1. **Batteries and Charger**

Lead Acid or Ni-Cd, any one of these two can be used by contractor. Both the specification along with specification for their charger are given below:

1. **Ni-Cd ALKALINE BATTERIES (PARTIAL RECOMBINATION TYPE) WITH CHARGERS FOR 33/11 kV AND 66/11 kV SUB-STATIONS**

**Part-A :Ni-Cd ALKALINE BATTERIES (PARTIAL RECOMBINATION TYPE) FOR 33/11 kV AND 66/11 kV SUB-STATIONS**

1. **SCOPE**

        This specification covers the requirements and tests for 24 V, 30 V 110 V, 220V partial recombination type Nickel-Cadmium alkaline batteries with chargers, for use in 33/11 kV and 66/11 kV sub-stations.

The batteries covered in this specification are for indoor use. For out-door application a suitable enclosure shall be provided, preferably made of an insulating material like FRP/SMC/DMC/Poly carbonate plastic material, heat/alkali/humidity/UV resistant, confirming to S1 or D1 grade of IS: 13410/IS: 13411 or other relevant international standard, in order to have rust free enclosure. The enclosure shall have rainproof ventilating louvers backed with fine brass wire mesh & suitable canopy. The enclosures shall confirm to IP: 52 degree of protection.

**2.** **APPLICABLE STANDARDS**

All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS codes, standards etc.) referred to herein, the former shall prevail. Unless otherwise modified in this specification, the Ni-Cd batteries shall comply with latest version of IEC 62259.

All work shall be carried out as per the following standards and codes.

| **Sl.No.** | **International Standards** | **Indian Standards** | **Description** |
| --- | --- | --- | --- |
| 1 | IEC: 62259 | - | Secondary cells and batteries containing alkaline or other non-acid electrolytes-Nickel-cadmium prismatic secondary single cells with partial gas recombination |
| 2 | IEC: 60623 | IS: 10918 | Secondary cells and batteries containing alkaline or other non-acid electrolytes-vented Nickel\_Cadmium prismatic rechargeable single cells |
| 3 |  | IS: 1146 | Rubber & Plastic container for lead acid storage batteries |
| 4 | IEEE: 1106 |  | Recommended practice for maintenance, testing & replacement of Ni-Cd storage batteries for generating stations & substations |
| 5 | IEEE: 1115 |  | Recommended practice for sizing of Ni-Cd batteries for stationary applications |
| 6 |  | IS 13410 | Glass reinforced Polyester sheet moulding compounds. |
| 7 |  | IS: 1248 | Voltmeter |

**3. STANDARD RATING**

The recommended voltage ratings of batteries, for use at 33/11 KV and 66/11 KV sub-stations, shall be 24 volts or 30 volts. The batteries for the above application shall have a rating of 45 Ah (Minimum) in case of 24 V battery system or as per the load requirement of the substation.

**Note:** Utilities may specify 110 or 220 V DC system if so required. For batteries intended for use with individual or groups of breakers or with higher DC System voltage, lower Ah ratings can be used depending upon the requirements.

1. **CELL VOLTAGE**

The nominal voltage of a single cell shall be 1.2 V

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Nominal Voltage Rating of battery** | **Nominal single cell voltage** | **Float cell voltage** | **Number of cells (to be finalized)** | **Permissibe**  **D.C. System voltage variation** | **End of discharge cell voltage (Min.)** |
| (V) | (V) | (V) | (V) | (V) | (V) |
| 24 | 1.2 | 1.4 to1.42 | 19 | 21.7 to 27 | 1.14 |
| 30 | 1.2 | 1.4 to1.42 | 23 | 26.2 to 32.7 | 1.14 |
| 110 | 1.2 | 1.4 to 1.42 | 87 | 99.2 to 123.5 | 1.14 |
| 220 | 1.2 | 1.4 to1.42 | 170 | 193.8 to 241.4 | 1.14 |

Note: As the nominal cell voltage is 1.2 V, nominal battery bank voltage may not exactly match nominal DC system voltage.

1. **CAPACITY AT 200C TEMPERATURE**

Battery capacity shall be decided based on the following load cycle:-

(a) 800W for 1/2 minute to end cell voltage of not less than 1.14 V per cell considering loads (i) to (iv) below.

(b) 300 W for 1 hour to end cell voltage of not less than 1.14 V per cell considering loads (iii) & (iv) below.

(c ) 100W for 05 hrs to end cell voltage of not less than 1.14 V per cell considering loads (iv) below.

The load cycle has been decided based on the following considerations:-

* 1. Tripping of 03 Nos. circuit breakers simultaneously with battery for which a total load of 500 W has been considered.
  2. Closing of 3 circuit breakers one after the other for which a load of 500 W per circuit breaker has been considered.
  3. Emergency lighting load of 200 W for 01 hour.
  4. 100 W load for panel indication lamps, relays, PLCC/ VHF communication systems, computer etc. for a period of 06 hours.

1. **BATTERY SIZING**

The supplier shall carry out battery sizing calculations based on the load cycle specified in line with IEEE 1115 and submit the same to the owner justifying the type/number of cells considered against the requirement.

Following factors shall be considered while carrying-out battery sizing calculations:-

* + 1. Ageing factor – 1.25
    2. Design margin –1.0
    3. State of charge –0.9

The number of cells shall be determined as per load cycle and the battery system voltage level. The owner, if required for the battery system, may specify provision for the number of spare cells.

1. **CONSTRUCTION**

The cells shall have prismatic, spill-proof type of construction with partial recombination feature. The cells shall be flooded type containing sufficient reserve electrolyte. Battery shall be equipped with nickel-plated inter-cell connectors and terminals. The cells shall be housed in high-strength impact resistant & alkali-resistant containers and should be transparent / translucent to facilitate checking of electrolyte level. Container and Lid should bewelded and should not cause leakage of electrolyte/gases during operation even in case of normal mechanical/electrical abuses. O-rings of nitrile rubber with Epoxy sealing shall be used to ensure proper sealing of bushings etc. Flip-top vent plugs/ valves with flame arrester feature shall be provided. The regulating valve type design shall be of self-resealing type. Construction of cells shall be so as to ensure proper air circulation between the cells for heat dissipation/ ventilation (by providing either insulated button separators integral with the outer surface of the cell container or by suitably designing the inter cell connectors). The containers shall be strong enough, so that excessive bulging of container does not occur during service. Cells shall be supplied in filled & charged state or otherwise electrolyte in dry form & battery water separately or electrolyte in liquid form shall be shipped as desired by the owner.

