# SUPPLY CHAIN MANAGEMENT
## THIRUVANANTHAPURAM

## SPECIFICATION

**110V, 100AH TUBULAR TYPE LEAD-ACID STATIONARY BATTERIES**

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| **APPLICABLE TO KSEBL** | **Rev#0** | DOC. NO.: **SCM-SPEC/XT/110V,100AH Tubular Batteries** |
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**Technical Specification and Evaluation Committee for Transmission Material**

**(i) Document Approval & Control Status**

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**(ii) Amendments and History**

| *Sec. #* | *Rev. #* | *Date* | *History of Change* |
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1. **PURPOSE:**

Purpose of this document is to document updates & history, upkeep and publish the specifications related to **110V, 110AH Tubular Type Lead-Acid Stationary Batteries** in a professional manner

2. **SCOPE:**

The Scope of this document is to inform and alert all relevant stakeholders including KSEBL. Public, KSERC etc regarding the current specifications and historical changes adopted in specifications of **110V, 110AH Tubular Type Lead-Acid Stationary Batteries** used in field by KSEBL

3. **RESPONSIBILITY:**

**The Executive Engineer (T), Office of Chief Engineer, Supply Chain Management** shall compile and take necessary steps to publish the specification in KSEBL website and shall inform relevant stakeholders regarding updates and revisions

4. **PROCEDURE FOR REVISION:**

Modifications if any, in the technical specification will be incorporated as **Revisions.** Any changes in values, minor corrections in pages, incorporation of small details etc. will be considered as Minor Modification. **The Revisions due to minor modifications will be assigned as Rev. No.0.1, 0.2 etc.**

A complete updation of the technical specification will be considered as Major modification. **The Revisions due to major modifications will be assigned as Rev. No.1.0, 2.0 etc.**

All the details of regarding the revisions (both minor and major) will be incorporated in **"(ii)-Amendments and history"** above.

The concerned officers, in consultation with the Technical Committee will review and suggest changes required and the revision suggestion will be approved by **Chief Engineer (SCM).** Those who notice any discrepancy or have any suggestion regarding revision, may bring the matter to the attention of Chief Engineer (SCM) in writing or through e-mail id:**cescm@kseb.in**

**CONTENTS**

**SPECIFICATION FOR 110V, 100AH TUBULAR TYPE LEAD-ACID STATIONARY BATTERIES IN TRANSPARENT CONTAINER**

**1.0) SCOPE:-**

1.1. This specification covers design, manufacture, assembly of components, testing at manufacturer's works, packing, supply and delivery to site, TUBULAR TYPE LEAD-ACID BATTERIES in transparent container and associated accessories for indoor installation at power plants/substations.

1.2. Supervision of erection and commissioning of the battery bank shall have to be undertaken on mutual acceptance of the terms and conditions for the same, if required.

**2.0) QUALIFYING REQUIREMENTS FOR BIDDERS:-**

2.1. The bidders who have 3 years experience in design, manufacture, supply, erection of Tubular Batteries in Transparent container and whose equipment is in successful operation in at least two similar kinds of projects as on the date of bid opening are eligible to submit the bids. The bidders shall have offices located in various regions equipped with the required instruments and properly trained personnel for taking care of after sales service throughout the expected life of the equipment.

2.2. The equipment covered by this specification is a very important source of power supply for a power plant / substation and hence should be of high quality and reliability. The bidder's factory shall be preferably ISO 9001 and ISO 14001 approved and TPM certified.

2.3. The bidder shall be financially stable and the following documents shall be submitted by the bidder with the bid.

a) List and Quantity of machineries installed in the works of bidder relevant to the equipment in the bid. The plates should be manufactured using high pressure die-casting machine for particular type of product.

b) The bidder must have their own DM water & automatic Acid dilution plant in their works.

c) Details and range of products manufactured.

d) Bidder must have minimum of 3000A automatic discharge capability of testing in their works as well as in their NABL accredited R&D.

e) List of past supplies of similar type of products from their works (minimum 3 years).

**3.0) APPLICABLE STANDARDS:-**

3.1) IS-1651 : Lead acid batteries with tubular positive plates.

IS-8320 : General requirements for methods of tests for lead acid storage batteries.

