JOINT CANADA-UNITED STATES
NATIONAL STANDARD

ANSI/CAN/UL 1973:2022

STANDARD FOR SAFETY

Batteries for Use in Stationary and Motive Auxiliary Power Applications

ANSI/UL 1973-2022

SCC FOREWORD

National Standard of Canada

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SCC is a Crown corporation within the portfolio of Innovation, Science and Economic Development (ISED) Canada. With the goal of enhancing Canada's economic competitiveness and social well-being, SCC leads and facilitates the development and use of national and international standards. SCC also coordinates Canadian participation in standards development, and identifies strategies to advance Canadian standardization efforts.

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UL Standard for Safety for Batteries for Use in Stationary and Motive Auxiliary Power Applications, ANSI/CAN/UL 1973

Third Edition, Dated February 25, 2022

Summary of Topics

The Third Edition of UL 1973 has been issued to reflect the latest ANSI and SCC approval dates, and to incorporate the proposals dated May 21, 2021 and October 29, 2021.

The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated May 21, 2021 and October 29, 2021.

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ANSI/UL 1973-2022

FEBRUARY 25, 2022

ANSI/CAN/UL 1973:2022

Standard for Batteries for Use in Stationary and Motive Auxiliary Power Applications

The title of the First Edition of UL 1973 was the Standard for Batteries for Use in Light Electric Rail (LER) Applications and Stationary Applications.

The title of the Second Edition of UL 1973 was the Standard for Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications.

First Edition – February, 2013
Second Edition – February, 2018

Third Edition

February 25, 2022

This ANSI/CAN/UL Safety Standard consists of the Third Edition.

The most recent designation of ANSI/UL 1973 as an American National Standard (ANSI) occurred on February 25, 2022. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page, Preface or SCC Foreword.

This standard has been designated as a National Standard of Canada (NSC) on February 25, 2022.

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Preface

This is the Third Edition of the ANSI/CAN/UL 1973, Standard for Batteries for Use in Stationary and Motive Auxiliary Power Applications.

UL is accredited by the American National Standards Institute (ANSI) and the Standards Council of Canada (SCC) as a Standards Development Organization (SDO).

This Standard has been developed in compliance with the requirements of ANSI and SCC for accreditation of a Standards Development Organization.

This ANSI/CAN/UL 1973 Standard is under continuous maintenance, whereby each revision is approved in compliance with the requirements of ANSI and SCC for accreditation of a Standards Development Organization. In the event that no revisions are issued for a period of four years from the date of publication, action to revise, reaffirm, or withdraw the standard shall be initiated.

In Canada, there are two official languages, English and French. All safety warnings must be in French and English. Attention is drawn to the possibility that some Canadian authorities may require additional markings and/or installation instructions to be in both official languages.

Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at http://csds.ul.com.

To purchase UL Standards, visit the UL Standards Sales Site at http://www.shopulstandards.com/HowToOrder.aspx or call tollfree 1-888-853-3503.

This Edition of the Standard has been formally approved by the UL Standards Technical Panel (STP) on Batteries Used in Stationary and in Light Electric Rail Applications, STP 1973.

This list represents the STP 1973 membership when the final text in this standard was balloted. Since that time, changes in the membership may have occurred.

STP 1973 Membership

Name	Representing	Interest Category	Region
Abbassi, Mathher	NYC Department of Buildings	AHJ	USA
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Balash, Gary	East Penn Mfg Co Inc	Producer	USA
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Name	Representing	Interest Category	Region
Warner, Nick	Energy Storage Response Group	General	USA
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Xie, Fei	Institute Of Physics Chinese Academy Of Sciences	General	China
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International Classification for Standards (ICS): 29.220

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This Standard is intended to be used for conformity assessment.

The intended primary application of this standard is stated in its scope. It is important to note that it remains the responsibility of the user of the standard to judge its suitability for this particular application.

CETTE NORME NATIONALE DU CANADA EST DISPONIBLE EN VERSIONS FRANÇAISE ET ANGLAISE.

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INTRODUCTION

1 Scope

1.1 These requirements cover battery systems as defined by this standard for use as energy storage for stationary applications such as for PV, wind turbine storage or for UPS, etc. applications. These systems shall be installed in accordance with NFPA 70, C22.1, or other applicable installation codes.

