

VOLUME-2
PART- I
Section-12
110 V DC Systems

Contents

| | |
|--|----------|
| 12. 110 V DC System | 1 |
| 12.1 Intent of Specifications | 1 |
| 12.2 Scope of Supply | 1 |
| 12.2.1 110 V DC Equipment | 1 |
| 12.2.2 Miscellaneous Items | 1 |
| 12.2.3 Services | 2 |
| 12.3 Specific Parameters and Layout Conditions | 2 |
| 12.3.1 Layout and General Arrangement | 2 |
| 12.3.2 Design considerations | 2 |
| 12.4 Rating and Functional Characteristics | 4 |
| 12.4.1 Batteries | 4 |
| 12.4.2 Battery Chargers | 4 |
| 12.4.3 Inverters | 4 |
| 12.5 Performance Guarantee | 5 |
| 12.6 Design and Construction Details for 110 V DC System | 5 |
| 12.6.1 Standards | 5 |
| 12.6.2 Cubicles | 6 |
| 12.6.3 Batteries and battery racks | 6 |
| 12.6.4 Charging Equipment | 7 |
| 12.6.5 DC Distribution Boards | 11 |
| 12.6.6 Inverter | 12 |
| 12.7 Detection of Abnormalities and Faults | 13 |
| 12.8 Ventilation and painting of battery room | 13 |
| 12.9 Transport | 14 |
| 12.10 Tests | 14 |
| 12.11 Drawings, Documents and Design Calculations | 15 |
| 12.11.1 Design memorandum | 15 |
| 12.11.2 Drawings and documents | 15 |
| 12.11.3 Design calculation | 16 |
| 12.12 Delivery, Installation and Commissioning | 16 |
| 12.13 Spare Parts | 16 |
| 12.14 Special tools | 17 |
| 12.15 Quality Assurance and Testing | 17 |
| 12.16 Guaranteed and Technical Particulars | 17 |
| 12.17 Completeness of Equipment | 17 |
| 12.18 Deviations from Specification | 17 |

12. 110 V DC System

12.1 Intent of Specifications

The intent of these specifications is to define the scope of work under this section which covers the provision of labour, tools, plants, materials and performance of work necessary for the design, manufacture, quality assurance, quality control, shop assembly, shop testing, delivery at site, storage at site, erection, acceptance testing, commissioning, performance testing, handing over to Purchaser and guarantee for trouble free operation of 110 V DC System for Keyi Hydro Electric Project, Arunachal Pradesh as per the specifications hereunder, complete with all auxiliaries, accessories, any other parts which is required for the satisfactory operation of the facilities, spare parts and warranting a trouble free safe operation of the installation.

It is not the intention to specify the minute details/smallest items to deliver a functional system or to define the standard manufacturing practice but to outline the performance, constructional, operational and guaranteed requirements. It is the responsibility of the contractor to ensure these requirements.

12.2 Scope of Supply

12.2.1 110 V DC Equipment

- Two (2) set of Valve regulated Lead acid (VRLA) type 400 AH battery bank complete with terminal connections for series/ parallel connections of cells, hardware, connecting cables and associated accessories,
- Two (2) sets of float cum boost battery chargers, one for each battery bank along with associated equipment, hardware, connecting cables etc.
- One (1) set of DC distribution board for Powerhouse complete with control, indication and annunciating devices.
- One (1) set of Ni-Cd DC battery system of 24 V, 50 AH along with associated equipment, hardware, connecting cables and DC distribution board etc for Intake power supply.
- One (1) set of 3 kVA capacity inverter for the Intake power supply.

12.2.2 Miscellaneous Items

- Necessary DC-DC converters may be provided for 24 V DC System.
- One (1) set of 5 kVA or higher capacity inverter along with its distribution boards,
- Seismic-proof racks, hardware, interconnecting cables and other accessories etc. for each bank of batteries,
- Cell testing voltmeter,
- Coordination and provision of necessary contacts and/or ports for integration with plant SCADA system

- Spare parts.
- Special Tools and instruments, if applicable

12.2.3 Services

- Transportation and delivery to site including all logistics and proper site storage and preservation as per manufacturer's recommendation.
- Site installation and commissioning
- Field / touch-up painting including all painting materials
- Consumables required at site during erection.
- Performance and field acceptance testing as per the relevant clause of this section and submission of report
- Training of Purchaser's personnel including operation and maintenance staff
- All the technical documentation including preparation and submission of O & M manuals

12.3 Specific Parameters and Layout Conditions

12.3.1 Layout and General Arrangement

The 110V DC system in the powerhouse shall have provision for float and boost charging of DC batteries. The AC supply for chargers for DC batteries shall be supplied from station service boards as per the single line diagram for the 110V DC system.

