TECHNICAL DESCPRIPTION AND SPECIFICATIONS OF POWER CONDITIONING UNIT FOR SPV–WIND-DIESEL HYBRID SYSTEM

SYSTEM INTRODUCTION:

The PV Wind diesel hybrid system shall consists of:

a) 25 KWp SPV Array
b) 2 X 60 kW DG Set (415V, 3 phase, 4 wire, 50 Hz)/2X55 KW WEG
c) Power conditioning unit (PCU) 25 kVA (3 phase, 415 V 50Hz)
d) Battery Bank 240V, 500Ah (VRLA)
e) ACDB & DCDB– 1 No. each

Site : This system is scheduled for installation & commissioning at Kadvakallu near Ananthapur (AP) where BHEL wind farm is already existing.

Eligibility criteria :

Vendors shall have the technology of such hybrid power conditioning unit (PCU) & must have supplied & installed such hybrid PCU, which is working satisfactorily for last one year are eligible to quote. Customer certificate endorsing satisfactory operation to be produced along with techno-commercial bid.

Bidding instruction:

(A) Offer is invited in Two part bid system viz. Techno-commercial bid and Price bid. Price bid of vendors, whose techno-commercial offer are meeting the technical and commercial parameters specified in the tender will be opened.

(B) All commercial conditions/deviations must be mentioned clearly and enclosed with the technical bid (Un priced bid) separately.

SCOPE OF WORK :

- Supply of PCU to BHEL, R&D, Hyderabad.
- E&C of PCU at Kadvakallu
- AMC of PCU at the site.

FUNCTIONAL REQUIREMENT :

Power conditioning Unit (PCU) shall operate in Photovoltaic System to synchronize with the common AC bus & to export 3-ϕ power to AC bus /Local grid. Refer scheme in page 15.

AC bus is obtained by :

a) A DG grid of capacity 2x60 kW, 3-ϕ, 415 V, 50 Hz,
b) The system also incorporates 2x55 kW Wind Electric Generator (WEG) to the common 'AC' bus.
c) To start with PCU output shall be dispatched to common AC bus. To this AC bus potential DG / WGE shall get synchronized. The frequency and voltage regulation of the WEG output shall be monitored and controlled by a master controller by operating the dump load (**Master controller is not in the scope of this specification).**

Commands for starting the DG in the event of battery low condition shall be incorporated within PCU. SPV power in conjunction with battery power provided solar power output is also Low) shall be fed to load.

1.0 SCOPE OF SUPPLY:

25 kVA PCU- one no. consisting of :

1. PWM battery charger – 25KW capacity.
2. Bi-directional inverter – 25kVA, 415V, 3phase, 4 wire, 50Hz.
3. Data logger.
4. Software for parallel operation of inverter and common AC bus.
5. System will be configured as a single modular type such that the multiple inverters and Genset would feed to a single site load/AC bus with appropriate feeder. Remote communication via telephone line (telephone line will be provided).
6. ACDB & DCDB in one common enclosure (refer page 15-18).

Note : 1) Item no. 1 to 4 shall be in one common enclosure.
2) Item no. 6 shall be in another common enclosure.

2.0 SYSTEM FEATURES & REQUIREMENTS :

2.1 The Master controller and PCU shall interact in the following manner for following function.
(Master controller (MC) –not in the scope of supply by vendor. BHEL shall organize for this unit).

2.1.1 Modbus communication to be provided for RE controller (Master Controller – MC) to instruct the PCU with the following:

- Modbus communication port shall be multi drop RS485 based. PCU shall incorporate the same.
- PCU ONLINE command implying getting connected / synchronised to the grid
- PCU OFFLINE command implying getting disconnected from the grid
- KW EXPORT SET VALUE command
- KW IMPORT SET VALUE command

- Status of the batteries in the form of battery voltage and current, measured values of power flow (export / import), offline / online status, self tracking / source tracking mode, etc. to be made available to MC on STATUS request commands (one or more). The battery current value should be signed, in order to indicate the direction (charging / discharging).

2.1.2 MC will provide one potential free contact to indicate to PCU that at least One (or more) DG / WEG sets are online, so that PCU can switch over to source tracking mode. The same contact will be used to indicate when the last commutating machine (DG/WEG) goes offline, to enable PCU to switch over from source tracking to self tracking mode. This contact will be directly derived from the contactors of the DG sets and WEGs, in order to ensure that there is minimum delay in communicating the status to PCU.

