

2 X 660 MW Udangudi Supercritical Thermal Power Project - Stage – 1

**TAMIL NADU GENERATION & DISTRIBUTION
CORPORATION LTD. (TANGEDCO)**

VOLUME – II

TECHNICAL SPECIFICATION FOR
220V DC Lead Acid Battery

BHEL DOCUMENT NO. : PE-TS-435-508-E001
REVISION NO. : 0



BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA-201301, UTTAR PRADESH, INDIA



**TECHNICAL SPECIFICATION FOR
220V DC Lead Acid Battery**

SPECIFICATION NO. PE-TS-435-508-E001

VOLUME II

REVISION 0 DATE : 19.04.19

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COMPLIANCE CERTIFICATE

The bidder shall confirm compliance to the following by signing/ stamping this compliance certificate and furnishing same with the offer.

1. The scope of supply, technical details, construction features, design parameters etc. shall be as per technical specification & there are no exclusion/ deviation with regard to same.
2. There are no deviation with respect to specification other than those furnished in the 'schedule of deviations'.
3. Only those technical submittals which are specifically asked for in NIT to be submitted at tender stage shall be considered as part of offer. Any other submission, even if made, shall not be considered as part of offer.
4. Any comments/ clarifications on technical/ inspection requirements furnished as part of bidder's covering letter shall not be considered by BHEL, and bidder's offer shall be construed to be in conformance with the specification.
5. Any changes made by the bidder in the price schedule with respect to the description/ quantities from those given in BOQ-Cum-Price schedule enclosed with NIT shall not be considered (i.e., technical description & quantities as per specification shall prevail).

BIDDER'S STAMP & SIGNATURE



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SECTION –I
SPECIFIC TECHNICAL REQUIREMENTS



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1.0 SCOPE OF ENQUIRY

- 1.1 This specification covers the design, manufacture, inspection and testing at manufacturer's works, proper packing and delivery to site of 220V DC BATTERY.
- 1.2 Standard technical requirements of the 220V DC BATTERY are indicated in Section-II. Project specific technical/ quality requirements / changes are listed in Section-I & Data Sheet-A.
- 1.3 The stipulations of Section-I, followed by those of Data Sheet-A, followed by Section-II shall prevail in case of any conflict between the stipulations of Section-I, Section-II & Datasheet-A.

2.0 BILL OF QUANTITIES:

- 2.1 Quantity requirements shall be as per BOQ cum Unpriced Price Schedule enclosed with NIT.

3.0 SPECIFIC TECHNICAL REQUIREMENTS:

3.1 Technical /Quality/ Inspection:

S. No.	Reference clause No. of Section II (if any)	Specific Requirement/ Change
1	Section-II, Clause no. 3, D): Power & Control Cables	Shall be read as: "Power & Control Cables excluding Interfacing Cables of BHMS. These cables are in Bidder's scope of supply
2	Section-II, Clause no. 4.02): System Concept	Additionally Shall be read as: "The battery shall be designed to restrict maximum fault level on DCDB limited to 25kA for 1 Sec"
3	Section-II, Clause no. 4.05): System Concept	Additionally Shall be read as: "An ageing factor of 1.0, design margin 1.1 and temperature correction factor considering minimum electrolyte temperature of 17 deg C shall be considered for sizing the battery as per IEEE 485 and IS-1652. Based on the above calculations, next higher available battery rating will be provided."
4	Section-II, Clause no. 5.1, d): Other Technical requirements.	Additionally Shall be read as: "maximum and minimum level indication shall be provided on the container".
5	Section-II, Clause no. 5.1, i): Other Technical requirements.	Shall be read as: "End take off connections from positive, negative and tap cell terminals of the battery, shall be done through single core copper cable having stranded copper conductor and EPR insulation (Cable size in line with Datasheet-A)".
6	Section-II, Clause no. 5.1, i): Other Technical requirements.	Shall be read as: "All connectors and lugs shall be capable of continuously carrying the 120 minutes (2 hrs.) discharge current of the respective Batteries and through fault short circuit current which the battery can produce and withstand for the period declared".
7	Section-II, Clause	Shall be read as: "The bidder shall supply lead coated bent copper



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	no. 5.1, i): Other Technical requirements.	plate, tubular copper lugs, clamps, bolts, nuts, washers, etc. for termination of these cables on batteries. Suitable numbers of inter rack connectors shall be supplied by the bidder to suit the battery room layout during detailed engineering. Calculation for sizing of connectors and fasteners shall be furnished during detail engineering".
8	Section-II, Clause no. 5.1, j): Other Technical requirements.	Shall be read as: "Insulated mild steel racks suitably treated/coated with alkali /acid resistant compound mounted on the insulators shall be provided for the batteries".
9	Section-II, Clause no. 5.1, m): BHMS.	Additionally Shall be read as: BHMS shall measure & store "battery charging and discharging current".
10	Section-II, Clause no. 5.1, m): BHMS.	Shall be read as: Battery Health Monitoring System shall measure and store the following parameters : 1. each cell voltage 2. battery charging and discharging current 3. Ambient and Cell temperature
11	Section-II, Clause no. 7.1): INSPECTIONS & TESTING	Additionally Shall be read as: "Type test conducted on similar or higher rating of battery in an independent laboratory or witnessed by third party, shall be submitted for customer's review".
12	Section-II, Clause no. 7.3 (A): INSPECTIONS & TESTING	Shall be read as: Following type tests reports conducted as per IS1652 / IEC 60896 shall be submitted for the battery: ☐ Verification of constructional requirements. ☐ Dimensional check ☐ Test for capacity ☐ Retention of charge test ☐ Ampere - hour and watt-hour efficiency tests. ☐ Life & Endurance test. ☐ Short circuit current and internal resistance measurement test. ☐ Test for loss of capacity on storage ☐ Test for resistance to overcharge ☐ Test for voltages & specific gravity during discharge. ☐ Internal resistance measurement test. Following Acceptance tests shall be conducted for the battery: ☐ Visual inspection. ☐ Dimensional check ☐ Test for capacity ☐ Test for voltages & specific gravity during discharge. ☐ Internal resistance of cells. Following Site tests shall comprise the following: ☐ Check name plate details according to the specification ☐ Check for physical damage ☐ Check tightness of all bolts, clamps, joints and connecting terminals



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		☐ Check for electrolyte level ☐ Check for correct polarity ☐ Check charging and discharging cycle Necessary equipment, including the variable resistor, tools, tackles and instruments shall be arranged by BHEL.
13	Section-II, Clause no. 7.4): INSPECTIONS & TESTING	Shall be read as: For all components / materials, for which type test reports have been asked as per relevant standard, such Type tests should have been carried out on identical components / materials. In absence of such type tests reports or in case such reports are not found to be meeting the specification/standards requirements, vendor shall conduct all such type tests without any commercial/delivery implication to BHEL according to the relevant standards and reports shall be submitted to the owner for approval. Such Type tests should have been conducted within last 5 years from date of contract (i.e. 15.12.2015), from on similar or higher rating of components/ materials of battery in an independent laboratory only or witnessed by third party".
14	Section-II, Clause no. 7.5): INSPECTIONS & TESTING	"The bidder shall indicate cost...." Shall be read as: Charges for all type tests (if required to be conducted by bidder) are deemed to be included in the bid price.
15	General	Shall be read as: Boost mode of FCBC charger shall be sized to boost charge the fully discharged battery to its normal capacity in a period of 8 hours.

4.0 220V DC SYSTEM

Battery and charger will be connected to DCDB. Under normal conditions, each charger will cater continuous loads and trickle charging current of batteries. If load is high and exceeds the charger capacity, then excess load will be supplied by the battery. All the terminals and inter-cell and inter-bank connectors will be fully insulated. In case of failure of AC, battery will meet the DC load requirement. After restoration of power, the float charger will continue to supply the loads as well as trickle charge the battery.

