48V VALVE REGULATED LEAD ACID BATTERY & CHARGER

September 2025

Engineering Department

WEST BENGAL STATE ELECTRICITY TRANSMISSION COMPANY LIMITED
পশ্চিমবঙ্গ রাজ্য বিদ্যুৎ সংবহন কোম্পানি লিমিটেড
(পশ্চিমবঙ্গ সরকারের একটি উদ্যোগ)
Regd. Office: Vidyut Bhawan, Block – DJ, Sector-II, Bidhannagar, Kolkata 700091. CIN: U40101WB2007SGC113474; Website: www.wbsetcl.in

Updates for WBSETCL / TECH SPEC / Rev.-2.1

1. **Modification done on Cl. No. 15{Annunciation System}**. This following point is added "For Remote indication & metering through SAS, please follow our technical specification for **Substation Automation system**."(for SAS operated S/s only)

2. "One DC voltmeter and DC ammeter (with shunt) shall be provided for ~~all~~ each R[2.1] charger" as per Cl. No. 11{Instruments} of BATTERY CHARGER.

MAINTENANCE FREE VALVE REGULATED LEAD ACID BATTERY & ASSOCIATED BATTERY CHARGER

1. SCOPE :

1.1. This specification covers the design, manufacture, assembly, testing at the manufacturer's works of 48 V D.C. Maintenance free Valve regulated Lead Acid Battery, having minimum capacity of 300 AH and associated battery charger with provisions of both float and boost charging of battery alongwith necessary accessories, fittings etc. Each battery shall have sufficient capacity for continuous DC supply to PLCC Terminals, Protection Coupler Units, Fiber Optic Terminals, EPAXes, Remote Terminal Unit (RTU) etc. as and when required as well as float charging current of the battery.

1.2. The battery shall consist of 24 number of cells, float & boost voltage to achieve a system voltage 48V. Battery shall have 20% spare capacity. Supplier shall furnish characteristic curve for satisfactory operation and maintenance of battery under service condition.

Bidder shall furnish calculation in support of selection of Float & Boost Voltages.

2. DEVIATIONS :

Normally the offer should be as per Technical Specification without any deviation. But any deviation felt necessary to improve performance, efficiency and utility of equipment must be mentioned in the Deviation Schedule with reasons duly supported by documentary evidence. Such deviations suggested may or may not be accepted by WBSETCL. Deviations not mentioned in Deviation schedule will not be considered.

3. RATING OF BATTERY AND FUNCTION OF CHARGER :

D.C. Power Supply shall comprise of Battery and a Battery Charger in parallel operation. In this mode the charger shall be required not only to continuously feed a variable load but also deliver trickle/boost charging current for the battery. Battery will be capable of feeding the DC load requirement of the Telecom equipment of Substation in case of failure of the charger.

4. TRICKLE / BOOST CHARGE VOLTAGE :

The trickle and Boost charge voltage per cell shall be as follows :

i) TRICKLE CHARGE: Voltage shall correspond to 2.15 V/cell to 2.27 V/cell.

ii) BOOST CHARGE: Continuous variation shall remain between 2.00 V/cell and 2.75 V/cell. The voltage at any time during duty cycle shall not be less than 1.85 V / cell.

5. VOLTAGE REGULATION OF CHARGER FOR FLOAT CHARGING:

Output voltage for float charging from battery charger shall be auto controlled by adjusting the firing angle of thyristor for float charger to keep the voltage variation within ± 1% from no load to full load and AC supply voltage variation of ±10% and frequency variation of ± 3% of 50 Hz. Manual control of output voltage shall also be possible through Auto/Manual selector switch.

6. CLIMATIC CONDITIONS:

The equipment to be supplied against the specification shall be suitable for satisfactory continuous operation under the following tropical conditions:

Max. Ambient Air Temperature	50°C
Max. Daily Average Ambient Temperature	45°C
Max. Yearly Weighted Ambient Temperature	35°C
Min. Air Temperature	(-) 5°C
Max. Humidity	100%
Min. Relative Humidity	26%
Average Number of Thunder Storm days per annum	40
Average Annual Rain Fall	15-100cm
Number of Months during which Tropical Monsoon Conditions prevail (Jun-Sep)	4months
Altitude above MSL	As per location of Substation
Average Number of Rainy days per Annum	120days
Seismic Level (Horizontal Acceleration)	0.3g
Degree of Pollution	Heavy
Intensity of Solar Radiation	1.0 kW/sq.m.
Max Wind Load	195 kg/sq.m.

7. CURRENT REGULATION OF CHARGER FOR BOOST CHARGING :

Anautomatic current controller for boost charging shall control the output current of the boost charging by adjusting the firing angle of the thyristor. Manual control of the output current shall also be possible through Auto/Manual selector switch.

