Certification Requirements for Battery System Compliance to IEEE 1625

Version 1.12.2

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Section 1 Introduction

1.1 Purpose

The purpose of this *Certification Requirements Document (CRD)* is to define the CTIA Battery Compliance Certification Program requirements for validating compliance to the IEEE Std 1625™[1] -2008 ("IEEE 1625") Standard for Rechargeable Batteries for Multi-Cell Mobile Computing Devices.

The certification program is described in the CTIA Certification document *Battery Compliance Certification* Program, available at https://www.ctiacertification.org/program/battery-compliance-certification/.

The CTIA Certification document *Certification Requirements Status List (CRSL),* available at https://www.ctiacertification.org/program/battery-compliance-certification/, defines the current status of each requirement within this document.

1.2 Scope

This document defines the process to validate each requirement in the IEEE 1625 specification.

1.3 Applicable Documents

The following documents are referenced in this CRD. Unless otherwise specified, the latest released version shall be used:

Standard for Rechargeable Batteries for Multi-Cell Mobile Computing Devices, IEEE Std 1625-2008, October 2008, Institute of Electrical and Electronics Engineers, Inc.

Battery Compliance Certification Program, Latest Revision, CTIA Certification.

Certification Requirements Status List, Latest Revision, CTIA Certification.

ANSI/ISO/ASQ-Q9001, Quality Management System – Requirements.

IEC 60695-11-10, Fire Hazard Testing – Part 11-10: Test Flames – 50 W Horizontal and Vertical Flame Test Methods, International Electrotechnical Commission.

IEC 60721-3-7, Classification of Environmental Conditions – Part 3-7: Classification of Groups of Environmental Parameters and their Severities - Portable and Non-Stationary Use, International Electrotechnical Commission.

IEC 60950-1, Information Technology Equipment – Safety – Part 1: General Requirement, International Electrotechnical Commission.

IEC 61000-4-2, Electromagnetic Compatibility (EMC) Part 4-2 Testing and Measurement, Techniques - Electrostatic Discharge Immunity Test, International Electrotechnical Commission.

IEC 61000-4-5, Electromagnetic Compatibility (EMC) Part 4-5 Testing and Measurement, Techniques -Surge Immunity Test, International Electrotechnical Commission.

[1] IEEE Std 1625 is a registered trademark of the Institute of Electrical and Electronics Engineers, Inc.

IEC 62281, Safety of Primary and Secondary Lithium Cells and Batteries During Transport, International Electrotechnical Commission.

IEC 62368-1, Audio/video, information and communication technology equipment - Part 1: Safety requirements, International Electrotechnical Commission.

IEC 62368-3, Audio/video, information and communication technology equipment - Part 3: Safety aspects for DC power transfer through communication cables and ports, International Electrotechnical Commission.

UL 1642, Standard for Lithium Batteries, Underwriters Laboratories.

UL 2054, Household and Commercial Batteries, Underwriters Laboratories.

Manual of Tests and Criteria, Part III, Sub-section 38.3, United Nations, New York and Geneva.

1.4 Acronyms and Definitions

Ambient Temperature: 20 ± 5 °C

C-Rated capacity of a Battery or Cell as defined by IEC 62133-2 and UL 2054

CRD – Certification Requirements Document

CRSL – Certification Requirements Status List

DOE – Design of Experiment

ESD – Electrostatic Discharge

FMEA – Failure Mode and Effects Analysis

Laminated Enclosure Cell: A cell which is essentially prismatic in shape and whose contents are enclosed within a sealed flexible pouch rather than a rigid casing

PM – Preventive Maintenance

PMD – Program Management Document

PTC – Positive Temperature Coefficient. Refers to a passive overcurrent protection device that is technically a resettable conductive polymer-based thermistor. Also known as a CID (Current Interrupt Device)

SOC – State of Charge based on Coulomb counting. 100% SOC can be achieved by following the cell vendor's recommended algorithm

SOP – Standard Operating Procedure

Section 2 Validation Process

Compliance of battery systems to the IEEE 1625 standard shall be validated through a combination of reviewing of evidence, auditing of facilities and processes, and testing of products. The descriptive fields provided for each line item requirement in the CRSL define the validation process for each requirement in this CRD. Definitions for these entries are provided within the CRSL itself.

Section 3 System Integration Considerations

3.1 System Integration Considerations

Reference: IEEE 1625, Section 4.1

Purpose: Conduct a system analysis that considers two independent faults.

Procedure: Review an FMEA or equivalent analysis of the energy storage system, including the cell, pack, host, charger and accompanying accessories and the interaction between the subsystems, to determine that hazards (as defined in IEEE1625 Annex F) occurring as a result of two independent faults for charge, one fault for discharge or one fault for system storage are minimized.

Compliance: Shall include all of the following:

Documents include all system components as described in the system registration with CTIA Certification.

Analysis considers a minimum of two independent faults for charge.

Analysis considers a minimum of one independent fault for discharge.

Analysis considers the impact of hazards occurring due to reasonable and foreseeable misuse.

Analysis identifies end-user responsibilities for reliable total system operation per Clause 10 of IEEE 1625.

Analysis identifies vendor's responsibilities for independent and/or distributed control schemes for reliable total system operation.

Analysis considers all system usage scenarios to include charge, discharge, and storage.

Analysis includes the cell, pack, host, adapter, and accompanying accessories that are a part of the system.

Analysis includes interactions between the subsystems.

3.2 Specifications and Components - Cell

Reference: IEEE 1625 Section 4.2

Purpose: Verify that the cell meet the specifications in IEEE 1625 standard, section 4.2, Table 2.

Procedure: Review vendor's evidence.

Compliance: The cell meets the specifications in IEEE 1625 standard, section 4.2, Table 2. For the UN Manual of Tests and Criteria Part III, Subsection 38.3, use the latest version.

3.3 Specifications and Components - Pack

Reference: IEEE 1625 Section 4.2

Purpose: Verify that the pack meet the specifications in IEEE 1625 standard, section 4.2, Table 2.

Procedure: Review vendor's evidence.

Compliance: The pack meets the specifications in IEEE 1625 standard, section 4.2, Table 2. For the UN Manual of Tests and Criteria Part III, Subsection 38.3, use the latest version.

3.4 AC Subsystem Requirements

Reference: IEEE 1625, Section 4.2

Purpose: Ensure compliance to IEC 60950-1, IEC 62368-1, IEC 62368-3, or standard of destination country.

Procedure: Confirm compliance to IEC 60950-1, IEC 62368-1, IEC 62368-3, or standard of destination country.

Compliance: Ensure compliance to electrical safety requirements of the country of destination. Minimum marking shall be NRTL (Nationally Recognized Testing Laboratory). Refer to: www.OSHA.gov.

3.5 DC Subsystem Requirements

Reference: IEEE 1625, Section 4.2

Purpose: Ensure compliance to standard of destination country.

Procedure: Confirm compliance to standard of destination country.

Compliance: Ensure compliance to electrical safety requirements of the country of destination. Minimum marking shall be NRTL (Nationally Recognized Testing Laboratory). Refer to: www.OSHA.gov.

Section 4 Cell Considerations

All tests will be performed on a minimum of 5 samples unless otherwise specified (all samples must pass compliance).

Inspection/Analysis criteria shall be done on a sample of one

4.1 Cell Considerations

Reference: IEEE 1625, Section 5.1

Purpose: Cell has defined the operating regions and conditions of the product. This clause includes the precautions and considerations required for design, manufacturing, and testing of rechargeable Li-ion and Li-ion polymer cells, over their product lifetime, to minimize latent problems.

Procedure: Verify that the cell vendor has cell specifications, incorporating a definition of an Operating region and that this region is apparent to the pack and system vendors. Design parameters shall be of the format: limit + tolerance 1/− tolerance 2, or maximum limit and minimum limit, as defined by the cell vendor.

Compliance: Operating region is defined in the cell specification and is clear to potential pack and system vendors. All design parameters show tolerances.

4.2 Design Requirements

Reference: IEEE 1625, Section 5.2

Purpose: Design process includes definition of nominal cell performance, physical and chemical design parameters, analysis of and mitigation of known and potential faults, characterization of the manufacturing process capability (or specification of processes requirements for the manufacture of a cell), and the initial confirmation of cell performance.

Procedure: Review cell vendor documentation demonstrating the cell meets the intended design. Examples of documentation to be reviewed are engineering summaries and/or evaluation that show testing of the cell to its design parameters.

Compliance: Cell meets the requirements of its design.

4.3 Separator Stability

Reference: IEEE 1625, Section 5.2.2.2

Purpose: The separator material shall have sufficient chemical, electrochemical, thermal, and mechanical stability to meet every requirement of the cell vendor on safety performance for the product lifetime of the cell, under all normal operating conditions.

Procedure: Review the Declaration Letter and separator selection criteria.

Compliance: Separator materials have the appropriate properties to meet expectations of safety performance for the product lifetime of the cell, under all normal operating conditions.

4.4 Strength and Physical Integrity

Reference: IEEE 1625, Section 5.2.2.4

Purpose: The selection of the thickness of the separator shall be through the design and qualification. The separator material shall provide adequate strength in all directions with the "Z" direction (normal to the electrode plane) being the most important for cell safety performance. The separator shall have sufficient physical integrity to withstand handling during the cell manufacturing process.

Procedure: The cell vendor's engineering analysis of the separator strength shall be reviewed. The engineering analysis shall be conducted to determine if the separator's physical strength provides adequate robustness for handling during cell production and adequate cell safety. The cell vendor analysis shall include one or more of the following: a FMEA, a fault tree analysis, empirical or destructive testing, or a cause-and-effect (fishbone) analysis to mitigate hazards developing from small faults.

Compliance: Engineering analysis satisfying procedure criteria exists

4.5 Shrinkage Allowance

Reference: IEEE 1625, Section 5.2.2.5

Purpose: Adequate coverage of electrodes to meet cell safety requirements is met.

Procedure: Verify that at least one of the following analyses exists: fault tree analysis, empirical or destructive testing, or a cause-and-effect (fishbone) analysis for the separator to consider the allowances to reflect and compensate for a worst-case tolerance. The area and width of the separator shall take into consideration allowances for certain separator shrinkage characteristics.

Compliance: Analysis compensating a worst-case tolerance exists.

4.6 Electrode Design Criteria

Reference: IEEE 1625, Section 5.2.3

Purpose: Electrode design constituents for both the negative electrode (anode) and positive electrode (cathode) shall be designed for performance, safety, and durability in the designated application.

Procedure:

1) Verify that design analysis which includes one or more of the following: an FMEA, a fault tree analysis, empirical or destructive testing, or a cause-and-effect (fishbone) analysis for the electrode design criteria that considers allowances to reflect and compensate for a worst-case tolerance analysis exists.
2) Verify that the design criteria specify material content, purity, and environmental factors, which will enable the electrode material to support the manufacturing process and usage in the end application.
3) Verify that the declaration letter provided by the cell vendors states the "Designated Application" is a "Mobile Computing Device".

Compliance: Documentation satisfying the design constituents for both the negative electrode (anode) and positive electrode (cathode) exists.

4.7 Electrode Capacity Balance and Electrode Geometry

Reference: IEEE 1625, Section 5.2.4

Purpose:

a) The cell design shall ensure that after formation the reversible charge capacity of the negative electrode [Q-reversible (N)] is greater than the reversible charge capacity of the positive electrode [Q-reversible (P)].
b) The active area of the negative electrode shall completely cover the active areas of the positive electrode to meet reliability requirements.
c) Allowance shall be made in the design to maintain the cell balance during the useful life of the cell, regardless of cell geometry and cell charge conditions (temperature, current density, etc.).
d) The electrode design shall maintain adequate coverage to meet cell reliability requirements.
e) The cell vendor shall conduct a design analysis that includes one or more of the following: a FMEA, a fault tree analysis, empirical or destructive testing, or a cause-and-effect (fishbone) analysis for the electrode capacity balance and electrode geometry that considers allowances to reflect and compensate for a worst case tolerance analysis.
f) Such considerations shall include, but are not limited to, width, alignment, temperature, and any age-related changes in size.

Procedure Verify that documentation exists which:

a) Demonstrates anode capacity is always greater than cathode capacity throughout the useful lifetime of the cell.
b) through d) Negative electrode active area is greater than the positive electrode active area initially and during the lifetime of the cell.
c) Shows that the cell vendor has conducted a design analysis that includes one or more of the following: a FMEA, a fault tree analysis, empirical or destructive testing, or a cause-and-effect (fishbone) analysis for the electrode capacity balance and electrode geometry that considers allowances to reflect and compensate for a worst case tolerance analysis.

Compliance: Documentations referring to the requirements above are available.

4.8 Electrode Geometry

Reference: IEEE 1625, Section 5.2.4

Purpose: To ensure that the electrode alignment parameters are designed and controlled such that the safety of the cell is not compromised.

Procedure: Teardown 5 cells.

Compliance: The negative electrode active area shall extend beyond all positive electrode active area edges by at least 0.1 mm (plus process margin) unless process capability/stability is demonstrated to be less than 0.1 mm.

4.9 Electrode Tabs (Connection to Cell Terminals)

Reference: IEEE 1625, Section 5.2.5

Purpose: To ensure proper design and control of electrode tab length and overhang such that safety of the cell is not compromised. (Refer to Figure 5 of IEEE1625).

Procedure: Review design and test data regarding the extending (electrically conductive) tab end. Verify on 5 samples that tabs do not overhang both sides of the electrode.

Compliance: Engineering data for tab design (exposed tab length and tab overhang) is available. Exposed tab length is within vendor's specification. Tabs do not overhang both sides of the electrode.

4.10 Application of Insulation

Reference: IEEE 1625, Section 5.2.6.1

Purpose: Reduce the potential of short circuit by ensuring the proper insulation of the internal cell tab.

Procedure: Verify on 5 samples that the insulation scheme (may contain multiple components) continues until it reaches the point of attachment to the cell terminal. Not applicable to the cells that have more than one single tab at cell core initiation (such as stacking or folding configurations).

Compliance: Tabs with opposite polarity as the enclosure shall be insulated from its electrode assembly (electrodes and separator) exit point until it reaches the point of attachment to the cell terminal.

4.11 Insulation Adherence

Reference: IEEE 1625, Section 5.2.6.2

Purpose: To verify that the insulation is permanently adhered and has good puncture resistance.

Procedure: Review insulation material test/evaluation report and specification sheet as applied to its usage within the cell.

Compliance: Evaluation report indicates that the insulation material has permanent adherence and good puncture resistance. Additional insulation has been used if only a single layer of separator isolates the tab from the opposite electrode.

4.12 Insulation Characteristics

Reference: IEEE 1625, Section 5.2.6.3

Purpose: Insulation material shall have electrochemical, chemical, mechanical, electrical, and thermal stability over the temperature range of use, storage, and transportation as specified by the cell vendor.

Procedure: Verify the existence of insulation material test/evaluation report <u>or</u> specification sheet showing electrochemical, chemical, mechanical, electrical, and thermal stability over the temperature range of use, storage, and transportation.

Compliance: Evaluation report or specification sheet indicates proper electrochemical, chemical, mechanical, electrical, and thermal stability over the temperature range of use, storage, and transportation per vendor's specification.

4.13 Vent Mechanism

Reference: IEEE 1625, Section 5.2.7.1

Purpose: Cell designs shall include a reliable vent mechanism, such as a seam, a score, etc.

Procedure: Test lab to verify vent design and operation on 5 cells per their internal procedure.

1) Take 5 samples at ambient temperature (SOC is not critical; HOWEVER, to reduce hazards discharged cells are recommended).
2) Canister type cell: Penetrate the can on opposite end of the cell canister. Not the same side as the vent.
3) Seal the gas supply to the hole in the cell using an appropriate sealing method.
4) Use compressed inert gas (e.g. Air or inert gas (eg. N2, Ar etc.) and pressurize at a rate of 5 +/-1 psi (35 kPa +/- 7 kPa) intervals.
5) Hold pressure for a minimum of 5 sec per interval.
6) Note the activation pressure of the vent.

- This requirement does not apply to laminated enclosure cells.

Compliance: Vent operates per the vendor's specification. Visual inspection confirms that the vent operated at its intended location.

4.14 Retention of Cell Contents

Reference: IEEE 1625, Section 5.2.7.2

Purpose: To verify the cell vent mechanism is designed to minimize projectiles and maximize retention of cell contents.

Procedure: Review design report. This requirement does not apply to laminated enclosure cells.

Compliance: Design report includes vent mechanism design that minimizes projectiles and maximizes retention of cell contents.

4.15 Projectile Testing

Reference: IEEE 1625, Section 5.2.7.3

Purpose: To confirm vent design performance.

Procedure: Verify the availability of a report and/or certificate demonstrating UL 1642 Section 20 Projectile Test (Mar. 2012 release).

Compliance: Compliance per UL 1642 Projectile Test. Test report or certification shall exist.

4.16 Over-current Protection Device

Reference: IEEE 1625, Section 5.2.8

Purpose: To confirm that cells qualified with ancillary protective measures are employed at the pack level with such measures intact.

Procedure: Review cell specifications to determine if component cell was qualified with a PTC, CID or other protective device. Review current construction of 1 sample to see if same device is in evidence in pack construction.

Compliance: If the cell design was qualified with a PTC, CID or other protective device, this protective device is present in the battery pack.

4.17 Over-voltage Protection

Reference: IEEE 1625, Section 5.2.9

Purpose: To confirm that recommended current to the cell and the upper-limit voltage to the cell, for the appropriate cell overvoltage protection function, at specified temperatures during charge have been provided.

Procedure: Confirm the existence of recommended current and upper-limit voltage under charge, at specified temperatures in the cell operating regions.

Compliance: Recommended cell upper limit voltage, under charge, is listed in the cell specification.

4.18 Manufacturing Process

Reference: IEEE 1625, Section 5.3.1

Purpose: To confirm correct and consistent operation of critical machines in the manufacturing process.

Procedure: Verify that the facility has ISO 9001 compliance.

Compliance: Facility has ISO 9001 compliance.

4.19 Materials Specifications

Reference: IEEE 1625, Section 5.3.2

Purpose: To validate that impurity limits have been defined.

Procedure: Verify that the design report defines impurities and their critical limits. Verify that the raw material specifications for impurities are within critical limits. Verify the raw material data/records comply with the raw material specifications.

Compliance: Raw material specifications for impurities are within critical limits as listed in the design report. Actual raw material meets the specification.

4.20 Cleanliness of Manufacturing Operations

Reference: IEEE 1625, Section 5.3.4

Purpose: To ensure that proper environmental controls are in place and effective in the manufacturing and staging area. Measures are in place to prevent the introduction of metal contamination.

Procedure: Verify that the temperature, humidity and impurity levels in the manufacturing area are specified in the control plan and implemented. Verify vendor has systems in place to prevent the introduction of metal contamination.

Compliance: Temperature, humidity and impurity levels are within specification. Methods and survey operations by which manufacturing and supporting supply chain facilities present no conditions that can cause degradation or damage to materials before, during and after production.

4.21 Manufacturing Traceability

Reference: IEEE 1625, Section 5.3.5

Purpose: To ensure that an effective cell traceability plan has been implemented.

Procedure: Confirm traceability method and validate incorporation within the product.

Compliance: Cell has traceability from the market back to manufacturing site and production lot.

4.22 Uniform Coating of Active Materials

Reference: IEEE 1625, Section 5.3.6.1

Purpose: To ensure that the electrode coating process has been properly characterized, optimized, controlled, and continuously improved.

Procedure: Verify that the negative and positive electrodes' weight and thickness are controlled within the specifications.

Compliance: Material specifications exist and are current. Negative and positive electrodes weight and thickness are controlled within specifications.

