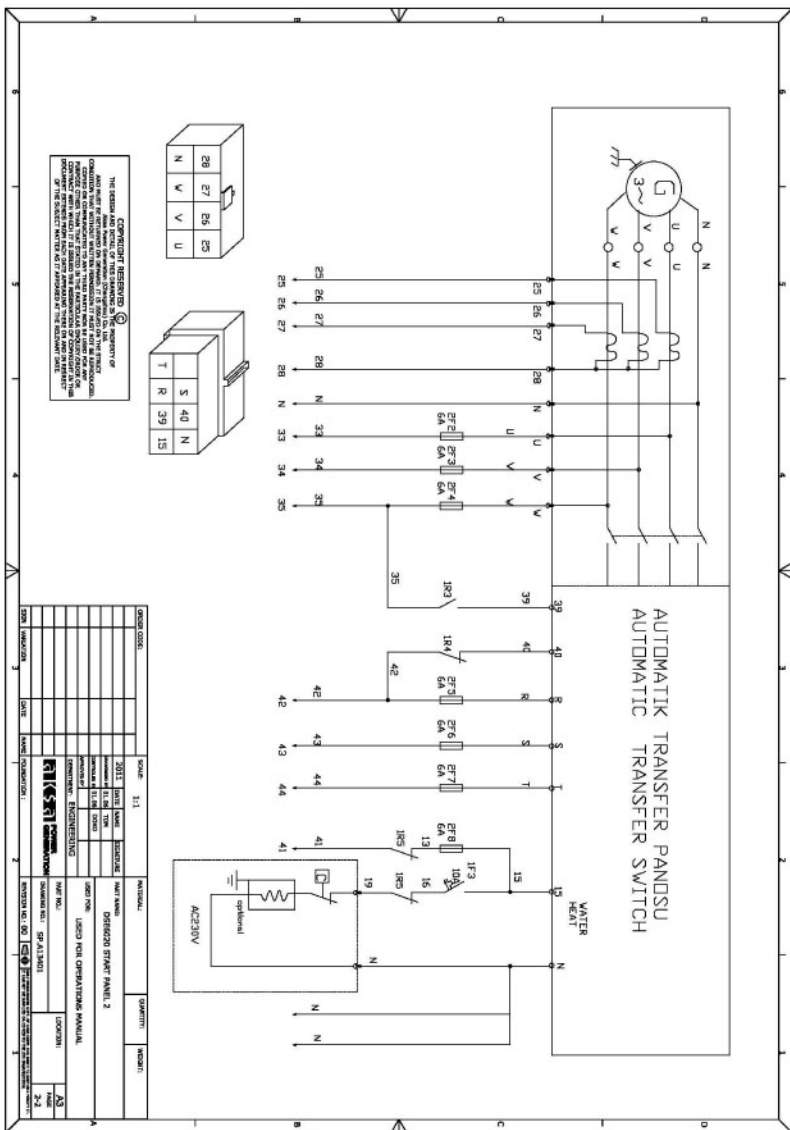
FAILURES DUE TO OVERLOAD AND UNBALANCED LOAD IN EXCESS OF THE GENERATING SET POWER (SUCH AS ALTERNATOR AND CONTACTOR FAILURES) ARE NOT COVERED BY THE WARRANTY.