8. DESCRIPTION OF BATTERY:

8.1. Type:

The DC batteries shall be VRLA (Valve regulated Lead Acid) type & shall be Normal Discharge type and shall conform to IS 15549:2004/ IEC 60896-21 & 22:2004 standard.

These batteries are to be factory-filled, charged& shall be suitable for a long life under continuous float operations & occasional discharges. The 48V DC system is positive pole earthed system. The offered battery shall be compact and shall require no maintenance. All safety equipment required for installation shall be provided by the manufacturer.

8.2. Constructional requirements:

The design of battery shall be as per field proven practices. Partial plating of cells is not permitted. Paralleling of cells externally for enhancement of capacity is not permitted. Protective transparent front covers with each module shall be provided to prevent accidental contact with live module/ electrical connections.

8.3. Plates:

Positive plates shall be made of flat pasted type using high corrosion resistant alloy for durability, maintenance free, long life both in cyclic as well as in float applications. The Grids are of Semi Radial Squarish grid to reduce internal resistance and travel current in shorter time.

Negative plates shall be heavy duty, durable flat plate using lead alloy pasted Semi Negative Squarish Grid. Negative plates shall be designed to match the life of Positive plates & combination of positive & negative plates shall ensure long life, durability & trouble-free operation of battery.

Computer controlled/ PLC operated in-house equipment should be deployed for preparation of lead oxide and paste to ensure consistency in paste quality & properties. Conventional/ manual type of paste preparation will not be allowed.

8.4. Containers:

The container material shall have chemical & electro-chemical compatibility & shall be acid resistant and shall conform to UL-94/ ASTM-D-2863 standard. The material shall meet all the requirements of VRLA batteries and be consistent with the life of battery. The container shall be fire retardant & shall have an Oxygen index of at least 28%. The porosity of the container shall be such as not to allow any gases to escape except from the regulation valve. The tensile strength of the material of the container shall be such as to handle the internal cell pressure of the cells in the worst working condition. Cell shall not show any deformity of bulge on the sides under all working conditions. The container shall be capable of withstanding the rigours of transport, storage and handling. The containers shall be enclosed in a steel tray.

For identification, each cell/module shall be marked in a permanent manner to indicate the following information:

(i) Cell Serial Number
(ii) Positive & Negative, embossed on the cover
(iii) Month & Year of Manufacturing

8.5. Cell Covers:

The cell covers shall be made of suitable material compatible with the container material and permanently fixed with the container by Hermetic Heat Sealing technique. It shall be capable to withstand internal pressure without bulging or cracking. It shall also be fire retardant. Fixing of Pressure Regulation Valve & terminal posts in the cover shall be such that the seepage of electrolyte, gas escapes and entry of electro-static spark are prevented.

8.6. Separators :

The separators used in manufacturing of battery cells, shall be of glass mat or synthetic material having high acid absorption capability, resistant to sulphuric acid &shall have good insulating properties. Sufficient separator overlap & PVC shield protection in bottom edges of the plates is to be provided to prevent short circuit formation between the edges of adjacent plates. The design of separators shall ensure that there is no misalignment during normal operation & handling.

8.7. Pressure Regulation Valve:

Each cell shall be provided with a pressure regulation valve. The valve shall be self resealable. The vent plug shall be made with suitable grade of fire retardant plastic material. Each valve opening shall be covered with flame barrier capable of preventing the ingress of flame into the cell interior, when the valve opens & hydrogen/ oxygen gas mixture is released. The valve unit shall be such that it cannot be opened without a proper tool. The valve shall be capable to withstand the internal cell pressure specified by the manufacturer.

8.8. Terminal Posts:

Both the +ve& -ve terminals of the cells shall be capable of proper termination & shall ensure its consistency with the life of the battery. The terminals shall have adequate solid copper core cross-section to avoid overheating at maximum current load. The surface of the terminal post extending above the cell cover including bolt hole shall be coated with an acid resistant & corrosion retarding material. Terminal posts or any other metal part which is in contact with the electrolyte shall be made of the same alloy as that of the plates or of a proven material that does not have any harmful effect on cell performance. Both +ve& -ve posts shall be clearly and unambiguously identifiable.

8.9. Connectors, Nuts & Bolts, Heat Shrinkable Sleeves:

Where it is not possible to bolt the cell terminals directly to assemble a battery, separate non-corroding lead coated copper connectors of suitable size shall be provided to enable connection of the cells. Copper connections shall be suitably lead coated to withstand corrosion due to sulphuric acid/fumes at a very high rate of charge or discharge.

Nuts & bolts for connecting the cells shall be made of copper, brass or stainless steel. Copper or brass nuts & bolts shall be effectively lead coated to prevent corrosion. Stainless steel bolts & nuts can be used without lead coating.