4.23 Burr Control - Review

Reference: IEEE 1625, Section 5.3.6.2

Purpose: To ensure that burrs are controlled.

Procedure: Verify that the manufacturer has a method to prevent internal short circuit caused by burrs, either by:

1) Manufacturing control, which consists of measurements at least once per shift or once per manufacturing lot at each cutting point to determine whether or not burr heights are less than 50% of the lower tolerance limit of the separator thickness; or

2) Design prevention, which may include insulation taping or coating at uncoated foil, or documented engineering analysis (such as FMEA) that shows that burr heights may exceed 50% of the lower tolerances of the separator without resulting in internal shorts. Considerations may include coating thickness, separator thickness, coated versus uncoated electrodes areas, insulators and electrode overlap.

Li-Ion Cell Element Cross Section

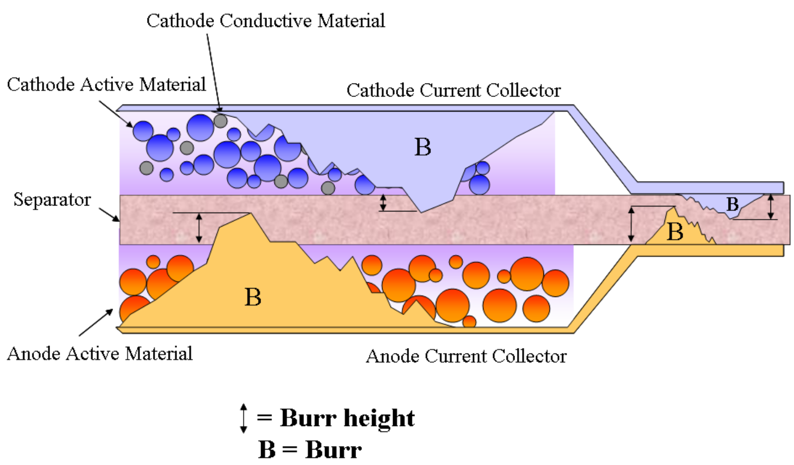


Figure 1

Compliance: Either 1) manufacturing control ensures that burrs do not exceed 50% of the lower tolerance limit of the thickness of the separator or 2) design prevention with documented engineering analysis (such as an FMEA) shows that burr lengths with greater limits cannot cause internal shorts.

4.24 Burr Control - Inspection

Reference: IEEE 1625, Section 5.3.6.2

Purpose: To ensure that the tolerance on burr height is controlled to limit the potential for internal shorts.

Procedure: Confirm design parameters to the reference. Using inspection data, confirm that the manufacturing process is in control. This is not applicable if design prevention is present.

Compliance: Inspection data shows compliance to specified tolerances. For those cases where an out of control condition was noted, action was taken. This is not applicable if design prevention is present.

4.25 Prevention of Damage to Electrodes

Reference: IEEE 1625, Section 5.3.7

Purpose: To ensure that the manufacturing process has methods to detect damaged electrodes.

Procedure: Check the vendor's manufacturing process for handling of electrodes. Verify the criteria for damaged electrodes (wrinkling, tearing or deformation). Verify that the system for removal of damaged electrodes is installed in manufacturing process and is effective.

Compliance: Availability of criteria for damaged electrodes (wrinkling, tearing or deformation). Damaged electrode detection system removes the damaged electrodes.

4.26 Characteristics of Manufacturing Equipment

Reference: IEEE 1625, Section 5.3.8

Purpose: Ensure that manufacturing processes not directly specified in the referenced standard have been properly characterized, optimized, controlled, and continuously improved.

Procedure: Verify production flow and process control documentation. Verify that the equipment is selected based on engineering analysis and capability studies. Ensure product consistently meets or exceeds specs.

Compliance: Equipment characterization/optimization documentation is available. In-process quality controls are implemented.

4.27 Defective Electrodes

Reference: IEEE 1625, Section 5.3.9

Purpose: To ensure that non-conforming electrodes are scrapped.

Procedure: Confirm compliance parameters and implementation. When possible, inspect discarded material and verify proper disposal process. Verify that the non-conforming electrodes are actually scrapped.

Compliance: Verify that all electrode material meets primary specification. Confirm that all non-conforming material is safely discarded and not reworked. “Scrapped” means “destroyed”.

4.28 Preventive Maintenance Plan

Reference: IEEE 1625, Section 5.3.10

Purpose: To ensure that the vendor has implemented an effective Preventative Maintenance (PM) plan.

Procedure: Review PM Process and schedule.

Compliance: Verify the preventive maintenance schedule and its implementation. Verify that PM plan clearly identifies routine and critical maintenance activities. The PM intervals are established based on inputs from equipment vendors and in-house data collection.

4.29 Periodic Cell Teardown Analysis

Reference: IEEE 1625, Section 5.3.11

Purpose: To ensure winding process (key manufacturing machines) is operating adequately and consistently.

Procedure: Cell teardown analysis or equivalent analysis methods which can check whether or not the winding process (key manufacturing machines) is operating adequately and consistently is conducted at least once (per key manufacturing machine) per shift.

Compliance: The winding process (key manufacturing machines) is operating adequately and consistently. Verify the analysis or evidence documentation showing the check of data per shift exists on site.

4.30 Tension and Damage

Reference: IEEE 1625, Section 5.4.2.1

Purpose: To ensure that the electrode winding process has been properly characterized, optimized, and controlled.

Procedure: Review documentation in order to establish proper winding and stacking process considerations.

Compliance: Tension (winding processes only) and damage characterization/optimization documentation is available. Actual winding tension settings are per the conditions in the engineering report and product meets the specification.

4.31 Collection of Loose Material

Reference: IEEE 1625, Section 5.4.2.2

Purpose: To ensure that the vendor has an effective method for collection of loose material produced.

Procedure: Verify that the report identifies possible sources of contamination by loose material and identifies processes which control loose material within acceptable limits. Cell vendor’s process demonstrates effectiveness for collection of loose material.

Compliance: Engineering report identifying possible sources of contamination by loose material is available. Controls are placed to collect the loose material produced in the process.

4.32 Detection of Damaged Cores

Reference: IEEE 1625, Section 5.4.2.3

Purpose: The vendor shall have a method to detect nonconforming cell cores.

Procedure: Verify that methods such as high-voltage dielectric test (high-pot), voltage test, resistance/impedance test, and/or aging is in place. A vision system is used to ensure electrode integrity at an appropriate point in the assembly process.

Compliance: Damaged cores are detected using a defined methodology. Vision system is used to check for electrode integrity.

4.33 Control of Electrode Spacing

Reference: IEEE 1625, Section 5.4.3

Purpose: To ensure that the cell core design and the associated core assembly processes have been properly characterized, optimized, and controlled to prevent damage to the cell core.

Procedure: Verify engineering report for uniform compression, dimensional characteristics and winding spindle removal process. Verify that the actual core assembly settings are per the engineering report. Verify product compliance to parameters documented in the engineering report.

Compliance: Materials are inspected and meet primary specification upon completion of core assembly. Confirm that process equipment does not damage and/or modify the cell core during process movement (input and output) of this operation.

4.34 Uniformity of Winding Pressure (to Core) or Stacking Pressure (to Stack)

Reference: IEEE 1625, Section 5.4.4

Purpose: To ensure that the cell core assembly processes have been properly characterized, optimized, and controlled to prevent damage to the cell core.

Procedure: Verify documentation referring to tension, uniform compression and dimensional characteristics. Note the actual settings.

Compliance: Documentation is available showing process parameters. Actual settings comply with the documentation.

4.35 Avoidance of Contaminants

Reference: IEEE 1625, Section 5.4.5

Purpose:

1) The winding/stacking process shall prevent introduction of contaminants from the winding process (dust, flakes from electrodes) into the cell.
2) The vendor shall prevent introduction of contaminants from the preparation of materials for core or stack including electrode and separator and can as well as through all processes including winding/stacking process to sealing of the cell cap.

Procedure: Identify possible sources of contamination (flaking, dust, etc.) during the winding/stacking process and the process of preparation of materials via FMEA or equivalent. Evaluate the control plans or equivalent referred to in the FMEA. Review and validate that the winding/ stacking process keeps contamination within the allowed limits as listed in the engineering report.

Compliance: Vendor shall provide an FMEA or equivalent and control plan. Ensure that FMEA items are covered in the control plan. Review and validate that the winding/stacking process and the process of preparation of materials keep contamination within the allowed limits as listed in the control plan.

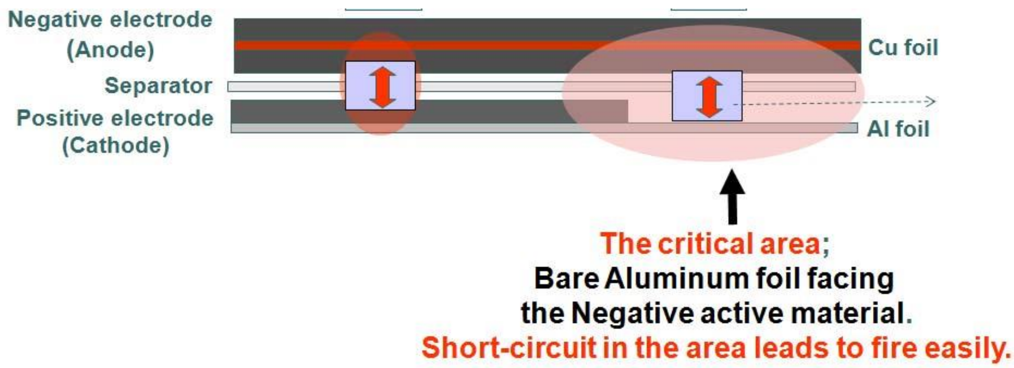
4.36 Internal Short Avoidance

Reference: IEEE 1625, Section 5.5.1

Purpose: To ensure that the method of assembly for insulating material (whether for electrode, current collectors, or internal insulation) is designed to provide reliable protection against latent shorts for the product lifetime of the cell.

Procedure: Lab to tear down 5 fresh samples and verify proper insulation placement. Lab to review insulating material specifications in regard to stability of the material's insulating property over time. The vendor shall provide a method to avoid a short where the bare aluminum foil interfaces with the negative electrode.

Compliance: Validate that all likely material interfaces that may result in a latent internal short are insulated. Validate the method of assembly for insulating material properties is sufficient to provide protection from shorts over the projected lifetime of the cell. Validate method to avoid a short where the bare aluminum foil interfaces with the negative electrode.



4.37 Tab Positioning

Reference: IEEE 1625, Section 5.5.2.1

Purpose: To ensure that the process for positive and negative tab placement has been properly characterized, optimized, and controlled to prevent short circuit.

Procedure: Teardown 5 samples or conducts inspection by an appropriate vision system (example x-ray).

Compliance: The positions of negative and positive tabs are staggered so they do not overlap each other.

4.38 Tab Positioning (Audit)

Reference: IEEE 1625, Section 5.5.2.1

Purpose: To ensure that the process for positive and negative tab placement has been properly characterized, optimized, and controlled to prevent short circuit.

Procedure: Verify the positive and negative tab design documentation. Verify assembly process documentation for proper tab alignment and positioning. Review factory x-ray measurement data from a minimum of 5 samples showing tab placement. Review calibration certificate and measurement systems analysis for x-ray equipment used to produce data to ensure sufficient repeatability. Review design analysis to confirm design demonstrates sufficient margin from short circuit concerns due to tab placement variation.

Compliance: Tab placement meets product design specification. Ensure that vendor's vision system is calibrated and repeatable. Vendor to show design analysis demonstrate safety and prove that they are meeting Design Specification.

4.39 Integrity of Cell Core/Stack

Reference: IEEE 1625, Section 5.5.2.2

Purpose: To ensure that the integrity of the wound or stacked electrodes is verified through resistance or continuity check or equivalent means.

Procedure: Confirm product specification to inspection parameters. Validate that an effective real time (Hi-Pot or equivalent) 100% testing process is in place.

Compliance: Validate test procedures and test parameters. Verify test parameters via review of engineering documentation. 100% testing is required.

4.40 Positioning of Insulating Plate

Reference: IEEE 1625, Section 5.5.3

Purpose: To confirm the characteristics of the material, color, proper positioning and presence of insulating materials.

Procedure: Teardown 5 samples and inspect for insulation plate.

Compliance: If the design requires an insulation plate, the plate shall be properly positioned and readily visible.

4.41 Positioning of Insulating Plate - Inspection

Reference: IEEE 1625, Section 5.5.3

Purpose: To confirm the characteristics of the material, color, proper positioning and presence of insulating materials.

Procedure: Inspect insulating plate placement process and associated controls documentation.

Compliance: If the cell has insulating plates, the insulating plates are properly positioned and readily visible (refer to Figure 7 of IEEE 1625) and meets the insulating plate's specification for insulating characteristics. Additionally, the process control documentation confirms that the insulating material is checked with resistive measurement or other technological means or methods.

4.42 Electrode Alignment

Reference: IEEE 1625, Section 5.5.4

Purpose: The proper alignment of positive and negative electrodes is critical to prevent hazards. The vendor shall conduct 100% inspection (post-winding or stacking of electrodes) and should use a vision system to inspect 100% of the electrode assemblies.

Procedure: Cell vendor to conduct 100% inspection using a vision system to ensure the overlap on top and bottom of the electrode assembly. Also, conduct 100% inspection to ensure no damage is caused by the case insertion process. Polymer cells shall be inspected via a vision system either prior to or following complete assembly. Verify that the negative electrode overlaps the positive electrode by at least 0.1 mm unless the vendor shows supporting evidence (DOE, engineering studies, etc.) that justifies less than 0.1 mm overlap on each side is acceptable. Ensure that vendor's vision system is calibrated and repeatable.

Compliance: 100% inspection is done with vision system for overlap. Overlap is at least 0.1 mm on each side.

4.43 Cell Aging and Screening

Reference: IEEE 1625, Section 5.5.5

Purpose:

1) The vendor shall develop and apply appropriate cell aging and screening process.
2) The sorting criterion shall identify and eliminate early failures.

Procedure:

1) Inspect the implication of vendor's developed and applied appropriate cell aging and screening process.
2) Inspect early failures is eliminated according to the sorting criterion.

Compliance:

1) An appropriate cell aging and screening process shall be developed and applied.
2) The sorting criterion is identified and shall eliminate early failures.

4.44 Aging Qualification Process

Reference: IEEE 1625, Section 5.5.6.2

Purpose: To verify the effectiveness of the cell aging process.

Procedure: Inspect cell maker has a cell aging qualification process and it is implemented.

Compliance: Cell vendor shall have an aging qualification process and shall subject a statistically significant number of cells of a given type to the vendor's normal aging process.

4.45 Aging Qualification Testing

Reference: IEEE 1625, Section 5.5.6.2

Purpose: To ensure that the cell aging, grading, and sorting processes have been properly characterized, optimized, controlled, and continuously improved to remove early term failures.

Procedure: Review cell aging process and supporting records. Review cell aging process validation.

Compliance: Cell aging, grading, and/or sorting process has been developed and implemented. Process is in control. Performance variations for each production lot are identified. Cell aging process validation conducted per IEEE 1625 Section 5.5.6.2.1.

4.46 Cell Leakage

Reference: IEEE 1625, Section 5.5.7

Purpose: To ensure that a process has been implemented to remove cells that are leaking electrolyte.

Procedure: Verify that the end product (Cell) is inspected and all leaking cells are removed.

Compliance: The inspection process does not damage and/or modify the cell. All leaking cells are removed. All non-conforming material is safely discarded and not reworked. Process feedback is in place to modify and rectify process if out of control.

4.47 Care during Cell Assembly

Reference: IEEE 1625, Section 5.5.8

Purpose: To ensure that the welding and other operations have been properly characterized, optimized, controlled, and continuously improved to prevent damage to the cell.

Procedure: Review cell welding process and inspection data during cell assembly operations.

Compliance: Cell enclosure, cell case, and critical cell design elements are not damaged or altered during cell assembly and post assembly operations. Inspection processes are in place and are effective to maintain compliance. Process feedback is in place to modify and rectify the process if out of control.

4.48 Disposition of Defective Material

Reference: IEEE 1625, Section 5.5.9

Purpose: Rejects/failures (non-cosmetic) identified by any station in the manufacturing process shall be quarantined. Retest or reintroduction onto the production line shall be prohibited. A representative quantity of rejects/failures shall be analyzed per vendor’s quality system as part of closed loop corrective and preventive action process in order to identify and eliminate root cause.

Procedure: Inspect and review cell manufacturing has a quarantine and analysis process for rejects/failures (non-cosmetic) cell.

Compliance: Cell vendor has a quarantine and analysis process for rejects/failures (non-cosmetic) cell.

4.49 Destruction Plan

Reference: IEEE 1625 Section 5.5.9

Purpose: To verify that the vendor has a verifiable destruction plan to ensure failed cells do not reach secondary markets.

Procedure: Review vendor’s destruction plan which ensures failed cells do not reach secondary markets.

Compliance: Destruction plan ensure failed cells do not reach secondary markets.

4.50 Qualification of New Cell Designs

Reference: IEEE 1625, Section 5.6.1

Purpose: To ensure that the cell qualification processes have been properly characterized, optimized, controlled, and continuously improved. Additionally, to ensure that all cells are required to pass such tests before being given production status.

Procedure: Review design procedure. Use vendor's specifications or documentation to ensure control of this criterion or process (see Table 1 of IEEE1625). Verify that the new cell model approval process follows an established procedure identifying key components, processes and limitations, which, if changed, may increase the hazard of the cell in use. If any of these key components, processes, or limitations are changed, requalification by the cell vendor, of the cell, shall be required.

Compliance: Design review procedure shall include performance, reliability and safety related testing. Verify that the testing is being performed and results meet the specification.

4.51 Ongoing Testing and Qualification of Production Cells

Reference: IEEE 1625, Section 5.6.2

Purpose: To establish production cell qualification and periodic re-qualification requirements.

Procedure: Verify specification availability which lists the qualification tests and intervals and review qualification test data. Cell vendor has to provide justification regarding the re-qualification interval and test regiment.

Compliance: Verify that the cell vendor is conducting qualification tests at specified intervals and that work instruction is available.

4.52 Cell Transportation Regulations

Reference: IEEE 1625, Section 5.6.5

Purpose: Ensure compliance to UN Manual of Tests and Criteria.

Procedure: Review test report or certificate confirming compliance to UN Manual of Tests and Criteria.

Compliance: Test report or certificate confirming compliance to Manual of Tests and Criteria exists.

4.53 Cell Thermal Test

Reference: IEEE 1625, Section 5.6.6

Purpose: To ensure cells demonstrate thermal stability.

The cell design shall maintain adequate isolation properties during a temperature excursion of at least 1 hour in the cell in order to maintain safety of the cell. The cell design shall maintain isolation under high temperature stress conditions for a reasonable period of time to maintain the safety of the cell.

Procedure: 5 fully charged cells (per cell manufacture's specifications), randomly selected, shall be suspended (no heat transfer allowed to non-integral cell components) in a gravity convection or circulating air oven at ambient temperature. The oven temperature shall be ramped at 5 ± 2°C per minute to 130 ± 2°C. After 1 hour at 130 ± 2°C, the test is ended.

Compliance: Cells shall not flame or explode when exposed to 130°C for 1 hour.

4.54 Cell Thermal Test on Cycled Cells

Reference: IEEE 1625, Section 5.6.7.1 and 5.6.7.2

Purpose: To ensure cycled cells demonstrate thermal stability.