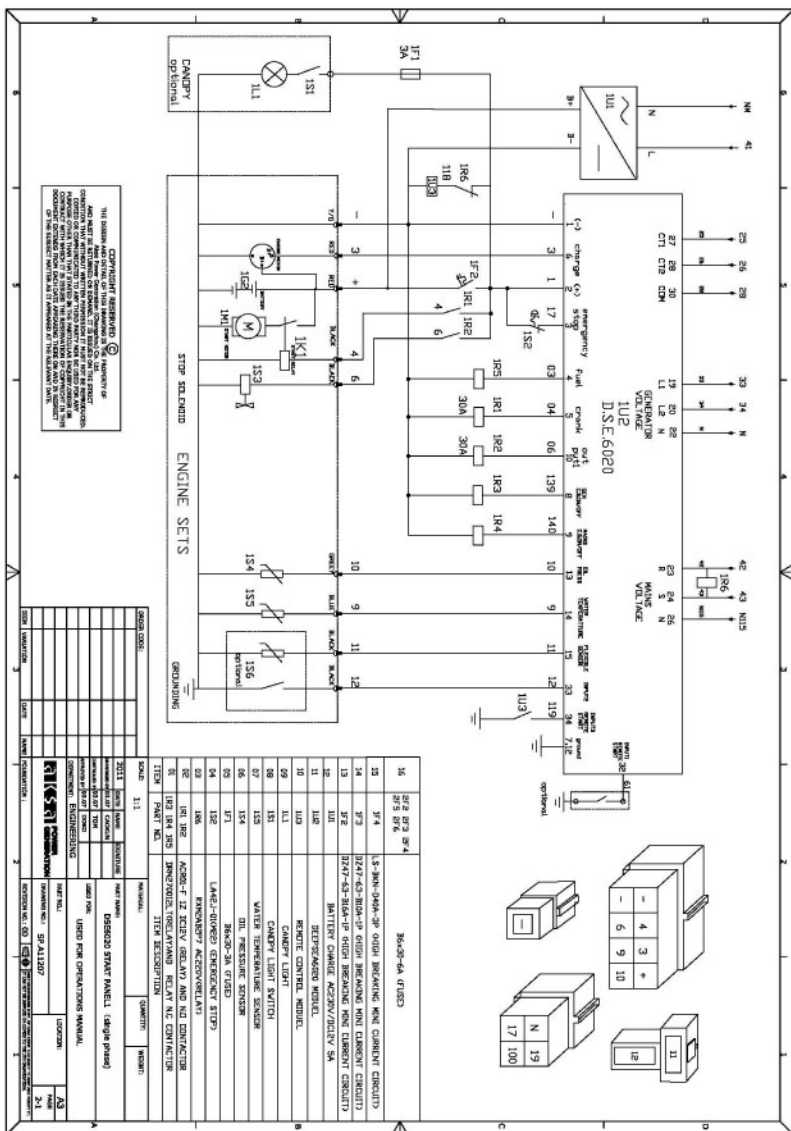
FAILURES DUE TO OVERLOAD AND UNBALANCED LOAD IN EXCESS OF THE GENERATING SET POWER (SUCH AS ALTERNATOR AND CONTACTOR FAILURES) ARE NOT COVERED BY THE WARRANTY.

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.

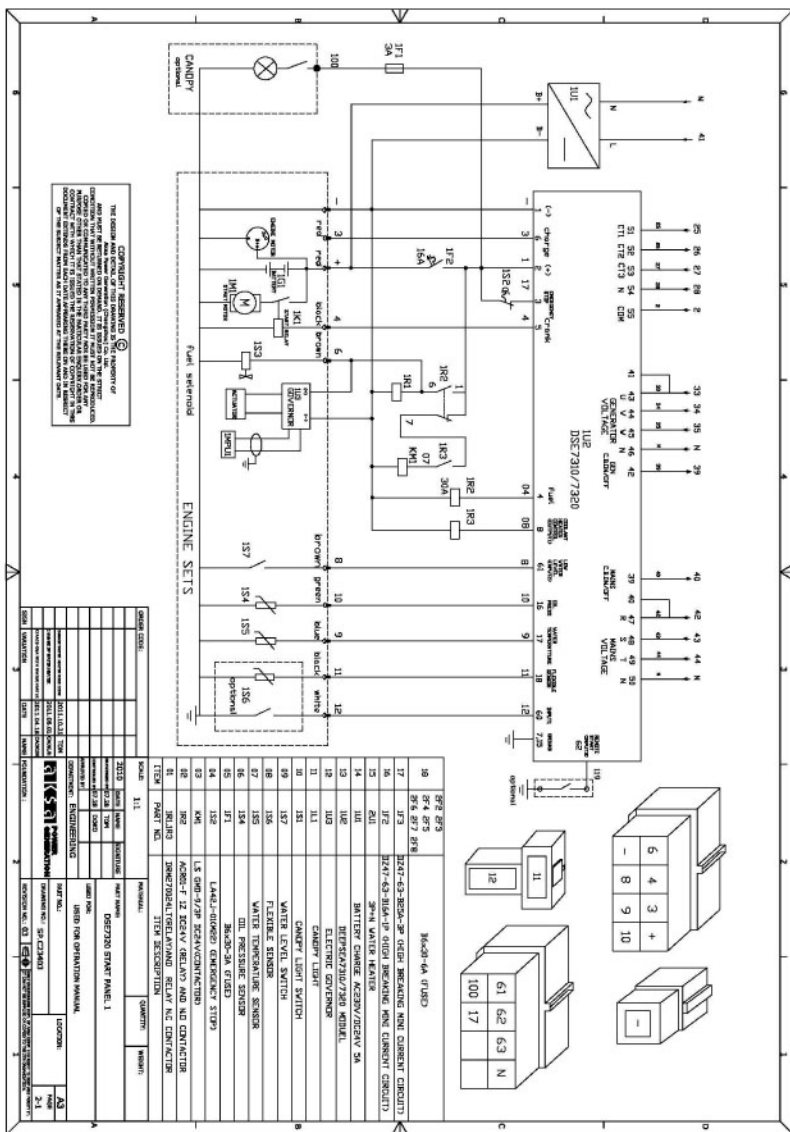
WARRANTY PERIOD IS 1 YEAR BEGINNING FROM THE PURCHASE DATE.