All inter cell connectors shall be protected with heat shrinkable silicon sleeves for reducing the environmental impact including a corrosive environment.

More than one cable may be required to be connected to the battery terminals. Suitable arrangement for termination of multiple cables shall be provided so as to avoid extra load on the battery terminals.

8.10. Necessary insulating supports for termination of these cables on batteries shall also be supplied by the bidder. All connectors shall be capable of continuously carrying the 30 min. discharge current of the respective batteries and shall be capable to carry 4 KA for 1 sec.

8.11. Flame Arrestors:

Each cell shall be equipped with a Flame Arrestor to defuse the Hydrogen gas escaped during charge & discharge. Material of the flame arrestor shall not affect the performance of the cell.

8.12. Battery Bank Stand:

All batteries shall be mounted in a suitable metallic stand/ frame. The frame shall be properly painted with the acid resistive paint& should have protection against harmful effects due to tropical environment. The suitable insulation shall be provided between stand/ frame and floor to avoid the grounding of the frame/ stand. The jointing of the frames should not leave crevices and ensure proper and tight fit.

Numbering tags for each cell shall be attached to the racks. Provision for clamping outgoing cables shall be kept.

9. CAPACITY REQUIREMENTS:

When the battery is discharged at 10-hour rate, it shall deliver 80% of Rated Capacity (corrected at 27°C) before any of the cells in the battery bank reaches 1.85 V/cell.

The battery shall be capable of being recharged from the fully exhausted condition (1.75 V/cell) within 10hrs upto 90% state of charge. All the cells in a battery shall be designed for continuous float operation at the specified float voltage throughout the life.

The capacity (corrected at 27°C) shall also not be less that Rated capacity & not more that 120% of Rated capacity before any cell in the battery bank reaches 1.75 V/cell. The battery voltage shall not be less than the following values, when a fully charged battery is put to discharge at a rate of $1/10^{th}$ of the Rated Capacity:

(a) After SIX minutes of discharge: 1.98V/cell
(b) After SIX hours of discharge: 1.92V/cell
(c) After EIGHT hours of discharge: 1.85V/cell
(d) After TEN hours of discharge: 1.75V/cell

Loss in capacity during storage at an average ambient temperature of 35°C for a period of 6 months shall not be more than 60% and the cell/battery shall achieve 85% of its rated capacity within 3 charge/discharge cycles and full rated capacity within 5 cycles, after the storage period of 6 months. Voltage of each cell in the battery set shall be within 0.05V of the average voltage throughout the storage period. Ampere hour efficiency shall be better than 90% and watt-hour efficiency shall be better than 80%. However, the battery to be manufactured and to be delivered at site in such a way that load can be connected with the battery within 15 days from the date of installation. Date of initial charging is to be mentioned on the battery.

10. EXPECTED BATTERY LIFE

The battery shall be capable of giving 1200 or more charge/discharge cycles at 80% Depth of Discharge at an average temperature of 27°C. Depth of Discharge is defined as the ratio of the quantity of electricity (in Ampere Hour) removed from a cell or battery on discharge to its rated capacity. The battery sets shall have a minimum expected life of 20years at Float operation.

11. ASSOCIATED EQUIPMENTS & ACCESSORIES (For each set of battery) :

a) Best quality metallic stand/frame as per Clause 9.12.
b) Stand insulators +5% extra
c) Inter row connectors :Appropriate quantity
d) Inter tier connectors
e) Centre-zero (3-0-3) volts DC Voltmeter : 1 No
f) Torque wrench/ Spanners : 1 No
g) Connection hardwares, such as strips, bolts, nuts(with 5% extra)
h) Cable clamps with hardware
i) Cell numbering tags with fixing arrangement
j) Two sets of special tools and tackles for connecting terminals of the battery
k) Any other accessories not specified but required for satisfactoryoperation.

12.1. TYPE TEST OF BATTERY:

The Bidder/ Supplier shall supply type tested battery as per IS 15549:2004/ IEC 6089621 & 22 over the range of at least one capacity per design. The Bidder/ Supplier shall submit necessary evidences enclosed along with tender documents.

Sr. No.	DESCRIPTION
1	Gas Emission
2	High Current Tolerance
3	Short Circuit Current & DC Internal resistance
4	Protection against Internal Ignition from External Spark source
5	Protection against Ground Short Propensity
6	Content & Durability of required marking
7	Material Identification
8	Valve Operation
9	Flammability Rating of Material
10	Intercell Connector Performance
11	Discharge Capacity
12	Charge Retention during Storage
13	Float Service with Daily Discharge for reliable mains power
14	Recharge behavior
15	Service Life at an operating temperature of 40°C for brief duration exposure time
16	Impact of Stress Temperature of 60°C for brief duration exposure time with 3hrs discharge test
17	Abusive Over Discharge
18	Thermal Runaway Sensitivity
19	Low Temperature Sensitivity
20	Dimensional Sensitivity at Elevated Internal Pressure & Temperature
21	Stability against Mechanical abuse of units during installation