Procedure: 5 cells shall be cycled per cell vendor's specification at 45 °C ± 2 °C for 100 cycles. Cells shall be fully charged per the vendor's specification before testing and suspended (no heat transfer allowed to non-integral cell components) in a gravity convection or circulating air oven at ambient temperature. The oven temperature shall be ramped at 5 ± 2°C per minute to 130 ± 2°C. After 1 hour at 130 ± 2°C, the test is ended.

Compliance: Cells shall not flame or explode when exposed to 130°C for 1 hour.

4.55 External Shorting

Reference: IEEE 1625, Section 5.6.8

Purpose: To ensure that fully charged fresh cells can withstand a short circuit condition.

Procedure: Five fresh cells charged fully in accordance with the vendor's specifications shall be subjected to the short-circuit test with a circuit load having a resistance load of 80 +/- 20 mOhm at 55 ± 5°C. The cells are to reach equilibrium at 55 ± 5°C, before the short circuit is applied.

The cell is to discharge until a fire or explosion is obtained, or until it has reached a completely discharged state of less than 0.1 volts and the cell case temperature has returned to ±10°C of the elevated chamber ambient temperature (i.e. 55 ± 5°C).

Compliance: As a result of the test, cells shall not explode or catch fire, and the cell casing shall not exceed 150°C.

Table 1 Section 4 - ATL Sample Submission Requirements

Section	Name	Purpose	Samples for Test	Reusable?
4.1	Cell Considerations	Cell has defined the operating regions and conditions of the product. This clause includes the precautions and considerations required for design, manufacturing, and testing of rechargeable Li-ion and Li-ion polymer cells, over their product lifetime, to minimize latent problems.	0	
4.2	Design Requirements	Design process includes definition of nominal cell performance, physical and chemical design parameters, analysis of and mitigation of known and potential faults,	0	

		characterization of the manufacturing process capability (or specification of processes requirements for the manufacture of a cell), and the initial confirmation of cell performance.		
4.3	Separator Stability	The separator material shall have sufficient chemical, electrochemical, thermal, and mechanical stability to meet every requirement of the cell vendor on safety performance for the product lifetime of the cell, under all normal operating conditions.	0	
4.4	Strength and Physical Integrity	The selection of the thickness of the separator shall be through the design and qualification. The separator material shall provide adequate strength in all directions with the “Z” direction (normal to the electrode plane) being the most important for cell safety performance. The separator shall have sufficient physical integrity to withstand handling during the cell manufacturing process.	0	
4.5	Shrinkage Allowance	Verify that at least one of the following analyses exists: fault tree analysis, empirical or destructive testing, or a cause-and-effect (fishbone) analysis for the separator to consider the allowances to reflect and compensate for a worst case tolerance. The area and width of the separator shall take into consideration allowances for certain separator shrinkage characteristics.	0	
4.6	Electrode Design Criteria	Electrode design constituents for both the negative electrode (anode) and positive electrode (cathode) shall be designed for performance, safety, and durability in the designated application.	0	
4.7	Electrode Capacity Balance and Electrode Geometry	a) The cell design shall ensure that after formation the reversible charge capacity of the negative electrode [Q-reversible (N)] is greater than the reversible charge capacity of the positive electrode [Q-reversible (P)]. b) The active area of the negative electrode shall completely cover the active areas of the positive electrode to meet reliability requirements. c) Allowance shall be made in the design to maintain the cell balance during the useful life of the cell, regardless of cell geometry	0	

		and cell charge conditions (temperature, current density, etc.). d) The electrode design shall maintain adequate coverage to meet cell reliability requirements. e) The cell vendor shall conduct a design analysis that includes one or more of the following: a FMEA, a fault tree analysis, empirical or destructive testing, or a cause-and-effect (fishbone) analysis for the electrode capacity balance and electrode geometry that considers allowances to reflect and compensate for a worst case tolerance analysis. f) Such considerations shall include, but are not limited to, width, alignment, temperature, and any age-related changes in size.		
4.8	Electrode Geometry	To ensure that the electrode alignment parameters are designed and controlled such that the safety of the cell is not compromised.	5	Sample to be used for 4.9, 4.10, 4.16 4.37, 4.36, 4.40
4.9	Electrode Tabs (Connection to Cell Terminals)	To ensure proper design and control of electrode tab length and overhang such that safety of the cell is not compromised. (Refer to Figure 5 of IEEE1625).	0	Use samples from 4.8
4.10	Application of Insulation	Reduce the potential of short circuit by ensuring the proper insulation of the internal cell tab.	0	Use samples from 4.8
4.11	Insulation Adherence	To verify that the insulator material will be stable in a temperature range of use, storage, and transportation as specified by the cell vendor.	0	
4.12	Insulation Characteristics	Insulation material shall have electrochemical, chemical, mechanical, electrical, and thermal stability over the temperature range of use, storage, and transportation as specified by the cell vendor.	0	
4.13	Vent Mechanism	Cell designs shall include a reliable vent mechanism, such as a seam, a score, etc.	5 (N/A for laminated cells).	Not reusable
4.14	Retention of Cell Contents	To confirm vent design performance.	0	

4.15	Projectile Testing	To confirm vent design performance.	0	
4.16	Over-current Protection Device (Only if inside the Cell)	To confirm that cells qualified with ancillary protective measures are employed at the pack level with such measures intact.	0	Use samples from 4.8
4.17	Over-voltage Protection	To confirm that recommended current to the cell and the upper-limit voltage to the cell, for the appropriate cell overvoltage protection function, at specified temperatures during charge have been provided.	0	
4.18	Manufacturing Process	To confirm correct and consistent operation of critical machines in the manufacturing process.	0	
4.19	Materials Specifications	To validate that impurity limits have been defined.	0	
4.20	Cleanliness of Manufacturing Operations	To ensure that proper environmental controls are in place and effective in the manufacturing and staging area. Measures are in place to prevent the introduction of metal contamination.	0	
4.21	Manufacturing Traceability	To ensure that an effective cell traceability plan has been implemented.	0	
4.22	Uniform Coating of Active Materials	To ensure that the electrode coating process has been properly characterized, optimized, controlled, and continuously improved.	0	
4.23	Burr Control	To ensure that burrs are controlled.	0	
4.24	Burr Control	To ensure that the tolerance on burr height is controlled to limit the potential for internal shorts.	0	
4.25	Prevention of Damage to Electrodes	To ensure that the manufacturing process has methods to detect damaged electrodes.	0	
4.26	Characteristics of Manufacturing Equipment	Ensure that manufacturing processes not directly specified in the referenced standard have been properly characterized, optimized, controlled, and continuously improved.	0	

4.27	Defective Electrodes	To ensure that non-conforming electrodes are scrapped.	0	
4.28	Preventive Maintenance Plan	To ensure that the vendor has implemented an effective Preventative Maintenance (PM) plan.	0	
4.29	Periodic Cell Teardown and Analysis	To ensure winding process (key manufacturing machines) is operating adequately and consistently.	0	
4.30	Tension and Damage	To ensure that the electrode winding process has been properly characterized, optimized, and controlled.	0	
4.31	Collection of Loose Material	To ensure that the vendor has an effective method for collection of loose material produced.	0	
4.32	Detection of Damaged Cores	The vendor shall have a method to detect nonconforming cell cores.	0	
4.33	Control of Electrode Spacing	To ensure that the cell core design and the associated core assembly processes have been properly characterized, optimized, and controlled to prevent damage to the cell core.	0	
4.34	Uniformity of Winding Pressure (to Core) or Stacking Pressure (to Stack)	To ensure that the cell core assembly processes have been properly characterized, optimized, and controlled to prevent damage to the cell core.	0	
4.35	Avoidance of Contaminants	1) The winding/stacking process shall prevent introduction of contaminants from the winding process (dust, flakes from electrodes) into the cell. 2) The vendor shall prevent introduction of contaminants from the preparation of materials for core or stack or stack including electrode and separator and can as well as through all processes including winding/stacking process to sealing of the cell cap.	0	
4.36	Internal Short Avoidance	To ensure that the method of assembly for insulating material (whether for electrode, current collectors, or internal insulation) is designed to provide reliable protection against latent shorts for the product lifetime of the cell.	0	Use samples from 4.8

4.37	Tab Positioning (Testing)	To ensure that the process for positive and negative tab placement has been properly characterized, optimized, and controlled to prevent short circuit.	0	Use samples from 4.8
4.38	Tab Positioning (Audit)	To ensure that the process for positive and negative tab placement has been properly characterized, optimized, and controlled to prevent short circuit	0	
4.39	Integrity of Cell Core/Stack	To ensure that the integrity of the electrodes is verified through resistance or continuity check or equivalent means.	0	
4.40	Positioning of Insulating Plate - Test	To confirm the characteristics of the material, color, proper positioning and presence of insulating materials.	0 (N/A for laminated cells).	Use samples from 4.8
4.41	Positioning of Insulating Plate - Inspection	To confirm the characteristics of the material, color, proper positioning and presence of insulating materials.	0	
4.42	Electrode Alignment	The proper alignment of positive and negative electrodes is critical to prevent hazards. The vendor shall conduct 100% inspection (post-winding or stacking of electrodes) and should use a vision system to inspect 100% of the electrode assemblies.	0	
4.43	Cell Aging and Screening	1) The vendor shall develop and apply appropriate cell aging and screening process. 2) The sorting criterion shall identify and eliminate early failures.	0	
4.44	Aging Qualification Process	To verify the effectiveness of the cell aging process.	0	
4.45	Aging Qualification Testing	To ensure that the cell aging, grading, and sorting processes have been properly characterized, optimized, controlled, and continuously improved to remove early term failures.	0	
4.46	Cell Leakage	To ensure that a process has been implemented to remove cells that are leaking electrolyte.	0	
4.47	Care During Cell Assembly	To ensure that the welding and other operations have been properly characterized, optimized, controlled, and	0	

		continuously improved to prevent damage to the cell.		
4.48	Disposition of Defective Material	Rejects/failures (non-cosmetic) identified by any station in the manufacturing process shall be quarantined. Retest or reintroduction onto the production line shall be prohibited. A representative quantity of rejects/failures shall be analyzed per vendor quality system as part of closed loop corrective and preventive action process in order to identify and eliminate root cause.	0	
4.49	Destructive Plan	To verify that the vendor has a verifiable destruction plan to ensure failed cells do not reach secondary markets.	0	
4.50	Qualification of New Cell Designs	To ensure that the cell qualification processes have been properly characterized, optimized, controlled, and continuously improved. Additionally, to ensure that all cells are required to pass such tests before being given production status.	0	
4.51	Ongoing Tests and Qualification of Production Cells	To establish production cell qualification and periodic re-qualification requirements.	0	
4.52	Cell Transportation Regulations	Ensure compliance to UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria.	0	
4.53	Cell Thermal Test	To ensure cells demonstrate thermal stability. The cell design shall maintain adequate isolation properties during a temperature excursion of at least 1 h or 60 min in the cell in order to maintain safety of the cell. The cell design shall maintain isolation under high temperature stress conditions for a reasonable period of time to maintain the safety of the cell.	5	Not reusable
4.54	Cell Thermal Test on Cycled Cells	To ensure cycled cells demonstrate thermal stability.	5	Not reusable
4.55	External Shorting	To ensure that fully charged fresh cells can withstand a short circuit condition.	5	Not reusable

		Total Samples Required	**25 (20 for laminated cells)**	

Section 5 Pack Considerations

All tests will be performed on a minimum of 5 samples unless otherwise specified (all samples must pass compliance).

Inspection/Analysis criteria shall be done on a sample of one

5.1 Pack Management

Reference: IEEE 1625 Section 6.2.1

Purpose: To ensure that all components used in the construction of the battery pack shall have adequate electrical, thermal and mechanical ratings.

Procedure: Review electrical, thermal and mechanical specification of pack and all components specification.

Compliance: All components used in the pack have adequate electrical, thermal and mechanical ratings. The component specifications meet the pack specification.

5.2 Cell Component

Reference: IEEE 1625 Section 6.2.2

Purpose: To determine whether the cell operates within its operating temperature, voltage, and current limits.

Procedure: Obtain the cell specification sheet and the pack specification. Verify that the pack does not allow the cells to be operated outside their voltage, current and temperature limits.

Compliance: The cell operates within its operating temperature, voltage and current limits.

5.3 Pack Components

Reference: IEEE 1625 Section 6.2.2

Purpose: To determine whether the components used in the pack operate within their specification

Procedure: Verify that the component operating range is at least -25°C to 85°C.

Compliance: The components (except for the cells and thermal devices designed to activate at specific temperatures) are rated for -25°C to 85°C.

5.4 Pack Components -Test

Reference: IEEE 1625 Section 6.2.2

Purpose: To determine that protection circuit components will not fail in a manner likely to cause a hazard if exposed to ambient temperatures of 100 °C for a period of 4 hours.

Procedure: Place the pack protection circuit in a thermal chamber for at least 4 hours at minimum of 100°C (Allow the pack to cool to ambient temperature). Verify that the overvoltage, under-voltage, short circuit protection and temperature protection remain operational or that the pack is permanently disabled.

Compliance: All safety features shall remain operational, or the pack shall be permanently disabled

5.5 Battery Management Circuit Consideration

Reference: IEEE 1625 Section 6.2.3.1

Purpose: Ensure that upper limits for charge/discharge current, voltage, temperature and time limitations are based on conformance to the cell vendor's cell specification.

Procedure: Review the cell and pack specification to ensure that upper limits for charge/discharge current, voltage, temperature and time limitations are based on conformance to the cell vendor's specification.

Compliance: The upper limits for charge/discharge current, voltage, temperature and time limitations conform to the cell vendor's cell specification.

5.6 Battery Management Circuit Design

Reference: IEEE 1625 Section 6.2.3.1

Purpose: To verify that the intermediate voltage taps are not employed except for cell balancing or cell voltage monitoring

Procedure: Review the pack schematic and inspect one battery sample.

Compliance: Intermediate voltage taps are not employed except for use in cell monitoring or balancing.

5.7 Current Limiting

Reference: IEEE 1625 Section 6.2.4.1

Purpose: To determine whether the upper discharge current and time limit do not exceed the cell specification.

Procedure: Subject the pack at 100% SOC to a load in excess of discharge over-current protection identified in cell and battery pack specifications and at the minimum operating temperature, ambient temperature, and maximum operating temperature. This may require testing at additional specified temperature regions.

Compliance: Operation of pack over-current protection is within specified time over the temperature range tested. In systems where current limiting is performed outside of the pack, the pack shall incorporate short-circuit protection.

5.8 Cell Connections Termination Points

Reference: IEEE 1625 Section 6.2.5.2

Purpose: To verify that the wires conveying cell voltages from series connection points are terminated with sufficient spacing or encapsulated or current limited to prevent conductive paths from forming.

Procedure: Inspect a battery and measure whether wires conveying cell voltages from series connection points are terminated with not less than 4 mm spacing. If the spacing is less than 4 mm then the terminating points shall be encapsulated or the sense lines shall limit current in the event of a short circuit that would exceed the maximum discharge rating of any cell. "Wires" applies to any conductor type such as tabs or flexible printed wiring assemblies.

Compliance: The individual cell voltages wires terminated with not less than 4 mm spacing or the terminating points were encapsulated or current limited.

5.9 Cell Connections

Reference: IEEE 1625 Section 6.2.5.2

Purpose: To prevent short circuits between un-insulated conductors.

Procedure: Review evidence to determine if more than 1 mm spacing is maintained after the drop test specified in IEEE 1625 section 6.12.5.2 and the vibration test specified in section IEEE 1625 6.12.5.3.

Compliance: More than 1 mm spacing is maintained between un-insulated conductors after drop and vibration testing.

5.10 Accidental short Circuit

Reference: IEEE 1625 Section 6.2.5.4

Purpose: The design of the battery pack circuit board shall provide adequate runner spacing, soldering pad area size, and distance between solder pads.

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Procedure: Review evidence to verify the design of the battery pack circuit board was considered to prevent the accident of short circuit by circuit board.

Compliance: The design of the battery pack circuit board shows the consideration of prevent the accident of short circuit by circuit board.

5.11 Short Circuit – General

Reference: IEEE 1625 Section 6.2.6.1

Purpose: Verify that the battery pack has short circuit protection.

Procedure: Apply a short at the fully charged pack output terminals and verify that the discharge current terminates. Perform short circuit tests with a resistance of 80 +/- 20 milliohms at minimum and maximum operating temperatures for 1 hour.

Compliance: The battery pack has short circuit protection and limits the discharge current. All safety features shall remain operational, or the pack shall be permanently disabled. No fire, smoke, or explosions occurs

5.12 Short Circuit – Connector Design

Reference: IEEE 1625 Section 6.2.6.2

Purpose: To verify that the pack connector design minimize the possibility of accidental external short circuit.

Procedure: Review the pack connector and design and determine whether contacts are designed to minimize accidental short circuit.

Compliance: The pack connector design minimizes the possibility of accidental external short circuit.

5.13 Fault Handling

Reference: IEEE 1625 Section 6.2.7

Purpose: To verify when voltage, current and temperature are exceeded, the pack will take action to mitigate hazards.

Procedure: Review the system protection state diagram and identify the conditions that should cause the system to take a mitigating action. Subject the battery pack to each identified condition and determine whether the system successfully mitigated the hazard.

Compliance: The system action shall be one of the following: Restriction in use (for example, reduced capacity or charge rate), temporary disablement of function or functions within the pack or host (for example, disable charge if temperature is too high) or permanent disablement of the pack

5.14 Charging Voltage

Reference: IEEE 1625 Section 6.2.9

Purpose: To determine that the pack/host combination or pack is designed to prevent the charging voltage and current from exceeding the cell specification.

Procedure: Review the pack/host design to ensure the charging voltage and current do not exceed the cell specification.

Compliance: The host/pack combination or pack design shall not allow charging in excess of the cell specification.

5.15 Cell Matching

Reference: IEEE 1625 Section 6.3.2.1

Purpose: To determine that the blocks of series-connected cells in a pack are matched per specification for voltage, capacity, and size.

Procedure: Review the cell and pack specification.

Compliance: The blocks of series-connected cells in a pack shall be matched per specification for voltage, capacity, and size.

5.16 Cell Sourcing

Reference: IEEE 1625 Section 6.3.2.2

Purpose: To determine that cells in series-connected blocks are from the same cell manufacturing lot(s).

Procedure: Review vendors manufacturing procedure. Open an exemplar battery pack to verify the cell manufacturing lot(s) specified by the cell vendor.

Compliance: Vendor's manufacturing procedure requires cells from same manufacturing lot to be used in series-connected blocks. The cells in series-connected blocks are from the same manufacturing lot(s).

5.17 Old and Fresh Cells

Reference: IEEE 1625 Section 6.3.2.3.2

Purpose: To determine that cells are not connected in cell blocks and series of blocks in a battery pack using a combination of old and fresh cells.

Procedure: Open an exemplar battery pack to verify that the cells are not connected in cell blocks and series of blocks using a combination of old and fresh cells.

Compliance: The cells are not connected in cell blocks and series of blocks in a battery pack using a combination of old and fresh cells as determined by the cell vendor.

5.18 Different Cell Vendors

Reference: IEEE 1625 Section 6.3.2.3.3

Purpose: To determine that the cells are not connected in cell blocks and series of cell blocks using a combination of cells made by different vendors.

Procedure: Open an exemplar battery pack to verify that the cells are not connected in cell blocks and series of cell blocks using a combination of cells made by different vendors.

Compliance: The cells are not connected in cell blocks and series of cell blocks using a combination of cells made by different vendors.

5.19 Reworked Cell

Reference: IEEE 1625 Section 6.3.2.3.4

Purpose: To determine that the cells are not connected in cell blocks and series of cell blocks using a combination of cells comprised of cells reused from previously built assemblies. Also to confirm that once a weld has been removed from a cell, the cell has been discarded and destroyed to prevent entrance into the secondary market.

