Template for submitting comments/inputs on revision of the Draft GR for "Lithium-Ion Battery for Telecom Applications (TEC 67030:2024)")

Name of Manufacturer/Stakeholder:

Organization:

Contact details:

Clause No.	Clause Description	Comments, if any	Remarks, if any

Note: The comments/inputs on the draft GR (Standard No. TEC 67030:2026) may be furnished in the above format through email to adgfa-tec-dot@gov.in with copy to dirfa.tec@gov.in, rafa.tec-dot@govcontractor.nic.in, rafa2.tec-dot@govcontractor.nic.in and ddgfla.tec@gov.in at the earliest and within prescribed time period.

वर्गीय अपेक्षाओंआवश्यकताओं

के लिए मानक

सं. टीईसी

६७०३०:२०२६67030:2024

(सं: टीईसी ६७०३०:२०२४/जीआर/टीएक्स/एलआईबी-001/01 मार्च-16 को अधिक्रधमत करता है)

STANDARD FOR GENERIC REQUIREMENTS

TEC 67030:2064

(Supersedes No. TEC 67030:2024/GR/TX/LIB-001/01. MAR-16)

लिथियम आयन बैटरी फॉर टेलीकॉम एप्लीकेशन

Lithium Ion Battery for Telecom Applications

ISO 9001:2015

दूरसंचार अभियांत्रिकी केंद्र

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FOREWORD

Telecommunication Engineering Centre (TEC) is the technical arm of Department of Telecommunications (DOT), Government of India. Its activities include:

- Framing of TEC Standards for Generic Requirements for a Product/Equipment, Standards for Interface Requirements for a Product/Equipment, Standards for Service Requirements & Standard document of TEC for Telecom Products and Services
- Formulation of Essential Requirements (ERs) under Mandatory Testing and Certification of Telecom Equipment (MTCTE)
- Field evaluation of Telecom Products and Systems
- Designation of Conformity Assessment Bodies (CABs)/Testing facilities
- Testing & Certification of Telecom products
- Adoption of Standards
- Support to DoT on technical/technology issues

For the purpose of testing, four Regional Telecom Engineering Centers (RTECs) have been established which are located at New Delhi, Bangalore, Mumbai, and Kolkata.

ABSTRACT

This document covers the generic requirements of lithium-ion batteries for use in the Telecommunication Network applications for 0.5C charge/discharge rate to provide uninterrupted power supply to the Telecommunication Equipment. Battery should have all the necessary electronics and intelligence built into it so that battery performance is safest and proper with the existing power plants. The batteries in Telecom Network are used for Float and cyclic application depending upon the requirement and location. The battery may be required to provide a back-up between 2 to 72 hours.

CONTENTS

HISTORY SHEET

Sl. No	*Standard/Document No.*	*Title*	*Remarks*
1.	TEC/GR/TX/LIB-001/01. MAR-16	Lithium Ion Battery for Telecom Applications~~Lithium Ion Battery for Telecom Applications~~	First Issue
2.	TEC 67030:2024	Lithium Ion Battery for Telecom Applications	Second Issue* Revised version of GR on Lithium Ion Battery for Telecom Applications. Aligned with latest TEC template in addition to make it compatible with latest IEC standards and latest advancements in Li-Ion battery technology.
3.	TEC 67030:2026	Lithium Ion Battery for Telecom Applications	Third Issue Requirements in respect of some of the parameters have been changed in the relevant clauses to accommodate advancements, more optional features for the purchaser and for better clarity

~~***Note:** The earlier Release 2 issue (available on the TEC website before September, 2024) required some editorial corrections and further improvement due to inadvertent errors w.r.t. the final approved version. Accordingly, the earlier Release 2 issue has been replaced by this updated Release 2 document. Therefore, for all relevant purposes, this document may~~

~~be referred.~~

REFERENCES

S.No.	*Document No.*	*Title/Document Name*
1.	IS2500	Sampling Inspection Procedures
2.	UL1642,	Safety Requirements
3.	IEC 62133	Safety Requirements
4.	ISO 9001:2015~~2008~~	Quality Management System Requirements.
5.	ISO 14001 (Latest Issue)	Pertaining to environmental requirements
6.	UL-94 V-0	Underwriters Laboratories Standard on Fire Retardant Materials.
7.	IEC 61000-4-2	Electrostatic Discharge (ESD) Immunity limits.
8.	IEC 62619	Safety requirements for secondary lithium cells and batteries, for use in industrial applications
9.	UL1973	Safety Standard for energy storage systems.
10.	IEC 60529	Degrees of protection provided by enclosures (IP Code)
11.	TEC14016:2010 (old no. QM-333 Issue March 2010	Standard for Environmental Testing of Telecommunication Equipment

12.	TEC10009: 2024	Safety Requirements of Telecommunication Equipment

Note:

1. Unless otherwise explicitly stated, the latest approved issue of the standard /GR/IR, with all amendments in force, listed in references, on the issuance date of this GR/IR are applicable.

CHAPTER 1

1.0 Introduction

This document covers the generic requirements of lithium-ion batteries for use in the Telecommunication Network applications for 0.5C charge rate and discharge rate. The batteries are used to provide uninterrupted power supply to the Telecommunication Equipment. Batteries are required to have all the necessary electronics and intelligence built into it to ensure that the battery performs in the safest and proper manner with existing power plants.

1.1 The battery is normally not allowed to discharge beyond 80% of C (rated capacity). Number of discharge cycles up to 80% DOD, per month may be up to four to five in metropolitan areas and more in the semi-urban & rural areas depending upon the capacity in terms of commercial mains supply conditions (`C', wherever used in this document, stands for the capacity of the cell/module). These types of batteries are charged normally at 0.5C rate in a constant current / constant voltage charge mode. The battery may be charged at higher rate, if recommended by the manufacturer.

1.2 The batteries in Telecom Network are used for Float and cyclic application depending upon the requirement and location. The battery may be required to provide a back-up between 2 to 72 hours. In Telecom Network the batteries are also used as a power reserve for Telecommunication equipment. The SPV power generator, which supplies the charging power to these batteries can deliver the current which is approximately 50% of the battery bank capacity (C/2 rate of charge) for 3 to 4.5 hours on any bright sunny day and is sufficient to recoup the lost battery capacity fully, during the day. The discharge rate for these batteries is between 0.5C to1 C up to 80% of its rated capacity, depending on application requirements.