12.2. ROUTINE TEST OF BATTERY:

(i) Physical Examination Test
(ii) Visual Inspection
(iii) Dimensions, Mass & Layout
(iv) Marking & Packing
(v)

12.3. ACCEPTANCE TEST OF BATTERY

(i) Polarity Marking
(ii) Verification of Dimensions
(iii) Open Circuit Voltage of each Cell & Total Open Circuit voltage of the battery bank
(iv) Test of AH Capacity

12.4. LIST OF FACTORY & SITE TESTS FOR BATTERY

Sr. No.	TEST	FACTORY TESTS	SITE TESTS
1	Physical Verification	YES	YES
2	Capacity Test on the cell at 1/10th of Rated Capacity, corrected at 27°C	YES	
3	8hrs Charge & 15mins Discharge Test at Full Rated Load		YES

13. PACKING :

All equipments shall have to be dispatched suitably and securely, packed in wooden crates, suitable for handling during transit by road indicating Name of the Consignee Officer, Name of the Purchaser, LOA No., Destination Station, Crate Sl.No. etc.

GUARANTEED TECHNICAL PARTICULARS FOR VALVE REGULATED LEAD ACID BATTERY

(To be filled in and signed by the Bidder)

Sr. No.	DETAILS	48V 300AH Battery
1	Type/ Designation	
2	Manufacturer's type designation	

3	Ampere-Hour capacity 10hrs rate of discharge to 1.75V	
4	Total No. of Plates per cell	
5	Nominal Cell Voltage (V)	
6	No. of Cells in each Bank	
7	No. of Spare Cell, if any, in each Bank	
8	Internal Resistance for each Cell	
9	Resistance of the Battery including Inter-connection between the Cells (Ω)	
10	Cell Discharge rate in Ampere (from rated Voltage to final discharge rate in Ampere (i) 5hrs Discharge rate in Amp (ii) 2hrs Discharge rate in Amp (iii) 1hr Discharge rate in Amp (iv) 30min Discharge rate in Amp (v) 10min Discharge rate in Amp (vi) 1min Discharge rate in Amp (vii) 30sec Discharge rate in Amp (viii) 1sec Discharge rate in Amp (Please furnish a graph showing Amps against time for the type of battery offered)	
11	Short Circuit Current (Amps)	
12	(i) Material of Cell Containers (ii) Material used for Battery Box (iii) Trays	
13	Thickness, Type & Material of Separators	
14	Constructional details and dimension: Surface area plates of (i) Positive Plate (ii) Negative Plate in Sq.mm.	
15	(i) Ampere Hour efficiency (%) (ii) Watt Hour efficiency (%)	
16	(i) Recommended Float Charge Current & Voltage (ii) Recommended Boost Charge Current & Voltage	
17	Time required for Boost Charging from Discharged condition	
18	(i) Max. Charging Current/Cell (ii) Nominal Charging Rate	
19	(i) Whether explosion proof or vent plugs provided (ii) Whether vent is spill proof	
20	Type of Inter Cell connection & whether they are covered with plastic sleeves	

21	(i) Dimensions of each 2V Block/Cell a. Length (mm) b. Width (mm) c. Height (mm) (ii) Thickness of Container (mm)	
	(iii) Net weight of the cell complete with acid 12V block (kg)	
22	Expected Life Span of Battery	
23	Accessories provided	
24	Special conditions, if any	

BATTERY CHARGER

1 This specification covers the design, manufacture, assembly, testing at manufacturer's works of battery charger with provisions of both float and boost charging of VRLA type battery. The Battery Chargers as well as their automatic regulators shall be of static type and shall be compatible with VRLA batteries.

The minimum ampere-hour ratings of battery shall be 300 AH. The voltage rating of 300AH battery shall be 48 +/- 10% volt with +ve pole earthed. The D.C. system shall consists of Battery Charger of 48V, 300AH

2 STANDARDS :

2.1 The equipment covered by this specification shall unless otherwise stated, be designed, constructed and tested in accordance with the applicable sections of the latest Indian Standard specification and Indian Electricity Rules.

IS :2026 Power Transformer
IS :2959 AC Contactors for voltages not exceeding 1000 Volts.
IS :1248 Indicating instruments
IS : 2208 HRC Fuses
IS :13947(P-3) Airbreak switches, disconnectors& fuse combination units for voltage not exceeding 1000 V AC or 1200 V DC.
IS :2147 Degree of protection provided by enclosures for low voltage swichgear& control gear
IS :3231 Electrical relays for Power System Protection
IS :3842 Electrical relays for A C System Protection
IS :5 Colours for ready mix paint

3 DEVIATIONS :

Normally the offer should be as per Technical Specification without any deviation. But any deviation felt necessary to improve performance, efficiency and utility of equipment must be mentioned in the Deviation Schedule with reasons duly supported by documentary evidence and advantages of such deviations. Deviations suggested may or may not be accepted. But deviations not mentioned in Deviation Schedule will not be considered.