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| IS-1885 | : | Electrical vocabulary, secondary cells and batteries. |
| IS-1069 | : | Water for storage batteries. |
| IS-266 | : | Sulphuric acid for storage batteries. |
| IS-1146 | : | Specification for rubber and plastic container for Lead acid storage batteries. |
| IS-6071 | : | Synthetic separator for lead acid batteries. |
| IEEE-485 | : | IEEE Recommended practice for sizing of large lead acid Storage batteries for generating stations and substations. |
| IEEE-484 | : | Recommended practice for design and installation of Storage Batteries. |
| IEC-896-1 | : | Stationary Lead – acid Batteries. |

**4.0) DESIGN AND CONSTRUCTIONAL FEATURES OF BATTERIES:-**

4.1) **Type:-** The battery shall be lead acid tubular type in transparent container made of SAN (Styrene Acrylo Nitrile) polymer. During the design stage the factors such as Temperature correction factor, Ageing factor etc as per IEEE-485 are to be considered.

4.2) **Positive Plates:-** The plates shall be of first class material and workmanship and shall be free from blow-holes, cracks and other imperfections. The tubular positive plates shall consist of a suitable bar with spines cast of suitably alloyed Lead to give adequate mechanical strength and minimum electrical resistance.

The tubular spines shall be cast of an alloy of lead and antimony with antimony content not greater than 3 % by weight. The casting shall be done using proper controlled procedure preferably using high pressure casting machine at 100 bar. Low antimony alloy will ensure low water loss and a guaranteed topping up frequency of not more than once in 6 months. High pressure cast spines will ensure long life and trouble free operation.

Porous, acid resistant and oxidation resistant tubes shall be inserted one over each spine. After insertion, the tube shall be adequately filled and packed with active material (preferably through a rotary shaking machine) before their lower ends are closed by common plastic bar. The construction and material of tube shall be such as to reduce the loss of active material and shall be able to withstand normal internal stresses developed during service.

4.3) **Negative Plates:-** The negative plates shall be of flat pasted type. The pasting shall be done on an automated machine for better control of process parameters. It should have adequate mechanical strength and would be so designed that active material is maintained in intimate contact with the grid under normal working conditions throughout the life of the battery. Lead antimony alloy grid with maximum 3% antimony content or lead calcium alloy grid shall be used.

4.4) **Separators:-** The separators shall be microporous polyethylene envelope type to avoid direct as well as side shorts. It should be acid resistant, chemically inert and should have excellent oxidation resistance and high degree of porosity to ensure minimum internal resistance. The average pore size shall be less than I micron. It should not exhibit any tendency to swell or shrink at temperature encountered during operation. Microporous synthetic separators shall conform to latest IS 6071.

4.5) **Containers:-** Containers shall preferably be made of transparent SAN copolymer giving excellent clarity, outstanding chemical resistance, rigidity and toughness with very high insulating qualities which eliminate the need for separate cell insulators. It shall have adequate mechanical strength to prevent bulging, cracking etc. during the life span of battery when operating under expected temperature range and due to action of static and dynamic loads and the action of electrolyte. These containers should enable the electrolyte level and the cell condition to be monitored at a glance. The containers shall conform to latest edition of IS-1146.

4.6) **Cell Lids:-** It should be moulded from opaque SAN or ABS (Acrylonitrile butadiene styrene) and sealed to the container. It should be easily removable if the need arises.

4.7) **Microporous Ceramic Vent Plugs:-** The vent plugs should be specially designed incorporating a microporous ceramic filter which effectively returns all acid spray to the cell without spilling out. It shall also allow free exit of oxygen and hydrogen which is generated at the end of boost charging. On removal, the plugs shall permit drawing of the electrolyte sample for servicing and of checking of the electrolyte level. The vent plug should preferably be flame retardant type to prevent any fire hazard in the battery room. The number of vent plugs are to be decided as per IS 1651.

4.8) **Connectors:-** Connectors shall be of lead plated copper. The lead coating shall be adequate and tenacious. Minimum thickness of lead coating shall be 25 microns. Connectors should be adequately designed to carry maximum duty cycle as specified and shall offer minimum resistance. The current density for Copper connectors shall not be more than 15 Amps/sq.mm. While considering the terminal voltage of the cell at the time of testing for discharge, the voltage drop due to inter-row and inter-cell connectors shall be considered. Connectors shall be adequately designed to withstand various stresses due to temperature changes, attack of acid and dynamic forces that could occur during the operation of the battery. Bolt head & connectors shall be permanently insulated to avoid any accident.