1.3 **Float and Cyclic Application**: The battery is normally not allowed to discharge beyond 80% of C (rated capacity). Number of discharge cycles up to 80 %

DOD, per month may be up to four to five in metropolitan areas and more in the semi-urban & rural areas depending the commercial mains supply conditions. These types of batteries are charged/ discharged normally at C/2 in a constant voltage/constant current mode ('C', used in this document, stands for the capacity of the cell/module). The battery may be charged at higher rate if recommended by the manufacturer.

Batteries are normally of 12V, 24V and 48V. These batteries are formed by connecting up to 15 cells each having normal voltage as 3V or above of the rated capacity in series to form modules subject to compliance of clauses 3.1 & 3.11(design practice and cell matching clauses). For 12V, 24V, 48V modules, capacity up to 314 Ah, 200Ah, 150Ah, 100Ah, 75Ah and 50Ah can be used subject to the condition that the paralleling of cells within the module is not permitted.

The Type Approval is to be generally granted for the battery module. TAC is valid for the battery module of particular design, capacity–, Make & Model only. Maximum capacity of the battery bank shall be declared by the OEM/ manufacturer while seeking Type Approval Certificate of battery module. In case of specific requirement from purchaser for rack / battery system level certificate, rack level / battery system level Type approval certificate shall be granted.

1.4 **SPV Application:** In Telecom Network the batteries are also used as power reserve for Telecommunications equipment. The SPV power generator, which supplies the charging power to these batteries can deliver the current which is approximately 50% of the battery bank capacity (C/2 rate of charge) for 3 to 4.5 hours on any bright sunny day and is sufficient to recoup the lost battery capacity fully, during the day. The discharge rate for these batteries is between C/2 to C/20 up to 80% of its rated capacity, depending on application requirements. The manufacturer should provide the discharge tables of the battery at C, C/2, C/3, C/4, C/5, C/6, C/8, C/10, C/20 rate of discharge to enable the field unit to set the charge controller voltage low disconnect to ensure that battery is not allowed to discharge beyond 80% of its rated capacity.

2.0 Description

Lithium batteries are categorized by their chemical composition (anode, cathode and electrolyte), internal construction and availability in cylindrical, prismatic configuration. It is necessary to consider all relevant safety aspects at the battery design stage, recognizing the fact that they may differ considerably, depending on the specific lithium system, power output and battery configuration. The following design concepts for safety are common to all lithium batteries.

a) Abnormal temperature rise above the critical value defined by the manufacturer shall be prevented by design.

b) Temperature increases in the battery shall be controlled by a design which limits current flow.

For higher capacity, paralleling of basic module will be used. Paralleling of the modules is permitted only with an electronic controller like Parallel Battery management System to maintain state of Charge (SOC) between parallel connected modules.

2.1 Battery construction:

Design Practices: The internationally adopted design practices shall be followed. The paralleling of cells within the module is not permitted. Paralleling of modules for enhancement of capacity is permitted. Minimum capacity of the basic cell shall not be less than 50Ah. However, purchaser may decide to procure Li ion battery having lower capacity cells, depending on the requirement.

Stacking (Mounting) Arrangement: The cells must be packaged as 12V, 24V, 48V models, and the models shall be so designed as to be suitable for horizontal, vertically and handstand position, can be installed in standard 19'' cabinet or mounted on the wall. Any installation position & method shall be as per requirement to ensure space & floor loading requirements. However,

the change in the number of stacks as per purchase order shall not be treated as a deviation from Type Approval Certificate (TAC). Maximum capacity of battery bank shall be mentioned while seeking type approval for battery module.

The stacking arrangement shall be such that end terminals of the battery shall be top two adjacent modules on the same side of stack to minimise voltage drop from power plant.

Rack Assembly Arrangement (Optional): The rack assembly arrangement maybe up to 800 Ah capacity where modules are arranged in row & columns as a rack in battery bank.

2.2 **Battery Module Composition:** The prescribed battery module ratings should be 50Ah or 75Ah or 100Ah or 150 Ah or 200Ah or 314 Ah.

2.3 **Container (Module):** The cell shell, made of Aluminum metal shall be capable to meet all the requirements of lithium cell and be consistent with the life of battery and it shall be in a rigid casing of sufficient strength to prevent flexing. However, the Cell shell material can also be specified as steel/ rigid plastic cases as option depend upon purchaser's requirement. The container shall be subjected to safety standard are met.

2.3.1 The module container, made of painted galvanized sheet shall be capable to meet all the requirements of lithium- i-o-n battery module and be consistent with the life of battery. Shell and container both shall also have chemical and electro-chemical compatibility.

2.3.2 The container shall be symmetrical in shape and stand level on the plane level surface.

2.3.3 The tensile strength of the module container be such as to handle the internal pressure of the cell in the worst working condition. Module shall not show any deformity or bulge on the sides under all working conditions.

2.3.4 The container shall be capable of withstanding the rigorous of transport, storage, handling and internal cell pressure in the worst working conditions.

2.3.5 Entire clause 2.3 is applicable for Battery module only.

2.4 **Type of container (cell) material:** The material of container (cell) shall be designed by AS (Aluminum shell). However, the container material can also be plastic as an option depending upon the purchaser's requirement.

~~2.5~~ **Cell/module Covers:** The module covers shall be made of suitable steel/GI/ plastic material compatible with the container material and permanently sealed with the container. It shall be capable to withstand internal pressure without bulging or cracking. It shall also be fire retardant and shall comply with the provisions of clause 2.3.

2.5

2.6 **Pressure release Valve:** Each cell shall be provided with a pressure release valve. The valve may open only as a final protection of the worst cell condition when abnormal cell over charge/ discharge happens which further cause cell expansion, extreme high internal gas pressure. Once the safety valve blows off, the cell cannot be reused.

2.7 **Terminal Posts:** The terminals both +ve &-ve shall be capable of proper termination and shall ensure its consistency with the life of the battery. The surface of the terminal post extending above the cell /module cover including bolt shall be coated with an acid resistant &corrosion retarding material. Terminal posts or any other metal part which is in contact with the polar material that does not have any harmful effect in cell /module performance. Both Positive and negative posts shall be clearly and unambiguously identifiable. The terminal posts & its sealing shall be capable to with stand the heat generated in cell/module during external short circuit condition.

2.8 **Battery System Configuration:** The system shall employ a modular configuration to provide flexibility, keeping in view the future backup requirements. Battery modules shall be accommodated in a 19" (482.6 mm) standard rack along with Parallel Battery Management System.

