

Standard Specification  
for  
Battery and Battery Charger

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## 1 GENERAL TECHNICAL REQUIREMENTS:

- 1.1 All materials/components used in Batteries and Battery chargers shall be free from flaws and defects and shall conform to the relevant Indian/IEC standards and good engineering practice.
- 1.2 **For 765, 400 & 220 kV sub-stations**, DC System shall consist of two (2) float-cum-boost chargers and two (2) battery sets for each of 220V and 48V systems respectively.
- 1.3 **For 132 kV sub-stations**, DC System shall consist of two (2) float-cum-boost chargers and two (2) battery sets for 220V/110V system. For 48V system, DC scheme shall consist of one (1) battery and one (1) float-cum-boost chargers.
- 1.4 Bidder shall select number of cells, float, and Boost voltage to achieve following system requirement:

System Voltage	Maximum Voltage during Float operation	Minimum voltage available when no charger working and battery fully discharged up to 1.85V per cell	Minimum Nos of cells
220 Volt	242 Volt	198 Volt	107
110 Volt	121 Volt	99 Volt	54
48 Volt	52.8 Volt	43.2 Volt	23

The bidder shall furnish calculation in support of battery sizing, selection of number of cells, float and Boost voltages during detailed engineering for Employer's acceptance. Battery sizing calculations shall be done as per IEEE- 485 based on following duty cycle:

	Load	Duration	Type of Loads
220V DC System	Continuous Load	3 hours	Relays, IEDs, Station HMIs, spring charging, Isolator interlocking load, Miscellaneous permanently connected loads etc.
	Emergency Load	1 hour	Substation emergency lighting loads.
	Momentary Load	1 minute	Breaker closing, Tripping loads (taking simultaneous occurrence as per system)
48V DC System	Continuous Load	10 hours	Continuous load associated with PLCCs/DTPCs and Communication equipment. (when speech is not working)
	Momentary Load	15 minutes	Loads associated with PLCCs (when speech is working)

## 2 BATTERY:

- 2.1 **Type:** The DC Batteries shall be VRLA (**Valve Regulated Lead-Acid**) type and shall be Normal Discharge type. These shall be suitable for a long life under continuous float operations and occasional discharges. Air-conditioning shall be provided in Battery room and the requirement of which has been specified elsewhere in the Technical Specification. The 220V DC system is unearthed, and 48V DC system is +ve earth system.
- 2.2 **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.**
- 2.3 **Containers:** The container material shall have chemical and electro-chemical compatibility and shall be acid resistant. The material shall meet all the requirements of VRLA batteries and be consistent with the life of battery. **The container shall be fire retardant and 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 or bulge on the sides under all working conditions. The container shall be capable of withstanding the rigors of transport, storage and handling. The containers shall be enclosed in a steel tray.
- 2.4 **Cell Covers:** The cell covers shall be made of suitable material compatible with the container material and permanently fixed with the container. It shall be capable of withstanding 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.
- 2.5 **Separators:** The separators used in manufacturing battery cells shall be of glass mat or synthetic material having high acid absorption capability, resistant to sulphuric acid and good insulating properties. The design of separators shall ensure that there is no misalignment during normal operation and handling.
- 2.6 **Pressure Regulation Valve:** Each cell shall be provided with a pressure regulation valve. The valve shall be self-re-sealable and flame retardant. The valve unit shall be such that it cannot be opened without a proper tool. The valve shall be capable of withstanding the internal cell pressure specified by the manufacturer.
- 2.7 **Terminal Posts:** Both the +ve and –ve terminals of the cells shall be capable of proper termination and shall ensure its consistency with the life of the battery. The surface of the terminal post extending above the cell cover including bolt hole shall be coated with an acid resistant and 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 and –ve posts shall be clearly and unambiguously identifiable.
- 2.8 **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 or 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 at a very high rate of charge or discharge.
- Nuts and bolts for connecting the cells shall be made of copper, brass, or stainless steel. Copper or brass nuts and bolts shall be effectively lead coated to prevent corrosion. Stainless steel bolts and 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.
- 2.9 **Flame Arrestors:** Each cell shall be equipped with a Flame Arrestor to defuse the Hydrogen gas escaped during charge and discharge. Material of the flame arrestor shall not affect the performance of the cell.
- 2.10 **Battery Bank Stand:** All batteries shall be mounted in a suitable metallic stand/frame. The frame shall be properly painted with acid resistant paint. **Suitable insulation shall be provided between stand/frame and floor to avoid the grounding of the frame/stand.**
- 2.11 **Capacity Requirements:** When the battery is discharged at 10-hour rate, it shall deliver 80% of C (rated capacity, corrected at 27° Celsius) before any of the cells in the battery bank reaches 1.85V/cell.