2.1.3 In source tracking mode, the PCU should try to maintain export / import as per the settings given by the MC via MODBUS, unless otherwise compelled to override the same due to battery condition or PV output capability.

2.1.4 PCU should override the set points given by MC if situation demands. Maintaining the batteries SOC is the responsibility of PCU. PCU can decide when to charge the batteries and the charge rate, as the situation demands, and inform MC via MODBUS, so that MC can ensure that grid condition comply (such as adjusting load or turning ON a DG set, etc). to meet PCU requirements. MC will not furnish any commands regarding charging / discharging of batteries. PCU is expected to self manage the batteries.

2.1.5 In self tracking mode, the power exported by the PCU cannot be directly controlled by the MC via Modbus commands. It will be decided by the load and the PCU.

2.1.6 In the Modbus protocol, MC will be the master and the PCU should be configured to be in slave mode of operation.

2.1.7 MC will decide as to, when any generating source should come ONLINE or go OFFLINE, including DG sets, WEGs and SPV system. MC will also regulate the adjustable load to meet grid requirements.

2.1.8 The PCU is expected to stay connected to the grid and function for a voltage variation of ± 15% and a frequency variation of ± 5 Hz on the grid. If the grid condition goes out of these bounds, the PCU can disconnect itself from the grid.

2.1.9 The PCU should be capable of handling a 25 KW PV input power coupled with 240 V / 500 Ah batteries.

2.2 TECHNICAL SPECIFICATIONS: PV CHARGE CONTROLLER

1. This shall be solid state PWM based with protections against lightning and surge.
2. Battery charging from solar shall be the first priority and shall be charged at the maximum rate depending on the solar radiation till battery terminal voltage reaches 2.26±0.2 V/ cell. (Battery type employed shall be VRLA-SMF battery). Battery operating parameters shall be software settable.
3. When battery terminal voltage reaches 2.35V/ cell the battery recharging rate is automatically reduced to the finishing rate.
4. The charger shall switch on to trickle charge mode after this.
5. The switching element employed shall be IGBT / MOSFET.
6. Type of charger: Series PWM, 3-step control with Battery temp. compensation.
7. Input : From PV source 240V nominal, 10 Nos. SPV modules in series.

Protection against	:	Short circuit Deep discharge Over charge Battery high temperature & Over voltage Battery high charge current
Indications	:	PV Charger 'ON' Input 'ON' Control 'ON' Battery on Trickle High Battery Temperature Fault Low Solar Power Boost mode enabled High Battery Voltage fault System Fault Charger Over temperature
Dielectric Strength	:	2 kV between input/output and Ground with EMI protections removed.
Cooling	:	Forced, with temperature sensitive Fan Operation
Ambient temperature	:	50°C (max.)
Operating Humidity	:	98% maximum(Non Condensing)
Assembly/ mounting	:	As per normal industrial practice.

2.3 INVERTER :

2.3.1 Basic System Operation ('Full Auto' mode):

• Under light to medium load conditions the inverter shall supply the site load from the battery bank and/or solar panels depending on the availability of solar power.

• In the event the battery voltage drops ≤1.95 V PC (this set VPC shall be variable at site by an operator depending on the site conditions or the site load increased above a preset level), The Battery will be charged by the source available on AC bus i.e WEG or DG.

• Once the batteries have reached the predetermined level of charge the available solar energy shall be utilized to reduce the load and on the Genset which will subsequently be brought off line and stopped provided the site load was not excessive leaving the inverter to again supply the load.

2.3.2 System Features and Options:

- Solar resources are fed directly to the site load via the inverter as much as possible to minimize losses due to battery inefficiency.
- Local LCD (Liquid Crystal Display) and keyboard for system control and monitoring instantaneous system data.
- Time and date stamped system data logs available for importation into a spreadsheet for analysis via a local RS232 connection.
- The data obtained shall be class II accurate or better. The repeatability of such data shall be taken into consideration.
- Remote control and monitoring option shall be made available (with local dedicated telephone line or with Internet or with GSM network.
- Automatic dial out on system faults and data down load option available.