2.9 **Rack:** The rack structure shall be made up of rigid fame work of steel profiles

and shall be free of sharp edges or sharp corners. The structural strength of the rack shall be able to withstand the ultimate mechanical load capacity of the rack without any deformity. The rack shall have suitable ventilating arrangements (forced cooling from the sides is not permitted). The front door (if provided) and rear door may be of hinged or removable type. The gauge of metal sheet for panels shall not be less than 1.5mm. The unit may be floor mounted or wall mounted as specified by the purchaser. The unit may be either expandable or of ultimate size, as per purchaser's requirement. The base of rack shall ensure uniform floor loading of not more than 975 kg/Sq mete. Lifting facilities shall be provided by removable eyebolt located at the top of the rack. The necessary arrangement for fixing the rack on the floor shall also be provided .The rack shall also provide with bottom clearance of 110 mm with a tolerance of +/- 10 mm .The top of the rack shall be fully covered except for proper ventilation and bus bar or cables entries .Each air flow vent shall be covered by a grill to prevent foreign material larger than 5 mm dropping into the rack .Proper thermal engineering of hardware design shall be done by the manufacturer so as to ensure the uninterrupted use of the equipment. In case of outdoor rack, rack shall be protected from dust & water complying to IP55 in accordance with IEC 60529.

2.10 **Type of +ve active material:** The positive plates active material shall be designated as, for example: Lithium Iron Phosphate: LFP

2.11 **Type of Plates assembling:** The plates assembling shall be designated as:

Winding Type: W

Stacking Type: S

Sign-writing and labeling: All the cells/modules shall be properly sign written with reference to the supplier Installation and Maintenance Manuals.

2.12 **Designation**: The cell/modules shall be designated by symbols as given in the clauses 2.4, 2.10 and arranged in sequence.

2.13 **Sign-writing and Labelling :** All the cell/modules shall be properly sign written with reference to the Supplier's Installation and Maintenance Manuals.

2.14 **Marking:** The following information shall be indelibly & durably marked.

2.14.1 Cells: Sign-writing of item nos. 4,5 and 6 mentioned below (clause 2.14.2) shall be of organic erosion resistant or organic erosion resistant sticker consistent with the life of battery shall be pasted on the cell. The Manufacturer may also use other advance methods including screen printing in addition QR code (optional) for marking on the cell.

2.14.2 Modules: All the information may be on the module itself. Sign-writing of item nos. 4, 6 and 9 mentioned below shall be of acid resistant or acid resistant sticker consistent with the life of battery shall be used on the module cover. Items 1,2,3,5 and 7 mentioned below shall be screen printed on the module. Marking of item no. 8 mentioned below may be done either with sign-writing or to be screen printed as per the Manufacturer's requirement. The other advance methods may also be used for permanent marking on the module.

1. GR No.:
2. Manufacturer's Name and Identification:
3. Model No.:
4. Serial No. of the cell/module:
5. Ah capacity of cell/module at C/5 rate of discharge:
6. Month and Year of manufacture:
7. TAC No:
8. Name of the USER: e.g. BSNL/MTNL
9. Battery SoC at the time of dispatch.

2.15 Connectors: Where it is not possible to bolt the cell terminals directly to assemble a battery, separate non corroding copper or aluminum connectors of suitable size (copper: -2A per sq mm, Aluminum: 1A per sq mm, or Al Alloy (>95%:) 1.2A or more per sq mm) shall be provided to enable connection of the cells. Connectors shall be suitably tin or nickel coated to withstand corrosion. The thickness of the tin or nickel coating of connectors shall not be less than 0.025 mm. The area of cross section of the connectors shall be sufficient to meet the requirement of the rate of discharge and shall be rated at 2 amp/mm square (minimum). For test purpose it shall be C/2 rate of discharge. No flexible cable is permitted for series parallel connections.

The manufacturer can adapt bolted or laser welded type cell interconnection.

For laser welding type interconnection, suitable cell interconnection material shall be used.

2.16 **Nuts, Bolts & Washers:** Nuts, bolts & washers for connecting the cells shall be made of copper for –ve and aluminum for +ve. Stainless steel nuts, bolts & washers can be used. This clause is not applicable for welded type of cell interconnection.

2.17 **Normative references:** The documents referred here are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies. For sampling plan, IS 2500: Sampling Inspection Procedures is applicable

3.0 **Functional Requirements:**

Nominal Cell Voltage: ≥ 3.2V per cell;

Module Voltage: 12V, 24V and 48V per module

3.1 **Cell Capacity**: When a cell is discharged at C/5 rate, it shall deliver 100% of rated capacity (corrected at 25°Celsius) before the cell voltage reaches end cell voltage specified by manufacturer (e.g. 2.75 V). Cell capacity should be more than 50Ah or 75Ah or 100 Ah or 150Ah or 200Ah or 314 Ah (as specified by the purchaser ~~manufacturer~~).

3.2 **Module capacity:** The capacity (corrected at 25°Celsius) shall not be less than C (rated capacity) and not more than 120% of C (rated capacity) when discharged to the voltage of 40.52 V (11.2V in case of 12V and 22.4V in case of 24V module) at C/5 discharge rate. The capacity of the module at discharge rates C/2 to C/20 shall be as given below:

~~3.2~~

Rate of	Module

Discharge	Discharge Current	Capacity expressed as % of C/5 Discharge rate	End module voltage (12V / 24V /48V)
C/2	0.5C	97.6	11.2/ 22.4/40.5 2V
C/3	0.333C	99.1	11.2/ 22.4/40.5 V42V
C/4	0.25C	99.2	11.2/ 22.4/40.5 V42V
C/5	0.2C	100	11.2/ 22.4/40.5 V42V
C/8	0.125C	100	11.2/22.4/40.5 V42V
C/10	0.1C	100	11.2/22.4/40.5 V42V
C/20	0.05C	100 (SPV Application only)	11.2/22.4/40.5 V42V

Table 1: Capacity of Module at discharge rates C/2 to C/20

3.3 **Charging:** The module shall be capable of being recharged from the fully exhausted condition (11.2 / 22.4 / 40.5 V42V for module of 12V/24V/48 V respectively) at the specified charge voltage. The module design shall permit the charging of the battery at 14.4/28.8/54 V for module for 12V/24V/48 V respectively, in constant current constant voltage charging mode.

(Note: Voltage measurement tolerance shall be considered +/- 0.5% of FSR.)

