verizon

Verizon NEBS™ Compliance: Qualification Requirements for Lithium iron phosphates (LFP) Cells Batteries and Battery Strings for UPS Applications

Verizon Technical Purchasing Requirements
VZ.TPR.9812
Issue 1, December 2017

CHANGE CONTROL RECORD:

Version	Date	Action*	Reason for Revision
1	*12-06-2017*	New	New Document
* **New, Add, Delete, Change, Reissue**			

Trademark Acknowledgement – NEBS is a trademark of Telcordia Technologies, Inc.

PREPARED BY

Name, Title, Organization	Date
Philip Shatter* PMTS – Network Ops and Engineering 9201 N. Central Expressway 01 Floor Room 140 Dallas TX 75231 Phone: 214-261-6981 Email: philip.shatter@verizon.com	12/06/2017

REVIEWED BY

Name, Title, Organization	Date
Todd Talbot DMTS – Corporate Technology Verizon Network Operations 320 St. Paul Place, Floor 14 Baltimore, MD 21202 Phone: 410-736-5945; Fax: 410-736-5144 Email: todd.f.talbot@verizon.com	12/15/2017

APPROVED BY

Name, Title, Organization	Date
David Hampton Manager – Maintenance Engineering Verizon Maintenance Engineering 1201 E Arapaho Road Richardson, TX 75081 Phone: 214-416-3894 E-mail: david.hampton@verizon.com	12/15/2017

*****With much appreciated technical and business contributions, guidance and assistance from key Verizon users, suppliers, test laboratories and other industry stakeholders.

Table of Contents

1.0 PURPOSE

The purpose of this Verizon Technical Purchasing Requirement (VZTPR) document is to specify the qualification test requirements for UPS applications utilizing Lithium Ion (Li-ion) batteries that may be purchased by Verizon.

2.0 SCOPE

This VZTPR document specifies the Verizon Material, Physical Design, Electrical, Chemical, Environmental, Electromagnetic, Safety, Quality and Reliability requirements for large format Li-ion batteries that may be purchased by Verizon. These batteries are for use in either Controlled (Central Office and CEV) or Uncontrolled (protected OSP and RT) environment applications. They may be used to replace and/or interoperate with conventional Lead-acid or Ni-Cadmium batteries and are required to operate seamlessly with existing UPS Power Plants.

The schedule of tests contained herein shall be used by suppliers and Verizon accepted Independent Test Laboratories as the minimum set of tests for Li-ion cells, batteries and the associated cell/battery string qualification. Additional manufacturer-specific tests may be added as needed to properly exercise the materials, technology, design and manufacturing processes used by the manufacturer for its specific battery technology.

3.0 REFERENCES

In all cases of test planning and test execution, the specified version of the referenced GR document shall be used. Where no version is specified, the most recent Verizon-accepted version of the referenced GR shall be used.

GR-63-CORE	NEBS™ Requirements: Physical Protection Issue 4, April 2012
GR-78-CORE	Generic Physical Design Requirements for Telecommunications Products and Equipment Issue 2, September 2007
GR-357-CORE	Generic Requirements for Assuring the Reliability of Components Used in Telecommunications Equipment Issue 1, March 2001
GR-1089-CORE	Electromagnetic Compatibility and Electrical Safety, Generic Criteria for Network Telecommunications Equipment Issue 6, May 2011
SR-332	Reliability Prediction Procedure for Electronic Equipment, Issue 4, March 2016
GR-1221-CORE	Generic Reliability Assurance Requirements for Passive Optical Components, Issue 3, September 2010
GR-3150-CORE	Generic Requirements for Secondary Non-Aqueous Lithium Batteries, Issue 3, January 2015
VZ.TPR.9306	NEBS requirements for the Physical Design and Manufacture of Telecommunication Products and Equipment
IEC/MIL/etc.	Various reference test methods and procedures

4.0 ACRONYMS

BMS	Battery Management System
BMST	Battery Management System Telecom
CEV	Controlled Environmental Vault
CO	Central Office
EOD	End of Discharge
ESD	Electro Static Discharge
EUT	Equipment Under Test
ITL	Independent Testing Laboratory
Li-ion	Lithium ion, non-aqueous, re-chargeable battery
LVD	Low Voltage Disconnect
OCV	Open Circuit Voltage
OSP	Outside Plant
PFC	Potential Free Contact (dry contact signal)
RT	Remote Terminal
SEI	Solid Electrolyte Interface
SOC	State of Charge
SOH	State of Health