5.0 LIST OF CODES & STANDARDS (Refer Annexure-I enclosed with Section-I).

6.0 LOAD DUTY CYCLE (Refer Annexure-II enclosed with Section-I).

7.0 SINGLE LINE DIAGRAM FOR 220V DC SYSTEM (Refer Annexure-III enclosed with Section-I).

8.0 LIST OF ACCESSORIES (Refer Annexure-IV enclosed with Section-I).

9.0 DOCUMENTS REQUIRED ALONG WITH TECHNICAL OFFER (Refer Annexure-V enclosed with Section-I).

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- 10.0** DOCUMENTS REQUIRED AFTER AWARD OF LOI (Refer Annexure-VI enclosed with Section-I).



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DATA SHEET-A

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1.	Rated voltage (V)	:	220V DC
2.	Type of Battery	:	High Discharge Lead-Acid Plante F-Type, HDP
3.	Conforming to	:	IEEE/ IS standards
4.	DC system Fault level & duration	:	25KA for 1 Sec
5.	Material of Battery Rack	:	Mild Steel rack coated with three coats of anti-acid paint of approved shade
6.	Design Ambient Temperature	:	50 Deg. C
7.	Minimum Electrolyte Temperature to be considered for Battery Sizing	:	17 Deg. C
8.	No. of cells	:	108
9.	End cell voltage	:	1.85V/cell
10.	Nominal Float voltage (V)	:	2.25 V/cell
11.	Boost voltage (Maximum) (V)	:	Bidder to furnish the detail along with offer
12.	AH Capacity of Battery	:	Bidder to furnish quoted AH capacity and battery sizing as per LOAD DUTY CYCLE (Annexure-II)
13.	Arrangement of batteries on racks	:	Single tier for batteries having cell weight 50kg or more
14.	Cable size to be terminated at Battery end	:	1) Main plant: 2 RUNS 1C x 400 sq.mm (Cu) FS CABLE/ pole. 2) Offsite areas (WT/ RO & SEA WATER INTAKE): 2C x 50 sq.mm (Cu) FS CABLE.
15.	Tapping to be provided in battery	:	No
16.	Tapping to be provided at which cell (if Tapping is applicable)	:	NA
17.	Recommended boost charging rate	:	Bidder to furnish the detail along with offer
18.	Recommended trickle charging rate	:	Bidder to furnish the detail along with offer

Notes:

1. Suitable number of copper lugs for cable termination at battery terminals shall be provided by bidder as per cable size informed by BHEL above.
2. Bidders stand guarantee that the rating offered at S. No. 12 shall meet 'Load Duty Cycle' as per Annexure-II of specification.
3. Refer Annexure-III (Single Line Diagram of 220V DC system) for connection arrangement of Battery, charger and DCDB.
4. Suitable number of inert-cell, inter-row and inter-bank connectors to be provided by bidder.



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S. No.	PARAMETER	UNIT	VALUE
1.0	Make and Type		
2.0	AH capacity at 27° C and end voltage		
2.1	At 10 Hr discharge rate	AH	
2.2	At 1 Hr discharge rate	AH	
3.0	Battery Discharge current		
3.1	At one minute rate	Amp	
3.2	At 30 minutes rate	Amp	
3.3	At 30 minutes rate at end voltage	Amp	
3.4	At 60 minutes rate	Amp	
3.5	At 60 minutes rate at end voltage	Amp	
3.6	At 120 minutes rate at end voltage	Amp	
4.0	Types of plates		
4.1	Negative plates		
4.2	Positive plates		
5.0	Method of connection between cells		
6.0	Voltage per cell at the end of charge at the finishing rate	V	
7.0	Recommended Trickle charge current	Amp	
8.0	Type and material of separators		
9.0	Material of container		
10.0	Type of container		
11.0	Internal resistance of cells	Ohms	
12.0	Total resistance of connectors	Ohms	
13.0	Insulator Material for		
13.1	Cells		
13.2	Racks		
14.0	Average life	Years	
15.0	Recommended boost charger rating for		
15.1	Charging in 8 hours	Amp	
15.2	Charging in 10 hours	Amp	
16.0	Allowable ripple content acceptable to battery (r.m.s)	%	



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17.0	Hydrogen evaluation		
18.0	Cell designation in accordance with IS: 1651/1652		
19.0	Applicable standard		
20.0	Whether battery performance curve and calculation for capacities enclosed		
21.0	Recommended Maximum period of storage of Electrolyte before first charge		
22.0	Amount and specific gravity of electrolyte per cell required for first filling at 27° C		
23.0	Recommended specific gravity of electrolyte at 27° C		
23.1	When fully charged		
23.2	When fully discharged		
24.0	Container dimensions	(L X B X H)mm	
25.0	Distance between centres of cells when erected	Mm	
26.0	Terminal connectors		
26.1	Type		
26.2	Material		
27.0	Battery Racks		
27.1	Type & Material		
27.2	Outline dimensions	(L X B X H) mm	
27.3	Net weight	Kg	
28.0	Weight per cell	Kg	
28.1	Net dry weight	Kg	
28.2	Net weight with electrolyte	Kg	
29.0	Total shipping weight of one battery unit (without electrolyte)	Kg	
30.0	Taps provided at cell no.		
31.0	Connection from battery to charger (busbar/ cable)		
32.0	Recommended size of (busbar/ cable)		
33.0	Whether backup calculation furnished		
34.0	Cable lugs at battery terminals of suitable size		

Note: Indicates data / documents to be furnished after the award of Contract as per agreed schedule by the vendor (as applicable)

**1.0 LEAD ACID PLANTE BATTERY**

(Data to be furnished for each rating)

Sl.No.	Description	Unit	Rating-1	Rating-2
1	Manufacturer of battery			
2	Quantity	Nos.		
3	Applicable standard			
4	DC System Voltage	V		
5	Battery type			
6	Type of Container			
7	Type of the cell			
8	Cell designation as per IS			
9	Cell dimensions	mmxmmxm m		
10	Weight of complete cell - Without electrolyte - With electrolyte	Kg		
11	Plates - No.of positive plates per cell - Types of positive plates - Types of negative plates			
12	No. of Cells per battery			
13	Rated cell voltage			
14	Ampere Hour rating	AH		
15	Battery capacity referred to a cell end voltage of 1.85	AH		
16	Load cycle duration	Hours		
17	10 hour rating at 27°C to 1.85V per cell	A		
18	Minimum cell voltage during duty cycle	1.85 V		
19	WH efficiency	>75 %		
20	AH efficiency at 10 hour discharge rate	> 90%		
21	Float charging (Volt / cell , Amp)	V,Amp		
22	Boost charging in 10 hours (Volt / cell , Amp) - Start - Finish	V,Amp		
23	Maximum short circuit current for a dead	KA		



Sl.No.	Description	Unit	Rating-1	Rating-2
	short across terminals			
24	Internal resistance of • Battery • Each cell of battery	Ohm		
25	Taps provided of cell No.			
26	Internal resistance of each cell of battery	Ohm		
27	Mounting arrangement			
28	Racks • Material • No.of racks • Overall dimension of rack			



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ANNEXURE-I

LIST OF APPLICABLE STANDARDS

- | | | |
|-----|---|-------------|
| 1. | STATIONERY LEAD ACID PLANTE BATTERY | IS 1652 |
| 2. | RECOMMENDED PRACTICE FOR SIZING LEAD ACID BATTERIES | IEEE 485 |
| 3. | SPECIFICATION FOR WATER FOR STORAGE BATTERIES | IS 1069 |
| 4. | SPECIFICATION FOR SULPHURIC ACID FOR LEAD ACID BATTERIES | IS 266 |
| 5. | RUBBER & PLASTIC CONTAINERS FOR LEAD ACID BATTERIES | IS 1146 |
| 6. | SYNTHETIC SEPARATORS FOR LEAD ACID BATTERIES | IS 6071 |
| 7. | SEALING COMPOUND FOR LEAD ACID BATTERIES | IS 3116 |
| 8. | METHODS OF TESTS FOR LEAD ACID BATTERIES | IS 8320 |
| 9. | SPECIFICATION FOR HIGH PERFORMANCE PLANTE'S CELLS | BS-6290 |
| 10. | ELECTRICAL VOCABULAR, PRIMARY CELLS AND BATTERIES. | IS: 1885 |
| 11. | LEAD-ACID BATTERIES FOR TRAIN LIGHTING & AIRCONDITIONING SERVICES | IS: 6848 |
| 12. | STATIONARY LEAD-ACID BATTERIES – VENTED TYPES – GENERAL REQUIREMENTS & METHODS OF TESTS | IEC60896-11 |
| 13. | INDIAN ELECTRICITY RULES & INDIAN ELECTRICITY ACTS | |

Note:

Vendor to note that wherever IS is mentioned equivalent IEC is also acceptable. In case of any technical requirement not covered by IEC, technical requirement as per IS shall prevail.