2.3.3 OPERATING PARAMETERS :

Solar Regulator	25 kW PWM
DC Input Voltage	240V DC nominal
Output Voltage	415 V AC ±1% during Standalone inverter operation. Inverter to fallow generator Voltage up to ±15% of the Nominal output voltage during parallel operation.

Output Frequency	**50Hz ±0.5% during Standalone inverter operation.** Inverter to follow generator Frequency up to ±5Hz of the Nominal output frequency during parallel operation.
Continuous Rating	25KW/30 KVA
Surge Rating	150% of the continuous Rating for minimum of 30 Seconds.
Control Type	Voltage source, microprocessor Assisted output regulation
Wave Form	Microprocessor/ DSP generated Sine wave output.
Parallel Operation Power Control	Phase Controlled Pulse Width Modulation (PWM)
THD	Less than 5%
Efficiency	Min. 92%
Internal Protection System (Electronic detection)	• Inverter Continuous overload • Peak current (SC) protection • Heat sink over temperature • Over/under voltage • Over/under frequency protection • Over/under battery voltage Protection
RFI	Designed to minimise both conduced and radiated RFI emission
Alarm Signals	Via System fault relay(voltage Free contact)
Front Panel Interface ambient or panel temperature	40X4 LCD panel with membrane Solar radiation in W/M^2 Inverter kWh summation

2.3.4 Cabinet

Material	:	CRCS (Steel sheet)
Finish	:	Powder coating, Beige color after due treatment.
Cable Entry	:	From rear, 200mm from ground level

2.3.5 Environmental:

Operating Temperature Range : 5-50 degrees Celsius

Enclosure : Rated for IP30

2.3.6 Terminations :

Cable glands & lugs to be provided in PCU for the following:

a) PCU Solar +ve & -ve - 1x70 sq.mm cable - 2 nos

b) Battery +ve & -ve - 1x70 sq.mm cable – 2 nos

c) Three phase & Neutral output – 3 ½ x35 sq.mm

e) Signal cable glands for

i) Pyranometer
ii) Module temperature sensor

2.4 INTEGARTED DATA LOGGER - To be supplied with the system.

- This shall be part of Power conditioning unit.
- Adjustable logging period from, 60 second average to 24 hour daily logs.
- Time and date stamped log entries.
- Time and date annotated fault log, holding the log description and operating statistics.
- View and change system set point configurations remotely.
- Bulk log download for immediate data importation into spread sheet.
- Automatic dial out when the logging database is full or when a system fault occurs.
- Real time feedback of voltage, power factor, frequency of the inverter module.
- Real time voltage, current, temperature, solar renewable current contribution, solar radiation and ambient or panel temperature.
- Periodic logging of battery statistics including battery voltage, current, temperature and renewable current contribution

2.4.1 SYSTEM SUMMATIONS VIEWING :

- Inverter input kWh/Ah.
- Inverter output kWh.

2.4.2 DOWNLOADABLE LOG PARAMETERS:

- Solar charge current.
- Battery Current.
- Battery Voltage.
- Battery Temperature.
- Ambient or panel temperature.
- Inverter kW, voltage, pf, frequency.
- Solar radiation (in conjunction with an external Pyranometer).
- 1 no. pyranometer shall be supplied.
- Battery temperature sensors and the panel temperature sensors shall also be supplied.

Note: Accuracy of data and Repeatability of data shall be furnished in the offer.

2.4.3 MONITORING UNIT

Necessary PCs with color monitors, modems, hardware & software shall be supplied by the vendor along with Data Logger and Plant Monitoring unit. These will include software and hardware required for interfacing the plant. The PCs should be latest models available.

3.0 DC & AC DISTRIBUTION BOARD (DCDB/ACDB):

This shall be housed in a common enclosure.

