FG Wilson Diesel Generator Set
Operator & Maintenance Manual

2 Cylinder Diesel Engine

Dear Customer,

We are glad that you have selected our state of art “FG WILSON DG SETS”.

Each FG Wilson Generator Set is a result of long term research & development. The research & development takes into consideration the arduous operating conditions and user practices to create a world class reliable product.

Every Generating Set is thoroughly tested and passes through a series of checks & stringent quality control to ensure trouble free operation.

This Operation & Maintenance manual has been prepared by keeping in mind needs of most of the users starting from the installation right up to the maintenance schedules and trouble shooting charts.

Kindly study the manual carefully before operating the Genset.
Use only genuine FG WILSON spare parts for servicing and maintenance to keep the generating set running in good condition.

We are sure this FG Wilson Generator Set will serve you well for years as you continue to maintain it, as presented in this manual.

Yours faithfully,

For FG Wilson.

(Sales & Service)

While asking for assistance Please provide the following Information

- ✓ Your Name , Phone or Fax Number & Email-ID
- ✓ Engine Serial No
- ✓ Name of the Customer
- ✓ Engine Location
- ✓ Type of Use
- ✓ Approx. Running Hrs. of Engine
- ✓ General Description of Assistance Required

ANNEXTURE

SECTION I – WARRANTY & SERVICES

Installation & Commissioning report

SECTION II – GENSET

Introduction
Name plate details
Genset rating
Know your genset
Do's and Don'ts
Installation
Safety information
Attention before use
Start and stop genset

SECTION III – ENGINE

Technical Specifications
Maintenance schedule
Engine & Genset Model Number
Oil level checking
Changing oil level
Lub oil filter
Fuel system
Maintenance of cooling system
Thermostat
Coolant top up
Start up precaution
Maintenance air cleaner
Battery
Fuel and fluid specification
CPCB 2 & EGR System
Fault finding chart

SECTION IV – AC ALTERNATOR

General
Operating principal
Automatic voltage regulator
Salient features of alternator
Standard reference condition
General comment on load condition
Selection ac alternator different load application
Technical specification
Exploded view & parts list
G. A. Diagram
Assembly of engine
AVR input selection

SECTION V- CONTROL PANEL

STANDARD CONTROL PANEL

Introduction
Control panel
Control panel circuit diagram
Fault finding chart

AMF CONTROL PANEL

Introduction
Features of Panel
Pre Start Checks
Construction of Panel

PREFACE

This manual gives you information on the Genset operation and maintenance. The performance of the Genset solely depends on its proper maintenance and operation.

So, please maintain your Genset properly as per the instructions and schedule provided in this manual section wise.

Section I SERVICE

Section II GENSET

Section III ENGINE

Section IV ALTERNATOR

Section V CONTROL PANEL

Section VI ACOUSTIC ENCLOSURE

CONVENTIONS

Each Warning / most important instruction in the manual succeeds the  sign.

All the significant procedures are highlighted in bold letters in the manual.

SECTION I

INSTALLATION & COMMISSIONING REPORT

Genset Model No.		**Details of Alternator**
Sr. No & Mfg. Date (as mentioned on Name plate)		**Alternator Make :**
		Alternator Model :
Engine Model No.		**KVA Rating :**
Engine Sr. No. (as mentioned on Name plate)		**No. of Phases :**
		Alternator Sr. No :
Battery Make		
Battery Serial No		
Control Panel Model / Sr. No.		
Date of Installation		

Name & Address of Customer	**Site Address of Customer**

	Contact Person Name	**Phone No.**	**Mobile No**	**e-mail id**
1				
2				
3				

PRE COMMISSIONING CHECKS

Sr. No.	**Nature of Checks**	**Status**	**Remarks**
1	Genset Installation.		
2	No obstruction to cooling air inlet and air outlet.		
3	All canopy doors must open fully for service access.		
4	DG set room ventilation, if installed in a room.		
5	Fitment of exhaust silencer and exhaust piping.		
6	Earthing a) 2 Nos. of earthing pits for genset / control panel Body. b) 1 Nos. of earthing pit for neutral. c) 1 Nos. of earthing pit for alternator.		
7	Visually check for all fasteners.		
8	Visually check for all wiring connection in control panel.		
9	230 V supply connections from Electricity for battery charger if standard control panel used.		
10	Visually check all the connectors and actuators on engine.		
11	**Electricity board Load**		
	a) R- Phase		
	b) Y- Phase		
	c) B- Phase		
	Please ensure electricity board load equally distributed in all three phase		
12	**Electricity board Voltage**		
	a) R-Y Phase		
	b) Y-B Phase		
	c) B-R Phase		
	a) R-N Phase		
	b) Y-N Phase		
	c) B-N Phase		

CARRY OUT FOLLOWING INSTRUCTIONS DURING COMMISSIONING

Sr. No.	Check Details		OK	NOT OK	Remarks
1	Lub Oil Level				
2	Fuel Level				
3	Coolant Level				
4	Leakages				
	a) Oil Leakage • Cam cover • Chain case Cover • Oil sump • Oil filter • Turbo • All hoses				
	b) Coolant Leakage • Radiator • Radiator inlet and outlet Hoses • Coolant Pump • Engine inlet and outlet Hoses • Oil Cooler				
	d) Fuel Leakage • Fuel Filter • Fuel Feed pump • Low pressure pipe • IMV Pump • HP Pipe • Back Leak pipe • Fuel tank • Fuel tank Drain plug				
	e) Air Leakage				
5	Phase Difference	Reading in Amp			
	R- Phase				
	Y- Phase				
	B- Phase				

Performance Trial :									
Load (%)	Testing Time (min)	Load (Amps)			Voltage (Volts)			Frequency (Hz)	Remarks
		R	Y	B	R	Y	B		
0	5								
25	5								
50	5								
75	5								
100	10								
Commissioning Date & hrs									
Customer's remarks, if any :									

I hereby declare that Generator has been tested under load conditions and performance is found to be satisfactory.

Name and Sign of Customer

Name and Signature of Service Engineer / Dealer

SECTION II

GENSET

1. INTRODUCTION

This new Genset is designed to provide you superior performance and reliability. The Genset is a complete system that incorporates advanced engineering concepts.
As the Genset is compact and light weight in its class, it gives the advantage of optimizing valuable space.

The environment friendly CRDI Diesel engine powering the Genset meets the most stringent exhaust emission norms that are certified by ARAI, India. This DG set is lowest in noise level that is certified for noise compliance by CPCB, India.

2. NAME PLATE DETAILS

3. GENSETS RATING

Engine Alternator matching is achieved by following STP conditions.

Ambient Temperature : 25º C

Relative Humidity : 60%

Altitude : 100 meter from MSL

De ration is applicable if actual site conditions vary from the STP conditions.

4. KNOW YOUR GENSET

Genset Rating- It is punched on name plate.

Genset is a diesel engine driven field power unit mounted on base frame inside the acoustic enclosure. FG Wilson Diesel Engine is used as the prime mover.

All necessary controls, meters and other indicators are provided on control panel. This panel has various indicators and facilities for starting / stopping of the Genset.

Details of control panel & its operation have been described in Control Panel Section.
The Genset is used as power source for supplying AC power.

5. Do's and Don'ts

Do's

Always operate the DG with closed canopy doors

- **Coolant Level Check: -** Check coolant level and top up required amount as and when required. Fill the specified coolant only. Always maintain "Min" coolant level.

- **Lubricating Oil Level Check: -** Check lubricating oil level. It should not be less than 'Min' level. If required, please top up oil level to 'Max' mark only with same grade of oil.

- **Air Intake System: -**Check vacuum indicator, if it shows a red band with stopping of engine, remove the air cleaner and clean the air cleaner housing with compressed air, then change filter filament.

- **Belt: -** Inspect the mark on the Belt Tensioner. If it has reached the maximum travel, replace the belt.

- **Hoses & Connections: -** Inspect if there is crack & damages on hoses and connections. If so they need to be replaced.

- **Electrical Checks: -** Check all connections i.e. battery, all sensors & ECU, AVR and alternator output cable connection for proper tightness.

- **Battery Check: -** Check water level & terminal pole connections for looseness & sulphation. Clean the terminal pole and use petroleum jelly to avoid sulphation.

- **Cleanliness:** - Keep the DG set free from dust and clean it on daily basis.

- **Diesel Fuel: -** Keep the close track of diesel level so as to keep fuel system free from air. Water from water separator needs to be drained daily.

- **Running Hours:** - On daily basis check engines of DG set's running hours and get in touch with the nearest dealer for frequent recommended service checks.

- **Load Application:** - Keep electrical load on DG set up to 75-80% of DG set capacity for optimum performance & prolonged life. If Genset is used as standby application then run the Genset for 30 min. in a week on at least 25 % of rated load.

- **Logbook:** - Maintain daily log book consisting of run hours, start time, stop time, oil pressure, coolant temperature, oil temperature, power factor, KW, KVA and current in Amperes.

- **Shutdown :**- It is important to run the engine on no load for 2 to 3 min. before loading the generator as well as before shutting down to allow lubricating oil & coolant to carry heat away from the combustion chamber, bearings etc.

Don’ts

- Do not carry out any checks in running condition.
- Do not open the radiator cap in engine for checking coolant level just after the engine has stopped, running as pressurized water in radiator may cause severe steam burn.
- Do not touch any moving part while engine is running.
- Do not check lubricating oil level during running or just after stopping as it will give you wrong reading.
- Do not add acid of any strength to the battery and impure raw water for maintaining the electrolyte level. Use distilled water only.
- Do not remove the battery when engine is running.
- Do not top up the engine oil level with used lubricating oil.
- Do not tamper Hour meter.
- Do not crank the engine more than 30 seconds continuously.
- Do not operate the engine with any leakage or with abnormal noise.
- Do not over extend the changing frequency of filters & lubricating oil.
- Do not allow dirt or any debris to enter oil system during oil change.
- Do not run the engine on “No Load” for long period.
- Do not bring naked light near battery.
- Do not allow unauthorized person to attend / operate the engine.
- Do not operate engine with any portion or ducting removed.
- Do not leave behind tools, empty vessel, wood, waste clothes, loose wires etc. inside DG set canopy after repair/maintenance work.

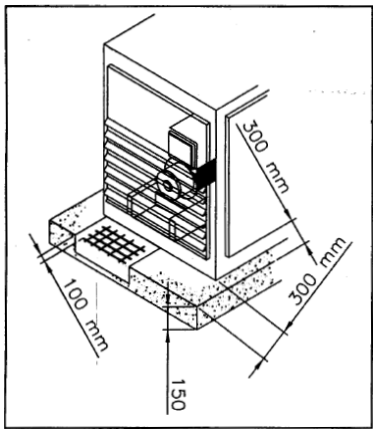
6. INSTALLATION

Location

Selecting a location for the Genset is very important aspect of any installation procedure. Always install the Genset in an area that will provide cross ventilation and physical protection to the unit. To carry out maintenance & inspection it is important to place the Genset in such a position so as to allow easy movement around the machine. 1.5 to 2.0 meters space around the Genset should be ensured, so that all canopy doors can be opened fully and person can walk around the Genset with doors open.

The location should be clean, dry and have good drainage capabilities to avoid water logging in case of rains.

Foundation



If the plane and hard ground is there the genset can be placed directly on the ground.

If uneven surface or hard ground is not available then follow the following guidelines.

Foundation should be elevated about 100mm from ground level. The foundation may be located on soil, structural steel.

A reinforced concrete pad or PCC 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 125 mm to 150mm deep and mass at least equal to that of the Genset. Also the foundation should be elevated 100 mm from the ground level.

Isolation

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

Vibration

The design of the Genset is such that only minimal vibration is transmitted to the foundation. Anti vibration mounts (AVM) are fitted between engine, alternator and base frame.
It is necessary to ensure that building structures are capable of supporting the Genset, fuel storage and accessories.

The silencer & related piping which are mounted at a height from the generating set radiate heat. Hence it is necessary to have ventilation on the side walls at a height of about two meters in case Genset is installed in a room. Ensure that sufficient cross ventilation is available in the room.

Air Inlet

Engine inlet air must be clean and as cool as possible. These conditions will help to improve engine life and performance.
Always run the generator with installed Air Filter to increase the set Life.

Exhaust

Design exhaust system in such a way that over all back pressure should not exceed by 50 mm of Hg.
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. Extended exhaust piping must be separately supported, not on the exhaust silencer of Genset. At points where the piping passes through a wall or roof, a metal thimble guard 300mm in diameter slightly larger than the pipe should be installed.

As per CPCB directive, the exhaust outlet should be at least 3 meters above the tallest point of a building in which the Genset is installed. Recommended I.D of exhaust piping beyond the silencer outlet on the Genset is as follows

Pipe Length	**Up to 10m**	**Up to 20m**	**Up to 30m**
Minimum I D	**75mm**	**100mm**	**150mm**

Any long horizontal or vertical piping should include water locks and drain trap 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 lock or rain trap be added to ensure the proper removal of water.

ELECTRICAL CONNECTION

The flexible cable should be connected from Genset to the connected load by a qualified electrician.

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

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 compatibility with the installation. This is vital when connection is made to an auto transfer switch, or if the machine is to be paralleled.

THREE PHASE OUTPUT

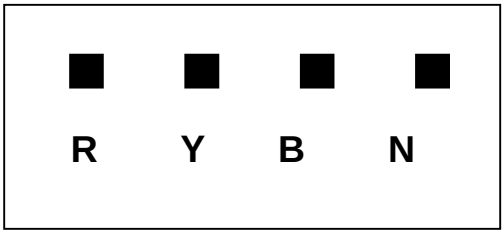
Generator set with R, Y, B, N four connection. 'N' is neutral and R, Y, B are live wires. Connecting the R, Y, and B can get the output of three Phases.

Connecting the **R and N** or **Y and N** or **B and N** can get the Single Phase output as shown in picture.

1. Connect the 'N' and any of ‘R’ or 'Y' or 'B' can get the single phase power output.

2. Connect the **R, Y, B** can get the three phase power output.

Please note that your Genset has three phase output. Don't overload the generator when you use single phase power. It is not recommended to use single phase output if your Genset is three phase.



SINGLE PHASE OUTPUT

Generator set with **R and N** or **Y** and **N** or **B** and **N** can get the single phase output.

 **Connect the p and N can get the single phase power output**	 **Connect the p and N can get the single phase power output connect ER terminal to earthing**

LOADING

When planning your distribution system it is important to ensure that a balanced load is presented to your Genset.

PROTECTION

The cables connecting the Genset with the distribution system should be protected by means of a circuit breaker, fuses which are provided in control panel.

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

POWER FACTOR

The power factor (cos Ø) 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 at its rated 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.

EARTHING REQUIREMENTS

⚠ 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.

NECESSITY OF EARTHING

Earthing provides protection to personnel and equipment by ensuring protective control gear and isolation of faulty circuit in following cases:

- Insulation puncture or failure.
- Accidental contact between high & low voltage lines.
- Breakdown of insulation between primary & secondary winding of a transformer.
- Lightning strokes.

EARTHING DETAIL AND GUIDELINES

A) EARTHING SYSTEM DETAILS

- An earthing pit should be there for DG set.
- Earthing value should be at least 1 ohm. It may get from depth of Min.13- 14 feet for earthing.
- Earthing Plate and strip size should be selected as per rating of the DG set.
- Watering pipe of 19 mm with funnel should be provided for each earthing pit.
- Earth pit cover should be provided.
- Separate earthing should be used for body and neutral.