The battery shall be capable of being recharged from the fully exhausted condition (1.75V/cell) within 10 hrs up to 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° Celsius) shall also not be less than C and not more than 120% of C before any cell in the battery bank reaches 1.75V/cell. The battery voltage shall not be less than the following values, when a fully charged, battery is put to discharge at C/10 rate:

- (a) After 6 minutes of discharge : 1.98V/cell
- (b) After 6 hours of discharge : 1.92V/cell
- (c) After 8 hours of discharge : 1.85V/cell
- (d) After 10 hours of discharge : 1.75V/cell

Loss in capacity during storage at an average ambient temperature of 35° Celsius 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. The 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%.

**2.12 Expected Battery Life:** The battery shall be capable of giving 1200 or more charge/discharge cycles at 80% Depth of discharge (DOD) at an average temperature of 27° Celsius. DOD (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.

**2.13 Routine Maintenance of Battery system:** For routine maintenance of battery system, the contractor shall supply 1 set of following tools:

- a) Torque wrench.
- b) Multimeter suitable for cell test (-3 - 0 - +3) volts with least count of 0.01 Volt.

**2.14 Type Test of Battery:**

- i. Contractor shall submit type test reports of following tests as per IEC 60896-21 & IEC 60896-22. The type test reports shall be submitted in accordance with the requirements stipulated in clause no. 9.2 of Technical Specification, Section: GTR.

S. No.	Description of test
Safe operation Characteristics	
1.	Gas emission
2.	High current tolerance
3.	Short circuit current and D.C. internal resistance
4.	Protection against internal ignition from external spark sources
5.	Protection against ground short propensity
6.	Content & durability of required markings
7.	Material identification
8.	Valve operation
9.	Flammability rating of materials
10.	Intercell connector performance
Performance Characteristics	
11.	Discharge Capacity
12.	Charge retention during storage
13.	Float service with daily discharges
14.	Recharge behavior
Durability Characteristics	

15.	Service life at an operating temperature of 40°C for brief duration exposure time.
16.	Impact of a stress temperature of 60°C for brief duration exposure time with 3 h rate discharge test.
17.	Abusive over-discharge
18.	Thermal runaway sensitivity
19.	Low temperature sensitivity
20.	Dimensional sensitivity at elevated internal pressure and temperature
21.	Stability against mechanical abuse of units during installation

ii. List of Factory & Site Tests for Battery:

S. No.	Test	Factory Tests	Site Tests
1.	Physical Verification		√
2.	C/10 Capacity test on the cell	√	
3.	8 Hrs. Charge and 15 minutes discharge test at full rated load		√

2.15 **Installation and commissioning: Manufacturer of Battery shall supervise the installation and commissioning** and perform commissioning tests as recommended in O&M manual / or relevant standards. All necessary instruments, material, tools, and tackles required for installation, testing at site and commissioning are to be arranged by Battery manufacturer/ Contractor.

i. Contractor shall be submitted following documents for approval:

- Data sheet as per [Annexure-I](#)
- GA of cell and layout drawing
- Discharge Data for 10 Hour, 8 Hour, 3 Hour, 2 Hour, 1 Hour, 15 Minutes and One Minute indicating capacity factors for end cell voltage of 1.75 V & 1.85 V.
- Temperature correction factors
- Installation and commissioning Instructions
- O & M Manual

### 3 BATTERY CHARGER:

The DC system for 220V DC is unearthed and for 48V DC is +ve earthed. The Battery Chargers as well as their automatic regulators shall be of static type and shall be compatible with the offered VRLA batteries. All battery chargers shall be capable of continuous operation at the respective rated load in float charging mode, i.e. Float charging the associated Lead-Acid Batteries at **2.13 to 2.27 Volts per cell** while supplying the DC load. The chargers shall also be capable of Boost charging the associated DC Battery at **2.28 to 2.32 volts per cell** at the desired rate.