3.1 DC DISTRIBUTION BOARD :

The 25 KWp SPV array shall be grouped into 4 sub-groups of each 6.4 KWp (Each PV Module rating : 24V/160Wp). The sub-array positive terminals shall be terminated on to MCBs in the DCDB. In all there will be 4 MCBs of each 500V, 25A (2 pole connected in series, rated for 250V dc each). **The DCDB shall be as per the scheme enclosed.**

3.1.1 Electrical :

PV array Voltage	: 380 V DC nominal
PV current from each Sub array	: 20 A DC
AC voltage	: 415 V AC
Phase	: 3 Ph, 4 wire
Frequency	: 50 Hz ±5%
System earthing	: Solidly grounded system (enclosure)

3.1.2 Internal wiring shall be rated for 150A and bus bar used for wiring shall be of Red & Black colors for positive & negative respectively

3.2 AC DISTRIBUTION BOARD :

The PCU output is evacuated through an ACDB with a single feeders. Appropriately rated MCB shall be provided for the feeder. **Detailed scheme of ACDB is enclosed.**

TECHNICAL SPCIFICATIONS:

Incoming	Three phase & a neutral connected to AC bus.
Indicating instruments	AC Voltmeter – 1 No. AC Ammeter – 1 No. for input current.. AC Frequency Meter - 1 No. AC Ammeter - 3Nos. for feeders. 3ϕ Energy Meter –1 No. for feeders Voltmeter and Ammeters shall be Fitted with phase selector switches.
Operating Humidity	95% (maximum)
Ambient Temperature	50^0 Celsius (Maximum)
Mode of Earthing	M8 bolt provided at the rear
Assembly	As per normal industrial Practice
Finish	Powder coating, Beige colour.
Cable Entry	From rear, 200mm above Ground level

3.3 CABLE ENTRY DETAILS FOR BOTH AC & DC DB:

DC SIDE:

INCOMING :

a) 1 core 25 sq.mm PVC insulated & sheathed copper cable, armoured - 4 nos FROM SPV ARRAY PJB 1-4 (positive).

b) 1 core 70 sq.mm PVC insulated & sheathed copper cable - 1 no. FROM SPV ARRAY AJB 1 (negative)

c) 2 core 2.5 sq.mm copper cable - 1 no AUX.SUPPLY (from Mains 220VAC supply for digital voltmeter & Ammeter).

d) 1x 70 Sq.mm PVC insulated and sheathed copper cable – 2 nos FROM BATTERY +VE & -VE.

OUTGOING :

a) 1 core 70 sq.mm PVC insulated & sheathed copper cable - 1 no. TO PCU Solar +ve .

b) 1 core 70 sq.mm PVC insulated & sheathed copper cable - 1 no. TO PCU Solar -ve .

c) 1 core 70 sq.mm PVC insulated & sheathed copper cable - 2 nos. TO PCU BATTERY +VE & -VE.

d) 1 core 70 sq.mm - 1 no. SPARE.

AC SIDE:

a) 3 ½ core 70 sq.mm PVC insulated & sheathed copper cable - 2 nos. FROM AC Bus & TO PCU output.

b) 3 ½ core 70 sq.mm - 1 no. SPARE .

NOTE : Suitable cable glands to suit the above size cable of single compression, nickel-plated brass shall be provided. Suitable hardware & copper lug shall be provided in the bus bars (for cable sizes

4.0 General Electrical and Mechanical specifications applicable to PCU, DCDB & ACDB

4.1 Electrical :

4.1.1 Bus bars and bus connections

Power connections shall be done through bus bars only.

a) The bus bar arrangement shall generally to IS:375-1963. The MCCBs & the corresponding bus bar chambers shall be in located in separate compartments.

b) Bus bar material shall be electrical grade tinned copper of suitable size depending on current rating. The cross section shall be uniform throughout the length. Current density to be maintained as 1.2A/mm sq.

c) The clearance between positive & negative terminals in air shall be not less than 50 mm. Abnormal conditions such as short circuits shall not permanently reduce the distance between the bus bars and connections below the mean acceptable values. In case, such clearance is not possible to be provided, suitably insulated barriers shall be used.

d) Bus bars shall be identified by color. The color code shall be as per IS:375- This may be done through coloured PVC sleeves. Bus bar support shall be hylam/FRP of suitable thickness.

4.1.2 All wires shall run and fixed neatly and shall allow clear access to all components.

4.1.3 All wiring shall be arranged and supported in such a manner that there shall be no strain on termination.

4.1.4 Each wire shall be identified at each end and in accordance with the schematic diagram with ferrule in an indelible manner. The ferrule shall not move/ slide over.