The DC power requirements for control and protection circuits, emergency lighting, black start of units and inverters in the powerhouse shall be supplied from the 110V DC distribution board.

The static inverters will be connected to the 110V DC system and a distribution board. The inverter will serve essential consumers of the control system, power outlets circuits of control room, office areas and individual sockets intended for electronic appliances & computers, monitors, printers and uninterrupted lighting in critical areas. In addition it will supply a limited number of illumination fittings during complete failure of AC station supply system.

The AC power supply for 110V DC battery charger shall be taken from unit-station service boards and the charger shall be so designed that they can give full charging currents within the given voltage variation.

Battery bank of 110V DC shall be capable of supplying successfully total station loads of 110V DC systems respectively for at least three (3) hours without any assistance from the charger and without its terminal voltage falling below 96 V.

12.3.2 Design considerations

- (i) Sizing criteria of 110V Battery Charger:

Chargers each complete with float charging and float cum boost charging functions etc. are required.

- Normally, each of the two float chargers shall be supplying half of the total DC load and also be supplying the trickle charging current for one battery bank. In case of failure of one of the float chargers, the other should be able to supply the complete DC loads of the powerhouse and trickle charging current to both the battery banks automatically.
- Each boost charger shall be used for charging one battery bank speedily. During boost charging, the load would be continued to be met by float charger.
- If float charger fails during boost charging the boost charging is continued by boost charger and the load is supplied through the respective tap cells through blocking diode.
- Provision shall be made so that each of the boost chargers can be selected to charge any one of the battery banks at a time.
- Suitable interlocking shall be provided between float charger & boost charger, float charger output circuit breaker & bus tie breaker, incoming breakers of DCDB and boost charger I & II.
- The DC loads of the powerhouse shall comprise of:
 - Control, protection and operational loads of powerhouse & 132kV switchyard.
 - Continuous loads such as indication, alarms of powerhouse & 132kV switchyard, continuous loads of telephones, UPS, SCADA, continuously energised coils, other electronic equipment etc.
 - Emergency lighting loads of powerhouse & switchyard.
 - Unit starting loads: field flashing, DC motors if applicable.
 - Intermittent and momentary loads.

(ii) Sizing criteria of 110V Battery:

Each Battery bank shall have 50% capacity of total capacity required as per sizing calculation and minimum 400Ah. The sizing of the battery shall be strictly as per IEEE-485, 1997. Necessary design margin and aging factor may be considered as per IEEE-485.

The following load cycle shall be considered for sizing of D.C. System:

- Continuous Load- for 5 Hrs. Such as indication, annunciation, control, UPS, telephone, continuously energised coils etc.
- Intermittent Loads- for 1 minute. Such as tripping and closing of Circuit Breakers, contactors, field flashing, DC operated valves etc.
- Emergency Lighting- for 5 hours.
- Other Loads- 30 minutes like pressure oil pump etc.

The battery will furnish practically all the heavy current demands for meeting the operating contingencies such as failure of AC supply or when charger is under maintenance etc.

(iii) Sizing criteria of sectionalised DCDB:

- One common 110V DCDB having 2 sections separated by breaker shall be supplied.
- The continuous current rating shall be based on maximum DC loads as described above.
- 10% design margin shall be adopted while arriving at the final continuous current rating.

- Temperature rise shall be as per IS: 13947.
- Adequate short circuit withstand capacity shall be built in all the components including busbars.
- The following auxiliary supply shall be available for use in the protection system.
- AC supply 415V/240V (+/-10%), 50Hz (+/-5%) with +/-10% combined voltage and frequency variation.