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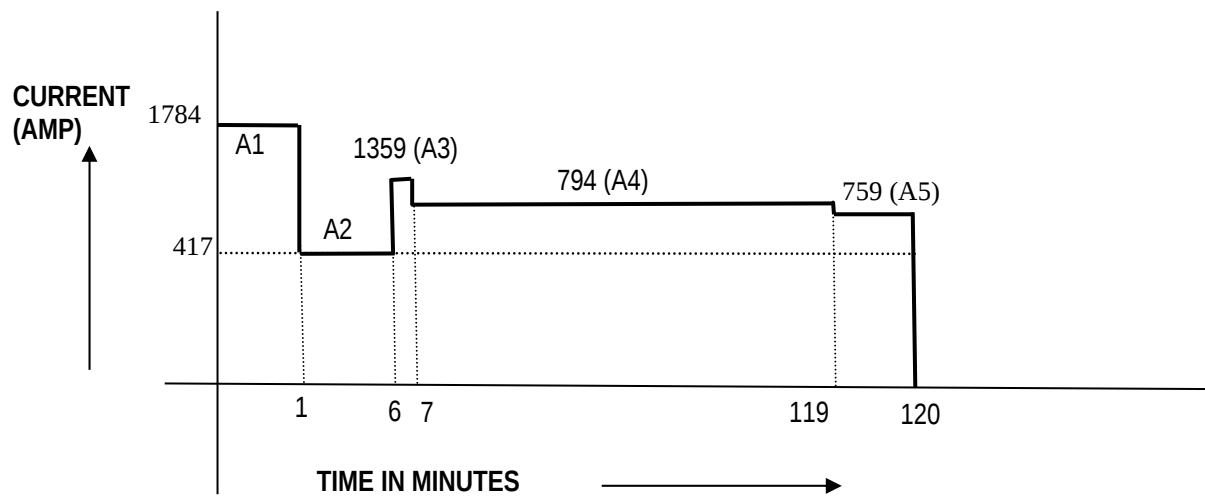
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ANNEXURE-II

LOAD DUTY CYCLE LOAD DUTY CYCLE OF AREA 1 (MAIN PLANT & ASSOCIATED STATION LOADS)



Duration	0-1 min	1-06 min	06-07 min	07-119 min	119-120 min
Current	1784	417	1359	794	759

FACTORS TO BE CONSIDERED FOR BATTERY SIZING:

1. AGEING FACTOR : 1.0 for Lead-Acid
2. MIN.ELECTROLYTIC TEMP. : 17 °C
3. END CELL VOLTAGE : 1.85V/cell
4. DESIGN MARGIN : 1.1
5. TEMPERATURE CORRECTION FACTOR : IEEE 485 for Lead Acid shall be the principle for sizing the battery including temperature correction factor.

Note:

1. Supporting Calculation for temp correction factor as per IEEE shall be furnished for batteries which are not designed at 27 °C.
2. Due to maximum AH capacity limitation, bidder can offer battery with parallel banks. However, because of layout constraint, bidder can offer maximum of 2 banks in parallel.



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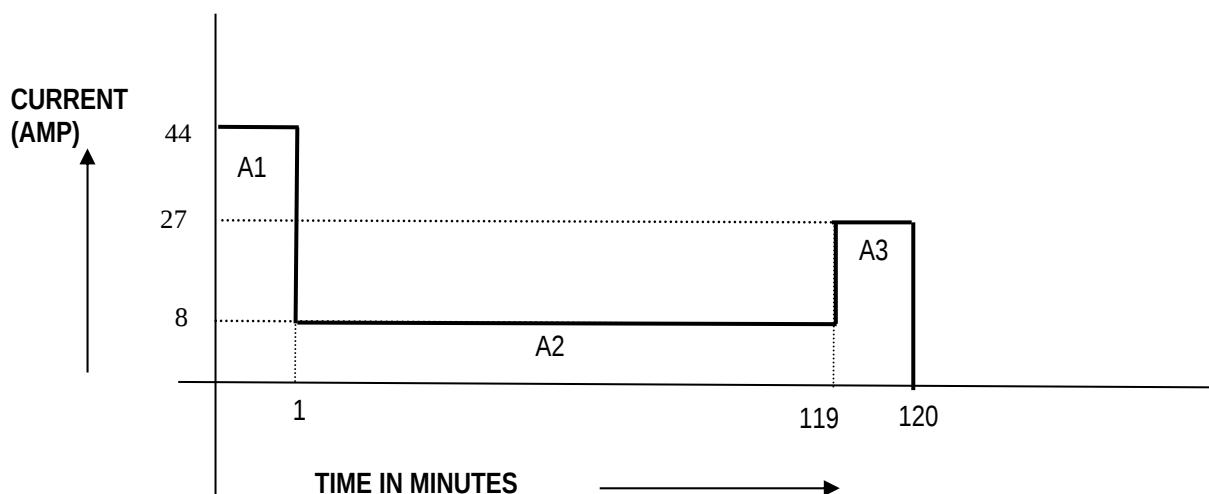
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**LOAD DUTY CYCLE OF AREA 2 (FOR WATER TREATMENT & RO PLANT
LOADS)**



Duration	0-1 min	1-119 min	119-120 min
Current	44	8	27

FACTORS TO BE CONSIDERED FOR BATTERY SIZING:

1. AGEING FACTOR : 1.0 for Lead-Acid
2. MIN.ELECTROLYTIC TEMP. : 17 °C
3. END CELL VOLTAGE : 1.85V/cell
4. DESIGN MARGIN : 1.1
5. TEMPERATURE CORRECTION FACTOR : IEEE 485 for Lead Acid shall be the principle for sizing the battery including temperature correction factor.

Note:

Supporting Calculation for temp correction factor as per IEEE shall be furnished for batteries which are not designed at 27 °C.



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LOAD DUTY CYCLE OF AREA 3 (FOR SEA WATER INTAKE LOADS)



Duration	0-1 min	1-119 min	119-120 min
Current	33	7	20

FACTORS TO BE CONSIDERED FOR BATTERY SIZING:

1. AGEING FACTOR : 1.0 for Lead-Acid
2. MIN.ELECTROLYTIC TEMP. : 17°C
3. END CELL VOLTAGE : 1.85V/cell
4. DESIGN MARGIN : 1.1
5. TEMPERATURE CORRECTION FACTOR : IEEE 485 for Lead Acid shall be the principle for sizing the battery including temperature correction factor.

Note:

Supporting Calculation for temp correction factor as per IEEE shall be furnished for batteries which are not designed at 27 °C.