4.9) **Electrolyte:-** The Electrolyte shall be battery grade Sulphuric acid conforming to latest edition of relevant IS-266. The strength of the electrolyte in the cell during operation shall conform to the governing IS specification for the cell. Required quantity of electrolyte for the initial filling with 10% extra quantity shall be supplied in no-returnable non-degradable acid resistant strong plastic containers.

4.10) **Water:-** Water used in preparation of electrolyte and also to bring the level of electrolyte to the correct position during the course of operation or testing shall conform to the latest IS-1069.

4.11) **Terminal Post:-** Positive and negative terminal posts of the cells shall be clearly and unmistakably identifiable. Terminal post shall be designed to accommodate external bolted connections conveniently and positively. All metal parts of the terminals shall be of lead coated type. Bolts, heads and nuts, except seal nuts shall be hexagonal and shall be lead coated type. Terminal posts shall be adequately fixed to prevent its turning or twisting when the connectors are being fixed or removed. The junction between terminal posts and cover and between the cover and container shall be adequately sealed to prevent any seepage of the electrolyte. All terminals shall be provided with insulated covers.

The pole terminal should be of lead with a brass core insert, which shall increase the conductivity. The pole should have a double layered protection against crevice corrosion. The lead lining of the terminal should be protected against any contact with the electrolyte at the places where it emerges out of the cell interior through an injection moulded plastic encapsulation.

4.12) **General Requirements for Tests:-**

Specific Gravity of Electrolyte:- The specific gravity of a fully charged cell shall be adjusted to 1.200 +/- 0.005 at 27 deg. C as per the requirement of IS 1651.

**Temperature Correction:-** The capacity of the cell shall be corrected to 27deg.C using the proper temperature correction factor pertaining to the type of the cell and the rate of discharge. The temperature correction should be made using factors supplied by the manufacturer but shall generally conform to some national or international standard for the similar type of cell.

**Observations:-** The observations, during any test shall be performed as specified in IS 1651.

4.13) **Tests:-** All type test as per IS/ IEC & Routine Test.

1) Test for Capacity
2) Test for Voltage during discharged
3) Ampere hour and Watt hour efficiency tests
4) Loss of Capacity on Storage
5) Water Loss Test

4.13.1) **Test for Capacity:-** The cell shall be tested for its rated capacity output. The fundamental requirement shall be a discharge for 10 hours whilst discharge at other rates, as decided mutually between the manufacturer and purchaser, may also be performed.

A fully charged cell shall be stand idle for a period of 12 – 24 hours before performing this test. The cell shall be discharged at a constant current $I_{10}$ = C/10 where C is the rated 10 hour discharge capacity of the subject cell till the voltage of the cell reached 1.85 volts per cell. In case of more than one cell being tested at a time (in most of the cases), the discharge to be continued at a time when the voltage of the group has reached 1.85 x n volts where n is the number of cells in the group.

The capacity of the cell thus established shall have to be corrected for temperature variation during the test if the temperature is different from 27 deg, C. The temperature correction shall be as per the relevant IS for the type of the cell in the question.

The capacity output, at the first discharge, corrected to 27 deg. C shall not be less than 85% of the rated capacity of the cell. The cell shall reach 100 % of its rated capacity within 4 charge-discharge cycles.

4.13.2) **Test for Charging Efficiency:-** Since the cells are expected to operate at various state of charge (SOC), the charging efficiencies at various depth of discharge needs to be measured and standardized for this application. Typically, charge efficiencies at 80%, and 10% SOCs are to be notified.

Charge Efficiency at 80% SOC:

A fully charged cell shall be discharged at a constant current of $I_{10}$ for 2 hours. The voltage at the end of 2 hours ($V_1$) to be very meticulously noted.

The cell, then shall be charged at a constant of $I_{10}$ for 2 hours and after a rest period of 2-4 hours shall again be discharged at a constant current of $I_{10}$. The time taken to reach the voltage $V_1$ is to be noted during this discharge.

The ratio of these two times would be designated as the charge efficiency of the cell.

The time of discharge shall change to 9 hours for 90% SOC. The test procedure being similar to the one explained.

The cell appropriate for this application should have the following charging efficiencies:

At 80% SOC, charge efficiency is 80% and at 10% SOC, the charge efficiency is 90%.

