GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
(Railway Board)

INDIAN RAILWAY STANDARD SPECIFICATION FOR VALVE REGULATED (SEALED) LEAD ACID STATIONARY BATTERY & CHARGER FOR RAILWAY S&T INSTALATIONS

0. FOREWORD

0.1 This specification is issued under the fixed serial No.S-93, followed by the year of original adoption as standard, or in the case of revision, the year of last revision.

0.2 This specification requires reference to the following standards:

IS: 1885 (Pt. VIII) –1986	Electro technical vocabulary: Part VIII Secondary Cells and Batteries
IS: 1651-91	Stationary cells and batteries, Lead acid type.
IS: 266-77	Sulphuric acid
IRS:S 23	Electrical Signalling & Interlocking Equipment.
BS: 6290 Pt. IV: 1987	British standard specification for Lead acid valve regulated sealed type batteries.
IRS:S 86/92	Battery chargers for S&T equipment.

0.3 Whenever, in this specification, any of the above mentioned specifications are referred by number only without mentioning the year of issue, the latest issue of that specification is implied, otherwise, the particular issue referred to is meant.

0.4 This specification is intended chiefly to cover the technical provisions and does not include all the necessary requirements of the contract.

0.5 For the purpose of this specification, the terminology given in IRS:S 23 (whenever applicable), IS: 1885 (Part VIII) – 1986 and IRS:S 86/92 shall apply.

PART–A

A.1 SCOPE

A.1.1 This standard specifies rated AH capacity, performance requirements and tests for batteries of valve regulated (sealed) lead acid type with immobilized electrolyte and chargers for the same.

A1.2 The specification covers batteries up to 500AH capacity and is applicable for:

- Monoblock batteries in sizes of 4, 6 & 12 Volts.
- Individual cells of 2V housed in metal trays for ease of stacking.

Note:

1. The VRLA batteries / cells shall be charged at a CONSTANT VOLTAGE OF 2.25V PER CELL AS RECOMMENDED BY THE MANUFACTURER WITH CHARGING CURRENT LIMITED TO 1/5 OF THE RATED CAPACITY IN AMPS.

2. The battery chargers of voltage and current ratings corresponding to various AH capacities are to be procured as per Part 'B' of this specification.

3. The effect of temperature, effect on capacity due to storage for long duration, determination of state of charge of VRLA batteries, installation & maintenance instruction and other important information about these batteries is brought out in Annexure enclosed to this specification. This Annexure however does not form part of this specification.

A.2 RATING AND DESIGNATION

A.2.1 The rating assigned to the cell shall be the capacity expressed in Ampere hours (after correction to 27 deg. C) stated by the manufacturer to be obtainable when the cell is discharged at 10 hour rate (c_{10} a final voltage of 1.75 V.

A.2.2 DESIGNATION

The cell shall be designated by symbols given below, arranged in the following sequence

Type of positive plate as in Cl. 2.2.1	AH rating of cells as in Cl. 2.2.2	Type of container as in Cl. 2.2.3	VRLA

NOTES:

1. The plates are not replaced in this type of construction, therefore, this designation does not include the number of positive plates; and

2. The designation of partially plated cells is not being standardized because partial plating of cells in this type of construction is not done.

A.2.2.1 The positive plate shall be designated by the letter F or T to indicate Flat/tubular type.

A.2.2.2 The capacity rating shall be indicated by a number equal to the capacity in AH.

A.2.2.3 The material of the container shall be designated by the letter P, indicative of plastic container. The material of the container shall be Polypropylene copolymer or similar material of equivalent low permeability to water vapour.

P – Plastics

Example F 400 P VRLA – designates a Valve Regulated Lead acid cell /Battery having flat pasted positive plates and a capacity of 400AH at 10 hour rate in plastic container. Polypropylene Copolymer 9PPCP) shall be denoted bythe letter 'P' only.

A.3 CONSTRUCTIONAL REQUIREMENTS

A3.1 The maintenance free valve regulated lead acid batteries shall be made in standard sizes of

A.3.1.1 Mono-block construction

4V up to 300AH capacity;
6V up to 200AH capacity
12V up to 120AH capacity as and required by the purchaser.

A.3.1.2 Stackable single cells

2V cells of capacities 20, 40, 80, 100, 120, 200, 300, 400, 500 AH. The cells shall be housed in metal trays to facilitate stacking to form the required battery bank. 20, 40 & 80AH cells should also be individually for track circuit applications if required by the purchaser.

A.3.2 Containers

A.3.2.1 The container shall be made in a suitable flame retardant plastic material and be so designed as to minimize flexing of surfaces under internal operating pressures.

A.3.2.2 The containers shall be enclosed in epoxy coated steel trays. The steel trays shall be so designed as to make both vertical and horizontal stacking of cells/batteries possible.

A.3.2.3 The container/lid material shall be resistant to sulphuric acid.

A.3.3 Lids/ Covers

The Lid/cover shall be made in a suitable flame retarding plastic material compatible with the container material and shall be welded to the container by heat sealing or any other suitable technique.

The complete container along with lid/cover shall be able to withstand without fracture for 5 hours at 25 deg.C an internal pressure of 5 times the normal operating pressure declared by the manufacturer. The complete design includes the pillar to lid seal which shall be designed to remain gas-tight and electrolyte tight during the designed life of the battery.

A.3.4 **Pillar seal Assembly**

A.3.4.1 The pillar to lid seal shall be designed to remain gas tight and electrolyte-tight during the designed life of the unit.

A.3.4.2 The terminals shall conform to clause 3.2 of BS: 6290: Part 4 of 1987.

A.3.5 **Separators**

The separators used shall be porous to electrolyte but electrically insulating. Sufficient separator overlap to the edges of the plates shall be provided to prevent short circuits forming between the edges of adjacent plates. These shall be either made of glass or synthetic material having high acid absorption capabilities and shall be resistant to sulphuric acid. Separators shall meet the following requirement.

A.3.5.1 The uncompressed water absorption of the separator shall be atleast 5 gm of water/.gm of separator material.

A.3.5.2 Requirement of wicking test on separators

a) The total wicking height shall not be less than 25 inches in 24 hours.
b) The minimum water content at 5 inches height shall be atleast 5 grams of water per gram of separator.
c) The weight of water per gram shall be at least 90% of the value at 5 inches when checked at a height of 18 inches.

A.3.6 **Valve**

The valve shall operate at the specified pressure and tolerance limits. The valve shall not allow ingress of air into the unit.

The vent plug used shall be explosion resistant and self re-sealing and pressure regulating type. Vent plug shall be such that it cannot be opened without proper tool.

A.3.7 **Terminal posts**

Positive and negative plates shall be clearly and unambiguously identifiable.

A.3.8 **Connectors**

The connectors used shall conform to Clause 6.5 of IS: 1651-91. The internal inter-cell connectors used in the battery shall prevent acid creepage through the intercell partition.

A.3.9 **Nuts and Bolts**

Nuts and bolts for connecting the cells shall be made of copper, brass or stainless steel and effectively lead coated to prevent corrosion. Stainless steel bolts/nuts can be used without lead coating. Stainless steel used shall be of special grade which is resistant to sulphuric acid.

A.3.10 **Electrolyte**

The sulphuric acid and water used for electrolyte for the battery should conform to IS: 266-77 and IS: 1069-64 respectively.

A.4 **QUALITY REQUIREMENTS**

A.4.1 The materials shall be of the best quality and the workmanship shall be of the highest class as per standards laid by RDSO.

A.5 **QUALITY ASSURANCE**

A.5.1 The batteries shall be manufactured as per quality assurance procedure laid down so as to meet the requirement of the specification.

A.5.2 The Routine tests shall form a part of the QA procedure and records maintained.

A5.3 Amongst other requirements of the specification, validation and system monitoring of QA procedure shall form a part of type approval. The necessary Plant & machinery and Test instruments shall be available with the manufacturer to ensure compliance to the approved QAP.

A.6 **MARKING**

The following information shall be indelibly and durably marked on outside of each battery / cells

i) Manufacturer's type and trade name followed by
ii) S.No. of the battery/cell
iii) AH capacity of the battery at 10 hour rate.
iv) Month and year of manufacture.

A.7 **PACKING**

Manufacturers shall be responsible for safe transportation of cells/ battery, which should be packed and delivered in good condition to consignee at his depot. If there is any damage, manufacturer shall replace the damaged cell/ battery free of cost.