WIRE SIZE SELECTION

SR NO	PHASE	KVA	KW	AMP	COPPER SQMM	ALUMINIUM SQMM	CABLE TYPE
1	1	10	8	43.4782609	6	10	TWIN ARMOURED CABLE
2		15	12	65.2173913	16	25	
3		20	16	86.9565217	25	35	
4		25	20	108.695652	35	50	
5		30	24	130.434783	50	70	

SR NO	PHASE	KVA	KW	AMP	COPPER SQMM	ALUMINIUM SQMM	CABLE TYPE
1	3	10	8	13.9285466	1.5	2.5	4 CORE ARMOURED
2		15	12	20.8928198	2.5	4	
3		20	16	27.8570931	4	6	
4		25	20	34.8213664	6	10	
5		30	24	41.7856397	10	16	
6		40	32	55.7141862	16	25	
7		62.5	50	87.053416	25	35	3.5 CORE ARMOURED
8		82.5	66	114.910509	50	70	
9		100	80	139.285466	70	95	
10		125	100	174.106832	95	150	
12		140	112	194.999652	120	185	
13		160	128	222.856745	185	240	
14		180	144	250.713838	185	300	

B) EARTHING EXTENSION

- Earthing extension may be done with GI strip, copper strip or copper wire as per site and DG set rating.
- GI strip should be joined with help of GI Nut and bolt only. Welding should be avoided to join the strips.
- Neutral earthing extension should be separated from body earthing extension.
- Earthing extension should be joined at earthing points specified in Silent DG.

POWER CABLING AND END TERMINATION

A. POWER CABLE SELECTION CHART

Power cable should be used of 3.5 cores Armoured or 4 Core Armoured for 3 Phase DG set and 2 Core Armoured for single phase DG set. Power cable may be of Copper or Aluminum as per site condition and requirement. Always select cable after calculation of de ration on account of temperature, laying method and number of runs. Please refer the Table for selection of power cable as per rating of DG sets.

Note:-

a. Correct size cable glands should always be used for holding the cable.
b. Control wiring should always be done with 2.5 Esq. Copper cable.

B. END TERMINATION DETAIL

Proper Lug and Thimble should be used to terminate the cable in bus bar or contactors. Crimping tools should be used to fix thimble and lug. Cable should be fixed properly with cable gland plate using Compression gland.

C. CABLE LYING

Cable may be laid at ground, trench, and cable tray or on wall as required. At least 2 to 3 loop should be used to lay the cable. Cable should not have any stress and sharp bend. Avoid joints in cable.

7. SAFETY INFORMATION

This generator is developed for specific applications. Do not attempt to modify the unit in any way or use it for any application that it is not designed to do. Ask the dealer or contact manufacturer if you have any questions

- The generator produces a very powerful voltage. That can cause extremely dangerous electrical shock. Avoid contact with bare wires, terminals etc. never permit unqualified person to operate or service the Generating set.

- Never handle any kind of electrical cord or device while standing in water, while barefoot or with wet hands or when feet are wet. Dangerous electrical shock could result.

- The national electric code requires that the frame and external conductive parts be properly connected to an approved earth ground. Local electrical codes may vary.

- Use a ground fault circuit interrupter if any, damp or highly conductive area such as metal decking or steel work.

- Do not use worn, bare, frayed, damaged electrical cords or wiring with the generator. A defective cord may result in electrical shock or may cause damage to equipment.

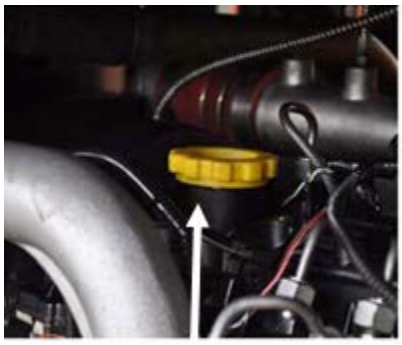
- Comply with all laws regulating the storage and handling of diesel fuel. Diesel fuel is highly flammable and explosive. Avoid spilling diesel fuel on a hot engine, do not allow smoking, open flames, spark or heat in the vicinity while handling diesel fuel.

- Do not overfill the fuel the fuel tank. Leave one inch space below fuel filling neck to allow diesel fuel expansion. Diesel fuel could overflow and cause fire or explosion if tank is overfilled. Allow at least 20 minute cool down before refueling. Never refuel tank while engine is running.

8. Attention Before Use

Before use, place the generator set to flat level surface. For outdoor usage, provide adequate protection cover in order to avoid rain pour and sun. The environment should be clean and be prohibited to place caustic things such as acidity, alkalescency and so on nearby.

Please check and restart the Generator set after connecting Genset loading lines.



OIL FILLING CAP

OIL LEVEL GAUGE

MAINTAIN OIL LEVEL

1. Please check & fill the oil in the engine.
2. Add appropriate amount of engine oil before the use of new generator set.
3. Do not use dirty or used oil.
4. Pay attention to the oil level of the oil dip stick while adding engine oil, which should not exceed the upper limit mark on the oil dip stick and also no lower than lower mark.
5. Please check & fill the diesel fuel in fuel tank. The signs are as follows

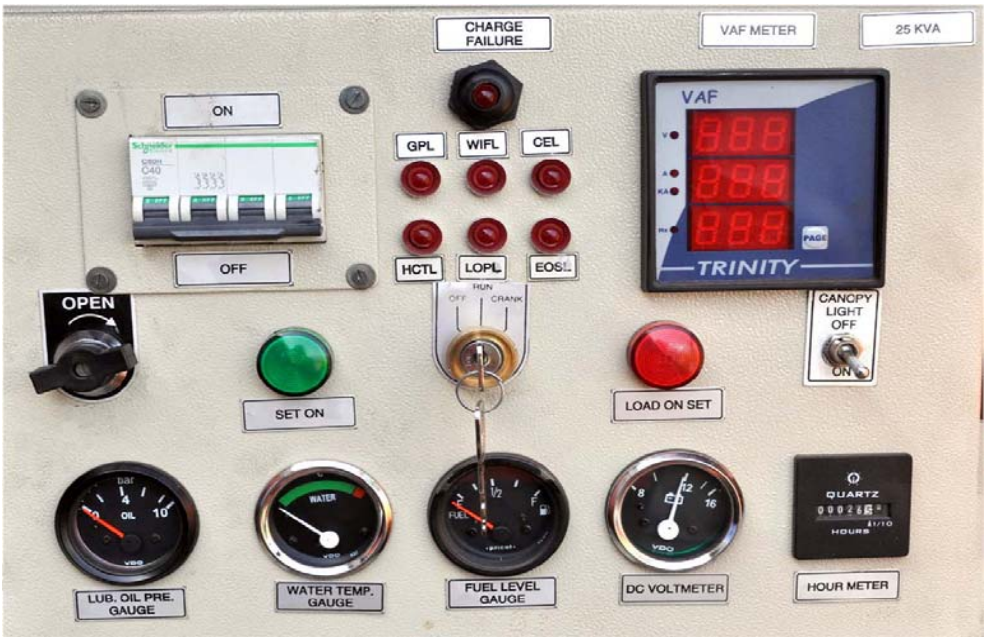
Note: Use commercial High Speed Diesel fuel.

6. Please fill the coolant in radiator tank. The signs are as follows.

RADIATOR CAP

Add only non-contaminated coolant into the coolant tank, water with impurity will block water tank and its inner water circulation, causing damage to the overheating of generator set. Please add antifreeze into the compensating bottle/tank.

Start and Stop Genset



IGNITION SWITCH WITH KEY

- Ensure that MCB is in **"OFF"** position before starting & stopping of Genset.
- To start the Genset, turn the ignition key clockwise to **CRANK** position to start the engine. As soon as the engine starts release the key to **RUN** position.
- To stop the Genset, turn the ignition key anticlockwise to "**OFF"** position to stop the engine.

SECTION III

TECHNICAL SPECIFICATIONS OF FG WILSON 2 CYLINDER DIESEL ENGINES

ENGINE

Sr.No	Description	Unit	Data	
1	Engine Model		FBDH2- 1.2D / FBD2-1.2D2/3	FBD2-1.2D1
2	Type of Engine	-	Vertical,4-stroke,CRDI with Turbo charger & Charge Air Cooler	Vertical,4-stroke,CRDI, Naturally Aspirated
3	Rated Speed		3000/1500	1500
4	Number of Cylinders	-	2	2
5	Bore	mm	87	87
6	Stroke	mm	100	100
7	Cubic Capacity	Lit.	1.2	1.2
8	Number & Arrangement of Cylinder	-	2-Vertical	2-Vertical
9	Firing order	-	1-2	1-2
10	Working cycle	-	4- Stroke Diesel	
11	Combustion principle	-	Compression Ignition	
12	Compression ratio	-	17.5 : 1	19 : 1
13	Direction of Rotation(looking from flywheel side)	Anti – clockwise		
14	Cooling system	-	Liquid cooled	
15	Overall Dimensions			
	Length	mm	530	530
	Width	mm	640	640
	Total Height	mm	721	721
16	Dry Weight of Standard Engine	Kg	210 Kg	185 Kg
17	Lubrication system	-	Forced Feed System with ‘G’ rotor pump	
18	Oil Sump/Pan Capacity (max.)	Lit	4.5	4.5
19	Recommended fuel specification	Commercial High Speed Diesel (Specifacatio:IS1460 updated from time to time)		
22	Recommended oil specification	SAE 15W40 – CH4		
21	Lube oil consumption	< 0.1% of fuel consumption		

PREVENTIVE MAINTENANCE CHECKS - DIESEL ENGINE					
Daily	**Weekly**	**Monthly**	**Every Six Months / 500 Hrs**	**Every 1 Year / 1000 Hrs**	**24 Months/ 2000 Hrs**

	Repeat Daily Checks	Repeat daily & weekly checks	Repeat daily weekly & monthly checks	Repeat daily, weekly, monthly & 6 months checks	Repeat daily, weekly, month, 6 months & yearly checks
Check engine oil level. Top up if required with same grade of oil.	Check air system for hoses, clamps, pipings etc.	Check foundation bolts	Change oil.	Change Air filter element	Change coolant
Check / Fill diesel in Fuel Tank	Check lubrication system for leakages and rectify.		Change lube oil filter Element.	Clean Radiator Externally	
Drain water in fuel if water in fuel signal ON & drain if required	Check fuel system for leakages and rectify.		Change fuel filter element	Turbocharger visual inspection	
Check leakages & Service Indicator.	Check cooling system for leakages and rectify.		Clean air cleaner housing & change filter element if required.	Check condition of rubber hoses	
Clean Engine Externally.	Check Battery & Battery connection.		Check Sensors / wiring	Check & replace belt if necessary	
	Check Fasteners and retighten.		Check & replace oil separator assembly	Check the free rotation of fan hub, tensioner, idler pulley and battery charging alternator	
	Check alternator & control Panel connection.				
	Check Gauges & Indicators on control panel.				
	Check battery charger connection &charging voltage				

MAINTENANCE SCHEDULE

NOTE:

Lube oil, lube oil filter and fuel filter change after every 500 Hrs.
Air filter element to be changed, when service indicator shows red band.
Component checking & cleaning activities are to be carried out when Genset is not in operation.
As this engine electronically control, cleaning with water is not recommended.

MAJOR OVERHAUL

Major overhaul is recommended at 7000 hrs depending upon performance of engine.

Following points are to be considered:

a) Lube oil pressure it should be > 2.0 kg/ cm2.
b) Exhaust condition it should not be smoky.
c) Capacity of engine to sustain load.
d) Excessive blow bye.
e) Abnormal sound from engine.

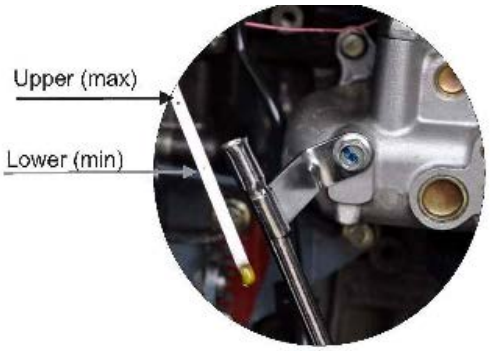
Following activities are to be carried out:

a) Check cylinder head for valve leakage- valve grinding / replacement if required.
b) Decarburizations of combustion chamber, piston ring grooves.
c) Replace cylinder liner, piston & piston ring set.
d) Replace bearings
e) Crank shaft grinding, if required Replace joints, gaskets & 'O' rings of dismantled components.

NOTE: Engine overhaul work should be done at authorized service dealer only.

MAINTENANCE OF LUBRICATION SYSTEM

A) OIL LEVEL CHECKING



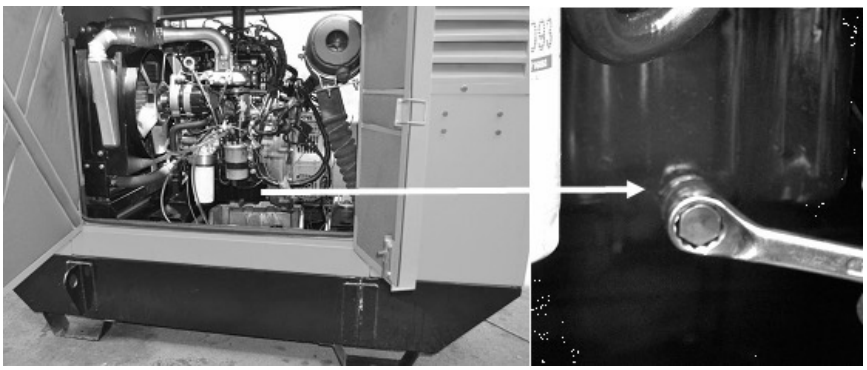
- Ideally the oil level should be checked with engine at room temperature and minimum half hour after stopping the engine. Ensure that engine is in horizontal position.
- Take out the dipstick, wipe it with a non fraying rag and insert it back as far as it will go and then withdraw again.
- The film of oil left on the dip stick should be within upper (max) & lower (min) marks.
- If the level only reaches to the lower mark, the oil should be topped-up without delay.

Warning:
Failure to attend to this may result in serious damage to the engine (Piston & bearing seizure)

B) CHANGING ENGINE OIL

- Change engine oil at every 500 hrs or six months, whichever comes earlier.
- Position engine on level surface.
- Run engine until warm (Lube oil temp. approx. 80º C).
- Stop the engine.

Warning:
Take care when draining off hot oil: Danger of scalding! Collect used oil in suitable receptacle ready for proper disposal to prevent environmental pollution.



- Place oil tray under the engine.
- Remove the drain plug.

- Drain the engine oil from oil sump.
- Assemble the drain plug with new copper washer.
- Fill in fresh lube oil as per the recommendations.
- Normal oil sump capacity is @ 4 liters.
- Dispose the engine oil as per local rules & regulation.

C) LUBE OIL FILTER

- Remove the oil filter by hand or special spanner and drain the oil completely.
- Check the condition of sealing ring, if necessary change it.
- Add fresh oil (@ 0.5 liters) in the filter assembly.
- Replace the oil filter in place of old one. Apply slight oil on sealing ring and assemble the oil filter until sealing ring is evenly seated.
- Check oil level, oil pressure and leakage through sealing ring, if any.

D) FUEL SYSTEMS

1. FUEL FILTER

1. Disconnect the fuel lines (fuel tank to fuel filter and fuel filter to fuel pump-IMV).
2. Replace the fuel filter with new “O” ring in place of old one.
3. Complete the filter assembly and fuel line connections before starting the engine.
4. Change over period, for fuel filter, is given in maintenance schedule.