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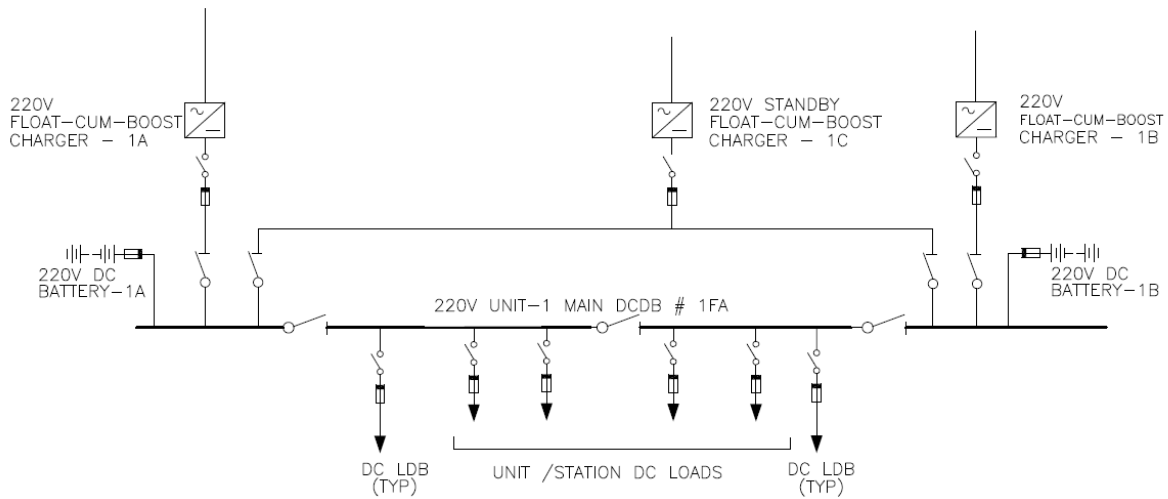
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ANNEXURE-III

SINGE LINE DIAGRAM FOR 220 V DC SYSTEM OF AREA-1 (FOR MAIN PLANT & ASSOCIATED STATION LOADS)





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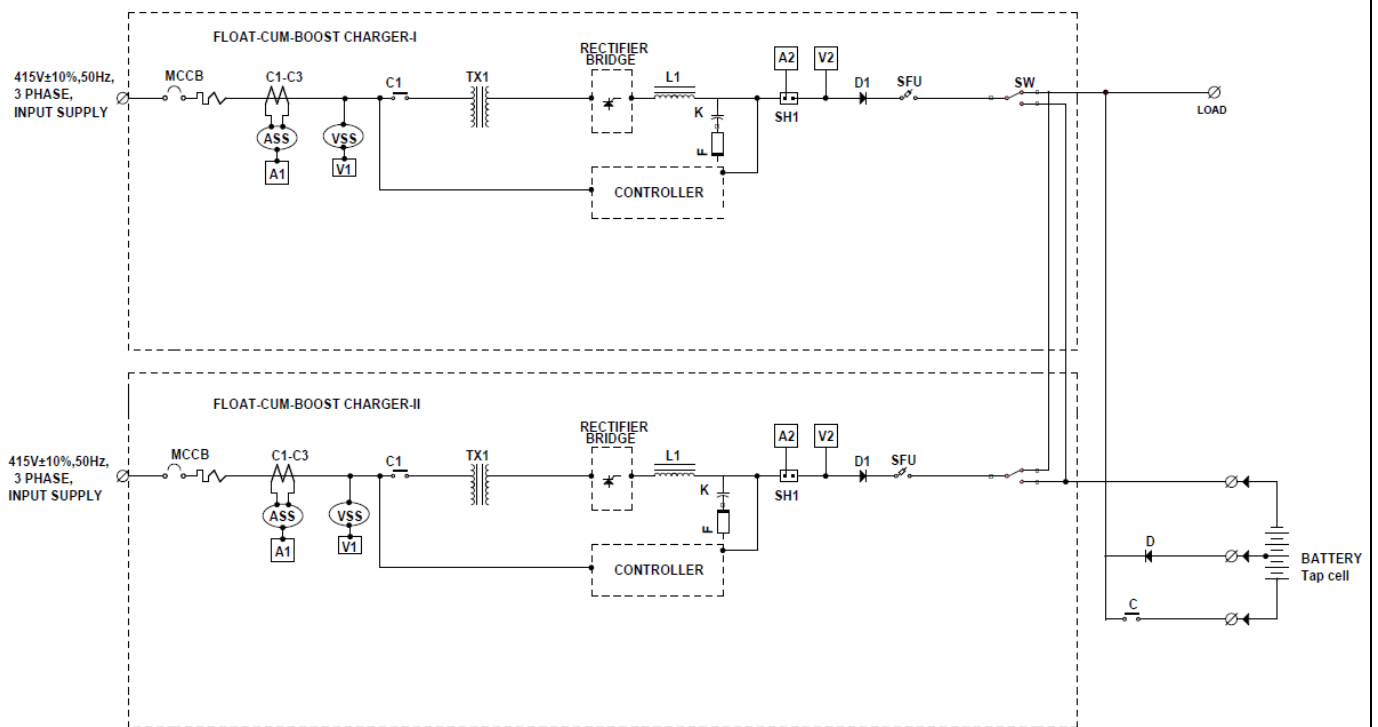
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SINGLE LINE DIAGRAM FOR 220 V DC SYSTEM OF:

AREA 2 (FOR WATER TREATMENT & RO PLANT LOADS)

&

AREA 3 (FOR SEA WATER INTAKE SYSTEM LOADS)



LEGENDS

	SELECTOR SWITCH FOR METER
	SELECTOR SWITCH
	POTENTIOMETER
	DC CAPACITOR
	CHOKE
	THYRISTOR (SCR)
	FUSE
	THERMO-MEGNATIC MCCB
	DC CURRENT SENSING SHUNT
	BATTERY
	INTERCONNECTION CABLE
	CABLE TERMINAL
	FUSE SWITCH
	CONTACTOR
	CHARGER FAIL RELAY (BOOST)



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ANNEXURE-IV

ACCESSORIES

Following accessories shall be provided for each battery bank (Already part of BOQ cum price schedule).

1.1 Each battery bank of 108 cells is furnished with following items.

Sl. No.	Fittings
1	First charge of electrolyte plus 10% extra
2	Mild Steel racks with 3 coats of anti-acid paint
3	Cell inter-connectors with 5% extra and one extra end take-off Interbank, Inter-row connectors with 5% extra (Insulated). Insulators (If applicable).
4	Cell numbering tags with fixing arrangement
5	Anti-splash type vent plug

1.2 Following accessories shall be provided for each AREA 220V DC System

Sl. No.	Accessories	QTY
1	Inter-connector bolt wrench	1 No.
2	Electronic Syringe type Hydrometer with temperature measurement and with built in memory.	1 No.
3	Specific gravity correction chart	1 No.
4	Acid resistant Jug	1 No.
5	Thermometer with plug & cap, specific gravity correction scale	1 No.
6	Cell testing voltmeter (digital) with leads (3-0-3V) with built in memory	1 No.
7	Pocket thermometer	1 No.
8	Electrolyte resisting funnels	2 Nos.
9	Electrolyte resisting jug of adequate capacity	1 No.
10	Rubber apron	1 No.
11	Pair of Rubber hand gloves	1 Set
12	Cell lifting straps	1 Set
13	Insulated Spanner for cells	1 No.
14	First aid box	1 No.
15	Goggles (Industrial)	2 Nos.
16	No smoking Notice	2 Nos.
17	Wall mounting holders for hydrometer and thermometer	2 Nos.
18	Wall mounted teak wood/Acid resistant rubber insulated steel rack for above items.	1 No.