A.8 MANUAL OF INSTRUCTIONS

A.8.1 Two copies of instruction manual of initial treatment and routine maintenance during service shall be supplied by the manufacturer along with every set of battery. Instruction manual is to be prepared using good quality paper with clear and handsome printing using modern facilities like electronic typewriters, printer of DTP. The manual still have a thick polythene sheet cover with plastic spiral binding or comb binding.

A.8.2 n addition, an instruction card containing the following information shall be provided along with each battery/cell.

a) Designation of cell/battery
b) AH capacity
c) Nominal voltage
d) Charging voltage

A.9 OPERATIONAL REQUIREMENTS

A.9.1 All the cells / batteries shall be designed for continuous full load operation under

i) Temperature from 0 to 55 deg.C under dry heat conditions.
ii) Relative humidity up to 95% with temperature going up to 40 deg. C.

A.9.2 The batteries shall be non-spillable and shall be capable of being used in any position.

A.9.3 The design of the battery shall be such that the generation of gas due to chemical reaction is effectively controlled and allows recombination within the battery of over 99% of the gas generated during the normal usage.

The efficiency of the recombination shall be tested.

A.9.4 Valve

A.9.4.1 The valve referred in Cl. 3.6 shall be so designed that it operates at the pressure between 2 psi to 9 psi to release the excess gas and re-seal automatically as soon as the gas pressure within the cell drops to atmospheric value.

A.9.4.2 All the cells shall be subjected to pressure test up to 10 psi.

A.9.5 The self discharge rate at room temperature shall not be more than 5% of the rated capacity per month.

A.10 **Tests**

A.10.1 Classification of tests

A.10.1.1 **Type tests**

The following shall constitute type test and shall be carried out in the given sequence.

a) Verification of constructional requirements
b) Verification of marking and packing
c) Verification of dimensions
d) Test for capacity
e) Test for charge retention
f) Endurance test
g) Ampere hour and watt hour efficiency test.
h) Test for voltage during discharge
i) Test for endurance under short circuit conditions
j) Test for gas recombination efficiency.

A.10.1.2 For conducting type tests, eight units shall be taken. Dimensional checks, verification of constructional requirements and capacity test shall be done for all the units. Remaining tests shall be done as per the following table.

Test	**Samples Numbers**							
	1	2	3	4	5	6	7	8
a) Test for capacity	X	X	X	X	X	X	X	X
b) Voltage during discharge	X	X	-	-	-	-	-	-
c) AH & WH efficiency test	-	-	X	X	-	-	-	-
d) Test for charge retention	-	-	X	X	-	-	-	-
e) Endurance test	-	-	-	-	X	X	-	-
f) Endurance under short circuit	-	-	-	-	-	-	X	X
g) Test for gas recombination efficiency	-	-	-	-	X	-	-	-

If any of the samples fails in the relevant type test, testing authority may call for fresh samples not exceeding twice the original number and subject them again to all tests or test in which the failure has occurred as agreed between the manufacturer and the buyer. If there is any failure in any of the re-test, the type shall be considered as not having passed the requirements of this standard. All tests shall be carried out at an ambient temperature of 27 deg. C ± 5 deg. C.

A.10.1.3 At the time of initial type test, the manufacturer shall submit authenticated test results of the specified minimum charge/discharge cycle life for the cyclic application and similar test results for the float mode application.

A.10.1.3 **Acceptance test**

The following shall constitute the acceptance tests

a) Marking and packing
b) Verification of dimensions
c) Test for capacity
d) Test for voltages during discharge.

A.10.1.4 The acceptance tests shall be performed at the manufacturer's premises by the inspection wing of RDSO on each lot offered.

A.10.1.5 The purchaser may, at his discretion undertake test for capacity and voltages during discharge after installation of the battery at site.

A.10.1.6 **Sampling scheme and criteria for acceptance**

The sampling scheme and criteria for acceptance shall be in accordance with Cl. 11.1 of IS: 8320-1982.

A.10.2 **Verification of constructional requirements**

The cell/battery shall meet the requirements specified under Cl. A.3.1, A.3.2, A.3.7 & A.3.9.

A.10.3 **Verification of marking packing**

The marking on the cells/batteries shall meet the requirements specified in Cl. 6 and packing shall meet the requirements of Cl. 7.

A.10.4 **Test for Capacity**

A.10.4.1 The test shall be conducted as per Cl. 12.5 of IS: 1651-91 with following changes.

i) When a fully charged cell is discharged at a constant current I = 0.1 C_{10} amperes, the discharge shall be stopped when the closed circuit voltage across the cell falls to 1.75 volts.
ii) On the first discharge, the cell shall give not less than 85% of the rated capacity. The cell/battery shall give 100% rated capacity within 5 discharges.

A.10.4.2 Test for capacity may, by mutual agreement between the supplier and the purchaser be carried out at rates other than 10 hour rate. In such cases, a 3 hour rate is recommended. Corresponding final voltages are given in the Table – II. For the purpose of acceptance, the capacity test shall be carried out at one rate only.

A.10.5 **Test for Charge Retention**

A.10.5.1 This test shall be carried out on a minimum number of 2 samples. After measuring and recording the capacity in accordance with Cl. 10.4.1 & 10.4.2, the battery shall be charged at a constant voltage of 2.25 V/Cell or as recommended by the manufacturer. A current limit of not more than 20% of the rated capacity in amperes is permitted, which may reduce the voltage in the beginning of the charging. The ambient temperature shall be 27 deg.C ± 5. The battery shall be charged for 16 hours or until the charging current has stabilized, except for transient fluctuations, for a period of 3 hours, whichever occurs first.

A.10.5.2 After charging the battery, it shall be left on open circuit for 30 days and then the battery shall be discharged at 10 hour rate and capacity C' shall be determined. It shall be corrected to 27 deg. C. The % loss in capacity R is given by

$$\frac{C-C'}{C} \times 100$$

The % loss in capacity R shall not exceed 15%.

A.10.6 **Endurance test**

A.10.6.1 The endurance charge / discharge cycles test shall be carried out on a minimum of tw cells of which capacities have been determined as per Cl. 10.4 and no other tests have been carried out.

A.10.6.2 The cells shall be charged continuously at a constant voltage of 2.25V/cell or as specified by the manufacturer with a maximum current of 20% of the rated capacity in amperes for total period of 2000 hours as given below.

a) 2- cycles of 300 h charging followed by test discharge
b) 3-cycles of 200 h charging followed by test discharge &
c) 8-cycles of 100 h charging followed by test discharge.

A.10.6.3 Through out these periods of charge, the cell shall be immersed in a tank of water, the temperature of which shall be maintained t 40 ± 3 deg. C. The cell shall be so immersed that the top of the cell is 25 mm above the water level in the tank. If several cells are placed in the tank, a distance of 25mm shall be maintained between them. The distance between a cell and the side of the tank shall also be at least 25mm. At the end of each period of charging as specified above, the cell shall be subjected without recharging to a test discharge at C_{10} rate to an end voltage of 1.75.

A.10.6.4 At the end of the last discharge cycle i.e. after 2000 hours shall not be less than 90% of the original capacity of the battery.

A.10.7 **Ampere hour and watt-hour efficiency tests**

A.10.7.1 The test shall be carried out as per Cl. 12.9 of IS: 1651-91 and the AH efficiency shall not be less than 90% and the watt-hour efficiency shall not be less than 75%/ The end point voltage shall be as per Cl. 10.4.1 (i).

A.10.8 **Test for Voltage during discharge**

A.10.8.1 The test shall be carried out as per Cl. 12.10 of IS: 1651-91 and the samples shall meet the requirements brought out in Cl. 12.10.1 of IS: 1651-91.

A.10.9 **Test for Endurance under short circuit conditions**

A.10.9.1 This test has to be carried on a minimum of 2 units. The capacity of each of the 2 units shall be determined as per Cl. 10.4. Recharging shall be done at the manufacturer's recommended rate. A short circuit load of 1.8 ± 0.3 m ohm shall be applied to each of the unit for one minute duration. The units shall be cooled down and recharged as per manufacturer's instructions. Their capacities shall be determined as per Cl. 10.4. The capacities measured after the short circuit test shall not be less than 90% of the unit's C_{10} capacity.

