Genset Catalogue

Part One

Part Two

CHAPTER – 1

GENERAL DESCRIPTION OF GENSET

1.0 INTRODUCTION

Your new genset is designed to provide you with superior performance and reliability, allowing you to avoid annoying maintenance programmes which would prevent you from getting the job done.

The genset is a complete system that incorporates advanced engineering concepts which are backed by 55 years of experience.

Your Genset is fitted with an alternator which will produce the correct voltage with optimum wave form, fast response and precise voltage regulation.

As you continue reading, you will learn how the machine is operated and cared for. With proper care during maintenance and operation, your genset will be ready to respond to your emergency standby or prime power needs.

1.1 DESCRIPTION OF GENSET PACKAGE

Refer to figure 1A. The major components of the genset are clearly shown. Stationary or mobile units are available with each package including an alternator, diesel engine, exhaust, cooling system, and a control system.

The engine is equipped with a close control governor which will hold the engine speed within the tolerance necessary to deliver the rated power and frequency as per ISO 3046, DIN 6271 and BS 5514.

1.2 ENGINE

The engine incorporated in the generating set is of proven reliability and is specifically designed to operate in conjunction with an alternator. The engine is of the heavy-duty industrial type 4-stroke compression ignition and fitted with all accessories necessary to provide a reliable power supply.

1.2.1 COOLING SYSTEM

a) WATER COOLED ENGINE

The engine cooling system comprises of a radiator, high capacity pusher fan and thermostat. The alternator is coupled to the engine with a flexible steel disc type coupling (on some models, the alternator is coupled to the engine flywheel via a flexible rubber element coupling) and the package is arranged so that the alternator is the first component to come into contact with the cooling air flow as it passes over the genset.

As the air flows over the unit, the fan pushes it through the radiator. As this air flow passes over the

engine.

This method of cooling allows the alternator fan to pull a portion of the cooling air through the alternator. Both the engine and alternator are therefore kept at their proper operating temperature.

b) AIR COOLED ENGINE

The engine is cooled by a high capacity high efficiency cooling air blower mounted on engine. The blower forces air over cylinder liners and cylinder heads to keep the engine temperature optimum for best performance. Hot air leaving engine after cooling is ducted away by using air guide ducts.

For enclosed gensets ventilation is achieved by using special fans to remove radiated heat from engine and alternator and ensuring that there is no hot air recirculation.

All engines, when used to drive alternators to provide either emergency standby or prime power, require careful attention to air flow. The notes provided in the Installation Section of this manual should be consulted before selecting a location for your genset.

1.2.2 ENGINE GOVERNOR

The primary function of the governor system is to maintain engine speed in relation to varied load requirements. This is accomplished by the governor which senses engine speed and controls the engine fuel rate, in order to maintain practically constant speed. The engine speed governor maintains engine speed within limits regardless of the steady load.

As the alternator load increases, the engine speed is reduced.

Because the speed must remain relatively constant, the governor, sensing engine speed, will increase fuel flow to the engine, thus adjusting horsepower to a point sufficient to maintain engine speed and compensate for the load change. The same principle is applied when the load decreases. As the load is reduced the speed would increase, the governor will then reduce fuel delivery thus decreasing the horsepower to maintain the proper speed.

1.3 BRUSHLESS ALTERNATOR

As per the requirements of the customer, we provide an option of brushless or brush type alternator for KGPI genset. The following paras mention both in brief. Brushless excitation type alternator eliminates the maintenance associated with slip rings and brushes. The internal components of the alternator are designed so as to assure efficient and economical operation.

The control system consists of an automatic voltage regulator (within the alternator), protective circuits and the necessary instruments to allow you to monitor the operation of genset. On most models current is supplied through twelve leads enabling the operator to reconnect the genset to obtain a variety of three phase voltages up to 480 volts. Single phase units supply current through a two or three lead to Connections offering a variety of voltages from 120- 250V. Units can be supplied in 50 Hz outputs. See

Alternator Maintenance Section for further details of connections available.

A brushless alternator is a synchronous rotating field type unit, which produces alternating current. This alternator unit is completely self-contained and is designed and constructed to provided trouble free operation, ease of maintenance and long service life.

1.3.1 Stator frame assembly

The stator frame is made up of either high quality Aluminum Alloy (Gravity die cast) or of fabricated steel structure.

The stator core is made of high quality low content silicon stampings. The stator pack is 'skewed' to reduce the tooth ripples in the voltage waveform. Lifting points provided on the frame assembly.

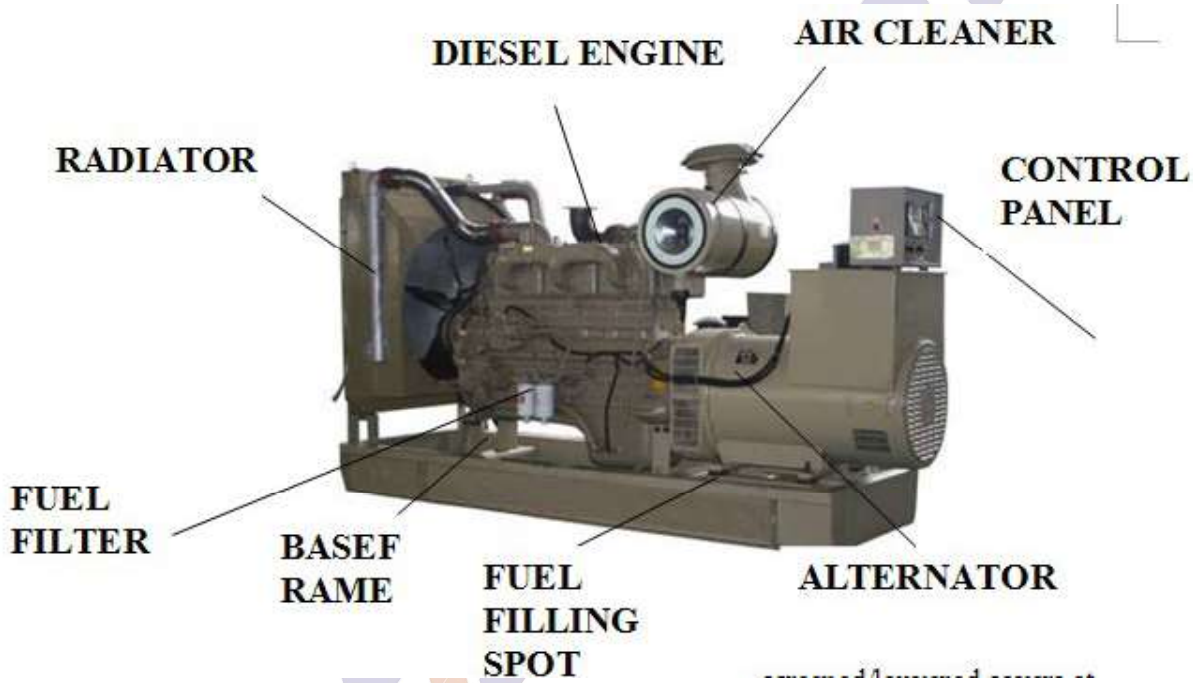


figure 1A

NOTE: In case of Genset with acoustic enclosure, the positions of some peripherals may change. (Example – Control Panel, Fuel filling spout, Fuel level indicator etc.)

1.3.2 Rotor Assembly

A high grade precision machined shaft carries the rotor assembly, which comprises the alternator rotating field system, the exciter rotor/rotating rectifier system and the cooling fan. The rotor is mechanically wedged and supported on the end winding to allow an over speed up to 2250 rev/min for 2 minutes.

On completion the whole rotor assembly is dynamically balanced within precision limits to ensure

vibration-free running.

1.3.3 Ventilation

The cast-aluminum centrifugal fan at the drive end draws cooling air through screened/louvered covers at the non drive end and discharges it through similar side-mounted covers at the drive end. The side only/exit for the air leading to a reduction in the overall length of the alternator.

1.3.4 Principle of Operation

The electrical power produced by the genset is derived from a “closed loop system” consisting of the alternator, exciter and voltage regulator. The process being when the engine starts rotating the internal components of the generator. The residual magnetism in the exciter field induces a voltage in the exciter rotor. This alternating voltage is converted to direct current by diodes. The current leaving the rectifier flows through the main rotor creating a magnetic field. If the first pole of the rotor was north, the following or next pole to induce that particular armature coil would be south.

As the rotor turns it induces the rotor armature with an alternating +-+-+- voltage. Therefore an alternating voltage is developed within each coil.

From the main armature the alternating voltage is circuited to the load and sensed by the voltage regulator, which controls the output voltage of the alternator unit. By sensing output voltage the regulator will vary the exciter field intensity by controlling the exciter field current flow. The greater the intensity of the exciter field, the greater the output of the alternator exciter. When the machine is first started the amount of current flowing from the exciter armature through the rectifier and on to the main field is minimum. At that time the voltage regulator will send its maximum output back to the exciter field. This in turn increases the intensity of the main field. The voltage regulator will continue to deliver its maximum output until the required voltage is obtained.

This completes the endless loop of control from the exciter to the main field of the generator, to the stator, voltage regulator and back to the exciter. By completing this process the genset will attain its rated voltage by the time the engine reaches full speed.

1.3.5 Voltage regulator

The voltage regulator supports the control system as both a voltage sensor to the main armature and a current supplier to the exciter field of the generator.

When the genset runs without a load, it makes available the rated voltage. When a load is applied, the voltage monitored by the voltage regulator decreases due to the current drain of the load. The voltage regulator upon sensing this drop in voltage will send a sufficient amount of increased current to the exciter field to meet the demand of the load.

As the load is reduced the regulator will realise a voltage increase and proportionately decrease the current flowing the exciter field.

In a ‘no-load’ condition the regulator will only supply the exciter field with enough current to compensate for the internal losses of the alternator. This system of voltage regulation provides the most efficient control of output voltage.

1.4 BRUSH TYPE ALTERNATOR

It is of salient port, self-excited or self regulated type. They are designed to operate at 1500 rpm. The alternators can be supplied for foot cum flange mounting and for different voltages. They comply with BS 5000, IEC60034 and IS08528 standards.

1.41 Stator

It is a MS fabrication fitted with laminated pole bricks and C.I. end shields. The poles are fixed rigidly to the frame bolts. It carries copper field coils with glass ‘F’ insulation varnish impregnated and properly insulated. The NDE side of the end frame provides an easy access to the slipping assembly. The I.D. is checked for a uniform air gap to be maintained with the rotor.

1.4.2 Rotor

High grade armature laminations are stacked on a ground steel shaft, supported at both ends by the MS core end plates having optimum number of holes for sufficient cooling. A double layered star connected loop winding of enameled copper of class ‘F’ insulation is wounded into the armature slots with epoxy wedges, hyperthermia insulations and overhang of the coils is arrested by the overhang rings. The rotor is resin impregnated. Gel coated hardeners achieved overall rigidity of rotor. The rotor is dynamically balanced.

1.4.3 Excitation Unit

It senses the load current and regulates the terminal voltage of the generator. It is mounted on the NDE shield. It can be removed and assembled as a separate unit. The voltage adjustments can be done on its rapid terminal board tapings as well as by adjusting the air gap of the E cores.