1.2 These requirements also cover battery systems as defined by this standard for use in light electric rail (LER) applications and stationary rail applications such as rail substations. These systems are intended for installation within either the rail car or within a sheltered stationary location such as a rail substation. These battery systems may utilize regenerative braking from the trains as a source of energy for recharging and are intended for direct or indirect connection to the rail power lines. These battery systems are intended for balancing loads during peak hours, serving as an energy storage device during regenerative breaking of the trains, and as a source of emergency power to move trains to the nearest station during power outages.

1.3 These requirements are also applicable to batteries for use in vehicle auxiliary power (VAP) systems that are utilized in recreational vehicles and other vehicles to provide power for various applications such as lighting and appliances. These batteries are not used for traction power in the vehicles, since batteries for traction power are to be evaluated to UL/ULC 2580 and UL/ULC 2271 as applicable to the intended motive application.

1.4 Annex B of this standard includes requirements specific to sodium-beta type technologies. Annex C of this standard includes requirements specific to flowing electrolyte technologies. Annex H of this standard includes requirements specific to vented and valve regulated lead acid and nickel cadmium batteries. Annex I of this standard includes requirements specific to mechanically recharged metal-air batteries.

1.5 This standard evaluates the battery system's ability to safely withstand simulated abuse conditions. This standard evaluates the system based upon the manufacturer's specified charge and discharge parameters.

1.6 This standard does not evaluate the performance (i.e. capacity measurements under various discharge conditions) or reliability (i.e. capacity measurements under various environmental conditions) of these devices.

1.7 Figure 1.1 is a boundary diagram example for a battery system for this application. Figure 1.2 is a boundary diagram example for a module for this application.