Procedure: Review the SOP of battery pack vendor to verify.

Compliance: Cells are not connected in cell blocks and series of cell blocks using a combination of cells comprised of cells reused from previously built assemblies. Once a weld has been removed from a cell, the cell shall be discarded and destroyed to prevent entrance into the secondary market.

5.20 Cells are different in construction or capacity

Reference: IEEE 1625 Section 6.3.3

Purpose: To determine that different types of cells are not used in the same pack in a manner that leads to a hazard. In case different types of cells used, pack designs shall document the analysis of the behavior of cells of different types used in the same pack.

Procedure: Review the battery pack specification to determine whether different types of cells are used in the same pack or not. In case different types of cells are used, review the analysis of the behavior of cells of different types used in the same pack with reference to battery pack specification.

Compliance: Different types of cells are not used in the same pack in a manner that leads to a hazard. In case different types of cells are used in the pack, the design documents the behavior of cells of different types used in the same pack and it does not lead to a hazard.

5.21 Cell Monitoring

Reference: IEEE 1625 Section 6.3.4.1

Purpose: To determine that temperature ranges for operation are set based on the operating temperature ranges recommended by the cell, battery pack, and host device vendors.

Procedure: Review the temperature ranges recommended by the cell, battery pack, and host device vendor with reference to operating temperature range.

Compliance: Temperature ranges for operation are set based on the operating temperature ranges recommended by the cell, battery pack, and host device vendors.

5.22 Before Charge Requirements

Reference: IEEE 1625 Section 6.3.5

Purpose: To determine that pack/host checks the conditions for operation specified by the cell vendor before initiating the charge.

Procedure: Review the charging state diagram to determine that conditions are checked as specified by the cell vendor before initiating the charge (Example temperature, voltage etc).

Compliance: Before charge is initiated, the pack/host checks to determine if the pack is within the conditions for operation specified by the cell vendor.

5.23 Charge

Reference: IEEE 1625 Section 6.3.6.1

Purpose: To determine that the maximum charging voltage measured at the cell block does not exceed the value specified on the Cell specification sheet.

Procedure: Perform a normal charge test on a fully discharged battery pack measuring cell block voltage.

Compliance: The maximum charging voltage measured at the cell block does not exceed the value specified on the Cell specification sheet.

5.24 Redundant Overvoltage Protection

Reference: IEEE 1625 Section 6.3.6.3

Purpose: To determine that the battery management circuit has incorporated at least two independent cell/cell block overvoltage protection functions, in addition to voltage limits designed into the charging circuit. At least one of the overvoltage protection functions is in the pack. The independent circuits are protecting each cell/cell block from overvoltage in the event of a failure of the primary circuit.

Procedure: Review the battery pack and host specification to determine that the battery management circuit has incorporated at least two independent cell/cell block overvoltage protection functions, in addition to voltage limits designed into the charging circuit. Verify that at least one of the overvoltage protection functions is in the pack. Verify that the at least two overvoltage protection circuits are protecting each cell/cell block from overvoltage independently.

Compliance: The battery management circuit has incorporated at least two independent cell/cell block overvoltage protection functions, in addition to voltage limits designed into the charging circuit. Voltage control of neither the pack nor cell stack is considered an independent overvoltage protection function. At least one of the overvoltage protection functions is in the pack. At least two overvoltage protection circuits are protecting each cell/cell block from overvoltage independently.

5.25 Monitoring of Each Cell Block

Reference: IEEE 1625 Section 6.3.6.4

Purpose: To determine that the combination of cell, battery pack, and host device/charger detects the voltage of each cell block in the battery pack and controls the charge if overvoltage occurs. Charging may resume at a specified overvoltage recovery level, which shall consider both voltage and time.
The second protection circuit shall monitor the voltage of the cell blocks. If the cell voltage rises beyond the maximum charge voltage to the cell critical voltage, the pack shall be permanently disabled from charging.

Procedure:

1) Charge the battery pack bypassing the normal charge control to verify the performance of primary over voltage protection for each cell block.
2) Charge the battery pack bypassing the normal charge control and primary overvoltage protection to verify the performance of the secondary over voltage protection for each cell block.

Compliance:

1) Charging is terminated at or below specified voltage (cell specification) and it may resume at or below specified (cell specification) over voltage recovery level which shall consider both voltage and time.
2) Charging is terminated at or below specified (cell specification) over voltage and pack shall be permanently disabled from charging.

5.26 Recovery from Over discharge

Reference: IEEE 1625 Section 6.3.6.6

Purpose: To determine that a cell or cell blocks, has been discharged beyond the expected minimum state, the pack/system follows the cell vendor’s recommendation to recover from this condition.

Procedure: Discharge the cell or cell blocks beyond the minimum state specified by the cell vendor. Charge such a cell or cell blocks using normal charge algorithm to verify the performance.

Compliance: In case of a cell, or cell blocks, discharged beyond the expected minimum state, the pack/system follows the cell vendor’s recommendation to recover from this condition.

5.27 Discharge

Reference: IEEE 1625 Section 6.3.7.1

Purpose: To determine that the minimum discharge voltage and maximum discharge current are set on the basis of a cell / battery specification.

Procedure: Review the cell and battery pack specification to make sure that the minimum discharge voltage and maximum discharge current of the battery pack are within cell specification.

Compliance: The minimum discharge voltage and maximum discharge current of the battery pack are within cell specification.

5.28 Over-current Precautions

Reference: IEEE 1625 Section 6.3.7.2

Purpose: To ensure that a pack has at least one level of over current protection

Procedure: Review the cell specification and pack schematics to determine whether the cell or pack has at least one level of over-current protection. For example, a PTC, a fuse or a Field Effect Transistor (FET).

Compliance: The pack has one level of over-current protection.

5.29 Under-voltage Protection

Reference: IEEE 1625 Section 6.3.7.3

Purpose: To ensure that the pack have at least one under-voltage protection circuit that disables battery discharge to the external system.

Procedure: Review the battery pack specification to verify that at least one under-voltage protection circuit is available in the pack and it disables battery discharge at voltage specified by the cell vendor.

Compliance: The pack have at least one under-voltage protection circuit that disables battery discharge to the external system at voltage level specified by the cell vendor.

5.30 Low Cell Voltage Cut-off

Reference: IEEE 1625 Section 6.3.7.4

Purpose: To verify that the pack ceases to provide power or the host ceases to draw power from the pack if any cell block is detected with a voltage equal to or less than specified by the cell vendor.

Procedure: Discharge the pack using a system and/or electronic load to observe the low cell voltage cut-off protection level. This should be at or above the cell manufactures specification.

Compliance: The pack ceases to provide power or the host ceases to draw power from the pack if voltage on any cell / cell block is detected at or at some level above the cell manufacturer's specification.

5.31 Low Voltage Power Down

Reference: IEEE 1625 Section 6.3.7.5

Purpose: To determine that in the event that the voltage of one or more cell blocks reaches the minimum operating voltage as specified by the cell vendor, the battery management circuit maintains a low-power state in order to minimize further discharging of the cells.

Procedure: Review the battery specification to verify how the low power state is implemented. Review the test report(s) submitted by the battery pack vendor to verify the implementation of the low power state.

Compliance: In the event of the voltage of one or more cell blocks reaches the minimum operating voltage as specified by the cell vendor, the battery management circuit maintains a low-power state.

5.32 Cell Monitoring

Reference: IEEE 1625 Section 6.3.8.2

Purpose: To determine that cell blocks connected together are monitored to compare the voltage of each cell block. When cell blocks differ by more than a specified limit under specified conditions, the battery pack is disabled.

Procedure: Review the cell imbalance algorithm defined by the pack vendor. Charge or discharge a cell block in a pack which has a suitable initial charge status to create a voltage difference between blocks which is greater than that allowed by the algorithm. To verify the pack is disabled, attempt to charge or discharge the pack under the conditions specified by the pack vendor.

Compliance: When cell block voltages differ by more than the limit specified by the vendor, it is not possible to charge or discharge the pack under the conditions specified by the vendor.

5.33 Cell Temperature

Reference: IEEE 1625 Section 6.3.9.1

Purpose: To determine that charging is terminated if the temperature of the hottest cell exceeds the maximum safe charging temperature specified by the cell vendor. The host/pack monitors the temperature of the pack during discharge (hottest cell) and ensures that this does not exceed the maximum temperature, as specified by the cell vendor. In the event that this temperature is exceeded, the pack ceases to provide power.

Procedure: Monitor temperature at the location of the hottest cell based on data from pack/host vendor.

This test may be conducted with the pack placed in the environmental chamber and the host placed outside of the chamber, alternatively the pack/host combination may be placed in the environmental chamber.

1) Charge test: Record the hottest cell temperature during the test. Initiate normal charging and set the chamber to 10 degrees C above the maximum safe charging temperature specified by the cell vendor. Determine at what cell temperature the host/pack terminates the charging of the battery pack.
2) Discharge test: Record the hottest cell temperature during the test. Initiate normal discharging and set the chamber to 10 degrees C above the maximum safe discharging temperature specified by the cell vendor. Determine at what cell temperature the host/pack terminates the discharging of the battery pack.

Compliance: Charging and discharging is terminated if the temperature of the hottest cell (based on test data from the vendor) exceeds the maximum safe temperature specified by the cell vendor. Operating modes where the cell discharge rate is less than C/10 are exempted, as they do not induce a thermal stress to the cell

5.34 Communication of Error Messages

Reference: IEEE 1625 Section 6.4.2.2

Purpose: To determine that the battery management circuit and host communicates on a regular basis—not less frequently than every 5 s. The communication is advising the host of the condition of the pack. The host/pack combination is communicating potential battery issues as they occur. In cases where a hazard may result, the battery shall fail safe. In the event that the system does not respond within a defined time period to a message indicating a potential hazard, the pack shall take action independent of the host (see IEEE1625 Section 6.2.7). Conformance is ascertained by demonstrating arrival of messages to the host system.

Procedure: Review the battery pack / host specification to determine that there is communication between host and battery pack. Verify that the communication is done on regular basis - not less frequently than every 5s. Verify that communication is advising the host the condition of the pack. In the event that the system does not respond within a defined time period to a message indicating a potential hazard, the pack shall take action independent of the host (for example in case of over voltage, over current, temperature outside limits, cell imbalance, etc) to disable the battery pack.

Compliance: The battery management circuit and host communicate on a regular basis—not less frequently than every 5 s. The communication is advising the host of the condition of the pack. In the event that the system does not respond within a defined time period to a message indicating a potential hazard, the pack takes action independent of the host based on Fault Handling (CRD Clause 5.13).

5.35 Alternate Standard

Reference: IEEE 1625 Section 6.4.4

Purpose: To determine that the system as a whole ensures proper management of the battery pack including, but not limited to, the ability to identify the insertion of a different pack and identifying its state of charge (SOC).

Procedure: For host designs with a user replaceable battery pack: Insert one battery pack in the host device. Record the SOC for the battery. Replace the battery with another pack with different SOC (at least 10% difference in SOC with first battery) the host device. Confirm that SOC indicated is of new battery pack.

Compliance: The system as a whole ensures proper management of the battery pack including, but not limited to, the ability to identify the insertion of a different pack and identifying its state of charge (SOC).

5.36 Prevention of Shifting Cells

Reference: IEEE 1625 Section 6.5.2.2

Purpose: To determine that cells are located within the pack in a manner that will minimize shifting, such as location tabs in the pack casing, padding between cells (insulating), or adhesive.

Procedure: Review the design analysis, to verify the following:

a) Cells with the minimum expected dimensions are unable to shift under normal usage conditions (as defined by the battery pack vendor).
b) Cells with the maximum expected dimensions fit into the pack without the need for unreasonable insertion force, and with no distortion to the pack.

Compliance: Cells are located within the pack in a manner that will minimize shifting, such as location tabs in the pack casing, padding between cells (insulating), or adhesive.

5.37 Connection Spacing

Reference: IEEE 1625 Section 6.5.2.3

Purpose: To determine that appropriate spacing is provided to prevent abrasion, wear, or damage to cable leads and/or connectors in the battery pack.

Procedure: Battery and/or host vendor need to provide a declaration stating "appropriate spacing is provided to prevent abrasion, wear, or damage to cable leads and/or connectors in the battery pack."

Compliance: The appropriate spacing is provided to prevent abrasion, wear, or damage to cable leads and/or connectors in the battery pack.

5.38 Cell Orientation

Reference: IEEE 1625 Section 6.5.3.1

Purpose: To determine that the individual unit cells in a battery pack are arranged in accordance with correct polarity.

Procedure: Verify that the individual unit cells in a battery pack are arranged in accordance with correct polarity.

Compliance: The individual unit cells in a battery pack are arranged in accordance with correct polarity.

5.39 Vent Mechanism

Reference: IEEE 1625 Section 6.5.3.2

Purpose: To determine that the vent mechanism of the cell is not covered or obstructed with plastic or other material in the battery pack in such a way as to prevent its operation.

Procedure: Review the vent mechanism design in the battery pack to verify whether cell vent is covered or obstructed with plastic or other material in the battery pack in such a way to prevent its operation. If the pack construction allows material (for example, epoxy, potting material) to come in direct contact with the outlet area of the cell vent, then a venting test is conducted to show that, in the case of a venting cell, the pack is not preventing the escape of gasses from any cell in the pack.

Compliance: The vent mechanism of the cell is not covered or obstructed with plastic or other material in the battery pack in such a way as to prevent its operation. If the pack construction allows material (for example, epoxy, potting material) to come in direct contact with the outlet area of the cell vent, the pack does not prevent the escape of gasses from any cell in the pack.

5.40 Cell Insulation

Reference: IEEE 1625 Section 6.5.3.3

Purpose: To determine that the cells at a different electrical potential are electrically insulated from each other to prevent unintended shorting together.

Procedure: Verify that the cells at a different electrical potential are electrically insulated from each other to prevent unintended shorting together per battery pack specification.

Compliance: The cells at a different electrical potential are electrically insulated from each other to prevent unintended shorting together per battery pack specification.

5.41 Cell Connections

Reference: IEEE 1625 Section 6.5.4.1

Purpose: To determine that the connections are not soldered directly to the cells.

Procedure: Verify that the connections are not soldered directly to the cells.

Compliance: The connections are not soldered directly to the cells.

5.42 Testing Weld Strength

Reference: IEEE 1625 Section 6.5.4.4

Purpose: To determine that tab welds for cells have specified strengths to ensure that they meet minimum specified strength requirements.

Procedure: Verify by reviewing the battery vendor document (SOPs) that strength of the tab welds are checked and are within the specification.

Compliance: Tab welds for cells have specified strengths to ensure that they meet minimum specified strength requirements.

5.43 Welding Placement

Reference: IEEE 1625 Section 6.5.4.5

Purpose: To determine that the welding is only applied in areas designated by cell vendor in accordance with agreed upon specifications.

Procedure: Verify that the welding is only applied in areas designated by cell vendor in accordance with agreed upon specification.

Compliance: The welding is only applied in areas designated by cell vendor in accordance with agreed upon specifications.

5.44 Internal Pack Connections

Reference: IEEE 1625 Section 6.5.5.1

Purpose: To determine that battery pack is designed to protect against unintended electrical connections between the circuit board and other electrical components and devices.

Procedure: Verify that the battery pack is designed to protect against unintended connections between the circuit board and other electrical components and devices.

Compliance: The battery pack is designed to protect against unintended electrical connections between the circuit board and other electrical components and devices.

5.45 Electrolyte Leakage

Reference: IEEE 1625 Section 6.5.6

Purpose: To determine that the battery pack is designed to ensure that any electrolyte leakage from the cells does not interfere with the proper operation of safety provisions within the pack.

Procedure: Review the document provided by the battery vendor to ensure that any electrolyte leakage from the cells does not interfere with the proper operation of safety provisions within the pack. Methods may include encapsulation of the electronic circuitry, printed circuit layout and spacing of components, mechanical orientation of the cell vents, etc.

Compliance: Review vendor analysis that addresses when electrolyte leakage occurs. The battery pack is designed to ensure that any electrolyte leakage from the cells does not interfere with the proper operation of safety provisions within the pack.

5.46 Connector Design

Reference: IEEE 1625 Section 6.5.7.1

Purpose: To determine that connector/terminal is designed to minimize the possibility of accidental short circuit.

Procedure: Review the document provided by the battery vendor to ensure that connector / terminal is designed to minimize the possibility of accidental short circuit.

Compliance: The connector/terminal is designed to minimize the possibility of accidental short circuit.

5.47 Connector Compatibility

Reference: IEEE 1625 Section 6.5.7.2

Purpose: Connector/terminal shall adhere to host device mechanical considerations (see 6.28).
To determine that the packs are constructed to mechanically prevent reverse-polarity insertion into the host device.

Procedure: Verify that the packs are constructed to mechanically prevent reverse-polarity insertion into the host device.

Compliance: The packs are constructed to mechanically prevent reverse-polarity insertion into the host device.

5.48 Pack Enclosure Openings

Reference: IEEE 1625 Section 6.5.8

Purpose: To determine that pack enclosure openings are designed such that potential hazards due to foreign debris entering the pack will not result in the compromise of the protection circuit or shorting of circuits or components. Packs shall comply with IEC 60950-1:2005 with regard to enclosure openings.

Procedure: Review that the battery pack is compliant to IEC 60950-1: 2005 (with regard to enclosure openings).

Compliance: The pack enclosure openings are designed such that potential hazards due to foreign debris entering the pack will not result in the compromise of the protection circuit or shorting of circuits or components. Packs are complaint to IEC 60950-1:2005 with regard to enclosure openings.

5.49 Pack Enclosure Openings for venting

Reference: IEEE 1625 Section 6.5.8

Purpose: To determine that the pack enclosure allows for the venting of pressure from the pack in the event of a cell rupture.

Procedure: Battery and/or host vendor need to provide a declaration stating, "pack enclosure allows for the venting of pressure from the pack in the event of a cell rupture."

Compliance: The pack enclosure allows for the venting of pressure from the pack in the event of a cell rupture.

5.50 Marking

Reference: IEEE 1625 Section 6.6.2.1, 6.6.2.2, 6.6.2.3, 6.6.2.4, 6.6.2.5 and 6.6.2.6

Purpose: To determine whether the battery has all the required markings.

Procedure: Inspect the battery marking and determine that the following are specified: Part number, Voltage, Pack Capacity, Pack Energy, Chemistry, Vendor name or identification, Agency Approvals and Unique Identifier. Identifier must be unique, but serialization is not required.

Compliance: The battery is marked with the following: Part number, Voltage, Pack Capacity, Pack Energy, Chemistry, Vendor name or identification, Agency Approvals and Unique Identifier.

5.51 Traceability

Reference: IEEE 1625 Section 6.6.3

Purpose: To verify whether the vendor has traceability plan for critical components and cells.

Procedure: Review the traceability plan of the vendor to ensure that there are a traceability plan for the critical components and cells.

Compliance: There is a traceability plan for critical components and cells.

5.52 Identification Code

Reference: IEEE 1625 Section 6.6.4.2

Purpose: To verify whether the battery management circuit contains an electronically readable identification code that enables traceability. This code can be the unique identifier code.

Procedure: Review evidence showing that the battery management circuit contains an electronically readable identification code that enables traceability.

Compliance: The battery management circuit contains an electronically readable identification code that enables traceability.

- This applies to embedded packs where the battery management circuit may be located at the host level.

5.53 Over-temperature protection

Reference: IEEE 1625 Section 6.7.2.3

Purpose: To verify that the battery pack contains at least one thermal protection circuit or device independent of internal cell devices. To verify that the combination of cell, pack, and host device/charger has at least two independent thermal protection devices or mechanisms.