A.10.11 **Test for gas recombination efficiency**

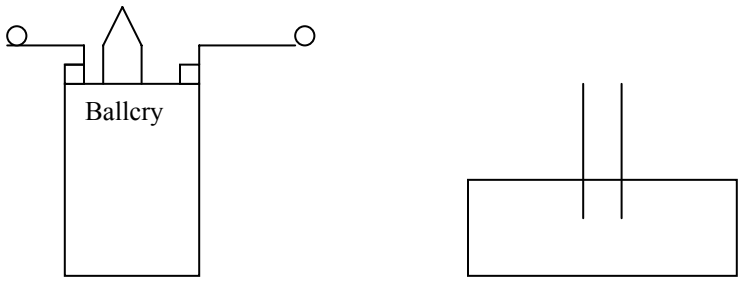
A.10.11.1 Gas recombination efficiency is calculated using the fully charged battery after it had finished the 10 hour rate capacity test with the following test conditions.

A.11.1.1 **Charge**

The battery for test is charged continuously for 96 hours at a constant current of 0.01 C_{10} A, provided however that the said recharging is not made in case where the battery after ocnducting the over charge performance test has already been fully recharged.

A.11.1.2 Gas collection

Gases are collected in the way as illustrated in figure 1 below.



A.11.1.3 Additional charge

Within one hour after completion of charge specified in 11.1.1 above, charge continuously at a constant current of 0.005 C_{10} A.

A.11.1.4 Time for gas collection

One hour right after charging.

A.11.1.5 Duration of gas collection

One hour (during the additional charge).

A.11.1.6 Ambient temperature of the battery 27 ± 5 deg.C.

A.11.1.7 Calculation of gas recombination efficiency

From the liberated gases collected to 27 deg. C, 101.3 kPa (1013 mbar) per 1 AH charged as per 11.1.1 above during which gases are collected, and the gas recombination efficiency is calculated by the following equation.

$V = P/P_o \times .298/(t + 273) \times V/Q$

Where

V = Amount of liberated gas (ml/ah) as converted to 27 deg.C, 101.3 kPa (1013 mbar) per AH of charged electricity.

P = Ambient atmospheric pressure (kPa, mbar, mmHg)

P_o = 101.3 in case unit of 'P' is kPa, 1013 when expressed by 'mbar', and 760 when by 'mmHg'.

t = Ambient temperature of the measuring cylinder

V = Volume of gases collected (ml)

Q = Electricity charged during gas collection (AH)

Gas recombination efficiency = (1-v/684) x 100 (%)
Where

684 is a theoretical volume of gases generated (ml) per 1 AH at 25 deg. C, 101.3 kPa (1013 mbar)

A.12 **Information to be supplied by the purchaser**

i) Nominal voltage
ii) Capacity (in AH at the 10 hour rate)
iii) Mono-block type or stackable single cell type
iv) No. of cells per battery for stackable cells.
v) Cell/Battery designation in accordance with the standard.
vi) Accessories and spares required if any.

Table – II

Capacities and final cell voltages at various rates of discharge at 27 deg. C.

Rate of discharge	Capacity expressed as % of C-10 capacity rating	End cell voltage
C-1	50.0	1.67
C-2	63.3	1.67
C-3	71.7	1.70
C-4	78.2	1.74
C-5	83.3	1.74
C-10	100.0	1.75

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Part B

CHARGER FOR VALVE REGULATED (SEALED) LEAD ACID STATIONARY BATTERY

B.1 **Scope**

B.1.1 This specification lays down the requirements and tests for battery chargers for use in Railway S&T installations for charging of Valve Regulated (sealed) Lead acid stationary Secondary cells/batteries.

B1.2 The battery chargers covered in this specification are self regulating type, capable of giving constant output voltage for the full input range of 160-270V, AC and load current varying from 10% to 100% with temperature compensation.

B.1.3 Whenever the AC input voltage goes below 155V or above 275, the AC supply to the charger is disconnected and automatically reconnected whenever AC supply is restored in the range 155-275V.

B.14 The nominal output voltage and the rated output current of the charger are required to be specified by the purchaser.

Note No. 1

Recommended current limit for chargers of some of the standard capacity secondary cells in use on Railways are given below.

SN	Cell cap (Amps. Hrs.	C/10 Rate	Recommended current rating of charger	Max permissible load (Amps.)
1	20	2	4	2
2	40	4	8	4
3	80	8	16	8
4	120	12	24	12
5	200	20	40	20
6	300	30	60	30
7	400	40	80	40
8	500	50	100	50

Note No 2

The current ratings of 5, 10, 15, 20, 25, 30, 50, 60, 75, 80 & 100 and nominal voltage ratings of 12, 24, 36, 48, 60, 110 & 220 volts are recommended for adoption by Railways. This will help in standardizing the equipment and ultimately in testing and Maintenance.

B.2 **Terminology**

For the purpose of this specification, the terminology given in IRS:S 23 & IRS:S 86/92 shall apply.

B.3 **Construction**

B.3.1 The chargers shall conform to drawings, dimensions and layout, if any specified by the purchaser.

B.3.2 The chargers shall be of natural air cooled type and shall be suitable for indoor use in the cabins where the maximum ambient temperature may reach 55 deg. C. The chargers shall be of shelf or floor mounting type as specified by the purchaser.

B.3.3 The charger shall be of robust construction. They shall be housed in shelf supporting cubicles made of cold rolled close annealed mild steel sheet of thickness not less than 1.6 mm. The cubicles shall be adequately ventilated. Ventilating openings shall be less than 3-mm size for protection against entry of lizards etc. The cubicles shall conform to IP-31 type of protection as specified in table I of specification no. IS: 2147-1962.

B.3.4 The charger cubicles shall be treated with zinc chromate primer followed by electrostatic epoxy powder coating paint finish; passivation shall be done through seven-stage process. Small metal parts such as nuts, bolts ad washers shall be either galvanised or chrome plated. All other metal parts of the charger shall be plated for prot3ection against corrosion.

B.3.5 The layout of the components and wiring shall be such that all parts are easily accessible for inspection, repairs and replacement.

B.3.6 The AC input portion shall be clearly isolated and protected to prevent accidental contact.

B.3.7 All cables and wires used for wiring shall conform to specification No. IRS:S 76-92 and shall be procured from RDSO approved suppliers. The cables and wires used shall be neatly secured in position by bunching and strapping. Aluminium wires shall not be used. The gauge of wiring shall be such that the current density does not exceed 3 Amps/mm^2. The colour scheme used for wiring shall conform to normal conventions and shall be shown in the instruction manual.

B.3.8 All connectors shall be made through crimped eyelets and shall be numbered with PVC cable marker rings corresponding to the numbers / letters shown in the schematic wiring diagrams. Soldering shall be used only where use of crimped eyelets is not possible.

B.3.9 The schematic wiring diagram referred in cl. 3.8 shall show all wiring used for interconnecting the main components of the charger. This diagram shall be drawn on an anodised aluminium plate of thickness not less than

1mm and size not less than 150 mm x 100 mm and shall be firmly fixed on the inside of the cover of the charger.

B.3.10 The components provided on the front panel shall be as per drg. No.SDO/RDSO/VRLA/BC/001.

B.3.11 All non-current carrying metal parts shall be bonded together and earthed. An earth terminal suitable for taking minimum 4 mm dia wire and with suitable marking shall be provided.

B.3.12 All cable entry holes should be provided with rubber grommets.

B.3.13 The charger unit shall have separate battery and load terminals for all ratings.

B.4 Components

ICs and other components used in the equipment shall be of industrial grade and shall conform to HIREL programme of CDIL or equivalent. Capacitor used should be certified for atleast +105 deg.C. Source of procurement of components shall be given.

B.4.1 Transformer and chokes

B.4.1.1 The main transformer shall be double wound and shall conform to category 3 (Cl. 3.1) of IS: 6297 (Pt. II) 1973. Class B or higher grade insulating material shall be used.

B.4.1.2 The transformers and chokes shall be vacuum impregnated.

B.4.1.3 When tested in accordance with cl. 6.2.1.6 of IS: 6297 (Pt. II) 71, the main transformer shall show an insulation resistance of not less than 1000 Meg ohms. This value shall not fall below 500 Meg ohms at the end of climatic tests as per cl. 8.13.

B.4.1.4 The maximum permissible rise in temperature above ambient shall be 65 deg.C for transformers and chokes.