12.4 Rating and Functional Characteristics

12.4.1 Batteries

| | |
|--|-----------------------|
| 110 V Battery bank | Lead Acid VRLA |
| No. of battery banks | 1 |
| No. of cells in each battery bank | 55 |
| Nominal cell voltage | 2 V |
| Cell voltage at floating charge | 2.15 - 2.2 V |
| Nominal end cell voltage | 1.85V at 10 hour rate |
| Minimum Ampere-Hour capacity of each battery bank (10 hour discharge rate to 1.85V /cell at 25°C) | 400 Ah |

12.4.2 Battery Chargers

| | |
|--|----------------------------|
| AC Power Supply | 415 \pm 10 %V,3-phase, 4 |
| Frequency | 50 \pm 3% Hz |
| Nominal DC output voltage | 110V adjustable |
| Voltage Regulation (From no load to full load) | \pm 1 % |
| Ripple of output voltage (peak to peak) | |
| With battery connected | < 1 % RMS |
| Without battery connected | <2 % RMS |

12.4.3 Inverters

| | |
|---------------------------|--|
| Rated capacity | 5kVA (minimum) at $\cos \phi = 0.8$ lag. |
| Rated input voltage (dc) | 110 plus (+) 10%/ minus (-) 10% V DC |
| Rated output voltage (ac) | 240 V AC |
| Rated frequency of output | 50Hz |

| | |
|-----------------------------|-------------------------|
| Voltage regulation | $\pm 2 \%$ |
| Frequency | $50 \pm 0.5 \%$ Hz |
| Overload capacity for 1 sec | 2 times rated current |
| Overload capacity for 1 min | 1.5 times rated current |

12.5 Performance Guarantee

The DC system along with all auxiliaries and accessories shall be capable of performing intended duties under specified conditions. The Contractor shall guarantee the reliability and performance of the individual equipment as well as of the complete system.

12.6 Design and Construction Details for 110 V DC System

12.6.1 Standards

The system and equipment shall be designed, built, tested and installed to the latest revisions of the following applicable standards. In the event of other standards being applicable they will be compared for specific requirement and specifically approved during detailed engineering for the purpose:

| Standards | Description |
|--------------|--|
| IEEE Std 485 | IEEE recommended practice for sizing Lead Acid batteries for stationary applications. |
| IS15549 | Stationary valve regulated lead acid batteries - specification. |
| IEC 60146 | Semiconductor converters. |
| IEC 60270 | Partial discharge measurements |
| IS: 13947 | Degree of protection provided by enclosures for low voltage switchgear and control gear. |
| IS: 8828 | Miniature air break circuit breakers for voltage not exceeding 1000 volts. |
| IS:8623 | Factory built assemblies of switchgear and control gear for voltage up to and including 1000 V AC and 1200 V DC. |
| IS: 8320 | General requirement and methods of tests for lead acid storage batteries. |
| IS: 1069 | Water for storage batteries. Water for storage batteries. |
| IS: 1070 | Specification for water, distilled quality |
| IS: 6071 | Synthetic separators for Lead Acid batteries. |

12.6.2 Cubicles

All cubicles shall be of metal enclosed free floor standing type, of manufacturer's standard production of protection class IP 4x.

12.6.3 Batteries and battery racks

12.6.3.1 Battery

The battery shall be made of stationary type lead acid cells with high discharge performance type positive plates manufactured to conform to latest issue of IS: 15549 and relevant IEC. The battery shall be maintenance free.

12.6.3.2 Containers

The containers for the cells shall be of impervious, moulded transparent plastic/glass material having heat resisting, high strength, non-reacting and low inflammable properties. The containers shall be mounted on insulator blocks. The containers shall be of robust construction and free from flaws, bubbles or foreign matter. The size of the containers shall be such that sufficient sediment space shall be available and the battery shall not require cleaning during its normal life.

12.6.3.3 Plates

The positive and negative plates shall conform to latest issue of IS: 15549 for "stationary cells and batteries of lead acid type" and shall be fixed on the top of the containers, hanging type.

12.6.3.4 Separators

The separators shall be of acid resistant synthetic material conforming to latest issue of IS 6071. These shall maintain the electrical insulation between the plates and shall allow electrolyte to permeate freely & shall have excellent oxidation resistance and minimum internal resistance. These shall be free from defects such as cracks, pin holes, etc.

12.6.3.5 Electrolyte

The electrolyte shall be prepared from the battery grade sulphuric acid conforming to latest issue of IS: 266 and shall have a specific gravity of 1.2 at 27 degree C. Plate Group Bar with Terminal

The plate group bar with terminals shall conform to latest issue of IS: 1651. The positive and negative terminals shall be clearly marked for easy identification.

12.6.3.6 Vent plug

Suitable filters made of micro porous ceramic materials shall be provided which shall effectively return all acid spray to the cell, but allow free exit of oxygen generated towards the end of boost charging.