1.4.4 Principle of operation

Brush type alternator consists of a number of coils wound over a rotating armature and gets induced by and e.m.f. due to the magnetic flux generated from a wound stator.

An excitation unit is provided to regulate the terminal voltage and current that varies due to changes in the magnetic field. A current collecting unit consisting of slip rings and brushes, collects the current generated

and passes it on to the terminals. An excitation unit regulates and suitably feeds or excites the field to strengthen it so that the e.m.f. it induces in the rotating armature also varies accordingly as per the load demand. While starting the residual magnetism induces a current in the rotor armature.

1.5 VIBRATION ISOLATION

All gensets are fitted with anti vibration mountings which are designed to reduce vibration being transmitted from the rotating mass of the genset to the foundation on which the genset is mounted. Vibration isolators are selected to suit the particular duty and are fitted between the engine, alternator feet and the base frame. On some of the models the vibration isolators are fitted between the base frame and the foundation depending on the system requirement.

1.6 FUEL TANK AND BASE FRAME

The design of the base frame incorporates removable fuel tank with a capacity of approximately 8 hours operation. The tank is provided with fittings to facilitate either manual or automatic filling. The base frame is manufactured from heavy gauge sheet steel and welded to form a rigid assembly.

1.7 SILENCER AND EXHAUST SYSTEM

Exhaust silencer is provided to reduce noise emission from the engine and designed to direct exhaust gases to areas where they will not be objectionable. On ‘stand alone’ open gensets, the exhaust silencer is generally placed outside the Genset room, with suitable extension piping from engine. Stainless steel expansion bellow is provided on the engine, to facilitate the exhaust piping. For generating sets with acoustic enclosure, residential type silencer is fitted inside or outside the enclosure with flange fitting at the outlet to enable discharge of exhaust gases at desired location, through extension piping, as required.

1.8 CONTROL PANEL

All control panels are mounted in welded steel enclosures equipped with a sealed hinged door for easy access and servicing.The control panel is available in several variations to suit the requirement of the installation. The Control System is fully described in Section 4.

1.9 GENSET CIRCUIT BREAKER

To protect the alternator winding, a suitably rated moulded case or miniature circuit breaker (depending on the genset model) is supplied mounted in a strong fabricated steel enclosure. Current transformers are fitted on each of the phases on the cabling to the circuit breaker enclosure for current measurement. In some configurations the main circuit breaker may be incorporated in the automatic transfer panel.

1.10 SYSTEM PROTECTION

An additional and substantially important function of the control system is the protection of the engine against faults such as high temperature, low oil pressure, over speed or other malfunctions. To prevent damage to the cranking motor and deep discharge of the starting battery, a crank limiting circuit is included on all automatic start sets. A detailed explanation of these systems is included in Section 4.

1.11 CONTROL PANEL POWER SUPPLY

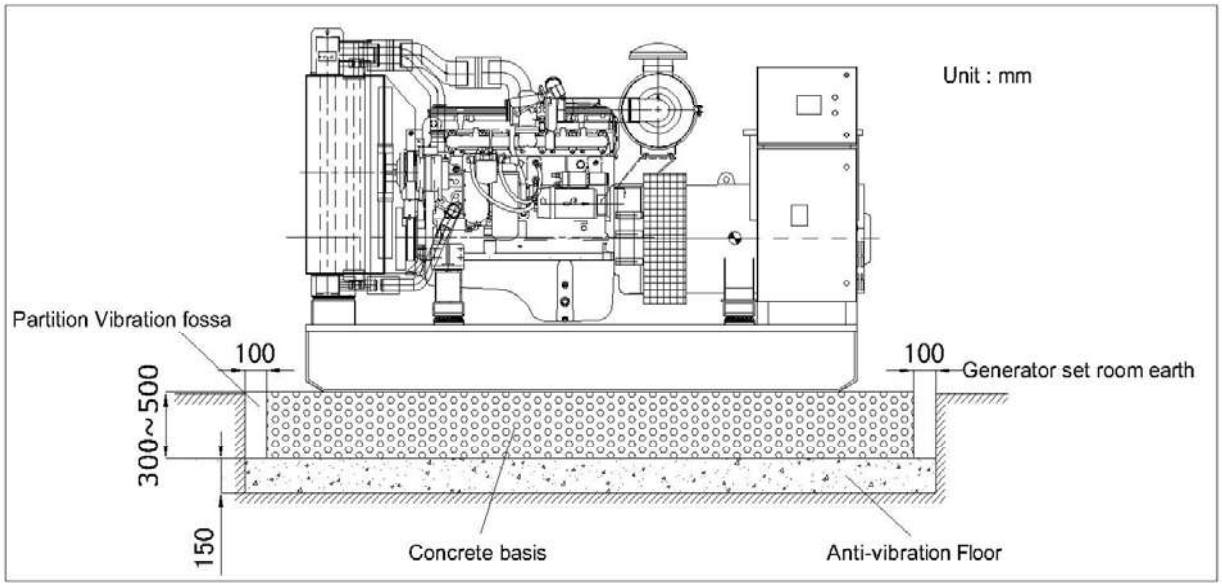
Engine instruments and the control panel are supplied from the battery fitted to the genset.

This battery also provides power for operation of the cranking motor to start the engine and for the stop solenoid.

The stop solenoid is of the ‘energised to stop’ or run type requiring a DC supply to energise the solenoid for stopping the engine or requiring supply to start the engine.

CHAPTER – 2

INSTALLATION



2.1 LOCATION

Selecting a location for the genset is very important part of any installation procedure. Always locate the genset in an area that will provide adequate ventilation and physical protection for the unit. For the purpose of simplifying maintenance and inspection requirements it will also be important to place the genset in such a position so as to allow easy movement around the machine without overcrowding. Generally, 1.5 to 2.0 meters space all around the genset should be ensured.

The location should be clean, dry and have good drainage capabilities. Should the location be outdoors protect the genset with a weatherproof enclosure (available as an optional retrofit item).

Another point to keep in mind is the space required to undertake major overhaul or service operations. In some cases it may be necessary to remove major components.

Doors must be sized to allow access in and out for the complete generator set and major accessories. Air inlet and outlet vents can often be made removable to floor level to provide an access point.

For acoustic enclosures ensure that the openings provided for fresh air inlet and outlet are not blocked.

2.2 FOUNDATION

A reinforced concrete pad makes the best foundation. A pad with sufficient mass in proportion to the size of the genset will provide the rigid support necessary to minimize deflection and vibration.

Typically this should be 150 mm to 200 mm deep and a mass at least equal to that of the gensets. The foundation may be located on soil, structural steel, building floors etc., provided the total weight of the foundation and genset package does not exceed the allowable bearing load of the support. Allowable bearing loads of structural steel can be obtained from Engineering Handbooks while local building codes will provide the allowable bearing loads for different types of soil.

2.2.1 Isolation

It is advisable that the principal foundation of each genset rests on bedrock or solid earth completely independent of other foundations, cement work, walls or operating platforms.

2.2.2 Vibration

The design of the genset is such that only minimal vibration is transmitted to the foundation. Anti vibration mounts are fitted between engine, alternator and baseframe or in larger capacity gensets vibration isolators are mounted below the baseframe.

In generator rooms situated on upper floors special attention to vibration isolation is necessary. Often spring type vibration isolators will be needed.

It is necessary to ensure that building structures are capable of supporting the genset, fuel storage and accessories.

Refer to figure 2-2 for Typical ventilation arrangement for water-cooled engines.

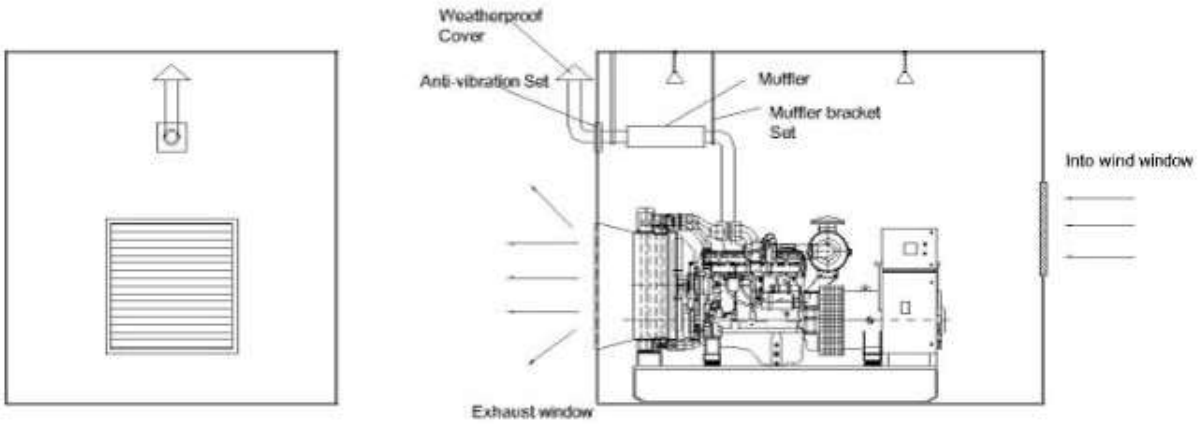


Figure2.2-A Typical Ventilation arrangement for Water Cooled Engines

This layout drawing shows a typical genset installation. It is meant as a guide only. Full details of the particular unit should be assessed and the installation layout designed to suit the requirements of your site.

Notes:

• The circuit breaker position can vary according to the requirements of the installation. It may also be mounted remote from the genset.

• The control panel can be made to allow wall mounting.

• Depending on cable routing to the genset room and terminal points at the generator, the power cables may be installed for bottom from ducts or floor trenches.

• Openings should be provided behind the alternator for incoming cold air and directly in front of the radiator for outgoing hot air. The cold air first passes over the alternator, then the engine, picking up radiant heat as it passes. It then passes through the radiator and is discharged through a duct to the outside of the genset room.

• A temperature rise of 5-15 Deg C (9-27 Deg F) in the cooling air can be expected at full load.

2.3 GROUNDING

Grounding should be done in accordance with applicable National, Local Code or Regulation.

2.4 AIR INLET

Engine inlet air must be clean and as cool as possible. These conditions will drastically effect both engine life and performance.

Normally the inlet can be taken from the area surrounding the installation site. However, in some cases the condition of the air surrounding the machine may warrant ducting the air from outside or another room.

When it does become necessary to duct air in, the air filter should remain mounted to the engine as opposed to a remote mounting (such as on a roof or in another room). This will eliminate the possibility of dirt leaking through the duct work upstream of the air filter.

Canopy Temperature

Air temperature near air cleaner should not exceed 5 ^{o} C above ambient. Sufficient window openings required to maintain air inlet temperature within the limit.

2.5 COOLING AND VENTILATION

The radiated heat given off by the engine, generator and exhaust piping can result in a temperature high enough to adversely affect operating and maintenance personal or the performance of the genset. Locate the genset in a room or area that will provide or allow sufficient ventilation to remove this heat as well as the heat radiated from the engine cooling water by the radiator. Preferably provide exhaust fans to drive hot air outside.

If acoustic enclosures are placed in an enclosed place, ensure that enclosure is well ventilated and

exhaust gases are driven out of the enclosure.