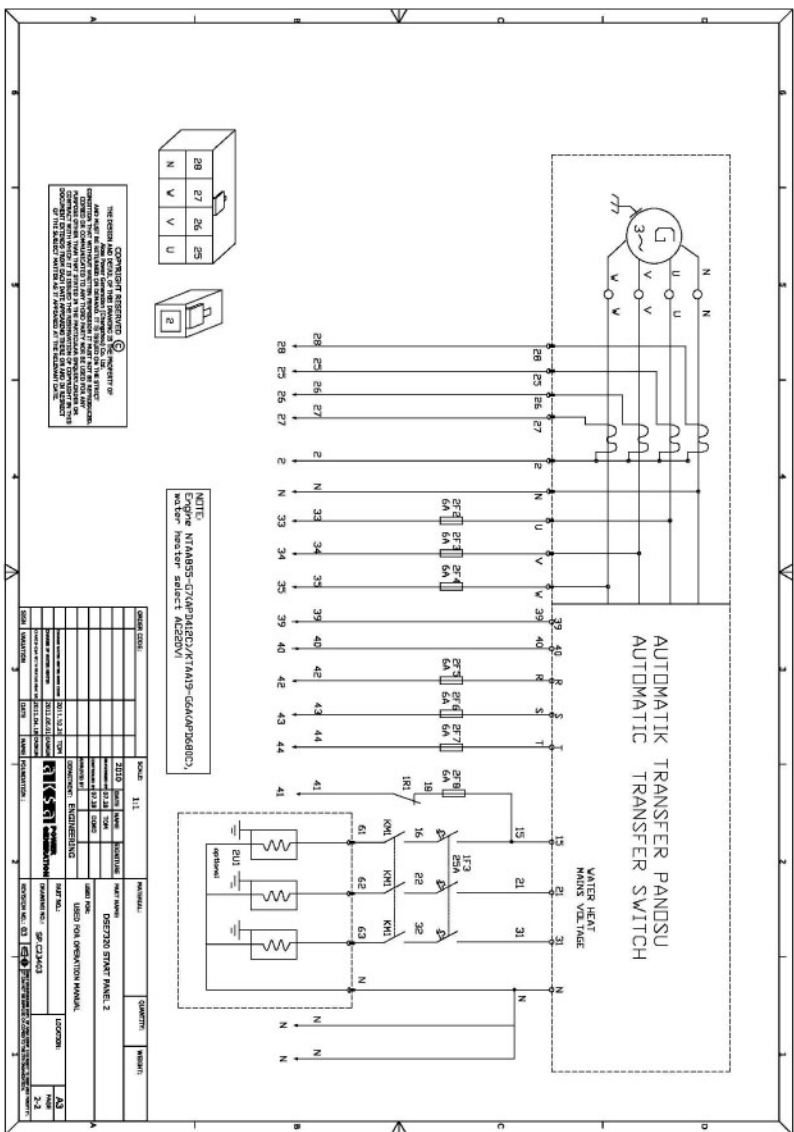


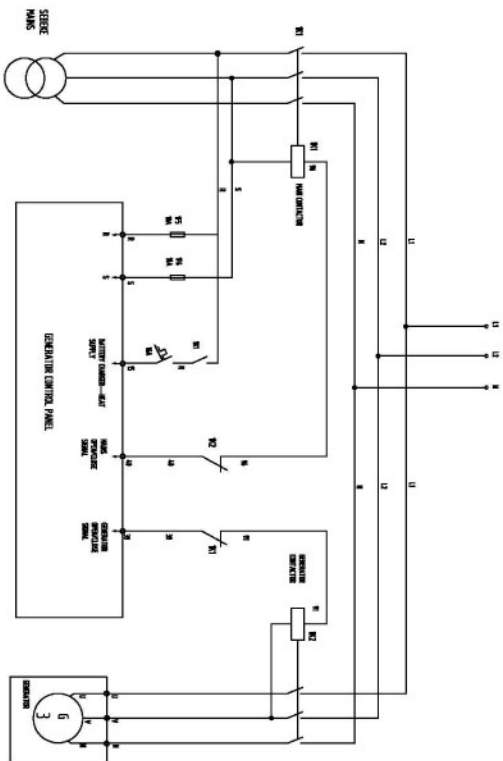


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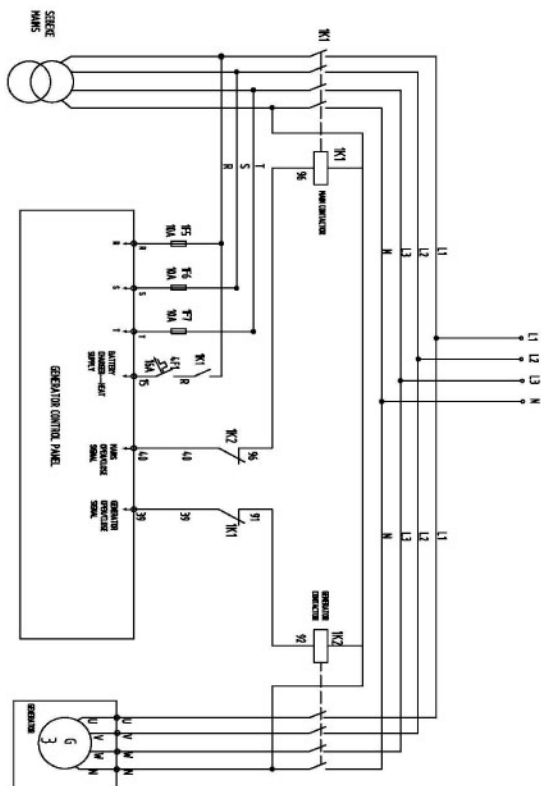




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NOTE:

W1, W2 — 4P AC CONTACTOR

F3 — 02A7-63-376A-1P (HIGH BREAKING MAIN CURRENT CIRCUIT)

F5, F6 — 8P-10-10A (FUSE)

F7

GENERAL DATA				SPECIFICATION			
MODEL				RATED			
TYPE				RATED			
RATED POWER				RATED VOLTAGE			
RATED CURRENT				RATED FREQUENCY			
RATED EFFICIENCY				RATED SPEED			
RATED FACTOR				RATED PROTECTION			
RATED WEIGHT				RATED DIMENSIONS			
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NOTES

This image shows a full page of white paper with horizontal blue or grey ruling lines. The lines are evenly spaced and run across the width of the page, providing a template for handwriting practice. There are no margins, text, or other markings on the page.