Procedure: Review the pack and system documentation.

Compliance: The battery pack shall contain at least one thermal protection mechanism independent of internal cell devices or mechanisms. This mechanism shall include a thermal sensor (examples may include thermistors, integrated circuits, etc.) that enables the system to determine the cell temperature with sufficient accuracy to limit operation outside of the cell's thermal specifications. Alternate approaches such as derating may be used to compensate for the inaccuracy of the thermal measurement system (sensor, placement, etc). The combination of cell, pack, and host device/charger has at least two independent thermal protection devices or mechanisms.

5.54 Electrostatic discharge- Design

Reference: IEEE 1625 Section 6.7.3

Purpose: Ensure precautions have been taken to avoid damage to protection circuits and other devices from ESD during handling.

Procedure: Review process documentation for ESD protection throughout the assembly process. Identify areas of risk to protection circuits and other devices from ESD during handling and storage.

Compliance: All ESD sensitive components and parts shall be stored and handled in an ESD safe environment. Containers used for transport of such parts shall be ESD safe container. The need for appropriate ESD precautions for operators and equipment shall be documented in work instructions. Evidence shall exist that the elements of ESD protection have been implemented.

5.55 Electrostatic discharge

Reference: IEEE 1625 Section 6.7.3

Purpose: Validate the ability of the pack to withstand ESD.

Procedure: Subject pack to ESD in accordance with IEC 61000-4-2 per product level 2 at a minimum.

Compliance: Performance of pack protection circuitry per Section 5.11 of this document after the ESD test. If the pack includes an over voltage protection mechanism that could be susceptible to ESD damage, it shall be verified as functional after the ESD test. All compliance testing shall be done at ambient temperature only.

5.56 Altitude Simulation

Reference: IEEE 1625 Section 6.7.4

Purpose: To determine whether the pack meet the requirement for altitude as specified in the most recent version of IEC 62281.

Procedure: Follow IEC 62281 test procedure

Compliance: Meets IEC 62281 for altitude requirements.

5.57 Humidity Consideration

Reference: IEEE 1625 Section 6.7.5

Purpose: To determine whether hygroscopic material is used as electrical insulation in the pack.

Procedure: Review vendor’s evidence for user replaceable packs. For embedded packs (not user replaceable) subject Embedded Pack Host to drop impact test in accordance to UL 2054.

Compliance: Hygroscopic material shall not be used as electrical insulation in the pack.

5.58 Assembly / Manufacturing Factory

Reference: IEEE 1625 Section 6.8.2

Purpose: Verify that the factory is maintained as a clean and orderly environment per the vendor's quality system to prevent contamination of the end product, which may affect its operation.

Procedure: Review vendor's declaration.

Compliance: The factory is maintained as a clean and orderly environment per the vendor's quality system to prevent contamination of the end product, which may affect its operation.

5.59 Solder Joints

Reference: IEEE 1625 Section 6.8.3.1

Purpose: To verify that precautions shall be implemented to ensure sufficient solder flux activation to avoid incomplete solder connections.

Procedure: Review vendor's declaration.

Compliance: Precautions shall be implemented to ensure sufficient solder flux activation to avoid incomplete solder connections.

5.60 Component protection during pack assembly

Reference: IEEE 1625 Section 6.8.3.2

Purpose: To verify that precautions are taken to avoid damage to cells, battery management circuit, and battery pack during manufacturing, including ultrasonic welding.

Procedure: Review vendor's declaration.

Compliance: Precautions shall be taken to avoid damage to cells, battery management circuit, and battery pack during manufacturing, including ultrasonic welding.

5.61 Manufacturing Considerations

Reference: IEEE 1625 Section 6.8.3.3

Purpose: To verify that precautions are taken to avoid damage to conductors and insulators, for example, from sharp edges, burrs, pinching, or kinking.

Procedure: Review the pack documentation.

Compliance: Precautions are taken to avoid damage to conductors and insulators, for example, from sharp edges, burrs, pinching, or kinking.

5.62 Protection from electric discharge

Reference: IEEE 1625 Section 6.8.3.4

Purpose: To verify that precautions are taken to avoid damage to protection circuits and other devices from electrostatic discharge (ESD) during handling.

Procedure: Review the pack documentation.

Compliance: To verify that precautions are taken to avoid damage to protection circuits and other devices from electrostatic discharge (ESD) during handling.

5.63 Protection function verification in Process

Reference: IEEE 1625 Section 6.8.3.5

Purpose: To determine whether the protection functions are verified per the documented vendor’s process.

Procedure: Review evidence.

Compliance: Protection functions are verified per the documented vendor’s process.

5.64 Adherence to Process control

Reference: IEEE 1625 Section 6.8.3.6

Purpose: To verify whether critical processes such as welding have a quality control and a maintenance plan to control the consistency of the assembly process and adherence to specifications.

Procedure: Review the quality control maintenance plan.

Compliance: Critical processes such as welding have a quality control and a maintenance plan to control the consistency of the assembly process and adherence to specifications.

5.65 Welding operations

Reference: IEEE 1625 Section 6.8.3.7

Purpose: To determine whether there is no damage to cell container and critical cell design elements during welding and other operations.

Procedure: Review vendor’s declaration.

Compliance: To determine whether there are no damage to cell container and critical cell design elements during welding and other operations.

5.66 Flaming rating of materials

Reference: IEEE 1625 Section 6.9.1

Purpose: To ensure that the materials used in pack assembly are rated a minimum V1/VTM1 for the enclosure, battery terminal and printed circuit boards and V2/VTM2 minimum for other internal parts. The flame ratings shall be in accordance with UL 94 or IEC 60695-11-10.

Procedure: Review evidence.

Compliance: The materials used in pack assembly are rated a minimum V1/VTM1 for the enclosure, battery terminal and printed circuit boards and V2/VTM2 minimum for other internal parts. The flame ratings shall be in accordance with UL 94 or IEC 60695-11-10.

5.67 Quality control

Reference: IEEE 1625 Section 6.10

Purpose: Determine whether the pack assembler have a statistical process control function in place that meets the requirements of the host vendor.

Procedure: Review pack and host vendor's evidence.

Compliance: The pack assembler has a statistical process control function in place that meets the requirements of the host vendor.

5.68 Record keeping

Reference: IEEE 1625 Section 6.10.1

Purpose: Complete records of the packs, cells, assembly dates, assembly lines, and pack designs shall be maintained for a minimum of seven years.

Procedure: Review vendor's declaration.

Compliance: Complete records of the packs, cells, assembly dates, assembly lines, and pack designs shall be maintained for a minimum of seven years.

5.69 Qualification

Reference: IEEE 1625 Section 6.11.1

Purpose: Verify that new pack designs pass specified tests identified by the vendor before qualification as a production pack.

Procedure: Review vendor's specifications or documentation.

Compliance: New pack designs pass specified tests identified by the vendor before qualification as a production pack.

5.70 Design Analysis

Reference: IEEE 1625 Section 6.11.2

Purpose: Verify whether FMEA or similar processes are carried out on new pack designs and the manufacturing processes.

Procedure: Review vendor's FMEA or similar process.

Compliance: FMEA or similar processes are carried out on new pack designs and the manufacturing processes.

5.71 Qualification Testing

Reference: IEEE 1625 Section 6.11.3

Purpose: To ensure that vendors are familiar with battery testing standards and utilize one or more of these standards as part of their testing process.

Procedure: Review Declaration.

Compliance: Vendors are familiar with battery testing standards and utilize one or more of these standards as part of their testing process.

5.72 Ongoing Reliability Testing

Reference: IEEE 1625 Section 6.11.4

Purpose: Verify that compliance with the internal specification of the vendor is maintained and manufactured packs pass the qualification tests at intervals specified by the vendor.

Procedure: Review Declaration.

Compliance: Compliance with the internal specification of the vendor is maintained and manufactured packs pass the qualification tests at intervals specified by the vendor.

5.73 Production Testing, Sample sizes and Data recording

Reference: IEEE 1625 Section 6.12.1, 6.12.2 and 6.12.4

Purpose: 1. General: Verify that 100% of the manufactured outgoing packs are tested for functionality.
2. Sample sizes: Verify that all tests are carried out on a statistically valid number of samples.
3. Data recording: Verify that records of the samples and test results are maintained for the expected life of the product.

Procedure: Review Declaration.

Compliance: 1. General: 100% of the manufactured outgoing packs are tested for functionality.
2. Sample sizes: All tests are carried out on a statistically valid number of samples.
3. Data recording: Records of the samples and test results are maintained for the expected life of the product.

5.74 Test Method

Reference: IEEE 1625 Section 6.12.5.1

Purpose: To verify whether test methods are agreed upon by the pack and host vendors.

Procedure: Review Declaration.

Compliance: To verify whether test methods are agreed upon by the pack and host vendors.

5.75 Drop Test

Reference: IEEE 1625 Section 6.12.5.2

Purpose: Verify that production packs pass the drop impact test of UL 2054.

Procedure: Review vendor's evidence. The embedded (not user replaceable) battery packs test be done on the system base.

Compliance: The cells have not shifted beyond the design specification reviewed in Clause 5.36 after being subjected to the drop test. Verify there are no conditions that would affect the safety of the pack.

5.76 Vibration Test

Reference: IEEE 1625 Section 6.12.5.3

Purpose: To ensure that the production pack complies with the vibration test specified in IEC 62281.

Procedure: Review vendor's evidence.

Compliance: The cells have not shifted beyond the design specification reviewed in Clause 5.36 after being subjected to the vibration test. Verify there are no conditions that would affect the safety of the pack.

5.77 Tab Welding

Reference: IEEE 1625 Section 6.12.5.4

Purpose: To verify that samples from the tab welding station are taken and subjected to a pull test.

Procedure: Review vendor's evidence.

Compliance: Samples from the tab welding station are taken and subjected to a pull test.

5.78 Interpretation of results

Reference: IEEE 1625 Section 6.12.6

Purpose: To verify that the various tests shall be correlated and compared to results of previous tests.

Procedure: Review Declaration.

Compliance: Various tests shall be correlated and compared to results of previous tests.

5.79 Adherence to transport regulations

Reference: IEEE 1625 Section 6.13.3.1

Purpose: Ensure compliance to UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria

Procedure: Review test report confirming compliance to UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria.

Compliance: Test report confirming compliance to UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria exists.

Table 2 Section 5 - Sample Submission Requirements

CRD Sec	Name	Purpose	# Samples	Reusable?
4.16	Over-current Protection Device (Only if in the pack)	To confirm that cells qualified with ancillary protective measures are employed at the pack level with such measures intact.	0	Use sample 5.16
5.1	Pack Management	To ensure that all components used in the construction of the battery pack shall have adequate electrical, thermal and mechanical ratings.	0	
5.2	Cell Component	To ensure that the pack design specification considered the cell specification as defined in Annex E or equivalent cell specification as defined by cell maker.	0	
5.3	Pack Components	To determine whether the components used in the pack operate within their specification	0	
5.4	Pack Components - Test	To determine that protection circuit components will not fail in a manner likely to cause a hazard if exposed to ambient temperatures of 100 °C for a period of 4 hours.	5	
5.5	Battery Management Circuit Consideration	Ensure that upper limits for charge/discharge current, voltage, temperature and time limitations are based on conformance to the cell vendor's cell specification.	0	
5.6	Battery Management Circuit Design	To verify that the intermediate voltage tabs are not employed except for cell balancing or cell voltage monitoring.	0	Use sample 5.16
5.7	Current Limiting	To determine whether the upper discharge current and time limit do not exceed the cell specification.	1	Not reusable
5.8	Cell Connections - Test	To verify that the wires conveying cell voltages from series connection points are terminated with sufficient spacing or encapsulated or current limited to prevent conductive paths from forming.	0	Use sample 5.16
5.9	Cell Connections	To prevent short circuits between un-insulated conductors.	0	
5.10	Accidental short Circuit	The design of the battery pack circuit board shall provide adequate runner spacing, soldering pad area size, and distance between solder pads.	0	
5.11	Short Circuit - General	Verify that the battery pack has short circuit protection.	2	Not

				reusable
5.12	Short Circuit – Connector Design	To verify that the pack connector design minimize the possibility of accidental external short circuit.	0	
5.13	Fault Handling	To verify when voltage, current and temperature are exceeded, the pack will take action to mitigate hazards.	0	Move to host
5.14	Charging Voltage	To determine that the pack/host combination or pack is designed to prevent the charging voltage and current from exceeding the cell specification	0	Move to Host
5.15	Cell Matching	To determine that the blocks of series-connected cells in a pack are matched per specification for voltage, capacity, and size.	0	
5.16	Cell Sourcing	To determine that cells in series-connected blocks are from the same cell manufacturing lot(s).	5 (Open Pack)	Sample to be used for 5.6, 5.8, 5.17, 5.18, 5.23, 5.32, 5.38, 5,40, 5.41
5.17	Old and Fresh Cells	To determine that cells are not connected in cell blocks and series of blocks in a battery pack using a combination of old and fresh cells.	0	Use sample 5.16
5.18	Different Cell Vendors	To determine that the cells are not connected in cell blocks and series of cell blocks using a combination of cells made by different vendors.	0	Use sample 5.16
5.19	Reworked Cell	To determine that the cells are not connected in cell blocks and series of cell blocks using a combination of cells comprised of cells reused from previously built assemblies. Also to confirm that once a weld has been removed from a cell, the cell has been discarded and destroyed to prevent entrance into the secondary market.	0	
5.20	Cells are different in construction or capacity	To determine that different types of cells are not used in the same pack in a manner that leads to a hazard. In case different types of cells used, pack designs shall document the analysis of the behavior of cells of different types used in the same pack.	0	

5.21	Cell Monitoring	To determine that temperature ranges for operation are set based on the operating temperature ranges recommended by the cell, battery pack, and host device vendors.	0	Move to Host
5.22	Before Charge Requirements	To determine that pack/host checks the conditions for operation specified by the cell vendor before initiating the charge.	0	Move to Host
5.23	Charge	To determine that the maximum charging voltage measured at the cell block does not exceed the value specified on the Cell specification sheet	0	Use sample 5.16
5.24	Redundant Overvoltage Protection	To determine that the battery management circuit has incorporated at least two independent cell/cell block overvoltage protection functions, in addition to voltage limits designed into the charging circuit. At least one of the overvoltage protection functions is in the pack. The independent circuits are protecting each cell/cell block from overvoltage in the event of a failure of the primary circuit.	0	Move to Host
5.25	Monitoring of Each Cell Block	To determine that the combination of cell, battery pack, and host device/charger detects the voltage of each cell block in the battery pack and controls the charge if overvoltage occurs. Charging may resume at a specified overvoltage recovery level, which shall consider both voltage and time. The second protection circuit shall monitor the voltage of the cell blocks. If the cell voltage rises beyond the maximum charge voltage to the cell critical voltage, the pack shall be permanently disabled from charging.	0	Move to Host
5.26	Recovery from Over-discharge	To determine that a cell or cell blocks, has been discharged beyond the expected minimum state, the pack/system follows the cell vendor's recommendation to recover from this condition.	0	Move to Host
5.27	Discharge	To determine that the minimum discharge voltage and maximum discharge current are set on the basis of a cell / battery specification.	0	
5.28	Over-current Precautions	To ensure that a pack has at least one level of over current protection	0	
5.29	Under-voltage Protection	To ensure that the pack have at least one under-voltage protection circuit that disables battery discharge to the external system.	0	
5.30	Low Cell Voltage Cut-off	To verify that the pack ceases to provide power or the host ceases to draw power from the pack if any cell block is detected with a voltage equal to or less than specified by the cell vendor	0	Move to Host

5.31	Low Voltage Power Down	To determine that in the event that the voltage of one or more cell blocks reaches the minimum operating voltage as specified by the cell vendor, the battery management circuit maintains a low-power state in order to minimize further discharging of the cells.	0	
5.32	Cell Monitoring	To determine that the cell blocks connected together are monitored to compare the voltage of each cell block. When cell blocks differ by more than a specified limit under specified conditions, the battery pack is disabled.	0	Use sample 5.16
5.33	Cell Temperature	To determine that charging is terminated if the temperature of the hottest cell exceeds the maximum safe charging temperature specified by the cell vendor. The host/pack monitors the temperature of the pack during discharge (hottest cell) and ensures that this does not exceed the maximum temperature, as specified by the cell vendor. In the event that this temperature is exceeded, the pack ceases to provide power.	0	Move to Host
5.34	Communication of Error Messages	To determine that the battery management circuit and host communicates on a regular basis—not less frequently than every 5 s. The communication is advising the host of the condition of the pack. The host/pack combination is communicating potential battery issues as they occur. In cases where a hazard may result, the battery is failing safe. In the event that the system does not respond within a defined time period to a message indicating a potential hazard, the pack shall take action independent of the host (see 6.2.7). Conformance is ascertained by demonstrating arrival of messages to the host system.	0	Move to Host
5.35	Alternate Standard	To determine that the system as a whole ensures proper management of the battery pack including, but not limited to, the ability to identify the insertion of a different pack and identifying its state of charge (SOC).	0	Move to Host
5.36	Prevention of Shifting Cells	To determine that cells are located within the pack in a manner that will minimize shifting, such as location tabs in the pack casing, padding between cells (insulating), or adhesive.	0	
5.37	Connection Spacing	To determine that appropriate spacing is provided to prevent abrasion, wear, or damage to cable leads and/or connectors in the battery pack.	0	
5.38	Cell Orientation	To determine that the individual unit cells in a battery pack are arranged in accordance with correct polarity.	0	Use sample 5.16

5.39	Vent Mechanism	To determine that the vent mechanism of the cell is not covered or obstructed with plastic or other material in the battery pack in such a way as to prevent its operation.	5 (if required by construction review)	Not reusable
5.40	Cell Insulation	To determine that the cells at a different electrical potential are electrically insulated from each other to prevent unintended shorting together.	0	Use sample 5.16
5.41	Cell Connections	To determine that the connections are not soldered directly to the cells.	0	Use sample 5.16
5.42	Testing Weld Strength	To determine that tab welds for cells have specified strengths to ensure that they meet minimum specified strength requirements.	0	
5.43	Welding Placement	To determine that the welding is only applied in areas designated by cell vendor in accordance with agreed upon specifications.	0	
5.44	Internal Pack Connections	To determine that battery pack is designed to protect against unintended electrical connections between the circuit board and other electrical components and devices.	0	
5.45	Electrolyte Leakage	To determine that the battery pack is designed to ensure that any electrolyte leakage from the cells does not interfere with the proper operation of safety provisions within the pack.	0	
5.46	Connector Design	To determine that connector/terminal is designed to minimize the possibility of accidental short circuit.	0	
5.47	Connector Compatibility	Connector/terminal shall adhere to host device mechanical considerations (see 7.8.3.1). To determine that the packs are constructed to mechanically prevent reverse-polarity insertion into the host device.	0	Move to Host
5.48	Pack Enclosure Openings	To determine that pack enclosure openings are designed such that potential hazards due to foreign debris entering the pack will not result in the compromise of the protection circuit or shorting of circuits or components. Packs shall comply with IEC 60950-1:2005 with regard to enclosure openings.	0	
5.49	Pack Enclosure Openings for venting	To determine that the pack enclosure allows for the venting of pressure from the pack in the event of a cell rupture.	0	Move to Host