Points to remember in any type of installation:

1. Ensure that hot air is positively discharged from the building by fitting a flexible connection between the radiator and the duct

2. The size of the openings should be calculated to ensure that excessive restriction is not imposed on the flow of cooling air. Openings should at least be as big as the radiator core area but, as a guide, an area on 150% of the core area of the radiator should be allowed for.

3. For weather protection, louvers should be fitted to the intake and exhaust openings. These can be either of the fixed or movable type.Manually operated movable louvers may be acceptable in some cases, but they are not acceptable for automatic standby units. Radiator air should not be depended upon to move the louver vanes.

2.6 EXHAUST

The exhaust system is used to direct exhaust gases to non-confined areas and reduce the noise to tolerable levels. When designing a system the main objective is to minimize back pressure. Excessive back pressure in an exhaust system will create horsepower loss and increase the engine operating temperature, and emissions.

When bends are required in an exhaust system, always make the radius at least 150% of the inside diameter of the pipe. As most exhaust system designs are governed by the physical characteristics of the building or room in which they are located, it is of the utmost importance that the exhaust pipe be routed in a path offering the least amount of turns or bends so not to increase back pressure more than 50 mm of Hg.

Be sure that all pipes are well supported and that springs or other dampers are used at points of high vibration. Due to the heat radiation of the exhaust pipes it is recommended that all pipes be located at least 250 mm from any combustible material. Wrapping the exhaust pipes with high temperature insulation or installing fitted insulated sections will aid in preventing excessive heat radiation within the room.

At points where the piping passes through a wall or roof, a metal thimble guard 300 mm in diameter slightly larger than the pipe should be installed.

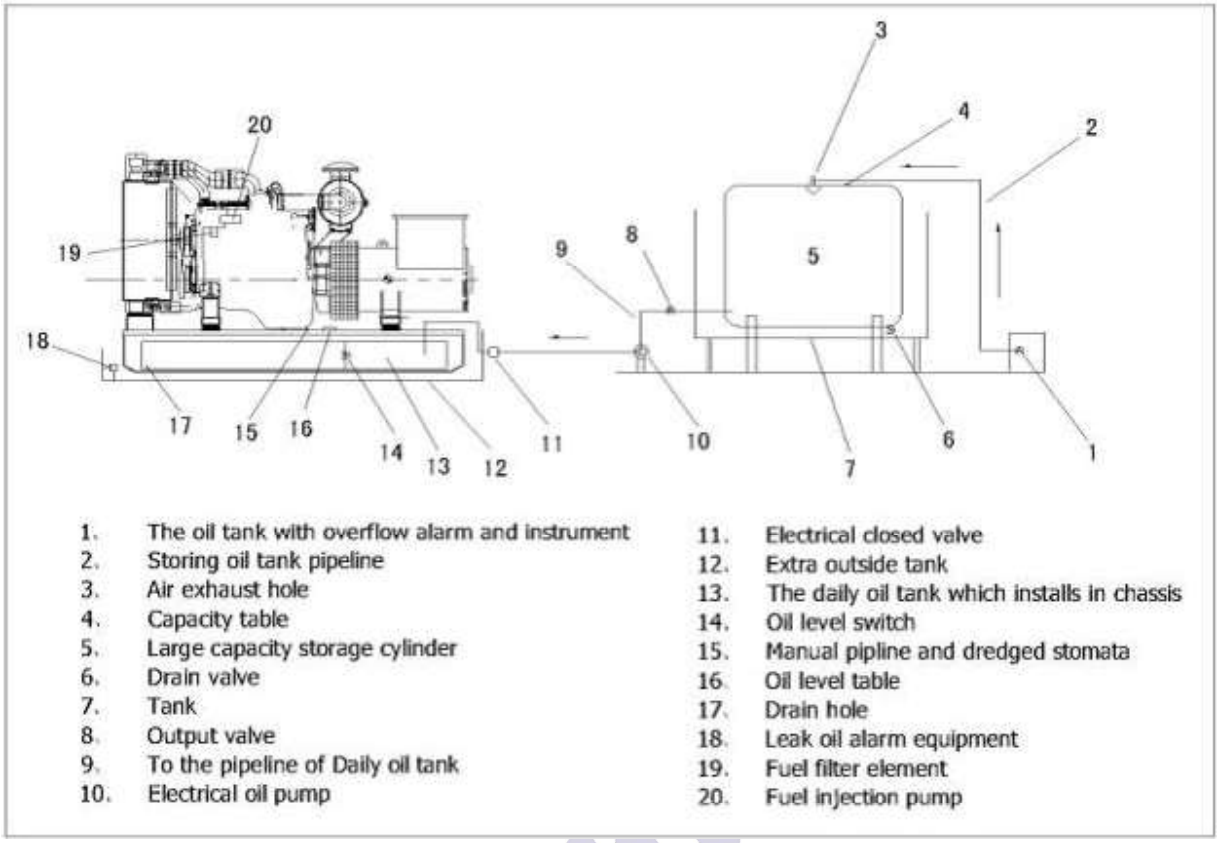


Figure3.3

As shown in Figure 3.3 bevel the end of the pipe at a 30-45 degree angle. Should the pipe end be horizontal, bevel the pipe from the top back to the bottom. This will not only reduce the noise levels at the outlet but will also minimize entrance of precipitation on horizontal Pipes The level or height at which the outlet is situated should be sufficient to prevent fumes and odours from becoming an annoyance or potential izzard. Also, an exhaust pressure actuated rain cap is recommended for use on vertical outlet pipes.

Any long horizontal or vertical piping should include water legs and drain traps at their lowest points so that water does not reach either the silencer or the engine. It is also recommended that a slight slope downward from the silencer to the water leg or rain trap be added to assure the proper removal of water.

By locating the silencer as close to the engine as possible you will be able to minimize the noise level in the exhaust piping. Each genset installation should have it's own exhaust system and should not be connected to a system accommodating more than one genset as the possibility of exhaust gas and condensation backflow may cause permanent damage to an idle engine.

Note: Health warning: Inhalation of exhaust fumes is potentially lethal. The correct installation of exhaust systems to prevent accumulation of exhaust gas cannot be over emphasized. Additionally, prolonged exposure to engine exhaust noise can be damaging to hearing. A genset should never be

operated without a fully installed exhaust system and all personnel in close vicinity should wear ear protection.

2.6.1 FLEXIBLE CONNECTIONS

The exhaust piping should be connected via a flexible joint located on the engine exhaust outlet. This connection serves three purposes.

1. It relieves some of the weight of the exhaust piping from the engine.

2. It isolates the exhaust system from vibration.

3. It allows for some movement of either the genset or exhaust system components.

Long piping runs should be divided into sections separated by additional flexible connections. This will also compensate for the expansion and contraction of the piping itself due to temperature change. Any insulation material used for a flexible connection should allow for the expansion and contraction of the connections, due to temperature changes.

Generating sets with acoustic enclosure are provided with exhaust outlets having connecting flanges. Exhaust gases from the outlet can be routed away to desired location. For up to 3 meter distance exhaust pipe size same as provided on the outlet can be used. For longer lengths total exhaust system assessment should be done by competent person. In no case, exhaust back pressure should exceed 50 mm of Hg when measured at exhaust manifold of engine, at rated load.

2.7 FUEL SYSTEMS

The fuel system must be capable of delivering to the engine a clean and continuous supply of fuel. When designing a fuel system, always incorporate the requirements of Local, State, or National Codes, which may pertain to either the fuel system or the electrical apparatus utilized by the system.

2.7.1 Diesel Fuel Bulk Storage

Bulk fuel storage is the most preferable method of providing fuel supply. This method allows bulk fuel purchases which will minimize dirt and contamination possibilities, especially when the fuel is seldom used. The bulk storage tank may be located either above or below the ground.

A vent must be installed on the main tank to relieve the air pressure created by filling the tank as well as preventing a vacuum within tank as fuel is consumed. The tank bottom should be rounded and placed on a 2 degree tilt to assure a concentrated settling of both water and sediments. At the low point of the tank a drain valve should be installed to remove water that may accumulate due to condensation.

Underground tanks must be pumped periodically to remove this water. This is best done by placing a tube through the filter pipe to the low end of the tank. For these reasons it is imperative that the tank be placed in or on stable ground to assure that eventual settling does not change the location of the low point of the tank. Burying the tank below the frost line will help in avoiding seasonal settling.

Another consideration to be made when locating the main tank is the height difference between it and the auxiliary tank (day tank). The maximum vertical lift capabilities of a standard electric motor driven

fuel transfer pump is 5m. Do not place either tank at a level that would exceed the pump lift capabilities. Also keep in mind the possibilities of pressure drop created by excessive horizontal distances and pipe work bends.

The fuel delivery line carrying fuel to the engine and the fuel return line for carrying excessive fuel back to the tank should be no smaller than the fitting sizes on the engine. For longer runs or extremely low ambient temperatures increase the size of these lines to ensure adequate flow.

The fuel lines can .be made of any fuel compatible material such as steel pipe or fuel line tube that will tolerate ambient conditions. Overflow piping should be of the same material and one size larger.

The fuel return line should enter the tank at the top and contain no shut-off valve. This line should be designed with a minimum amount of bends or dips to prevent an air lock in the system. The fuel delivery line should pick up the fuel from the point no lower than 20mm from the bottom of the tank. If at all possible locate this line at the end of the tank opposite that of the return line and at the high end of the tank. Flexible fuel lines should be used at a point between the tank and engine (preferably adjacent to the genset) to avoid the potential damage that could be created by vibration.

2.7.2 Day Tanks

Auxiliary tanks or day tanks as they are commonly referred to are recommended. Refer figure 3-4 for typical fuel installations.

All standard gensets with acoustic enclosure are provided with tank fitted in the base frame. This day tank will produce a ready fuel supply.

2.7.3 Filters and Traps

Clean fuel will aid in attaining maximum engine life and dependability. Primary filters are recommended for use between the engine filters and the transfer pump. Water and sediment traps should also be included upstream of the transfer pump. However, on border line pump installations do not increase fuel line restrictions to a point exceeding the capabilities of the pump.

⚠ 2.7.4 FIRE PRECAUTIONS

When designing a genset installation the following points should be noted:

-The room should be designed so that there is an easy escape route for operating personnel in the event of fire within the room.

-A recommended type of fire extinguisher or fire extinguishing system should be provided to fight the fire.

-Gravity operated fire valves operated by fusible links, mounted above the engine, can be installed in the fuel lines.

–The room should be kept clean and free from accumulated rubbish which can be a fire hazard.

2.8 STARTER BATTERIES

Resistance in the starting circuit has a significant effect on the starting ability of the engine. Therefore, the batteries should be located as close as possible to the genset (batteries should be accessible for servicing). Maintenance procedures should be carried out rigorously since the batteries have to be in perfect condition to start the diesel engine.

⚠ Note: Batteries emit inflammable gas. Do not smoke or create sparks or naked flames adjacent to batteries.

2.9 ELECTRICAL CONNECTION

Only fully qualified and experienced electrical technicians should be allowed to carry out electrical installation work.

The electrical connection to the genset should be made with flexible cable to prevent the transmission of vibration and possible damage to the alternator or circuit breaker terminals

If it is not convenient to use flexible cable throughout then a link box can be installed close to the set with a flexible connection between it and the set.

The cable may be laid in a duct or on cable tray. When bending cable reference must be made to the recommended minimum bending radius. No rigid connection should be made between the set and the cable support system, e.g., cable tray.