4 MINIMUM RATING OF THE BATTERIES :

It shall be possible to set the charger to the following voltages across its battery terminals by means of a switch on the front of panel.

i) Trickle Charge	: A preset voltage corresponding to 2.13 V/Cell to 2.27 V/Cell as required.
ii) Quick Charge (During failure of main Float Charger)	: A preset voltage corresponding to 2.4 V/Cell
iii) Boost Charger	: Continuously variable between 2.0 V/Cell and 2.75 V/Cell as required.

Provision of dropper diode should be kept in order to limit the load voltage within specification during quick mode of operation.
Provision of DC contactor should be there in parallel to the dropper diodes to bypass the dropper diodes under float condition or when D.C. supply is fed from battery to the load under A.C. power failure condition

5. LOAD IMPOSED ON CHARGERS:

The following load will be imposed on the chargers:

Under normal operating conditions the charger should give a D.C. output to PLCC Terminals, Protection Coupler Units, Fiber Optic Terminals, EPAX es RTUs etc. as and when required as well as float charging current of the battery.

6. RATING OF THE CHARGERS:

The float charger and the float-cum-Boost Charger shall have adjustable output current 60 Amps D.C. for 300 AH for float charging and 60 Amps DC for boost charging. Charger shall have 20% spare capability.

7. GENERAL DESCRIPTION FOR CHARGERS OF 48 V, 300 AH BATTERY:

i. The charger shall be suitable for charging the battery and supplying the load simultaneously. The entire charger scheme shall be divided in two sections, "float

charger section" and "float-cum-boost charger section". The float-cum-booster charger shall be suitably operated either in float mode or in boost-cum-standby float charger mode.

ii. Under normal operating condition, with the input AC supply present, the float charger section' shall supply the DC load and also float the battery by trickle charging and the "float cum boost charger section" shall be kept off. The maximum demand load on the charger shall be 60A for 300AH Battery.

iii. Charger shall regulate the float/boost voltage in case of prescribed temperature rise of battery as per manufacturer's recommendation to avoid thermal runaway. Necessary temperature sensors shall be provided in mid location of battery banks and shall be wired up to the respective charger for feedback control. The manufacturer shall demonstrate this feature during testing of each charger.

iv. The battery chargers shall be provided with facility for both automatic and manual control of output voltage and current. A selector switch shall be provided for selecting the mode of output voltage/current control, whether automatic or manual. When on automatic control mode during float charging, the chargers output voltage shall remain within + 1% of the set value, for AC input voltage variation of + 10%, frequency variation of + 5% a combined voltage and frequency variation of + 10% and a DC load variation from zero to full load.

v. The battery chargers shall have constant voltage characteristics throughout the range (from zero to full load) at the floating value of the voltage so as to keep the battery fully charged but without harmful overcharge.

vi. The chargers shall have load limiters having drooping characteristics, which shall cause, when the voltage control is in automatic mode, a gradual lowering of the output voltage when the DC load current exceeds the Load limiter setting of the Charger. The Load limiter characteristics shall be such that any sustained overload or short circuit in DC system shall not damage the Charger nor shall it cause blowing of any of the Charger fuses. The Charger shall not trip on overload or external short circuit.

vii. Uniform and step less adjustments of voltage setting (in both manual and automatic modes) shall be provided on the front of the Charger panel covering the entire float charging output range specified. Step less adjustments of the Load-limiter setting shall also be possible from 80% to 100% of the rated output current for Charging mode.

viii. During Boost Charging, the Battery Charger shall operate on constant current mode (when automatic regulator is in service). It shall be possible to adjust the Boost charging current continuously over a range of 50 to 100% of the rated output current for Boost charging mode.

ix. The Charger output voltage shall automatically go on rising, when it is operating on Boost mode, as the Battery charges up. For limiting the output voltage of the Charger, a potentiometer shall be provided on the front of the panel, whereby it shall be possible to set the upper limit of this voltage anywhere in the output range specified for Boost Charging mode.

x. The Charger manufacturer may offer an arrangement in which the voltage setting device for Float charging mode is also used as output voltage limit setting device for Boost charging mode and the Load-limiter of Float charging mode is used as current setting device in boost charging mode.

xi. The `float-cum-boost charger section' shall be kept in boost mode through float/ Boost selector switch. During Boost Charging, the Battery Charger shall operate on constant current mode (when automatic regulator is in service) at the specified current needed for the battery. During this operation, `the float charger section' shall supply the load current only while boost charger section of float cum boost charger shall boost charge the battery and the load supply shall be disconnected from the battery through a contact of a contactor. If the `float charger' fails during this period, the Float cum Boost charger will take care of connected DC load thru dropper diodes, without any interruption. Load terminal voltage is kept within 48V+/-10% limits. It shall be possible to adjust the Boost charging current continuously over a range of 50 to 100% of the rated output current for Boost charging mode. The charger should be capable of restoring fully discharged battery to a state of full charge in eight hours with 25% spare margin over maximum charging rate.