12.6.3.7 Markings

Acid level line shall be permanently and indelibly marked around on all the containers.

The following information shall be indelibly marked on outside of each cell/battery:

- Manufacturer's name and / or trademark.
- Country and year of manufacture.
- Normal rating of the cell.
- Cell number.

12.6.3.8 Installation of Batteries

The battery sets shall be installed on racks in a separate battery room provided with induced ventilation. The bidder shall offer the racks and mounting insulator, etc.

The bidder shall indicate and provide the proposed arrangement of the battery and include the arrangement for fixing and mounting of interbank, inter-row, inter cell and bus-off connectors, etc.

The bidder shall examine the adequacy of the space for installing batteries as per arrangement proposed in the Powerhouse layout drawings appended at drawing section.

Bare tinned copper connectors shall be employed for inter-cell, inter row and inter tier connectors. However, the tee-off connections from the battery unit shall be made with acid resisting cables of suitable size. The suitable terminal box /junction box for connection of battery terminals to incoming cables from the charger panels through bolts studs and nuts shall be provided. Fuses shall be provided in the positive and negative main battery leads. The fuses shall be adequately sized and rated for their duty. The fuses shall be mounted as close to the battery terminals as practicable.

The connectors shall preferably be of bolted type and the bolts and nuts shall be of similar materials as that of connectors and the same shall be provided with corrosion resistant coating.

All the electrical installation within the battery room including lighting fixtures, local switches, power outlets, etc. shall be of the acid resistant explosion-proof type. The fans, which draw the air from the battery room, shall also be of the explosion-proof type, and shall be coated with acid resistant paint.

A lockable fused load break switch shall protect each battery. This shall be installed inside a totally enclosed box with hinged door (protection class IP4x), which will be located close to the battery room.

12.6.4 Charging Equipment

12.6.4.1 Design Consideration

The battery charger set shall comprise of one float charger and one float cum boost charger units as charging equipment. The chargers shall be of adequate capacity to meet the float and boost charging requirements of the battery. In the float-charging mode, charger shall be capable of supplying the continuous DC load of the power station in addition to a small amount of current so as to keep the battery floating in a fully charged condition. In case of failure of AC mains, the batteries shall alone meet

the continuous and emergency power requirements of the power station resulting in rapid discharge. After the battery has discharged to a considerable extent resulting in voltage per cell falling to 1.85 V, the battery would need recharging in a short period by setting the charger in boost charging mode. In addition to boost charging the battery, the charger in the boost charging mode shall be capable of simultaneously supplying the continuous DC load of the station at required voltage.

The float charger and boost cum float charger units in the charger set shall have 3-phase, full wave, full control thyristor controlled Rectifier Bridge. The incoming supply to the three phase thyristor-bridge of the float and boost cum float charger units shall be through separate three phase double wound dry transformers. The triggering of the thyristor shall be controlled by AVR units, which senses feedback from output voltage and current. This feedback signals are suitably processed and compared with reference signal generated in the AVR circuits. The error is amplified and phase compensated by high gain operational amplifier and output of final amplifier is fed to the triggering circuit which controls the output voltage by adjusting the firing angles of thyristors. The bidder may offer AVR/rectifier bridge with integrated/digital circuit technology to achieve the specified performance of the charging units.

The boost cum float charger shall be capable to operate as a float charger with fully automatic changeover facility, under full float load, in case of failure of exclusive float charger unit.

When the battery requires "Boost charging" the rectifier shall be capable to provide the adequate output voltage. "Boost charging" shall be performed with the batteries disconnected from the associated switchgear with full load supplied through float charger to connected load with rated voltage.

12.6.4.2 Type and Ratings

The rating of float and boost cum float charger units shall be as under:

| A) | Float Charger Unit | For 110 V DC |
|----|---|---|
| | a) Input supply | 415 \pm 10% V, 3 phase, 50 \pm 3% Hz |
| | b) DC Output | Float charger unit shall be capable of supplying low ripple (ripple content to be less than 1%) DC to supply the continuous DC load in addition to float charge a battery of 110 V, 400 Ah capacity between an approximate voltage range of 2.15 to 2.20 V per cell. Contractor shall check the above mentioned current rating as per system requirement during detailed engineering and furnish calculations for approval. |
| | | The rectifier unit of the charger shall also be capable of supplying an impulse load of 6 (six) times its rated capacity. The float charger shall have drooping characteristics so as to transfer the load beyond its capacity to the battery. |
| B) | Boost cum Float Charger Unit | |
| | The rating of the boost cum float charger unit shall be as follows: | |
| | a) Input supply | 415 \pm 10% V, 3 phase, 50 \pm 3% Hz |