When single core cables are used the gland plates must be of non-ferrous material, e.g., aluminum, brass or a non-metallic material such as teflon.

The cable must be suitable for the voltage being used and adequately sized to carry the rated current with allowances made for ambient temperature, method of installation, proximity of other cables, etc.

All electrical work should be carried out in accordance with any applicable National, Local Standards, Codes or Regulations.

All connections should be carefully checked for integrity. Phase rotation must be checked for compatibility with the installation. This is vitally important when connection is made to an auto transfer switch, or if the machine is to be paralleled.

2.9.1 Protection

The cables connecting the genset with the distribution system should be protected by means of a circuit breaker, fuses or other means to disconnect the genset in case of overload or short circuit.

2.9.2 Loading

When planning your distribution system it is important to ensure that a balanced load is presented to your genset. If loading on one phase is excessive in comparison to the other two phases this will cause overheating in the alternator windings, imbalance in the phase to phase voltage output and possible

damage to sensitive 3 phase equipment connected to the system. Ensure that no phase current exceeds that of the current rating of the genset.

It may be necessary to reorganize the electrical distribution system if a genset is to be connected to an existing installation.

2.9.3 Power Factor

The power factor (cos phi) of the connected load should be determined. Power factors below 0.8 will overload the generator. The genset will provide its kilowatt rating and will operate satisfactorily from 0.8 to unity power factor. Particular attention must be given to installation with automatic or manual power factor correction equipment to ensure that a leading power factor is not present under any conditions. This will lead to voltage instability on the generator output and may result in damaging over voltages.

2.9.4. Grounding Requirements

(See Paragraph 3.3)

Regulations vary and advice should be sought from the local supply utility as to their requirements. The factory connects the frame of the alternator to the frame of the genset therefore the complete mass of the genset is at the same potential. The connection if required of the generator winding star point / neutral to earth is the responsibility of the installation technicians.

⚠ * Warning: Never attempt to work on live wiring. Always stop the genset and open the circuit breaker on the load cables before working on the alternator or it's connectors.

2.9.5 Start Up

Before attempting to start the genset refer Chapter 4 of this Section.

2.10 NOISE CONTROL

Your genset can be supplied with accessories and components to reduce noise emissions. Typically available are residential and super critical silencers, acoustic louvers and splitter vents, fan silencers and acoustically treated enclosures.

The requirements for each site vary enormously and for any critical installation we recommend you consult your dealer at an early stage. The information needed to select acoustic equipment is:
– The model and capacity of genset
– The location and overall site plan.
– The designed noise level at a fixed distance, normally 1m or 7m.
– Environmental conditions, ambient temperature etc.

Noise emissions from diesel gensets (without acoustic treatment) are at sound pressure levels of between 100 dB(A) and 110 dB (A) at 1m. Kirloskar Gensets with acoustic enclosures have a typical noise pressure level of 75 dB(A) or less (average) at a distance of 1 meter from the enclosure.

Intermediate levels of treatment will prove more economic and are often satisfactory depending only on the nature and type of installation. Hospital Care Areas will require more attention than the normal commercial / industrial installation.

CHAPTER – 3

CONTORL SYSTEMS AND OPERATIONS

3.1 CONTROL SYSTEM

The Control System consists of:-

A) Control Panel providing a means of starting and stopping the Generator Set, monitoring its operation and output, and causing the engine to automatically shut down in the event of a circuit fault condition arising from low oil pressure, high coolant temperature, over speed, low fuel level (optional).

B) An Alternator Circuit Breaker providing a means of switching the Generator output, and automatically disconnecting the load in event of short circuit.

3.2 CONTROL SYSTEMS AND OPERATIONS

Preparing for Operation

Before starting your DG set be sure that it is positioned on a level surface so that proper liquid levels can be obtained. Check engine oil, radiator coolant, battery electrolyte and fuel levels.

Be sure that the Genset will be operated in a well ventilated area with all exhaust fumes piped away.

⚠ Before connecting batteries, ensure control panel is switched off.

Prolonged inhalation of exhaust fumes may result in serious illness or death.
Never attempt to disconnect a load connection or perform maintenance while the Genset is in operation.

To avoid an accidental start of the engine, always disconnect the battery when performing major operations.

As the battery system is negative earth. The negative connection should be disconnected first and reconnected last. The cover of the control panel should not be removed while the genset is in operation. The cover, when removed, exposes live electrical connections. Maintenance on the control panel should only be carried out by a qualified technician
Prolonged exposure to the noise levels of a diesel engine can impair hearing unless proper ear protection is worn.

Before any attempt is made to operate the machine, be sure that engine and alternator are properly earthed.

Local and national regulations for the grounding of gensets should be adhered to as well as those regulations which describe the methods of connection and minimum sizes of grounding conductors based on the size of the load cables.

⚠ Important

Adequate grounding of the genset is necessary for both stationary and wheel mounted units to prevent the possibility of injury or death in the event of electrical fault.

When filling the fuel tank, do not smoke or use an open flame in the vicinity. Also the tank should never be filled when the Genset is operating or while the engine is hot. Spilled or vaporized fuel could be ignited easily.

⚠ Important

Always shut down the Genset and switch off circuit breaker prior to connecting, or disconnecting load cables. Only restart when a sound connection has been made.

3.3 INITIAL START-UP

The following procedure should be used to make initial start-up of the Genset.

These steps are critical and must be followed closely to avoid complications in operating the Genset.

3.3.1 Check the engine oil and coolant levels replenishing if necessary.

3.3.2 Fill the fuel tank.

3.3.3 The following procedure should be used when starting the Generator for the first time or when it has been out of service for a time for maintenance purposes.

3.3.3.1 Ensure the key switch is turned OFF.

3.3.3.2 Ensure the circuit breaker is switched OFF.

3.3.3.3 Connect the batteries to the engine with correct polarity.

3.3.3.4 Prime the fuel system using the hand priming pump and bleed entrapped air from the fuel filtersee engine manual for details.

3.3.3.5 Turn the Key switch to start Position “ON”. Engine control system will be switched on.

In manual mode, allow an interval of approximately 10 Seconds between cranking attempts, and should

the engine still not have started after four cranking attempts, refer to the engine manual to determine the cause of failure to start.

3.3.3.6 After the engine has been started check for any abnormal noise or vibration
3.3.3.7 Check fluid leakage or high temperature.

3.3.3.8 Check the control panel for indications of abnormal operation, in particular above normal engine temperature or below normal oil pressure.

3.3.3.9 Immediately the engine reaches full operating speed the voltmeter should be checked to ensure that the voltage has reached the correct operating level. The voltage is factory set at the voltage regulator and needs no further adjustment. Should the output voltage be incorrect, adjustment of the voltage should only be carried out by a qualified technician.

Voltage adjustment is achieved by varying the setting of a potentiometer mounted inside the automatic voltage regulator which is fitted in the alternator terminal box.

3.3.3.10 The frequency of the output voltage should also be checked on the panel meter. No load frequency is approx. 52 Hz, for 50 Hz units.

3.3.3.11 When the generator is producing voltage, check the phase rotation of the generator by connecting a phase rotation meter to the terminals on the generator side of the circuit breaker. (Caution: DO NOT close the circuit breaker). This check should be carried out by a qualified technician and the result noted for use later if Generator is to be connected to an existing system.

3.3.3.12 After the voltage and frequency checks have been made, shut the machine down by pressing “O” on genset control panel.

⚠ IMPORTANT
Always shut the genset down prior to connecting, or disconnecting, load cables. Only restart when a sound connection has been made.

3.4 SHUTDOWN PROCEDURE
To shut down the Genset, turn off the load using the circuit breaker, and press button the “O” (as per applicable) position. In case of an emergency where immediate shut down is necessary press the emergency off push button.

3.5 NORMAL START-UP PROCEDURE
(For manual operation)
On subsequent starts follow the procedure explained below. This start up procedure must be strictly

adhered to. ENSURE KEY SWITCH IS TURNED, TO POSITION “OFF”.

3.5.1 Make a visual check of the entire Genset. Watch for signs of leaks from the engine i.e. fuel system, cooling system and lubrication system.

3.5.2 Check engine oil, water and fuel levels, replacing if necessary. Check the battery terminals for corrosion, cleaning where necessary. Check the battery electrolyte
level and fill with distilled water if necessary.

3.5.3 Turn ON. DC ON switch unit will get DC power. For manual starting press the start button on genset control unit.

3.5.4 Starter supply will disconnect atomaticallyafter getting supply from AC alternator. This will be sensed by genset control unit.

3.5.5 Lub. oil pressure gauge will show lub. oil pressure and low lub. oil pressure switch contact will get opened.

3.5.6 Once the engine is started battery charging alternator starts charging the battery and charging current is indicated on DC ammeter.

3.5.7 Run the set on no load for atleast 2-4 minutes. Put the Main Current Circuit Breaker ON. Genset output is available to load.

3.5.8 Water temperature gauge is provided which indicates engine water temperature.. For healthy condition this needle is should be in green zone.

3.5.9 AC voltmeter will show alternator output voltage. AC ammeter will show load current depending upon the connected load.

3.5.10 Refer to Section D for specific engine maintenance requirements.

3.5.11 Dispose off any loose items or debris in the vicinity of Genset that may inhibit operation or could cause injury.

3.5.12 Drain condensate traps in the exhaust system, if so equipped, and check for exhaust leaks.

If engine does not start in first attempt allow an interval of approximately 10 Seconds between cranking attempts, and should the engine still not have started after four cranking attempts, refer Section D to determine the cause of failure to start.

3.5.13 Check for any abnormal noise or vibration.

3.5.14 Switch on the Alternator Circuit Breaker. Load may be applied immediately to the Genset. However, the maximum step load that can be accepted in anyone step is dependent on the operating temperature of the Genset. With the Genset cold (not more than 20 degrees C/68 degrees F) the

maximum step load acceptance is approximately 50% of rated output. However, with genset at normal operating temperature (approx 80 degrees C/ 176 degrees F) the maximum load that can be accepted depending on the type of engine in one step is 60-100% of the Genset rating. These figures are given as a guide only and the relevant technical data sheet should be consulted when in doubt.

⚠ WARNING: Always shut down the Genset prior to connecting, or disconnecting, load cables. Only restart after proper connections has been made.

If at any time the generator stops because of a fault, the fault should be rectified before trying to restart the generator.

Centre button (with Hand symbol) : This button is used to start the set in manual mode. By pressing the button START output will get On & starter will get the supply through start relay at the same time fuel solenoid will also get energized. Starter will automatically Will disconnect after getting supply from alternator (Phase & neutral).

Left button (with "O" symbol) is used to stop the set, to reset the fault & to terminate the AUTO mode.

3.6 CONTROL SYSTEM FUNCTIONAL DESCRIPTION

The 703 is an engine auto start and protection module. It utilizes advanced surface mount construction techniques to provide a compact, yet highly specified module.

Operation is via three push-buttons mounted on the front panel with STOP, MANUAL START and AUTO positions.

OPERATION

Stop mode - This is used to stop the engine when it is running and to cancel 'Auto' mode. It is also used to reset any Shutdown Alarm condition.

Manual mode - This mode is used to manually start and run the engine, which can be stopped by pressing the Stop button.