Figure 1.1

Components of a battery system

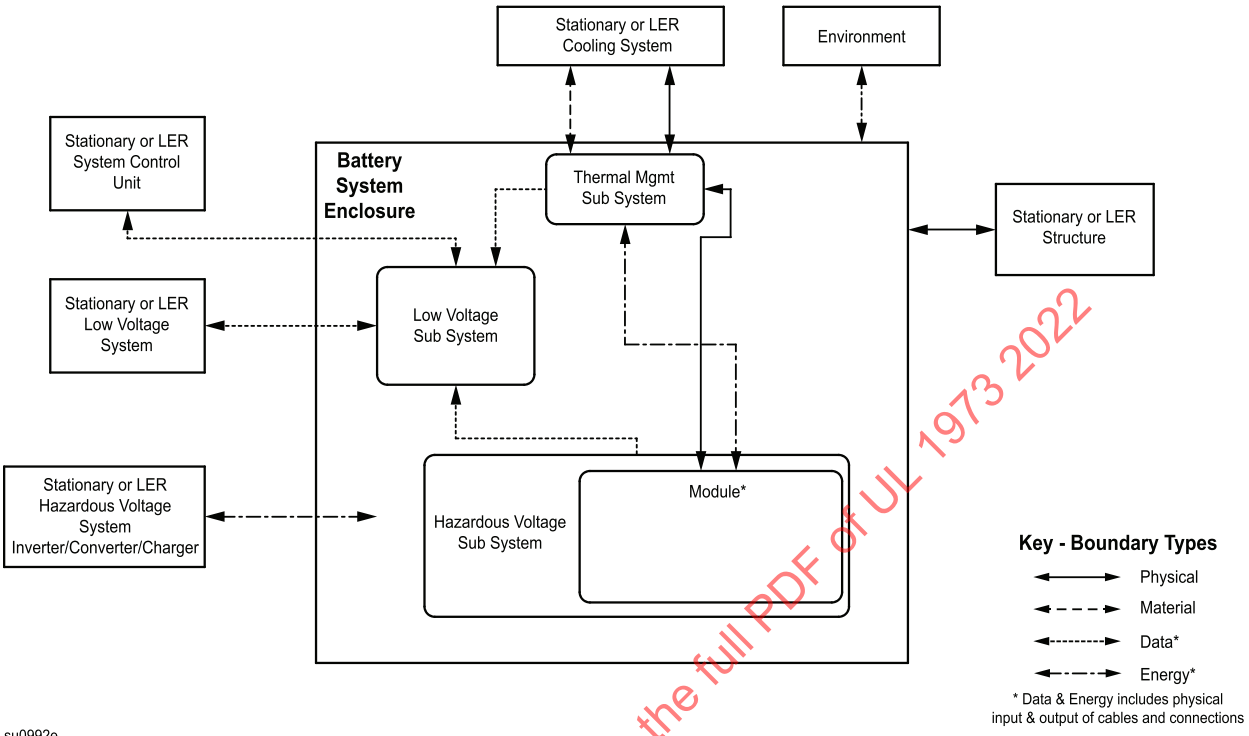

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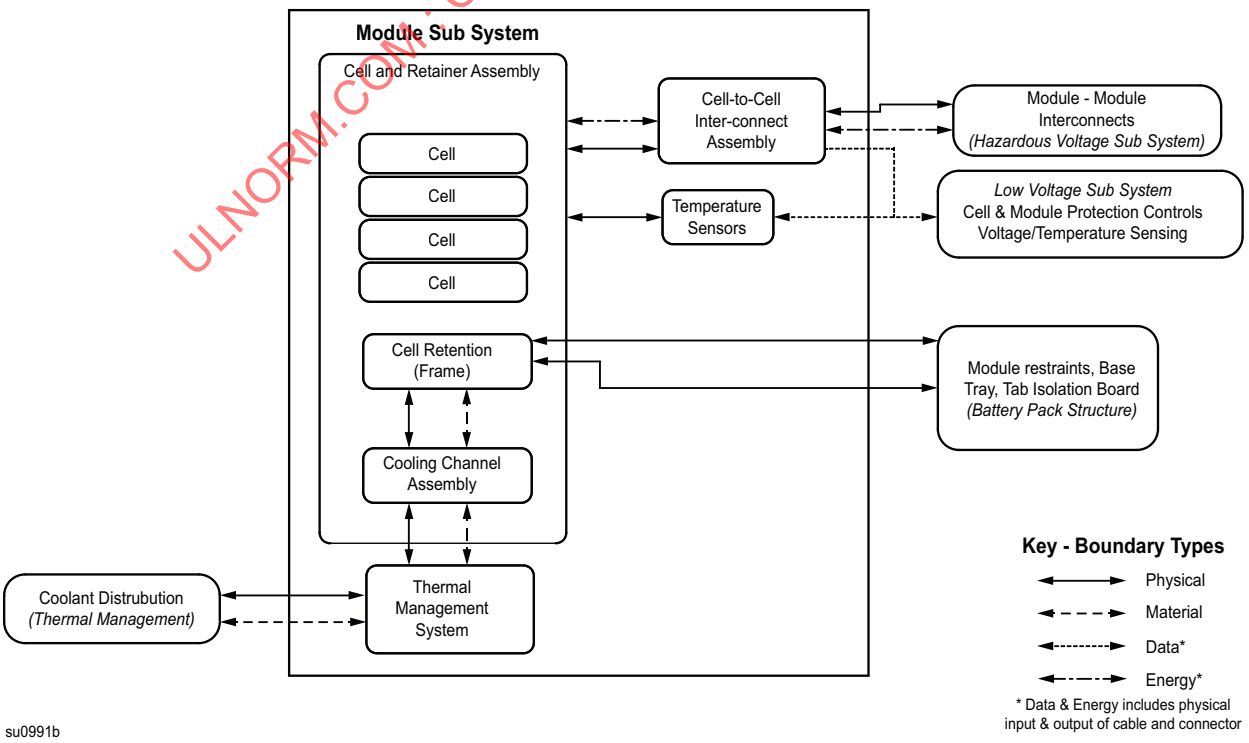
Figure 1.2

Module – boundary diagram



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2 Components

2.1 A component of a product covered by this standard shall comply with the requirements for that component. See Annex A for a list of standards covering components generally used in the products covered by this standard. A component shall comply with the CSA, UL, and/or ULC standards as appropriate for the country where the product is to be used.

3 Units of Measurement

3.1 Values and their respective units of measurement that are stated without parentheses constitute the requirement of the standard and those in parentheses constitute explanatory or approximate information.