| | | |
|--|--------------|---|
| | b) DC output | The boost cum float charger unit shall be capable of supplying at 90 to 160 V a maximum charging current with voltage per cell varying from 1.55 to 2.9 V for boost charging a battery of 400 Ah capacity, in addition to supplying the continuous DC load of the station at 110 V DC. Contractor shall check the above mentioned current rating as per system requirement during detailed engineering and furnish calculations for approval. |
|--|--------------|---|

12.6.4.3 Design Details of Chargers

The chargers shall be of solid state, thyristor-controlled rectifier with 3 phases, full wave full control bridge circuit having low ripple factor direct current output. The ripple content shall not exceed 1%.

The transformers used shall be suitable for operation with 3 phase, $415 \pm 10\%$ V, $50 \pm 3\%$ Hz, AC supply and shall be air-cooled & dry type.

The chargers shall have Auto and Manual modes for regulating DC output voltage i.e. whether float or boost.

In auto mode, the regulating system of float charger shall float the battery between 116 V - 121 V and hold the voltage nearly flat from zero to full load but with definite drooping characteristics at load greater than full load, so that such loads are transferred to the battery. The automatic voltage regulating system shall have built in limiting features which will automatically bring down the output voltage when output current exceeds the full load current of the float charger. The regulating system shall maintain constant DC Voltage within +1% of the set value with an AC voltage variation of $\pm 10\%$ and frequency variation of +5%. The AVR should be suitable for setting the DC output voltage within + 20% of 110 V in steps of 2.5%. It shall be ensured that in case of failure of float charger, during the battery healthy condition, the boost cum float charger shall automatically change over to float charger mode to supply the DC load.

Effective current limiting features and filters shall be provided on both input and output to minimise harmonics etc.

The rectifiers shall utilise diode/thyristors and heat sinks rated to carry 100% of the load current continuously.

The boost charging unit in boost cum float charger shall have arrangement for regulating DC output voltage so as to maintain the constant charging current. During boost charging (since the battery shall be connected to the boost charger at a higher voltage), it shall be ensured that the load connected to the battery is not subjected to higher voltage by reducing the number of cells or any other means. The full details of the scheme offered to meet the above specified requirement shall be furnished.

The maximum temperature attained by any part of float and boost cum float chargers when in service at site under continuous full load conditions shall not exceed the permissible limits fixed by relevant standards and as corrected to site conditions.

The degree of protection provided for the chargers shall be IP: 42 as per IS: 13947.

12.6.4.4 Charger control Panels

Charger control panels shall be rigid, self-supporting structure completely assembled, totally enclosed, cubicle type construction made out of structural steel members with sheet steel coverings. The control panels shall have hinged front and back with concealed type hinged locks and latches. The control panels shall have adequate cross-ventilation arrangement, to avoid any undue rise in temperature. All equipment and wiring used in the control panels shall be tropicalised, dust and vermin-proof. The degree of protection provided for the panels shall be IP: 4x as per IS: 13947. Necessary terminals for grounding the panel with two distinct and separate earthing shall be provided.

Bus bars shall be made of high conductivity aluminium. Temperature rise limit of bus bars over ambient temperature shall be as per relevant IS.

Necessary primer and finishing coats of light grey paint shall be given to the control panels. All external cables connected to the charger panels shall be arranged for bottom entry and suitable glands shall be provided for the cables. Exterior colour shade shall be 631 as per IS: 5

The sheet steel thickness for load bearing part & gland plate shall be 2.5mm. Rest is 2mm.

The float and boost charging rates shall both be adjustable from the front of the charger control panels. Each charger shall be protected against any damage from over-load currents and shall be so designed that it can continuously deliver at least rated current output without operation of the protective over-load device from abnormal conditions of low battery voltage down to 88 V (80% of the rated voltage). Necessary selector switches for "Float charging mode and Boost Charging mode" shall be provided. These shall be of "make before break type".