B.4.1.5 The gauge of winding copper wire shall be such that the current density does not exceed 2Amp./sq.mm.

B.4.2 Rectifying elements

B.4.2.1 The charges shall use silicon diodes and /or silicon controlled rectifier / bipolar transistors /MOSFETs for rectification. The rectifier cells and stacks shall comply with IS: 3895-66. They shall be suitably protected against surges.

B.4.2.2 The rectifier stacks shall be connected for full wave rectification. The stacks shall be of robust construction and of adequate rating. The

temperature rise above ambient shall not exceed 50 deg. C or 20 deg. C less than that specified by the manufacturer which ever is less. The current rating of power components such as diodes, SCRs etc. shall be rated more than twice the maximum current flowing through them.

B.4.2.3 The manufacturer shall declare the peak reverse voltage of the rectifier elements under the ambient conditions, the number of elements used and manner of their connection. The peak reverse voltage rating should not be less than two times the expected reverse voltage across the rectifier elements.

B.4.2.4 All resistors used shall be atleast double the power capacity, which is supposed to be dissipated in them. The voltage rating of capacitor shall be atleast 50% above peak value. The resistors and capacitors used in control cards, firing cards and comparator cards etc. shall be of tolerances not more than 5% & 10%. The resistors and capacitors used elsewhere in the charger shall be of tolerance not more than 10% & 20% respectively.

B.4.2.5 Potentiometer used for current and voltage control should be wire wound type conforming to JSS 50502 obtained through RDSO approved suppliers. The potentiometers shall have high quality phenolic body mould specially selected contact material and the spindle, but and back cap should be of brass with nickel plating.

B.4.3 **Printed circuit cards and Components**

B.4.3.1 **PCB Material:** Material for the printed circuit board shall be copper clad glass epoxy of grade FR-4 or equivalent. PCB shall normally be of standard size (e.g.3/4/6U).

B.4.3.2 **Outline Dimensions**: PCB's shall be of standard size.

B.4.3.3 **Board Thickness:** The thickness of PCB cards and motherboard shall be as per currently available technology. There should be no deformity in the PCB cards or the motherboard due to mounting of heavy components or due to ageing effect.

B.4.3.4 **Track Width**: The track width shall be 0.5mm nominal. In no case it should be less than 0.3mm. Lesser width for use of SMD technology may be considered.

B.4.3.5 **Spacing between tracks**: Spacing between tracks shall be 0.5mm nominal and in no case it shall be less than 0.3mm. Lesser width for use of SMD technology may be considered.

B.4.3.6 The PCB shall be specifically designed to suit the circuitry used and no extra wires or jumpers shall be used for interconnection of components on the PCB. The components shall be soldered with wave-soldering machine shall have specific approval of RDSO, Lucknow.

B.4.3.7 The cards shall be provided with testing points and the corresponding voltages/ waveforms shall be indicated in the fault diagnostic procedure and service manual to facilitate testing and fault tracing.

B.4.3.8 Conformal coatings: Assembled & tested PCB should be given a conformal coating to enable them for functioning under adverse environmental conditions. The coating material should be properly chosen to protect the assembly from the following hazards-

a) Humidity
b) Dust and dirt
c) Airborne contaminants like smoke and chemical vapours
d) Conducting particles like metal clips and filings.
e) Accidental short circuit by dropped tools, fasteners etc.
f) Abrasion damage and
g) Vibration and shock (to a certain extent.

B.4.3.9 The solder masks shall be applied on the solder side and component side of the card.

B.4.3.10 Following description shall be engraved on the component side of the PCB.

a) Component outline in the proximity of the component.
b) Manufacturer's name
c) PCB name
d) Equipment name
e) Part Number

B.4.3.11 Following description shall be engraved/ marked with permanent marker on the PCB.

a) The manufacturers name
b) Month and year of manufacture.

B.4.3.12 Printed circuit cards shall be fitted with gold plated Euro/ D type plug in connectors with locking arrangement. Mechanical arrangement e.g. a clip or a screw to hold the PCB in inserted position shall be provided. Screws should be countersunk and held on PCB when it is plugged out. The PCB shall be mechanically polarized so that if is not possible to insert the PCB into wrong slot. Suitable mechanical arrangement shall be provided against wrong insertion of connectors.

B.4.3.13 Heat Dissipating Components: All components dissipating 3W or more power shall be mounted so that its body is not in contact with the board unless a clamp, heat sink or other means are used for proper heat dissipation.

B4.3.14 **Burning in**: After mounting of components the populated PCB cards kept in proper chassis in energized condition shall be burnt in for 168 hours at 60 deg.C.

B.4.3.15 The distribution of the power supply on the cards should be such that different voltage tracks (0.5V etc.) follow the same route as far as possible. The track of power supplies should be as thick and wide as possible.

B.4.4 **Meters**

B.4.4.1 Each charger shall be provided with a DC ammeter to indicate the total current delivered by the charger. The ammeter shall be of the moving coil type mounted flush with the casing on the front panel. The range of the ammeter scale shall be 125% to 150% of the rated output current of the charger. The rated output current of the charger shall be indicated on the meter scale by a distinct green marking.

B.4.4.2 An arrangement shall be provided so that it may possible to read on ammeter either the total current of the charger or current drawn by the battery set.

B.4.4.3 Each charger shall be provided with a DC Voltmeter to indicate the output voltage of the charger. The Voltmeter shall be of the moving coil type mounted flush with the casing on the front panel. The range of the Voltmeter scale shall be 150% to 175% of the nominal output voltage of the charger. The limits of voltage in float mode of working as specified in Cl. 5.6.1 shall be indicated on the meter scale by a green band.

B.4.4.4 The meters shall conform to Cl. 1.1.1 (c) of IS: 2419 and shall be of accuracy class 1.5 or better of IS: 1248.

B.4.4.5 The minimum scale length of the meters shall be 60mm for chargers of nominal output voltage up to 24V and rated output current up to 20 Amps. For chargers, where either the voltage or the current exceeds these limits, the scale length shall be minimum 90mm for both meters.

B.4.5 **Switches and Terminals**

B.4.5.1 Each charger shall be provided with a (ON/OFF) Rotary switch as per IS: 4064 (Pt. I).

B.4.5.2 The charger shall be in “Float mode” immediately after being switched ON. In order to change it to Boost mode, a two position rotary switch a per IS: 4064 (Pt. I) will be provided under a cover so that the charger is not brought in boost mode inadvertently.

B.4.5.3 Two potentiometers designated as ‘Total current and ‘Battery path current be provided at suitable location inside the front panel. They will be provided with lock nuts.

B.4.5.4 A potentiometer control designated 'Voltage control' shall be provided to adjust the output voltage over a range of 2.0 to 2.30 volts per cell under float mode of working. This shall be provided inside the cubicle accessible only after removal of cover. The initial setting will be at 2.25V.

B.4.5.5 Current output terminals shall be externally terminated. These shall be provided with red and black insulating ends of adequate size to indicate positive and negative terminals respectively.

B.4.5.6 The input, output and earth terminals shall be provided inside the cubicle and shall be accessible only when the cover is removed. The sizes of terminals shall be commensurate with the current rating of their charger.

B.4.5.8 All current carrying terminals shall be of brass and shall be plated for protection against corrosion.

B.4.5.9 Rating of switches used in the charger shall be atleast more than 50% of the charger rating.

B.4.6 Indication & Protective Devices

B.4.6.1 A green LED of 10 mm size to indicate that the input supply is ON shall be prominently provided.

B.4.6.2 A red LED of 10mm indication shall be available to indicate reverse connection to the battery. The indication shall be located near output/battery terminals. The charger shall also be protected against damage due to reverse battery connection.

B.4.6.3 Separate red LED indications shall be provided to indicate overload and short circuit condition.

B.4.6.4 HRC fuses conforming to IS: 2208 shall be provided in the DC output circuit.

B.4.6.5 In addition to fuses, protection against short circuit and overload at output terminals shall be available as envisaged in cl. 5.5.

B.4.6.6 Chargers shall be provided with means of protection against spikes in line voltages by providing line surge suppresser (MOVRs) on the input side.

B.4.6.7 Thyristors and electronic subassemblies shall be protected against accidental over voltages whether internal or external in origin.

B.4.6.8 Power semiconductors shall be protected with high braking capacity fuses. Suitable protection for high voltage surges or short circuits shall be given.