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.

3.1 All 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. In automatic control mode

during Float charging, the Charger output voltage shall remain within  $\pm 1\%$  of the set value for AC input voltage variation of  $\pm 10\%$ , frequency variation of  $\pm 5\%$ , a combined voltage and frequency variation of  $\pm 10\%$  and DC load variation from zero to full load.

- 3.2 All battery chargers shall have a constant voltage characteristic throughout the range (from zero to full load) at the floating value of the voltage to keep the battery fully charged but without harmful overcharge.
- 3.3 All chargers shall have load limiters having **drooping characteristic**, 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.**
- 3.4 Uniform and stepless 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. Stepless adjustments of the Load- limiter setting shall also be possible from 80% to 100% of the rated output current for Charging mode.
- 3.5 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.
- 3.6 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.**
- 3.7 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.
- 3.8 Suitable filter circuits shall be provided in all the chargers to **limit the ripple content (Peak to Peak) in the output voltage to 1%, irrespective of the DC load level**, when they are not connected to a Battery.
- 3.9 **MCCB:** 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 should be closed at a time. It shall be of P2 duty and suitable for continuous duty. MCCB's should have auxiliary contacts for annunciation.
- 3.10 **Rectifier Transformer:** The rectifier transformer shall be continuously rated, dry air cooled (A.N) and of class F insulation type. The rating of the rectifier transformer shall have **10% overload capacity**.
- 3.11 **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 fast acting HRC fuses shall be provided in each arm of the rectifier connections.



- 3.12 **Instruments:** One AC voltmeter and AC Ammeter along with selector switches and One DC voltmeter and DC ammeter (with shunt) shall be provided for all chargers. The instruments 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 center zero voltmeter with selector switch shall also be provided for 220V chargers for testing purposes.
- 3.13 **Air Break Switches:** One DC output switch shall be provided in all chargers. They shall be air brake type suitable for 500 volts AC/ 250 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. The rating of switches shall be suitable for their continuous load. Alternatively, MCCB's suitable ratings would also be acceptable in place of Air Break Switch.
- 3.14 **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.** The Fuse failure annunciation shall be provided on the failure of any fuse.
- 3.15 **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.
- 3.16 **Annunciation System:** Audio-visual indications through bright LEDs shall be provided in all Chargers for the following abnormalities:
- AC power failure
  - Rectifier/chargers fuse blown.
  - Over voltage across the battery when boost charging.
  - Abnormal voltage (High/Low)
  - Any other annunciation if required.
- Potential free NO Contacts of above abnormal conditions shall also be provided for common remote indication "**Charger Trouble**" in Employer's Control Board. Indication for chargers 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.
- 3.17 **Name Plates and Marking:** The name plates shall be white with black engraved letters. On top of each Charger, on the 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.
- 3.18 **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 later for provision of suitable lugs and drilling of gland plates. The Charger shall be tropicalized 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 IEC 60947-1.

- i. All indicating instruments, control switches and indicating lamps shall be mounted on the front side of the Charger.
- ii. Each Charger shall be furnished completely wired up to 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. All terminals shall be numbered for ease of connections and identification. Each wire shall bear a ferrule or tag on each end for identification. At least 20% of 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 **2kV 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.

3.19 **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 Employer. **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.**

### 3.20 TESTS

- i. Battery chargers shall conform to all type tests as per IEC 60146-1. Performance tests on the Chargers as per Specification shall also be carried out on each Charger as per specification. Rectifier transformer shall conform to short circuit test as per IS:2026. Following type tests shall be carried out for compliance of specification requirements:
  - a. Visual inspection
  - b. Insulation test
    - i. AC or DC Voltage test (High voltage test)
    - ii. Insulation Resistance test
  - c. Light load and Functional test
  - d. Measurement of Ripple voltage and current
  - e. Power loss determination - Efficiency tests
  - f. Temperature rise test
  - g. Checking the control equipment - Voltage regulation test
  - h. Checking the protective device - Load limiter characteristics test/current limit test
  - i. Temperature compensation feature demonstration

- j. Short circuit test at no load and full load at rated voltage for sustained short-circuit.
- k. Degree of protection test
- ii. The Contractor may be required to demonstrate to the Employer that the Chargers conform to the specification particularly regarding continuous rating, ripple free output, voltage regulation and load limiting characteristic, before dispatch 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.
- iii. 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 Employer.
- iv. The Contractor shall present type and routine test certificates for inspection of the following components, whenever required by the Employer.
  - a. Switches.
  - b. Relays/ MCCBs
  - c. Instruments.
  - d. DC fuses.
  - e. SCR.
  - f. Diodes.
  - g. Condensers.
  - h. Potentiometers.
  - i. Semiconductor
  - j. Annunciator.
  - k. Control wiring.
  - l. Push buttons and contactors.