NOTE:

- To remove the air lock, in the fuel line, loosens the IMV pump banjo bolt of supply pipe. Keep the ignition key in RUN position then submersible fuel feed pump will start; keep the pump on till total air get removed.
- Do not clean filter. Using cleaned filter, leads to reduce filtration efficiency and damage fuel injection system.
- The routine maintenance schedule is meant to serve as guide only for normal fuel and engine operating conditions. Replacement of fuel filter may have to be made earlier than recommended period.

Warning
When working on the fuel system, keep naked lights away.

2. FUEL TANK CLEANING

- Cleaning frequency every six months. This frequency may vary according to fuel condition.
- Fuel tank is located below the engine.
- To remove the tank first removes the feed pump & necessary connections.
- Fuel tank to be removed from control panel side of canopy.
- Drain the diesel from tank completely.
- Clean the tank with fresh diesel & with compressed air
- Check & clean breather of diesel tank.
- Refit the tank on its position.
- Fit the feed pump in its position & reconnect all connections.
- Fill tank with fresh diesel.
- Remove the air from fuel system.

E) MAINTENANCE OF COOLING SYSTEM

CLEANING OF RADIATOR:

- If Radiator or Charge Air Cooler fins are found clogged during periodic checking.
- The system should be cleaned thoroughly.
- Remove the radiator service door, if fitted.
- If possible use compressed air for cleaning. Start blowing air on to the radiator & charge air cooler from protection screen side. (i.e. opposite direction to normal cooling air flow).
- While removing dirt on the fins, do not use hard brush.
- Remount radiator service door.

NOTE: Clean only when engine is stationary and cold.

F) THERMOSTAT

Inspect the thermostat for damage. Make sure thermostat is clean & free from corrosion. Suspend the thermostat & a 100º C thermometer in a container of water. Do not allow the thermostat or thermometer to touch the container. Heat the water slowly to the wax element in the thermostat as sufficient time to react to the rising water temp. Thermostat must begin to open at 78º C Thermostat must be fully opened at 87 º C.

Note: If above tests do not meet, replace the thermostat.

G) COOLANT TOP UP

If system is top up by water, it leads to dilution of coolant and hence coolant concentration becomes lower.

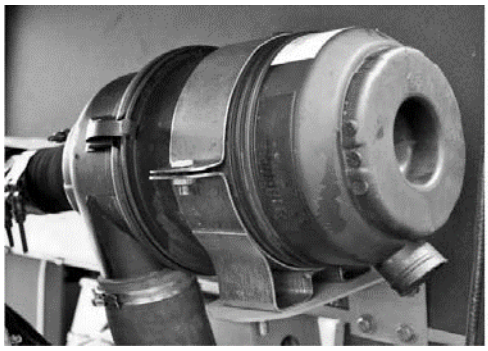
In order to maintain the coolant concentration it is must to top up the system by premixed coolant only

H) START UP PRECAUTIONS

Before you start the engine or after a long period please ensure following points.

- Check lube oil level, if required fill lube oil to the 'Upper' mark on dip stick.
- Check coolant level & fuel level in radiator & fuel tank.
- Check battery leads connections, electrolyte level in battery.
- Check wiring loom connections to all sensors & ECU.
- Remove the air from fuel system.

I) MAINTENANCE OF AIR CLEANER



Dry filter air cleaner is supplied as standard fitment on Gensets.

- For change of Air cleaner element, the 'Restriction Indicator' should be checked. If the Red indicator is seen through the window even after engine is stopped, the air cleaner element should be changed.
- Stop the engine and wait about 10 minutes.
- Remove the filter element from air cleaner.
- Clean filter housing by cotton cloth.
- Assemble new filter element.
- Re-assemble the air cleaner.

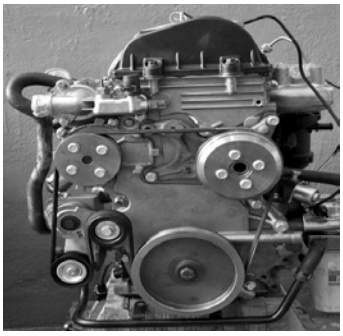
NOTE:

Always cover the engine inlet manifold while the air cleaner is being serviced.

Cleaning of air filter with compressed air is not allowed

BELT DRIVE

CHECKING POLY 'V' BELT



- Inspect Poly 'V' belt over whole length for damage or cracks. Replace the damaged or cracked belt.
- Check the Belt Tensioner mark. If it has reached the maximum mark, replaced the belt.
- Check the alignment by using alignment gauge.

REPLACING POLY 'V' BELT

- To replace the belt, lower the belt tensioner arm to release pre-tension and then remove the belt.
- Fit new belt.
- Check the alignment by using alignment gauge.

NOTE: Engine is fitted with Auto-Tensioner as a standard fitment.

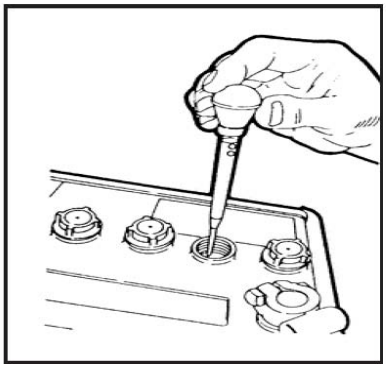
BATTERY

A) CHECKING ELECTROLYTE LEVEL

- Remove cell caps.
- If electrolyte test elements (pegs) are provided, the level should be high enough to wet the bottom of these.
- If no such elements are provided, the alternative method is to insert a clean wooden stick into the cell, until it touches the top edge of lead plates. The electrolyte should wet the stick over a length of about 10 to 15 mm. If the electrolyte level is low, top-up with distilled water only.
- Re-place cell caps.

B) CHECKING SPECIFIC GRAVITY OF ELECTROLYTE

- Check the specific gravity of electrolyte with a hydrometer, five minutes after adding distilled water.
- Measure the specific gravity of electrolyte in the individual cells with a commercial hydrometer.
- The measured values (Table below) indicate the state of charge of the battery.
- Charge the battery if the reading is below the values given in the table.



Specific Gravity

Normal	Status
1.270 – 1.280	Fully charged
1.230 - 1.240	Half charged, Recharge
<1.230	Discharged, Charge up immediately

CONNECTIONS

Connections to terminals, terminal strips, plugs and sockets should be periodically checked against the circuit diagrams.

INSTRUMENTS

Instruments fixture clips and screw should be tightened if they have worked loose during transit.

TIGHTENING TORQUES FOR GENSET

Sr. No	Fastener	Torque (Nm)
1	AVM mounting bolts M12x30	58 – 64
2	Engine front mounting support foot M12 x 30	58 – 64
3	Genset Cover M10x35	46 – 54
4	Genset cover adaptor plate M10x 30	46 – 54
5	Coupling plate (Spigot plate) M8 x 20	22 – 28
6	Radiator mounts M8 x 20	22 – 28
7	Alternator mounting bolt M12 x 30	58 – 64
8	Spacer to Fan hub bolt M8 x 70	22 – 28
9	Fan to Spacer M6 Bolt	09 – 12
10	Control panel mounting bolt M8 x 25	22 – 28
11	ECU mounting bkt. Bolt M6 x 20	09 – 12

PROCEDURE FOR TIGHTENING THE FASTENERS

- Lubricate the fasteners with engine oil.
- Tighten the fasteners with open Spanner / Ring Spanner by hand.
- All the fasteners are to be tightened equally and diagonally (opposite manner).

FUEL AND FLUID SPECIFICATIONS

1) DIESEL FUEL SPECIFICATIONS

Diesel fuel must be clean, fresh, meet fuel specifications and be sourced from known and reputable supplier. Clean, fresh and properly specified diesel fuel will provide assurance of maximum engine performance and maximum fuel injection system longevity. The use of out-of-specification, dirty or questionable quality diesel fuel will result in engine performance and start ability problems as well as reductions in engine and fuel injection system life.

FG Wilson diesel engines are operating on commercial High Speed Diesel fuel. However, some geographical areas, by virtue of cold / winter temperature, FG Wilson recommend the use of Winter Grade fuel.

At low temperatures, waxing may occur and clog the fuel system, thus causing operational problems. For ambient temperature below 10ºC, it is expected to use "Winter Grade HSD" which may be available at the local outlets. If it is not available then it is recommended that HSD should be mixed with pure Kerosene in the following proportion.

- 15 % Kerosene for ambient temperature below +10ºC down to 0ºC.
- 30 % Kerosene for ambient temperature below 0ºC down to -10ºC.
- 50 % Kerosene for ambient temperature below -10ºC down to -20ºC.

2) COOLANT SPECIFICATIONS

Ethylene Glycol based Anti-freeze with corrosion inhibitor / coolant usage is required for all FG Wilson engines. Never operate engines with the cooling system filled with only water. First the anti-freeze coolant mixture prevents or reduces the potential for corrosion within the cooling system. Secondly, the anti-freeze coolant increases the boiling point of cooling fluid, reducing the potential of localized boiling within the engine and engines overheat in general. Lastly, the anti-freeze/coolant reduces the freezing point of the engine coolant, thereby reducing or preventing potential engine damage caused by freezing.

Many different brands and types of anti-freeze are available in the market. Some anti-freeze/coolants are designed exclusively for automotive type cooling systems with aluminum cooling system components. Other anti-freeze is designed exclusively for use within heavy-duty, predominately cast iron cooling systems and requires that the coolant solution be" charged" with a Supplemental Coolant Additive (SCA). Other anti-freeze solutions are designed for long life and are sometimes designed "permanent".

FG Wilson recommends only those ant-freeze/coolants which are ethylene glycol based and designed to protect aluminium coolant components, thus automotive anti-freeze/coolant. Long life anti-freeze/coolants may be used so long as the anti freeze is changed at least every two (2) years as is required by the FG Wilson engine Maintenance schedule. FG Wilson does not recommend the use of low silicate heavy duty antifreeze coolant which may or may not require the use of SCA's.

The following provides guidelines for the selection of acceptable ant-freeze/coolants for FG Wilson diesel engines.

ANTI-FREEZE/COOLANT CONCENTRATION

FG Wilson recommends that the minimum anti-freeze/coolant concentration be 50% when mixed with water. Concentration below 30% will not provide adequate corrosion protection. Concentration of anti freeze/coolant in excess of 60% provides no appreciable additional freeze protection and can actually reduce the heat rejection capability of the cooling system. As such, FG Wilson recommends that an anti-freeze/coolant mixture of 50% anti-freeze/coolant AND 50% water be used for most general applications. Please refer details regarding freezing points as supplied from your anti-freeze/coolant supplier for mare exact information.

WATER SPECIFICATIONS

FG Wilson recommends that the engine cooling fluid solution be made up of the ethylene glycol based anti-freeze/coolant and water. The quality of the base water does play a large role in the overall chemical composition of the coolant solution and the corrosion prevention characteristics of the solution. As such, tap water may be used as long as the water meets the following specifications with reference to SAE j1941:

PROPERTY	SPECIFICATION	TEST METHOD
Total Solids (max.)	340 ppm	ASTDM 1888
Total Hardness (max. $CaCO_3$)	170 ppm	ASTDM 1126
Chloride (max.)	40 ppm	ASTDM 512
Sulphate (max. SO_4)	100 ppm	ASTDM 516
PH	5.5 – 9.0	ASTDM 1293

ANTI-FREEZE COOLANT MINIMUM RECOMMENDATIONS/SPECIFICATIONS

FG Wilson recommends that only automotive type anti-freeze/coolants be used in the engines. These anti-freeze/coolants are typically “high Silicate”, although not always, and are designed to prevent corrosion in cooling systems with aluminium components.

NOTE: many brands/products meet the specifications presented above and may be used within FG Wilson diesel engines. The engines owner is responsible for determining the suitability of any given anti freeze/coolant to the minimum specifications provided. Failure to follow the above coolant guidelines may impact the engine warranty.

RECOMMENDED OIL

API- CH4 15W-40

ITEM	SPECIFICATION	QTY
Engine Oil	API –CH4 15W40	4.5 Liters

RECOMMENDED LUBRICANTS

ITEM	SPECIFICATION	QTY
Coolant (ANTI FREEZE AGENT WITH CORROSION INHABITER)	Ethylene Glycol	6.5 Liters

CPCB – 2 & EGR SYSTEM

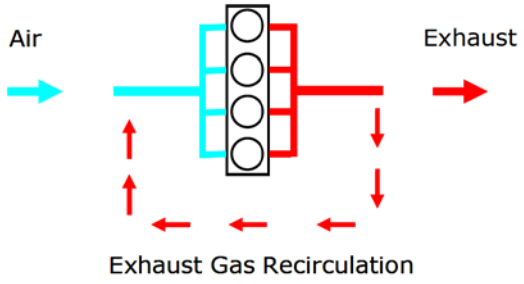
What is CPCB? (Central Pollution Control Board)

To implement pollution control norms defined by Ministry Of Environment & Forests. (MOEF)

What is CPCB-II ?

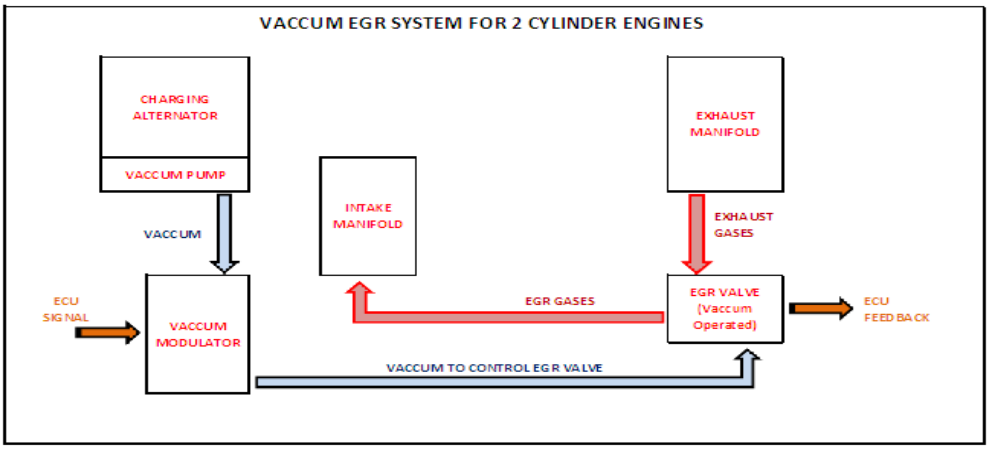
Next level of emission norms after CPCB I mandating significant reduction in exhaust emissions for Diesel gensets upto 800 KW.