4 Undated References

4.1 Any undated reference appearing in the requirements of this standard shall be interpreted as referring to the latest edition of the reference, including all revisions and amendments.

5 Normative References

5.1 The following standards are referenced in this standard, and portions of these referenced standards may be essential for compliance. Battery systems covered by this standard shall comply with the referenced installation codes and standards as appropriate for the country where the battery system is to be used. When the battery system is intended for use in more than one country, the battery system shall comply with the installation codes and standards for all countries where it is intended to be used.

American Society of Mechanical Engineers (ASME) Codes

ASME B31.3, *Process Piping Code*

ASTM B117, *Standard Practice for Operating Salt Spray (Fog) Apparatus*

ASME BPVC, *Boiler and Pressure Vessel Code*

American Society for Testing and Materials (ASTM) Standards

ASTM D543, *Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents*

ASTM D638, *Standard Test Method for Tensile Properties of Plastics*

ASTM D4490, *Standard Practice for Measuring the Concentration of Toxic Gases or Vapors Using Detector Tubes*

ASTM D4599, *Standard Practice for Measuring the Concentration of Toxic Gases or Vapors Using Length-of-Stain Dosimeters*

CSA Group Standards

CSA C22.1, *Canadian Electrical Code, Part I Safety Standard for Electrical Installations*

CAN/CSA-C22.2 No. 0, *General Requirements – Canadian Electrical Code, Part II*

CSA C22.2 No. 0.15, *Adhesive Labels*

CAN/CSA-C22.2 No. 0.17, *Evaluation of Properties of Polymeric Materials*

CAN/CSA-C22.2 No. 0.2, *Insulation Coordination*

CSA C22.2 No. 0.8,*Safety Functions Incorporating Electronic Technology*

CSA C22.2 No. 94.2, *Enclosures for Electrical Equipment, Environmental Considerations*

CAN/CSA C22.2 No. 107.2, *Battery Chargers*

CSA C22.2 No. 113, *Fans and Ventilators*

CSA C22.2 No. 60335-2-29, *Household and Similar Electrical Appliances – Safety – Part 2-29: Particular Requirements for Battery Chargers*

CAN/CSA-E60730-1, *Automatic Electrical Controls for Household and Similar Use – Part 1: General Requirements*

CAN/CSA-C22.2 No. 62368-1, *Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements*

Institute of Electrical and Electronics Engineers (IEEE) Standards

IEEE 693, *Recommended Practice for Seismic Design of Substations*

IEEE 1625, *Rechargeable Batteries for Multi-Cell Mobile Computing Devices*

IEEE 1635/ASHRAE Guideline 21, *Guide for the Ventilation and Thermal Management of Batteries for Stationary Applications*

IEEE 1725, *Rechargeable Batteries for Cellular Telephones*

International Code Council (ICC)

ICC IBC, *International Building Code*

International Electrotechnical Commission (IEC) Standards

IEC 60068-2-52, *Environmental Testing Part 2: Tests – Tests Kb, Salt Mist, Cyclic (Sodium Chloride Solution)*

IEC 60068-2-64, *Environmental Testing – Part 2-64: Tests – Test Fh: Vibration, Broadband Random and Guidance*

IEC 60364-6, *Low-Voltage Electrical Installations – Part 6: Verification*

IEC 60417 Database, *Graphical Symbols for Use on Equipment*

IEC 60529, *Degrees of Protection Provided by Enclosures (IP Code)*

IEC 60664-1, *Insulation Coordination for Equipment Within Low-voltage Supply Systems – Part 1: Principles, Requirements and Tests*

IEC 60812, *Analysis Techniques for System Reliability – Procedures for Failure Mode and Effects Analysis (FMEA)*

IEC 61000-4-2, *Electromagnetic Compatibility (EMC) – Part 4-2: Testing and Measurement Techniques – Electrostatic Discharge Immunity Test*

IEC 61000-4-3, *Electromagnetic Compatibility (EMC) – Part 4-3: Testing and Measurement Techniques – Radiated, Radio-Frequency, Electromagnetic Field Immunity Test*