5.50	Marking	To determine whether the battery has all the required markings.	5	Y
5.51	Traceability	To verify whether the vendor has traceability plan for critical components and cells.	0	
5.52	Identification Code	To verify whether the battery management circuit contains an electronically readable identification code that enables traceability. This code can be the unique identifier code.	0	
5.53	Over-temperature protection	To verify that the battery pack contains at least one thermal protection circuit or device independent of internal cell devices.	0	
5.54	Electrostatic discharge - Design	Ensure precautions have been taken to avoid damage to protection circuits and other devices from ESD during handling.	0	
5.55	Electrostatic discharge - Test	Validate the ability of the pack to withstand ESD.	0	Use sample s from 5.50
5.56	Altitude Simulation	To determine whether the pack meet the requirement for altitude as specified in the most recent version of IEC 62281.	0	
5.57	Humidity Consideration	To determine whether hygroscopic material is used as electrical insulation in the pack.	0	
5.58	Assembly / Manufacturing Factory	Verify that the factory is maintained as a clean and orderly environment per the vendor's quality system to prevent contamination of the end product, which may affect its operation.	0	
5.59	Solder Joints	To verify that precautions shall be implemented to ensure sufficient solder flux activation to avoid incomplete solder connections.	0	
5.60	Component protection during pack assembly	To verify that precautions are taken to avoid damage to cells, battery management circuit, and battery pack during manufacturing, including ultrasonic welding	0	
5.61	Manufacturing Considerations	To verify that precautions are taken to avoid damage to conductors and insulators, for example, from sharp edges, burrs, pinching, or kinking.	0	
5.62	Protection from electric discharge	To verify that precautions are taken to avoid damage to protection circuits and other devices from electrostatic discharge (ESD) during handling.	0	

5.63	Protection function verification in Process	To determine whether the protection functions are verified per the documented vendor's process.	0	
5.64	Adherence to Process control	To verify whether critical processes such as welding have a quality control and a maintenance plan to control the consistency of the assembly process and adherence to specifications.	0	
5.65	Welding operations	To determine whether there is no damage to cell container and critical cell design elements during welding and other operations	0	
5.66	Flaming rating of materials	To ensure that the materials used in pack assembly are rated a minimum V1/VTM1 for the enclosure battery terminal and printed circuit boards and V2/VTM2 minimum for other internal parts. The flame ratings shall be in accordance with UL 94 or IEC 60695-11-10.	0	
5.67	Quality control	Determine whether the pack assembler have a statistical process control function in place that meets the requirements of the host vendor.	0	
5.68	Record keeping	Complete records of the packs, cells, assembly dates, assembly lines, and pack designs shall be maintained for a minimum of seven years.	0	
5.69	Qualification	Verify that new pack designs pass specified tests identified by the vendor before qualification as a production pack.	0	
5.70	Design Analysis	Verify whether FMEA or similar processes are carried out on new pack designs and the manufacturing processes.	0	
5.71	Qualification Testing	To ensure that vendors are familiar with battery testing standards and utilize one or more of these standards as part of their testing process.	0	
5.72	Ongoing Reliability Testing	Verify that compliance with the internal specification of the vendor is maintained and manufactured packs pass the qualification tests at intervals specified by the vendor.	0	
5.73	Production Testing, Sample sizes and Data recording	1. General: Verify that 100% of the manufactured outgoing packs are tested for functionality. 2. Sample sizes: Verify that all tests are carried out on a statistically valid number of samples. 3. Data recording: Verify that records of the samples and test results are maintained for the expected life of the product.	0	

5.74	Test Method	To verify whether test methods are agreed upon by the pack and host vendors.	0	
5.75	Drop Test	Verify that production packs pass the drop impact test of UL 2054.	0	
5.76	Vibration Test	To ensure that the production pack complies with the vibration test specified in IEC 62281.	0	
5.77	Tab Welding	To verify that samples from the tab welding station are taken and subjected to a pull test.	0	
5.78	Interpretation of results	To verify that the various tests shall be correlated and compared to results of previous tests.	0	
5.79	Adherence to transport regulations	Ensure compliance to UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria.	0	
		Total Packs Required	18	

Section 6 Host Device Considerations

All tests will be performed on a minimum of 1 sample unless otherwise specified (all samples must pass compliance). Refer to Table 3 Section 6.

Inspection/Analysis criteria shall be done on a sample of one

6.1 Input

Reference: IEEE 1625, Section 7.2.1

Purpose: Ensure specific surge and transient limits are included in the system design specifications.

Procedure: Review system design specifications.

Compliance: Ensure specific surge and transient limits are included in specification.

6.2 Input (Surge)

Reference: IEEE 1625, Section 7.2.1

Purpose: Validate the ability of the system to filter damaging conducted transient voltages to prevent damage to either the host device's charge control circuitry or the battery pack's safety circuitry.

Procedure: For adaptors with AC mains ports apply transients of 1.2/50(8/20)µs waveform in accordance with IEC 61000-4-5. Ten transients (five positive and five negative) at levels of 1kV line to neutral, 2kV line to ground and 2kV neutral to ground, shall be applied at each zero crossing and peak (0, 90, 180 and 270 degrees phase angle) of the applied ac voltage. Transients shall be applied at a rate of one per minute or less. If testing done at rates faster than one per minute cause failures and tests done at one per minute do not, the test done at one per minute prevails.
For adaptors connected to a vehicle wiring harness, apply pulses 1, 2a, 2b, 3a, 3b and 4 in accordance with ISO 7637-2, at test level III, for at least the minimum number of pulses or test time and for the minimum burst duration or at the minimum pulse repetition time.
The equipment shall be on during the test and the battery pack shall be in the fully discharged state at the beginning of the test. If the adaptor has no ground connection only line to neutral transients need to be applied.
When a DC-DC adapter is connected to an AC adapter then the combined unit needs to be tested as an AC adapter.

Compliance: The battery pack safety circuitry functionality (overcharge, over-current, under-voltage) remains after surge regime application, and one full charge/discharge cycle is successfully completed per section IEEE 1625 clause 7.3.3 Algorithm Verification.

6.3 Overvoltage

Reference: IEEE 1625, Section 7.1, 7.2.2

Purpose: Ensure host device is designed to indefinitely withstand the maximum voltage from the adapter, under a single fault condition, to prevent a cascading failure through the system to the battery pack and/or cell.

Procedure: Initiate a charging condition via a way that allows host to charge. Once charging is verified introduce the worst-case faulted overvoltage condition identified in the charging system analysis described in the design analysis tools identified in IEEE 1625 section paragraph 4.1. Primary to secondary fault in adapter is excluded. One sample is required for this test.

Compliance: No cascading failure through the system to the battery pack and or cell after 24 hours. At a minimum a complete charge cycle shall be performed under normal operating conditions to validate performance system specification after application of overvoltage.

6.4 Over-current (Charge)

Reference: IEEE 1625, Section 7.1, 7.2.3

Purpose: Ensure that the host limits current in such a way that the battery is not charged with a current greater than the maximum charge current specified by the battery vendor.

Procedure: Charge in a system with a battery (or emulated battery) and monitor current through the entire charge cycle. One sample is required for this test.

Compliance: After an initial settling period, the maximum charge current specified by the battery vendor is not exceeded. Such transient effects are limited to charge initiation including the pre-charge condition. Repetitive undesirable transients may constitute non-compliance.

6.5 Over-current (Discharge)

Reference: IEEE 1625, Section 7.1, 7.2.3

Purpose: The system (consisting of battery cell, battery pack, and host device/charger) shall contain at least two independent discharge over-current protection functions. This requirement shall be verified by test of a pack representative of a production-level pack installed in a system if necessary to engage all over-current protection mechanisms.

Procedure: Subject a Pack representative of a production-level pack in a system if necessary to a load in excess of discharge over-current protection. The test shall be conducted at the minimum operating temperature, ambient temperature, and maximum operating temperature. The Pack may be installed in a system if necessary to engage all over-current protection mechanisms.

Compliance: Operation of system over-current protection is within specified time and current over the temperatures tested.

6.6 Fault Isolation and Tolerance

Reference: IEEE 1625, Section 7.2.4

Purpose: Ensure that if a system design allows overvoltage or over-current to propagate to the battery pack, the battery pack can withstand this overvoltage and / or over-current.

Procedure: Review system documentation.

Compliance: Ensure that an overvoltage or over-current condition that propagates to the battery pack can be survived by the battery pack.

6.7 Fault Isolation and Tolerance Test

Reference: IEEE 1625, Section 7.1, 7.2.2, 7.2.3, 7.2.4

Purpose: Validate performance of system level charge over-current or overvoltage protection during a worst case single fault condition as identified in section IEEE 1625 7.2.

Procedure: Setup worst case conditions as identified in clause IEEE 1625 7.2.3 for overcurrent situations. Measure current and voltage at the battery pack. Setup worst case conditions as identified in section IEEE 1625 7.2.2 for overvoltage situations. Measure current and voltage at the battery pack.

Compliance: Current and voltage are limited or prevented from propagating to the cell or the pack so the cell/pack can withstand the condition (via protection either in host or pack, or cell).

6.8 Safety

Reference: IEEE 1625, Section 7.1, 7.3.1

Purpose: Ensure the charging system, or any part of the host device, does not disable or override the safety features inside the battery pack. The host/pack shall follow the recommendations on the Cell specification sheet.

Procedure: Review system documentation such as FMEA, FTA or equivalent.

Compliance: The charging system or any part of the host device does not disable or override the safety features inside the battery pack and that the recommendations on the cell specification sheet are followed.

6.9 Pack Identification

Reference: IEEE 1625, Section 7.3.2

Purpose: Ensure proper identification scheme is employed and communicates or indicates the maximum charge voltage.

Procedure: Review system documentation.

Compliance: Determine the identification scheme employed within the system and verify that the maximum charging voltage is communicated or indicated. A mechanical scheme only is not sufficient.

6.10 Pack Identification Test

Reference: IEEE 1625, Section 7.3.2

Purpose: Exercise the identification scheme in a faulted mode to ensure charging is terminated.

Procedure: Based on analysis interrupt the identification / communication scheme and insert battery and initiate charge. Sample of one is required.

Compliance: Charge current is terminated or not initiated.

6.11 Algorithm Verification

Reference: IEEE 1625, Section 7.1, 7.3.3

Purpose: Validate proper charge algorithm is identified and executed.

Procedure: Insert fully discharged battery (or emulator) into system and monitor current and voltage during charge cycle. Compare to specification to ensure proper charge current and voltage is provided as specified by the pack vendor. One sample is required.

Compliance: Ensure proper charge current and voltage is provided as specified by the pack vendor.

6.12 Communication Fault

Reference: IEEE 1625, Section 7.3.5

Purpose: Validate integrity of communication interface (if present and periodic update communication is used) and proper actions are taken upon interruption of the interface.

Procedure: Interrupt communications per system specifications and monitor current. A sample of one is required.

Compliance: Charging is terminated or not initiated.

6.13 Temperature Qualification

Reference: IEEE 1625, Section 7.1, 7.3.6

Purpose: Validate performance of temperature protection and monitoring temperature prior to and during charging process.

Procedure: Charge in a host at a temperature exceeding the charge temperature specified. A sample size of one is required.

Compliance: Charging system shall monitor the battery temperature prior to and during charging process.

Charging is disabled when operating temperature limits of the Pack are exceeded.

6.14 Initiation of Charging Above Specified Voltage Threshold

Reference: IEEE 1625, Section 7.1, 7.3.7.1, 7.3.7.2

Purpose: Validate charging system does not initiate charging when a battery is above a specified voltage.

Procedure: Charge a battery (or emulator) above the specified voltage or simulate the voltage condition and insert into the charging system (Power applied to charging system prior to insert AND power applied to charging system post insert). A sample of one is required.

Compliance: Monitor current to ensure charging does not initiate per specification.

6.15 Initiation of Charging Below Voltage Threshold

Reference: IEEE 1625, Section 7.1, 7.3.7.1, 7.3.7.3

Purpose: Validate charging system does not initiate normal charging when a battery is below a specified voltage.

Procedure: Discharge a battery (or emulator) below the specified voltage or simulate the voltage condition and insert into the charging system (Power applied to charging system prior to insert AND power applied to charging system post insert). A sample of one is required.

Compliance: Monitor current to ensure charging does not initiate per cell, pack and host specification.

6.16 Over-discharge Protection

Reference: IEEE 1625, Section 7.1, 7.3.7.1, 7.3.7.4

Purpose: If the host/pack incorporates a battery discharge capability feature (normal operation is excluded), Validate that host/pack terminates discharge as defined by pack/cell vendor's specification.

Procedure: Reduce the voltage at the host/pack interface until the host terminates discharge. Specified nominal discharge current should be utilized to reduce voltage. A sample of one is required.

Compliance: Verify that the pack discharge limit is not exceeded.

6.17 Repeated Fault

Reference: IEEE 1625, Section 7.1, 7.3.7.1, 7.3.7.5

Purpose: The system shall disable charging and discharging of a specific battery pack, in a controlled manner pertinent to the application, if a repeated fault that could compromise the safety of operation of the system is identified.

Procedure: Verify the system disables the charging and discharging of a specific battery pack if any fault condition specified in IEEE 1625, Section 7.3.7.2, 7.3.7.3 and 7.3.7.4 continually reoccur. Perform repeated faults identified by system Vendor to procedure. The vendor shall specify how many times the fault shall occur before charging and discharging is permanently disabled. This is not applicable to systems that disable charging and discharging permanently after the first occurrence of the fault.

Compliance: The system shall disable the charging and discharging of a specific battery pack if a repeated fault occurs as defined by the applicable specifications of the System.

6.18 Multi-Pack System Requirements

Reference: IEEE 1625, Section 7.4.2, 7.3.3

Purpose: Ensure that multi-battery pack systems implement requirements for the charging algorithm to each battery pack independently.

Procedure: Review system documentation.

Compliance: Ensure multi-battery pack systems have implemented charging algorithm to each battery pack independently.

6.19 Multi-Pack System Charging Battery Packs

Reference: IEEE 1625, Section 7.4.3

Purpose: Ensure that in a multi-battery system that the system prevents a battery pack from directly charging another battery pack without use of an appropriate charge control.

Procedure: Review system documentation.

Compliance: Ensure multi-battery systems utilize appropriate charge control.

6.20 ESD

Reference: IEEE 1625, Section 7.5

Purpose: Validate ability of the host to withstand ESD

Procedure: Subject host to ESD in accordance with IEC 61000-4-2 per product level 2 at minimum. If a host supports a removable battery pack, ESD testing should be performed on the battery contacts of the host (the battery pack is tested separately under section 5.55 ESD Test (IEEE 1625: 6.7.3). A sample size of one is required.

Compliance: No safety critical failures, such as loss of charge control or damage to battery protection circuitry provided in the host.

6.21 Component Specifications

Reference: IEEE 1625, Section 7.6

Purpose: Confirm that the pack and host operate within their specified temperature ranges and that the total system interaction does not exceed the temperature ratings of any components at worst case conditions specified by host vendor (such as maximum RF transmit power, gaming applications, video capture or playback, etc.).

Procedure: Instrument the critical components within the pack to monitor temperature.
Place the host-pack combination in a thermal chamber at the maximum specified host operating temperature for charging. Operate the host-pack combination at the worst case charge condition, allow the test to run until there is no more change in monitored temperatures.
Repeat test procedure above for the discharge condition.

Compliance: Components are rated properly, and no component temperature specification is exceeded.

6.22 Temperature Specification

Reference: IEEE 1625, Section 7.1, 7.6

Purpose: Ensure system has incorporated temperature limitations as agreed by cell, battery pack, and host vendor.

Procedure: Instrument the critical components within the pack to monitor temperature. Place the host-pack combination in a thermal chamber above the maximum specified host operating temperature for charging. Operate the host-pack combination at the worst case charge condition, allow the test to run until there is no more change in monitored temperatures or the system takes action to prevent the pack and cell from exceeding their respective temperature limits. Repeat both test procedures above for the discharge condition.

Compliance: Action is taken to maintain temperature within the operating temperature limits of the pack and cell. Components are rated properly and no component temperature specification is exceeded.

6.23 Mating of Pins

Reference: IEEE 1625, Section 7.8.1.1

Purpose: Ensure host and battery connections mate properly and capable of good electrical contact.

Procedure: Review host and battery pack connector specification.

Compliance: Ensure designs coordinate.

6.24 Mating of Pins Test

Reference: IEEE 1625, Section 7.8.1.1

Purpose: Validate integrity of connection throughout respective product lifetimes of mating components.

Procedure: Measure contact resistance after life cycle (defined in system specification).

Compliance: Verify that contact resistance is within specification and mechanical integrity precludes shorting of contacts.

6.25 Pin Separation

Reference: IEEE 1625, Section 7.8.1.2

Purpose: Ensure power and ground pins are sufficiently separated.

Procedure: Review host device battery interface.

Compliance: Power and ground pins are sufficiently separated to minimize the possibility of an accidental short circuit between those two pin.

6.26 Pin Polarity

Reference: IEEE 1625, Section 7.8.1.3

Purpose: Verify battery pack is able to be connected with proper polarity only.

Procedure: Analyze mechanical design of battery pack and host.

Compliance: Ensure that the battery cannot be inserted with incorrect polarity and that electrical contact is made only when the battery pack is properly installed into the host.

6.27 Conductor Ratings

Reference: IEEE 1625, Section 7.8.2

Purpose: Ensure conductors and connectors have proper current rating for the current load with adequate margin as determined by the system vendor.

Procedure: Review electrical tolerance analysis.

Compliance: Conductors and connectors have proper current rating.

6.28 Connector Strength and Performance over Expected Life

Reference: IEEE 1625, Section 7.8.3.1, Section 7.8.3.2

Purpose: Verify host connector mechanical robustness.

Procedure: Maker shows system documentations and connector specifications which can verify the mechanical robustness of host connector.

Compliance:

1) Connection between battery and host is mechanically robust.
2) Acceptable contact resistance per specification is maintained over the lifetime of the connection system.

6.29 Metallurgy Consideration

Reference: IEEE 1625, Section 7.8.5

Purpose: Ensure host device and battery pack have compatible metallurgy composition to minimize corrosion and resistance changes.

Procedure: Review host device and battery pack connector specifications. IEC60950-1 Annex J has a list of metallurgical compatibilities that may be referred to for additional information.

Compliance: Proper metallurgy composition exists within the connection system.

6.30 Mating Force

Reference: IEEE 1625, Section 7.8.6

Purpose: Ensure proper mechanical force between the electrical contact points is maintained.

Procedure: Review system documentation.

Compliance: Design minimizes fretting or other electrical degradation of electrical contact points.

6.31 Shock and Vibration

Reference: IEEE 1625, Section 7.8.7

Purpose: Validate the ability of the host device to withstand shock and vibration caused by normal usage. Ensure the host does not propagate faults to the battery pack and cells when they are installed in the system.

Procedure: Prior to subjecting samples to testing, initial mass and voltage must be measured and recorded. The host shall be subjected to a half-sine shock with a peak acceleration of 300 m/s2 minimum and a pulse duration of 6 milliseconds. The exposure shall consist of 3 shocks in the positive direction followed by 3 shocks in the negative direction while secured in 3 mutually perpendicular positions for a total of 18 shocks.

Compliance: No mass loss (beyond allowable limits), no short-circuit, No abnormal heating, no smoke, no fire, no explosion and / or leakage from battery pack or host.

Mass of battery m	Maximum mass loss $\Delta m / m$ %
$m \le 1$ g	0,5
1 g < $m \le 5$ g	0,2
$m > 5$ g	0,1

6.32 Drop

Reference: IEEE 1625, Section 7.8.8

Purpose: Validate the ability of the battery to withstand a drop while installed in the host device.

Procedure: The host is used to fully charge an installed battery pack. An independent External charger shall not be used for this test. Following the charging procedure, the drop Test shall be conducted as follows.

For devices where the normal application is at the head level, the drop height shall be 1500 mm

For all other devices, the drop height shall be 1000 mm.