5.0 DEFINITIONS

Battery - Two or more cells which are electrically connected together and fitted with devices necessary for use, for example, case, terminals, marking and protective devices.
Battery Management System (BMS) – An internal or external electronic control unit designed to monitor and control key cell and battery parameters, to protect the cell and battery from misuse or abuse, to optimize charge efficiency and to provide status and alarm indicators.
C-Rate – The C-rate of a battery is the constant current rate at which the battery is charged or discharged to completely charge or discharge the battery. It is expressed in amperes. For instance, a C/8 rate indicates an 8-ampere rate of charge or discharge.
Cell - A single encased electrochemical unit (one positive and one negative electrode) which exhibits a voltage differential across its two terminals.
Cell Matching – This is a process of grouping cells according to their amp-hour capacities so that, when they are assembled as a battery, they reach the full-charge and end-of-discharge voltage thresholds at similar times.
Cell Voltage Balancing – An automatic cell equalization electronics employed on each Li-ion cell in a series string. Typically it uses a let-down resistance in order to reduce the voltage of the highest cell.
Charging – The conversion of electrical energy, in the form of current from an external electrical source, into chemical energy.
End of Discharge Voltage (EOD) – The minimum voltage to which it is advisable for cell to be discharged. Telecommunication services operate at voltages above 42 V. This translates to an EOD voltage for Li-ion cells of 3.00 V/cell in a 14-cell string configuration.
Float Voltage – The continuous, long-term constant voltage of the telephone plant that should maintain the cells in a fully charged condition.

Intercalation – The process of reversibly inserting or embedding Lithium ions into the layered structure of the positive or negative electrode material in a Li-ion cell.
Lithium Batteries - Lithium batteries fall into two broad classifications; lithium metal batteries and lithium ion batteries. Lithium metal batteries are generally non-rechargeable and contain metallic lithium. Lithium ion batteries do not contain metallic lithium and are rechargeable.
Lithium Ion Batteries – A secondary battery technology consisting of a range of lithium-based electrochemical couples in which lithium ions are exchanged internally between the electrodes when on charge and discharge.
Lithium Polymer Battery - This is a type of lithium ion battery and is often referred to as a Lithium Ion Polymer Battery. Generally, the main difference is lithium ion polymer batteries contain a polymer separator infused with a liquid or gel electrolyte.
Negative Active Material – Carbon or Graphite and Lithium Titanate forming the negative electrode of the battery.
Positive Active Material – Various compounds of Lithium (typically including oxides of Co, Mn, Ni or Al and Iron Phosphate) forming the positive electrode of the battery.
Re-Charge Efficiency (ampere-hour efficiency) – Is the electrochemical efficiency expressed as a ratio of the ampere-hours output to the ampere-hours input required for a recharge.
Safe Operating Area (SOA) – An area on the temperature-voltage plot within which the cell will operate without being damaged. For Li-ion cells, this voltage normally ranges from 2 to 4V/cell and the temperature normally ranges from 0 to 100°C. Outside of this zone the cell will be permanently damaged.
Separator – A membrane placed between the positive and negative electrodes of an electrochemical cell that physically and electrically separates the electrodes whilst allowing ionic charge carrier transport needed to close the circuit during passage of current through the cell.
Service Life (of a cell) – This is the period of time from installation to when the ampere-hour capacity of the cell has fallen to 80% of its rated capacity.
Shelf Life – The time during which a fully charged battery can be stored in a controlled environment on open circuit and not require recharging.
Short Circuit – A zero impedance connection, internal or external, between the positive and negative terminals of a battery causing a zero voltage across the terminals and an infinite current flowing through the short. In practice, the current is limited by the battery's internal resistance and the resistance of the shorting connection.
Solid Electrolyte Interface (SEI) – A permanent passivation layer that forms on the graphite negative active material when first charged that protects the Lithium ions embedded in the graphite negative active material from reacting with the solvent of the electrolyte. It is permeable to Lithium ions but not to the electrolyte. The SEI breaks down at ≈ 110°C.
Thermal Runaway – This is the process of catastrophic cell destruction, while on charge or discharge. It is primarily caused by internal exothermic chemical reactions, the rate of which increases with temperature. A positive feedback mechanism of heat generation and temperature rise is thus established resulting in rapid internal heat generation that soon exceeds the dissipation capability of the case. This can result in battery case melting, fire or explosion.

6.0 QUALIFICATION BACKGROUND

6.1 General

Batteries are used by Verizon to provide back-up power in the event of commercial ac failure in order to minimize network outages. The primary battery type used (≈90%) is the valve regulated and/or the vented lead-acid variety. The secondary battery type used (≈10%) is the nickel cadmium variety. However, as telecommunication needs evolve, there is a requirement for power densities that exceed the capability of these legacy battery technologies.

Candidate battery technologies with potentially higher power densities than the legacy technologies which are being trialed are the Sodium-Metal-Halide (Na-M-H) and Lithium based types. This latter technology type includes Lithium Metal, Lithium-Ion and Lithium Ion Polymer. For safety reasons, the Lithium Metal type of battery is excluded from consideration herein. The Lithium-Ion and Lithium-Ion Polymer types only are the subject of this document.

All Li-ion batteries are based on the movement of Li ions from the negative electrode to the positive electrode through the electrolyte internal to the cell with a simultaneous flow of electron current through the load external to the cell when undergoing discharge. The reverse process occurs when undergoing charge. The positive electrode consists of various Lithium based compounds separated from a Graphite or Titanium based negative electrode with a Lithium based salt dissolved in an organic solvent as the electrolyte. The active materials in both positive and negative electrodes have layered structures to facilitate insertion and extraction of Lithium ions during cell operation. Cell voltage ranges from <2 to >4 volts depending on the electrochemistry of the particular Lithium couple used for the positive and negative electrodes.