Battery shall have provision for water top up to ensure electrolyte level does not fall below recommended level.

1. **ELECTRODES**

Electrodes shall be deigned for maximum durability under all service conditions. + ve and –ve electrodes shall be made by encapsulating/impregnating active material in order to ensure that the battery is able to perform reliably over its life. +ve and –ve electrodes shall be separated by micro porous separators. The structure of electrodes shall be elastic enough to absorb mechanical stresses & volume changes during charge/discharge cycles.

1. **ELECTROLYTE**

The electrolyte shall be prepared from battery grade potassium hydroxide (KOH) confirming to IEC 60993. The cells shall contain sufficient reserve electrolyte for efficient heat dissipation &to reduce water topping up interval. Reserve electrolyte shall not be less than 06 ml/Ah.

1. **CONNECTORS**

Nickel-plated copper inter-cell connectors shall be used forconnecting up adjacent cells and rows. Bolts, nuts and washers shall be nickel-plated steel/stainless steel. All terminals and cell inter-connectors shall be fully insulated or have insulation shrouds.

1. **TERMINALS**

Separate terminals shall be provided on the end cell for connecting load through DCDB and for connecting charger leads. All terminals shall be of suitably sized nickel-plated steel. Suitable nickel-plated copper lugs shall be provided by the supplier for use of the purchaser for connecting up the load wiring. All connectors and leadsshall be suitable for carrying 30-minute discharge current continuously and rated for short circuit duty of 4kA for 01 second.

1. **MANUAL OF INSTRUCTIONS**

The manufacturer shall supply a copy of the instruction manual for commissioning & initial treatment of the battery and maintenance during service with every battery bank ordered.

1. **RECOMBINATION EFFICIENCY**

In order to reduce topping-up frequency, recombination of Hydrogen & Oxygen gases evolved during charging/discharging shall be achieved by using safe and reliable technology such as catalytic conversion/valve regulation technique or both. Minimum recombination efficiency shall be 80%. Recombination efficiency test shall be done in accordance with IEC 62259. In case the batteries are operated at high temperatures & are frequently boost charged the water consumption may be higher & topping-up frequency may increase.

1. **BATTERY RACKS**

Suitable corrosion resistant battery racks and cable supports shall be provided. Metallic racks shall be properly earthed. The bottom tier of stand shall have a ground clearance of 150mm minimum above the floor. Racks shall be made of alkali resistant powder coated steel or stainless steel or FRP to ensure corrosion resistance.

1. **TEMPERATURE RANGE**

Battery must be capable of continuous operation in temperatures range of -15oC to +50oC for prolonged periods. No Air-conditioning shall be provided where batteries are to be installed.

1. **ACCESSORIES**

The following accessories (BIS certified) shall be supplied with each set of battery:-

* 1. Clamp-on type digital multi-meter of AC/DC current range having ISI mark.
  2. Pair of gloves

1. 10” Slide insulated wrench for opening terminal nuts
2. Plastic/glass syringe
3. Alcohol thermometer
4. Hydrometer for use while filling electrolyte.
5. **CHARGE RATE**

Fully discharged batteries should be able to get recharged in 7 hours maximum to 90% of capacity with charging current in the range of 0.1 to 0.4CmA rate at 20ºC. At higher temperatures, the charging time may be more. The trickle charge rate shall be 1-2 mA/Ah.

1. **CELL DESIGNATION**

The practice as per IS: 10918 (latest version) shall be followed.

1. **POLARITY MARKING**

The polarity of the terminals shall be marked for identification. Positive terminal may be identified by 'P' or a (+) sign or red colour mark and negative terminal may be identified by 'N' or (-) sign or blue colour mark. Marking shall be permanent and non-deteriorating.

1. **WARNING MARKING**

The battery shall be furnished with a warning plate located at conspicuous place specifying the use of 'ALKALINE ELECTROLYTE ONLY' (in block letters) and specifying proper filling level of the electrolyte. Marking shall be permanent and non-deteriorating.

1. **PACKING**

The batteries shall be securely packed in wooden crates suitable for handling during transit by rail/road and secured to avoid any loss or damage during transit. Carton boxes duly palletized shall also be acceptable.

1. **TESTS**

The batteries shall be tested for type, acceptance and routine tests in line with IS: 10918 & IEC: 62259 (latest versions). The owner may at their discretion to accept the batteries based on type tests already carried-out. In such cases, Type test reports for tests carried out not earlier than 05 years from bid opening date from NABL accredited labs shall be acceptable.

Note : In case Type tests are repeated, life cycle test may not be insisted upon Ni-Cd battery of the specific ratings to be ordered, as this test takes a long time (2-3 years). However, satisfactory evidence is to be furnished for having made this test on cell of any other Ah capacity of the same design.

1. **BUYBACK OF USED/UNSERVICEABLE BATTERIES**

Manufacturer shall buyback used/unserviceable batteries from the substations where batteries are replaced. The owner shall confirm the following particulars of used/unserviceable batteries to enable the bidder to quote buyback rates:

1. Type & number of cells for disposal
2. Make
3. Year of make/purchase
4. Capacity
5. Condition of cells

The bidder should quote their rates for buyback considering the salvage value of the above cells.

1. **SAFE DISPOSAL OF UNSERVICEABLE BATTERIES**

The bidder shall have facilities for proper treatment & disposal of used/unserviceable batteries that are bought back from the users, in line with the environmental protection rules & regulations of the country.

1. **GUARANTEE**

The batteries shall be guaranteed for a period of 36 months from the date of commissioning.

**Part B : CHARGER FOR Ni-Cd BATTERY (RECOMBINATION TYPE)**

1. **SCOPE**

This specification covers the requirements and tests for Battery charger for partial recombination type Nickel-Cadmium alkaline batteries for use in 33/11 KV and 66/11 KV sub-stations.