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ANNEXURE-V

DOCUMENTS REQUIRED ALONG WITH THE TECHNICAL OFFER

- i. Battery sizing calculation with respect to load duty cycle (Annexure-II) enclosed with Section-I to be provided along with supporting documents (capability / discharge curve, temperature correction factor, float charging factor & published technical catalogue) for considered factors.
- ii. Unpriced Price Schedule as enclosed with NIT with "Quoted" word against items with bidder's signature and company stamp.
- iii. A copy of the sheet "Compliance certificate" with bidder's signature and company stamp.
- iv. A copy of sheet "Data Sheet-A" with required information and bidder's signature and company stamp.



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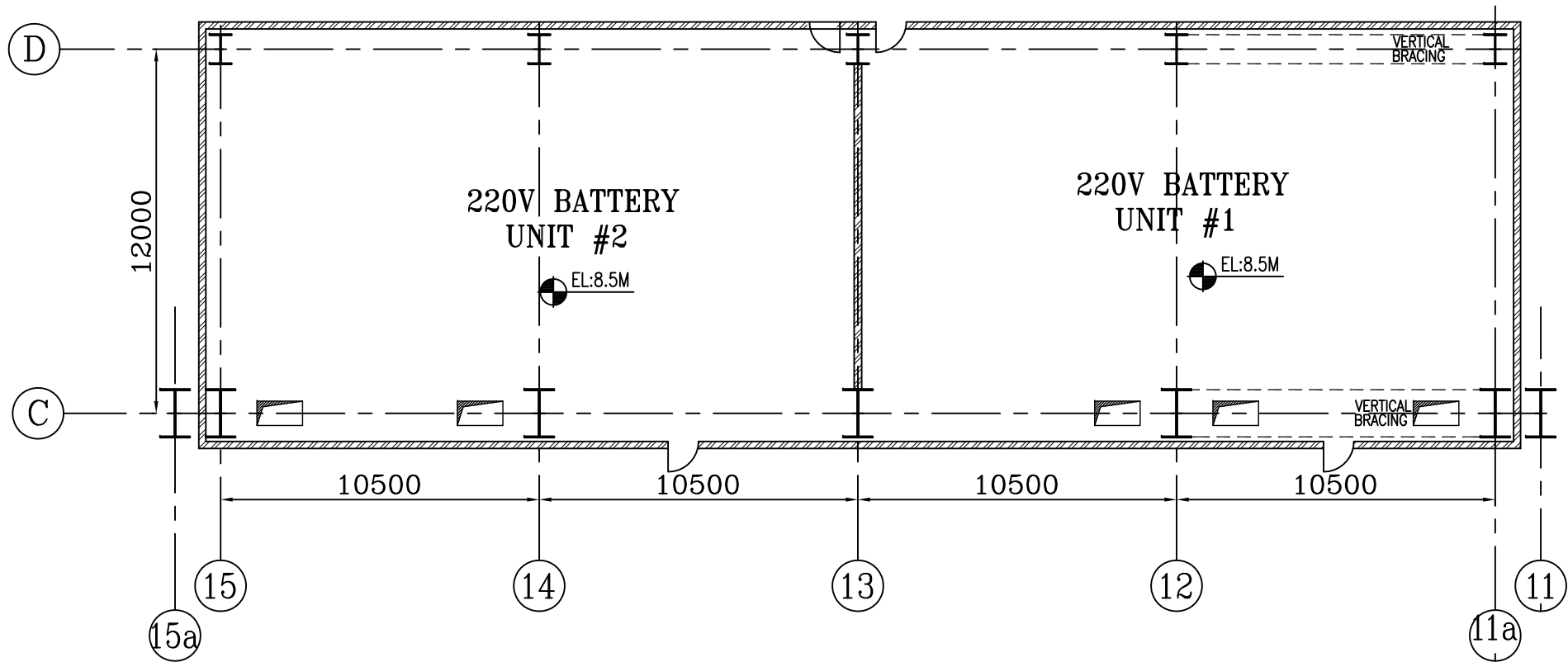
SHEET 1 OF 1

ANNEXURE-VI

DOCUMENTS REQUIRED AFTER AWARD OF LOI

S. NO	DOCUMENT TITLE	DWG. / DOCUMENT No.
1	Data Sheet for battery	PE-V0-435-508-E201
2	General Arrangement Drawing for battery	PE-V0-435-508-E202
3	Battery sizing calculation (Including battery catalogues, curves etc.)	PE-V0-435-508-E203
4	Bill of Material for battery	PE-V0-435-508-E204
5	Field Quality Plan for battery	PE-V0-435-508-E903
6	List of E&C Spares for battery	PE-V0-435-508-E206
7	List of O&M Spares for battery	PE-V0-435-508-E207
8	List of Mandatory Spares for battery	PE-V0-435-508-E208
9	O&M Manual for battery	PE-V0-435-508-E209
10	Fault calculation & Connector sizing calculation	PE-V0-435-508-E210
11	Type test reports for the battery	PE-V0-435-508-E211
12	Cable Termination arrangement for battery terminal	PE-V0-435-508-E212
13	Loose items to be shipped with battery	PE-V0-435-508-E213
14	Battery room layout	PE-V0-435-508-E214
15	Power Circuit Diagram of BHMS	PE-V0-435-508-E215
16	GA of BHMS	PE-V0-435-508-E216
17	QAP of BHMS	PE-V0-435-508-E217

ANNEXURE-VII





**TECHNICAL SPECIFICATION FOR
220V DC BATTERY**

SPECIFICATION NO. PE-TS-435-508-E001

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SECTION-II

STANDARD TECHNICAL REQUIREMENTS



TECHNICAL SPECIFICATION FOR 220V DC BATTERY

SPECIFICATION NO. PE-TS-435-508-E001

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1.0 INTENT OF SPECIFICATION

The intent of specification is not to specify all details of design & construction of material. The material shall, however, conform in all aspects to high standard of design, engineering and workmanship and be capable of performing in continuous operation up to & after bidder's guarantee period in manner acceptable to purchaser who will interpret the drawings & specification and shall have power to reject any work or material which in his judgement is not in full accordance with this specification.

2.0 CODES & STANDARDS

- 2.1 The material shall comply with all currently applicable safety codes and statutory regulations of India as well as of the locality where the material is to be installed.
- 2.2 The design, material, construction, manufacture, inspection, testing and performance of 220V DC Battery shall conform to the latest revision of relevant standards and codes of practices as per Annexure-I.
- 2.3 In case of conflict between the applicable reference standard and this specification, this specification shall govern.

3.0 SERVICES AND EQUIPMENT TO BE EXCLUDED

- A) Civil works like foundation and cable cellar, flooring of the battery room etc.
- B) Ventilation of battery and charger room.
- C) DCDB
- D) Power and control cables
- E) Erection of the equipment
- F) Battery charger, battery fuse box and discharge resistor panel

4.0 SYSTEM CONCEPT

- 4.01 **Main Plant:** 220V DC system shall be an ungrounded system comprising of two sets of batteries (2X100%) with 1x100% float cum-boost charger for each set of battery and one sectionalised 1X100% DCDB & 1 no. common standby float cum boost charger for each unit. The 220V DC system is designed to cater the control, protection, interlocking, emergency lighting and emergency dc drives for main plant and associated station (excluding CHP & Switchyard). The load duty cycle and typical single line diagram for 220V battery and charger connections for Main Plant is enclosed as Annexure-II & Annexure-III respectively.



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- 4.02 The battery shall be designed to restrict maximum fault level on DCDB limited to 50kA for 1 Sec.
- 4.03 In case of failure of AC, battery will meet the DC load requirement. After restoration of power, the float/float cum boost charger will continue to supply the loads as well as trickle charge the battery.
- 4.04 The 220V batteries shall be sized considering emergency load cycle requirement of 120 minutes and various factors as per Annexure-II.
- 4.05 The voltage at load terminal will not exceed the limits of +10% and -15% of nominal system voltage for 220V DC system.
- 4.06 Batteries shall be connected to DC distribution board through single cores copper cables. Battery terminals shall be made suitable for cable size to be informed during contract stage. Long barrel heavy duty copper lugs for cable termination at battery terminals shall be in the scope of bidder. Size of the cable shall be informed during detailed engineering.
- 4.07 The equipment will be located indoor but in a hot, humid and tropical atmosphere.
- 4.08 Necessary accessories required for maintenance and testing of batteries shall be supplied with each battery bank as per enclosed Annexure-IV.