Auto mode - (for AMF application only) This selects the automatic mode of operation, in which the module will await the remote start signal. Once received, the module will initiate its pre-configured Start Sequence, observing the start delay timer before starting the engine. When the remote start signal is removed, the module will initiate its preconfigured Stopping Sequence.

The module monitors the engine and provides the following functions:

• In Auto mode Automatic Start with 3 attempts and Automatic Crank Disconnect – with adjustable Start and Stop Timers and Fail to Start indication.

• Configurable Pre-heat and Energies to Stop functions.

• Low Oil Pressure and High Engine Temperature Shutdown.

• Over speed (frequency) protection.

• Charge Fail Alarm

• Two fully configurable auxiliary inputs. 1st

Auxiliary input is connected to Low fuel shutdown. 2nd auxiliary input is connected to emergency stop condition.

All alarms are indicated by high visibility red LED's.

The module's microprocessor provides a comprehensive list of timers and configurable functions. Parameter settings can be adjusted using the front panel push buttons once in Configuration Mode. PI see installation procedure.

FEATURES

• Micro-processor based design
• Automatic Engine Starting and Stopping
• Automatic Shutdown on fault condition
• Configurable via front panel
• Simple push-button controlled operation
• 10-30V DC operating voltage
• Configurable Digital Inputs
• Configurable Solid State Outputs
• Configurable Timer Settings
• Solid State Fuel and Crank outputs
• External Remote Start input
• LED Alarm indication
• Stop Delay Timer
• Energize to Stop timer
• Pre-heat Timer
• Over Speed Shutdown
• Optional Under speed Protection
• Low Oil Pressure Shutdown
• High Engine Temp Shutdown

The 700 series modules have been designed for front panel mounting. The module is fitted into the cutout, and screw holes are provided for secure fixing.

3.7 OPERATION

a) Carry out Pre-start Checks:-

Alternator Circuit Breaker Off

Engine coolant level

Engine oil level

Fuel level

All electrical contacts secure

Control panel key switch in the Off Position.

b) Switch off the Alternator Circuit Breaker.

3.7.1 Do not crank the engine for more than 5- 7 seconds if the engine fails to start.

Allow an interval of approximately 10-15 Seconds between cranking attempts, and should the engine still not have started after four cranking attempts, refer to the engine manual to determine the cause of failure to start.

At this point your genset should be running normally; the protective switches i.e. low oil pressure and high engine coolant temperature will be open and sensing their respective operating conditions. In the event of a fault the relevant fault circuit will operate and shut down the Genset.

3.8 CONTROL PANEL EQUIPMENT

The control panel is matched with an instrument panel consisting of the following:

3.8.1 Generator Instrumentation

The A.C. instrumentation provided is as follows: -

1 no. ammeter with selector switch, to monitor the current in each phase or 3 ammeter (optional).

1 no. voltmeter and selector switch to monitor the phase

to phase and phase to neutral output voltage.

1 no frequency meter monitoring the frequency of the alternator output.

1 no. hours run meter monitoring the running time of the engine (useful for establishing maintenance periods).

The following description explains the function of each instrument:-

The A.C. VOLTMETER Indicates the voltage the Genset is supplying to the load. The reading

indicated by the voltmeter will vary depending on the connections made inside the alternator terminal box, the setting of the voltage regulator, and the position of the voltmeter selector switch. It should not, however, vary when the set is operating.

The A.C. AMMETER indicates current being delivered which is dependent on the connected load. The ammeter displays current on each phase which is selected by means of the ammeter selector switch. In case of 3 ammeters selector switch is not required.

THE FREQUENCY METER indicates the frequency of the generator output. The engine maintains a relatively constant speed under governor control so as to provide proper operating frequencies of 50Hz or 60 Hz when the generator is operating at full rated load. At partial loads the frequency will be some percent higher than normal, depending on the droop of the governor. In practice at no load, frequencies of approximately 52 and 62.4 Hertz respectively are normal.

3.8.2 Engine Instrumentation

The engine instrumentation is as follows:-

1 no. engine lube oil pressure gauge.

1 no. engine coolant temperature gauge.

1 no. ammeter (To indicate charging current)

1 no. battery voltmeter (optional)

The following description explains the function of each instrument and gives the proper reading for normal operation.

The ENGINE WATER TEMPERATURE is connected to the engine at an access port which allows it to sense the temperature of the engine coolant. This gauge continually monitors the temperature of the coolant during operation. The normal temperature should be approximately 85 Deg C (green zone). This is an electrical device operating from the genset battery when the engine is running.

The ENGINE OIL PRESSURE GAUGE monitors engine oil pressure from the moment the engine is cranked.
The proper engine oil pressure rating should be approx. 3 bar - 4.5 bar at 1500 RPM. (Under full or 75% load condition) DC ammeter - This indicates battery-charging current when the engine is running and charging alternator

is developing the voltage. Battery voltmeter (optional) - This indicates battery voltage. This also indicates battery condition when engine is cranking. If battery voltage is not proper during cranking then check the battery and its connections.

The FAULT LIGHTS indicate that a shut down has been initiated by the protective circuitry.

3.9 ALTERNATOR CIRCUIT BREAKER

The molded case circuit breaker (MCB/MCCB) is of sufficient rating for the genset output. The genset output is switch able through this device, handle up being “on”. The breaker will carry its rated current continuously. Breaker will trip to the impositions if the rating of any one phase is exceeded for a period depending on the percentage overload and the MCB/MCCB characteristics. The breaker must then be moved to the “off” position before enclosing.

3.10 MAINTENANCE

No regular maintenance is required for the control system. However, to ensure that the generating set is always available for service when required, the following is recommended:-

3.10.1 Every two weeks, carry out an operational test on the system as illustrated in paragraph 4.7a. check and replace fuel levels.

3.10.2 Every four weeks, carry out an operational test on the system. The genset should be operated on at least 50% load for 2-3 hours.

3:10.3 Every six months, check tightness of all connections, tighten if necessary.

CHAPTER – 4

OPTIONAL EQUIPMENT

4.0 INTRODUCTION

Standard panels may be fitted with a variety of optional equipment during production of the generating set to meet specific requirement. Your panel may contain one or more of the following options.

4.1 BATTERY TRICKLE CHARGERS

These chargers are designed to ensure that the starter batteries maintain their charge even if the generator is not operated for long periods.

The chargers are available in two sizes (5 Amp nominal rating and 10 Amp nominal rating). A 10A charger is generally located in a separate box placed adjacent to the control panel. Control switches are not normally fitted but the chargers are automatically disconnected on generator start-up. When the engine is running the batteries are charged from the engine driven automotive-type alternator. The absence of a switch mean that the trickle charger cannot be inadvertently switched off.

However if considered essential as ON/OFF control switch can be provided. To monitor the charging current a suitably scaled moving coil DC ammeter can be provided.

NOTE: Batteries which have a very low charge should not be connected to these chargers as damage may result. An auxiliary supply of 220-240V AC is required for this option.

4.2 HEATERS

Immersion type heaters working on mains supply (110/ 220 V) can be fitted in the engine water system to ensure that the engine is kept warm easy to start and able to take load quicker. Heaters are provided with an integral non-adjustable thermostat set at approximately 40°C (100°F). The rating of the heaters in kilowatts (kW) varies depending on the size of engine. Normally the heaters with 1 kW capacity are used. Ant consideration heaters in the form of “heat-tracing” tape can be fitted to the alternator stator winding. These operate at a relatively low temperature and do not require a thermostat.

These heaters are all automatically disconnect on engine start-up.

Control switches (ON/OFF) are not normally fitted but are available as a further option.

NOTE: An auxiliary supply of 220-240V AC is required for this option.

4.3 FUEL TRANSFER PUMPS

Where a fuel transfer pump is required to transfer fuel from bulk storage tanks to the generator day tanks, a 220/240V AC single phase pump is fixed to the base frame, float switches are fitted in the day

tank and control relays, switches, lamps and overloads are fitted in the control panel.

The controls on the panel door consist of two illuminated push-button. The red is a combined trip lamp and stop button, with the green being a run lamp and manual start push-button.

For automatic pump operation the red illuminated push-button must be in the ON (out) position. The pump may be manually started at any time, provided the red push-button is in the ON position, by pressing the green push button. The pump will only run in the manual mode if the green push-button is kept depressed. Inside the panel is a DC relay (PR) which is energized by a low level switch in the day tank and de-energized by a high level float switch. A contact of this relay is in the pump contactor circuit and will cause the pump to run when "PR" is energized and the pump controls are set for automatic operation.

The pump contractor is fitted with an electrical overload which operates if the current drawn by the pump is significantly higher than normal. If this overload operates the trip lamp (red) will illuminate. The green lamp is illuminated when the pump contactor is energized.

NOTE: An auxiliary supply of 220-240V AC is required for this option. These pumps must be primed with fuel before initial running to ensure that the bearings are lubricated. Care should be taken to ensure that the pumps never run when bulk tanks are empty or when the fuel fill lines are closed.

4.4 METERS

Where more information is required as regards generator loading, the following meters may be added.

1. Three ammeters instead of one ammeter and a selector switch. This provides continuous indication of the running current in each phase.

2. Kilowatt (kW) meter.
These are generally three phase unbalanced load moving coil meters. The meter is fitted on the panel front, with the transducer mounted on the chassis. This provides accurate readings of the load being supplied by the engine.

3. Digital RPM and Hour meter
This is optional to the standard frequency meter.

4.5 GAUGES

To give further information on engine performance the following gauges may be fitted.

1. Oil Temperature Gauge

This is an electrical device operating from the genset battery, which monitors the lubricating oil temperature when the engine is operating.-

The normal operating temperature should be approximately Ambient temperature +80°C for air-cooled engines and Ambient temperature +65°C for water cooled engines, though this will vary between engine models.

2. Ammeter for Engine Driven Charger

This gauge monitors the current flow to and from the battery. It is primarily used to observe the charging current being supplied from the engine driven battery charging alternator. When the batteries are fully charged this charging current will be small (less than 5 Amps) but with a partially discharged battery or just after an engine start this current may be as high as 30 Amps.

4.6 SPEED /VOLTAGE CONTROL

Volts Adjust Potentiometer

To allow minor adjustments of voltage to be made from the control panel, a single turn 5k Ohm potentiometer can be fitted. This allows an adjustment of up to 5% about the rated voltage.

Speed adjust Potentiometer

This option can only be used when the engine speed is being controlled by an electronic governor. The engine speed/ frequency can be varied using this potentiometer.

4.7 ALARM SIGNALLING

Two options are available to supplement the standard fault indications on the panel. These are:

1. A set of volt free contacts which changeover in the event of a generator fault. These contacts remain in the “alarm” condition until the fault is reset.

2. A siren which sounds in the event of a generator fault condition. The siren (D.C. operated) is supplied loose for fitting in a convenient location.

The siren can be switched off by pressing the MUTE push- button on AMF panels, or by turning the key to the OFF position on Keystart panels.

4.8 AUTOMATIC MAINS FAILURE

OPTIONS

Mains Sensing Relay Option

When an AMF panel is supplied without a changeover panel the mains sensing relay, which is normally located the changeover panel, may be fitted in the set mounted control panel.

This relay requires a three phase from the incoming side of the mains switch. The relay can then be adjusted such that it will de-energize and start the set when the mains voltage drops below the set point.