1. **CODES AND STANDARDS** 
   1. All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS codes, standards etc.) referred to herein, the former shall prevail. All work shall be carried out as per the following standards and codes.

| Sl.No | International standards | Indian standards | Description |
| --- | --- | --- | --- |
| 1 |  | IS:5 | Colours for ready mix paints. |
| 2 |  | IS : 1248 | Direct acting indicating analogue electrical measuring instruments. |
| 3 | IEC : 947-1 | IS : 13947 Prt-1 | Low voltage switchgear and control gear - General. |
| 4 | IEC : 947-2 | IS : 13947 Prt.-2 | Low voltage switchgear and control gear - Circuit Breaker |
| 5 | IEC : 947-3 | IS : 13947 Prt-3 | Specification for low voltage switchgear and control gear – Switches, Disconnectors, Switch disconnectors & Fuse combination units. |
| 6 | IEC : 947-4 | IS : 13947 Prt-4 | Specification for low voltage switchgear and control gear –Contactors |
| 7 |  | IS : 13947 Prt-5 | Specification for low voltage switchgear and control gear – Control Circuit Devices & Switching Elements |
| 8 | IEC: 439 | IS:8623 | Low voltage switch-gear and control-gear assemblies |
| 9 |  | IS:8686 | Static protective relays |
| 10 | IEC:225 | IS : 3231 | Electrical relays for power system protection. |
| 11 |  | IS : 3842 | Application guide for Electrical relays for AC System |
| 12 | IEC 146 | IS : 3895 | Mono-crystalline semi-conductor Rectifier Cells and Stacks. |
| 13 | IEC 146 | IS : 4540 | Mono crystalline semi-conductor Rectifier assemblies and equipment. |
| 14 |  | IS:6619 | Safety Code for Semi-conductor Rectifier Equipment. |
| 15 |  | IS : 9000 | Basic environmental testing procedures for electronic and electrical items. |
| 16 | IEC: 60269 | IS:13703 Prt-4 | Low voltage fuses for protection of semiconductor devices. |
| 17 |  | IS:1901 | Visual indicating lamps |
| 18 |  | IS:6005 | Code of practice for phosphating of Iron and Steel. |
| 19 | IEC: 227 | IS:694 /IS: 1554 | PVC Insulated Cable for working voltages upto and including 1100 V. |

* 1. Equipment complying with other internationally accepted standards such as IEC, BS, VDE. etc. will also be considered if they ensure performance and constructional features equivalent or superior to standards listed above. In such a case, the Bidder shall clearly indicate the standard(s) adopted, furnish a copy in English of the latest revision of the standards along with copies of all official amendments and revisions in force as on date of opening of bid and shall clearly bring out the salient features for comparison.

1. **EQUIPMENT DESCRIPTION** 
   1. a) The Battery Chargers as well as their automatic regulators shall be of static type. Battery chargers shall be capable of continuous operation at the respective rated load in Float mode, i.e. Float charging the associated Ni-Cd Batteries (partial recombination type) while supplying the D.C. loads. The Batteries shall be Float charged at 1.4 to 1.5 Volts per cell. All chargers shall also be capable of Boost Charging the associated Batteries at 1.42 to 1.7 Volts per cell at the desired rate. The Chargers shall be designed to operate, as mentioned above, up-to an ambient air temperature of 50°C. Tapping arrangement in the battery bank shall be provided to limit the over-voltage for supplying load within allowed voltage range under boost charge conditions. The charger should automatically switchover to float charge & to boost charge when the specified limit of voltage is approached. However, necessary timer circuit shall be used to allow a finishing charge before switching over to float mode, as recommended by battery manufacturer in order to ensure that battery gets fully charged. Recommended values of charger rating, tapping cell and specified voltages for automatic changeover to float/boost mode are given in table below, however, the manufacturer may suggest any changes in the recommended values with justification at the time of supply :

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Rating of Charger** | **Charger Rating during Float Charging at 1.4 to 1.45 V per cell** | **Charger Rating during Boost Charging at 1.42 to 1.7 V per cell** | **Tapping to be provided at ---th cell** | **Switching Voltage to Boost Mode** | **Switching Voltage to Float Mode** |
| **Volt** | **Ampere** | **Ampere** | **n** | **Volt** | **Volt** |
| 24 | 10 | 25 | 15 | 22 | 32 |
| 30 | 10 | 25 | 18 | 26 | 38 |
| 110 | 5 | 5 | 69 | 94 | 146 |
| 220 | 5 | 5 | 136 | 194 | 285 |

Note : Charger rating shall be arrived at with charger in boost mode and also supplying 100% float load i.e. charger current shall be sum of float & boost rating.

b) Battery Chargers shall automatically select the appropriate mode of operation i.e. Float or Boost. Means shall be provided to avoid current/voltage surges of harmful magnitude/nature, which may arise during changeover.

c) Soft start feature shall be provided to build up the voltage to the set value slowly within fifteen seconds. The chargers shall have load limiters, 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 characteristic shall be such that any sustained overload or short circuit in DC system shall neither 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. After clearance of fault, the Charger voltage shall build up automatically when working in automatic mode.

During external short circuit, output of the charger shall be automatically reduced to near zero volt till it is not isolated/disconnected & normal output voltage shall be restored by charger circuit on isolation with out any harm to source transformer/protection/ regulator circuit

d) During Float charging, the Charger output voltage shall remain within ±1% of the set value for AC input voltage variation of 230 +10% -15%, frequency variation of ±5%, a combined voltage and frequency (absolute sum) variation of 10% and a continuous DC load variation from 5% to full load. Uniform and stepless adjustments of voltage setting shall be provided on the front of the Charger panel covering the entire Float charging output range specified. Stepless adjustment of the load limiter setting shall also be possible from 80% to 100% of the rated output current for Float charging mode.

e) During Boost charging, the Battery Chargers shall operate on constant current mode with maximum current limiter setting (When automatic regulator is in service).

f) Energising the Charger with fully charged battery connected plus 10% load shall not result in output voltage greater than 110% of the voltage setting. Time taken to stabilise, to within the specified limits in clause 3.1 (d), shall be less than five seconds.

g) Momentary output voltage of the Charger, with the Battery connected shall be within 90% to 110% of the voltage setting during sudden load Change from 80% to 20% of full load or vice-versa. Output voltage shall return to, and remain, within the limits specified in clause 3.1 (d) in less than 1 second after the above-mentioned change.

h) 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 the float charging mode is also used as Boost charging current setting device.

i) Suitable filter circuits shall be provided in all the Chargers to limit the ripple content (peak to peak) in the output voltage to 3% irrespective of the DC load, even when they are not connected to a battery.

j) The DC System shall be ungrounded and float with respect to the ground potential when healthy.

k) Battery shall be isolated in case of short circuit on the load side.

l) Battery test circuit shall be provided with suitable resistance for discharging the battery for 30Sec at 5 hr rate.

m) All potentiometers shall be electronically locked to contain the various parameters within allowable limits even if the setting position of potentiometers is changed to extreme positions.

n) Insulation resistance shall be 5 M Ohm min.