If the device can be used in both applications, the worst case test condition shall be used.

The battery pack, installed in the host, is dropped once from the specified height (measured from the lowest point of the suspended host to the concrete) onto a concrete surface.

The orientation of the resulting impacts shall be in the direction identified as the most critical for the battery pack's safety. A fixture may be used if the resulting impact is judged as technically the same as that from the freefall described herein. This procedure shall be repeated for a total of three different packs (one drop per pack).

Compliance: None of these impacts from the drop test shall cause a hazard. Upon completion of testing and a 1 hour observation period, the battery pack shall be inspected to ensure that no safety feature has been compromised, as a result of the drop test, and a battery cell has not been visibly damaged to the extent that a hazard results. No abnormal heating, no smoke, no fire, no explosion and / or leakage from battery pack or host.

6.33 Foreign Objects

Reference: IEEE 1625, Section 7.8.9

Purpose: Ensure precautions were taken to minimize the potential for foreign objects and / or liquids to enter the host device and cause a short circuit either during the manufacturing process or end-user operation.

Procedure: Review system documentation.

Compliance: Ensure proper precautions were taken to minimize the potential for foreign objects and / or liquids to enter the host device and cause a short circuit either during the manufacturing process or end-user operation.

6.34 Critical Testing Practices

Reference: IEEE 1625, Section 7.9.1

Purpose: Ensure preproduction testing includes all system design criteria in applicable sub clauses of IEEE 1625, Section 7.

Procedure: Review system verification documentation.

Compliance: Preproduction testing and production sampling include all of the design criteria specified in IEEE 1625, Section 7.

6.35 Qualification of New Host Device Designs

Reference: IEEE 1625, Section 7.9.2

Purpose: Ensure new host device designs pass specified tests identified by the vendor before qualification as a production host.

Procedure: Review host device documentation.

Compliance: Ensure tests specified by the vendor were performed and passed.

6.36 Ongoing Testing and Verification of Production Host Devices

Reference: IEEE 1625, Section 7.9.3

Purpose: Ensure production host devices pass qualification tests at specified intervals.

Procedure: Review host device documentation.

Compliance: Qualification tests are performed and passed as specified by the host vendor at the prescribed intervals. Follow documentation requirements consistent with IEEE 1625, Section 11.2.

Table 3 Section 6 - ATL Sample Submission Requirements

CRD Sec	Name	Purpose	Host Samples	Pack Samples	Adapter Samples	Reusable?
5.6	Battery Management Circuit Design (Embedded Packs Only)	To verify that the intermediate voltage tabs are not employed except for cell balancing or cell voltage monitoring.	0	0	0	Use sample 5.16
5.7	Current Limiting (Embedded Packs Only)	To determine whether the upper discharge current and time limit do not exceed the cell specification.	(1)	0	0	Not reusable
5.8	Cell Connections - Test (Embedded Packs Only)	To verify that the wires measuring individual cell voltages are terminated with sufficient spacing or encapsulated or current limited to prevent conductive paths from forming.	0	0	0	Use sample 5.16
5.11	Short Circuit – General (Embedded Packs Only)	Verify that the battery pack has short circuit protection.	(2)	0	0	Not reusable
5.13	Fault Handling	To verify when voltage, current and temperature are exceeded, the pack will take action to mitigate hazards.	3 (3)	3	0	Not reusable
5.16	Cell Sourcing (Embedded Packs Only)	To determine that cells in series-connected blocks are from the same cell manufacturing lot(s).	0	0 (5) Open pack	0	Sample to be used for 5.6, 5.8, 5.17, 5.18, 5.20, 5.23, 5.32, 5.38, 5.40, 5.41
5.17	Old and Fresh Cells (Embedded Packs Only)	To determine that cells are not connected in cell blocks and series of blocks in a battery pack using a combination of old and fresh cells.	0	0	0	Use sample 5.16

5.18	Different Cell Vendors (Embedded Packs Only)	To determine that the cells are not connected in cell blocks and series of cell blocks using a combination of cells made by different vendors.	0	0	0	Use sample 5.16
5.23	Charge – General (Embedded Packs Only)	To determine that the maximum charging voltage measured at the cell block does not exceed the value specified on the Cell specification sheet	0	0	0	Use Host sample from 5.30
5.25	Monitoring of Each Cell Block	To determine that the combination of cell, battery pack, and host device/charger detects the voltage of each cell block in the battery pack and controls the charge if overvoltage occurs. Charging may resume at a specified overvoltage recovery level, which shall consider both voltage and time. The second protection circuit shall monitor the voltage of the cell blocks. If the cell voltage rises beyond the maximum charge voltage to the cell critical voltage, the pack shall be permanently disabled from charging.	0 (5)	5 (0)	0	Not Reusabl e Use Host sample from 5.30
5.26	Recovery from Over-discharge	To determine that a cell or cell blocks, has been discharged beyond the expected minimum state, the pack/system follows the cell vendor's recommendation to recover from this condition.	0	0	0	Use sample from 5.30
5.30	Low Cell Voltage Cut-off	To verify that the pack ceases to provide power or the host ceases to draw power from the pack if any cell block is detected with a voltage equal to or less than specified by the cell vendor	5 (5)	5 (0)	0	Sample to be used for 5.35, 5.26, 5.25, 5.33
5.32	Cell Monitoring (Embedded Packs Only)	To determine that cell blocks connected connected are monitored to compare the voltage of each cell block. When cell blocks differ by more than a specified limit under specified conditions, the battery pack is disabled.	0	0	0	Use sample from 5.16

5.33	Cell Temperature – General	To determine that charging is terminated if the temperature of the hottest cell exceeds the maximum safe charging temperature specified by the cell vendor. The host/pack monitors the temperature of the pack during discharge (hottest cell) and ensures that this does not exceed the maximum temperature, as specified by the cell vendor. In the event that this temperature is exceeded, the pack ceases to provide power.	0	0	5	Not Reusable Use sample from 5.35
5.35	Alternate Standard	To determine that the system as a whole ensures proper management of the battery pack including, but not limited to, the ability to identify the insertion of a different pack and identifying its state of charge (SOC).	0	0	0	Use sample from 5.30
5.38	Cell Orientation (Embedded Packs Only)	To determine that the individual unit cells in a battery pack are arranged in accordance with correct polarity.	0	0	0	Use sample 5.16
5.40	Cell Insulation (Embedded Packs Only)	To determine that the cells at a different electrical potential are electrically insulated from each other to prevent unintended shorting together.	0	0	0	Use sample 5.16
5.41	Cell Connections – General (Embedded Packs Only)	To determine that the connections are not soldered directly to the cells.	0	0	0	Use sample 5.16
5.48	Pack Enclosure Openings	To determine that pack enclosure openings are designed such that potential hazards due to foreign debris entering the pack will not result in the compromise of the protection circuit or shorting of circuits or components. Packs shall comply with IEC 60950-1:2005 with regard to enclosure openings.	0	0	0	
5.53	Over-temperature protection	To verify that the combination of cell, pack, and host device/charger has at least two independent thermal protection devices or mechanisms."	0	0	0	

5.66	Flaming rating of materials	To ensure that the materials used in pack assembly are rated a minimum V1/VTM1 for the enclosure battery terminal and printed circuit boards and V2/VTM2 minimum for other internal parts. The flame ratings shall be in accordance with UL 94 or IEC 60695-11-10.	0	0	0	
5.75	Drop Test (embedded only)	Verify that production packs pass the drop impact test of UL 2054.	3	0	0	
6.1	Input	Ensure specific surge and transient limits are included in the system design specifications.	0	0	0	
6.2	Input (Surge)	Validate the ability of the system to filter damaging conducted transient voltages to prevent damage to either the host device's charge control circuitry or the battery pack's safety circuitry.	1 (1)	1 (0)	1 (0)	Not reusable
6.3	Overvoltage	Ensure host device is designed to indefinitely withstand the maximum voltage from the adapter, under a single fault condition, to prevent a cascading failure through the system to the battery pack and/or cell.	1 (1)	1 (0)	0	Not reusable
6.4	Over-current (Charge)	Ensure that the host limits current in such a way that the battery is not charged with a current greater than the maximum charge current specified by the battery vendor.	1 (1)	1 (0)	0	Sample to be used for 6.5, 6.10, 6.11, 6.12, 6.14, 6.15, 6.16, 6.17
6.5	Over-current (Discharge)	The system (consisting of battery cell, battery pack, and host device/charger) shall contain at least two independent discharge over-current protection functions. This requirement shall be verified by test of a pack representative of a production-level pack (see Clause	0	0	0	Use sample from 6.4

		4) installed in a system if necessary to engage all over-current protection mechanisms.				
6.6	Fault Isolation and Tolerance	Ensure that if a system design allows overvoltage or over-current to propagate to the battery pack, the battery pack can withstand this overvoltage and / or over-current.	0	0	0	
6.7	Fault Isolation and Tolerance Test	Validate performance of system level charge over-current or overvoltage protection during a worst case single fault condition as identified in section IEEE 1625 7.2.	1 (1)	1 (0)	1	Not reusable
6.8	Safety	Ensure the charging system, or any part of the host device, does not disable or override the safety features inside the battery pack. The host/pack shall follow the recommendations on the Cell specification sheet.	0	0	0	
6.9	Pack Identification	Ensure proper identification scheme is employed and communicates or indicates the maximum charge voltage.	0	0	0	
6.10	Pack Identification Test	Exercise the identification scheme in a faulted mode to ensure charging is terminated.	0	0	0	Use sample from 6.4
6.11	Algorithm Verification	Validate proper charge algorithm is identified and executed.	0	0	0	Use sample from 6.4
6.12	Communication Fault	Validate integrity of communication interface (if present and periodic update communication is used) and proper actions are taken upon interruption of the interface.	0	0	0	Use sample from 6.4
6.13	Temperature Qualification	Validate performance of temperature protection and monitoring temperature prior to and during charging process.	1 (1)	1 (0)	1	Not reusable
6.14	Initiation of Charging Above Specified Voltage Threshold	Validate charging system does not initiate charging when a battery is above a specified voltage.	0	0	0	Use sample from 6.4

6.15	Initiation of Charging Below Voltage Threshold	Validate charging system does not initiate normal charging when a battery is below a specified voltage.	0	0	0	Use sample from 6.4
6.16	Over-discharge Protection	If the host/pack incorporates a battery discharge capability feature (normal operation is excluded), Validate that host/pack terminates discharge as defined by pack/cell vendor's specification.	0	0	0	Use samples from 6.4
6.17	Repeated Fault	The system shall disable charging and discharging of a specific battery pack, in a controlled manner pertinent to the application, if a repeated fault that could compromise the safety of operation of the system is identified.	0 (1)	1 (Faulted) (0)	0	Use samples from 6.4
6.18	Multi-Pack System Requirements	Ensure that multi-battery pack systems implement requirements for the charging algorithm to each battery pack independently.	0	0	0	
6.19	Multi-Pack System Charging Battery Packs	Ensure that in a multi-battery system that the system prevents a battery pack from directly charging another battery pack without use of an appropriate control charging subsystem.	0	0	0	
6.20	ESD	Validate ability of the host to withstand ESD.	1 (1)	1 (0)	1	Not reusable
6.21	Component Specifications	Confirm that the pack and host operate within their specified temperature ranges and that the total system interaction does not exceed the temperature ratings of any components at worst case conditions specified by host vendor (such as maximum RF transmit power, gaming applications, video capture or playback, etc.).	1 (1)	1 (0)	1	Not reusable
6.22	Temperature Specification	Ensure system has incorporated temperature limitations as agreed by cell, battery pack, and host vendor.	1 (1)	1 (0)	1	Not reusable
6.23	Mating of Pins	Ensure host and battery connections mate properly and capable of good electrical contact.	0	0	0	

6.24	Mating of Pins Test	Validate integrity of connection throughout respective product lifetimes of mating components.	0	0	0	
6.25	Pin Separation	Ensure power and ground pins are sufficiently separated.	0	0	0	
6.26	Pin Polarity	Verify battery pack is able to be connected with proper polarity only.	0	0	0	
6.27	Conductor Ratings	Ensure conductors and connectors have proper current rating for the current load with adequate margin as determined by the system vendor.	0	0	0	
6.28	Connector Strength and Performance over Expected Life	Verify host connector mechanical robustness.	0	0	0	
6.29	Metallurgy Consideration	Ensure host device and battery pack have compatible metallurgy composition to minimize corrosion and resistance changes.	0	0	0	
6.30	Mating Force	Ensure proper mechanical force between the electrical contact points is maintained.	0	0	0	
6.31	Shock and Vibration	Validate the ability of the host device to withstand shock and vibration caused by normal usage. Ensure the host does not propagate faults to the battery pack and cells when they are installed in the system.	3 (3)	3 (0)	0	Not reusable
6.32	Drop	Validate the ability of the battery to withstand a drop while installed in the host device.	3 (3)	3 (0)	0	Host may be reused if not damaged unless pack is embedded with the agreement of the manufacturer

6.33	Foreign Objects	Ensure precautions were taken to minimize the potential for foreign objects and / or liquids to enter the host device and cause a short circuit either during the manufacturing process or end-user operation.	0	0	0	
6.34	Critical Testing Practices	Ensure preproduction testing includes all system design criteria in applicable sub clauses of IEEE 1625, Section 7.	0	0	0	
6.35	Qualification of New Host Device Designs	Ensure new host device designs pass specified tests identified by the vendor before qualification as a production host.	0	0	0	
6.36	Ongoing Testing and Verification of Production Host Devices	Ensure production host devices pass qualification tests at specified intervals.	0	0	0	
7.3	Adapter ESD Requirements	Validate ESD tolerance of the adapter and system to withstand ESD per IEC 61000-4-2.	0	0	1	Not reusable
		Total Samples Required	**22 (31 for embedded Hosts)**	**23 (embedded 5 extra pack)**	**12**	

*1) Figure in parenthesis refers to embedded system.

Section 7 Total System Reliability Considerations

7.1 Information Communication for end user

Reference: IEEE 1625 Section 9.2.1

Purpose: Determine that required user information is provided.

Ensure information on Figure 10 at IEEE 1625 shall be make available to the end user through appropriate means; on the label and/or owner's manual and/or help file, and/or internet Web site.

Procedure: Determine by inspection that the following information is made available to the user by one or more of (a) printed on the label for the battery, (b) printed on the label for the host device, (c) printed in the owner's manual, and/or (d) posted in a help file or Internet web site.

Do not disassemble or open, crush, bend or deform, puncture, or shred.

Do not modify or remanufacture, attempt to insert foreign objects into the battery, immerse or expose to water or other liquids, or expose to excessive heat, fire, or other hazard. Only use the battery in the system for which it was specified.

Only use the battery with a charging system that has been qualified with the system per this standard.

Use of an unqualified battery or charger may present a risk of fire, explosion, leakage, or other hazard.

Do not short-circuit a battery or allow metallic or conductive objects to contact the battery terminals.

Replace the battery only with another battery that has been qualified with the system per this document.

Use of an unqualified battery may present a risk of fire, explosion, leakage, or other hazard.

Promptly dispose of used batteries in accordance with local regulations.

Battery usage by children should be supervised.

Follow the explanation of a security implementation per IEEE 1625 Clause 10.3.1.

Avoid dropping the host or battery. If the host or battery is dropped, especially on a hard surface, and the end user suspects damage, take it to a service center for inspection.

Improper battery use may result in a fire, explosion, leakage, or other hazard.

Storage and operating conditions, including temperature, shall be specified.

Compliance: Language that communicates the intention of each of the above warnings is included with the product.

Section 8 System Security Validation

8.1 Host and Battery Authentication

Reference: IEEE 1625, Section 10.3.1 and IEEE 1625 Section 6.6.4.1

Purpose: To ensure that there is an authentication method in place.

Procedure: Identify method of authentication that has been implemented.

Compliance: A method of active or passive authentication has been implemented.

8.2 Ensuring Supply Chain Security

Reference: IEEE 1625, Section 10.4.1

Purpose: To ensure that adequate security of supply chain is in place and that a security audit plan exists and is being followed.

Procedure: Audit supply chain security process.
Verify that the vendors have documented processes which address the integrity of their supply chain such that no materials enter the supply chain inappropriately.
Verify that these processes have been implemented, are being followed and the vendor is periodically verifying compliance to the processes.

Compliance: Practices and/or procedures exist and are followed to ensure supply chain security.

8.3 Avoid Defective Parts

Reference: IEEE 1625, Section 10.4.2

Purpose: To ensure that adequate security of supply chain, including defective components, is in place and that a security audit plan exists and is being followed. Ensure defective components do not re-enter the supply chain.

Procedure: Audit supply chain security process.
Verify that the vendors have documented processes which address the integrity of their supply chain such that no defective materials enter the supply chain. Verify that these processes have been implemented, are being followed, and the vendor is periodically verifying compliance to the processes.

Compliance: Practices and/or procedures exist and are followed to ensure supply chain security.

8.4 Battery Pack Identification

Reference: IEEE 1625, Section 10.5

Purpose: Determine the vendor has a means of identification within a battery pack to allow verification, by said vendor, of the battery pack and cells if the external housing is destroyed.

Procedure: Review the battery pack documentation to determine the method implemented.

Compliance: A means of identification within the battery pack has been implemented to allow identification of cell(s) and pack, if the external housing is destroyed.

Section 9 Quality System Requirements

9.1 Quality System Requirements

Reference: IEEE 1625, Section 11.2

Purpose: Determine that vendor's quality system meets requirements of ISO-9001.

Procedure: Determine by inspection that vendor holds valid relevant ISO-9001 certificate.

Compliance: Vendor is registered to ISO-9001.

9.2 Definition of Safety Critical Variables

Reference: IEEE 1625, Section 11.3

Purpose: To ensure that the vendor has defined and documented product and process variables that relate to product safety (safety critical variables).

Procedure: Evaluate the vendor's product and process documentation.

Compliance: Safety critical variables have been defined. Compliance to this requirement will not be evaluated separately, but instead will be demonstrated as a part of the cell, pack, host, and system requirements.

9.3 Determination of Critical Measurement Process Capability

Reference: IEEE 1625, Section 11.4

Purpose: To ensure that the vendor has validated the measurement capability of those critical measurement processes used to assess safety critical variables to both understand and minimize the impact of measurement error.

Procedure: Evaluate the vendor's product and process documentation, with particular attention to measurement system analysis studies.

Compliance: Critical measurement processes have been shown to be capable to assess the safety critical variables defined. Compliance to this requirement will not be evaluated separately, but instead will be demonstrated as a part of the cell, pack, host, and system requirements.

9.4 Determination of Process Stability

Reference: IEEE 1625, Section 11.5.

Purpose: To ensure that the vendor's processes that relate to safety critical variables (both product and process) are sufficiently stable such that they can be reliably predicted and thus controlled.

Procedure: Evaluate the vendor's product and process documentation, with particular attention to process tracking data used to substantiate process stability for process or part qualification.

Compliance: Vendor's processes that relate to safety critical variables (both product and process) are sufficiently stable. Compliance to this requirement will not be evaluated separately, but instead will be demonstrated as a part of the cell, pack, host, and system requirements.

9.5 Manufacturing control of safety critical variables

Reference: IEEE 1625, Section 11.6

Purpose: To ensure that the vendor a) Set objectives and document the plan of those process parameters in which the vendor requires SPC; b) Document and maintain processes, limits, and resources specific to the process parameters requiring SPC; c) Maintain records to provide evidence that the specific controlled process parameters are carried out to the established plan and processes; d) Document the action taken should item a), item b), and/or item c) (in sub clause 11.6) be out of control.