Each float/boost chargers/ charger control panels shall have the following instruments relays, control switches and other accessories:

- 415 V Triple pole Moulded case circuit breaker of suitable capacity with overload and short
- circuit release and contacts for ON/OFF indication and annunciation.
- ON/OFF switch or push buttons for the MCCB/contactors.
- Pilot lamps to indicate AC mains "ON" condition.
- Double wound impregnated, natural air-cooled, 3 phase main transformer with taps range of + 10% in steps of 2.5% of 415 V rated voltage.
- Booster Transformer.
- Ballast chokes to limit the variations with charging current due to fluctuation in the supply voltage.
- Mode Selector Switch.
- 0-500V range flush-mounted AC voltmeter with voltage selector switch
- Constant potential controller to stabilize the DC voltage within + 1% of the set value with an AC voltage variation of $\pm 10\%$ of the set value with simultaneous load variation of 0-110%.
- Auto/manual switch to operate the regulator manually in case of failure of automatic potential controller.

- Raise/lower push buttons for manual operation of the voltage regulator.
- 3 Phase, full wave full control bridge rectifier circuit.
- 0-150 V flush mounted DC voltmeter for float charger and float cum boost charger.
- DC ammeter to suit the charger output flush type.
- DC ammeter (centre zero) to measure trickle charging current to battery as well as discharging current from battery.
- Compression type cable glands of suitable size for PVC unarmoured Al cables,
- Double pole moulded case circuit breaker of suitable capacity with overload and short circuit release and with contacts for annunciation.
- Interlocking contactor to prevent the load getting connected to high voltage at the time of boost charging.
- Blocking diode.
- Compression type cable gland of suitable sizes for PVC unarmoured Aluminium conductor cables entering from the bottom for the AC and DC supply and also suitable cable supports for the above cables inside the panel.
- AC failure alarm relay with signalling contacts.
- DC Earth Fault relay with signalling contacts.
- DC under voltage relay with signalling contacts.
- Surge suppressor for protection against AC Voltage Transients

Float and boost cum float charger control panels shall be kept in the DC room floor of the Powerhouse.

12.6.5 DC Distribution Boards

12.6.5.1 Type and ratings

The DC Distribution Board (DCDB) shall be integral type with battery charger.

Bus bar shall be made of high conductivity aluminium. Temperature rise limit of bus bars over ambient temperature shall be as per relevant IS and not exceed 45 deg C above ambient of 40 deg C.

DCDB shall be energised from respective charger/battery.

The rating of DC bus bars, incoming and outgoing feeders on main distribution boards shall be as follows:

| | | |
|----|-----------------------|---|
| i) | Bus Bars(Continuous): | Adequate continuous current rating with suitable short circuit capacity to meet the short-circuit power supply requirement from battery and charger but in no case less than 20 kA. |
|----|-----------------------|---|

| | | |
|------|--------------------------|--|
| ii) | Incoming feeders (1 No.) | 200 A DC continuous current, 20 kA breaking current capacity double pole moulded case circuit breakers. |
| iii) | Outgoing feeders: | MCCBs, 20KA breaking current capacity. Nos. of feeders shall be as per system requirement & as shown in the drawing plus 20% spare. Feeder ratings shall be as per system requirement & owner's requirement. |

12.6.5.2 Design and Construction

The distributor panels shall be totally enclosed and shall have adequate cross-ventilation arrangement to avoid any undue rise in temperature. All equipment and wiring shall be tropicalized, dust and vermin-proof. The degree of protection provided for the distribution panels shall be IP: 4X as per IS: 13947. Necessary terminals for grounding the panels with two distinct and separate earthing shall be provided.

All external cable connection to the panels shall be arranged for bottom entry. Suitable cable glands and supports shall be provided for PVC/XLPE insulated unarmoured cables.

The panel shall be so designed as to permit extension in either direction and shall be complete with all accessories, including fixtures, supporting frame channels, foundation bolts, etc. for securing the panels to the floor. Space heaters to operate from the 230 V AC supply shall be provided. The panels shall match with that of charger control panels in respect of colour shade & enclosure thickness and shall be given necessary primer and finishing coats.

The incoming feeder shall be controlled by MCCB and the outgoing feeders shall be controlled by MCBs.

The DC bus shall be provided with an earth fault relay DC under voltage relays shall be connected to initiate alarm whenever the bus voltage falls below 99 V for 110 V.

At least 20% spare terminals shall be provided in the terminal blocks. The interior of the panels shall be provided with AC lighting and spare AC plug socket for maintenance test, etc.