When battery voltage drops below a set value, the charger is switch ON in the boost mode and charging starts. However, if power supply fails, while boost charging operation is in progress, the battery shall be connected to the load bus through the DC contactor immediately to avoid any interruption. A Tap Cell diode should be incorporated between an intermediate cell and the load bus to provide an uninterrupted DC supply to the load bus.

xii. If there is any trouble in " float charger section ", i.e. When converter kept at off/standby mode, If Main Float fails, boost charging section will immediately be switched on at float mode and take over the function of Main Float without any interruption. Normally Battery shall be kept parallel with load bus thru D.C. contactor. Suitable arrangement shall be provided at the charger output circuit for isolation of battery with locking arrangement during maintenance. For accommodation of these two sections, separate compartments shall be used so that maintenance or rectification work can be carried out in one section while the other remains in service.

xiii. Suitable choke and filter circuit shall be provided to get stabilised and to limit ripple content within 5mV psophometric at full load with battery disconnected.

8. MCCB

The AC input supply, 400 volts ± 10%, 3 phase, 4 wire, 50 Hz, shall be provided through suitably rated switches and fuses/MCCB & contactor having thermal over load and short circuit protection. All Battery Chargers shall have 2 Nos. MCCBs on the input side to receive cables from two sources. Mechanical interlock should be provided such that only one shall be closed at a time. It shall be of P2 duty and suitable for continuous duty. MCCB's should have auxiliary contacts for annunciation.

9. Rectifier Transformer

The rectifier transformer shall be continuously rated, dry air cooled (A.N) an of class F insulation type. The rating of the rectifier transformer shall have 10% overload capacity. The transformer shall be of suitable rating to comply with maximum output with minimum input voltage. Calculation for the ratings of the transformer and other particulars of the elements considered in the battery charging scheme are to be furnished by the successful bidder during detailed engineering indicating the basic design data.

10. Rectifier Assembly

The rectifier assembly shall be fully/half controlled bridge type and shall be designed to meet the duty as required by the respective charger. The rectifier shall be provided with heat sink having their own heat dissipation arrangements with natural air cooling.

Necessary surge protection devices and rectifier type test acting HRC fuses shall be provided in each arm of the rectifier connections.

11. Instruments

One AC voltmeter and one AC ammeter along with selector switches shall be provided for all chargers. One DC voltmeter and DC ammeter (with shunt) shall be provided for ~~all~~ each charger R[2.1]. The instruments shall be of 96 mm X 96 mm square dial & shall be flush type, dust proof and moisture resistant. The instruments shall have easily accessible means for zero adjustment. The instruments shall be of 1.5 accuracy class. In addition to the above a centre zero voltmeter with selector switch shall also be provided for 48 V Chargers for testing purpose.

12. Air Break Switches

One DC output switch shall be provided in all chargers. They shall be air break type suitable for 500 Volts AC/ 250 V DC. The contacts of the switches shall open and close with a snap action. The operating handle of the switch shall be fully insulated from circuit. 'ON' and 'OFF' position on the switch shall be clearly indicated. Rating of switches shall be suitable for their continuous load. Alternatively, MCCB's of suitable ratings shall also be acceptable in place of Air Break Switch.

13. Fuses

All fuses shall be HRC Link type. Fuses shall be mounted on fuse carriers which are in turn mounted on fuse bases. Wherever it is not possible to mount fuses on carriers, fuses shall be directly mounted on plug-in type base. In such case one insulated fuse pulling handle shall be supplied for each charger. Fuse rating shall be chosen by the Bidder depending on the circuit requirement. All fuses in the chargers shall be monitored. Fuse failure annunciation shall be provided on the failure of any fuse.

14. Blocking Diode

Blocking diode shall be provided in the positive pole of the output circuit of each charger to prevent current flow from the DC battery into the charger. All the semi-conductor devices shall be protected with power transient suppressor circuit.