This includes following parts

1) Mains sensing module

2) Timer modules

3) Relay module

4) Load Transfer contractor

1) Three phase mains is applied to the LVM unit. This senses for mains under voltage, phase sequence, and phase missing. If all the conditions are OK, this gives mains healthy signal. This signal is used for starting and stopping the set.

2) Different timers are used for

(a) Mains restore delay. If mains restores correctly Mains ON contactor will get ON after this delay.

(b) Genset start delay after the mains fail.

(c) Set warming delay. After this delay genset contactor will get 'ON'.

(d) Set cool down delay. After load change over on mains. Set will run on 'No load' for a time set by this timer.

3) Relay modules - This includes electromechanical relays with appropriate current rating.

This controls outputs such as start, stop, common alarm. Mains contactor ON and generator contactor ON outputs are options.

4) Load transfer contactors - 3 pole (4 pole optional) contactors are used for automatic load transfer to either mains or generator. These contactors are electrically interlocked so as both the contactors will not get 'ON' simultaneously, (mechanical interlock is optional).

5) Selector Switch - This is used for selecting

the mode of operation. Auto Mode - In this mode, load will gets automatically connected to either mains or genset depending up to the status of mains. In this mode, genset control unit should be also in 'Auto.'

Man Mode - In this mode, load can be switched
'ON' or 'OFF' on either on mains or on genset depending upon the mains or genset supply available.

Off Mode - Load will get switched off.
Test Mode - Genset can be tested for start and stop using test ON and test OFF buttons.

Mains / Genset selector Switch - This switch is used to. Check over the voltage of either main or

genset.

Voltage selector switch - Ph-Ph or Ph-N (RYB, N) voltage can be seen on voltmeter with the help of this switch.

Indications
1) Load on mains - This will get 'ON' when mains contactor gets 'ON'.
2) Load on genset - This will get ON when genset contactor gets ON.
3) Mains Fail - This lamp will gets ON when mains fails or mains phase sequence is not proper.

4.9 FAULT FINDING

This section can be used to assist in finding the cause of faults listed under "Additional Alarm / Shutdowns".
It must be read in conjunction with the Trouble Shooting chapter of Section 4 of this manual and also the separate engine and alternator manuals.

FAULT INDICATION	CHECKS
1. Battery Charger Failure	1. Check the mains voltage. 2. Check the fuse provided. 3. Check the voltage at the output of charger.
2. Low Fuel Level	1. Check fuel level in day tank and fill as required 2. Ensure Fuel Transfer Pump (if fitted) is operating as described in Chapter 4A.3.
3. Earth Fault	1. Check all cable and wiring for bad connections or shorts to earth. 2. Check alternator winding as described in the Alternator Manual.

4. Earth Leakage	1. Check outgoing cabling and wiring for faults. 2. Do not re-start generator until fault has been cleared.
5. Over volts	1. Disconnect generator from load and restart. 2. Check voltage on panel meters. If voltage is normal ensure that the load is non capacitive (power factor correction equipment may lead to a capacitive load). 3. If voltage remains high and cannot be adjusted to the normal level refer to the alternator manual.
6. Under volts	1. Check the voltage of panel. 2. Check the engine rpm. 3. If voltage remains low and cannot be adjusted to normal level refer alternator manual.

Remark： Because the control panel of the diesel generator sets is base on Clients' requested, if the control panel of the diesel generator set is not the same as this Operation Manual, the operate technique depend on the control panel Operation Manual .

CHAPTER – 5

MAINTENANCE

5.1 GENERAL

A good maintenance programmed is the key to long genset life. Below is a program that should keep your machine in top running condition. Also included in this programme are routine maintenance operations required for the engine and alternator (see Engine Maintenance and Alternator Maintenance Sections).

It is good practice to have all of the maintenance and service operations performed by trained personnel familiar with genset maintenance. This along with a good service records system, should aid in developing an efficient maintenance program. The service records of each genset should include information such as complete nameplate data with model and serial numbers, all drawing and wiring diagrams, spare parts stock lists, as well as a service schedule and a copy of this manual.

These records will allow quick reference and may help to diagnose a problem in the future.

5.1.1 Daily Maintenance or at Each Start Up

Standby applications may lengthen these requirements to weekly.

1. Make a visual check of the entire genset. Watch for signs of potential leaks from the engine fuel system, cooling system or lubrication seals.
2. Check the alternator for obstructions in the cooling air ventilation screens.
3. Check the alternator and control box for heavy accumulation of dust and dirt. Clean any heavy accumulations as electrical hazards, as well as cooling problems, could arise.
4. Check the air filter. Clean or replace if necessary.
5. Check the fuel level.
6. Check the engine coolant level.
7. Be sure that the radiator air flow is not obstructed.
8. Check the condition of the fan and alternator belts and their tension
9. Check all hose connections and hose conditions.
10. Check the engine oil level.
11. Check the battery terminals for corrosion.
12. Check the battery electrolyte level and fill with distilled water if necessary.
13. Refer to the engine maintenance section for specific engine maintenance requirements.
14. Start the machine after all checks have been made.
15. Drain condensate traps in the exhaust system, if so equipped, and check for exhaust leaks.
16. Check for any abnormal noise or vibration.
17. Check for fluid leakage or high temperature.
18. Dispose of any unnecessary items in the vicinity of the genset that may inhibit operation or

represent cause of potential injury.

19. Check the control panel for indications of abnormal operation.

5.1.2 Maintenance Every Six Months or 250 Hours

1. Repeat the daily requirements.
2. Check all safety devices by electrically simulating a fault to ensure that all systems will function properly in the event of a fault.
3. Clean all battery cap vents.
4. Start the genset and observe the instrument panel to be sure that all gauges and meters are operating properly.
5. Tighten all exhaust connections.
6. Tighten all electrical connections.

7. Refer to the engine maintenance section, for further details.

5.2. ALTERNATOR UNIT CLEANING

The alternator unit should be cleaned inside and out on a regular basis. The frequency of such cleanings depends on the environmental conditions of the operating site. The following procedure should be applied when cleaning is necessary:-

Disconnect all power. Wipe dust, oil, water or any other liquids from the external surfaces of the alternator unit. All of these materials can work their way into the windings and may cause overheating or insulation breakdown. Remove these same materials from the ventilation screens around the circumferences of the unit.

Do not permit such material to accumulate on these screens as this will obstruct air flow. Such debris is best removed with a vacuum cleaner as a vacuum cleaner will not redeposit these materials on other parts of the equipment. DO NOT USE COMPRESSED AIR, STEAM OR A HIGH PRESSURE WATER CLEANER.

A vacuum cleaner should also be used to clean the windings of the alternator unit. This will remove dust from the coils that cannot be reached with a wiping cloth.

5.3. Radiator Maintenance

5.3.1 Introduction

The radiator supplied with your generator set is designed and constructed to give many years of trouble free operation in industrial environments. There are, however, several points of maintenance that will ensure trouble free operation.

5.3.2 GENERAL OPERATING NOTES

WARNING: Radiator coolant is normally very hot and under pressure. Do not work on the radiator or disconnect pipe work until it has cooled down. Do not work on the radiator or remove any guarding while the fan is in motion.

Corrosion in the radiator can be a prime cause of failure. This is prompted by air in the water. Always ensure pipe connections are free of leaks and bleed air from top of the radiator regularly to keep the system “air free”.
Radiators should not be left standing in a partially filled condition. Radiators left partly filled with water will suffer much more rapidly from the effects of corrosion. For an inoperative generator set, either drain the radiator completely or ensure that it is maintained full. Whenever possible, radiators should be filled with distilled or naturally soft water, dosed with suitable corrosion inhibitors.

5.3.3 CLEANING

5.3.3.1 EXTERNAL

In dusty or dirty conditions the radiator fins can become blocked with loose debris, insects, etc. and this fouling will have an effect on the performance of the radiator. For regular removal-of light deposits use a low pressure stream jet. More difficult deposits may need a detergent with a low pressure hot water hose.
Stubborn deposits, which cannot be removed by the above methods may require removal of the radiator and immersion in a heated alkali degreasing solution for about 20 minutes and then washing off with a hot water hose.

5.3.3.2 INTERNAL (Preferably call specialist)

If, due to leaky joints for instance, indiscriminate topping up with hard water has been carried out for some time, or if the generator set has been run without inhibitors the system may become fouled by scale.

To decaled the radiator call APT authorized service dealer being a specialized job.

The procedure is as follows:

1. Drain the water system and disconnect and bank off the pipe connections to the engine.
2. Prepare a 4% solution of inhibited acid solvent and fresh water. Add the acid to the water, never vice versa.
3. Allow several minutes for mixing, then heat the solution to 49°C (120°F) maximum.
4. Run the solution slowly into the radiator via the filler cap or a branch in the manifold. Effervescence

will occur; when it ceases, fill the radiator completely with the heated solvent.
5. Allow to stand for several minutes; then drain the solvent back into the original container through the bottom manifold or drain plug.
6. Examine the interior of the headers. If scale remains repeat the process outlined above with the solvent strength increased to 8%.
7. After decaling the acid solution has to be neutralized as follows:-
Fill the mixing container with fresh water, heat to boiling point then add common washing soda crystals at the following strength; 0.5 kg of soda to 20 litres water (1 lb soda to 4 gallons water). Fill the radiator with this solution, then drain it back into the container.
1. Flush the radiator in this manner several times, finally leaving the radiator full for at least an hour. Drain until empty and wash out the radiator with hot fresh water.
2. Before putting the radiator into service again, fill with water and apply a test pressure equal to twice that of the working pressure. Examine carefully for any leaks which may have been revealed by rescaling.
3. Prior to decommissioning, the coolant must be dosed with any necessary corrosion inhibitors and/or the correct proportion of antifreeze.

CHAPTER – 6

BATTERIES

6.1 SAFETY

ALWAYS ensure battery charging is carried out in a well ventilated area away from sparks or naked flames. A clear notice should be displayed stating “NO SMOKING OR NAKED LIGHTS PERMITTED IN THIS AREA”.

NEVER operate the charger where unprotected from rain or snow. The charger should not be used near water. Ensure that the mains supply has been correctly terminated and the GREEN/YELLOW lead MUST be connected to a good earth (Ref. 8.2)

ALWAYS switch charger off before disconnecting battery and ensure that there is no sparking or naked flames, as concentration of fumes in the area can cause the battery to explode.

NEVER group batteries close together around the charger as damage and premature failure to components will be caused by the corrosive fumes.

ALWAYS handle batteries with care and wash hands after contact to prevent the possibility of acid burns. Wear suitable protective clothing and display first aid notices.

NEVER permit unauthorized personnel in the battery charging area except under supervision.