All wiring shall be properly supported and cleated. Both ends of the wiring shall have numbered ferrules for proper identification.

12.6.6 Inverter

12.6.6.1 UPS

The UPS panel shall cater to 230V AC supply to the plant control equipment i.e. computer/hardware & other electronic panels as necessary as per system requirement. Incoming to the panel shall be from either DCDB (via inverter) or from AC panel depending on availability of power. Necessary change over relay with incoming MCCB shall be provided in the panel.

Inverter for the UPS panel shall be of PWM type & suitable for computer & other hardware power supply requirement.

No. of outgoing feeders with rating shall be finalised as per system requirement.

Degree of protection shall be IP: 4x as per IS: 13947. Colour shade & enclosure thickness shall match with other panel. The panel shall preferably be wall mounted with cable entry from bottom.

During failure of station AC supply, a limited number of illumination fittings shall be supplied through UPS.

12.6.6.2 Type and ratings

The rating of the 230V AC UPS panel shall be as follows:

- (i) Bus Bars: 230 V, AC, 10 kA short time current capacity Phase and Neutral Bus with adequate continuous current rating.
- (ii) Incoming AC feeder: 230 V, AC, 2 pole, 10 kA Breaking current capacity MCCB's of adequate rating.
- (iii) Outgoing feeder: 110V DC, 2 pole, 10kA MCBs of adequate rating.
- (iv) No. of feeders shall be as required for computers/hardware & other electronic panels in the plant as described in relevant section of the specification.
- (v) Inverter: PWM type Single phase, 230V, AC, minimum 5 kVA capacity.

12.7 Detection of Abnormalities and Faults

The 110 V DC systems shall have provision for detection of following faults and initiation of audio-visual alarms to indicate occurrence of any of the following faults. The DC system shall also be provided with a continuous earth-leakage indicating scheme suitable for operation with an earth fault on either pole. The abnormal operating conditions/faults shall be enunciated separately for each type of battery and its charging units as listed below:

- Over voltage on DC bus.
- Under voltage on DC Bus.
- Current limits in float and boost cum float chargers.
- Float charger failure.
- Boost cum float charger failure.
- AC supply failure.
- Earth leakage.
- Float output DC MCCB Trip.
- Boost output DC MCCB Trip.
- Controller card defective.

12.8 Ventilation and painting of battery room

The bidder shall indicate in the bid requirements of proper ventilation in the battery room. If any special ventilation requirements are necessary, the same shall be indicated. The wall painting and floor tiles required for the floor of room shall also be specified in the bid.

12.9 Transport

The battery shall be transported without acid in preferably dry charged condition. The acid shall be supplied separately in non-returnable containers and meet all requirements as laid under clause 1.8 of General Technical Specification.

12.10 Tests

The Contractor shall provide type and routine test reports as per relevant Indian Standards or other standards for the equipment covered by the specifications and detailed below. All test reports for the tests carried out at works shall be submitted and got approved from the Purchaser before despatch of equipment.

Each cell and the complete battery shall be subjected to the following acceptance tests in accordance with IS: 1651, as given below in presence of the purchaser's representative.

- Tests for capacities of individual cells and the complete battery.
- Dimensional checking of plates.
- Visual Inspection.
- Endurance Test.
- Ampere-hour and watt-hour efficiency test.

The Contractor shall furnish the details and testing facility available at his work.

The acceptance tests shall also be carried out at the discretion of the purchaser on batteries or each cell after installation at site. Certified copies of the test report for the following type tests as stipulated in the IS shall be supplied.

- Test for retention of charge.
- Specific gravity of a charged cell.

The charger panels and switchgear shall be assembled at the manufacturers works with all apparatus, instruments and meters connected and various components shall be tested in accordance with the latest issue of IS 3136, IS 13947, IS 8623 and other relevant Indian Standards in presence of Purchaser's representative. Other tests as may be necessary shall also be carried out. Manufacturer's type test certificates shall be furnished along with the bid.

The following tests on chargers shall be carried out.

Routine Tests:

- (i) DC voltage/current characteristics.
- (ii) High voltage test.
- (iii) AC measurement.
- (iv) Reverse leakage.
- (v) Visual inspection.

(vi) Operation of auxiliary devices.

Tests on Switch Boards (AC supply panel, DC distribution, 230V UPS panel).

Routine Tests:

- (i) Operational test.
- (ii) High voltage test.
- (iii) Test for variation of calibration of releases.
- (iv) Millivolt drop test.
- (v) Visual inspection.