IEC 61000-4-4, *Electromagnetic Compatibility (EMC) – Part 4-4: Testing and Measurement Techniques – Electrical Fast Transient/Burst Immunity Test*

IEC 61000-4-5, *Electromagnetic Compatibility (EMC) – Part 4-5: Testing and Measurement Techniques – Surge Immunity Test*

IEC 61000-4-6, *Electromagnetic Compatibility (EMC) – Part 4-6: Testing and Measurement Techniques – Immunity to Conducted Disturbances, Induced by Radio-Frequency Fields*

IEC 61000-4-8, *Electromagnetic Compatibility (EMC) – Part 4-8: Testing and Measurement Techniques – Power Frequency Magnetic Field Immunity Test*

IEC 61025, *Fault Tree Analysis (FTA)*

IEC 61373, *Railway Applications – Rolling Stock Equipment – Shock and Vibration Tests*

IEC 61508 (all parts), *Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems*

IEC TR 62660-4, *Secondary Lithium-Ion Cells for the Propulsion of Electric Road Vehicles – Part 4: Candidate Alternative Test Methods for the Internal Short Circuit Test of IEC 62660-3*

International Standards Organization (ISO) Standards

ISO 7000, *Graphical Symbols for Use on Equipment – Registered Symbols*

ISO 9227, *Corrosion Tests in Artificial Atmospheres – Salt Spray Tests*

ISO 13355, *Packaging – Complete, Filled Transport Packages and Unit Loads – Vertical Random Vibration Test*

ISO 13849 (all parts), *Safety of Machinery – Safety-Related Parts of Control Systems*

ISO 26262 (all parts), *Road Vehicles – Functional Safety*

National Electrical Manufacturers Association (NEMA)

NEMA 250, *Enclosures for Electrical Equipment (1000 Volts Maximum)*

National Fire Protection Association (NFPA) Codes and Standards

NFPA 2, *Hydrogen Technologies Code*

NFPA 68, *Explosion Protection by Deflagration Venting*

NFPA 69, *Explosion Prevention Systems*

NFPA 70, *National Electrical Code*

National Institute for Occupational Safety and Health (NIOSH)

Manual of Analytical Methods

Occupational Safety and Health Standards (OSHA)

Evaluation Guidelines for Air Sampling Methods Utilizing Spectroscopic Analysis

Society of Automotive Engineers (SAE) Standards

SAE J2464, *Electric and Hybrid Electric Vehicle Rechargeable Energy Storage System (RESS) Safety and Abuse Testing*

Telcordia

GR-63-CORE, *Network Equipment – Building System (NEBS) Requirements: Physical Protection*

UL Standards

UL 50E, *Enclosures for Electrical Equipment, Environmental Considerations*

UL 94, *Tests for Flammability of Plastic Materials for Parts in Devices and Appliances*

UL 157, *Gaskets and Seals*

UL 263, *Fire Tests of Building Construction and Materials*

UL 507, *Electric Fans*

UL 546, *Conductor Termination Compounds*

UL 583, *Electric-Battery-Powered Industrial Trucks*

UL 746A, *Polymeric Materials – Short Term Property Evaluations*

UL 746B, *Polymeric Materials – Long Term Property Evaluations*

UL 746C, *Polymeric Materials – Use in Electrical Equipment Evaluations*

UL 746E, *Polymeric Materials – Industrial Laminates, Filament Wound Tubing, Vulcanized Fibre, and Materials Used in Printed Wiring Boards*

UL 810A, *Electrochemical Capacitors*

UL 840, *Insulation Coordination Including Clearances and Creepage Distances For Electrical Equipment*

UL 969, *Marking and Labeling Systems*

UL 991, *Tests for Safety-Related Controls Employing Solid-State Devices*

UL 1012, *Power Units Other Than Class 2*

UL 1310, *Class 2 Power Units*

UL 1562, *Transformers, Distribution, Dry-Type – Over 600 Volts*

UL 1642, *Lithium Batteries*

UL 1741, *Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources*

UL 1974, *Evaluation for Repurposing Batteries*

UL 1989, *Standby Batteries*

UL 1998, *Software in Programmable Components*

UL 2054, *Household and Commercial Batteries*

UL/ULC 2271, *Batteries for Use in Light Electric Vehicle (LEV) Applications*

UL 2416, *Audio/Video, Information and Communication Technology Equipment Cabinet, Enclosure and Rack Systems*