E G R – Exhaust Gas Recirculation

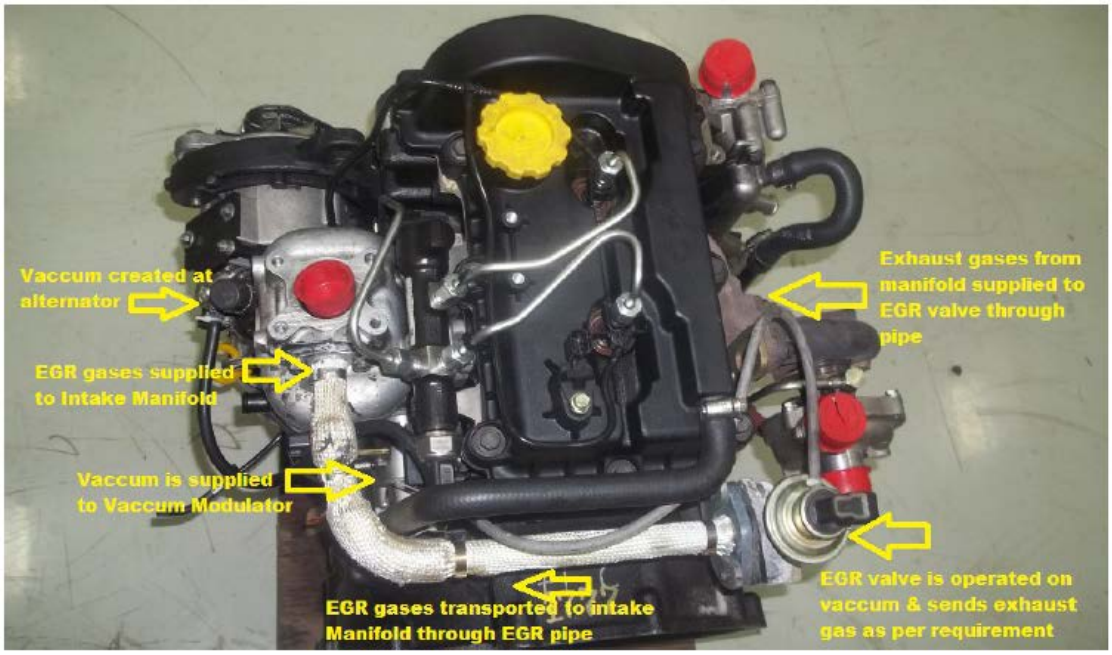


Exhaust Gas Recirculation

In EGR System, Part of the exhaust gas is rerouted into the combustion chamber, where it helps to attenuate the formation of NOX which is the most problematic emission in Diesel Engines by reducing the local reaction temperature. The exhaust gas acts as an inert gas in the combustion chamber, it does not participate in the combustion reaction. This leads to a reduction of the combustion temperature and controls Nitrogen Oxides.



Vaccum EGR System for 2 Cylinder Engine



The vaccum operated EGR system doesn't require special maintenance . However the system should be visually inspected for following points at every service interval.

- Check EGR valve for valve chocked / seized due to carbon deposition. Clean with petrol if required.
- Check vaccum pump for leakages/ pump not working.
- Check vaccum pipes for cracks / damages/ leakages. Replace if required.

FAULT FINDING CHARTS

The Engine will normally not give trouble, if maintained and serviced properly as per instructions given in previous sections. However, defects of elementary nature may arise and following suggestions will help operator to trace out the trouble and to rectify it effectively.

FAULT	Sr.No	CAUSE	REMEDY
Engine fails to start	1	Clogged air cleaner.	Clean air cleaner housing, Change air filter Element.
	2	High exhaust back pressure.	Clean exhaust silencer and manifold.
	3	Fuel tank empty.	Fill up tank & air vent.
	4	Fuel line leaking.	Check all fuel line. Connections for tightness. Change copper washer.
	5	Faulty fuel injector.	Replace injector.
	6	Choked fuel filter.	Replace fuel filter.
	7	Battery runs down.	Recharge battery.
	8	Battery of wrong capacity.	Use battery of recommended capacity.
	9	Faulty starter.	Repair the starter.
	10	Loose or dislodged wiring.	Tighten all wiring.

Engine is difficult to start	1	Clogged air cleaner.	Clean air cleaner housing, Change air filter Element.
	2	Fuel line leaking.	Check all fuel line connections for tightness. Change copper washer.
	3	Faulty fuel injector.	Replace injector.
	4	Engine used after a long time.	Flush & service engine thoroughly.
	5	Run down battery terminal loose or oxidized causing starter motor to run slowly.	Have battery inspected; clean terminals and coat with acid free grease.
	6	Grade of lube oil used is too viscous (applies particularly in winter).	Use correct grade of recommended lube oil.
	7	Fuel supply not sufficient.	Replace fuel filter.

FAULT	Sr.No	CAUSE	REMEDY
	1	Clogged air cleaner.	Clean air cleaner housing, Change air filter element.
Engine starts but stops after some Time	2	No fuel.	Replenish with pure fuel.
	3	Choked fuel injector holes.	Replace injector.
	4	Water mixed with fuel.	Change fuel & clean fuel tank
	5	Engine seized.	Contact nearest dealer.
	6	One or more cylinders not working.	Contact nearest dealer.
	7	Choked fuel filter.	Replace fuel filter.
	8	Faulty fuel filter.	Tighten all fuel connections

FAULT	Sr.No	CAUSE	REMEDY
Engine gives poor performance or engine lacks power	1	Clogged air cleaner.	Clean air cleaner housing, Change air filter element.
	2	High exhaust back pressure.	Clean exhaust silencer and manifold.
	3	Derating due to altitude and temperature.	Calculate Derating due to altitude and temperature and put correct load on the engine.
	4	Choked fuel injector holes.	Replace injector.
	5	Choked exhaust silencer.	Knock out soot from exhaust silencer.
	6	Faulty fuel pump.	Replace fuel pump.
	7	Fuel supply faulty.	Tighten fuel line Connections.
	8	Loose fan.	Tighten fan mounting bolts.
	9	Clogged radiator fins & radiator core.	Clean radiator fins & radiator core.
	10	Broken/seized/worn out piston rings.	Replace with new piston rings.
	11	Worn out cylinder liner.	Replace with new one.
	12	One or more cylinders not working.	Contact nearest dealer.
	13	Unsuitable fuel.	Drain the tank & fill with suitable fuel.

FAULT	Sr.No	CAUSE	REMEDY

Exhaust smoke badly	1	Insufficient compression due to sticking/broken compression rings.	Have compression rings and pistons inspected by a service engineer.
	2	Choked fuel injector holes.	Replace injector.
	3	Unsuitable fuel.	Drain the tank & fill with suitable fuel.
Engine overheats (shut down engine immediately)	1	Cooling fins of radiator tubes choked.	Clean cooling fins of radiator tubes.
	2	Injectors defective.	Replace injectors.
	3	Insufficient cooling.	Ensure free cooling air flow.
	4	Belt damaged/ broken.	Replace the belt.
Engine oil pressure too low (shut down engine immediately)	1	Wrong grade of lube oil used.	Use lube oil of recommended grade.
	2	Choked suction tube.	Clean suction tube thoroughly.
	3	Clogged oil passage.	Flush oil passage.
	4	Defective relief valve.	Replace with new one.
	5	Faulty oil pump.	Replace with new one.
	6	Engine oil not changed at recommended period.	Change the oil.
	7	Excessive play in main bearing.	Change bearing.
	8	Leaks in the lube oil system.	Check connections on filter & oil cooler, turbo drain & feed pipe.
Battery runs down frequently	1	Faulty starter.	Repair starter
	2	Loose wiring.	Tighten all loose wiring.
	3	Faulty battery charger.	Change battery charger.

In spite of all above corrective actions, if problem exists, it is recommended that electronic diagnostic kit to be used to identify/rectify the problem, as this engine is working on Electronic control management system.

SECTION IV

AC ALTERNATOR

1. GENERAL
BRUSHLESS ALTERNATOR DESCRIPTION

TYPE

Mecc Alte AC Alternator are of salient pole, revolving field, brushless, horizontally foot mounted, single bearing type. These AC Alternator are Self Excited Self Regulated type

CONSTRUCTION

STATOR FRAME

The stator frame is made of sheet metal, which reduces the overall weight of the machine and is aesthetically better. The sheet metal enclosures are fixed on the steel bars welded on the stator core.

STATOR CORE

The stator core is made of high quality low content silicon steel stampings with C-4 coating for better welding of core packs. These are oriented 90 deg after every one fourth length for better magnetic properties. The slots are skewed to reduce the tooth ripples in the voltage wave form.

STATOR WINDING

The armature coils are made from dual coated, class 200 copper wire & wound with a 2/3 pitch. The 2/3rd pitch winding eliminates the effect of triplen harmonics. This reduces the voltage distortion and increases the capability of the alternator to cope with non-liner loads.

STATOR / ROTOR INSULATION SYSTEM

The insulation system is class H. All wound components are impregnated in an unsaturated polyester resin with processes designed specifically to provide protection against the harsh environment encountered in the alternator applications. Resins are selected and developed to provide the high build required for static windings and high mechanical strength required for the rotating components can withstand on over speed of 2250 rpm for three minutes.

ROTOR CORE

The rotor core is made of high quality low content silicon steel stampings. The poles carry continuous damper windings to facilitate parallel operation.
End Shield: End shields are cast iron construction and are fixed by easily accessible high tensile bolts.

BEARING

The bearing used is of sealed bearing type. The bearing life is 30,000 hours of operation and is subject to working conditions and environment. High axial vibration from the engine or misalignment of the set will also stress the bearing reducing its life.

SHAFT
The shaft is made of high quality grade steel. The shaft is liberally designed for overload & short-circuits conditions.

ROTATING RECTIFIER ASSEMBLY
The rotating rectifier consists of the rectifier hub made of dough moldings compound, the rectifier fins and the rectifier diodes which is specially designed to withstand the centrifugal forces during rotation. The surge suppressor fitted across the field ensures the protection of the diodes in case of surges.

TERMINALS & TERMINAL BOX ASSEMBLY
AVR is fitted on the NDE panel of the terminal box as a standard supply. The terminal box has removable panels for easy access.

ENCLOSURE
IP23 is standard for all industrial alternators. The machine is protected against spraying water i.e. water falling as a spray at an angle up to 60º from the vertical shall have no harmful effect. Air filters are available as an option for all alternators at reduced rating (5% de-rate).

BALANCING
All alternator rotors are dynamically balanced to better than Grade 2.5(BS 6861: Part 1) for minimum vibration in operation.

RADIO INTERFERENCE
The absence of brush gear and the high quality of AVR design ensure low levels of interference with transmission.

2. OPERATING PRINCIPLES
Alternator is self excited machine.

- **Here the excitation power is** derived from the main output winding. Referring to Fig. initially the machine builds up voltage with the help of residual magnetism.
- The automatic voltage regulator (AVR) will sense this low voltage and compare it with the 'set reference' voltage Level and provides such power as is available from the main stator winding order to establish the exciter field.
- The power from the main output winding rectified in the AVR and added to residual voltage level of exciter to produce a greater magnetic field strength. This in turn increases output voltage from the exciter rotor.
- The output from the exciter rotor is rectified by rotating diodes which adds to the field strength and increases the output voltage from the main stator.
- The AVR senses this increase, compares it with the 'set reference' and uses the

increased power from the main stator to further increase the exciter field excitation as required.

3. AUTOMATIC VOLTAGE REGULATOR

Salient Features of AVR

- Fully encapsulated AVR aids to withstand humid and corrosive atmosphere conditions.
- Typical system response: Field current to 90% - 80%
- Machine volts to 97% - 300ms.
- Operating temperature: -40ºC to +60ºC.
- Storage temperature: -55ºC to +80ºC.
- Soft start circuitry is included to provide a smooth controlled build up alternator output voltage.
- Under frequency protection is set at 97% of 50Hz and the light emitting diode (LED) indicator, is lit when the condition is reached.
- Remote voltage adjustment possible in all the AVR types.
- It is usually fitted on a panel of the terminal box on anti-vibration mounts. It can also be separately fitted in switchboard, if required.

AVR ACCESSORIES

Droop CT (P1 only) RFI suppression, Thermistors and anti-condensation heaters are available.

Generator control accessories may be fitted, as an option, in the generator terminal box. When the options are supplied separately, fitting instructions are provided with the accessory.

Accessories available are droop transformer for parallel operation applicable to P1 generators and remote voltage adjust (hand trimmer). The latter being available for all AVR types but not fitted on the generator.

4. SALIENT FEATURES OF ALTERNATORS

ELECTRICAL PERFORMANCE

- AVR used on the machines of proven design, reliability and performance. These are uniquely encapsulated against moisture, sand, salt, humidity and corrosive atmosphere ensuring trouble free operations under the most demanding conditions. The voltage regulation offered is from 1.5% to 0.5% depending on the type of AVR used.
- Transient voltage dips are lower.
- Wave-form distortion on no-load is less than 1.5%. Total harmonic distortion and the telephone interference is less than 2%.
- All stators are wound to 2/3 pitch, which along with PMG excitation system.
- Damper winding on poles ensure smooth parallel operation with similar and dissimilar machines and with the grid. Power factor controller is recommended when balancing with grid.

- Liberally rated diodes used in rotating rectifier assembly ensure high reliability.
- The rotating diodes are protected by a surge suppressor, which has the ability to chop the transients.

PROCESS

- Gel coat application is a standard feature, which enhances the mechanical strength of the stator overhang and ensures trouble free performance in humid and corrosive atmosphere.
- Burr free stamping pack construction and file free winding results in excellent quality of winding and also better machine life.
- Hammer free assembly and sealed bearing increase bearing life.

5. STANDARD REFERENCE CONDITIONS

These alternators are designed for an ambient temperature of 40ºC. Outputs are normally quoted at 40ºC. These outputs must be multiplied by the following factors for higher ambient temperatures.

TEMPERATURE (º C)	MULTIPLIER
45	00.97
46	00.94
47	00.91
48	00.88

ALTITUDE

Above 1000m the effectiveness of the air is reduced sufficiently to make de-rating necessary. For altitudes above 1000m outputs must be multiplied by the following factors.

ALTITUDES	MULTIPLIER
1500	00.97
1501	00.94
1502	00.91
1503	00.88
1504	00.85
1505	00.82

ANTI-CONDENSATION HEATERS (SPACE HEATER)

Space heaters are recommended in areas of high humidity. Condensation or dew will form on all surfaces, which are cooler than ambient temperature. To avoid this, anti-condensation heaters can be fitted which will ensure the winding temperature remains a few degrees above the ambient temperature and hence no condensation will form. Note that the anti-condensation heaters should be ON only when the set is OFF and they should be switched off whilst the set is in use. They can be retrofitted at site.

6. GENERAL COMMENTS ON LOAD CONDITIONS

- Where a specific exists for any particular load or installation; it is always advisable to foreword a complete copy to the factory for examination. As a result of such an assessment it is sometimes possible to incorporate design changes to provide a more economic machine which still meets the specification.
- There are two basic conditions to check when sizing machines. The steady state condition, which is mainly concerned within temperature rise limits; and the transient condition of the machine voltage deviations when suddenly applying high current loads (e.g. during motor starting). It is essential that both these conditions are checked as a rating sufficient for the steady state condition is often not large enough to meet motor starting or voltage dip requirements.

7. SELECTIONS OF AC ALTERANTORS FOR DIFFERENT LOAD APPLICATIONS

The different types of loads encountered by an AC alternator can be broadly classified as

1. Linear Loads.
2. Motor Loads (part of linear loads, considered separately).
3. Non-linear Loads.

LINEAR LOADS

Linear loads are characterized by

a) Constant load impedance regardless of applied voltage.
b) The load current increases proportionately as the voltage increases and decreases as the voltage decreases.

Examples of linear loads are motor, incandescent lighting and heating loads.

SELECTION OF ALTERNATOR FOR LINEAR LOADS

To select the rating of AC alternator for linear loads the maximum connected load and the base load which is always connected, has to be considered. In arriving at arriving at a total load figure it is always wise to select the standard rating larger than that estimated.

This despite the fact that all the loads may not be operating at the same time and hence a smallest machine could have been selected. Future operating conditions and future growth are very difficult to estimate. An allowance of 15% to 20% excess capacity designed into a set now is a small price to pay compared with the cost of completely new larger unit that may be required to drive additional loads in a few years time.

POWER FACTOR

It is the nature of the applied load that dictates the system power factor.

The loads which operate at or very close to unity(1.0) power factor include most forms of lighting, all heating elements, rectifier and thyristor type loads & all domestic loads which are fractional hp motors (washing machine, refrigerator, etc.) For all remaining load types, some knowledge of operating power factor is required, which for motors depends a great deal on their size and power rating.

These AC generators perform satisfactorily at any power factor in the range of 0.8 p.f. lag to unity p.f. Operation at leading and lagging power factors (below 0.8) demands a derate and reference to the factory must be made.