3.4 **Voltages during Discharge**: The cell/module voltage shall not be less than following values, when a fully charged cell/module is put to discharge at C/5 rate:

S. No.	Discharge voltage (12V / 24V / 48V Module)	Time	Remarks

a)	12.52V/25.04V/47.0V (3.13V for cell)	4.00 hrs	
b)	12V/24V/45.0V (3.0V for cell)	4.5 hrs	
c)	11.2/22.4/42.0V (2.8V for cell)	4.96 hrs	
d)	10.8/21.6/40.5V (2.75V for cell)	5.00 hrs	

Table -2: Technical -requirements -for Voltage values during discharge

3.5 Battery Discharge Tables: The manufacturer shall provide the Tables & Graphs showing relation of the closed circuit voltage, internal resistance (IR) and the residual capacity of the module/each cell in the battery string, when it is discharged to the end voltage of 40.52 V/module (11.2 / 22.4 V for 12/24 V module respectively) at C/20, C/10, C/8, C/6, C/5, C/4, C/3 & C/2 rate of discharge. The manufacturer shall also provide the table & graph showing the relation between the internal resistance (IR) & residual capacity of each module at all the above discharge rates. For seeking Type Approval certificate, the manufacturer shall demonstrate the above values at any two rate of discharge.

3.6 Transient Response (Coup De Fouet): When the battery is put to load at C/3, immediately after taking it off from the float, the voltage of any of the cells in the battery shall not fall below 3.0V, throughout the battery life. In case of module, it shall not fall below 47V in the above conditions.

3.7 Loss of Capacity during Storage: The loss in capacity during storage at an average ambient temperature of 35° Celsius for a period of 6 months shall

not be more than 20% & the module shall achieve 95% of its rated capacity within 2 charge/discharge cycles & full rated capacity within 3 cycles, after the storage period of 6 months.

In case of battery, voltage difference of each cell in the battery string shall be within 0.05V of the average voltage throughout the storage period. In respect of basic cell, undertaking of Manufacturer / OEM shall be sufficient in this regard.

3.8 **Ampere Hour (Ah) Efficiency**: Shall be better than 95%.

3.9 **Watt-Hour Efficiency:** Shall not be less than 90%.

3.10 **Short Circuit:** External short Circuit (As per IEC62619), when applied to cell, until its voltage drops to Zero, shall not cause fire or explosion of the cell. External short Circuit, when applied to module, there shall be immediate protection by BMS and shall not cause fire or explosion of the module. No Internal short circuit shall occur throughout the life of the cell/module due to active material expansion.

3.11 **Cell Matching:** Cell matching is essential for optimum life and performance of the battery. The parallel connection of cells inside the module is not permitted. The difference between cell voltages in the cell module string, with the highest & lowest open circuit voltage shall be less than 0.05V under fully recharged condition. The difference in the highest and the lowest cell capacities shall not be more than 4% of their rated capacity.

3.12 **Internal Resistance (IR) Matching:** Internal Resistance (IR) of each cell/ module in the battery, when connected in series, shall be within +/-15% of the average cell Internal Resistance (IR). The Internal Resistance (IR) matching test certificate shall be obtained from any recognized or accredited Lab.

3.13 **Standard discharge & charge current (A):** 0.5 C at a temp. 25° C and humidity 65+5%RH.

3.14 **Module Charging Voltage (V):**

For 12V, charging voltage between 12 to 14.4V

For 24V, charging voltage between 24 to 29.2V

For 48V, charging voltage between 48 to 56V.

3.15 Cut-off Voltage (V):

For 12 V, cut-off voltage between 11 to 12.5 V

For 24 V, cut-off voltage between 22 to 25 V

For 48 V, cut-off voltage between 40.52 to 47 V

3.16 Environmental Requirement: Temperature range: operation temperature for sub-zero operation as per purchaser requirement, in other cases as under:-. Charging: -> 0℃ ~ 55℃

Discharging :-> -20℃ ~ 60℃

3.17 Relative Humidity:

Operation Relative humidity: >90 % (40°C ± 2°C)

MAX 95% (40°C ± 2°C),

Storage relative humidity: >95% (40°C ± 2°C).

3.18 Atmospheric pressure: Atmospheric pressure range: 70kPa -106kPa

3.19 Cycle Life: The Cell/module for both Float & SPV applications shall be capable of giving capacity retention rate of 80% at 80% DOD at an average temperature of 25 deg C at C/5 rate, at number of cycles 3500.

4.0 Electrical Requirements

4.1 Uniformity of electrical performance

4.2 Charge limitation: The Cell /module shall be capable of being recharged from the fully exhausted condition (2.7 5V/cell or 40.5 V/module) at the specified charge voltage. The Cell/module design shall permit the charging of the battery at 3.6 V/cell or 54/module, in constant voltage charging mode.

4.3 Discharge performance

Environment temperature	Discharging current	Technical requirements
25°C	0.5C	On discharge of the battery module, the capacity no less than 97% of rated capacity.
	0.33C	On discharge of the battery module, the capacity no less than 99% of rated capacity.
	0.2C	On discharge of the battery module, the capacity no less than 100% of rated capacity.
-10°C	0.1C	On discharge of the battery module, the capacity no less than 60% of rated capacity, appearance of battery module no change, no burst.
40°C	0.5C	On discharge of the battery module, the capacity no less than 95% of rated capacity, appearance of battery module no change, no burst.
55°C	0.5C	On discharge of the battery module, the capacity no less than 90% of rated capacity, appearance of battery module no change, no burst.

Table 3: Technical requirements for discharge performance

5.0 Safety Requirements:

5.1 Tests for Safety Requirements:

The equipment shall conform to relevant safety requirements as per as prescribed under Table no. 1 of the TEC document 'SAFETY REQUIREMENTS OF TELECOMMUNICATION EQUIPMENT': TEC10009: 2024 or latest.

Following tests are to be carried out as per UL1642/ UL1973, or IEC 62619.

a. Charging procedures for test purposes
b. Continuous charging at constant voltage/Overcharge Test (cells)
c. Temperature Cycling Test
d. External short-circuit (cell)
e. External short-circuit (battery)
f. Free fall/ Drop test
g. Thermal abuse (cells)
h. Crush (cells)
i. Over-charging of battery
j. Forced discharge (cells)
k. Vibration
l. Mechanical shock/Impact test
m. Design evaluation – Forced internal short-circuit (cells)

5.2 Anti-theft protection (optional):

Following anti-theft features shall be provided on the basis of the requirements from the purchaser: -

i. An alarm to be generated in case if BMS or battery communication is failed. The alarm indication shall be displayed locally (via LED/LCD) and/or extended to the SMPS controller in accordance with the configurations defined in Clauses 6.5.6, and 6.7.