UL 2436, *Spill Containment for Stationary Lead Acid Battery Systems*

UL/ULC 2580, *Batteries for Use in Electric Vehicles*

UL 5500, *Remote Software Updates*

UL 9540A, *Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems*

UL 60335-2-29, *Household and Similar Electrical Appliances – Safety – Part 2-29: Particular Requirements for Battery Chargers*

UL 60730-1, *Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements*

UL 62368-1, *Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements*

ULC Standards

ULC/ORD-C583, *Guide for the Investigation of Electric Battery Powered Industrial Trucks*

US Department of Defense (DOD) Standards

MIL STD 1629A, *Procedures for Performing a Failure Mode, Effects, and Criticality Analysis*

6 Glossary

6.1 BATTERY – A general term for either a single cell or a group of cells connected together either in a series and/or parallel configuration.

6.2 BATTERY MANAGEMENT SYSTEM (BMS) – A battery control circuit with active and programmable active protection devices that monitors and maintains the cells within their safe operating region; and which prevents overcharge, overcurrent, overtemperature, under-temperature and overdischarge conditions of the cells.

6.3 BATTERY PACK – Batteries that are ready for use, contained in a protective enclosure, which may or may not contain protective devices, cooling systems and monitoring circuitry. Although batteries may be the dominant energy storage device in the pack, the battery pack may include electrochemical capacitors as a type of hybrid pack.

6.4 BATTERY SYSTEM – Consists of a pack (i.e. battery, capacitor or hybrid pack) and external controls and circuitry related to the pack such as cooling systems, disconnects or protection devices external to the pack.

6.5 CAPACITOR PACK – Electrochemical capacitors that are ready for use in a battery system, contained in a protective enclosure, with or without protective devices, cooling systems, and monitoring circuitry. Although electrochemical capacitors may be the dominant energy storage device in the pack, the capacitor pack may include batteries as a type of hybrid pack.

6.6 CAPACITY, RATED (C_n) – The total number of ampere-hours that can be withdrawn from a fully charged battery at a specific discharge rate to a specific end-of-discharge voltage (EODV) at a specified temperature as declared by the manufacturer.

6.7 CASCADING – The runaway failure or thermal propagation of a battery system or battery module when:

a) One battery cell is triggered into catastrophic failure and this cell causes the failure of neighboring cells; and/or

b) Continued thermal propagation of catastrophic cell failures until part of or the entire system is on fire or causing excessive hazardous gas generation or leakage of hazardous liquids.

6.8 CASING – The container that directly encloses and confines the contents of a cell, monobloc battery or electrochemical capacitor.

6.9 CELL – The basic functional electrochemical unit containing an assembly of electrodes, electrolyte, separators, container, and terminals. It is a source of electrical energy by direct conversion of chemical energy.

6.10 CELL, CYLINDRICAL – A cell format with a rigid case that has straight parallel sides and a round cross section.

6.11 CELL, POUCH – A cell format with a flexible laminate case that is typically, but not limited to a prismatic shape, and that can have its tabs on the same side or on opposite sides of each other.

6.12 CELL, PRISMATIC – A cell format with a rigid case that has a rectangular shape.

6.13 CELL, SECONDARY – A cell that is intended to be discharged and recharged many times in accordance with the manufacturer's recommendations.

6.14 CELL BLOCK – One or more cells connected in parallel.

6.15 CHARGING – The application of electric current to battery or capacitor terminals, which results in a Faradic reaction that takes place within the battery that leads to stored electro-chemical energy or in the case of the capacitor, due to electrical charge being stored without a chemical reaction taking place.

6.16 CHARGING, CONSTANT CURRENT (CC) – Charging mode where current is held constant while charging voltage is allowed to vary.

6.17 CHARGING, CONSTANT VOLTAGE (CV) – Charging mode where voltage is held constant while charging current is allowed to vary.

6.18 COMBUSTIBLE VAPOR CONCENTRATION – A concentration in air greater than 25 % of the lower flammable limit (LFL) of the flammable vapor being measured or a concentration that can be ignited in accordance with 7.1.