B.4.6.9 Any accidental failure of the control card or any, of the electronic control/regulation circuits, the thyristors/SCR's MOSFETS/POWER

TRANSISTORS should be blocked immediately, and operation of the unit stopped by tripping the AC input supply to the unit.

B.4.6.10 Arrangement shall be provided such that the in case any fault occurs within the charger, output terminal DC voltage of the charger shall not exceed 2.35 V/cell.

B.4.6.11 Chargers of output current rating of 50 Amps and above shall be provided with extra fuses and alarms (visual and audible) as given below.

A-Fuses

i) Rectifier elements.
ii) Smoothening condenser

B-Alarms

i) Main fuse blown
ii) Output fuse blown
iii) Rectifier element fuse blown
iv) Smoothening condenser fuse blown
v) 'Mains on' Battery discharging.

The alarms shall be provided with a resetting button for cutting of the alarm. Attention lamp/LED which will light up when the fault persists and the audible alarm shall only be reset. Facility shall be provided for a single contact which will make for any of these conditions and can be wired externally.

B.5 Performance Requirements

B.5.1 Unless otherwise specified, the charger shall be suitable for operating on single phase AC supply mains of 230V nominal and of frequency 50±2Hz. Input AC voltage may vary from 160V to 270V.

B.5.2 Nominal output voltage and rated output current of the chargers shall be as specified by the purchaser. The charger shall be rated for continuous output.

B.5.3 The DC output of the charger shall be smoothened such that the r.m.s ripple content of the output voltage when delivering the rated output current through a resistive load measure by an oscilloscope /true r.m.s digital multimeter shall not be more than 2%. The requirement shall be met in all modes of working. The DC output will be temperature compensated to protect the batteries against increase in ambient temperature. The temperature compensation factor is ±3mV/ cell/ deg.C at 27 deg.C ambient temperature.

B.5.4.1 Additional requirement for battery chargers for telecommunication installations.

The output of the chargers shall not contain psophometric noise voltage of more than 2mV r.m.s.

B.5.4.2 Additional requirements for battery chargers for axle counter installation

PARD value (ripple and noise) of output voltage is specified as under

rms value	10mV
p-p value	50mV

Measured by means of storage type 50MHz oscilloscope when delivering rated output current in float mode.

B.5.5 The chargers shall be designed to deliver continuously the rated output current without damage to or deterioration of the components of the chargers. Beyond the rated load, arrangement shall be such that the current is limited automatically up to the rated current (when working in float mode) or up to the pre-selected value of current, regulating the output voltage of the charger. As soon as the overload conditions are removed, normal voltage should again be obtainable without need for any resetting.

B.5.6 The chargers shall be suitable for float charging and boost charging mode of working as selected by means of he selector switch mentioned in Clause 4.5.2.

B.5.6.1 **Float mode**

Under this mode of working, the charger shall give a d.c, output voltage – 2.25 V per cell. Manual adjustment of output voltage over a range of 2.0V to 2.30V per cell shall be possible by voltage control potentiometer (Clause 4.5.4). The value of output voltage shall be maintained within ±0.02V/cell of the set value over the entire range of input AC supply variation (Cl. 5.1) and output load variation from no load to full load.

B.5.6.2 **Boost mode**

Under this mode of working, the charger shall be capable of delivering an output current whose magnitude shall be capable of being selected by means of the current control potentiometer. The current shall be maintained constant (within ± 5% of the selected value) with the input voltage varying between the limits mentioned in cl. 5.1 and d.c. output voltage from 1.75 to 2.4V per cell.

B.5.6.3 **Current control**

In the float mode, the charger shall be able to give current as required by the batteries/cells when the voltage is fixed at 2.25V per cell. The current, however, shall not exceed the value set by current control potentiometer (Cl. 4.5.3).

B.5.6.4 The overall watt efficiency shall not be less than 70% for chargers of 500 watts or more rated output power & 65% for chargers of less than 500 watts rated output power in all modes of working. For chargers of 12V, current up to 40A, the overall watt efficiency shall not be less than 60%.

B.5.6.5 The power factor shall not be worse than 0.7 lagging in all modes of working a input AC terminals, at full load without connecting PF correcting capacitors.

B.5.6.6 The no load current of the charger shall not be more than 10% of the rated input current under float mode with input voltage variation as specified in Clause 5.1.

B.5.6.7 In case of AC mains failure, the reverse leakage current from the battery through the chargers shall not exceed 50mA. The measurement shall be taken after disconnecting the meter on the output side.

B.5.6.8 The charger should have soft start feature whereby on energisation, the output voltage should build up slowly in approximately 10 seconds, eliminating all starting surges.

B.5.6.9 The charger should have good transient response. For a 25% to 75% change in load, the undershoot/overshoot in output should come down within 10% of the output voltage within 250 mS. This test will be carried out without connecting batteries.

B.5.7 **Over and under Voltage protection**

a) DC over voltage protection: In case output DC voltage exceeds 2.37V/cell, the over voltage protection shall operate & shut off the charger output which can be restored through reset push button.

b) DC under voltage: Red LED indication shall appear with audible alarm (re-settable) when no charger output voltage is available although AC supply is available. At 1.9V/cell, red indication (Run DG set) shall appear with audible alarm (non-resettable type). This indication shall appear in float/ boost mode of working. The potential free contact shall be provided on the front panel of the charger cabinet to allow easy access for its use at site. The alarm / indications shall remain lit until the AC supply is restored.

Alarm/ indication shall work even if mains fail.

B.6 **Marking**

B.6.1 The marking / indications / labels shall not be affected ruing climatic tests.

B.6.2 All marking/ indications shall be easily legible and durable. Where the marking is by use of labels, the labels shall be metallic or screen printed. These shall be firmly stuck and shall not be capable of being removed by hand easily. Durability of a marking shall be checked by rubbing the marking by hand for 15 Sec with a piece of cloth soaked with petroleum spirit. This requirement shall also be met after completion of climatic tests.

B.6.3 All marking / indications shall be placed in the vicinity of the components to which they refer and shall not be placed on removable parts, if these parts can be replaced in such a way that the marking / indications can become misleading.

B.6.4 The words 'INDIAN RAILWAY PROPERTY' shall be indelibly etched, engraved on the charger at a conspicuous position, the size of letter shall be chosen depending upon the size of the charger cubicle but shall not be less than 20 mm high in any case.

B.6.5 Each charger shall be provided with a rating plate fixed outside at a conspicuous position. The rating plate shall be clearly and indelibly etched/engraved or anodized and shall show the following information.

a) Name or trade mark of manufacturer.
b) IRS number
c) Nominal Ac input voltage and frequency
d) Nominal DC output current
e) Nominal DC output voltage
f) Serial number & year of manufacture
g) Installation for which meant i.e. signal/Telecom/Axle counter.

B.6.6 The AC line terminal shall be indicated by the letter 'L' and neutral terminal by the letter 'N'. Earth terminal may be indicated either by letter 'E' or by symbol.

B.6.7 The designation of the components mounted on the front panel and their operating positions shall be indicated by engraved metal or plastic labels. The direction of rotation of voltage /current controlling potentiometers shall be indicated by use of arrows. The ratings of the fuses used shall be clearly marked on their base plates. Where the removable fuse carriers are interchangeable, they must also be individually identified.

B.6.8 The main components inside the charger, and the input and output terminals shall be clearly marked and identified.

B.7 **Instruction Manual**

B.7.1 Two copies of instruction manual shall be supplied with each charger. The manual shall include the following information.

a) Installation and operating instructions.
b) Guaranteed performance data and technical and other particulars of the charger.
c) Wiring diagrams showing components and their identification markings
d) List of al components used in the manufacture of charger and their values.
e) Trouble shooting procedures.
f) Explanatory notes on operation, maintenance and adjustment procedure.
g) Any other information which the manufacturer may like to give.

B.72. The instruction and Maintenance manual should be tied up on the inner side of the cover, which shall be opened at the site for cable termination.

B.8 **Test and Requirements**

B.8.1 Conditions of Tests – Unless otherwise specified, all tests shall be carried out at ambient atmospheric conditions.

B.8.2 For inspection of material, relevant clauses of IRS:S 23 shall also apply.

B.8.2.1 **Test equipment** – The ammeter and Voltmeters used in the tests shall be of an accuracy class equal to at least 0.5 of IS: 1248-1968.