15. Annunciation System

Audio-visual indications through bright LEDs shall be provided in all Chargers for the following abnormalities: -

(i) AC Power failure.
(ii) Rectifier/chargers fuse blown.
(iii) Over voltage across the battery when boost charging.
(iv) Abnormal voltage (High/Low)
(v) Battery discharged
(vi) Under voltage of AC input,
(vii) Individual charger failure,
(viii) Individual charger thermal overload,
(ix) Earth fault of the DC bus and
(x) Filter capacitor fuse fail
(xi) Charger output fuse fail
(xii) Charger over current
(xiii) Battery isolation fuse fail
(xiv) Any other annunciation if required

~~Potential free NO contacts of above abnormal conditions shall also be provided for common remote indication "CHARGER TROUBLE" in Owner's Control Board~~. For Remote indication & metering through SAS, please follow our technical specification for **Substation Automation system(**for SAS operated S/s only) R[2.1].Indication for charger in float mode and boost mode through indication lamps shall be provided for chargers. A Potential free contact for float/boost mode shall be provided for external interlocks.

The charger shall be provided with an over voltage mains release, alarm (remote) and indication (local) whenever voltage across load terminals exceeds desired voltages.

The charger shall give an indication locally and make a potential free contact available for operating a bell at a remote point whenever main fails or charger develops a fault and load is supplied by the battery.

16. Name Plates and Marking

The name plates shall be white with black engraved letters. On top of each Charger, on front as well as rear sides, larger and bold name plates shall be provided to identify the Charger. Name plates with full and clear inscriptions shall also be provided on and inside of the panels for identification of the various equipment and ease of operation and maintenance.

17. Charger Construction

The Chargers shall be indoor, floor-mounted, self-supporting sheet metal enclosed cubicle type. The Contractor shall supply all necessary base frames, anchor bolts and hardware. The Chargers shall be fabricated from 2.0mm cold rolled sheet steel and shall have folded type of construction. Removable gland plates for all cables and lugs for power cables shall be supplied by the Contractor. The lugs for power cables shall be made of electrolytic copper with tin coat. Power cable sizes shall be advised to the Contractor at a later date for provision of suitable lugs and drilling of gland plates. The Charger shall be tropicalised and vermin proof. Ventilation louvers, if provided shall be backed with screens. All doors and covers shall be fitted with synthetic rubber gaskets. The chargers shall have hinged double leaf doors provided on front and on backside for adequate access to the Charger's internals. All the charger cubicle doors shall be properly earthed. The degree of protection of Charger enclosure shall be at least IP-42 as per IS: 13947 Part -1.

(i) All the elements used in the battery charging scheme shall be suitably rated for the duty involved. All indicating instruments, control switches and indicating lamps shall be mounted on the front side of the Charger.All the instruments, switches and control equipment shall be from reputed manufacturer and be of best quality and shall conform to the relevant I.S. Specification. The switch shall be complete with position indicators.All the semi conductor devices shall be from reputed manufacturer and shall be protected with power transient suppressor circuit. In addition necessary fuses shall be provided for short circuit protection. The maximum temperature attained by any part of the equipment of the battery charger at specified rating should not exceed the permissible limits as stipulated in relevant
I.S.S. The designing of the equipment shall be made taking 50^{o}C as ambient temperature of the site.

(ii) Each Charger shall be furnished completely wired upto power cable lugs and terminal blocks and ready for external connections. The control wiring shall be carried out with PVC insulated, 1.5 sq.mm. stranded copper wires. Control terminals shall be suitable for connecting two wires, with 2.5 sq.mm stranded copper conductors. Each wire shall be continuous from end to end and shall not have any joint within itself. The insulation grade of the wiring shall be 1100 V grade. The colour of 3 Phase, 4 Wire AC. supply shall be red, yellow, blue and black for phases and neutral. The D.C. wiring shall be of the colour other than the above (preferably grey) with the +ve and -ve marking in the ferrule. All terminals shall be numbered for ease of connections and identification. Each wire shall bare a ferrule or tag on each end for identification. At least 20% spare terminals shall be provided for control circuits.

(iii) The insulation of all circuits, except the low voltage electronic circuits shall withstand test voltage of 2 KV AC for one minute. An air clearance of at least ten (10) mm shall be maintained throughout for such circuits, right up to the terminal lugs. Whenever this clearance is not available, the live parts shall be insulated or shrouded.

(iv) The input terminals of the battery charger shall be marked "R,Y,B,N" for AC. supply. The terminals where battery will be connected shall be marked as -ve (24), -ve (tap cell) and +ve common. There shall be five load terminals each of which shall be of 6A rating, one load terminal of 10A rating and one load terminal equal to the full load capacity of the charger. Charger shall be wired such that positive poles of both charger and the battery shall be earthed.

(v) Charger output shall be substantially free from switching surges, transients and hunting etc. Output circuit of the charger shall have proof against short circuit on the load side

(vi) Copper Earth bus of suitable cross section shall have to be used in the charger for earthing purpose.

18. Painting

All sheet steel work shall be pre-treated in tanks, in accordance with IS: 6005.