5.0 OTHER TECHNICAL REQUIREMENTS

5.1 Lead-Acid Batteries

- a) Batteries shall be stationery storage Lead Acid Plante high discharge type conforming to IS-1652/IEC60896-11/ IEEE 485-1995. The batteries shall meet the 'Load Duty Cycle' requirements under all site-operating conditions as specified.
- b) Each set of battery shall consist of number of cells assembled together on mounting racks.
- c) The battery shall be flooded cell with Plante Lead acid. In the event of failure of any cell, there shall be no interruption in power supply to load.
- d) Containers:
Container shall be made of clear view SAN type, suitable robust, heat resistance, leak proof, non-absorbent, acid resistant, non-bulging type and free from flaws, such as wrinkles, cracks, blisters, pin holes etc. Electrolyte level lines shall be marked on container. The marking for the electrolyte level should be for the upper and lower limits. Container shall be closed / sealed lid type. The pole sealing arrangement should be such that no acid particle gets entrapped due to acid creep



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as a result of capillary action and it should be possible to remove and refix the sealing to carry out the maintenance.

e) Vent Plugs:

Vent plugs shall be provided in each cell. They shall be anti splash type, having more than one exit hole shall allow the gases to escape freely but shall prevent alkali from coming out. The design shall be such that the water loss due to evaporation is kept to minimum. In addition the ventilator shall be easily removed for topping up the cells and of such dimensions that the syringe type hydrometer can be inserted into the vent to take electrolyte samples.

f) Plates:

The plates shall be designed for maximum durability during all service conditions including high rate of discharge and rapid fluctuations of load. The construction of plates shall conform to latest revisions of IS : 1652 as applicable. The separators shall maintain the electrical insulation between the plates and shall allow the electrolyte to flow freely. Separators should be suitable for continuous immersion in the electrolyte without distortion. The positive and negative post shall be clearly marked. The positive plates shall be supported from the ledges of the SAN container. They should not be supported at the bottom of container. Sufficient space shall allowed to allow the creepage of the plates.

g) Sediment Space:

Sufficient sediment space shall be provided so that cells will not have to be cleaned during normal life and prevent shorts within the cells.

h) Electrolyte:

The electrolyte shall be prepared from battery grade Sulphuric Acid conforming to IS-266 and distilled water conforming to IS-1069. The cells shall be shipped in dry uncharged condition and electrolyte shall be supplied separately in non-returnable containers. 10% extra electrolyte shall be furnished as extra fitting to cover spillage in transit or during erection.

i) Connectors and Fasteners:

Lead coated copper connectors/ Rubber moulded and fully insulated copper connectors shall be used for connecting up adjacent cells and rows. Bolts, nuts and washers shall be effectively lead coated to prevent corrosion. The thickness of lead-coating of connectors should not be less than 0.025 mm. The lead coating thickness shall be measured in accordance with APPENDIX F of IS:6848 (latest edition). All the terminals and cells inter-connectors shall be fully insulated or have insulation shrouds. End take off connections from positive and negative poles of batteries shall be made by single core cables having stranded copper conductors and PVC insulation. Necessary supports and lugs for termination of these cables on batteries shall also be supplied by the Bidder. All connectors and lugs shall be capable of continuously carrying the 30 minutes discharge current of the respective Batteries and through fault short circuit current which the battery can produce and withstand for the period declared. Bidder shall furnish necessary sizing calculations to prove compliance to the same.



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j) Battery Racks:

Wooden racks for all the batteries shall be provided. These racks shall be made of good quality first class seasoned teak wood in line with CPWD specification. They shall be free standing type mounted on porcelain/hard rubber/PVC pads insulators/High impact plastic insulators. Batteries having cell weight of 50 Kg or more will be arranged in single tier. The batteries rack and wooden support for cable termination shall be coated with three (3) coats of anti-acid paint of approved shade. Numbering tags, resistant to acid, for each cell shall be attached on to the necessary racks. The bottom tier of the stand shall not be less than 150 mm above the floor. Wherever racks are transported in dismantled condition, suitable match markings shall be provided to facilitate easy assembly.

Following information shall be indelibly marked on outside of each cell:

- Manufacturer's name and trademarks
- Manufacturer type designation
- Country and year of manufacture
- AH capacity at 10 hour discharge rate
- Serial number

k) Positive and negative terminal posts shall be clearly and indelibly marked for easy identification. Numbering tags for each cell shall also be attached on to the racks.

l) Following minimum information shall be given on the instruction cards:

- Manufacturer's instructions for filling and initial charging of the battery together with starting and finishing charging rate
- Maintenance instructions
- Designation of cell in accordance with relevant standard
- Storing conditions of electrolyte

m) **BATTERY HEALTH MONITORING SYSTEM (BHMS)**

- Battery Health Monitoring System shall include microprocessor based hardware and software to monitor the condition of each battery cell of 220V DC system battery banks on-line on 24x7 basis with Battery Health Monitoring System, it shall be possible to measure & analyse the individual cell and battery parameters so that any damage to battery shall be prevented by pro-active maintenance. Each Battery set shall have its own independent Battery Health Monitoring System.
- Battery Health Monitoring System shall measure and store the following parameters.
 - i) Each Cell Voltage
 - ii) Battery DC Current
 - iii) Ambient and Cell temperature



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- Further, Battery Health Monitoring System module shall have additional provision of accepting at least 6 Nos. of Digital inputs. Battery Health Monitoring System shall also be able to store these inputs status for future reference.
- Each battery shall be supplied with micro-processor based battery health monitoring system (BHMS) for individual cell healthiness monitoring which shall be located in 220V DC charger/ DCDB room. The voltage of each cell shall be monitored to ascertain any probable failure in the cell. In case of any failure, particular cell number will be indicated locally and alarm will be generated. Provision shall be kept to transmit the group alarm signal in remote also.
- Battery Health Monitoring System shall communicate with the DDCMIS & provide alarms for abnormal condition of Cell/ Battery as finalized by owner during detailed engineering. Battery Health Monitoring System modules shall have one port suitable for connecting laptop locally & one port suitable for TCP/ IP protocol for communication to DDCMIS system. DC FAIL alarm shall be generated and given in Central Control Room buzzer (Audio Visual Fascia). The cable required for connecting the cells to Battery Health Monitoring System & Battery Health Monitoring System to DDCMIS shall also be in bidder's scope.
- Technical Parameters:
 - a) Input Power Supply 230V AC (UPS) / 220V DC
 - b) Voltage Measurement Accuracy 0.5% or better
 - c) Current Measurement Accuracy 0.5% or better
 - d) Operating Temperature Range 0-50 deg C
 - e) Mounting Panel Mounting
 - f) IP Protection IP-42
- Necessary software for communication between Battery Health Monitoring System & DDCMIS as well as for analysis of stored data shall be provided by the bidder. The software for analysis shall be capable of showing graphical representation of various stored parameters & shall give some corrective suggestion based on the abnormal parameters. The software shall calculate & show battery Ah during charge/discharge cycles. Logging of cell/ battery parameters (voltage, current & temperature) & alarm conditions as well as event log of all activities affecting the battery bank shall be possible with date/ time stamp. Logged data can be exported in MS Excel format.
- Cable Requirement for BHMS:

In addition to all the accessories required for meeting the above requirement of BHMS system, Suitable length & type of Cables required to establish connection between the cells and BHMS should be considered by bidder in their scope of supply. Distance of 100 m is to be considered between Battery Health monitoring system and DDCMIS for cables and these cables should also be considered by bidder in their scope of supply.