MOTOR LOADS

During the starting of an induction motor, a very large current is demanded from the power source, which is known as the starting or locked rotor current. For sizing alternators which have to cater to motor loads, the following guidelines can be referred to.

METHOD OF STARTING	STARTING CURRENT
Direct on line	6 times motor full load current is not given. If starting KVA is 7.1 x HP rating of Motor
Start / Delta	Approx 3.5 times motor full load current
Motor Resistance	1.5 to 2 times motor full load current
65 % Tapping	4 times motor full load current
85 % Tapping	4.8 times motor full load current

FOR MOTOR APPLICATIONS THE FOLLOWING INFORMATION SHOULD BE FURNISHED

a) Rating of the motor/motors.
b) Type of motor (slip ring/squirrel cage).
c) Method of starting.
d) Rated full load current.
e) Starting power factor.
f) Any restriction on Transient Voltage Dip (Details of the same).
g) Frequency of starting.
h) Base load at the time of starting induction motor.
i) Any other load apart from the motor loads.
j) Sequence of starting of motors.

NON LINEAR LOADS

Over a period of time the loads applied to AC alternators have become more complex and more care has to be exercised in the sizing of the alternators to ensure satisfactory performance.

CHARACTERISTICS OF NON LINEAR LOAD

1) A non linear load is one in which the load current is not proportional to the instantaneous voltage. Often the load current is not continuous.
2) These are essentially electronic loads such as Computers, UPS equipments and variable speed motor drives.

EFFECTS OF NON LINEAR LOADS

Non linear loads generate harmonics in their current waveform which in turn leads to distortion of the AC alternator waveform. Depending upon the degree of voltage waveform distortion this can lead to instability of the excitation system and impact on other loads being supplied by the alternator.
Odd order harmonics cause overload of neutral conductors.

General Guidelines on duration for non linear loads

LOADS	DERATING FACTOR
Fluorescent lighting load	No de-rate required
UPS & Telecom load controlled by a 12 Thyristor bridge plus a filter	Non linear load should not exceed 90% of pulse alternator
UPS & Telecom load controlled by a 6 Thyristor bridge plus a filter	Non linear load should not exceed 66% of pulse alternator
UPS & Telecom load controlled by a 3 Thyristor bridge plus a filter	Non linear load should not exceed 35% of pulse alternator
Variable speed 6 Thyristor bridge controlled drive	Non linear should pulse not exceed 50% of alternator rating

The mentioned percentage figures are guide lines. There may be a problem with electronic load trying to cope with distorted waveform if distortion levels are unacceptable to the load.

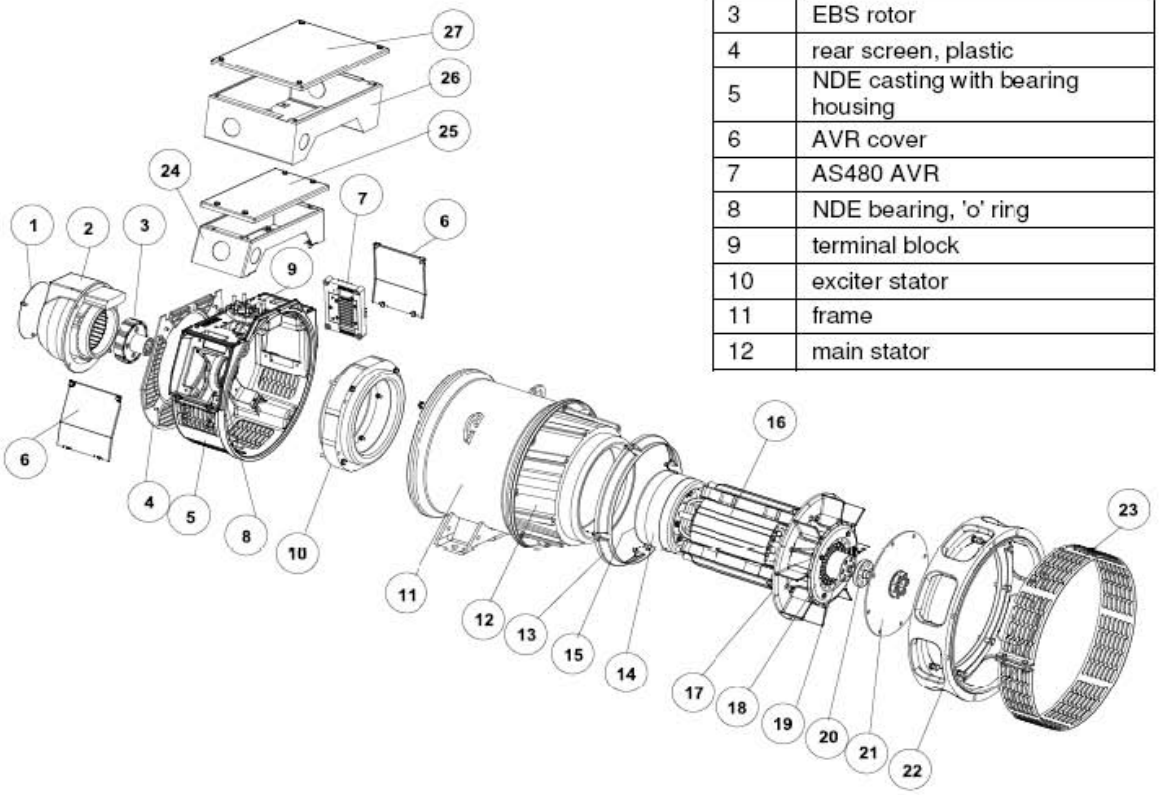
BETTER SIZING OF MACHINE IS POSSIBLE ON FURNISHING FOLLOWING INFORMATION

1) Number of system pulses: 3, 6 or 12 level of current distortion produced by the Non-linear load.
2) What is the maximum acceptable level of voltage distortion the Non- linear Load can accept.
3) Operating voltage and frequency.
4) If Non-linear load power requirement is stated in KW, then some guidance regarding operating power factor & system efficiency is required to establish the alternator load.

With the information guidance should be sought from the factory regarding alternator sizing for compatible equipment operation. Sizing for compatible equipment operation.

8. EXPLODED VIEW & PARTS LIST

Parts Identification Single Bearing



item	Description
1	cover, EBS
2	EBS unit
3	EBS rotor
4	rear screen, plastic
5	NDE casting with bearing housing
6	AVR cover
7	AS480 AVR
8	NDE bearing, 'o' ring
9	terminal block
10	exciter stator
11	frame
12	main stator
13	air flow baffle
14	exciter rotor
15	rotating rectifier assembly
16	main rotor assembly
17	fan, removable
18	fan hub, fixed
19	shaft
20	shaft spacer
21	coupling disc
22	DE adapter
23	DE screen
24	standard terminal box
25	standard terminal box lid
26	large terminal box
27	large terminal box lid

N.D.E. Non Driven End
D.E. Driven End
A.V.R. Automatic Voltage Regulator

9. G.A. DIAGRAM

Alternator 30 kVA 1 Phase 3000 rpm

INSTALLATION- LIFTING

WARNING: - Incorrect lifting or inadequate lifting capacity can result in severe personal injury or equipment damage. **MINIMUM LIFTING CAPACITY REQUIRED IS 250 Kg** alternator lifting lugs should not be used for lifting the complete alternator set.

Lifting lugs are provided at each end of the alternator for use with a shackle and pin type lifting aid or lifting hooks. Chains of suitable length and lifting capacity with spreader bar to avoid damage to the terminal box must be used.

The correct lifting arrangement is shown on a label attached to the alternator. A typical example is shown in Fig.

Alternators have no fan to support the drive and are supplied fitted with a transit strap clamping the coupling hub to the drive end adaptor ring. Once the transit strap is removed the rotor is free to move in the frame, and care is needed during coupling and alignment to ensure the frame is kept in the horizontal plane.

10. ASSEMBLY TO ENGINE

ENGINE TO ALTERNATOR COUPLING ASSEMBLY

During the assembly of the Alternator to the engine it will be necessary to firstly carefully align, and then rotate, the combined Alternator rotor-Engine flywheel assembly, as part of the construction process to allow location, insertion and tightening of the coupling bolts. This requirement to rotate the combined assemblies exists for single bearing units.

During the assembly of single bearing units it is necessary to align the alternator's coupling holes with engine flywheel holes. It is suggested that two diametrically opposite location dowel pins are fitted to the engine flywheel, over which alternator coupling can slide into final location into the engine flywheel spigot recess. The dowels must be removed and replaced by coupling bolts before the final bolt tightening sequence.

While fitting and tightening the coupling bolts it will be necessary to rotate the engine crank shaft-alternator rotor assembly. Care should be taken to ensure that rotation is carried out in an approved manner that ensures safe working practice when reaching inside the machine to insert or tighten coupling bolts, and that no component of the assembly is damaged by non-approved methods of assembly rotation.

Engine Manufactures have available a proprietary tool designed to enable manual rotation of the crank shaft assembly. This tool must always be used having been engineered as an approved method assembly rotation, by engaging the manually driven pinion with engine flywheel starter ring-gear.

UNDER NO CIRCUMSTANCES SHOULD A LEVER BE USED AGAINST THE FAN BLADES OR BAFFLE TO ROTATE THE GENERATOR ROTOR / ENGINE CRANK SHAFT ASSEMBLY.

WARNING: BEFORE WORKING INSIDE THE ALTERNATOR DURING THE ALIGNING AND FITTING

OF COUPLING BOLTS CARE SHOULD BE TAKEN TO LOCK THE ASSEMBLY TO ENSURE THERE IS NO POSSIBILITY OF ASSEMBLY ROTATIONAL MOVEMENT.

SINGLE BEARING ALTERNATOR

Alignment of single bearing alternator is critical. If necessary shim the alternator feet to ensure alignment of the machined surfaces. For transit and storage purposes the alternator frame spigot and rotor coupling plates have been coated with a rust preventative. This MUST BE removed before assembly to engine.

A practical method for removal of this coating is to clean the mating surface areas with an end bracket-adaptor arrangement as outlined below.

CAUTION:
CARE SHOULD BE TAKEN NOT TO ALLOW ANY CLEANING AGENT TO COME IN TO PROLONGED CONTACT WITH SKIN.

End Bracket/ Adaptor: SAE 3

The sequence of assembly to the engine should generally be as follows:

1. On the engine, check the distance from the coupling mating face on the flywheel to the flywheel housing / Genset cover mating face. This should be within 0.5mm of nominal dimension. This is necessary to ensure that a thrust is not applied to the AC alternator bearing or engine bearing.
2. Check that the bolts securing disc to the coupling hub are tight and locked into position. Torque tightening is 46-54 Nm.
3. Remove covers from the drive end of the alternator to gain access to coupling disc and adaptor bolts.
4. Check that coupling disc is concentric with adaptor spigot. This can be adjusted by suspending the rotor by means of a rope sling through the adaptor opening.
5. Offer the AC alternator to engine and engage both coupling disc and housing spigots at the same time, finally pulling home by using the housing and coupling bolts. Use heavy gauge washers between head and discs on disc to flywheel bolts.
6. Tighten coupling disc to flywheel. Refer to engine manual for torque setting of disc to flywheel bolts.

IMPORTANT

When fitting drive disc ensure that flywheel fixing bolt holes fall between fan blades to allow access for flywheel bolts. Use engine pulley to turn rotor

SINGLE BEARING 2 POLE / 4 POLE ALTERNATORS

Alternators offered can be specified to suit different engine build configurations of specific flywheel and flywheel housing/Genset cover combinations.

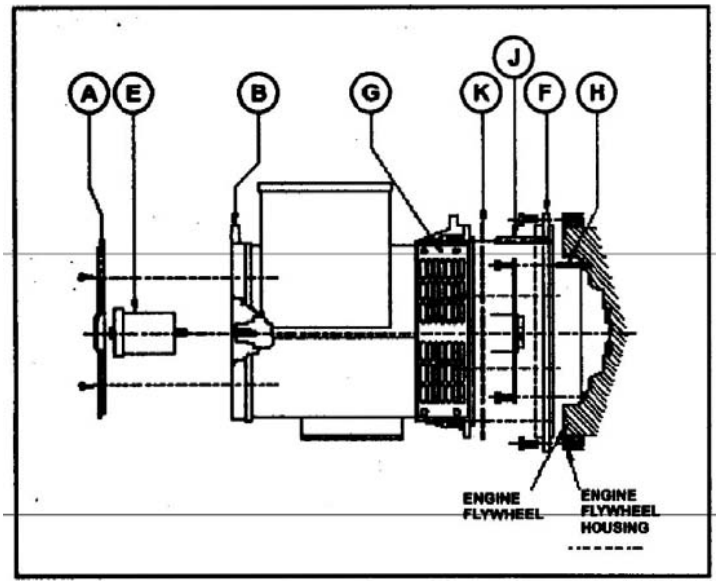
IMPORTANT: IT IS MOST IMPORTANT THAT THE APPROPRIATE ALTERNATOR BUILD IS ORDERED WITH PRIOR KNOWLEDGE OF THE INTENDED ENGINE FLYWHEEL/HOUSING AGREEMENT.

ALTERNATOR TO ENGINE ASSEMBLY INSTRUCTIONS

A) Remove louvered cover “A” from non-drive end bracket “B'.
B) Assemble locating bar “E” by screwing into shaft.
C) Remove transit bar “K”.
D) Remove side screens “G”.
E) If the adaptor ring is an individual item, as indicated “F”, bolted to the alternator D.E. bracket, remove from alternator and fit to engine flywheel housing.
F) Thread two locating pins “H” into two top flywheel holes.
G) Fit two locating pins “J” into two top holes of the engine flywheel housing / adaptor location holes.
H) Pick up alternator by cast lifting lugs on both ends with ½ ton shackles or lifting hooks using suitable lifting equipment.
I) Rotate alternator rotor such that two top holes coupling disc are in close axial alignment.
J) Push the alternator rotor forward only half (50mm) the available movement provided by locating bar “E”. It may be necessary to tap bar “E” with a hide mallet to ease the bearing out of housing.

IMPORTANT: DO NOT PUSH THE ROTOR FOREWORD TOO FAR. THERE IS A RISK THAT THE ROTOR WILL REST ON THE STARTER WINDING OUT HANG RESULTING IN THE WINDING DAMAGE ESPECIALLY IF ANY ROTATIONAL MOMENT OCCURS DURING ALIGNMENT WITH PINS “H”.

K) Support the weight of the rotor at coupling end whilst sliding the rotor forward to locate coupling disc holes over support pins “H”. Locating bar “E” will allow the rotor to move forward a further 50mm, the total movement bar “E” allows being 100mm. With coupling discs positioned against flywheel location fit securing screws and washers. Remove pins “H” and fit two final securing screws and washers.
L) Push generator onto engine guiding adaptor over locating pins “J” and onto engine flywheel housing location, or ring “F”, secure with screws and washers. Remove pins and replace with two screws and washers.
M) Remove locating bar “E”. Replace M10 screws “C” for barring purposes.
N) Remove lifting tackle and replace side screens “G” and louvered cover “A”.



EARTHING

The alternator frame should be solidly bonded to the generating set base plate. Anti Vibration Mounts are fitted between the alternator frame and its base plate. A suitably rated earth conductor (normally one half of the cross sectional area of the main line cables) should bridge across the anti vibration mount.

WARNING: REFER TO LOCAL REGULATIONS TO ENSURE THAT THE CORRECT EARTHING PROCEDURE HAS BEEN FOLLOWED.

PRE-RUNNING CHECKS

INSULATION CHECKS - Before starting the generating set, both after completing assembly and after installation of the set, test the insulation resistance of windings. The AVR should be disconnected during this test.