~~i.~~ii. ~~ii.~~ Gyroscope based on movement

~~ii.~~iii. GPS based on location

Purchaser shall specify the requirement for any of the options out of the above mentioned anti-theft features.

6.0 Battery Management System

A battery management system (BMS) manages a rechargeable battery (cell or battery pack) by protecting the battery from operating outside its Safe Operating Area, monitoring its state, calculating secondary data, reporting that data, controlling its environment, authenticating it and / or balancing it. If Central battery management system (CBMS) is provided, it shall collect all the information from the individual battery modules. Either battery modules (daisy chain) or CBMS communicate to the power plant. This CBMS or battery module shall also provide data logging of critical parameters of all battery modules.

The battery management system is mainly consisting of six different following components:

i. Solid-state switch for disconnecting charging path and current limiter circuit to regulate charging current.

ii. Solid-state switch for disconnecting discharging path that is disconnecting the battery discharging circuit to prevent a total discharge.

iii. The current sensor to measure the charging/discharging-currents.

iv. The BMS cell board or the central box that are monitoring and balancing the single cells.

v. The power supply for the energy supply of the BMS.

vi. 4 nos of cells temperature sensors for monitoring of cell temperature.

vii. For standalone battery bank, CBMS with LCD display is required being not integrated with SMPS power plant. For battery bank integrated with SMPS power plant, no separate display is required as SMPS controller display is available to display critical parameters as reported in TEC GR No. 66110:2024.

Use of mechanical relays/ contactor are not permitted for charge/

discharge disconnect switch. Important data, like the address of a disrupted battery, the voltage level of a single cell, temperatures, S O C can be provided by BMS to battery monitoring tool for battery diagnosis.

BMS should have all the necessary electronics and intelligence built into it so as to ensure that the battery performs in the most-safe and proper manner even without any communications with existing power plants as per TEC GR No.66110:2024 which may be already installed at various sites.

6.1 Data Display accuracy: Accuracy in data display by BMS and actual value of battery modules shall be as follows:

6.1.1 Voltage accuracy: Charge/discharge voltage display accuracy shall be better than 0.5%.

6.1.2 Current Accuracy: Charge/discharge current display accuracy shall be better than 2%.

6.1.3 Capacity Accuracy: Display accuracy shall be better than 5%.

6.1.4 Temperature Accuracy: Temperature display accuracy shall be better than +/- 2 deg C.

6.1.5 General requirement: There is no corrosivity, explosibility and insulation destructive gas and conductive dust. There is no heat reassure nearby.

6.2 Monitoring Function:

A BMS should monitor the state of the battery as represented by the following:

6.2.1 Voltage: Battery voltage, voltages of individual cells, minimum and maximum cell voltage or voltage of periodic taps.

6.2.2 Temperature: Module temperature, temperatures of group of cells (refer clause 6.0 above).

6.2.3 Current: current in or out of the battery.

6.3 Other functions: Cell balancing, Log book function.

6.4 Computation: A BMS should calculate the following:

6.4.1 Maximum charge current as a charge current limit (CCL).

6.4.2 Maximum discharge current as a discharge current limit (DCL).

6.4.3 Energy [KWh] delivered since last charge or charge cycle.

6.4.4 Charge [Ah] delivered or stored (sometimes this feature is called Coulomb counter). Accumulated delivered Ah.

6.4.5 Total energy delivered since first use. Accumulated delivered KWh.

6.4.6 Total operating time since first use.

6.4.7 Total number of cycles. Charge / discharge cycle count.

6.4.8 State of charge (SOC) or depth of discharge (DOD): to indicate the charge level of the battery.

6.4.9 State of health (SOH): a variously-defined measurement of the overall condition of the battery.

6.5 Protection and Alarm: A BMS may protect its battery by preventing it from operating outside its safe operating area, such as:

6.5.1 Over Charge Protection: If battery module is in overcharge condition, charge circuit shall be cut off and alarms shall occur. There shall be no leakage, no smoke, no fiere, no explosion.

6.5.2 Over discharge protection: If battery module is discharged to ending voltage, discharge circuit shall be cut off and alarms shall occur. There shall be, no leakage, no smoke, no fire, no explosion.

6.5.3 Short Circuit Protection: If battery module output is short circuit, circuits shall be cut off and alarms shall occur. There shall be no leakage, no smoke, no fire, no explosion. Operation of battery module can be recovered manually or automatically after instantaneous charge.

6.5.4 Over Load Protection: If discharge current of battery module is beyond the threshold of overload protection current, circuits shall be cut off and alarms shall occur. Operation of battery module can be recovered manually or automatically after failure removed. Voltage of battery module shall be no less than rated voltage after instantaneous charge.

6.5.5 Temperature Protection: If temperature reaches the threshold of protection as mentioned in Table 4, circuits shall be cut off and alarms shall occur. If temperature reaches the thresholds of the recovery in Table 4 and

electronic components of BMS are not protected against high temperature, operation of battery module can be recovered automatically. There shall be no leakage, no smoke, no fir, no explosion.

Items	Thresholds for Charge protection temperature	Thresholds for Discharge protection temperature	Threshold of recovery
Environmental over temperature protection	60°C ± 2°C	65°C±2°C	45°C ± 2°C
Environmental under temperature protection	0°C ±2°C	−20°C±2 °C	0°C ± 2°C
Thresholds for the temperature protection point and recovery point can also be set by the user or manufacturer.			

~~Items~~	~~Thresholds for Charge protection temperature~~	~~Thresholds for Discharge protection temperature~~	~~Threshold of recovery~~

Table 4: Threshold of Temperature protection and Recovery

Environmental over temperature protection	60°C ± 2°C	65°C±2°C	45°C ± 2°C
Environmental under temperature protection	0°C ±2°C	-20°C±2 °C	0°C ± 2°C
Thresholds for the temperature protection point and recovery point can also be set by the user or manufacturer.			

Table 4: Threshold of Temperature protection and Recovery

6.5.6 Alarms shall be provided in accordance with TEC GR No.66110:2024. For battery banks integrated with SMPS based power plants, alarms shall also be extended in accordance with TEC GR No.66110:2024.