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- 6.1 Bidders shall guarantee that battery offered shall meet the 'Load Duty Cycle' and information given in Annexure –II as stipulated in this specification and as confirmed by them in technical data sheets. In case the performance of battery at site is not as per the performance guarantee, the bidder will have to replace the battery at site free of cost.

7.0 INSPECTIONS & TESTING

- 7.1 Offered equipment shall be of type test design. Type test certificates offered shall be within 5 years from date on contract (i.e. 15.12.2015). The bidder shall confirm compliance to quality plan enclosed with the specification, which is subject to BHEL & End customer approval and the inspection shall be carried out based on this approved Quality Plan (QP No. PE-QP-999-508-E002, Rev. 00).

- 7.2 All acceptance and routine tests as per relevant standards and as per QP (attached) shall be carried out by the manufacturer. Charges for all these routine and acceptance tests for all the materials shall be deemed to be included in the bid price.

- 7.3 The type, routine and acceptance test on battery will be conducted on two cells of battery as per relevant standard.

(A) Following type tests shall be conducted for the battery.

- Capacity test for voltage on battery during discharge at 27°C.
- Ampere hour & watt hour efficiency test
- Verification of constructional requirement
- Verification of marking
- Verification of dimension

(B) For following tests only type test reports will be submitted.

- Endurance test.
- Test for retention of charge

(C) Commissioning Checks:

All tests as listed below shall be carried out on sample cell selected at random by the owner at site after completion of installation.

- Verification of markings.
- Verification of dimensions.
- Test for capacities for 10 hrs discharge rate along with the test for voltage during discharge.
- The Bidder shall arrange for all necessary equipment, including the variable resistor, tools, tackles and instruments.

- 7.4 For all components / materials, for which type test reports have been asked as per relevant standard, such Type tests should have been carried out on identical components / materials. In absence of such type tests reports or in



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case such reports are not found to be meeting the specification/standards requirements, vendor shall conduct all such type tests without any commercial/delivery implication to BHEL according to the relevant standards and reports shall be submitted to the owner for approval. (Type test charges as per clause 7.5 shall not be applicable in such cases).

7.5 The bidder shall indicate cost of carrying out all the Type tests as specified in clause 7.3 of the specification. The charges for each of the Type tests shall be given separately in price schedule as indicated in BOQ cum Price schedule at Sr. No. 6.0.

7.6 All material used for the construction of the equipment / items shall be new and shall be in accordance with the requirements of this specification. Materials utilised shall be those, which have established themselves for use in such applications.

8.0 Instruction Manuals

Instruction manuals for the installation, operation and maintenance of battery to be supplied shall be furnished at least two months before the date of despatch of equipment.

The installation and maintenance manual of battery shall contain the following:

- A) General description giving type and rating of various batteries.
- B) Technical data.
- C) Salient constructional details.
- D) Instruction to be followed on receipt at site.
- E) Instructions for foundations, if any.
- F) Erection procedures and checks (handling at site, erection, pre-commissioning).
- G) Procedure for filling of electrolyte.
- H) Commissioning procedures and site tests.
- I) Routine, periodic and preventive inspection and maintenance procedures.
- J) Safety rules.
- K) Possible faults, their causes and remedies.
- L) Copies of the type, acceptance and routine test certificates in bound volume.
- M) Catalogues, literature and drawings.
- N) Outline dimension drawings showing constructional features, relevant cross sectional views and earthing details, operator oriented description of equipment and accessories.
- O) Operating procedures, maintenance procedures & precautions to be taken during operation and maintenance work.

8.1 Bidder shall furnish field quality plan detailing out the specific quality control procedure covering receipt of material/equipment and handling at site, storage, erection, commissioning, post commissioning etc.



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9.0 TOOLS AND TACKLE

Tools & tackle which are essential to facilitate assembly, adjustments, maintenance & dismantling of equipment shall be provided as part of equipment supplied. The above tools shall be supplied along with the initial consignment of equipment so as to be available prior to erection.

10.0 BASIC DESIGN DOCUMENTS

'Basic Design Documents' cover: Battery sizing calculations, battery data sheet, connector sizing calculation, Quality Plan, OGA for 220V battery, BOM, List of approved makes, type test reports & type test procedure (if applicable) for battery.

Successful bidder shall also prepare battery room lay out during detailed engineering based on BHEL input drawing. Same shall be subject to BHEL/end customer review and approval. There shall be no commercial implication towards the same.

11.0 AS-BUILT DRAWINGS

Though only supply of equipment is under bidder's scope, bidder may note that all as-built correction (as given by purchaser to vendor) shall have to be incorporated in the originals by the vendor and copies of the as-built corrected drawings / documents as per requirement shall be submitted by the vendor.

12.0 Statutory and regulatory requirements as per IE rule 1956 with amendment - 3 rule 1986, rules Nos. 35, 42, 50 & 51 shall be adhered to.

		QUALITY PLAN		CUSTOMER :			PROJECT: 2 X 660MW UDANGUDI STPP		SPECIFICATION NO. PE-TS-435-508-E001			
				BIDDER/ :			STANDARD QUALITY PLAN NO.- PE-QP-999-508-E002, REV.0		SPECIFICATION : TECHNICAL SPECIFICATION FOR 220V LEAD ACID BATTERY			
		SHEET 1 OF 4		SYSTEM			ITEM : LEAD ACID BATTERY		DOC. NO.			
SL. NO.	COMPONENT/ OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
1	2	3	4	5	6	7	8	9	P	W	V	11
1.0	RAW MATERIALS & BOUGHT OUT ITEMS											
1.1	(Pure Lead for Pos. plate, Lead Alloy for Neg. plate & Sulphuric acid)	Chemical	MA	Chemical Analysis	Random Sample	IS:1652, IS:266, IS:1069 & MFR's Std.	IS:1652, IS:266, IS:1069 & MFR's Std.	Test Cert.	3/2	-	1	
1.2	SEPARATOR											
a)	Visual	Visual	MA	Visual	Random Sample	IS:1652 & MFR's Std.	IS:1652 & MFR's Std.	Test Cert.	3/2	-	1	
b)	Physical	Physical		Physical	-do-	-do-	-do-	-do-	3/2	-	1	
c)	Chemical	Chemical		Chemical	-do-	(For Synthetic IS : 6071)	(For Synthetic IS : 6071)	-do-	3/2	-	1	
d)	Electrical Resistance Test	Electrical		Electrical	-do-	-do-	-do-	-do-	3/2	-	1	
e)	Acceptance test Dimension, Volume Porosity, Wettability of separator	Test		As per Standard	-do-	-do-	-do-	-do-	3/2	-	1	
1.3	TERMINAL POST											
a)	Dimensional Conformance	Visual	MA	Visual	Random Sample	IS:1652, IS:8320 & MFR's Std.	IS:1652, IS:8320 & MFR's Std.	Test Cert.	3/2	-	1	
b)	Material Conformance	Chemical	CR	Chemical	-do-	-do-	-do-	-do-	3/2	-	1	
c)	Thread size depth & chamfer	Physical	MA	Measurement	-do-	-do-	-do-	-do-	3/2	-	1	
d)	Surface finish & defects	Visual	MA	-do-	100%	-do-	-do-	-do-	3/2	-	1	
e)	Plating Quality	Thickness	CR	-do-	Random Sample	-do-	-do-	-do-	3/2	-	1	
BHEL			PARTICULARS			BIDDER/ VENDOR						
			NAME									
			SIGNATURE									
			DATE						BIDDER'S/ VENDORS COMPANY SEAL			