A 500V Megger or similar instrument should be used. Disconnect any earthing conductor connected between neutral & earth and megger an output lead terminal to earth. The insulation resistance reading should be in excess of 5 MW to earthy. Should the insulation resistance be less than 5 MW. The winding must be dried out as detailed in the Service and maintenance section of this manual.

IMPORTANT: THE WINDING HAVE BEEN H.V TESTED DURING MANUFACTURING AND FURTHER H.V TESTING MAY DEGRADE THE INSULATION WITH CONSEQUENT REDUCTION IN OPERATING LIFE. SHOULD IT BE NECESSARY TO DEMONSTRATE H.V TESTING, FOR CUSTOMER ACCEPTANCE, THE TESTS MUST BE CARRIED OUT AT REDUCED VOLTAGE LEVELS I.E. TEST VOLTAGE = 0.8 (2X RATED VOLTAGE + 1000)

DIRECTION OF ROTATION

Generators can rotate efficiently in either direction.

VOLTAGE AND FREQUENCY

Check that the voltage and frequency levels required for the generating set application are as indicated on the alternator nameplate.

AVR INITIAL SETTINGS

To make AVR selections remove the AVR cover and refer to the following sections depending upon type of AVR fitted.

Reference to the alternator nameplate will indicate AVR type.

Most of the AVR adjustments are factory set in positions which will give satisfactory performance during initial running test. Subsequent adjustment may be required to achieve optimum performance of the set under operating conditions.

The following 'jumper' connections on the AVR should be checked to ensure they are correctly set for the generating set application. Ref. Fig for location of selection links.

11. AVR INPUT SELECTION

High Voltage (220/240V) INPUT No Link.

AVR ADJUSTMENT

Having adjusted VOLTS and STABILITY during the initial start up procedure, the AVR control function UFRO should not normally need adjustment. If however, poor voltage regulation on-load is experienced, refer to the following paragraph to

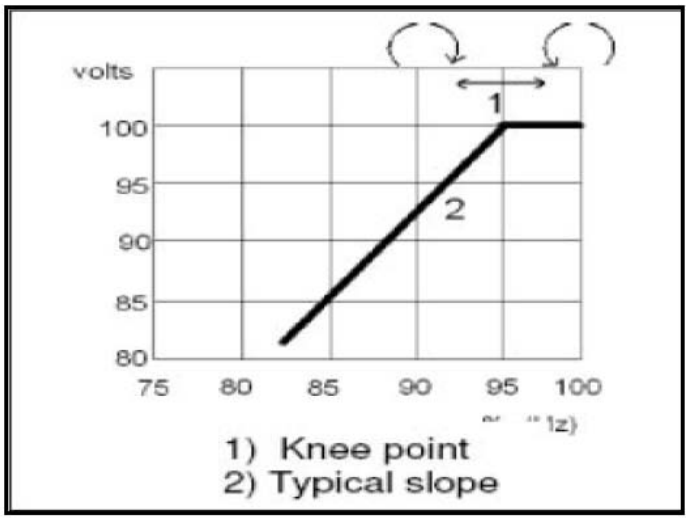
A) Check that the symptoms observed do indicate adjustment is necessary, and
B) To make the adjustment correctly.

UFRO (Under Frequency Roll Over)

The AVR incorporates an under speed protection circuit, which gives a voltage/speed (Hz) characteristic as shown.
The UFRO control potentiometer sets the “knee point”. Symptoms of incorrect setting are

A) The light emitting diode (LED) indicator, adjacent to the UFRO Control potentiometer, being permanently lit when the generator is on load.
B) Poor voltage regulation on load, i.e. operation on the sloping part of the characteristic.

Clockwise adjustment lowers the frequency (speed0 setting of the “knee point' and extinguishes the LED. For optimum setting LED should illuminate as the frequency falls just below nominal frequency, i.e. 47 Hz on a 50Hz alternator.



AVR FAULT FINDING

No voltage build-up when starting Set.	Check speed. Check residual voltage. Follow separate excitation test procedure to check generator.
Unstable voltage either on no-load or with load.	Check speed stability. Check stability setting.
High voltage either on no-load or with load.	Check speed. Check that generator load is not capacitive (leading power factor).
Low voltage no-load.	Check speed. Check link 1-2 or external hand trimmer leads for continuity.
Low voltage on-load.	Check speed Check UFRO setting Follow separate excitation procedure to check generator and AVR.

SECTION V

CONTROL PANEL

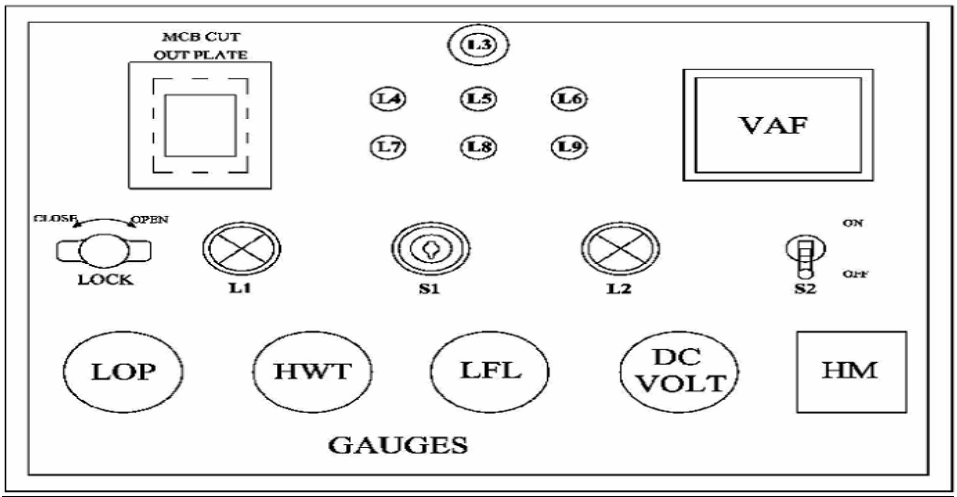
STANDARD CONTROL PANEL

1. INTRODUCTION

This section deals with installation, operating procedure, wiring schematic and trouble shooting of Genset control panel. Control panel controls, as well as act as a protection to Gensets.

Control panel requires wiring to make electrical connectivity between panel and distant parts like solenoid, battery, LOP switch, charging alternator etc. within the engine assembly.

1PH-CONTROL PANEL FRONT DOOR



CONTROL PANEL DOOR CONFIGRATION			
SR. NO.	ITEMS CODE	DESCRIPTION	QTY
1	L1	DG ON – LED GREEN	1
2	L2	LOAD ON DG – LED RED	1
3	L3	CHARGE FAIL LAMP	1
4	L4	GLOW PLUG – LED AMBER	1
5	L5	WATER IN FUEL – LED AMBER	1
6	L6	SERVICE CHECK – LED AMBER	1
7	L7	COOLANT TEMP. HIGH – LED RED	1
8	L8	LOW OIL PRESSURE – LED RED	1
9	L9	OVER SPEED – LED RED	1
10	S1	ENGINE START – STOP KEY SWITCH	1
11	S2	CANOPY LIGHT SWITCH	1
12	HM	HOUR METER	1
13	LOP	LOW OIL PRESSURE GUAGE	1
14	HWT	HIGH WATER TEMP. GAUGE	1
15	DCV	BATTERY VOLTAGE – VOLT METER	1
16	VAF	VOLTAGE, CURRENT & FREQUENCY METER	1
17	LOCK	PANEL LOCK NOBE TYPE	1

Voltage, current and lube oil pressure, coolant temperature and running hours are displayed on control panel by providing voltmeter, Ammeter, oil pressure gauge, coolant temperature gauge and hour meter. Genset protection is also provided by this panel to safe guard the Genset. When there is current spike exceeding the limit MCB trips and disconnects the Genset from load without any delay, this operation avoids further damage to the Genset. Fuses provide additional protection to the panel from load variation.

2. CONTROL PANEL

This unit is used to monitor the DG set and start/stops as necessary. This unit also manages the engine safety and operates the relay and glow appropriate indication according to fault and engine stops. The unit detects the faults, as low oil pressure, battery not charging, coolant high temperature etc. When fault arises, ECU will get the signals and automatically cut-off the fuel supply and Engine will stop.

OPERATION OF ENGINE SAFETY CIRCUIT

If engine gets tripped because of some fault then check the lamp indication on control panel to locate the cause. Following safety features provided to prevent engine damage.

1. **LOW OIL PRESSURE** - During operation, if oil pressure falls below the specified level the engine management will shut the engine **"OFF"**
2. **ENGINE HIGH TEMPERATURE-** During operation, if engine gets overheated the coolant temperature exceeds safety set points. The engine management system will switch off the engine.
3. **WATER IN FUEL -** If the fuel is contaminated with water, this gets accumulated at the bottom of fuel filter. This water collection stops the engine.
4. **OVER SPEED** -If due to any reason engine revolves beyond specified limit of defined 'rpm', the engine management system will stop the engine.

This safety features also indicated to the user on control panel.

Reset the fault by removing enable input **(in this case put DC ON/OFF switch to off position)**. Otherwise safeties will not be effective.

NOTE - Please contact authorized service representative while faults occurred. When engine is running there should not be any safety lamp **ON**

ELECTRICAL COMBIMETER

It is combination of voltmeter, ammeter and frequency meter. Voltmeter shows the voltage, which is in the unit. It is connected in mains to display the circuit voltage. Ammeter displays current by deflecting the pointer. Ammeter is connected in the circuit with the help of current transformer (wound primary). The range of ammeter decides on the basis of current flowing through the circuit.

INDICATING LAMPS

The bulbs in the indicating lamps should be inspected to ensure that they are tight in the holders. If found broken or damaged they should be replaced.

DG ON LAMP

Set on lamp is connected in parallel with line indicates the running condition of the Genset through fuse. It is of Green colour.

LOAD ON DG LAMP

Load on lamp is connected in between output line and neutral indicates the load on. It is of Red colour.

OIL PRESSURE GAUGE

It is connected to the oil pressure sensor, DC +ve and -ve. The oil pressure gauge indicates the oil pressure reading.

IGNITION SWITCH/MAIN SWITCH-KEY

It is connected to the battery +ve and starter solenoid. When it turns **ON from OFF** state then supply is passed and when it cranks then the generator engine will start or comes in action.

NOTE: Do not use it to stop the Genset in normal operating conditions.

CURRENT TRANSFORMER

The current transformer (CT) is used to measure the current flowing from the alternator output to load. It is primary wounded and functionally helps to display the current.

MINIATURE CIRCUIT BREAKER (MCB)

The MCB is used to break the supply in case of an overload. It can be used as a switch for supply manually. The range of MCB decides on its current carrying capacity.

FUSE LINK WITH FUSE CASE

Fuse links are provided to protect the instruments / meters from input supply variation.

NOTE: Use fuse link of appropriate rating while replacing the fuse link when blown out.

CONNECTIONS

Connections to terminals, terminal strips, plug and sockets should be periodically checked. They should be tightened or soldered again if necessary.

STARTING THE GENERATOR SET

1. Turn the ignition switch to ON position.
2. Ensure that everything is OK.
3. Turn the ignition switch to START position and hold in this position till the Engine starts.
4. Turn the ignition switch back to ON position.

SEQUENCE OF OPERATION

The exact sequence of the operation that takes place in the set is given below.

SET RUNNING NORMAL

a) When the engine reaches the rated speed the generator develops the rated voltage and generator running indication lamp (Green) glows in the control panel.
b) The battery-charging ammeter will start showing the net charging current to

the battery.

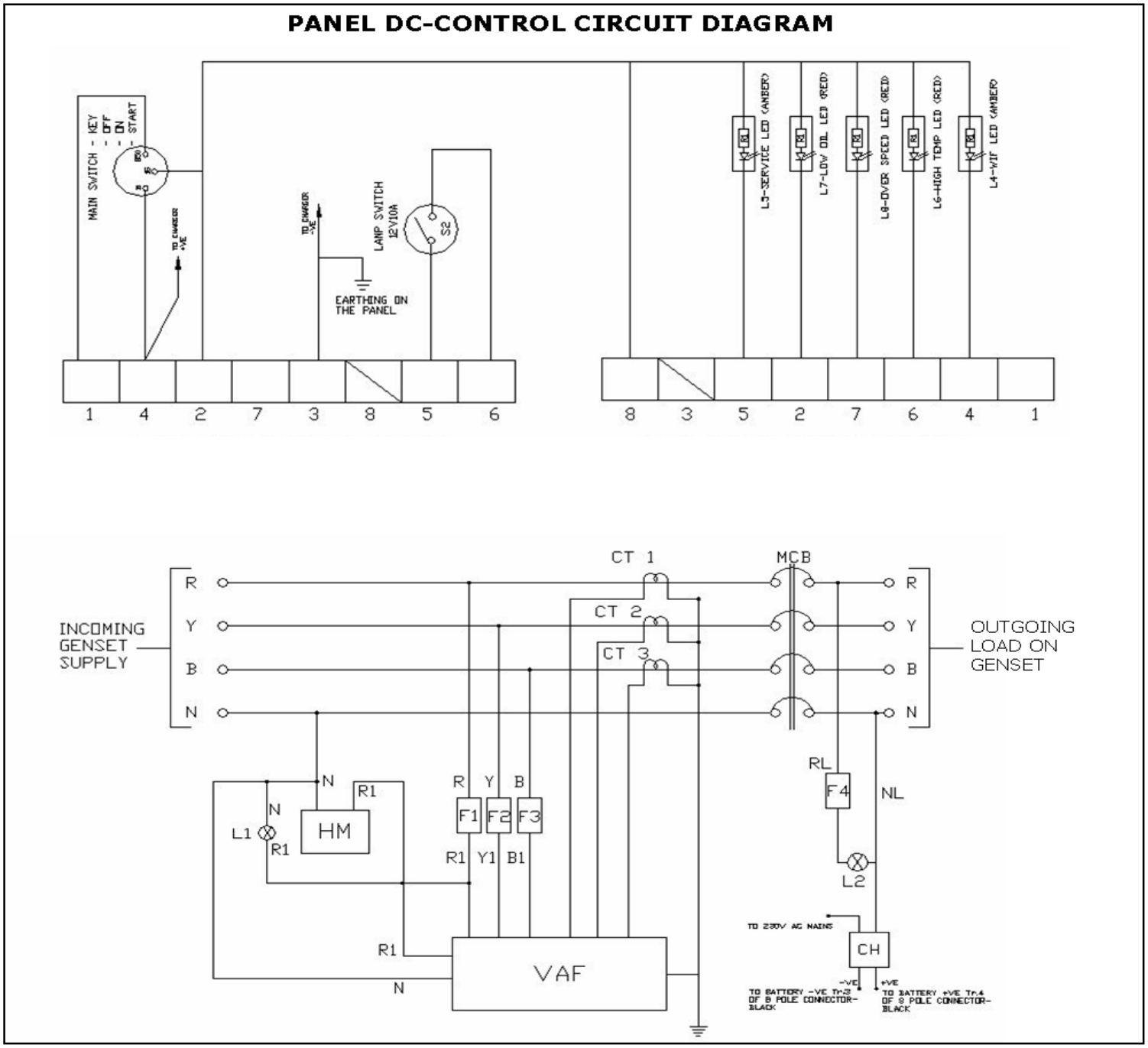
c) The load can now be switched ON by operating the OUTPUT MCB to get the output to operate load.
d) The ammeter will indicate the load current and the LOAD ON lamp (Red) will glow.