6.19 CRITICAL SAFETY – Any devices or circuits provided to protect against hazardous conditions where the failure of the device results in a hazardous condition as defined in UL 991.

6.20 DUT – Device under test.

6.21 ELECTROCHEMICAL CAPACITOR – An electric energy storage device where electrical charge is typically stored as a result of non-Faradaic reactions at the electrodes. (A subset of electrochemical capacitors referred to as an "asymmetric" type have non-Faradaic reactions at one electrode and Faradaic reactions at the other electrode.) A highly-porous surface of the electrodes increases the surface area for holding charge resulting in much larger capacitance and energy density. Electrochemical capacitors differ from common electrolytic capacitors in that they employ a liquid rather than a solid dielectric with charge occurring at the liquid-solid interface of the electrodes when a potential is applied. Some other common names for an electrochemical capacitor are "double layer capacitor", "ultracapacitor", "electrochemical double layer capacitor", "super capacitor", and "EDLC".

6.22 ENCLOSURE – The protective outer cover of the pack or battery system that provides mechanical protection to the pack/system’s contents.

NOTE: A flow battery stack is not considered an enclosure if protected by the outer enclosure of the system.

6.23 END-OF-DISCHARGE VOLTAGE (EODV) (Cell) – The voltage, under load, of the cell at the end of discharge. The EODV may be specified by the manufacturer, as in the case of a voltage-terminated discharge typical for lithium ion chemistries.

6.24 EXPLOSION – A violent release of energy that produces projectiles or a pressure wave from the DUT and results in DUT contents being forcibly expelled through a rupture in the enclosure or casing.

6.25 FIRE – The sustained combustion of the DUT's contents as evidenced by flame, heat, and charring or other damage of materials.

6.26 FLOWING ELECTROLYTE BATTERY – A rechargeable battery that stores its active materials, in the form of liquid aqueous electrolytes, external to the battery. The electrolytes, which serve as energy carriers, are pumped through two half cells separated by an ion-permeable separator, which provides separation of the two electrolytes while still allowing for the passage of ions during charging and discharging. Charging and discharging results in a chemical reduction reaction in one electrolyte and an oxidation reaction in the other electrolyte. Ions selectively pass through the separator membrane to complete the redox reaction. When in use the electrolytes are continuously pumped in a circuit between reactor and storage tanks. Three commercially available flowing electrolyte batteries technologies, two of which are zinc-based and a third, the vanadium redox types, are described below:

a) ZINC AIR – A flowing electrolyte battery technology that has one active aqueous electrolyte containing metal particles. During charging, zinc particles are generated from a zincate solution in a chemical reaction (oxygen is off gassed from the reaction), and then transported to a storage tank in a KOH solution as a charged electrolyte. During discharge the electrolyte is pumped through the reactor interface (flow battery stack) where the zinc particles combine again with oxygen from the surrounding air to form zincate.

b) ZINC BROMINE – A flowing electrolyte battery technology that has zinc at the negative electrode and bromide at the positive electrode with an aqueous solution containing zinc bromide and other compounds contained in two separate reservoirs. During charging, energy is stored as zinc metal within the cell and polybromide in the cathode reservoir. During discharge, the zinc is oxidized to zinc oxide and the bromine is reduced to bromide.

c) VANADIUM REDOX – A flowing electrolyte battery technology that contains vanadium salts in various stages of oxidation in a sulfuric acid, or in a mixture of sulfuric and hydrochloric acid electrolyte. Charging and discharging the battery changes the oxidation state of the vanadium in the electrolyte solutions.

6.27 FULLY CHARGED – A battery system, pack, module or cell which has been charged to its full state of charge (SOC) as specified by the manufacturer.

6.28 FULLY DISCHARGED – A battery system, pack, module or cell, which has been discharged to its end-of-discharge voltage (EODV) as specified by the manufacturer.