4.13.3) **Retention of Charge:-** The charge retention of a cell is the capability of the cell to retain its capacity during the period of no charge, i.e. when not connected to the system, during transportation or storage. A fully charged cell shall be discharged for capacity appreciation and recharged to full state of charge. The capacity output shall be noted as C1. After recharge the cell shall lie in open circuit condition for a period of 28 days. During this period, the temperature of the cell shall be kept close to 27 deg.C as much as practically possible. After completion of 28 days of idle standing, a second capacity discharge is to be performed. The capacity, corrected to 27 deg.C thus obtained, shall not be lower than 95% of the earlier actual capacity C1.

4.13.4) **Water Loss:-** The cell/battery after being fully charged shall be kept on a float charge of 2.4 volts per cell at a temperature of 40 deg. C for 21 days at a stretch. The loss of water due to evaporation and self discharge shall not be more than 0.65 grams per Ah.

The battery shall reach an equilibrium state of charge within 72 hours of such charging. This shall be indicated by the float current after 72 hours of constant float. The float current shall not be more than 3 mA per Ah.

4.14) **Battery Racks:-** The battery racks shall be constructed from good quality wood or of high strength good quality mild steel sections. These battery racks shall be painted by the bidder with two coats of acid/ alkali resistant paint of approved make in case of wood. When steel stands are used, they should be electrostatic powder coated with acid resistant granules as per approved coating process to provide a non-peelable protective coat. Cells need to be placed on properly insulated structure. The racks shall be of single tier/two tier construction depending upon the final layout based on place availability.

4.15) **Marking:-** Each cell shall be marked to meet the requirements of relevant Indian standards. In addition, each cell shall be legibly numbered serially to identify the cell during manufacture, testing, installation and operation of battery to identify after having assembled into battery bank in battery racks.

Following marking however, shall be provided

a) Manufacturer's type and trade name
b) Year of manufacture
c) Minimum & Maximum level of electrolyte
d) Type of container and standard AH capacity as per IS
e) Polarity marking as per relevant IS

Number plates from 1 to 55 shall be provided to mark the position of the cells in the assembled battery bank.

**SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS FOR 100 AH TUBULAR LEAD ACID BATTERIES**

| Description | Required | 110V, 100AH Tubular Battery |
|---|---|---|
| Capacity in AH | 100 AH | |
| Type of cell | Tubular Lead Acid (Normal Discharge) | |
| Nominal Voltage per cell | 2V | |
| Manufacturers Name | | |
| Standared to which battery is manufactured | | |
| IS nomenclature | | |
| Number of cells in the battery bank | 55 | |
| Nominal Voltage of battery | 110V | |
| **Declared Capacity at 27 degree C up to 1.80 ECV** | | |

| | | |
|---|---|---|
| Initial | 100 AH | |
| Rated | 100 AH | |
| End of Life (considering ageing factor during sizing calculation) | 100 AH | |
| Rated Capacity at minimum ambient temperature (As per formula (t=27{1+0.0043 (t-27)} | (As per formula ($C_t$=$C_{27}${1+0.0043 (t-27)} | |
| Rated Capacity at maximum ambient temperature (As per formula (t=27{1+0.0043 (t-27)} | (As per formula ($C_t$=$C_{27}${1+0.0043 (t-27)} | |
| Capacity in AH at End of Cell Voltage of 1.8V in 10 Hour Discharge | 100 AH | |
| Expected life of battery under normal operation and maintenance condition | 15 Yrs | |
| Internal resistance of cell(IR) | 0.95 milli Ohms | |

| | | |
|---|---|---|
| Total resistance of Battery | | |
| Loss in Capacity in 28 days due to self discharge | <8% | |
| **Recommented charging rate for** | | |
| a) **Float charging** | | |
| a.1)Limit current | 15 A | |
| a.2) Voltage | 2.23 V/Cell | |
| b) **Boost Charging** | | |
| b.1) Starting current | 12 A | |
| b.2) Finishing current | 6 A | |
| b.3) Voltage | 2.75 V | |
| **Trickle charging rate:** | | |