B.8.3 **Type tests** – The following shall comprise type tests and shall be carried out in the given sequence.

a) Visual Inspection	Cl. 8.6
b) Insulation resistance test	Cl. 8.7
c) Applied high voltage test	Cl. 8.8
d) Induced high voltage test	Cl. 8.9
e) Temperature rise test	Cl. 8.10
f) Performance test	Cl. 8.11
g) Test for protective devices	Cl. 8.12
h) Climatic tests	Cl. 8.13
i) Endurance test	

B.8.3.1 Only one charger of each type and output rating shall be tested for this purpose. The charger shall successfully pass all the type tests for proving conformity with this specification. If the charger fails in any of the type test, the purchaser or his nominee at his discretion, may call for another charger of the same type and output rating subject it to all tests or to the test(s) in which failure occurred. No failure shall be permitted in the repeat test(s).

B.8.4 **Acceptance tests**

The following shall comprise acceptance tests

a) Visual Inspection	Cl. 8.6
b) Insulation resistance test	Cl. 8.7
c) Applied high voltage test	Cl. 8.8
d) Induced high voltage test	Cl. 8.9
e) Temperature rise test	Cl. 8.10
f) Performance test	Cl. 8.11
g) Test for protective devices	Cl. 8.12

B.8.4.1 Visual Inspection, insulation resistance test and performance test shall be carried out on all chargers. The following sampling plan shall be adopted for the remaining tests.

Lot size	Sample size except for temperature rise test & Induced HV test.		Sample size for temperature rise test & Induced HV test.
2-8	2	1	For acceptance of the lot there shall be no failure.
9-15	3	1	
16-25	5	2	
26-50	8	2	
51-100	13	3	
101-150	20	3	
151-200	32	3	

B.8.5 **Routine tests**

Following shall constitute routine tests and shall be conducted by manufacturer on every battery charger and test results will be submitted during the inspection.

a) Visual Inspection	Cl. 8.6
b) Insulation resistance of main transformer	Cl. 8.7
c) Insulation resistance complete of charger	Cl. 8.7
d) Performance test	Cl. 8.11

B.8.5.1 The performance test may be carried out only at normal input voltage during the routine test.

B.8.6 **Visual Inspection**

The charger shall be visually inspected to ensure compliance with the relevant requirements of clauses 3,4,5 & 6.

B.8.7 **Insulation Resistance test**

This test shall be carried out

a) Before high voltage test
b) After high voltage test
c) After induced high voltage test (for main transformer only)
d) After the temperature rise test when charger has attained ambient temperature and
e) After the climatic tests have been completed.

The measurement shall be made at a potential of not less than 500V DC. The insulation shall be measured between

a) AC line terminals and earth
b) DC line terminals and earth
c) AC terminals and DC terminals

Value of the insulation resistance when measured at 40 deg. C & RH of 60% shall not be less than 10 Mega ohms for complete battery charger and shall not be less than 1000 Mega ohms for the mains transformer. There shall not be any appreciable change in the measured value of insulation resistance before and after induced high voltage test. When measured after the battery charger has attained ambient temperature after completion of temperature rise test, the insulation resistance will not be less than the limits mentioned above. When the test is repeated after the climatic test, the value shall not be less than 5 Mega ohms and 500 Mega ohms respectively. For measurements of IR values at different temperature and relative humidity, the table given in Cl. 8.7.1 of IRS:S 86/2000 shall be applicable.

B.8.8 **Applied high voltage test**

The charger shall withstand for one minute without puncture and arching, when a test voltage of 2000V rms is applied between

a) AC line terminals and earth
b) DC line terminals and earth
c) Primary and secondary winding of charger transformer

The test voltage shall be alternating of approximately sinusoidal wave form and of any frequency between 50 and 100 MHz. Printed circuit cards shall be removed and all four terminals of Rectifier Bridge shall be connected together during this test.

B.8.9 **Induced high voltage test**

The main transformer of the charger with no load shall be connected to a voltage equal to two times nominal supply voltage, the frequency being

equal to two times the rated frequency. The voltage shall be raised from 1/3rd of maximum value to full value as is consistent with accurate reading of the instrument. Full test voltage shall be maintained for one minute and shall then be rapidly reduced to 1/3rd of the value before being switched off. At the end of the test, the transformer shall be tested for the following.

a) Insulation resistance test	Cl. 8.7
b) No load current	Cl. 5.6.6

The values shall not differ from the specified value.

B.8.10 **Temperature Rise test**

The cold resistance of transformer and choke winding shall be measured after conditioning the charger until three consecutive temperature readings taken at 30 minutes interval are constant and the constant temperature shall be taken as reference temperature T_1.

The charger shall be connected to the AC supply mains setting the input voltage at 230V. Set the selector switch mentioned in Cl. 4.5.2 to the boost charging position. A resistive load shall be connected such that the rated DC current flows through the load and output terminal voltage remains at 2.3V per cell. The charger shall continue to draw the rated output current till such time the temperature equilibrium is reached i.e., the temperature variation between 3 successive readings taken at the interval of 30 minutes is less than 1 deg.C. Throughout the test, the rated load current shall be maintained. Once the temperature equilibrium has been reached, the temperature of the rectifying diodes, thyristors, power transistors, resistors, zener diodes, electric junction (carrying more than 5 Amp current) shall be measured by means of thermometer (thermo couple type) without disconnecting the load. The thermo couple used for determining the temperature rise of the different components shall be attached to the back of a small blackened disc of copper or brass 15mm in diameter and 1 mm thick which is flush with the surface of component. Then the charger shall be switched off and hot resistance of the winding of main transformer/chokes shall be measured within one minute of switching off.

The temperature rise of the winding shall be computed by the following formula

$$\frac{T = R_2 - R_1}{R_1} = (234.5+T_1) - (T_2 - T_1)$$

Where, T is the temperature rise
R_1 is the resistance at the beginning of the test
R_2 is the resistance at the end of the test
T_1 is the room temperature at the beginning of the test
T_2 is the room temperature at the end of the test

SN	Components	Max. permissible temperature rise above ambient temperature
1	Transformer & choke	60 deg. C for class B insulation or 99 deg. C for class F insulation.
2.	Silicon Diodes SCRs	50 deg C or 20 deg. C less than specified by manufacturer whichever is less.
3	Electric Junctions (terminals, switches etc.)	15 deg. C
4	Resistors	50 deg.C

During the test, the charger shall be protected from droughts and radiations from warmer object. After completion of test and retaining ambient temperature, charger shall meet the requirements as given in Cl. 8.7 and 8.8.

B.8.11 **Performance test**

The charger shall be tested for its output performance (watt efficiency, regulation, no load current, power factor and ripple content) by connecting a variable resistive load across the output terminals. The test shall be carried out at AC input voltages of 160 and 270V. Test connections for measurement shall be same as in Cl. 8.11 of IRS:SX 86-92.

Note: For chargers of output current higher than 20 Amps. If resistive load are not available, use of a water load is recommended. The capacity of the water load should be sufficient so that the temperature does not rise more than 35 deg. Above ambient during the test.

B.8.11.1 **Float working** – Set the charger to float mode of working by means of the selector switch mentioned in Cl. 4.5.2. Check the working of voltage control pot to ascertain whether variations from 2.0V / cell to 2.3V/ cell is possible at rated output current. Then adjust the output voltage at 2.25V/ cell at rated output current and at nominal input voltage. Vary the resistive load and record readings without disturbing the voltage control pot settings. Reading shall be taken at:

a) Nominal input voltage (230V)
b) 270V
c) 160V

B.8.11.2 **Boost working**

Set the charger to boost mode of working by means of the selector switch mentioned in Cl. 4.5.2. Set the voltage to 2.3V/ cell using boost pot and record readings for line and load variations. (Line voltages of 160V, 230V and 270V and load variations from 25, 50, 75 and 100%).

B.8.11.3 The charger shall fulfil the requirements of no load current, power factor, efficiency, ripple voltage, voltage stability under float mode of working and

current/voltage stability under boost mode of working as given in different clauses of this specification.

B.8.11.4 The charger may also be tested by actually connecting it to a set of batteries.

B.8.12 **TEST FOR PROTECTIVE DEVICES**

B8.12.1 **Overload/Short circuit**

During this all fuses of the charger shall be short-circuited. Charger shall be connected AC input voltage of 270V. Output terminals shall be short circuited through a suitable arrangement. Steady short circuit current shall be measured. It should not exceed rated current +10%.There shall not be any damage to charger. Working of overload/short circuit Indication/alarms will also be checked. This shall be achieved by controlling output current and voltage under short circuit condition and not by switching off under short circuit condition and not by switching off the input/output voltage under short circuit condition.