6.5.356.5.7 Secondary (Back-up) Protection: An independent secondary protection device in the form of a Miniature Circuit Breaker (MCB) may be provided at the battery bank / module output. The MCB shall be compliant with IEC 60947-2 and rated for DC operation at the system's rated voltage. It shall be manually resettable, externally accessible without dismantling the enclosure, and serve as a manually operable isolation point for maintenance or emergency disconnection, independent of the BMS firmware/communication state.

6.6 **Communication ports**: The manufacturer shall provide Modbus RS485 port for connectivity with SMPS power plant and shall also provide any other additional communication port(s) such as RS232, Ethernet or USB, CAN, wireless communications etc., as per the requirement of the purchaser. In case of no specific requirement, the manufacturer shall provide at least one communication port out of the above-stated ports.

6.7 LED/LCD provide power, Activity, and Fault status.

6.8 **Battery connection to load circuit:**

A BMS may also feature a pre-charged system allowing a safe way to connect the battery to different loads and eliminating the excessive inrush currents to load capacitors. The connection to loads is normally controlled through Solid-state switches.

6.9 **Optimization**

In order to maximize the battery's capacity, and to prevent localized under charging or over-charging, the BMS may actively ensure that all the cells that compose the battery are kept at the same voltage or State of Charge, through active or passive balancing.

7.0 Quality Requirements:

7.1 Battery shall be manufactured in accordance with the International Quality Standard ISO 9001:2015 for which the manufacturer shall be duly accredited.

7.2 **Quality of material and Workmanship:** All the material and workmanship shall be of professional grade and highest quality.

7.3 **Quality Assurance Tests:** Module/Batteries supplied against specific order after Type Approval shall be inspected and tested to ensure that the requirements of this document have been met.

7.4 Valid BIS certificate is required for the basic cell and its model to use in battery module for getting TAC for initial module only. In case of any change in design of basic cell and / or renewal / reissue of BIS certificate, fresh valid BIS certificate is required to be submitted by OEM / Manufacturer while getting TAC.

7.5 Cell manufacturer shall mention all the technical data sheets of the basic cell along with the life cycle for getting TAC for initial module only. In case of any change in design of basic cell, fresh such technical data sheets shall be furnished by OEM / Manufacturer while getting TAC.

7.6 TAC for higher capacity can be obtained for a particular capacity by performing the incremental tests as per applicable clauses of this document.

8.0 Various requirements of the product:

8.1 Field trial: Field trials shall be carried out to assess the performance of the module/battery for a period of 1 month or more period as decided by RTEC before clearance for bulk production.

8.2 Operational Requirements:

8.2.1 Ambient Conditions: All the cells, module & batteries shall be designed for continuous full load operation under all the conditions specified in TEC14016:2010 (old no. QM-333 Issue March 2010)~~QM-333~~ category B-2 and shall be capable to work satisfactorily at an altitude specified in relevant clause of TEC14016:2010 (old no. QM-333 Issue March 2010)~~QM-333~~ & saline atmosphere of coastal area in compliance of relevant clause of TEC14016:2010 (old no. QM-333 Issue March 2010)~~QM-333~~ respectively. It shall be capable to withstand the rigors of transportation in compliance of relevant clause of TEC14016:2010 (old no. QM-333 Issue March 2010)~~QM-333~~.

~~8.2.2~~ **Cooling arrangements:** Natural/forced air cooling will be employed such that the cells/module/batteries always operate within the safe temperature limits.

8.2.2

8.2.3 Fire Retardant: The material used in composition of the cell/module/battery shall be fire retardant and shall have a minimum oxygen index of 28% & shall comply UL-94 V-0 for this purpose.

8.2.4 Electro-Static Discharge: The cell/module shall not explode or burn when an electro-static discharge of 8KV is applied to any of its part exposed to contact. It shall be tested in accordance with IEC-61000-4-2.

8.2.5 Thermal Runaway: While operating in the normal operating conditions for cell shall not lead to dry out, throughout the life of the battery. Manufacturer shall supply the necessary data to support the requirements. The cell shall not exhibit thermal runway while working in the Indian environment conditions (average working temperature of 35 degrees Celsius) and at a charge rate of C/2.

8.2.6 **Battery Reliability**: In case of failure of one or two modules in the system shall not cause the failure of the system and shall be able to provide uninterrupted rated power to the load and only back-up hour capacity of the system may differ.

8.3 Disposal of unserviceable Batteries:

8.3.1 Lithium batteries are disposed of after their use (unserviceable). While there are no regulations for disposal of lithium batteries, the manufacturer shall take necessary action for safe disposal of unserviceable lithium-ion batteries in accordance with the latest regulatory guidelines / Act.

8.3.2 The battery manufacturer shall also comply the environmental requirements in accordance with ISO 14001 (Latest issue) for which the manufacturer shall be duly accredited.

CHAPTER -2

9.0 Guidelines for purchaser- The requirement contain in this clause is for the reference of purchaser only.

9.1 Installation & Maintenance Manual: Two copies of the Installation & Maintenance Manual in English shall be supplied along with each unit/set. The manual shall also include the following:

- Dimensioned lay out drawing for module
- Instructions for initial treatment, installation and commissioning procedures and routine maintenance during service. It shall also give the method to recoup the capacity lost during storage.
- Complete layout, detailed block schematic of the battery.
- The maintenance schedule (Daily/weekly/Fortnightly/ Monthly/Quarterly/ Half Yearly/Yearly) and procedure should be given clearly during storage/operation of the batteries.
- The cycle life will be clearly declared by the battery manufacturers.
- Earthing Guide lines for the battery if required.
- Detailed routine checks/tests to be carried out by the user to keep himself informed about the health of the cell/module and the corrective steps to avoid further deterioration of the cell/module, detected during such routine checks/tests.
- The procedure to check the fully charged condition of the cell/module and the procedure to verify the health and charged condition of the cell/module during operation.
- The test results obtained in the factory & feed-back format.
- Discharge tables at C, C/2, C/3, C/4, C/5, C/6, C/8, C/10 & C/20 rate of discharge.
- Safety measures to be observed in handling of the cells/mono blocks/modules.
- Precautions at the time of installation, operation and maintenance.

- Required Test Jigs and fixtures.
- The requirement of installation & maintenance manual (in terms of the no. of hard copy/soft copy/QR Code) may be indicated by purchaser at time of order.

9.2 In case of Manual in hard copy, it shall be prepared using good quality paper with clear and crisp printing. All the drawings in clear printing shall be attached to the hand book binding. One set of flow chart and interconnecting drawings for trouble shooting shall be provided with each manual. The handbook shall be in proper binding so as to make it presentable.