STOPPING

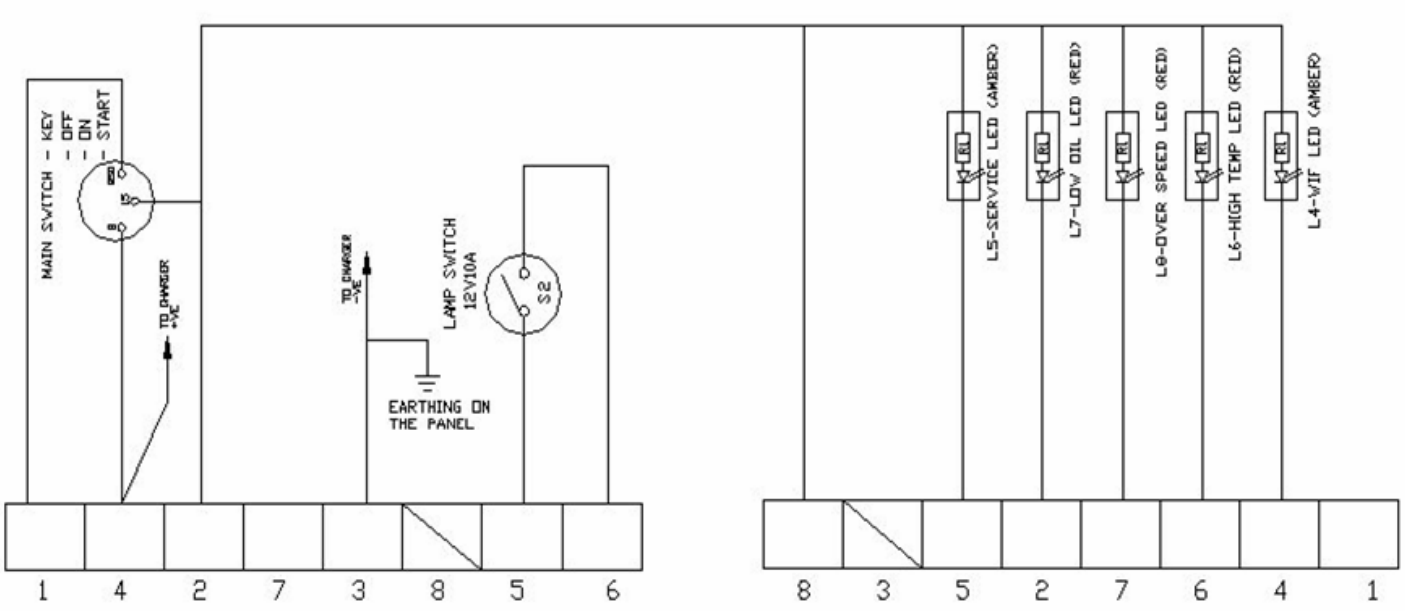
Put “OFF' the ignition key.

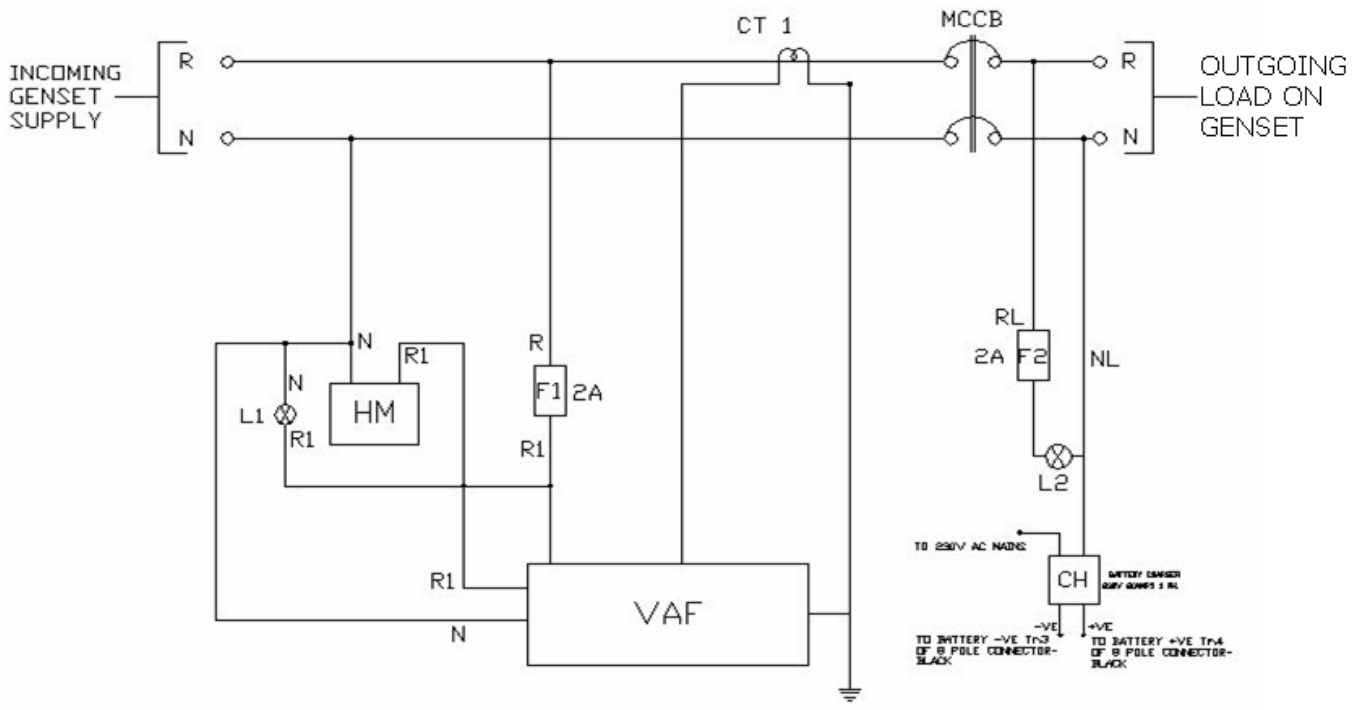
Put “ON” the emergency stop switch on the left side of the canopy.

THREE PHASES



PANEL DC-CONTROL CIRCUIT DIAGRAM





SINGLE PHASE

TEST PROCEDURE GENERATOR CONTROL PANEL

1) Ensure that the instruments, meters, MCB, terminals, switches, plugs and sockets etc. have not suffered any damage.
2) Ensure the mechanical operation of switches, knob, push button etc. is satisfactory.
3) Ensure that all electrical connections are tight.
4) Ensure that all instruments are functioning as per specifications.
5) Ensure that the switch boards withstand without any breakdown or damage to the recommended specifications.

FAULT FINDING CHART

GENERAL

The common troubles, their causes and remedies are given in the following table.

FAULT: Voltmeter, Frequency meter does not show any reading

SR.NO	CAUSE	RECTIFICATION
1	Capacity of the fuse insufficient to take starter solenoid current	Check starter solenoid
2	Meter fuse blown	Change the fuse

FAULT: DC control MCB trip out

SR. NO	CAUSE	RECTIFICATION
1	Short circuit in control circuit	Check the control circuit and eliminate the short circuit

FAULT: Load on lamp does not glow; Ammeter does not show any reading

SR. NO	CAUSE	RECTIFICATION
1	Out put MCB in off position	Put “ON” Output MCB

AMF CONTROL PANEL

1. INTRODUCTION

This section deals with installation, operating procedure, wiring schematic of genset control panel.

Control panel controls & safeguards the genset. Functionally it is used to Start / Stop the genset and monitor engine as well as electrical safeties.

On the other hand for electrical safeties such as overload protection, over voltage protection & Short Circuit protection is provided.

Parameter displays such as single phase AC Current, AC Voltage, Frequency, RPM, Engine running hours & Battery Voltage. Along with Fuel level Gauge & Water Temp. Gauge is provided to check the health of the system.

2. FEATURES OF PANEL

- Automatic changeover mains to genset.
- Battery charging through mains / genset output.
- Panel logic switch to select the operating mode (1- Auto, 0- Off, 2- Bypass).
- As auto operation fails, allow to start / stop manually.
- Remote mode is available for Remote operation.
- Low lube oil pressure automatic shutdown.
- High water temp. Automatic shutdown.
- Engine over speed automatic shutdown.
- Water in fuel automatic shutdown.
- Genset overload tripping.
- Water temp. Gauge.
- Mains / genset on indications.
- Load on Mains / Load on Genset indication.
- RPM, Frequency, total engine running hours.
- Battery voltage.
- Electrical gauge cluster is provided to display Load voltage, current and frequency.
- In case of failure to start, three starting attempts are provided.

3. PRE START CHECKS

- Ensure that the instruments, meters, MCB, terminals, switches, plugs and sockets etc. have not suffered any damage.
- Ensure that mechanical operation of switches, knobs is satisfactory.
- Ensure that all electrical connections are tight.

- Wire the earth connection to the panel body on the bolt provided for the purpose right side of the Panel.
- Ensure that the mains neutral potential (measure with the full load connected) is within 5VAC of earth potential.
- Electrical Gauge were already calibrated for 40KVA, 3 ph (as per customer specifications).
- Now connect the engine harness to the terminal strip as per the circuit diagram except B (+) & B (-).
- Then connect Mains Power wires, Genset Power wires & Load Output wires.
- Now connect Battery 1(+) and Battery (-).

Engine and control panel is ready to START.
DC control MCB be must on when a Battery charger on.

4. CONSTRUCTION OF PANEL

The control panel has following components on the front door.

A) AMF CONTROLLER

- This unit is the he heart of the AMF panel. The unit monitors the under / over voltage levels on the Mains supply.
- The unit operates the mains or DG contactors. The unit also starts / stops the DG and monitors the engine safety operations.
- The unit has a display for indicating engine speed, DG frequency, Battery Voltage, elapsed hours and various short text messages.
- The unit has inbuilt lamps /keyboard for AMF operation and flexible operating modes.

B) ELECTRICAL GAUGE CLUSTER

- This unit indicates the load voltage, current and frequency.
- The unit has an inbuilt logic that indicates the voltage of single phase (phase to neutral reading) and Voltage Phase to Phase.
- The unit has two numbers of an over load trip setting.
    1) OU0 - instant trip.
    2) OU0 – delayed trip.

That shutdown the mains contactor if load is on mains feeder, if the load is on genset feeder the engine will shutdown.

C) PANEL LOGIC SWITCH

- This rotary switch can be used to turn the panel OFF and operate it in the AMF or BYPASS modes.
- In the AMF mode, the panel operates under the control of the AMF controller. The AMF Controller itself has modes such as AUTO, MANUAL and OFF which increase the flexibility of the use.
- The BYPASS mode can be used to start/stop the DG and operate the MAINS / DG contactor directly. This mode has no availability of electrical/engine safety and hence should be used only in an emergency situation.

D) START/STOP KEY SWITCH

- This Key switch operates only in the BYPASS mode and cranks the engine directly. As there is no engine safety in this mode from control panel, in Bypass mode only ECU / controller safeties will protect the DG set. The switch should be released as soon as the engine fires and care should be taken of not to operate this switch while the engine is running.

E) CONTACTOR SELECTOR SWITCH

- This switch operates only in the BYPASS mode. The switch has (MAINS CONT. – OFF – GENSET CONT.) positions.
- The switch can be used to directly switch the Mains & DG contactor to switches on the load supply.
- As there is no electrical safety in this mode, it should be used only in an emergency situation after verifying that the supply is within the safe limits. **(While using this switch; switch of the contactor selector switch and then switch of the engine. and vice versa)**

F) WATER TEMPERATURE GAUGE

- It is connected to the Water Temp. Sensor, DC +ve and -ve. The Water temp. Gauge indicates the Water temp. Reading.

G) OIL PRESSURE GAUGE

- It is connected to the Oil Pressure. Sensor, DC +Ve and -Ve. The Water temp. Gauge indicates the Water temp. Reading.

H) INDICATION LAMP

- It is connected to the 3 Phase incoming supply (l'Jlains), load on fulains, set run, and load on DG.
- It is connected to various fault of engine safety

The control panel has following components inside the panel.

I) POWER REALY CARD

- The card contains the power relays used to energize the starter motor and the stop solenoid. The card has a 40 ampere fuse link to protect the contacts of the two relays against short circuit. The card has LED lamps indicating the operation of the two relays and also when the fuse link is open.

J) ENGINE CONTROL CONNECTORS (6 PIN & 8 PIN)

- These connectors connect the low voltage connections from the control panel to the engine components.

K) DC CONTROL MCB

- This 32 A, 1 pole MCB is used to connect / disconnect the battery supply into the panel when required. The MCB would also open automatically when the load current exceeds the set value and also in case of short circuit.

L) MAINS MCB

- Mains MCB is used to connect the three phase and neutral power connections from

mains.

M) GENSET MCB

- Genset MCB is used to connect the three phase and neutral power connections from genset.

N) LOAD OUTPUT TERMINAL

- Load out terminal is used to connect the output load, three phase and neutral.

O) MAINS CONTACTOR

- Mains contactor is used changeover the mains feeder to load.

P) GENSET CONTACTOR

- Genset contactor is used changeover the genset feeder to load.

Q) CURRENT TRANSFORMER

- The current transformer (CT) is used to measure the current dlowing from the load output. It is primary wounded and functionally helps to display the current on ELCL96AC.

R) HOOTER

- Hooter is used to create the audible alarm sound the control of controller.

S) STATIC BATTERY CHARGER

- The unit is connected to the load supply. It is used to supply the DG's battery with charge to maintain it at the optimum level. The charger's output varies automatically as per the battery's status.

T) TWO WAY RELAY

- This relay inverts the Lop switch logic.
- This relay is used to B- for LOP (stop relay).

5. FUNCTIONAL DESCRIPTION

A) FULLY AUTOMATIC OPERATION

- Ensure that the mains supply is available and within the specified limits.
- Ensure that the DG is in a working condition with a fully charged battery and with adequate fuel.
- Place the "Panel Logic Selection Switch" in the AMF position.
- If the unit were in the "Auto" mode, it would show the text "Auto" on the display.
- In case the unit is not in the Auto mode (i.e. it is in either OFF, or Manual or Settings mode), please press the MODE key on the keypad till the text on the display indicates the text "Auto"
- Once the is in the Auto mode and the mains is present, note the 'Mains OK' indicators and the 'Load On Mains' LED lamps glowing. At this point the mains is directly connected to load
- Test the AMF operation by shutting off the mains supply

- Load will be disconnected from Mains and the DG would start after few seconds. Once the DG is running, the engine speed would be displayed. Soon the Genset OK indicator and the Load on DG lamps would glow and the DG contactor would close, transferring the load to the DG's alternator
- On restoration of the mains supply, the DG contactor would open and the load has shifted directly on mains. The DG would shut down after a cooling timer period.

B) FULLY MANUAL OPERATION

- The unit has to be placed in the Manual mode by operating the MODE key till the text "Man" is indicated on the display.
- This can be done at any time, including when the Mains supply is healthy and when the load is from the mains feeder.
- In the Manual mode, pressing the Engine Star / Stop switch can start the DG. in this mode, the safety of the starter motor and the engine is ensured.
- Once the engine starts, the display indicates the tachometer which indicates the engine speed.
- If the engine is running at the correct speed (>3000 RPM), and the voltage of the single phase is within the set limits, the Genset OK indicator lamp lights.
- If the mains supply is present and the load is on mains (Mains OK indicators and the Load on Mains LED lamps are lit), the Genset cannot be connected to the load directly.
- To put the load on genset, first the load on mains must be switched off. Load on Mains is switched off by operating the "Mains contactor on/off' key once. The "Load on Mains" LED lamp would now stop glowing and disconnect load from Mains
- Once the load on Mains has been switched off, the Genset contactor can be closed by operating the Genset Contactor On / off key once. The "Load on Genset" LED glows and the Genset contactor closes.
- Thus the Load on Mains and Genset can be switched on and off in the manual mode.
- The engine can be switched off by operating the Engine Start/Stop switch once on a running engine. The engine would stop after a cooling period timer.
- All the safeties work in the Manual mode however the operation is not automatic i.e. the engine would not start/stop on its own, neither will the load transfer take place automatically.