6.2 CHARGER AND BATTERY CONNECTIONS

Ensure that secure and proper connections are made to a suitable mains plug with the following colour code:

MAINS

LIVE..... ....marked ‘L’ ..... .Brown lead

NEUTRAL....marked ‘N’ .....Blue lead

EARTH.....marked ‘E’ .. ...Green/Yellow lead

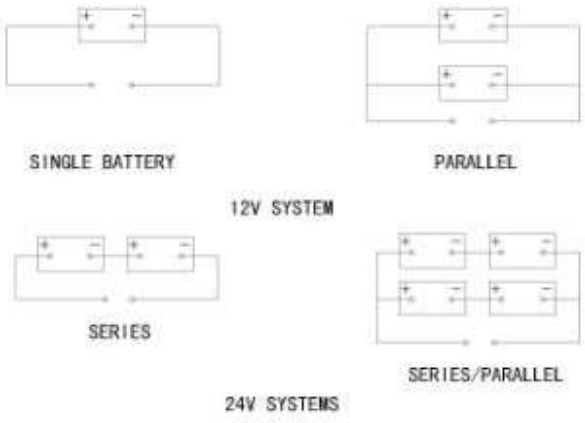
NOTE: Power supply rating must not be less than 13 AMPS.

BATTERY

Red..... Positive+

Black..... Negative -

Connections must be clean and free from corrosion.



6.3 CHARGER OPERATION

6.3.1 GENERAL

Follow the safety recommendations outlined in 8.1.

Check battery and charger are connected as described in 8.2.

Remove the battery filler caps or vent cover during charging. Check electrolyte level and adjust if necessary, following the procedures in 8.4.

Switch on charger and observe charge rate for normal operation. If any problem is encountered refer to Fault Finding 8.5.

6.3.2 STATE OF CHARGE

Allow the battery to settle for a short period with charger switched off before checking the specific gravity of each of the battery cells. Using -a hydrometer, the reading should be approximately 1.27 for each cell at a nominal temperature of +15°C.

6.3.3 CHARGING RATE

The charging rate depends on the Ampere-hour capacity (its size) of the battery, the condition of the battery and the level of charge present.

The initial charging current will decrease as the battery starts charging and the charging current will continue to decrease (or taper) as the battery voltage rises.

IMPORTANT: With proper use, by following the instructions, the Automatic Battery Charger should not overcharge and damage batteries. A lead acid battery will be damaged if the temperature of the battery rises above 52°C (125°F) by overcharging. Care should be taken when charging batteries that are hot, particularly in tropical countries, where charging should always be carried out in a cool shaded area. Consult the battery manufacturer’s information and always check the specific gravity with a hydrometer.

6.4 BATTERY MAINTENANCE

6.4.1 GENERAL

The “battery” is an assemble of cells containing a number of positive and negative electrodes or “plates” immersed in an electrically conductive fluid or electrolyte (sulphuric acid). The electrical, energy released during discharge is derived from the chemical reactions taking place within the cells. These reactions are reversible which means the battery can be repeatedly charged and discharged.

6.4.2 TOPPING UP AND FILLING

WATER

The most satisfactory water to use when preparing electrolyte is distilled water. This is also true for routine water additions to the battery. Generally speaking, any water that is safe to drink (excluding mineral waters) is safe to use in a battery. Do not use water of a known high mineral content. Avoid the use of metallic containers (except lead or lead lined containers). Metal impurities in the water will lower the performance of the battery.

TOPPING UP

Clean top of battery to avoid contamination and remove vent plugs. Add distilled water until level is 5-10 mm above the top edge of the separators. Replace and tighten vent plugs. Dry top of battery.

ELECTROLYTE AND SPECIFIC GRAVITY

The electrolyte in a lead-acid storage battery is a dilute sulphuric acid solution. A battery with a fully charged specific gravity of 1.265 corrected to 80°F (26.7°C) contains an electrolyte in approximately 36% sulphuric acid by weight or 25% volume. The remainder of the electrolyte is water. Pure (concentrated) sulphuric acid has a specific gravity of 1.835. The sulphuric acid in the electrolyte is one of the necessary ingredients in the chemical actions taking place inside the battery. It supplies the sulphate (804) which combines with the active material of the plates. It is also the carrier for the electric current as it passes from plate to plate. When the battery terminals are connected to an external load, the sulphate combines with the active materials of the positive and negative plates forming lead sulphate (PbS04) and releasing electrical energy. Electrons flow from the negative terminal to the load (such as fuel solenoid), and back to the positive terminal .

Specific gravity is a unit of measurement for determining the sulphuric acid content of the electrolyte. The recommended fully charged specific gravity of most 12 volt batteries today is 1.265 corrected to 80°F (26.7°C). water has arbitrarily been assigned a value of 1.000. therefore, electrolyte with a specific gravity
of 1.265 means it is 1.265 times heavier than pure water.

If it should become necessary to dilute concentrated sulphuric acid to a lower specific gravity always pour the acid into the water - do this slowly - never pour water into acid. A dangerous “spattering” of the liquid would result. This is caused by extreme heat which is generated whenever strong acid is mixed with water. Stir the liquid continually while acid is being added.

FILLING

Add electrolyte until level is 5 to 10 mm above the top edge of the separators. Allow battery to stand for 20 minutes. Check and adjust level as necessary. Replace and tighten vent plugs. The quantity of electrolyte required can be determined from the following table:

6.4.3 HYDROMETER-DESCRIPTION AND

HOW TO USE

The state-of-charge of a lead acid battery can be determined by the specific gravity of the electrolyte (its weight compared to water). The specific gravity can be measured directly with a hydrometer or determined by the stabilized voltage.

A hydrometer is a bulb-type syringe which will extract electrolyte from the cell. A glass float in the hydrometer barrel is calibrated to read in terms of specific gravity. A common range of specific gravity used on these floats is 1.160 to 1.325. Do not assume a battery will not take a charge because you have been charging it for a time and the float will not rise. The battery may have been fully discharged and will require considerable charging before reaching the minimum specific gravity on the float such as 1.160 (approximately 1/4 charged). The lower the float sinks in the electrolyte, the lower its specific gravity. The barrel must be held vertically so the float is not rubbing against the side of it. Draw an amount of acid into the barrel so that with the bulb fully expanded, the float will be lifted free, touching neither the side, top or bottom stopper of the barrel.

Your eye should be on a level with the surface of the liquid in the hydrometer barrel. Disregard the curvature of the liquid where the surface rises against the float stem and the barrel due to surface tension. Keep the float clean. Make certain it is not cracked.

The following table illustrates typical specific gravity alues for a cell in various stages of charge with respect to its ability to crank an engine. A fully charged specific gravity-of 1.265 corrected to 80°F (26.7°C) is assumed.

TYPICAL OPEN CIRCUIT VOLTAGE AND SPECIFIC GRAVITY VALUES

CHARGE LEVEL	SPECIFIC GRAVITY	VOLTAGE
100%	1.265	12.7
75%	1.225	12.4
50%	1.190	12.2
25%	1.155	12.0
DISCHARGED	1.120	11.9

Never take a hydrometer reading immediately after water is added to the cell. The water must be thoroughly mixed with the underlying electrolyte, by charging, before hydrometer readings are reliable. If a reading is being taken immediately after the battery has been subjected to prolonged cranking, it will be higher than the true value. The water formed in the plates during the rapid discharge has not had time to mix with the higher specific gravity acid above the plates.

6.4.4 INITIAL CHARGING

Within 24 hours of filling, or if battery stands inactive for more than 6 months, charge for at least 2 hours at the approximate current in amperes shown above. This charge will have to be carried out on a workshop type charger.

6.4.5 CLIMATE

TROPICAL CLIMATES

Most batteries used in temperate climates have a fully charged specific gravity in the 1.250 to 1.280 range. A fully charged electrolyte specific gravity of 1.210 to 1.230 is used in tropical climates. A tropical climate is considered one in which water never freezes. This milder strength electrolyte does not deteriorate the separators and grids as much as the higher strength electrolyte. This increases the service life of the battery. The lower specific gravity decreases the electrical capacity of the battery, especially the cold cranking performance. However, these losses are offset by the fact that the battery is operating at warm temperatures where it is more efficient and cold cranking performance is not required.

The following chart shows the approximate specific gravity values of batteries at various states of charge. One column shows values for batteries whose electrolyte specific gravity has been prepared for use in a temperate climate; the other column for batteries prepared for use in a tropical climate. It illustrates that batteries may be fully charged and yet have different values of specific gravity. The values shown are for a cell in various states of charge with respect to its ability to crank an engine at 80°F (26.7°C). The specific gravity values shown will vary depending on the ratio of electrolyte volume to active material and the battery construction.

State of charge	Specific Gravity Temperate Climates	Specific Gravity Tropical Climates
Fully charged	1.265	1.225
75% charged	1.225	1.185
50% charged	1.190	1.150
25% charged	1.155	1.155
Discharged	1.120	1.080

Batteries prepared for service in extremely cold weather use stronger electrolyte. In some instances specific gravities of 1.290 to 1.300 are used. The cold cranking performance increases as the specific gravity is increased.

6.4.6 ELECTROLYTE

Use only pure dilute sulphuric acid, of the correct specific gravity to suit temperature of operation:

COLD OR TEMPERATE CLIMATE	TROPICAL CLIMATE
1.270 Kg/L	1.230 Kg/L

Check specific gravity with a good quality hydrometer and correct readings as follows. If electrolyte temperature differs from the hydrometer's calibrated temperature:

For each 10°C above add 0.007 to observed reading.

For each 10°C below subtract 0.007 from observed reading.

For each 10°F above add 0.004 to observed reading.

For each 10°F below subtract 0.004 from observed reading.

(This can make a substantial difference at extreme temperatures).

Adjust specific gravity using distilled water.
Note - for safety always add acid to distilled water.

6.4.7 TEMPERATURE CORRECTION

Hydrometer floats are calibrated to give a true reading at one fixed temperature only. A correction factor must be applied for any specific gravity reading made when the electrolyte temperature is not

80°F (26.7°C). Some standard hydrometers use a reference temperature of 60°F (15.5°C). A temperature correction must be used because the electrolyte will expand and become less dense when heated. The float will sink lower in the less dense solutions and give a lower specific gravity reading. The opposite occurs if the electrolyte is cooled. It will shrink in volume, becoming denser. The float will rise higher and read too high.

Regardless of the reference temperature used as a standard a correction factor of 0.004 specific gravity (sometimes referred to as 4 “points of gravity”) is used for each 10°F (5.5°C) change in temperature. Four “points of gravity” (0.004) are added to the indicated reading each 10°F (5.5°C) increment above 80°F (26.7°C). This correction is important at extremes of temperature because it can become a substantial value.

The thermometer should be of the mercury-in-glass type with a scale reading as high as 125°F (52°C). The smaller the club immersion the better, but it should not exceed 1" (25mm). The electrolyte should be drawn in and out of the hydrometer barrel a few times to bring the temperature of the hydrometer float and barrel to that of the electrolyte in the cell.

6.5 FAULT FINDING

FAULT LOCATION

WARNING : REMOVAL OF THE COVER FROM THE CHARGER WILL EXPOSE DANGEROUSLY HIGH VOLTAGE TERMINALS. TESTS ON THE CHARGER WITH THE COVER REMOVED MUST ONLY BE CARRIED OUT BY A COMPETENT ELECTRICIAN USING SUITABLE INSTRUMENTS.

CHAPTER – 7

CLOSED COUPLED GENSET ASSEMBLY

Note on Assembly of close coupled genset with single bearing Alternator

7.1.Base frame:

Frequent relocation, initial installation ease, vibration isolation or isolating from mounting surfaces, such as trailers, are major uses of fabricated bases. No base should be rigidly connected to flexing surfaces.