9.3 **Instruction Card**: The requirement of instruction card may be clearly indicated by the purchaser at the time of ordering. However, the purchaser may specify only other special condition/requirements for proper working. The following information shall be provided on the instruction cards to be supplied with each battery set/module:

a) Designation of cell/module.

b) Ah capacity at C, C/20, C/10, C/8, C/6, C/5, C/4, C/3 & C/2 rate of discharge.

c) Nominal voltage.

d) Manufacturer's instructions for:

i) Charging

ii) Maintenance

iii) Any other information/instructions for better performance of the module, keeping the users conditions in view.

iv) Battery Low voltage disconnect to be set up for different rate of discharge

9.4 **Design Practices**: Purchaser may decide for lower capacity of basic cells specified under clause no.2.1 depending upon the specific requirement.

9.5 **Container:** Purchaser may decide for material of shell of the cell to be specified

as steel /resistant plastic other than aluminum depending on the specific requirement.

9.6 **Guarantee:** The manufacturer supplying the cells/module as per this GR shall be responsible for maintenance of these batteries as per the tender requirements or for a period mutually agreed to between the tendering authority and the manufacturer.

9.7 **Packing**: Packing shall be done in accordance with the latest guidelines for the batteries by QA wing of BSNL

9.8 **Condition of Supply:** To ensure the procurement of t h e correct type of cells/ module, the user shall furnish information regarding his requirements as listed below, at the time of inquiry or order. Similarly, the manufacturer shall furnish the information as listed below. The other terms and conditions of supply shall be subject to agreement between the two.

Information to be furnished by purchaser with inquiry/order

1. Application of the battery: Float/SPV.
2. Number of identical batteries required in parallel.
3. Number Cell per battery.
4. The Rate of Charge and discharge at which the batteries are to work.
5. 5. Capacity of the battery in Ampere Hours at C/5.
6. Type of stacking arrangement required: horizontal/vertical.
7. Number of stacks/tiers for battery.
8. Type of Communication ports required (Refer clause 6.6 of Chapter 1)
9. Type of specific stand required if any.
10. Proposed location of Installation and Ultimate consignee.
11. Operation temperature requirement for subzero operation (Refer clause 3 of Chapter 1)

12. Marking on the Modules (Refer clause 2 of Chapter 1)

13. Anti-theft protection feature requirement (Refer clause 5 of Chapter 1)

~~13.~~14. Requirement for secondary (back-up) protection via Miniature Circuit Breaker (MCB) at the module level (Refer clause 6.5.7 of Chapter 1).

~~14.~~15. Requirement for rack / battery system level Type Approval Certificate

~~15.~~16. Probable date of commissioning of the battery.

~~16.~~17. Accessories and spares required, if any.

~~17.~~18. Any other special condition/requirement.

Information to be furnished by the battery supplier

1. Capacity of the battery at C/5 rate.
2. Capacity of battery at other rate of discharge.
3. Manufacturers' name.
4. Method of connections between the cells, whether Bolted or Burnt.
5. Type and Material of the container.
6. Material of the separator.
7. Overall dimensions and weight of each complete cell.
8. Space and floor loading in the desired configuration.
9. Specific order if any in which the cells are to be arranged.
10. Procedure for monitoring the health of mono-block/battery during maintenance and preventive measures required.
11. Measures required to be taken, at the site of installation. Showing the state of discharge and procedure for recoupment thereof.

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Terminology

Amp Hour or Ah: A unit of measurement of a battery's electrical storage capacity. Current multiplied by time in hours' equals ampere-hours. One amp hour is equal to a current of one ampere flowing for one hour. Also, 1-amp hour is equal to 1,000mAh.

Ampere-Hour Capacity: The number of ampere-hours which can be delivered by a battery on a single discharge.

Anode: During discharge, the negative electrode of the cell is the anode. During charge, that reverses and the positive electrode of the cell is the anode. The anode gives up electrons to the load circuit and dissolves into the electrolyte.

Actual Capacity or Available Capacity: The total battery capacity, usually expressed in ampere-hours or milli-ampere hours, available to perform work. The actual capacity of a particular battery is determined by a number of factors, including the cut-off voltage, discharge rate, temperature, method of charge and the age and life history of the battery.

Battery: An electrochemical device used to store energy. The term is usually applied to a group of two or more electric cells connected together electrically.

Battery-Charge Rate: The current expressed in amperes (A) or milli-amps (mA) at which a battery is charged.

Cutoff Voltage, final: The prescribed lower-limit voltage at which battery discharge is considered complete. The cutoff or final voltage is usually chosen so that the maximum useful capacity of the battery is realized. The cut-off voltage varies with the type of battery and the kind of service in which the battery is used.

Capacity: The capacity of a battery is a measure of the amount of energy that it can deliver in a single discharge. Battery capacity is normally listed as amp-hours (or milli-amp-hours) or as watt-hours. **Capacity**

Retention: The available battery capacity under specific discharge condition, after being stored for a certain period under specific environment condition.

Cathode: Is an electrode that, in effect, oxidizes the anode or absorbs the electrons. During discharge, the positive electrode of a voltaic cell is the cathode. When charging, that reverses and the negative electrode of the cell is the cathode.

Cell: An electrochemical device, composed of positive and negative plates and electrolyte, which is capable of storing electrical energy. It is the basic "building block" of a battery.

Charge: The conversion of electric energy, provided in the form of current, into chemical energy within the cell or battery.

Charge Limit Voltage: Required and limited charge voltage for cell/battery module, which shall be recommended by battery manufacturer.

Charge Rate: The amount of current applied to battery during the charging process. This rate is commonly expressed as a fraction of the capacity of the battery. For example, the C/2 or C/5.

Charging: The process of supplying electrical energy for conversion to stored chemical energy.

Constant-Current Charge: A charging process in which the current applied to the battery is maintained at a constant value.

Constant-Voltage Charge: A charging process in which the voltage applied to a battery is held at a constant value.

Cycle: One sequence of charge and discharge.

Deep Cycle: A cycle in which the discharge is continued until the battery reaches its cut-off voltage, usually 80% of discharge.

Shallow Cycling: Charge and discharge cycles which do not allow the battery to approach its cutoff voltage.