* 1. **MCB**

AC MCCB shall be provided at the incomer. DC MCCB with provision of auxiliary contacts shall be provided at the output of the battery charger.

* 1. **Rectifier-Transformers and Chokes**

The rectifier transformer and chokes shall be dry and air cooled (AN) type. The rating of the rectifier-transformers and chokes shall correspond to the rating of the associated rectifier assembly. The rectifier-transformers and chokes shall have class-B insulation as per IS : 4540. Rectifier transformer shall confirm to all type tests as specified in IS 4540/IS 2026. Type test & routine test reports shall be submitted to the owner.

* 1. **Rectifier Assembly**

The rectifier assembly shall be full wave bridge type and designed to meet the duty as required by the respective Charger. The rectifier cells shall be provided with their own heat dissipation arrangement with natural air-cooling. The rectifier shall utilise diodes/thyristors with heat sinks rated to carry 130% of the load current continuously and the temperature of the heat sink shall not be permitted to exceed 85°C absolute duly considering the maximum temperature inside charger panel with ambient temperature of 50°C. The Contractor shall submit calculations to show what maximum junction temperature will be and what the heat sink temperature will be when operating at 130% and 100% load current continuously duly considering the maximum surrounding air temperature for these devices inside the charger panel assuming ambient temperature of 50°C outside the panel. Necessary surge protection devices and rectifier type fast acting fuses shall be provided in each arm of the rectifier connections. Static silicon controlled rectifiers and diodes complete with resistor/capacitor network for surge protection shall be provided

Design having IGBT or superior technology shall also be acceptable for which full justification & experience shall be required for acceptance.

* 1. **Instruments**

Analog or digital D.C. voltmeter, D.C. ammeter and A.C. voltmeter with 96 mm square display shall be provided for all Chargers. The instruments shall be flush mounted type, dust proof and moisture resistant. The instruments shall have easily accessible means for zero adjustments. The instruments shall be of 1.5 accuracy class.

* 1. **Control and Selector Switches**

Control and selector switches shall be of rotary stayput type of reputed make, confirming to relevant IS with escutcheon plates showing the functions and positions. The switches shall be of sturdy construction and suitable for mounting on panel front. Switches with shrouding of live parts and sealing of contacts against dust ingress shall be preferred. The contact ratings shall be at least the following :

i) Make and carry continuously - 10 Amps.

ii) Breaking current at 220 V DC - 0.5 Amp. (Inductive)

iii) Breaking current at 230 V AC - 5 Amp. at 0.3 p.f.

* 1. **Fuses**

Fuses shall be of HRC cartridge fuse link type. Fuses shall be mounted on fuse carriers, which are mounted on fuse bases. Wherever it is not possible to mount fuses on fuse carriers, they shall be directly mounted on plug in type bases. In such cases one insulated fuse pulling handle shall be supplied for each charger. Suitable fuse fail detector circuits with alarm contacts shall be provided for all D.C. fuses.

* 1. **Indicating Lamps**

The indicating lamp shall be of panel mounting, LED type and capable of clear status indication under the normal room illumination. The lamp covers shall be preferably screwed type, unbreakable and moulded from heat resistant material.

* 1. **Blocking Diode**

Blocking diode, wherever required, with full redundancy shall be provided in the output circuit of each Charger to prevent current flow from the D.C. Battery into the Charger.

* 1. **Annunciation System**

Visual indications through indicating lamps/LEDs or annunciation facia shall be provided in all Chargers for the following:

* + 1. A.C. supply failure
    2. Rectifier fuse failure
    3. Surge circuit fuse failure
    4. Filter fuse failure
    5. Load limiter operated
    6. Input AC MCCB trip
    7. Output DC MCCB trip
    8. Battery on Boost
    9. Load-side DC under-voltage & over-voltage alarm
    10. Battery side DC over-voltage alarm
    11. AC available – Battery discharge (Mains available battery discharge) alarm
    12. Potential free NO contacts shall be provided for following remote alarms:

a) Battery on boost

b) Charger trouble (this being a group alarm initiated by any of the faults other than ‘Battery on Boost’)

* 1. **Name Plates and Marking**

The nameplates shall be made of non-rusting metal/3 ply Lamicoid and shall have black background with white engraved letters and secured by screws. These shall be provided near top edge on the front as well as on rear side of Charger. Nameplates with full and clear inscriptions shall also be provided on and inside the panels for identification of various equipment.

* 1. Detailed dimensional drawings, commissioning and operating instructions and Test Certificates of the manufacturer shall be supplied with the equipment.
     1. **CONSTRUCTION**
  2. 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 Charger shall be fabricated using cold rolled sheet steel not less than 1.6 mm thick. The panel frame shall be fabricated using cold rolled sheet steel of thickness not less than 2.0 mm. Removable un-drilled gland plates of at least 3.0 mm sheet steel and lugs for all cables shall be supplied by the Contractor. The lugs for cables shall be made of electrolytic copper with tin plating. Cable sizes shall be advised to the Contractor at a later date for provision of suitable lugs and gland plates. Ventilating louvers shall be backed with fine brass wire mesh. All doors and covers shall be fitted with nitrile/neoprene/PU rubber gaskets. The Chargers shall have hinged double leaf doors provided on front and/or backside for adequate access to the Charger internals. All the Charger cubicle doors shall be properly earthed. The degree of protection of Charger enclosure shall be at least IP-42. The construction shall meet the requirements of IS 6619. All equipment mounted in the cabinet shall be provided with individual labels with equipment designation engraved.
  3. In case of outdoor mounting, the charger shall be provided with double doors on both front & back and shall pass IP-42 requirement with one door open on both sides. The enclosure shall be provided with a canopy.
  4. The layout of Charger components shall be such that their heat losses do not give rise to excessive temperature within the Charger panel. Location of the electronic modules will be such that temperature rise, in no case, will exceed 10°C over ambient air temperature outside the Charger.
  5. Each Charger panel shall be provided with an illuminating lamp (CFL or tube-light) and one 5 Amp. socket. Switches and fuses shall be provided separately for each of the above.
  6. Locking facilities shall be provided as following:

a) For locking Float/Boost selector switch in the float position only.

b) The Charger enclosure door shall have provision for padlocks. Padlocking arrangement shall allow ready insertion of the padlock shackle but shall not permit excessive movement of the locked parts with the padlock in position.