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NOTES

This image shows a single page of white paper with horizontal blue or grey ruling lines. The lines are evenly spaced and run across the width of the page, leaving small margins at the top and bottom. There are no vertical margin lines, and the page is completely blank except for the lines themselves.

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Head Office



TURKEY

Aksa Turkey (Head Office)

Gulbahar Cad.1,Sk.34212 Istanbul / Turkey

E-mail:apd@aksa.com.tr

Website:www.aksa.com.tr

Branch Offices & Warehouses



ALGERIA

Aksa Algeria

20,Rue D'Aniou Hydra,Alger

T:+213 21 60 81 46

F:+213 21 48 41 44

E-mail:aksaalgerie@aksa.com.tr



CHINA

Aksa China

Aksa Power Generation

(Changzhou) Ltd.

NO.19Tongjiang North Road,

Changzhou New District,

Changzhou,China

T:+86 519 851 50 205

F:+86 519 851 50 130

E-mail:aksa@aksapowergen.com



RUSSIA

Aksa Russia

107031,Moscow,Petrovka,27

Moscow,Russia

T:+495 641 52 00

F:+495 641 52 00

E-mail:tefep@aksa.com.tr



IRAQ

Aksa Iraq

English Village House

NO:353 Arbil / Iraq

T:+964 (0) 771 115 59 17

F:+964 (0) 771 115 59 17

E-mail:export@aksa.com.tr



VIETNAM

Aksa Vietnam

28 TER B Mac Dinh Street,

Dakao Ward, District 1,

HCM City

T:+84 8 391 47 014

F:+84 8 391 47 015

E-mail:Vietnam@aksapowergen.com



UNITED KINGDOM

Aksa UK

Unit 6, Pine Court Walker Road,

Bardon Hill Coalville Leicestershire,

LE67 1S2 U.Kingdom

T:+44(0) 1530 837 472

F:+44(0) 1530 519 577

E-mail:sales@aksa-uk.com



KAZAKHSTAN

Aksa Kazakhstan

M54-6 Abdullinyh Str,

Corner of Tole Bi Str.

Almaty-Kazakhstan

T:+7 727 250 67 31 / 250 67 41

F:+7 727 220 67 91

E-mail:aksa@arnakz



U.A.E

Aksa U.A.E

Post Box No 18167 Warehouse

Nc,RA08 / LC07 Jebel Ali Free

Zone Dubai-U.A.E

T:+971 4 883 32 92

F:+971 4 883 32 92

E-mail:sales@aksaae



JAPAN

Aksa Japan

8-5-302,Kashima,Hachioji-shi,

Tokyo,192-0353 Japan

T:+042-677-3361

F:+042-677-2884

E-mail:aksajapan@aksapowergen.com



SINGAPORE

Aksa Singapore

94 Tuas Avenue 11

639103 Singapore

T:+65 6863 2832

F:+65 6863 0392-6863 2956

E-mail:aksafe@aksafareast.com.sg



U.S.A

Aksa U.S.A

501 North 5th St,

Monroe,La,71201

T:+318 855 8377

F:+318 855 8381

E-mail:Sales@aksausa.com

Website:www.aksausa.com

Aksa Service & Spare Parts

Muratbey Beldesi Güney Girişi Cad.

No:8 34540 Çatalca

Istanbul / Turkey

T:+90 212 887 12 12

F:+90 212 887 15 25-887 19 39

E-mail:info@aksaservis.com.tr

Aksa Rental

Muratbey Beldesi Güney Girişi Cad.

No:8 34540 Çatalca

Istanbul / Turkey

T:+90 212 887 12 12

F:+90 212 887 15 25-887 19 39

E-mail:aksakiralama@aksakiralama.com.tr

Factories

TURKEY

Tasocagi Yolu No:22

Mahmutbey-Bagcilar

T:+90 212 446 43 01

F:+90 212 446 43 00

E-mail:apd@aksa.com.tr

CHINA

NO.19Tongjiang North Road,

Changzhou New District,

Changzhou,China

T:+86 519 851 50 205

F:+86 519 851 50 130

E-mail:aksa@aksapowergen.com