LEGEND : 1 - BHEL/ CUSTOMER 2 - VENDOR 3 - SUB- VENDOR P - PERFORM W - WITNESS V - VERIFICATION

		QUALITY PLAN		CUSTOMER :		PROJECT: 2 X 660MW UDANGUDI STPP TITLE		SPECIFICATION NO. PE-TS-435-508-E001				
				BIDDER/ : VENDOR		STANDARD QUALITY PLAN NO.- PE-QP-999-508-E002, REV.0		SPECIFICATION : TECHNICAL SPECIFICATION FOR 220V LEAD ACID BATTERY				
		SHEET 2 OF 4		SYSTEM		ITEM : LEAD ACID BATTERY		DOC. NO.				
SL. NO.	COMPONENT/ OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
1	2	3	4	5	6	7	8	9	P	W	V	11
1.4	CONNECTOR											
a)	Dimension	Dimension	MA	Measurement	Random Sample	IS:1652, IS:6848 & Appd. Drg./Doc.	IS:1652, IS:6848 & Appd. Drg./Doc.	Test Cert.	3/2	-	1	
b)	Thickness of lead coating	Visual		Visual	-do-	-do-	-do-	-do-	3/2	-	1	
1.5	VENT CAP											
a)	Dimensional Conformance	Dimension	MA	Measurement	-do-	Refer Remarks#	Refer Remarks#	-do-	3/2	-	1	<i># Vent cap shall be easily removed from topping up the cells and of such dimensions that the syringe type hydrometer can be inserted into vent to take electrolyte sample.</i>
1.6	CONTAINER											
a)	Verification Constructional requirement	Visual	MA	Visual	Sample Plan as per IS:1146	IS:1652, IS:1146, IS:8320	IS:1652, IS:1146, IS:8320	Test Cert.	3/2	-	1	
b)	Verification of Markings	Visual	MA	-do-	-do-	-do-	-do-	-do-	3/2	-	1	
c)	High Voltage Test	Electrical	MA	-do-	-do-	-do-	-do-	-do-	3/2	-	1	
d)	Drops Ball Test	Mechanical	MA	-do-	-do-	-do-	-do-	-do-	3/2	-	1	
e)	Plastic Yield Test	-do-	MA	-do-	-do-	-do-	-do-	-do-	3/2	-	1	
f)	Acid Resistance Test	Chemical	MA	-do-	-do-	-do-	-do-	-do-	3/2	-	1	
g)	Hydraulic thrust enduarnc test	Physical	MA	-do-	-do-	-do-	-do-	-do-	3/2	-	1	
2.0	FINISHED BATTERY	Routine Test	CR	Elec. & Meas.	100%	IS:1652 & IS:8320	IS:1652 & IS:8320	Test Cert.	3/2	-	1	
3.0	FINAL INSPECTION											
3.1	Type Test #											
a)	Verification Constructional requirement	Visual	MA	Visual	Sample Plan as per IS: 8320	IS:1652	IS:1652	Inspection Report	3/2	1	-	<i># Type Tests freports/ certificates within last 5 years from date of contract (i.e. 15.12.2015), shall be reviewed by BHEL/ Customer.</i>
b)	Verification of Markings	Dimension	MA	Measurement	-do-	-do-	-do-	-do-	3/2	1	-	
c)	Verification of Dimensions	-do-	MA	-do-	-do-	-do-	-do-	-do-	3/2	1	-	
d)	Test for Capacity & Voltage during discharge	Test	CR	As per IS: 1652	-do-	-do-	-do-	-do-	3/2	1	-	
BHEL			PARTICULARS			BIDDER/ VENDOR						
			NAME									
			SIGNATURE									
			DATE						BIDDER'S/ VENDORS COMPANY SEAL			

LEGEND : 1 - BHEL/ CUSTOMER 2 - VENDOR 3 - SUB- VENDOR P - PERFORM W - WITNESS V - VERIFICATION

		QUALITY PLAN	CUSTOMER :			PROJECT: 2 X 660MW UDANGUDI STPP			SPECIFICATION NO. PE-TS-435-508-E001			
			BIDDER/ :			TITLE			SPECIFICATION : TECHNICAL SPECIFICATION			
			VENDOR			STANDARD QUALITY PLAN NO.- PE-QP-999-508-E002, REV.0			TITLE FOR 220V LEAD ACID BATTERY			
SHEET 3 OF 4		SYSTEM			ITEM : LEAD ACID BATTERY			DOC. NO.				
SL. NO.	COMPONENT/ OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
e)	AH & WH efficiency Test	-do-	CR	As per IS:1652	Sample Plan as per IS:8320	IS:1652	IS:1652	Inspection Report	3/2	1	-	
f)	Retension of Charge	-do-	CR	-do-	-do-	-do-	-do-	-do-	3/2	1	-	
g)	Life & Endurance Test	-do-	CR	-do-	-do-	-do-	-do-	-do-	3/2	1	-	
h)	Short circuit current and internal resistance measurement test.	-do-	CR	IS:1652/ IEC: 60896-11	-do-	IS:1652/ IEC: 60896-11	IS:1652/ IEC: 60896-11	-do-	3/2	1	-	
i)	Test for loss of capacity on storage	-do-	CR	-do-	-do-	-do-	-do-	-do-	3/2	1	-	
j)	Test for resistance to overcharge	-do-	CR	-do-	-do-	-do-	-do-	-do-	3/2	1		
k)	Test for voltages & specific gravity during discharge	-do-	CR	-do-	-do-	-do-	-do-	-do-	3/2	1	-	
l)	Internal resistance measurement test.	-do-	CR	-do-	-do-	-do-	-do-	-do-	3/2	1	-	

		QUALITY PLAN		CUSTOMER :			PROJECT: 2 X 660MW UDANGUDI STPP		SPECIFICATION NO. PE-TS-435-508-E001			
				BIDDER/ :			TITLE		SPECIFICATION : TECHNICAL SPECIFICATION FOR 220V LEAD ACID BATTERY			
		SHEET 4 OF 4		VENDOR			STANDARD QUALITY PLAN NO.- PE-QP-999-508-E002, REV.0		TITLE		DOC. NO.	
SYSTEM		ITEM : LEAD ACID BATTERY										
SL. NO.	COMPONENT/ OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
3.2	Acceptance Test \$											
a)	Verification of Markings	Visual	MA	Visual	Sample Plan as per IS: 8320	IS:1652	IS:1652	Inspection Report	3/2	1	-	\$ Acceptance test shall be conducted at Site on completion of installation and commissioning and immediately prior to putting the battery in service.
b)	Verification of Dimensions	Dimension	MA	Measurement	-do-	-do-	-do-	-do-	3/2	1	-	
c)	Test for Capacity	Capacity	CR	As per IS: 1652	-do-	-do-	-do-	-do-	3/2	1	-	
d)	Test for Voltage during discharge	Voltage during discharge	CR	-do-	-do-	-do-	-do-	-do-	3/2	1	-	
e)	Internal resistance of cells.		CR	IS:1652/ IEC: 60896-11	-do-	IS:1652/ IEC: 60896-11	IS:1652/ IEC: 60896-11	-do-	3/2	1	-	
4.0	ACCESSORIES	Visual & Dimension	MA	Visual	100%	Appd. Drg./Doc.	Appd. Drg./Doc.	-do-	2	1	-	
5.0	CABLE LUGS	Visual	MA	Visual	100%	Appd. DataSheet	Appd. DataSheet	-do-	2	1	-	
NOTE:- Wherever IS is mentioned equivalent IEC is also acceptable. In case of any technical requirement not covered by IEC, technical requirement as per IS shall prevail.												
BHEL			PARTICULARS			BIDDER/ VENDOR			BIDDER'S/ VENDORS COMPANY SEAL			
			NAME									
			SIGNATURE									
			DATE									

LEGEND : 1 - BHEL/ CUSTOMER 2 - VENDOR 3 - SUB- VENDOR P - PERFORM W - WITNESS V - VERIFICATION