Cycle Life: For rechargeable batteries, the total number of charge/discharge cycles the cell can sustain before it's capacity is

significantly reduced. End of life is usually considered to be reached when the cell or battery delivers only 80% of rated ampere- hour capacity. NiMH batteries typically have a cycle life of 500 cycles, NiCad batteries can have a cycle life of over 1,000 cycles. The cycle of a battery is greatly influenced by the type depth of the cycle (deep or shallow) and the method of recharging. Improper charge cycle cutoff can greatly reduce the cycle life of a battery.

Discharge: The conversion of the chemical energy of the battery into electric energy.

Depth of Discharge: The amount of energy that has been removed from a battery (or battery pack). Usually expressed as a percentage of the total capacity of the battery. For example, 50% depth of discharge means that half of the energy in the battery has been used. 80% DOD means that eighty percent of the energy has been discharged, so the battery now holds only 20% of its full charge.

Discharge, deep: Withdrawal of all electrical energy to the end-point voltage before the cell or battery is recharged.

Discharge, high-rate: Withdrawal of large currents for short intervals of time, usually at a rate that would completely discharge a cell or battery in less than one hour.

Discharge, low-rate: Withdrawal of small currents for long periods of time, usually longer than one hour.

Electrode: An electrical conductor through which an electric current enters or leaves a conducting medium, whether it be an electrolytic solution, solid, molten mass, gas, or vacuum. For electrolytic solutions, many solids, and molten masses, an electrode is an electrical conductor at the surface of which a change occurs from conduction by electrons to conduction by ions. For gases and vacuum, the electrodes merely serve to conduct electricity to and from the medium.

Electrolyte: A chemical compound which, when fused or dissolved in certain solvents, usually water, will conduct an electric current. All electrolytes in the fused state or in solution give rise to ions which conduct the electric current

End-of-Discharge Voltage: The voltage of the battery at termination of a discharge.

Energy Density: Ratio of cell energy to weight or volume (watt-hours per pound, or watt-hours per cubic inch).

Float Charging: Method of recharging in which a secondary cell is continuously connected to a constant-voltage supply that maintains the cell in fully charged condition. Typically applied to lead acid batteries.

Internal Resistance: The resistance to the flow of an electric current within the cell or battery.

Life Cycle: Battery Charge & discharge cycles before battery reach specific performance failure under specific operation condition.

Open Circuit: Condition of a battery which is neither on charge nor on discharge (i.e., disconnected from a circuit).

Open-Circuit Voltage: The difference in potential between the terminals of a cell when the circuit is open (i.e., a no-load condition).

Oxidation: A chemical reaction that results in the release of electrons by an electrode's active material.

Parallel Connection: The arrangement of cells in a battery made by connecting all positive terminals together and all negative terminals together. The voltage of the group remains the same as the voltage of the individual cell. The capacity is increased in proportion to the number of cells.

Polarity: Refers to the charges residing at the terminals of a battery. **Positive Terminal:** The terminal of a battery toward which electrons flow through the external circuit when the cell discharges. See Negative Terminal.

Rated Capacity: Quantity of electricity, which a fully charged battery can deliver under specific conditions. Discharge battery module with C/5 to the end voltage of discharge, under 25°C ± 2°C environment condition. Rated capacity is marked with "C_5", its unit is "Ah". Discharge current is 0.2 C_5, its unit is "A". End voltage of discharge shall be recommended by battery manufacturer.

Self-Discharge: Discharge that takes place while the battery is in an open circuit condition.

Separator: The permeable membrane that allows the passage of ions, but prevents electrical contact between the anode and the cathode.

Series Connection: The arrangement of cells in a battery configured by connecting the positive terminal of each successive cell to the negative terminal of the next adjacent cell so that their voltages are cumulative. See Parallel Connection.

Shelf Life: For a dry cell, the period of time (measured from date of manufacture), at a storage temperature of 21 degrees C (69 degrees F), after which the cell retains a specified percentage (usually 90%) of its original energy content.

Short-Circuit: A condition that occurs when a short electrical path is unintentionally created. Batteries can supply hundreds of amps if short circuited, potentially melting the terminals and creating sparks.

Short-Circuit Current: That current delivered when a cell is short-circuited (i.e., the positive and negative terminals are directly connected with a low resistance conductor).

State of Charge: The ratio of discharged capacity and rated capacity. Battery module shall be discharged with C/5 to the end voltage of discharge, under 25°C±2°C environment condition. Discharge current is 0.2C5, its unit is "A". End voltage of discharge shall be recommended by battery manufacturer.

State of Health: The ratio of discharged capacity which is a fully charged used battery can deliver under specific conditions and rated capacity.

Thermal Runaway: A condition whereby a cell on charge or discharge will destroy itself through internal heat generation caused by high overcharge or high rate of discharge or other abusive conditions.

Trickle Charging: A method of recharging in which a secondary cell is either continuously or intermittently connected to a constant-current supply that maintains the cell in fully charged condition.

Vent: A normally sealed mechanism that allows for the controlled escape of gases from within a cell.

Voltage, end-point: Cell voltage below which the connected equipment will

not operate or below which operation is not recommended.

Abbreviations

A or Amps	Amperes
AC	Alternate Current
AFE	Analogue Front End
Ah	Ampere Hour
AS	Aluminium Shell
BMS	Battery Management system
BSNL	Bharat Sanchar Nigam Limited
C	Capacity
CBMS	Central Battery Management System
CAN	Controller Area Network
CCL	Charge Current Limit
DCL	Discharge Current Limit
DOD	Depth of Discharge
DOT	Department of Telecommunication
EMS	Energy Management System
ESD	Electro Static Discharge
FSR	Force Sensing Resistors
GR	Generic Requirements
IEC	International Electrotechnical Commission
IR	Interface Requirement
IS	Indian Standards

ISO	International Organisation for Standardisation
KV	Kilo Volts
KWh	Kilo Watt Hours
LCD	Liquid Crystal Device
LED	Light Emitting Diodes
LFP	Lithium Iron Phosphate
MTNL	Mahanagar Telephone Nigam Limited
Nicd	Nickel Cadmium
Nimh	Nickel Magnesium
NTC	Negative Temperature Coefficient
PCB	Printed Circuit Board
PCBA	Printed Circuit Board Assembly
QA	Quality Assurance
QM	Quality Manual
RTEC	Regional Telecommunication Centre
SMPS	Switching Mode Power Supply
SOC	State of Charge
SPV	Solar Photo Voltaic
SOH	State of Health
TAC	Type Approval Certificate
TEC	Telecommunication Engineering Centre
UL	Underwriters Laboratory

USB	Universal Serial Bus
VRLA	Valve Regulated Lead Acid
Wh	Watt Hours

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