4.1.5 Where wiring may lead to the door, it shall be done by flexible cable in non-metallic flexible hose and so installed that no mechanical damage can occur to the wiring as a result of movement of the door.

4.1.6 Earthing : A earth bus bar shall be provided inside the panel for Earthing and Earthing terminations shall be provided inside and outside the panel.

4.1.7 All components shall be mounted in such a manner ,so as to facilitate easy Accessibility for maintenance.

4.1.8 All breakers shall be door operated.

4.2 MECHANICAL:

4.2.1 Enclosure: Shall be made of 16 SWG CRCS Sheet.

4.2.2 The degrees of protection provided by the enclosure shall be IP30 of IS:2147- 1962.

4.2.3 EPDM /Neoprene rubber gaskets shall be provided for doors and covers. Gaskets shall be adequately secured. Gluing alone is not sufficient.

4.2.4 All fasteners shall be MS with nickel plated with suitable spring washers.

4.2.5 Danger Name plates in accordance with IS:2551-1963 danger notice plates and IS:8923-1978 warning symbol for dangerous voltage shall be provided.

4.2.6 Provisions shall be made for lifting and handling by eye bolts.

4.2.7 Cable entry : Cable entry shall be from rear side only.

4.2.8 Painting: Enclosure shall be painted with Powder coating Light biscuit or shade 385 of IS-5 or equivalent color, after necessary pretreatment

4.2.9 Labels: Legend marking on anodized etched aluminum plate for the following:
Name Plate – "DC / AC DISTRIBUTION BOARD" with BHEL logo.
Schematic of DC / AC distribution board to be fixed on front of the cubicle.

4.2.10 An inscription labels of anodized aluminum bearing the description of the functional unit shall be provided on the door of the comportment. Inscriptions shall also be provided for operating handles of switches, breakers etc. which are available on the front of the door indicating its purpose and modes of operation. Each TB in cable alley (wherever applicable only) shall also be identified by inscription labels. The inscription of incoming and outgoing as shown in the schematic shall also be labeled. All inscriptions on labels shall be in English with characters not less than 3 mm high and shall be in sizes suited to the items to which they refer.

4.2.11 General arrangement drawing of DCDB & ACDB enclosed in page no.16 of this specification is only indicative. Vendor shall furnish the GA drawing incorporating the details given.

5.0 SHOP TESTING & PACKING :

(a). The change controller /battery charger & Inverter shall have to be tested in presence of the authorized representative of BHEL in order to verify the capacity and proper working of all protective arrangements. Factory test report containing performance test such as Heat run, Efficiency & Regulation test, HV/IR test and Test for protection circuit etc. shall be Furnished

(b). PACKING : PCU shall be sealed in Polythene wrap and packed in wooden box with coir/foam stuffing. Wood employed shall be insect resistant and wooden crate shall be Nut & Bolt construction with base pallet. Each cubicle shall be packed separately.

6.0 SPARES :

The system supplied has to work continuously, trouble free. To attend any defects/breakdown in the electronic system/subsystems, necessary spares to be supplied along with the equipment. **A list of recommended spares needs to be furnished along with the offer**.

7.0 INSPECTION/TESTING:

BHEL reserves the right to inspect/testing of items before dispatch to site and the quality/progress of job at site. Any alterations/modification required at the site shall be implemented on mutually agreed basis

8.0 DELIVERY PERIOD :

The PCU shall be delivered to BHEL,R&D, Hyderabad within 10 weeks from the date of placement of P.O.

9.0 GUARANTEE:

9.1 The guarantee period for the equipment will be 24 calendar months from the date of commissioning. Commissioning means the satisfactory continues and uninterrupted operation of the equipment/work after all initial checks at the site for a period of minimum 30 days to the satisfaction of BHEL Engineer-in-charge. Any defective parts shall be replaced during this guarantee period on free of cost basis.

9.2 PERFORMANCE GUARANTEE: Supplier shall furnish a bank guarantee from a Nationalized bank for an amount equal to 10% of the contract value by way of guarantee for due and faithful performance of the agreement and other terms and conditions agreed to.

10.0 ANNUAL MAINTEANANCE CONTRACT (AMC) :

Beyond the Guarantee period of 2 years, Vendor shall carry out AMC to check the healthiness of the PCU and the associated items on per visit basis, considering minimum of 2 visits per year for a total of 3 years. For break down visits, vendor shall repair the PCU by replacing the defective components.