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

## 4 ANNEXURE-I

## BATTERY SYSTEM DATA SHEETS

S. No.	Description of Data	Unit	220 V/ 110 V	48 V
<b>1</b>	General Data			
<b>a)</b>	Battery Type:			
	Grid alloy: Pure lead (Pb), lead calcium (Pb-Ca), lead antimony (Pb-Sb), or lead selenium (Pb-Se) or other pl. specify			
	Cell type: Absorbed glass mat or gel cell or other please specify			
	Seller's type number			
	Number of positive plates per cell			
<b>b)</b>	Does each battery and battery [rack]/ [cabinet] meet the seismic requirements	[Yes] [No]		
<b>c)</b>	Manufacturer's Designed Life of Battery	Years		
<b>d)</b>	Recommended Battery Charger Data:			
	Floating voltage range	V		
	Boost charge	V		
	Current rating	Amps.		
	Recharge time	hour		
<b>e)</b>	Heat Released During:			
	Discharge duty cycle	Watt		
	Float charge	Watt		
	Boost Charge	Watt		
<b>f)</b>	Maximum Amount of Hydrogen Gas Evolved			
	During Battery-Boost Charge (2.33 V per cell) at Maximum Battery Temperature	(Liter/h)		
	Hydrogen Gas Evolution at Float	(Liter/h)		
<b>g)</b>	Time for the Battery may be stored without a freshening charge	months		
<b>h)</b>	Temperature Compensation Provided and its Details			
<b>2.</b>	Physical Description.			
<b>a)</b>	Battery Cell:			
	Size (L x W x H)	mm		
	Weight	Kg		
	Volume of electrolyte gal	L		
	Jar cover material			
	Jar container material			
	Separator material			
	Retainer material			
	Limiting-oxygen index (LOI)			
<b>b)</b>	Battery [Rack] [Cabinet]:			
	Outline or catalog number			
	Quantity of [racks][cabinets] for the battery			
	Description (tier or step type)			
<b>c)</b>	Total Net Weight of Battery Including [Racks] [Cabinets]	kg		
<b>d)</b>	Total Shipping Weight of Each Battery Jar and Associated Equipment	kg		

e)	Connectors:					
	Inter-cell:					
	Type					
	Material					
	No. per connection					
	Inter-[Tier] [Step]:					
	Type					
	Material					
	No. per connection					
	Terminal Detail:					
	Type					
	Material					
f)	Terminal Lugs for Power Cable:					
g)	Torque Data:		Initial Torque Value	Re- torque Value	Initial Torque value	Re- torque Value
	Inter-cell Connectors					
	Inter-[Tier] [Step]:					
3.	Performance Data.					
	Battery String Designation No. [1] [ ]					
	Float Voltage without Boost	V/cell				
	Float Voltage with Boost	V/cell				
	Boost Charge Voltage	V/cell				
	Recommended Frequency of Boost Charge					
	Recommended Duration of Boost Charge					
	Open-Circuit Voltage	V/cell				
	Short-Circuit Current at Battery Terminals at Float Voltage at (27°C):					
	Battery Discharge Characteristics	A or A/ positive plate				
	Guaranteed Amp-Hour Capacity (at the 10-hr rate) to Specified Final Voltage	AH				
	One-minute	A/cell				
	Fifteen-minutes	A/cell				
	One-hour	A/cell				
	Two-hours	A/cell				
	Three-hours	A/cell				
	Eight-hours	A/cell				
	Ten-hours	A/cell				
4.	Required operating environment.					
	Battery Room Ambient Temperature Range	(°C to °C)				
	Battery Room Ambient Design Temperature	°C				
	Battery Room Minimum/Maximum Design Temperature	(°C to °C)				
	Maximum temperature at which battery can be stored	°C				