7.1.1) Base frame should be rigid enough for the selected engine/alternator combinations so that it will not deflect during handling/operation of the set.

7.1.2) Provision should be made in the base frame for lifting of the set.

If the pads are provided on base frame for anti vibration mounts then these should have machined surface.

7.1.3) APT recommends that engine & alternator assembly should be mounted on ant vibration mount.

7.1.4) APT recommended typical base frame is shown in fig1. Drawings of base frame as recommended by APT for various combinations with single bearing KG alternator has been prepared & made available as required.

7.2. Following rules should be followed as a guideline while selection/positioning of the anti- vibration mountings

7.2.1) The number & type of the mounting should be selected such that the static deflection of each mount, for the weight under consideration should be 2 to 3 mm. This will insure about 80% of vibration isolation.

7.2.2) The anti vibration mountings should be positioned equidistance from center of gravity of the set to ensure equal weight distribution & uniform Deflection

7.2.3) Ref. the table1 APT part nos. of AVMs to be used below engine GE & alternator .

Please ref. the Table 2 Engine models flywheel housing used & alternator housing & disc coupling required.

2 Anti vibration mountings

Table 1

Sr. No.	Engine Model	KOEL part nos. for AVM below engine GE Qty. 2
1	HA294	02.432.02.0.00
2	HA394	02.432.02.0.00
3	HA494 & HA494 TC	02.432.02.0.00
4	HA694 & HA694TC	02.432.01.0.00
5	3R1040	02.432.02.0.00
6	4R1040	02.432.02.0.00
7	4R1040T	02.432.02.0.00
8	4R1040TA	02.432.02.0.00
9	6R1080T/TA	48.497.02.0.00
10	6SL 1500TA(180-200I	F6.626.02.0.00

Table 2

Sr. No.	Engine Model	Engine flywheel housing	Alternator Housing & disc coupling
1	HA294	SAE-2	SAE-2 & DISC SAE-11.5
2	HA394	SAE-3	SAE-3 & DISC SAE-11.5
3	HA494 & HA494 TC	SAE-3	SAE-3 & DISC SAE-11.5
4	HA694 & HA694TC	SAE-3	SAE-3 & DISC SAE-11.5
5	3R1040	SAE-3	SAE-3 & DISC SAE-11.5
6	4R1040 & 4R1040T	SAE-3	SAE-3 & DISC SAE-11.5
7	4R1040TA	SAE-3	SAE-3 & DISC SAE-11.5
8	6R1080T & 6r1080TA	SAE-3	SAE-3 & DISC SAE-11.5
9	6SL 9088TA(140 -160I	SAE-1	SAE-1 & DISC SAE-14
10	6SL 1500TA(180-200I	SAE-1	SAE-1 & DISC SAE-14
11	6SL6800TA(250I	SAE-1	SAE-1 & DISC SAE-14

7.3) Recommended Assembly procedure for Close Coupled Genset

7.3.1) All the fasteners used for assembly should be 8.8 high tensile strength. Bolt length should be such that minimum thread engagement in the respective tapped holes is 1.5 times the size of bolt. (That is for M10 bolt minimum thread engagement 15mm)

7.3.2) Check the crankshaft end play with the help of magnetic based dial it should be

For R1040/R1080/HA series between 0.19 to 0.36 mm.

For 6SL90 series between 0.12 to 0.33 mm.

7.3.3) Mount the specified AVMs on base frames on engine gear end side & alternator side. Clamp AVMs firmly on the base frame with suitable bolts & nuts.

7.3.4) Mount the alternator support channel on two AVMs on alternator side with suitable bolts. This channel is used to support the alternator & to maintain the center height.

7.3.5) Remove the fasteners for clamping coupling disc to alternator body (for transport purpose).

7.3.6) Mount the engine with suitable bolts on AVM (mounted on base frame) with temporary support to bell housing.

7.3.7) Remove the alternator front both sides' air outlet covers .

3.8) Assemble two taper pins with threading or M10X1.5X50 long studs on flywheel, on diametrically opposite tapped holes to guide the disc coupling when the alternator is being assembled on engine.

7.3.9) Locate the alternator adaptor-housing spigot to bell housing of engine. At the same time ensure locating pins are aligned with holes on alternator disc coupling. The alternator needs to be supported by lifting tackle during this process.

3.10) The bolts for alternator adapter & disc coupling can be accessed through the air ventilation window on the alternator adapter housing. Mount firmly alternator adapter with engine bell housing with the help of 12 bolts.

3.11) Remove the taper pins & fix the disc coupling of alternator to flywheel with suitable bolts. For bolts on the disc coupling suitable machined hard washers should also be used.

3.12) Remove the temporary support given below the bell housing & mount firmly the alternator on alternator support channel.

3.13) After assembly, check again the crank shaft end play it should be same as that measured on bare engine (3.2). Normally the alternator shaft has about 2 mm free axial movement on either side of nominal position of disc coupling to allow for variation in the interfacing dimension i.e. distance between disc coupling & meting face of adapter. Incase the crank shaft end play is not observed as mentioned above the alternator service person

should call for checking the alternator.

3.14) This will complete the close-coupled assembly.

Important : Do not run the set if there is a variation in Crank shaft end play after alternator assembly. To do so will cause engine failure.

Please ref. table below for tightening torque for Standard straight shank bolt with threads lubricated 8.8 tensile grade.

M10	5.0 kgm
M12	8.7 kgm
M14	14.0 kgm
M16	21.0 kgm

CHAPTER – 8

VERTICAL STOP SOLENOID SETTING

STEP BY STEP INSTRUCTIONS FOR MOUNTING, ALIGNING and SETTING OF THE FUEL STOP SOLENOID PART NO. : 4H.150.10.0.00 & F6.570.11.0.00

Please refer attached Drg. No. EC - O - 2010 named STOP SOLENOID ASSY. ON FUEL PUMP

1. Mount bracket assembly 03 on the Fuel pump at shown location and tighten M6 X 50 2 nos. Hex head screws 08.

2. Loosen the top nut 12 of the tie bar.

3. Attach the Tie Bar 10 to the FIP at the place shown.

4. Connect the Ball Joint 14 to the Fuel Stop Lever 17 by Nylock Nut 15 provided with the link.

5. Just tighten(don't apply force) the top nut 12 of the tie bar on the upper face of the bracket 03. Lock the tie bar With the top nut 12 & bottom nut 12A.

6. Adjust the length of the Link Rod 13 by rotating it in the Ball Joint Socket 14 such that, there will remain a gap G of approx. about 1.5 - 2.0 mm between lower stopper 19 of the FIP and the Stop Lever 17 when the stop lever is at its down most position (Press it down by hand -Fuel Off position). Note 3 on the attached reference Drawing.

7. Check resistance by digital multimeter on range 200 OHMS between Solenoid terminal 02 and bracket 03.

When the stop lever 17 is at Fuel ON position – TOP position the resistance should be approx. 0.3 Ohms

(Pull coil resistance for 12V solenoid). Now press the stop lever by hand to Fuel Off - bottom- position the resistance should increase to approx. 11 OHMS (and it is to be equal to HOLD coil resistance). This must be confirmed by moving the Stop Lever UP and DOWN manually prior to energizing the Solenoid. Repeat the point 7 two three times to confirm the setting. If this is correct then setting is OK.

8. If the resistance is not correct as per the point 7, then adjust slightly as per point 6.

9. Connect the battery –VE (negative) to bracket 03.

10. Connect Positive + VE (Positive) to terminal 02.

11. During pull operation solenoid is taking 40A current. After completion of stroke pull coil gets disconnected & hold coil holds the stop lever in stop position. Hold coil will take apron. 1A /0.5 A current. Use external actuating device (Relay/push button) of 50/60A current capacity to energies the solenoid. Use 4 sq mm cable from battery – relay/push button - stop solenoid. This will reduce the voltage drop in contacts & cables. For guaranteed operation of stop solenoid minimum 10V is required at solenoid terminal. (for 12 V system) & 18 V (for 24V solenoid).

12. Switch on the supply to the Solenoid momentarily and observe :
a) The voltage at the terminal 02 during the very brief period between energize and completion of the stroke is more than 9.5 V DC.

b) That the solenoid pushes down completely the Stop Lever 17. This is indicated by glowing of the Green LED located on the top of the cover near terminal 02. This indicates that the pull coil has disconnected.

13 Fault & remedies :

SR. NO.	OBSERVATION	CAUSE	CORRECTION
1.	Multimeter shows open circuit.	Fuse Blown	Replace fuse. Check alignment and setting as per instruction 5 to 7 above.
2.	Solenoid does not push the stop lever down and fuse blows.		DO
3.	Resistance does not change from LOW Pull value to HIGH Hold value.	a. Stroke is not fully completed. b. Built in switch does not operate.	Check setting as per instruction 5 to 7 above.
4.	Green LED does not glow.	a. Stroke is not fully completed. b. Built in switch does not operate. c. LED faulty.	Check setting as per instruction 5 to 7 above. If possible replace LED or ignore.
5	Multimeter shows resistance 11 ohm (Hold coil) in fuel ON position - ever top position	a. Pull coil open b. Internal switch Faulty.	Replace the solenoid.

CHAPTER – 9

WARNING

WARNING !

OPERATIONAL PROCEDURE
UPDATE
Warning: The excessive build up of unburned fuel gases in the exhaust system of diesel powered generating sets can create a potentially explosive condition which could cause personnel injury and/or equipment damage. Please follow the procedures below:

FUEL PRIMING

The fuel system on all engines should be completely primed to ensure immediate starting. Excessive cranking with an unprimed fuel system may cause a build up of unburned fuel gases in the exhaust system. Engine priming procedures can be found in the engine operation manual.

FAILURE TO START

If during initial start or during normal starting the engine fails to start after the initial 3 crank attempts, stop cranking and unscrew the plugs on the exhaust outlet elbows or stub pipes. White smoke (unburned fuel) will usually be present. Once all signs of unburned fuel have disappeared and any other problems causing the failure to start have been rectified, replace the plugs and repeat the cranking procedure. If it is necessary to demonstrate air valves closing when the engine is running this should be done at no load. The engine should absolutely not be restarted immediately afterwards. The closing of the flap valves

can cause oil carry over into the exhaust system which is highly volatile. The engine should be left for a period of time to allow these gases to dissipate.

HOT ENGINE SHUTDOWN

If the engine shuts down due to a fault condition such as high water temperature or low oil pressure, etc., do not restart immediately. Remove the plug on exhaust

outlet elbows or stub pipes to disperse fuel gases. Once these have disappeared and the shutdown fault has been cleared, restart the engine.

OIL PRIMING

The oil system on all engines should be completely primed to ensure safe operation. To ensure that

engine cranking for priming the oil system does not cause unburned fuel to build up in the exhaust system, first disconnect the supply to the fuel solenoid or actuator then crank the engine until a positive oil pressure is

registered on the gauge. Do not crank the engine for more than 5-7 seconds should the oil pressure fail to build up and indicate.

Allow an interval of approximately 10 seconds between cranking attempts, and should the oil pressure still not have built up after three cranking attempts, investigate the reason for lack of oil pressure prior to further cranking.

During normal cranking attempts, the unburned fuel gases will generally not build up to a dangerous level before the standard batteries are depleted. In cases where additional “fresh” batteries or an outside source of power are used, extra care must be taken.