| | | |
|---|---|---|
| 1) Mininmum | 100 mA | |
| 2) Maximum | 400 mA | |
| **Equalising charge** | | |
| a) Voltage | 2.3 V | |
| b) Current | 5A | |
| c) Duration | 6 hrs. | |
| d) Interval between successive equalising charge | 3 Months | |
| **Recommented specific gravity at 27 deg C** | | |
| a) for first filling | 1.220 +/- 0.005 | |
| b) at full charge | 1.240 +/- 0.005 | |

| | | |
|---|---|---|
| c) when battery is discharged at 10 hours rate | 1.160 – 1.130 | |
| **Permissible max. Temperature of Electrolyte** | | |
| 1) during initial charging | 50 deg C | |
| 2)During Normal operation | 45 deg C | |
| **Overall Dimension** | | |
| Each Cell LXWXH | | |
| Complete battery | | |
| Distance between cell centres | | |
| Quantity of electrolyte per cell | | |
| Quantity of electrolyte for battery (including 10% extra) | 55 x electrolyte per cell x 1.1 | |
| **Weight (+/- 5%)** | | |

| | | |
|---|---|---|
| **Each Cell** | | |
| without acid ( approx) | 9 kg. | |
| with acid (approx) | 15.0 kg. | |
| **Material and Type of Plates** | | |
| **1) Positive plate** | | |
| Material | Lead Antimony alloy spine | |
| Height of positive plate | 260 mm | |
| Thickness of positive plate | 9.3 mm | |
| Area of positive plate | | |
| No. Of positive plates per cell | 2 | |
| Wheteher positive plates of individual cells are interchangeable | Not recommended | |
| **2) Negative plates** | | |
| Material | Lead Calcium alloy grid | |

| | | |
|---|---|---|
| Height of negaitive plate | 250 mm | |
| Thickness of negative plate | 4.5 mm | |
| Area of Negative plates | | |
| No. Of negative plates per cell | 2 | |
| Whether negative plates of individual cells are interchangeable | Not recommended | |
| **Material and type of Separators** | | |
| Material | Synthetic fiber based material | |
| Thickness of separator | 1.7 mm | |

| | | |
|---|---|---|
| Clearance between bottom of plate and bottom of container | 23 mm | |
| Clearance between top of plate and top of container | 56 mm | |
| Whether explosion vents are offered | Yes | |
| Type of Vent and Filling Plugs | Explosion proof microporous ceramic made | |
| **Container** | | |
| Thickness of container | 6 mm | |
| Material of container | Transparent SAN | |
| **Cover** | | |
| Type of cover | Adhesive sealed | |

| | | |
|---|---|---|
| Material of cover | Opaque SAN | |
| **Connections** | | |
| Material of inter cell connectors | Insulated lead plated copper | |
| Thickness of inter cell connectors | 3 mm | |
| Method of connection | bolted | |
| Inter-row Inter-tier connectors and take-offs furnished? | Yes | |
| connection hardware with 5 % extra furnished? | | |
| Material of bolt, nut and washer for inter-cell and cable connections | Lead plated MS | |

| | | |
|---|---|---|
| cell insulators provided if yes, material of insulator | | |
| **Racks** | | |
| a)No of racks per battery | | |
| b)Number of cells per rack | | |
| c)Type of rack | | |
| d) Material of rack | | |
| e)Dimensions of the racks | | |
| Racks provided with | | |
| a) Numbering tags for cells | | |

| | | |
|---|---|---|
| b) Insulators | | |
| Insulator with 5% extra furnished for | | |
| a) Cell | | |
| b) Stand | | |
| **Ventilation requirements** | | |
| Cubic content of battery rooms | | |
| Gas generation per single cell per hour | 3.2 Litre | |
| No of air exchanges required per hour | | |
| Standared maintenance accessories provided | | |

| | | |
|---|---|---|
| Gasification voltage per cell | 2.36 V | |
| **Characteristic curve (Furnish curve numbers and attach separate sheet)** | | |
| 1) Charge hours Vs Volts during boost mode. | | |
| 2)Discharge hours Vs AH in percent of 10 Hrs | | |
| 3) Capacity Vs Ambient temperature | | |
| 4) Discharge rate Vs minimum discharge voltage | | |
| Recommented Max . Period of cell storage before the first charge( After instatllation and filling the electrolyte) | 12-18 Hrs. | |

| | | |
|---|---|---|
| Recommented Storage life of Battery( Dry Shelf life) | 12 months | |
| Does the battery meet required duty cycle curve. | | |