11.0 Following information shall be furnished along with offer:

11.1 Drawing:

GA drawings containing ,

- Internal clearances for power wiring such as busbar arrangement & busbar chamber details .
- Cable entries
- Mounting arrangement of components

11.2 Reference list :
Details of customer to whom such hybrid PCU has been supplied along with the location of the site where it is installed shall be furnished.

11.3 Clause wise response to this technical specifications shall be furnished.

11.4 Technical & commercial offer shall be furnished separately. Such of those offers which technically qualify will be eligible for opening commercial

12.0 DOCUMENTATION:

1. Four copies of complete documentation shall be provided.

2. Four copies of detailed operation and maintenance (O&M) Manual for the installed system shall be supplied. As a minimum, the manual shall contain the following descriptive material:

   a. Operation requirements and details.

   b. Trouble shooting procedures.

   c. All maintenance requirements and their schedules, including detailed instructions on how to perform each Task.

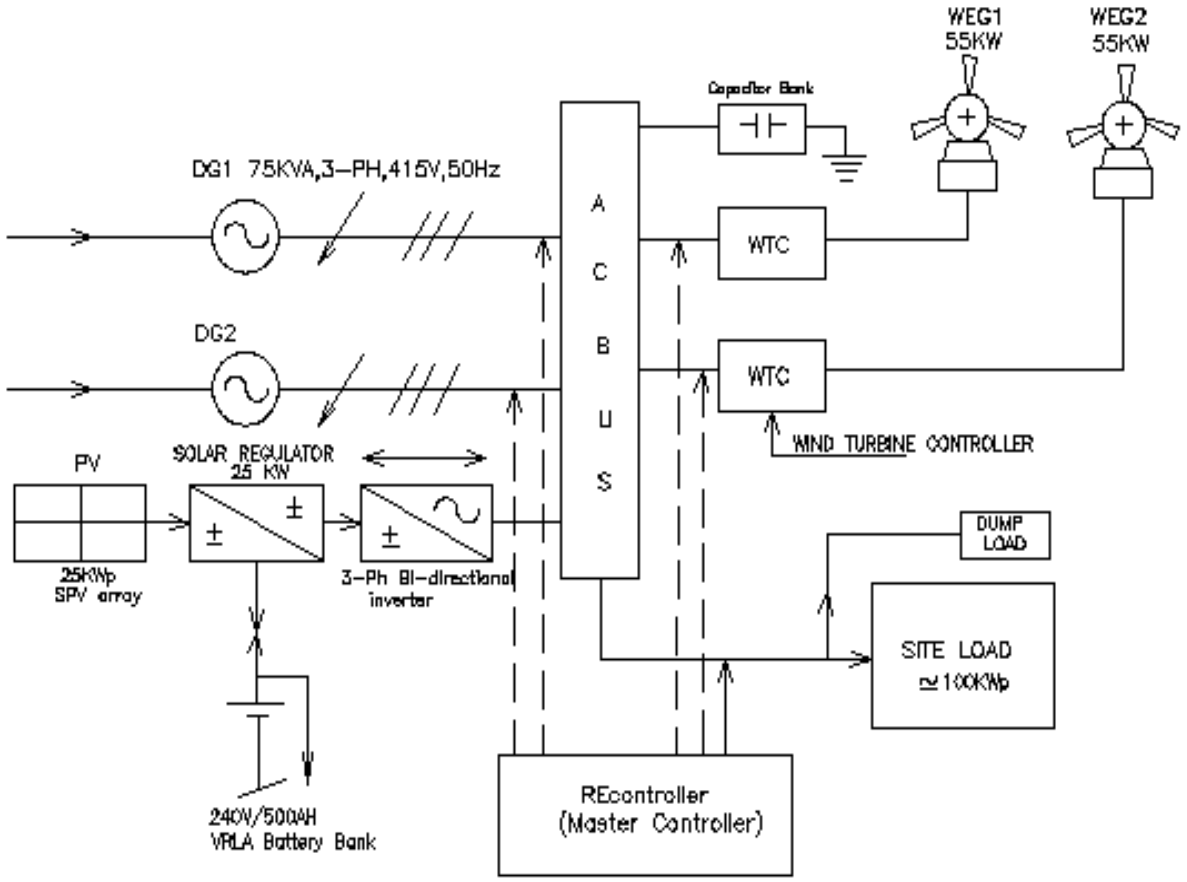
   d. Detailed schematics of all power, instrumentation and control equipment and subsystems along with their interconnection diagrams.