Procedure: Evaluate the vendor's process documentation, for manufacturing control of safety critical variables.

Compliance: Vendor's processes have been shown to be capable of meeting the specifications for the safety critical variables defined with acceptable margin. Compliance to this requirement will not be evaluated separately, but instead will be demonstrated as a part of the cell, pack, host, and system requirements.

Appendix A Change History

Date	Revision	Description
November 2010	1.0	• First Revision
February 2011	1.1	• Section 1.4 - Added "BPMD – Battery Program Management Document, C – Rated capacity of a Battery or Cell as defined by IEC 62133 and UL 2054, CRD – Certification Requirements Document, CRSL – Certification Requirements Status List, DOE – Design of Experiment, ESD – Electrostatic Discharge, FMEA – Failure Mode and Effects Analysis, PM – Preventive Maintenance, PMD – Program Management Document, PTC – Positive Temperature Coefficient. Refers to a passive overcurrent protection device that is technically a resettable conductive polymer-based thermistor. Also known as a CID (Current Interrupt Device), SOC – State of Charge based on Coulomb counting. 100% SOC can be achieved by following the cell vendor's recommended algorithm, SOP – Standard Operating Procedure". • Section 4.23 New - Added Figure 1 from 1725 CRD. • Section 4.25 Reference - Replaced "5.3.9" with "5.3.7". • Section 4.41 Compliance - Replaced "6.0" with "7". • Sample Table 4.8 - Add "4.36" to Reusable column. • Sample Table 4.36 - Add "Use samples from 4.8" to Reusable column. • Section 5.2 Procedure - Deleted all instances of "BMU". • Section 5.4 Procedure - Deleted "(if managed by the BMU)". • Section 5.8 Procedure - Replace "the" with "any" in last sentence. • Section 5.9 Procedure - Replaced "during" with "after". • Section 5.9 Compliance - Replaced "during" with "after". • Section 5.20 Compliance - Added "the" before "designs" and deleted "s" from "designs". • Section 5.35 Procedure - Deleted all instances of "exemplar". Replaced "D" with "difference". • Section 5.47 Purpose - Replaced "7.8.3.1" with "6.28". • Section 5.52 Procedure - Added "or identification" after "name". • Section 5.52 Compliance - Replaced "BMC" with "battery management circuit". • Section 5.75 Compliance - Replaced "Production packs pass the drop impact test of UL 2054. Not applicable for embedded (not user replaceable) battery packs." with "The cells have not

		shifted beyond the design specification reviewed in Clause 5.36 after being subjected to the drop test. Verify there are no conditions that would affect the safety of the pack." • Section 5.76 Compliance - Replaced "Production packs pass the drop impact test of UL 2054. Not applicable for embedded (not user replaceable) battery packs." with "The cells have not shifted beyond the design specification reviewed in Clause 5.36 after being subjected to the vibration test. Verify there are no conditions that would affect the safety of the pack." • Sample Table 5.2 - Deleted "BMU" from Purpose column. • Sample Table 5.16 - Deleted "5.19" from Reusable column. • Section 6.3 Procedure - Added "Primary to secondary fault in adapter is excluded." after "paragraph 4.1." • Section 6.5 Purpose - Deleted "(see Clause 4)". • Section 6.5 Procedure - Deleted "(see Clause 4)". • Section 6.8 Procedure - Added "such as FMEA, FTA or equivalent". • Section 6.17 Procedure - Added "Perform repeated faults identified by system Vendor to procedure". • Sample Table New - Added row 5.32. • Section 7.2 Procedure - Deleted "Delete "For certified adapters, perform the single fault test in Section 6.3 and the input test in Section 6.2 utilizing the host simulator at 0% and 100% loads. During surge testing, voltages on the output of the adapter shall be measured differentially at the host adapter using an oscilloscope. The oscilloscope shall be triggered from the surge generator. During the test the oscilloscope horizontal setting shall be adjusted from 1V/div to 50mV/div and the vertical setting shall be adjusted from 2ms/div to 400ns/div. The largest transients shall be recorded." • Section 7.9 Procedure - Replaced "DECEMBER" with "Use IEC 60721-3-7, Table 6, Class, 7M2 at a minimum, Non-Stationary Random Vibration and Shock (Type II)." • Section 7.9 Compliance - Added "No abnormal heating, no smoke, no fire, no explosion."
May 2011	1.2	• Section 4.11 Purpose - Replaced "To verify that the insulator material will be stable in a temperature range of use, storage, and transportation as specified by the cell vendor." with " Purpose: To verify that the insulation is permanently adhered and has good puncture resistance." • Section 4.11 Procedure - Replaced "Verify the existence of insulation material test/evaluation report and specification sheet as applied to its usage within the cell at a temperature range of use, storage, and transportation as specified by the cell vendor." with " Review insulation material test/evaluation report and specification sheet as applied to its usage within the cell."

		• Section 4.11 Compliance - Replaced "Evaluation report indicates that the insulation material has electrochemical, chemical, mechanical (permanent adherence & good puncture resistance) and thermal stability in a temperature range of use, storage, and transportation as specified by the cell vendor." with " Evaluation report indicates that the insulation material has permanent adherence and good puncture resistance." • Section 4.14 Purpose - Replace "To confirm vent design performance." with "To verify the cell vent mechanism is designed to minimize projectiles and maximize retention of cell contents." • Section 4.14 Procedure - Replace "Verify the availability of a report and/or certificate demonstrating UL 1642 Section 20 Projectile Test (Sept. 2005 release)" with " Review design report. This requirement does not apply to laminated enclosure cells." • Section 4.14 Compliance - Replace "Compliance per UL 1642 Projectile Test. Certification shall exist" with " Design report includes vent mechanism design that minimizes projectiles and maximizes retention of cell contents." • Section 4.18 Compliance - Replace "ISO-9000" with "ISO-9001". • Section 4.36 Procedure - Delete "if it could cause a hazard." • Section 4.36 Compliance - Add "Validate method to avoid a short where the bare aluminum foil interfaces with the negative electrode." • Section 4.37 Title - Delete "(Testing)". • Section 4.39 Purpose - Add "wound or stacked" before "electrodes". • Section 4.40 Title - Delete "- Test". • Section 4.53 Procedure - Replace "Test five cell samples, randomly selected. Starting at 20°C ± 5°C, the oven temperature shall be ramped at a rate of 5°C ± 2°C per minute until it reaches 130°C ± 2°C. After 1 h at 130°C ± 2°C, the test is concluded." with " 5 fully charged cells (per cell manufacture's specifications), randomly selected, shall be suspended (no heat transfer allowed to non-integral cell components) in a gravity convection or circulating air oven at ambient temperature. The oven temperature shall be ramped at 5 ± 2°C per minute to 130 ± 2°C. After 1 hour at 130 ± 2°C, the test is ended." • Section 4.54 Procedure - Add "± 2 °C" after "45 °C". • Section 4.55 Procedure - Delete "maximum" before "resistance". • Section 5.7 Compliance - Delete "s" from "temperatures". • Section 5.8 Title - Replace "- Test" with "Termination Points".

		• Section 5.9 Procedure - Replace "Review evidence to determine whether a 4 mm spacing is maintained after the shock test specified in section 6.12.5.2 and the vibration test specified in section 6.12.5.3." with "Review evidence to determine if more than 1 mm spacing is maintained after the shock test specified in section 6.12.5.2 and the vibration test specified in section 6.12.5.3." • Section 5.9 Compliance - Replace "A 4 mm spacing is maintained between un-insulated conductors after shock and vibration testing." with "More than 1 mm spacing is maintained between un-insulated conductors after shock and vibration testing." • Section 5.17 Procedure - Replace "Open an exemplar battery pack to verify that the cells are not connected in cell blocks and series of blocks in a battery pack using a combination of old and fresh cells as determined by the cell vendor." with "Open an exemplar battery pack to verify that the cells are not connected in cell blocks and series of blocks using a combination of old and fresh cells. • Section 5.39 Procedure - Delete extra period at end of paragraph. • Section 5.50 Procedure - Add "Identifier must be unique, but serialization is not required." • Section 5.55 Title - Delete "- Testing" • Section 5.79 Procedure - Replace "Confirm compliance to UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria." with "Review test report confirming compliance to UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria." • Section 5.79 Compliance - Replace "The certificate or test report meets the UN Manual of Tests and Criteria." with "Test report confirming compliance to UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria exists." • Section 5 Sample Table 5.1 - Add "Management" to "Name" column. • Section 5 Sample Table 5.20 - Delete "Use sample 5.16". • Section 6.7 Procedure - Delete "CRD 11" and parenthesis around "IEEE 7.2.3". • Section 6.17 Procedure - Add "The vendor shall specify how many times the fault shall occur before charging and discharging is permanently disabled. This is not applicable to systems that disable charging and discharging permanently after the first occurrence of the fault." • Section 6.21 Reference - Replace "6.7" with "7.6". • Section 6.31 Procedure - Replace "Use IEC 60721-3-7, Table 6, Class, 7M2 at a minimum, Non-Stationary Random Vibration and Shock (Type II)." with "The host shall be

		subjected to a half-sine shock with a peak acceleration of 300 m/s2 minimum and a pulse duration of 6 milliseconds. The exposure shall consist of 3 shocks in the positive direction followed by 3 shocks in the negative direction while secured in 3 mutually perpendicular positions for a total of 18 shocks." • Section 7.91 Procedure - Replace "Use IEC 60721-3-7, Table 6, Class, 7M2 at a minimum, Non-Stationary Random Vibration and Shock (Type II)." with "The host shall be subjected to a half-sine shock with a peak acceleration of 300 m/s2 minimum and a pulse duration of 6 milliseconds. The exposure shall consist of 3 shocks in the positive direction followed by 3 shocks in the negative direction while secured in 3 mutually perpendicular positions for a total of 18 shocks." • Section 6 Sample Table - Add 5.48 Pack Enclosure Openings row. • Section 6 Sample Table 6.32 - Replace "Not reusable" with" Host may be reused if not damaged unless pack is embedded with the agreement of the manufacturer". • Section 6 Sample Table - Add 7.3 Adapter ESD requirements. • Section 7 Sample Table - Delete rows 7.2 and 7.3. • Section 8.1 Procedure - Replace "this standard" with "CTIA Certification Requirements for Battery System Compliance to IEEE 1625". • Section 10.1 All - Replace "ISO-9000" and dates with "ISO-9001"
August 2011	1.3	• Section 3.2 Purpose - Add "IEEE 1625 standard," after "in". • Section 3.2 Compliance - Add "IEEE 1625 standard," after "in" and "For the UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria, it can be Fourth or Fifth Revised Edition." to the end of the paragraph. • Section 3.3 Purpose - Add "IEEE 1625 standard," after "in". • Section 3.3 Compliance - Add "IEEE 1625 standard," after "in" and "For the UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria, it can be Fourth or Fifth Revised Edition." to the end of the paragraph. • Section 5.3 Procedure - Replace "between" with "at least". • Section 5.7 Compliance - Delete "/cell". • Section 5.8 Procedure - Add ""Wires" applies to any conductor type such as tabs or flexible printed wiring assemblies." • Section 5.9 Procedure - Replace "shock" with "drop". • Section 5.9 Compliance - Replace "shock" with "drop". • Section 5.11 Procedure - Add "fully charged" after "the". • Section 5.32 Procedure - Replace "Perform the cell imbalance test to confirm cell imbalance algorithm defined by the battery pack vendor." with "Review the cell imbalance algorithm defined by the pack vendor. Charge or discharge a cell block

		in a pack which has a suitable initial charge status to create a voltage difference between blocks which is greater than that allowed by the algorithm. To verify the pack is disabled, attempt to charge or discharge the pack under the conditions specified by the pack vendor." • Section 5.32 Compliance - Replace "The blocks of parallel wired cells connected in series are monitored to compare the voltage of each cell block. When cell blocks differ by more than a specified limit under specified conditions, the battery pack is disabled." with " When cell block voltages differ by more than the limit specified by the vendor, it is not possible to charge or discharge the pack under the conditions specified by the vendor." • Section 5.66 Procedure - Add a comma after "enclosure". • Section 5.66 Compliance - Add a comma after "enclosure". • Section 5 - Sample Submission Requirements, line 5.50 - Replace "0" with "5" and "Use sample 5.55" with "Y". • Section 5 - Sample Submission Requirements, line 5.55 - Replace "5" with "0" and "Not reusable" with "Use samples from 5.50". • Section 6.7 Reference - Add "7.2.2, 7.2.3," after "7.1". Delete ", 6.6.5 (Pack). • Section 6.7 Procedure - Add "for overcurrent" after "7.2.3". • Section 6.15 Compliance - Delete "normal". Add "cell" after "per" and "and host" after "pack". • Section 6.17 Compliance - Replace "when" with "if". • Section 6 - Sample Submission Requirements, line 5.20 - Delete entire row.
December 2011	1.4	• 4.12 Compliance - Add ""or specification" after "report". • 4.18 Procedure - Change "ISO9000" to "ISO-9001". • 5.9 Procedure - Add "IEEE 1625" before sections "6.12.5.2" and "6.12.5.3". • 5.11 Compliance - Replace "The battery pack has short circuit protection and terminates the discharge current. All safety features shall remain operational, or the pack shall be permanently disabled" with "The battery pack has short circuit protection and limits the discharge current. All safety features shall remain operational, or the pack shall be permanently disabled. No fire, smoke, or explosions occurs".
May 2012	1.5	• Section 4.11 Compliance - Add "Additional insulation has been used if only a single layer of separator isolates the tab from the opposite electrode." after "resistance." • Section 4 Sample Table 4.8 - Add "4.16" to "reusable" column. • Section 4 Sample Table 4.13 - Add "(N/A for laminated cells)." to "Samples for Test" column.

		• Section 4 Sample Table 4.40 - Add "(N/A for laminated cells)." to "Samples for Test" column. • Section 4 Sample Table - Add "(20 for laminated cells)." to "Total Samples Required" row. • Section Sample Table 5.4 - Replace "0" with "5" in "# samples" column. • Section 5.11 Procedure - Replace "<=100 mohms" with " of 80 +/- 20 milliohms". • Section 5 Sample Table 5.39 - Add "(if required by construction review)." • Section 6 Sample Table 5.26 - Replace "5.25" with "5.30" in "Reusable" column. • Section 6 Sample Table 5.30 - Add "5.26" to "Reusable" column. • Section 6 Sample Table - Add row 5.75. • Section 7 Sample Table 7.15 - Replace "Qualification of Production Adapters" with "Ongoing Testing & Verification of Production adapters."
August 2012	1.6	• Section 1.3 - Replace "4-2" with "4-5" and "Electrostatic Discharge" with "Surge". • Section 3.4 Purpose and Procedure - Add "-1" to "60950". • Section 4.23 Procedure - Replace "Confirm lower specification limit of the separator thickness from vendor's separator specification. Confirm that the separator thickness is within the specification. Verify the burr height protruding the top surface (Figure 1) of the coated or uncoated electrode as confirmed by measurement. In case of burr height greater than 50% of separator's lower specification limit for thickness, verify documented engineering analysis that demonstrates burr heights with greater limits cannot cause internal shorts" with "Verify that the manufacturer has a method to prevent internal short circuit caused by burrs, either by: 1) Manufacturing control, which consists of measurements at least once per shift or once per manufacturing lot at each cutting point to determine whether or not burr heights are less than 50% of the lower tolerance limit of the separator thickness; or 2) Design prevention, which may include insulation taping or coating at uncoated foil, or documented engineering analysis (such as FMEA) that shows that burr heights may exceed 50% of the lower tolerances of the separator without resulting in internal shorts. Considerations may include coating thickness, separator thickness, coated versus uncoated electrodes areas, insulators and electrode overlap." • Section 4.23 Compliance - Replace "Burr height is less than or equal to 50% of the lower specification limit of separator thickness. In case of burr height greater than 50% of separator

		lower specification limit for thickness, documented engineering analysis is available and accepted. The burr height is within specification limits of documented engineering analysis." with "Either 1) manufacturing control ensures that burrs do not exceed 50% of the lower tolerance limit of the thickness of the separator or 2) design prevention with documented engineering analysis (such as an FMEA) shows that burr lengths with greater limits cannot cause internal shorts." • Section 4.24 Procedure - Replace "Confirm design parameters to the reference. Using inspection data, confirm that the manufacturing process is in control." with "Confirm design parameters to the reference. Using inspection data, confirm that the manufacturing process is in control. This is not applicable if design prevention is present." • Section 4.24 Compliance - Replace "Inspection data shows compliance to specified tolerances. For those cases where an out of control condition was noted, action was taken" with "Inspection data shows compliance to specified tolerances. For those cases where an out of control condition was noted, action was taken. This is not applicable if design prevention is present." • Section 5.53 Purpose - Add "To verify that the combination of cell, pack, and host device/charger has at least two independent thermal protection devices or mechanisms". • Section 5.53 Procedure - Add "and system" after "pack". • Section 5.53 Compliance - Add "The combination of cell, pack, and host device/charger has at least two independent thermal protection devices or mechanisms". • Section 5 Sample Table 5.53 - Delete "Move to Host" from "Reusable" column. • Section 6.32 Procedure - Add "For devices where the normal application is at the head level, the drop height shall be 1500 mm. For all other devices, the drop height shall be 1000 mm. If the device can be used in both applications, the worst case test condition shall be used." after "follows". Replace "a height of 1000 mm" with "the specified height". • Section 6 Sample Table - Add Row 5.53.
December 2012	1.7	• Section 4.13 Procedure - Add "an" after using in "3". Add "is" after "SOC" in "1". • Section 4.35 Purpose - Delete duplicate "or stack". • Section 6.24 Procedure - Delete "A sample of one is required." • Sample Table 6 - Add "0" to all empty cells.
April 2013	1.8	• Section 5.32 Purpose - Modify "To determine that cell blocks connected together are monitored to compare the voltage of each cell block. When cell blocks differ by more than a specified limit under specified conditions, the battery pack is disabled."

		• Sections 5 and 6 Sample Tables modified to reflect changes in 5.32.
August 2013	1.9	• Section 8.1 Procedure - Modify the description to 'Follow the explanation of a security implementation per IEEE1625 Clause 10.3.1.
December 2013	1.10	• Section 3.2 and 3.3 Compliance - Update the document version to "Fifth Revised Edition or Fifth Revised Edition Amendment 1". • Section 6.31 Procedure - Add "Prior to subjecting samples to testing, initial mass and voltage must be measured and recorded”. • Section 6.31 Compliance - Add " No mass loss (beyond allowable limits), no short-circuit"; and add Mass Loss Table. • Section 6.32 Compliance - Add “Upon completion of testing and a 1 hour observation period”.
May 2014	1.11	• Section 4.15 - Update the release date of the UL 1642 to Mar. 2012 release.
June 2015	1.12	• Section 5.9 Compliance – Editorial update. • Section 5.75 Procedure – Modified to “Review vendor’s evidence for user replaceable packs. For Embedded Packs (not user replaceable), subject Embedded Pack Host to drop impact test in accordance to UL 2054.”
October 2020	1.12.1	• Changed organization name from CTIA to CTIA Certification • Changed title of Battery Program Management Document to Battery Compliance Certification Program
June 2024	1.12.2	• Section 1.3 – Updated applicable documents • Section 3.2, 3.3 – Updated the Compliance section • Section 3.4 – Added IEC 62368-1 and IEC 62368-3 • Section 4.18 – Editorial update • Section 4.52 – Removed “Recommendations on the Transport of Dangerous Goods” • Section 4.53 – Updated the Compliance section • Section 4.54 – Removed “Cells shall not flame or explode as a result of the conditioning” from the Compliance section • Section 6 – Updated the minimum sample number from five to one