**4.6 WIRING**

* + 1. Each Charger shall be furnished completely wired upto power cable lugs and terminal blocks, ready for external connection. The power wiring shall be carried out with 1.1 kV grade PVC insulated cables conforming to IS:1554 (Part-I). The control wiring shall be of 1.1kV grade PVC insulated stranded copper conductors of 1.5 sq.mm. minimum, conforming to IS:694. Control wiring terminating at electronic cards shall not be less than 0.75 sq. mm. Control terminal shall be suitable for connecting two wires of 1.5 sq.mm. stranded copper conductors. All terminals shall be numbered for ease of connections and identification. At least 20% spare terminals shall be provided for circuits.
    2. Power and control wiring within panels shall be bundled separately. Any terminal or metal work which remains alive at greater than 415 V, when panel door is opened, shall be fully protected by shrouding.

An air clearance of at least ten (10) mm shall be maintained throughout all circuits, except low voltage electronic circuits, right upto the terminal lugs. Whenever this clearance is not available, the live parts should be insulated or shrouded.

* 1. **Painting**

Pre-treatment & phosphating with 7 tank process shall be provided as per IS: 6005. The phosphate coating shall be ‘class-C’ as specified in IS: 6005. Electrostatic powder painting with final shade – 692 (smoke grey) of IS: 5 shall be provided. The thickness shall not be less than 50 microns.

* 1. **Packing & dispatch**

The equipment shall be dispatched securely packed in wooden crates suitable for handling during transit by rail/road so as to avoid any loss or damage during transit.

1. **QUALITY ASSURANCE PLAN**
   1. The vendor shall furnish the following information along with his bid; failing which the bid shall be liable for rejection. Information shall be separately given for individual type of material offered.

i) The structure of Organization

ii) The duties and representatives assigned to staff ensuring Quality of work

iii) The system of purchasing, taking delivery and verification of materials

iv) The system for ensuring quality of workmanship

v) The quality assurance arrangements shall conform to the relevant requirement of ISO 9001 or ISO 9002 as applicable

vi) Statement giving list of important raw materials/components, list of sub-suppliers, list of standards according to which the raw materials are tested.

viii) List of manufacturing facilities available.

ix) Level of automation achieved and list of areas where manual process exists.

x) List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspections.

xi) Lists of testing equipment available with the bidder for final testing of equipment specified and test plant limitation if any, vis-à-vis the type, special acceptance and routine tests specified in the relevant standards. These limitations shall be very clearly brought out in schedule of deviations from specified test requirements.

* 1. The contractor shall also submit following information after award of contract:

i) Sub-suppliers of raw materials as well as bought out accessories & components. The equipment supplied shall adhere to the list of components submitted & as per type-tested equipment.

ii) Type test certificates of the raw materials and bought out accessories as required by the owner.

* 1. Manufacturing Quality Plan (MQP) shall be submitted. The owner hold points for stage inspection shall be discussed between the owner and contractor at the time of award of contract before the MQP is finalized.
  2. Makes of the following components (not restricted to) shall be subject to owner’s approval.

i) Relays

ii) Instruments

iii) SCR/IGBT

iv) Diodes

v) Annunciator

1. **TESTS**

Battery chargers including the components shall confirm to all type tests including heat run test as per relevant Indian standards. Performance test on the chargers as per specification shall also be carried out on each charger.

* 1. **TYPE TESTS** 
     1. Following type tests, in addition to the requirement of IS : 4540, should have been carried out on each rating and type of Battery Charger for which reports are to be submitted.
     2. Complete physical examination.
     3. Temperature rise test at full load (at highest voltage & highest current).
     4. Insulation resistance test.
     5. High voltage (power frequency) test on power and control circuits except low voltage electronic circuits.
     6. Ripple content test at
     7. No load
     8. Half load
     9. Full load
     10. Automatic voltage regulator operation test at specified A.C. supply variations at
         1. No load
         2. Half load
         3. Full load
     11. Load limiter operation test
     12. Short circuit test at full load and at no load for sustained short circuit of 1-minute minimum shall be carried out. The charger shall not trip, no fuse shall blow and charger current shall be limited to 150% of the rated current.
     13. Efficiency and power factor measurement.
     14. **Environmental Tests**

Steady state performance tests (clause 7.2.2 (f) and (g)) shall be carried out before and after the following tests.

i) Dry heat, Damp Heat, Vibration, Low temperature, Transportation, shock as per IS : 9000.

ii) Degree of protection test (IP-42).

* + 1. Rectifier transformer – As per IS 4540.
    2. If type tests are carried out against the contract, minimum 15 days notice shall be given by the contractor. The contractor shall obtain the owner’s approval for the type test procedure before conducting the type test. The type test procedure shall clearly specify the test set-up, instruments to be used, procedure, acceptance norms, recording of different parameters, interval of recording, precautions to be taken etc. for the type tests to be carried out.
    3. In case the contractor has carried out the type tests within last five years as on the date of bid opening, he may submit the type test reports from NABL accredited laboratory to the owner for waival of conductance of such type tests. These reports should be for the tests conducted on the equipment with identical design to that proposed to be supplied under this contract. The owner reserves the right for conducting any or all of the specified type tests under this contract.
  1. **ROUTINE TESTS :**
     1. Following routine tests shall be carried out on all Rectifier transformers in addition to tests required as per IS-4540.

a) Insulation resistance test.

b) High voltage (power frequency) test.