   e. Schematics shall indicate wiring diagrams, their numbers and quantities, types and ratings of all components and subsystems.

   f. CD consisting of above points in documentation shall be given.

   g. Dimensional details with layout in the form of drawings & weight of each system, electrical layout with & without packing shall be furnished at the time of quotation.

SCHEMATIC DIAGRAM OF SPV WIND DIESEL HYBRID SYSTEM



Note: 1) As the RE controllers is conjunction with AMF panel of DG set decides the DG turning "on". How will the DG be made ON, Inthe event of battery to be charged from DG, when battery Vpc <= 1.8Vpc

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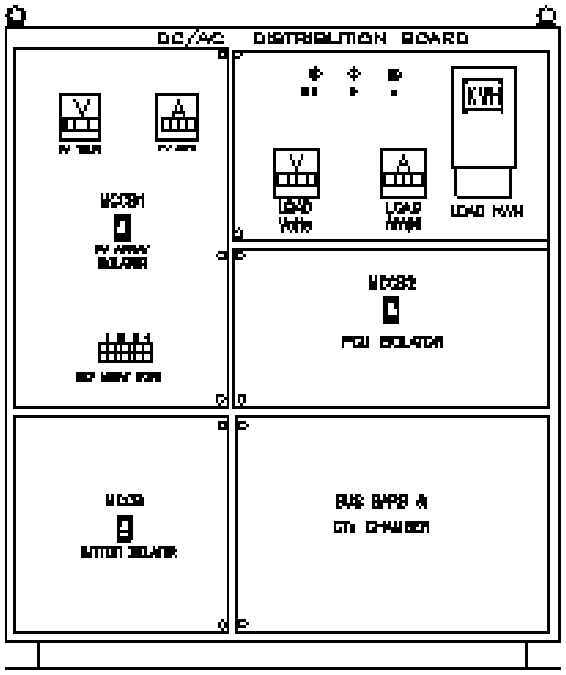
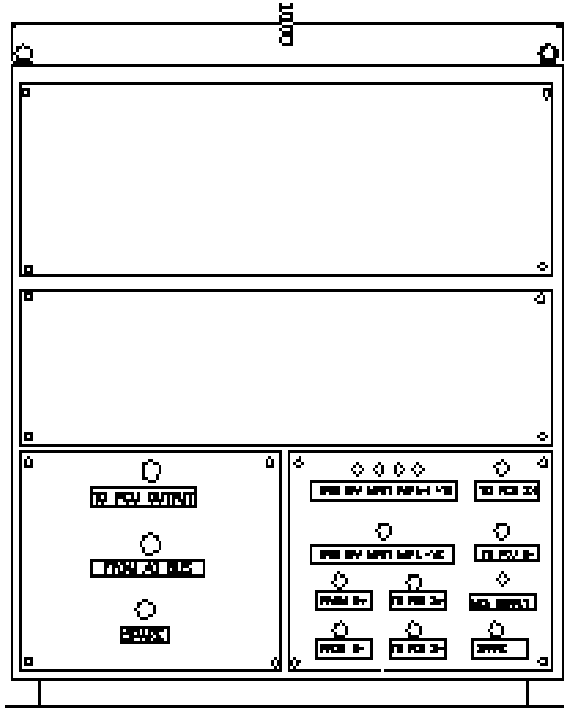
GENERAL ARRANGEMENT DRG OF DC/AC DB FOR 25KVA SYSTEM
(INDICATIVE – FOR REFERENCE ONLY)