The inverters shall be subjected to routine and acceptance tests as per relevant standard.

All test reports shall be submitted and got approved from the Purchaser before despatch of equipment.

12.11 Drawings, Documents and Design Calculations

12.11.1 Design memorandum

The Contractor shall submit to Purchaser a design memorandum prepared in accordance to clause 1.2 of "Section 1-General Technical Specifications of the proposed equipment /system fulfilling the contract specification/requirement for approval prior to submission of drawings and documents. The design memorandum shall include the design philosophy, methodology, system description, input parameters for design, standards and codes, design & selection criteria, equipment data, material specification, major technical features, basic arrangement / layout etc.

12.11.2 Drawings and documents

The Contractor shall submit all the drawings and documents in accordance with requirements stipulated under clause 1.2 in "Section 1 - Technical Documents" of "General Technical Specification (GTS)".

These drawings and documents shall include at least the following:

- Layout arrangement of 110 V DC battery - Plan & Sections
- Arrangement of connections of cells in 110 V battery bank
- OGA of 110 V Battery Chargers
- OGA of 110 V DC Distribution Board
- Layout and dimensional details of Inverter and AC supply panels
- Illustrative catalogue of 110 V tubular type batteries
- Discharge curves for different rates of discharge of 110 V tubular battery

12.11.3 Design calculation

The Contractor shall submit the design calculation in accordance to Clause 1.2 of “General Technical Specification (GTS)” covering at least the following, for review / acceptance.

- Calculations of the DC power consumption during standstill of the generator units, during start, operation and shut-down of one generator unit, taking into consideration that the floating charge voltage of cell is maintained,
- Calculations for capacity of the batteries; the bidder shall indicate the percentage reduction in battery capacity at the lowest temperature 00C compared to that at standard temperature of 27°C.
- Calculations for ratings/ capacities of the battery chargers.

12.12 Delivery, Installation and Commissioning

The Contractor shall follow the requirements of clause 1.8 packing & transportation, clause 1.9 site erection & clause 1.10 site tests of “Section 1 - General Technical Specifications.”

12.13 Spare Parts

The spare parts shall be as per following list.

| Sl. No. | Description | Quantities |
|---------|--|------------|
| 1 | Thyristor and diode stacks for one rectifier/ | 1 set. |
| 2 | Solid state or electronic control gear required for manual or automatic operation of the concerned equipment, each comprising one (1) piece of every type or size. | 1 lot |
| 3 | Battery cells | 2 nos |
| 4 | Electrolyte | 10% |
| 5 | Inter cell connectors for battery | 10 nos |
| 6 | Control switch & supervision relay | 2 nos. |
| 7 | Shunt resistor of each type used in Charger | 1 no.each |

12.14 Special tools

The Contractor shall propose the list of recommended special tools (other than those included under "Tools and Appliances" above) including their make and detailed specification as recommended by manufacturer(s) and to be accepted by the Purchaser.

12.15 Quality Assurance and Testing

The bidder shall submit the quality assurance plan along with bid for approval of the purchaser. The Contractor shall follow the quality assurance and testing requirements as per quality assurance plan approved by the purchaser.

12.16 Guaranteed and Technical Particulars

Guaranteed and Technical Particulars as called for in volume VI shall be furnished along with the bid. Bids lacking in this may be considered as unresponsive. Particulars subject to guarantee shall be clearly marked.

12.17 Completeness of Equipment

All fittings and accessories of the 110 V batteries, battery chargers, DC distribution boards, inverters, AC supply panels and associated equipment that may not have been specifically mentioned in these specifications but are usually necessary for completion of above equipment, shall be deemed to be covered by the specification and shall be indicated and furnished by the contractor without any extra charges to the purchaser.

12.18 Deviations from Specification

While the purchaser does not bind himself to accept any deviation, due consideration will be given to any special devices or equipment put forward by the supplier with a view to increase the efficiency of the equipment and minimise the maintenance cost of the equipment as a whole.

Should the supplier wish to depart from these specifications, he shall submit a complete and limited list of such deviation, together with full particulars of the reasons for the deviation in a separate schedule (annex-3) with special reference to clause and paragraph nos. of this specification. Unless this is done and also the purchaser's concurrence in respect of such deviations is obtained in writing, the equipment offered shall be deemed to comply in every respect with these specifications.