* + 1. Following routine tests shall be carried out on all Battery Chargers in addition to tests required as per IS-4540 :
       1. Complete physical examination.
       2. Short circuit test at full load and at no load for sustained short circuit of 1-minute minimum shall be carried out. The charger shall not trip, no fuse shall blow and charger current shall be limited to 150% of the rated current.
       3. Insulation resistance test.
       4. High voltage (power frequency) test.
       5. Ripple content test at

i) No load

ii) Half load

iii) Full load

* + - 1. Automatic voltage regulator operation test at specified A.C. supply variations at

i) No load

ii) Half load

iii) Full load

* + - 1. Load limiter operation test
      2. Checking of proper operation of annunciation system.
      3. Dynamic response test Overshoot/Undershoot in output voltage of the charger as a result of sudden change in load from 100% to 20 % and 20% to 100% shall be measured.
      4. Soak Test - All electronic modules shall be subjected to continuous operation for a minimum period of 72 hours. During last 48 hours, the ambient temperature shall be maintained at 50 deg. C. The manufacturer shall submit the record of carrying out this test to the owner’s engineer at the time of inspection.
      5. The charger shall be checked for gasketing arrangement as per drawing.
    1. Following routine tests shall be carried out on annunciation system.

1. Soak test shall be carried out as per Cl. 7.2.2 (j).
   1. **ACCEPTANCE TESTS:**
      1. Following acceptance tests and checks shall be carried out by the owner at the manufacturer’s works:

a) Complete physical examination.

b) Checking of proper operation of annunciation system.

c) Temperature rise test at full load.

d) Insulation resistance test.

e) Automatic voltage regulator operation.

f) Load limiter operation.

g) Dynamic response test.

* 1. Ripple content test
     1. Overshoot/Undershoot in output voltage of the Charger as a result of sudden change in load from 100% to 20% and 20% to 100% shall be measured with the Batteries connected/disconnected. Output voltage of the Charger connected with Battery shall be within 90 % to 110 % of the voltage setting in above conditions and shall return to, and remain, within the limits specified in clause 3.1 (d) in less than 2 seconds.
     2. The Contractor shall furnish for inspection, the type and routine tests certificates for Chokes and transformer whenever required by the Employer.

1. **GUARANTEE**

The battery charger shall be guaranteed for a period of 24 months from the date of commissioning.

1. **30 VOLT 100 AH LEAD ACID BATTERY**

**Part A : 30 Volt 100 Ampere-Hour Lead Acid stationary Battery**

**1. SCOPE**

This specification covers 30 Volt 100 Ampere-Hour Lead Acid stationary Battery, for use at 33/11KV substations for feeding auxiliary supply to Switchgear equipment at the time of interruption in mains supply. The battery is to be supplied along with wooden stand/rack as per description given below. Specifications of battery rack are indicated separately.

**2. APPLICABLE STANDARDS**

The cells of Lead Acid Battery shall conform to the requirements of IS 1651: 1991 with latest amendment thereof.

**3. STANDARD RATINGS**

The standards rating for 30 Volt Lead Acid Battery shall be 100 AH.

**4. CELL VOLTAGE**

The nominal voltage of a single cell shall be 2.1 to 2.2 Volts.

**5. CAPACITY AT ROOM TEMPERATURE**

The battery shall comprise of 15 cells with capacity not less than 100 AH at 10-hour rate of discharge to end voltage of 1.85 Volts per cell at room temperature not exceeding 32 degree C.

**6. GENERAL DESCRIPTION**

Cells shall be supplied in glass containers having ample space provided below the plate for accumulation of deposit. The glass containers shall be sufficiently robust, transparent and free from flaws. The bidder may also quote for battery with hard rubber containers, which shall conform to IS 1146: 1981.

Lead acid battery, comprising of closed type cells shall be complete with plante / tubular type positive plate assemblies, glass boxes, lids, micro porous plastic separators, polystyrene dowels and buffers, inter cell connectors and bolts & nuts. The battery shall be complete with (i) inter row connectors and bolts & nuts, acid jars and packing case, (ii) stands (iii) stand insulators (iv) cable sockets for end and tapping connections.

The sulphuric acid and water used for the preparation and maintenance of electrolyte shall conform to IS 266: 1977 and IS 1069: 1964 respectively.

The separators used shall be either wooden or synthetic. The wooden separators when used shall conform to IS 652:1960 and the synthetic separators to IS 6071: 1986.

The venting device shall be of anti-splash type with more than one exit hole and shall allow the gases to escape freely but shall effectively prevent acid particles or spray from coming out.

A suitable electrolyte level indicator indicating lower and upper limits shall be fitted to facilitate checking of electrolyte level in opaque containers. The materials used shall be acid proof and shall not deteriorate during service.

The manufacturer’s identification shall be embossed/impressed on the connectors. Where it is not possible to bolt the cell terminals directly to assemble a battery, separate lead, copper or aluminium connectors of suitable size shall be provided to enable connection of the cells.

The material for bolts and nuts shall be brass. Bolts and nuts for connecting the cells shall be effectively lead-coated to prevent corrosion.

Open cells shall be provided with spray arrestors of adequate area over the plates. These may be of glass sheet at least 3 mm thick and shall be adequately supported.

**7. MOUNTING STAND**

The cells shall be accommodated in double tier stand constructed of “SAL” wood and painted with 3 coats of acid proof paint. Necessary paint for this purpose shall be supplied. No metal fastenings shall be used. Stand should be self-supported and free from wrap & twist. The assembled stand / rack should be suitable for bolting end to end to form continuous row. The stands shall be supported on insulators to obtain necessary insulation from earth and there shall be insulators between each cell and stand. The price of stand shall be included in the cost of the battery.

**8. TERMINALS**

Separate terminals shall be provided for connecting load and charger leads to the battery terminals. All terminals shall be of M 12 size. The agency shall provide suitable copper lugs for use of the owner for connecting the load wiring.

* + 1. **ACCESSORIES**

The following accessories shall be supplied along with each battery and price for the same shall be included in the cost of the battery:-

1. One battery logbook
2. Two copies of printed instruction sheet
3. One no. cell testing voltmeter (3-0-3 volts) complete with leads
4. One no. floating hydrometer
5. One no. syringe hydrometer
6. One no. thermometer (0 to 100 degree C)with specific gravity correction scale
7. One set of suitable insulated spanners
8. One no. acid resisting funnel
9. One no. acid resisting jar
10. One pair of rubber gloves
11. Lead platted 2 nut – bolts and 2 washers set = 30 + 4 extra =34 Nos.
12. Cell insulators for mounting of cells = 15X4+6 extra = 66 Nos.
13. Rack insulator for mounting of battery rack = 8 Nos. minimum
    * 1. **CHARGE RATE**

Fully discharged batteries should normally be recharged at 10 Amps. for 10 hours at room temperature. New batteries and old batteries at high temperatures may need more time. Trickle charge rate shall be about 50 to 100 mA,

* + 1. **CELL DESIGNATION AND MARKING**

The practices indicated in relevant IS shall be followed for cell designation purpose.