C) OPERATION IN THE OFF MODE

- The Off mode is selected on the controller during the period when the genset should not start even if there is a power failure (i.e. night hours in a bank or during the weekends in an office).
- The unit has to be placed in the off mode by operating the mode key till the text “off” is indicated on the display.
- Now, if the mains is present and healthy, thus charging the load from mains directly.
- In case the mains goes outside the set limits, disconnect the load from mains to protect the load but the genset would not start.
- Once the mains supply is restored within limits, load will connect directly to mains.
- It is important to move the controller out of the OFF mode to auto mode once

the normal operation is desired to ensure automatic operation of the genset.

D) BYPASS MODE

- The Bypass mode uses no electronic control components, hence can be used in emergency situations when there is a failure of an electronic unit.
- The Bypass mode powers the starter motor and stop solenoid via the common relay card that is also used in the AMF mode operation.
- The Bypass mode is selected by moving the Panel Logic switch in the "Bypass" position.
- The Engine Star / Stop switch has activated only in the Bypass mode.
- There is no safety in the Bypass mode and hence only a trained person should operate these controls.
- The engine can be started by turning right side of Start/Stop switch till the engine fires. The switch must not be turned when the engine is running to avoid the damage caused by engaging the starter motor on a running engine
- The engine can be stopped by turning left side of Start/Stop switch till the engine stops completely. The switch must not be turned after the engine stops so as to prevent excessive heating of the stop solenoid.
- If the mains supply is present, the load will be connected directly. Please note that there is no electrical safety in this mode. Similarly, if the engine is running, the genset contactor can be closed by operating the load position.

6. PROGRAMMING PARAMETERS

Setting of

1. To bring the unit into the settings mode, operate the MODE key till the unit displays SET.
2. It is necessary to persist on a selected AMF mode for a few seconds before the associated keys start operating in that mode. Hence it is necessary to wait for a few seconds in the SET mode before the first four keys start work in that mode.
3. while the unit is in the SET mode, the first four keys from the left operate like the MODE (1), UP (2), SHIFT (3), EXIT (4), KEYS.
4. use the four keys to change the settings
   The password used to change any setting is “1234”. The password is necessary only to change the settings; the user can view the settings without knowing the password.

SETTINGS:

Sr. No.	Name	Function	Default Setting
1	Password		1234
2	LFDU	(Line Failure Duration) this timer determines the period in seconds for which the mains (line) must be continuously over or under the set limit. Once the timer elapse, the detects the mains input as faulty, opens the mains supply and starts the engine.	7
3	LRDU	(Line Restoration Duration) This timer determines the period in seconds for which the restored mains (line) must be continuously within the set limit. Once the timer elapses, the detects the mains input as healthy, and opens the genset supply then closes the mains supply.	8
4	StDU	(Starting Duration) This timer determines the period for which the genset is not to be started even after the mains has been detected as failed. This timer is used to load the UPS that may exist between the AMF panel and the load in an installation.	0
5	OPDU	(Operating Duration) This timer determines the period for which the engine runs without load to bring it to a working temperature.	0
6	LGDU	(Line to Genset Transfer Duration) This timer determines the delay between opening of the mains supply and closing of genset supply.	5
7	GLDU	(Genset to Line Transfer Duration) This timer determines the delay between opening of the genset supply and closing of mains supply.	5
8	CLDU	(Cooling Duration) This timer determines the period for which the genset runs without load to cool the engine and alternator after restoration of the mains supply.	
9	LnLo	this setting determines the voltage unit will detect the 'under voltage' condition and start the genset.	190
10	LnHI	This setting determines the voltage over which the unit will detect the 'over voltage' condition and start the genset.	260
11	PSdU	This setting determines the interval at which the engine will be started to keep it warm.	0
12	PSOn	This setting determine the duration for which engine will run in Periodic start.	0

13	CFDU	(Canopy fan timer). This delay in stopping the engine to switching off the canopy fan.	10
14	LinE	(Line selection 1/3 phase) This setting determines whether the rest uses for single phase or three phase applications.	PH3
15	SOL	(Solenoid Logic, Energized to Run/Energized to Stop) This setting determines the type of stop solenoid used.	ER
16	USPD	(Under speed trip setting) This setting determines the lower side speed of the engine below which the engine should be stopped.	2550
17	OSPD	(Over speed trip setting) this setting determines the upper side speed of the engine should be stopped.	3450
18	CrAt	(number of crank attempt setting) this setting determines the number of crank attempts by the unit before declaring "start failure" condition and preventing further crank attempts.	3
19	RSDU	Rest duration	60 sec

7. TROUBLE SHOOTING

1. **Engine does not start?**
   Check if 12V Dc is present at start out terminal (no.3) when you start the key switch. If no voltage, then check coil voltage at start Relay.

2. **Mains incoming indication does not glow?**
   Check mains MCB, check mains voltage at mains indicator lamp.

3. **Genset incoming indication does not glow?**
   Check mains MCB, check mains voltage at mains indicator lamp.

4. **Voltage does not display on ELCL96AC?**
   Check the wires 505, 507 & 508 will lose from connector on ELCL96AC.

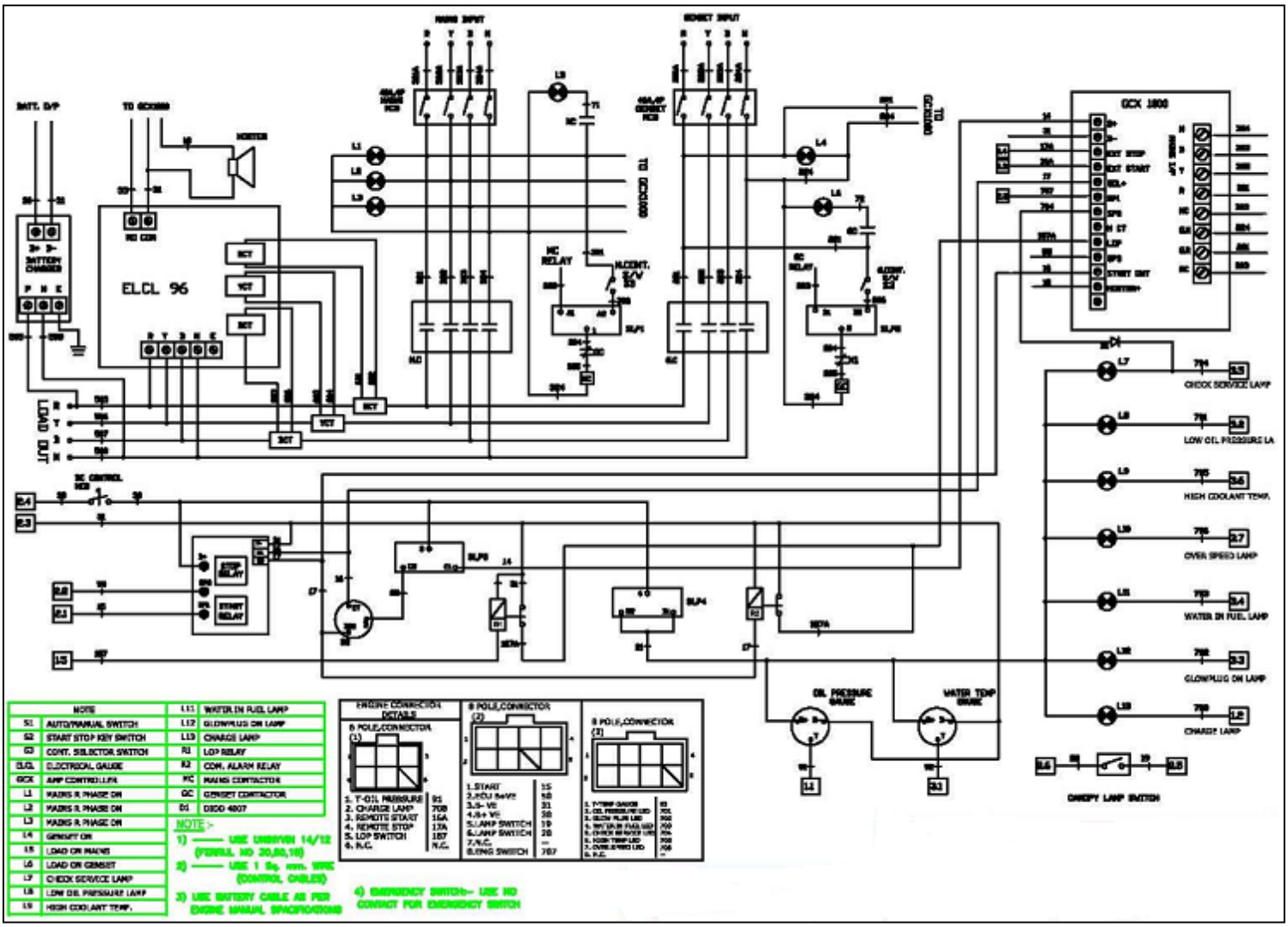
5. **Load on mains indication lamp does not glow? Not getting voltage at load output?**
   Check if mains MCB is off. Also check 71 & 324 wires will lose on lamps.

6. **Load on genset indication lamp does not glow? Not getting voltage at load output?**
   Check if GENSET MCB is off. Also check 72 & 224 wires will lose on lamps.

7. **Current showing zero on ELCL96AC?**
   Check load is connected properly; also check genset mcb is off when load is on Genset and check mains MCB is OFF when load is on mains.

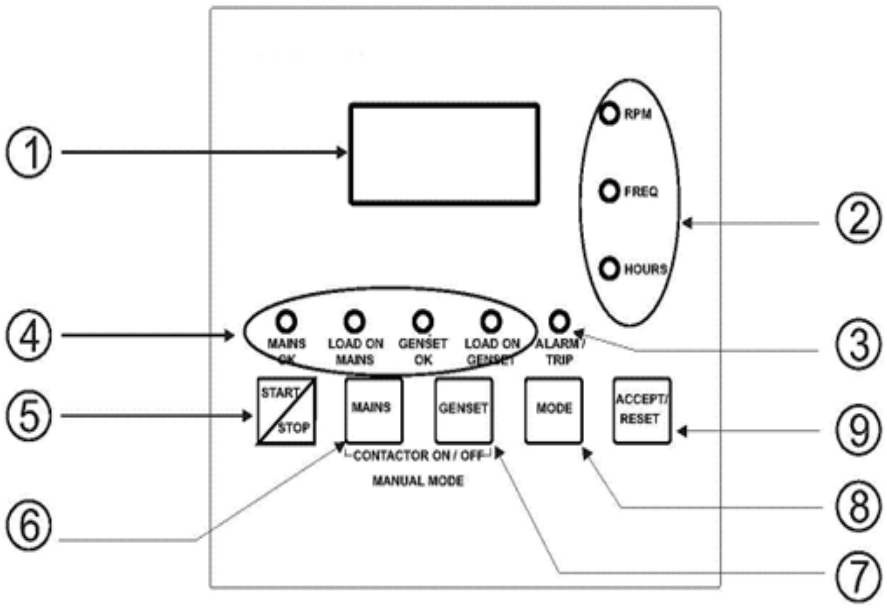
8. **If any fault occurs but Hooter does not give buzzer?**
   Check Hooter connections i.e.wire no.18 is not connected properly to .

8. PANEL AMF 3 PHASE CONTROL CIRCUIT DIAGRAM



NOTE			
S1	AUTO/MANUAL SWITCH	L11	WATER IN FUEL LAMP
S2	START STOP KEY SWITCH	L12	GLOWPLUG ON LAMP
S3	CONT. SELECTOR SWITCH	L13	CHARGE LAMP
ELCL	ELECTRICAL GAUGE	R1	LOP RELAY
GCX	AMF CONTROLLER	R2	COM. ALARM RELAY
L1	MAINS R PHASE ON	MC	MAINS CONTACTOR
L2	MAINS S PHASE ON	GC	GENSET CONTACTOR
L3	MAINS R PHASE ON	D1	DIODE 4007
L4	GENSET ON		
L5	LOAD ON MAINS		
L6	LOAD ON GENSET		
L7	CHECK SERVICE LAMP		
L8	LOW OIL PRESSURE LAMP		
L9	HIGH COOLANT TEMP.		

9. MANUAL



Item No.	Function
1	Display for RPM, Hours and Frequency
2	LEDs for indicating display mode
3	Alarm / Trip indication LED
4	LEDs for indicating Mains ok, Load on Mains, Genset ok, Load on Genset
5	• START / STOP switch in manual mode. • PROGRAM switch in
6	• Mains Contactor ON / OFF Switch in MANUAL mode • UP key in Program mode
7	• Genset Contactor ON / OFF switch in MANUAL Mode • SHIFT key in Program Mode
8	• Normally functions as MODE key • Functions as EXIT key in Program mode
9	• Accept key • Functions as RESET key if pressed continuously for 5 secs.

SECTION VI

CANOPY

1. CONSTRUCTION DETAILS

Canopy / Acoustic enclosure is essential to comply with CPCB norms, which state that "Noise level of the Genset should be less than 75 dBA when measured at a distance of one (1) meter in free field condition.

Canopy design is modular in construction & it does not require any special foundation. All panels are mounted on a common base frame which is also used to mount engine and alternator. It can be easily dismantled and assembled again. Panels are manufactured from CRCA sheets and are powder coated after essential surface treatment. Acoustic material is provided on side panels, doors and canopy roof to arrest the noise level. Fire resistant foam 25mm thick is used as acoustic material. Door, in front of control panel, has glass window through which operation of Genset can be monitored. In all 4 no. of doors are provided for proper maintenance. Doors are of swing type with heavy duty hinges & proper locking arrangement is provided for the doors.

Lifting hooks provided at the canopy base and rope catcher are to be used for lifting the canopy & Genset.

2. DIMENSION DETAILS OF CANOPY / ACOUSTIC ENCLOSURE

Overall size 2 cylinder engine genset canopy

Length	1950 mm
Width	950 mm
Height	1400 mm

SPECIAL FEATURES OF DESIGN

1) Compact construction and sleek design with a noise arrest of about 25dB Sound proof, weather proof and non polluting environment friendly silent enclosure.
2) Powder coated CRCA sheet for the enclosure.
3) 4 Heavy duty hinged doors for Enclosure.

3. GUIDELINES FOR INSTALLATION OF CANOPY/ ACOUSTIC ENCLOSURE

INTRODUCTION

Canopy / Acoustic enclosure is essential to comply with CPCB norms, which state that "Noise level of the Genset should be less than 75 dBA when measured at a distance of one (1) meter in free field condition.

LOCATION

Canopy Genset do not need any room. It should be placed in "free field condition". The wall if any should be 6 meters away from canopy Genset. (This is to avoid Noise reflection)

In this type of canopy air enters from the louvers provided on alternator side of canopy. Air then passes through alternator and radiator fan and finally hot air exits from duct provided on top side of the canopy. The side from where hot air comes out should not have any restriction for free flow of air.

In case Genset is required to be installed in a room, proper ducting should be ensured for inlet air & outlet air. Recirculation of hot exhaust gases in canopy is not advisable.

GUIDELINES FOR INSTALLATION OF GENSET

1) Lift the canopy Genset with the help of lifting hooks provided at base only.
2) While lifting canopy Genset use rope catcher to avoid damage of canopy.
3) Canopy Genset base should be placed on flat foundation.