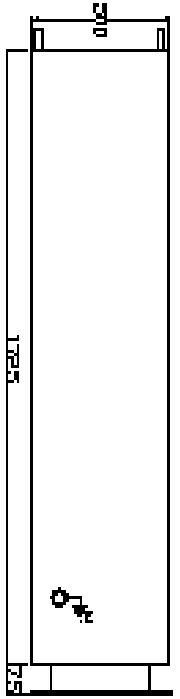
FRONT VIEW



REAR VIEW



SIDE VIEW



PURCHASE SPECIFICATION
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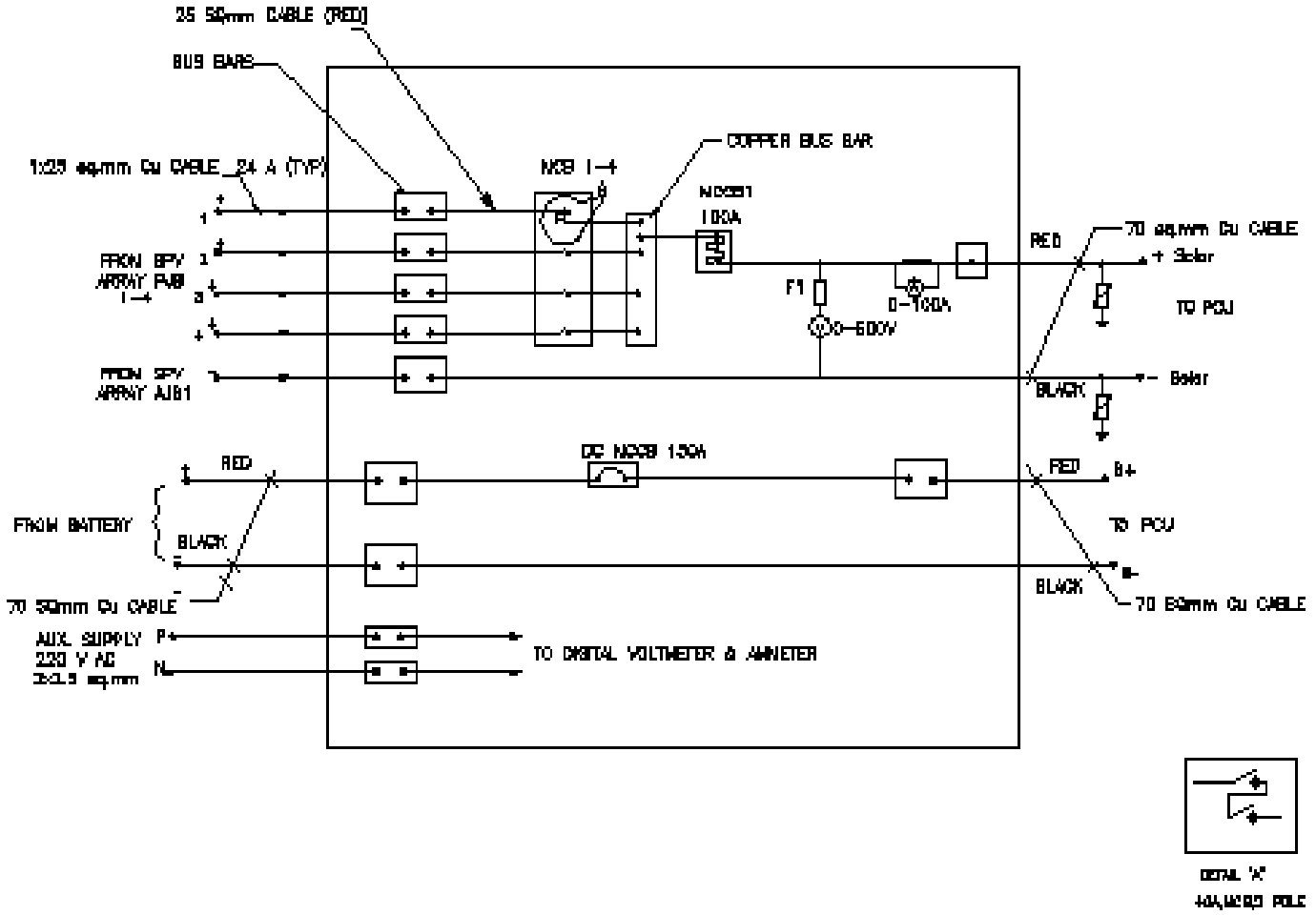
SCHEMATICS DAIGRAM OF DC DISTRIBUTION BOARD



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SCHEMATIC DIAGRAM OF AC DISTRIBUTION BOARD