The following information shall be indelibly and durably marked on the outside of the cell:-

1. Indicating the source of manufacture
2. Ah capacity at 10-hour rate
3. Upper and lower electrolyte level in case of transparent containers
4. Year of manufacture and
5. Country of origin
6. Each cell and battery may also be marked with the Standard Mark.

The polarity of the terminals shall be marked for identification. The positive terminal may be identified by “P” or (+) sign or Red colour mark and the negative terminal may be identified by “N” or (-) sign or a Blue colour mark. Terminal marking shall be permanent and non-deteriorating.

The battery shall be supplied with a warning plate located at conspicuous place specifying the use of “PARTICULAR ELECTROLYTE ONLY’ (in block letters) & specifying the proper filling level of the electrolyte. Marking shall be permanent and non-deteriorating.

* + 1. **TESTS**

The following tests shall be carried out in accordance with IS 1651:1991 with latest version thereof.

* + 1. **TYPE TESTS**

1. Verification of constructional requirements
2. Verification of marking
3. Verification of dimensions
4. Test for capacity
5. Test for voltage during discharge
6. Ampere-hour and watt-hour efficiency tests
7. Test for loss of capacity on storage
8. Endurance test
   * 1. **ACCEPTANCE TESTS**

The following shall constitute acceptance tests: -

1. Marking and packing
2. Verification of dimensions
3. Test for capacity, and
4. Test for voltage during discharge
   * 1. **ROUTINE TESTS**

The battery shall be tested after manufacture as per the requirement of IS: 1651-1991 (with latest amendment, if any). Two copies of test certificates indicating the results obtained during the tests shall be submitted.

* + 1. **MANUAL INSTRUCTIONS**

The manufacturer shall supply one copy of instruction manual for initial treatment and routine maintenance during service with each battery.

The following information shall be provided on the instruction cards:-

1. Designation of cell or battery
2. Ampere – Hour capacity
3. Nominal voltage
4. Manufacturer’s instructions for filling, initial charging
5. Normal and finishing charging rates and
6. Maintenance instructions
   * 1. **GUARANTEE PARTICULARS**

Expected life span of battery shall be minimum 10 years. Loss of capacity on storage of a fully charged battery stored for 28 days should not be more than 3%. Battery should be capable to bear under floating & over floating conditions.

The bidders shall essentially fill up the enclosed Schedule of Guaranteed Technical Particulars of Battery offered by him.

* + 1. **PACKING**

The battery shall be suitably packed in wooden crates suitable for handling during transit by rail/road, and secured to avoid any loss or damage during transit.

**Part B: Battery Charger**

* + - * 1. **SCOPE**

This specification covers design, manufacturing, testing at manufacturer’s works before dispatch and supply of 30 Volt 10 Ampere Single Phase Battery Charger required for charging of 30 Volt 100 Ampere-Hour Lead Acid Battery and for feeding auxiliary supply to Switchgear equipments at 33/11 kV substations.

* + - * 1. **STANDARDS**

Unless otherwise specified, the equipment shall conform to the latest applicable Indian standards and in particular to the following standards:-

|  |  |  |
| --- | --- | --- |
| 1 | IS: 3895 | Specification for Rectifier equipment’s in general |
| 2 | IS: 13947(Part II) | Specification for MCB |
| 3 | IS: 1248 | Indication instruments |
| 4 | IS: 2147 | Degree of protection for cubicles |
| 5 | IS: 375 | Specification for wiring |
| 6 | IS: 4540 | Mono crystalline semiconductor rectifiers assemblies & equipment |
| 7 | IS: 6619 | Safety code for semiconductor rectifier equipment |
| 8 | IS: 2026 | Transformers |
| 9 | IS: 4237 | General requirement for switchgear and control gear for voltage not exceeding 1000 Volts |
| 10 | IS: 4064 | Air Break switches and fuse combination units |
| 11 | IS: 6005 | Code of practice for phosphating of Iron & Steel |
| 12 | IS: 5 | Colour for ready mix paints |
| 13 | IS: 5921 | Printed circuit Board |
| 14 | IS: 249 | Printed circuit Board |
| 15 | IS: 5578 | Guide for making insulated conductor |

The agency shall clearly state the standards to which the equipment offered by him conforms.

* + - * 1. **DRAWING AND LITERATURE**

The bidder shall furnish all such drawings, instruction manuals, descriptive literature etc., as may be necessary for the proper understanding of the functioning of the charger.

The write-up should include the following:-

1. Technical specification of the charger.
2. Detailed circuit description of the charger. It should also include the functions of various components, protection circuits/cards, and relays along with their individual brief write-ups/leaflets.
3. List of the main components of the charger.
4. Following details are to be clearly indicated in the circuit diagram:-
   1. Make and Rating of components used
   2. All the fuses should be numbered and individual rating should be indicated.
      * + 1. **GENERAL DESCRIPTION**

The Charger shall be of simple design so as to ensure its reliable functioning and ease in maintenance/repairing. Complicated circuitry shall be avoided, as for as possible. The bidder shall indicate, as to how reliable functioning of the charger is achieved. He shall also indicate the quality control adopted for the reliable product.

The battery charging equipment shall comprise of a selenium/solid state silicon rectifier suitable for operation on 230/250 Volt Single Phase AC system. Associated transformer, regulatory resistance, switches etc. shall be accommodated in a sheet steel cubicle arranged for continuous load of 3 Amps. Adjustable from 0 to 3 Amps trickle charge of the battery and manual provision to operate at a higher voltage to recharge the battery of 100 AH capacity quickly at 10 Amp rate.