6.29 HAZARDOUS VOLTAGE – A sinusoidal voltage exceeding 42.4 Vpeak or 60 Vdc is considered hazardous.

6.30 INSULATION LEVELS – The following are levels of electrical insulation:

a) BASIC INSULATION – Insulation to provide basic protection against electric shock.

b) DOUBLE INSULATION – Insulation comprising both basic insulation and supplementary insulation.

c) FUNCTIONAL INSULATION – Insulation that is necessary only for the correct functioning of the equipment. Functional insulation by definition does not protect against electric shock. It may, however, reduce the likelihood of ignition and fire.

d) REINFORCED INSULATION – Single insulation system that provides a degree of protection against electric shock equivalent to double insulation under the conditions specified in this standard. The term "insulation system" does not imply that the insulation has to be in one homogeneous piece. It may comprise several layers that cannot be tested as basic insulation and supplementary insulation.

e) SUPPLEMENTARY INSULATION – Independent insulation applied in addition to basic insulation in order to reduce the risk of electric shock in the event of a failure of the basic insulation.

6.31 LEAKAGE – A condition where liquid escapes through an opening in a designed vent or through a rupture or crack or other unintended opening and is visible external to the device under test.

6.32 LIGHT ELECTRIC RAIL (LER) – A term used to specify a commuter train that obtains all of its motive energy from electricity.

6.33 LIMITED POWER CIRCUIT – A circuit supplied by a power source that meets SELV limits and whose power and current are further limited in accordance with the Limited Power Source Test of UL 2054. A limited power source is equivalent to a Class 2 circuit in accordance with Article 725 of NFPA 70 or Section 16 of C22.1. A similar concept to limited power is the term "low-voltage limited energy" (LVLE) as defined in Section 16 of UL 583 or ULC/ORD-C583.

6.34 LITHIUM ION CELL – A rechargeable cell where electrical energy is derived from the insertion/extraction reactions of lithium ions between the anode and the cathode. The lithium ion cell has an electrolyte that typically consists of a lithium salt and organic solvent compound in liquid or gel or solid form and has either a hard metal casing or a flexible polymeric pouch casing.

6.35 LITHIUM METAL CELL – A rechargeable battery technology that employs lithium metal as the anode material.

NOTE: These cells may be referred to as solid state batteries if they employ a solid polymeric or ceramic electrolyte.

6.36 MAINS SUPPLY (AC) – An ac power distribution system external to the equipment for supplying power to ac powered equipment. Examples of ac mains supply include public or private utilities and equivalent sources such as motor-driven generators and uninterruptible power supplies.

6.37 MANUFACTURING PRODUCTION LINE TESTING – Testing at the manufacturer's facilities used as a manufacturing check of their production. Depending upon the testing, it either can be a 100 % production test, or can be a periodic check or sampling of production. This testing is sometimes referred to as routine testing.

6.38 MATERIAL, HYGROSCOPIC – A material that has a strong affinity to attract moisture, will absorb moisture onto its molecular structure if exposed to ambient air, and internal moisture cannot be removed with hot air alone. Examples of hygroscopic materials are: nylon, ABS, acrylic, polyurethane, polycarbonate, PET, and PBT.

6.39 MATERIAL, NON-HYGROSCOPIC – A material that does not have an affinity for moisture and any moisture collected is adsorbed on the surface, typical moisture collection is due to condensation, and moisture is easily removed by passing a sufficient stream of warm air over the material. Examples of non-hygroscopic materials are: polyethylene, polypropylene, polystyrene, PVC.

6.40 MAXIMUM WORKING VOLTAGE – The highest voltage to which the insulation or component under consideration is or can be subjected to when the equipment is operated under conditions of normal use.

6.41 METAL-AIR BATTERY – An electrochemical battery that uses an anode made from pure metal and an external cathode of ambient air, typically with an aqueous or aprotic electrolyte. Primary, reserve, electrically rechargeable, and mechanically rechargeable metal-air battery configurations have been explored and developed. The metals that have been considered for use in metal-air batteries are calcium, magnesium, lithium, aluminum, and iron.

6.42 METAL-AIR BATTERY, MECHANICALLY RECHARGEABLE – A metal-air battery designed with a means to remove and replace the discharged anodes or discharge products (such as reacted electrolyte) with new ones for recharging. The battery essentially functions as a primary battery and the air electrodes operate only in a discharge mode. During discharging of a metal-air electrochemical cell, an oxygen