B.8.12.2 **Reverse Battery connection**

A fully charged battery shall be connected in reverse polarity to output terminals of charger. There shall be no emission of smoke or undue temperature rise of any component of charger. Working of corresponding indication/alarm will also be checked.

B.8.12.3 All the protection /alarms shall be within tolerance of ±0.02V/ cell for voltage and ±1% in case of current.

B.13 **CLIMATIC TESTS**

B.13.1 The climatic tests shall consists of

i) **Change in temperature test** IS: 9000 Part XIV Section II

Low temperature	$-5^{o}C \pm 3^{o}C$
High temperature	$+70\ ^{o}C \pm 2^{o}C$
Rate of change in temp	$1^{o}C$/min.
Duration	3 hrs at each temp.$-5^{o}C$ &+ $70^{o}C$
Cycle	3
Condition	Fully functional during test

ii) Dry Heat Test - Dry heat test as per IS 9000 Part III Section III

Temperature	$+70^{o}C$
Duration	16 hrs
Condition	Fully functional during test

(iii) **Cold Test** - IS 9000 Part II Section III

Temperature	-5°C ± 3°C
Duration	2 hrs
Condition	Fully functional during test

(iv) **Damp Heat test (Cyclic)** As per IS 9000 Part V Section I & II

Upper temperature	40°C ± 2°C
Humidity	95% max
Cycles	6
Condition	Fully functional during one hour period towards end of each cycle

(v) **Damp Heat (Steady state Storage)** as per IS:9000 Part IV

Temperature	40°C ± 2°C
Humidity	93% (+2%,-3%)
Cycles	4 days
Condition	Fully functional during test

(vi) **Dust test** as per IS 9000 Part XII

Duration	1 hour
Condition	After this test, electrical parameters shall be monitored in addition to physical checks

(vii) **Bump test** as per IS 9000 Part VII Sec.II

No. of bumps	1000
Peak acceleration	400m/Sec Sq.
Pulse duration	6 mS
No. of axes	03
Condition	After this test parameters shall be monitored in addition to physical checks

(viii) **Thermal cycling test**

(a) The PCB shall be subjected to thermal cycling as per the procedure given below. The assembled boards are to be subjected to rapid temperature cycling as mentioned below in the power off condition.
(b) This temperature cycling from 0 deg C to 70 deg. C, 1/2 hours at each temperature for 9 cycles and 1 hour at each temperature for the 10^{th} cycle. Dwell time of 1 hour is provided for the last cycle in order to oxidize defective solder joints exposed through thermal stress.
(c) The rate of rise/ fall of temperature shall be min 10 deg. C per minute
(d) In addition to physical checks, the electrical parameters are also to be monitored after this test.

(e) Power cycling: The power supply modules shall be subjected to 60 ON-OFF cycles for 1 hour. The ON-OFF switch usually provided in the modules may not be used for this purpose.

B.8.13.2 The climatic tests shall be carried out by setting the chargers in boost charge mode of operation by means of the selector switch mentioned in Clause 4.5.2. During the period of exposure in each test the chargers shall be connected to supply mains of nominal input voltage and shall deliver the rated output current at output voltage of 2.3V/cell to a resistive load.

B.8.13.3 Immediately after the damp heat test, the insulation resistance of the main transformer shall not go below 100 Mega ohms and for complete charger not below 5 Mega ohms which shall improve to 500 Mega ohms and a Mega ohms respectively after complete recovery.

B.8.13.4 During the last half hour of exposure under dry heat test, insulation resistance shall not go below 5 Mega ohms. The charger shall not show signs of any apparent damage or deterioration. The charger shall then satisfy the requirement of Cl. 8.7 and no load current shall not vary more than 5% of the initial value before test. Requirement of Cl. 6.1 will also be ensured.

B.8.14 **Vibration test:**

The charger shall be subjected to vibration test as per RDSO/SPN/144/2004

Description	Upto & including 75Kg weight	Over 75Kg weight
Freq. Range	05-350 Hz	5-150 Hz
Amplitude	± 6 mm constant displacement or 15m/ Sec.^{2} constant acceleration.	± 6 mm constant displacement or 15m/ Sec.^{2} constant acceleration.
No. of axes	3	3
No of sweep cycle	20	10
Total duration	105 min	105 min
If resonance is observed	10 min at each resonant freq.	10 min at each resonant freq.
Condition	After this test, electrical parameters shall be monitored in addition to physical checks as per Cl. 8.11.	

B.9 **PACKING AND LABELLING**

B.9.1 Charger units complete shall be packed in suitable boxes/crates, strong enough, without additional packing to prevent damage or loss to the unit during transit. Loose space inside the box/crate shall be filled up with suitable packing material.

B.9.2 It is desirable that the Fragile components such as meters and P.C cards are individually packed to prevent damage.

B.9.3 Each box shall be legibly marked at one end with code numbers, contents, quantity and name of manufacturer/supplier.

B.10 INFORMATION TO BE SUPPLIED BY THE PURCHASER

a) Nominal input voltage
b) Nominal output voltage and rated output current (Cl.1.4)
c) Drawings, Dimensions and layout if desired (Cl. 3.1)
d) Type of mounting required - shelf mounting of floor mounting (Cl. 3.2)
e) Whether the charger is being procured for signalling or Telecom or Axle counter installation (Cl. 5.4.1 & 5.4.2).

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ANNEXURE
GENERAL INFORMATION ABOUT VRLA BATTERIES

1. Effect of Temperature on VRLA batteries

The lead acid batteries both conventional as well as VRLA batteries are normally designed to give the full rated capacity and the expected life at the operating temperature of 27 deg.C. When the operating temperature is higher than 27 deg.C, the positive grid corrosion rate increases. This is due to ARRHENIUS principle which states that the rate of chemical reactions doubles for every 10 degC rise in ambient temperature. Thus the effect of temperature is same on both the conventional as well as VRLA batteries. But, the effect of increased temperature is more pronounced on VRLA batteries because of less volume of electrolyte available and also because there is no addition of electrolyte during the usage of the battery. It is said that the life of VRLA batteries gets reduced by 50% for every 10 deg.C rise in ambient temperature. For example, if designed life for a particular VRLA battery is 10 years at 27 deg.C, it becomes 5 years at 37 deg.C. The relationship between ambient temperature and life is given in figure 2.

2. Effect on Capacity when stored for long duration

A fully charged battery looses capacity when stored. This process of capacity loss is called as "self discharge". The various parameters that effect the self discharge are the Lead alloys, used for positive and negative grids, the purity of raw materials used in the manufacturing process, the processing techniques employed, and the storage conditions at the site. Considering the above, the capacity loss for VRLA batteries is around 1% per week.

Further, depending on the temperature at which these batteries are stored the loss of capacity due to self-discharge varies. The self discharge rate doubles for every 10 deg.C rise in temperature resulting in loss of capacity. In order to get optimum performance from thee batteries, the following course of action may be resorted to.

i) Always store the batteries in covered area away from direct sunlight, rain, storm dust etc.
ii) As far as possible, store the batteries at temperatures of 25 deg.C to 32 deg.C in a clean and dry location.
iii) VRLA batteries when stored for long duration (i.e. between the date of shipment and date of installation) a freshening charge should be given once very six months.

If the above procedure is followed the effect on capacity when stored forlong duration is negligible. However, the period for giving freshening charge get a shortened if these batteries are stored at elevated temperatures. The table below gives the storage interval at various elevated temperatures before which a freshening charge is to be given:

S.No	Temperature in Deg. C	Storage interval in months
1	32	6.0
2	37	4.5
3	42	3.0
4	47	2.25
5	52	1.5

3. Determination of state of charge of VRLA batteries

In conventional flooded batteries, the specific gravity of the electrolyte gives a fairly good indication of the state of charge of the battery. However, in a VRLA battery, it is not possible to measure the specific gravity of the electrolyte since it is completely absorbed in the spun glass microporous separator and the battery is sealed.

The terminal voltage of the battery is directly related to the concentration of the electrolyte. Therefore, if one were to measure the open circuit voltage of the battery, the state of charge can be determined. The open circuit voltage (OCV) readings should be taken after 24 hours of discontinuing charging. The OCV value is co-related to the stage of charge of VRLA batteries as per table I.