The equipment shall comprise of:-

1. AC mains switch/MCB 230/250 Volt Single Phase with fuses/MCB
2. Pilot lamp/LED type to indicate AC supply ON.
3. Ballast choke
4. Single Phase Double Wound Transformer for rectifiers
5. Main transformer single phase variac with rough and fine control to charge battery in steps of 6-12, 12-18, 18-24, 24-30, 30-36, 36-42 volts.
6. Full wave bridge connected plate/solid state silicon rectifier
7. Fuses for rectifier output
8. Moving Coil Ammeter 96-mm sq. flush mounting type (0-15 Amps.)
9. Moving Coil Voltmeter 96 mm sq flush mounting type (0-50 Volts)
10. Voltmeter fuses
11. DC ON/OF switches with fuses.

The sheet steel cubicle of the rectifier unit shall also accommodate the switches for charge rate selection, incoming from battery and various apparatus for battery control.

The chargers should have in-built automatic input voltage stabilizer in the range of 180 volt to 275 volt to facilitate steady output voltage and current from the charger.

* + - * 1. **CABINET**

The charger shall be enclosed in a cabinet made of sheet steel of not less than 1.5 mm thickness and should be suitable for mounting on a plane surface/floor with ventilation louvers on two sides and finish painted with synthetic enamel paint of white on inside and opeline green on outside. Two coat of zinc primer shall be applied before finishing synthetic enamel paint. The cabinet shall have vermin proof construction. The cabinet legs shall be of adequate height and strength and should provide minimum clearance of 100 mm from ground.

**6. FRONT PANEL MOUNTINGS**

The following provisions conforming to relevant ISS shall be made on the front panel:

1. Voltmeter to indicate battery/charger DC voltage
2. Voltmeter to indicate incoming AC voltage
3. Ammeter to indicate charging/load current
4. Indicating LEDs to indicate:-
   1. Supply of power;
   2. Charger on;
   3. Input voltage less than 180 Volt
5. Audio/Visual alarm to indicate:-
   1. Power failure;
   2. Charger failure;
   3. Battery disconnection/failure;
   4. Battery reverse; and
   5. DC under/Over voltage.

In case of failure of charger on fault, it should give buzzer as well as LED indication. However, the buzzer alarm should be provided with a reset switch. The indicating instruments shall be of class 1.0 accuracy

**7. TRANSFORMER**

The power transformer rectifier unit of the battery charger shall be designed for adequate VA rating but in any case it should not be less than 700 VA and should be rated for 300 V at factor of safety of 3. The heat dissipation and power control system should be designed with a factor of safety of 8. Rating of silicon diode should not be less than 15 A.

Please note, necessary documentary evidence, showing transformer rating of 700 VA along with test certificate from manufacturer, if bought-out, shall be enclosed, for approval of the owner.

**8 PROTECTION**

The charger should have built-in reverse polarity protection with indication lamp so as to protect the battery from high drains. The charger should also have MCB in the output circuit for protection from short circuits.

1. **LIGHT EMITTING DIODES**

For the purpose of indication LED indicators shall be provided.

1. **SWITCHES AND FUSES**

Control and instruments switches shall be of toggle type. All fuses shall be of HRC type and of English Electric/L&T make only.

1. **LABELS**

All front panel mounted equipment as well as the equipment mounted inside the cabinet shall be provided with individual labels with equipment designation engraved on aluminium plate (stickers are not acceptable).

1. **WIRING**

The charger shall be supplied completely wired ready for external connections at the terminal blocks. All the wiring shall be carried out with 1100 V Grade PVC insulated standard copper conductor of 2.5 Sq.mm. Colour coded wires should be used to facilitate easy tracing, as under :-

A. Single Phase AC Circuit:-

1. Red for Phase
2. Green for Earthling
3. Black for Neutral

B. D.C. Circuit:-

1. Red for Positive
2. Black for Negative

C. Control Wiring:- Gray for annunciation and other control circuits.

1. **FERRULES**

Engraved core identification ferules, marked to correspond with the wiring diagram shall be fitted at both ends of each wire.

1. **EARTHING TERMINALS**

The battery charger cabinet shall be provided with two separate suitable earthing terminals of good quality and adequate size.

1. **TESTING**

The manufacturers on each battery charger shall carry out the following tests and copy of the tests certificate for each charger shall be submitted:-

1. Checking of wiring and continuity of circuits and visual inspection
2. High voltage test on the equipment with accessories. (All equipment and wiring should be tested for with-standing the power frequency voltage of 2 KV r.m.s. for 20 seconds.)
3. Checking of charging current and load currents.
4. Checking of relays operation, alarm circuit operation, lamp indication, charger failure, mains failure, load fuse failure and annunciation (manufacturer’s test certificate for the instruments shall also be furnished).
5. Regulation and Ripple tests.
6. Efficiency test.
7. Burn-out/Heat-run test (for 10 Hrs.)
8. **CIRCUIT DIAGRAM AND WRITE-UP**

It is desired that the complete schematic of the charger is provided on a permanently laminated/engraved plate of suitable thickness, which has to be bolted/riveted at the four corners on the inside face of rear door. In addition, one more plate of similar type and dimension shall be provided on the outside of the rear door providing guidelines and instructions for operation of the charger. The guidelines and schematic to be provided on the plates shall be as per our approval for which separate drawings shall furnish, after award of contract.

1. **TERMINALS**

Separate terminals shall be provided for connecting load and battery leads to the charger. All terminals shall be of M12 size. Suitable copper lugs for connecting the load wiring are to be provided.

It would be the bidder responsibility to prove the adequacy of its design by submitting all technical particulars and relevant graphs to show suitability of charger for supplying load on continuous basis.

1. **PRINTED CIRCUTT BOARD**

The printed circuit boards should be made out of glass fiber re-in forced epoxy boards and should be coated with suitable protective coating for protection against humidity and corrosion.

1. **POLARITY MARKING**

The polarity marking of the terminals shall be marked for identification. The positive terminal may be identified by “P” or (+) sign or red colour mark and the negative terminal may be identified by “N” or (-) or blue colour. Terminal marking shall be permanent and non-deteriorating.

1. **MANUAL OF INSTRUCTIONS**

The manufacturer shall supply a copy of the Instruction Manual for commissioning and initial testing of the charger and maintenance during service with every charger supplied.

1. **PACKING** The charger shall be securely packed in wooden crates suitable for handling during transit by rail/road so as to avoid any loss or damage during transit.