Degreasing shall be done by alkaline cleaning. Rust and scale shall be removed by pickling with acid. After pickling, the parts shall be washed in running water. Then these shall be rinsed in slightly alkaline hot water and dried. The phosphate coating shall be 'Class-C' as specified in IS: 6005. Welding shall not be done after phosphating. The phosphating surfaces shall be rinsed and passivated prior to application of stoved lead oxide primer coating. After primer application, two coats of finishing synthetic enamel paint of shade - 692 (smoke grey) of IS-5 shall be applied, unless required otherwise by the Owner. The inside of the chargers shall be glossy white. Each coat of finishing synthetic enamel paint shall be properly staved. The paint thickness shall not be less than fifty (50) microns.

19. TESTS

Battery Chargers shall conform to all type tests as per relevant Indian Standard. Performance test on the Chargers shall also be carried out on each charger as per specification. Rectifier transformer shall conform to all type tests in IS: 4540 and short circuit test as per IS: 2026. Following type tests shall be carried out for compliance of specification requirements:- (i) Voltage regulation test.

(ii) Load limiter characteristics test

(iii) Efficiency tests

(iv) High voltage tests

(v) Temperature rise test

(vi) Short circuit test at no load and full load at rated voltage for sustained shortcircuit.

(vii) Degree of protection test

(viii) Measurement of ripple by oscilloscope.

(ix) Temperature compensation feature demonstration

The contractor may be required to demonstrate to the OWNER that the chargers conform to the specification particularly regarding continuous rating, ripple free output, voltage regulation and load limiting characteristic, before despatch as well as after installation at site. At site the following tests shall be carried out:- (i) Insulation resistance test

(ii) Checking of proper annunciation system operation

If a Charger fails to meet the specified requirements, the Contractor shall replace the same with appropriate Charger without affecting the commissioning schedule of the Sub-Station, and without any extra cost to the OWNER.

The Contractor shall present for inspection, the type and routine test certificates for the following components whenever required by the OWNER.

(i) Switches

(ii) Relays/MCCBs

(iii) Instruments
(iv) DC fuses
(v) SCR
(vi) Diodes
(vii) Condensers
(viii) Potentiometers
(ix) Semiconductor
(x) Annunciator
(xi) Control wiring
(xii) Push buttons and contactors

Makes of above equipment shall be subject to Owner's approval.

20. DOCUMENTATION

The successful bidder shall submit Six sets of drawings for approval.

The following drawing shall be supplied with the tender: -

(i) Outline drawings of all apparatus showing sufficient details to enable the purchaser to determine whether the design proposed can be installed satisfactorily or not.
(ii) Wiring diagram of battery charger.

G UARANTEED TECHNICAL PARTICULARS OF 48V BATTERY CHARGER :

(To be filled in and signed by the Bidder)

Sl. No. Particulars

1. Manufacturer's type and designation :

2. Rated DC output voltage across load terminals :

3. Rated DC output current across :

a) Load terminals (Amps) :
b) Battery terminals (Amps) :
c) Load plus battery terminals (Amps) :

4. AC Supply :

a) Phase (Single / Three) :
b) Nominal Voltage (Volts) :
c) Nominal frequency (Hz) :
d) Power drawn (max.) (KVA) :
e) Efficiency at full rated DC output :

5. Percentage taps provided on mains input

transformer (+/- %) :

6. Range of potentiometers for setting DC voltage across battery terminals for :

a) Trickle charging (Volts to Volts) :
b) Quick charging (Volts to Volts) :
c) Boost charging (Volts to Volts) :

7. Whether selection between present trickle charging and quick charging voltages can be made by means of a switch on front panel (Yes / No) :

8. DC voltage regulation across battery terminals for 0 to 100% load charges and specified mains voltage and frequency variations :

9. DC voltage across battery terminals under specified mains voltage and frequency variations when a load corresponding to 125% of rated charger output (battery plus load) is drawn from it (Volts) :

10. DC voltage range across load terminals for 0 to 100% load changes and specified mains voltage and fequency variation while the battery is on :

a) Trickle charge (Volts to Volts) :
b) Quick charge (Volts to Volts) :

11. Psophometric noise voltage across load terminals (mV) :

12. Whether over voltage mains release (and alarm) for 55 V across load terminals is provided (Yes / No) :

Sl. No. Particulars

13. Whether mains failure and charger failure alarms are provided (Yes / No) :

14. Details of indicating instruments on front panel :

a) Voltmeters and their purpose :
b) Ammeters and their purpose :

15. Details of indicating lamps and their purpose :

16. Voltage drop between battery terminals and load terminals when mains is switched off and 100% of the rated load current is drawn across load terminals :

17. Maximum permissible temperature rise over an ambient temperature of $50^{O}C$:

18. Range of current fluctuation :

19. Maximum limiting current :

20. Noise voltage across load terminal :

21. Ripple when floating across the battery :