Sometimes, it may not be possible to disconnect the batteries from service for 24 hours and then check the OCVs. Then the pattern of charging current delivered by a temperature compensated voltage - regulated charger after a discharge provides the alternate method for determining the full state of charge. The temperature compensation factor is 3 mv per cell/deg.C rise above the ambient temperature (27 deg.C).

Under normal conditions the batteries are floated at around 2.25V per cell i.e. in a 24V system, 12 cells are floated at 27 V. During charging as the cells approach full charge, the battery voltage rise to approach the charger output voltage i.e. 27V and the charging current decreases to the float current value of around 50mA/100 AH for VRLA batteries. So, when the charging current has stabilized at the float current for three consecutive hours or the voltage across the battery bank terminals is constant for six consecutive hours, the battery bank can be considered as having reached full state of charge.

If the charging voltage has been set at a value higher than 2.25V (but equal to or less than 2.30 VPC so as to reduce the charging time), it is normal practice to reduce the charging voltage to the float value of 2.25V after 12 hours. Then the float current will soon stabilise and the above method can be adopted for determining the state of charge.

As a ready recknoner, table-II gives "state of charge" vs "float charge voltage" for 12, 24, 60, 110 & 2V sets. Able III gives "state of charge" vs "On discharge voltage" for a 12V set. Table IV gives recommended float charge voltages and protection limits for 12, 24, 60 and 110V sets.

S.No	Item	Nominal required value
1	Float voltages setting at battery terminals	(2.25 x No. of cells) Volts 24V system - 27V 110V system - 123.75V 54 cell system - 121.5V
2	Boost voltage setting at battery terminals	(2.3V x No. of cells) Volts For 24V system - 27.6V For 110V system - 126.5V For 54 cell system - 124.2V
3	Normal battery charging current when battery put inot charge after discharge	10% of AH capacity eg. 100AH battery to be charged at 10A current
4	Maximum battery charging current when battery put in to charger after discharge	20% of AH capacity
5	Ripple content in DC voltage when measured with True RMS Multimeter at battery terminal	Should be less than 2% rms. 0.48 rms (Max) for 24V system 2.2V rms (Max for 110V system
6	Battery charging voltage high protection	2.37 PC i.e. Voltage trip at 28.44V for 24V system Voltage trip at 130, 35V for 110V system Voltage trip at 127.98V for 54 cell system.
7	Battery under voltage trip on discharge	1.75V PC i.e. 24V system should disconnect the load at 21V, 110V system should disconnect the load at 9.625V for 54 cell system - 94.5V

5. Installation and Maintenance Instructions

a) Installation

Dos

1. Unload and store the batteries in covered area on receipt of shipment.
2. Read 'Instruction and operating instruction manual' prior to installation of the batteries.
3. Clean the batteries as and when dust accumulates.
4. The batteries if placed in cubicle, provide sufficient ventilation.
5. The terminal bolt connections to be torqued to 10Nm (100 lb inch).
6. Retorque the connections once every six months
7. Always use suitable washers where ever bolt connections are provided.
8. Keep the batteries away from heat source, sparks, fire etc.
9. Charge the batteries once every six months, if stored for long periods.
10. After discharge recharge the batteries immediately.
11. Note down individual cell voltage readings once every three months.
12. Charge the batteries only at 2.25V per cell.

Don'ts

1. Do not locate the batteries in places exposed to direct sun light, rain, dust, storm etc.
1. Do not add water or acid.
2. Do not attempt to dismantle the battery.
3. Do not tamper with safety valves
4. Do not over tighten the terminal bolts
5. Do not boost charge the batteries for more than 12 hours.
6. Do not allow any metal objects to rest on the battery or fall across the battery terminals
7. Do not boost charge the batteries for more than 12 hours.
8. Do not mix the batteries of different capacities or makes.
9. Do not mix ordinary conventional/low maintenance batteries with maintenance free VRLA batteries.

b) Maintenance and operation

General

Batteries are rated to an end cell voltage of 1.75 VPC at all rates of discharge.

Floating charge method

In this type of operation, the battery is connected in parallel with a constant voltage charger and the critical load circuits. The charger should be capable of maintaining the required constant voltage of battery terminals and also supply normal connected load where applicable. This sustains the battery in a fully charged condition and also makes it available to resume the emergency power requirements in the event of an AC power interruption of charge failure.

Float and Boost voltages

Given below are the float and boost voltages per cell recommended for the POWER STACK battery system. The average "Volts per cell" 9VPC) value of the series string should be set tot he recommended voltage under float and boost conditions.

RECOMMENDED FLOAT VOLTAGE 2.25 VPC AT 27 DEG.C
RECOMMENDED BOOST VOLTAGE 2.30 VPC AT 27 DEG.C

Modern constant voltage output charging equipment is recommended for the floating charger method of operation of batteries. This type of charger, properly adjusted to the recommended float and boost voltages (Ref. Annexure - A) and following recommended surveillance procedures, will assist in obtaining consistent serviceability and optimum life. The charging current for the battery should be limited to 20% of its nominal AH capacity.

After the battery has been given its freshening charge, the charger should be adjusted to provide the recommended float voltage at the battery terminals.

Do not use float voltage lower or higher than those recommended. This will result in reduced capacity and / or reduced battery life.

Check and record battery terminal voltage montly. If normal battery float voltage is above or below the recommended value, adjust charger to provide proper voltage as measured at the battery terminals.

Important

It is preferable to have the following characteristics in the battery charger being used with these batteries.

h) High Voltage cur-off at 2.37 VPC
i) Low voltage trip at 1.60 VPC
j) Voltage ripple to be limited to 2% rms
k) Voltage regulation to be limited to ±1%.
l) Battery charging current shall be limited to a maximum of 20% of the 10 hour rated battery capacity in Amps.

Table - I

% State of charge	Open Circuit voltage +0.05 & -0.02
100	2.15
90	2.13
80	2.11
70	2.09
60	2.07
50	2.05
40	2.03
30	2.01
20	1.99
10	1.97
0	1.95

Table - II

SOC Vs Float Charge Voltage

SOC (%)	System Voltage				
	12V	**24V**	**60V**	**110V**	**2V**
0	12.00 -12.24	23.00 - 24.48	60.00-61.02	108.0-110.16	2.00-2.04
10	12.30 -12.54	24.6 - 24.8	61.05-62.07	110.7-112.86	2.05-2.09
20	12.54 -12.78	25.8 - 25.56	62.07-63.09	112.86-115.2	2.09-2.13
30	12.78 -13.02	25.56 - 26.04	63.09-65.01	115.2-117.18	2.13-2.17
40	13.02 -13.14	26.04 - 26.28	65.01-65.07	117.18-118.26	2.17-2.19
50	13.08 -13.26	26.16 - 26.52	65.04-66.03	117.72-119.34	2.18-2.21
60	13.2 - 13.88	26.4 - 26.76	66.00-66.09	118.8-120.42	2.20-2.23
70	13.32 - 13.44	26.64 - 26.88	66.06-67.02	119.88-120.96	2.22-2.24
80	13.38 - 13.5	26.76 - 27.0	66.09-67.05	120.42-121.5	2.23-2.25
90	13.44 - 13.53	26.88 - 27.06	67.02.67.65	120.96-121.7	2.24-2.255
110	13.47 - 13.554	26.94 - 27.108	67.35-67.77	121.23-121.986	2.245-2.259

Table - III

STATE OF CAHRGE Vs ON DISHARGE VOLTAGE
(for a 12V battery)

% State of charge	On Discharge voltage
100	12.65-12.90
90	12.55-12.80
80	12.40-12.70
70	12.25-12.55
60	12.10-12.40
50	11.95-12.25
40	11.80-12.10
30	11.55-11.85
20	11.25-11.55
10	10.60-11.15
0	10.35-10.60

Table - IV

System voltage	Float charge voltage setting	Protections			Ripple (RMS)	Voltage regulation (±)
		Over voltage cut off	Under voltage trip	Current limit (in rated capacity)		
12	13.5	14.22	9.6	20%	2%	1%
24	27.0	28.44	19.2	20%	2%	1%
60	67.5	71.1	48.0	20%	2%	1%
110	121.5	127.98	86.4	20%	2%	1%