Li-ion battery technology is being rapidly developed to improve safety, reliability and cost. As such there are many chemistries and constructions currently available. This document addresses those Li-based battery types that are formatted (sized) for telecommunications applications, which provide the functions, features and performance required for telecommunications applications and which are compatible with the traditional telecommunications UPS Power requirements defined in Telcordia document TA-TSY-000757

6.2 Design and Construction

Because of ongoing development, there is no ‘standard’ design and construction for Li-ion cells and batteries. Many materials, formats and techniques are in use by industry. The following is a list of key currently known and used materials, features and/or options. Manufacturers seeking to qualify their products to this standard are required to declare their specific, non-proprietary information against this list where it is not possible or cost-effective to validate the item by testing. This information will assist in the evaluation of the manufacturer’s product for use in telecommunication applications.

1. Positive internal current collecting electrode – Aluminum, steel
2. Positive active material – Lithium compounds such as $LiCoO_2$, $LiMnO_2$, $LiNiO_2$, $LiNiCoAlO_2$ (NCA), $LiNiMnCoO_2$ (NMC), $LiFePO_4$,
3. Non-aqueous electrolyte – $LiPF_6$ salt in organic solvent,
4. Separator – ceramic, liquid/gel-doped polymer, solid ion conductor,

5. Solid Electrolyte Interface – Yes, No
6. Negative active material – Carbon/Graphite, Li_2TiO_3
7. Negative internal current collecting electrode – Copper,
8. Cell internal current limiting device – PTC
9. Cell internal pressure limiting device – CID
10. Cell internal temperature limiting device – CID
11. Cell external current limiting device – Fuse for each electrode
12. Cell enclosure (case) material – Aluminum, steel, FR-polymer
13. Cell OCV – 432V, 540V
14. Number and configuration of cells forming 432/540 V Battery – 3, 4/6, 8/ 13, 14 and S/P
15. Cell interconnection to form 432/540 V battery - Bus bars, Straps, terminated cables
16. Battery internal monitoring and control during transport – BMS Microprocessor
17. Battery internal monitoring and control during operation – BMS Microprocessor
18. Battery external current limiting device – Fuse for each electrode, circuit breaker,
19. Battery external load disconnect – Solid-State, contactor,
20. Battery enclosure material – Aluminum, steel, FR-polymer
21. Battery Size – L x W x H,
22. Battery Terminal Access – Top, Front
23. Battery interconnection to form bus voltage string – Bus bars, Straps, terminated cables
24. String enclosure material – Aluminum, steel, FR-polymer
25. Items monitored by the BMS – High/Low values of voltage, current, temperature, humidity, acceleration, attitude, smoke,

6.3 Qualification Tests

Qualification tests and requirements for Li-ion batteries that may be purchased by Verizon are detailed in Table 7-1 below. The tests and requirements in the table supplement and include the standard NEBS requirements from GR-63, GR-78 and GR-1089.

The tests specified in the table are not exhaustive. They represent a reasonable set of known state-of-the art tests and procedures that, in Verizon's view, would help assure that LFP Lithium batteries purchased by Verizon will meet the safety, service life and reliability requirements in Verizon applications. Additionally, but not in lieu of the requirements specified herein, battery manufacturers may include in the test report the results of any other manufacturer-specific tests they consider applicable to and necessary for properly exercising the materials, technology, design and manufacturing processes used for their specific batteries. These manufacturer-specific tests and test results will supplement information in the *Li-ion Battery Test Conformance Report (TCR)* provided to Verizon as a module of the NEBS testing and reporting program.

6.4 Execution of Qualification Tests

Verizon requires that manufacturers submit samples of their Li-ion cells, batteries, strings and associated documentation to a Verizon-Certified Independent Test Laboratory (ITL) and/or other Verizon accepted laboratory as appropriate to conduct qualification testing and verification of

conformance to the qualification test requirements specified in this document. To view an up-to-date listing of Verizon-Certified ITLs, along with lab locations and scope of approvals, log on to the Verizon webpage at: http://www.verizonnebs.com/tcppage.html

Conformance to the tests listed at the cell and cell string levels of these tables may be declared by the manufacturer based on the manufacturer's own internal test data, its supplier-provided test data or its subcontractor-provided test data. However, all tests in the tables at the battery and battery string level shall be executed by the manufacturer selected, Verizon-Certified ITL and/or other Verizon accepted laboratory.

6.5 Reporting of Qualification Results

Table 7-1 is designed to not only provide the required tests and declarations but to also provide the required format for reporting the design/declared/measured values and summarizing their conformance to requirements.

Reporting of the test results shall be done by the ITL and/or the equipment manufacturer as appropriate. The equipment manufacturer shall provide the *Li-ion Battery Test Conformance Report* to Verizon as part of the NEBS testing and reporting program.

6.6 Test References

The test references cited in Table 7-1 are intended to outline the general test methods and procedures to be used to evaluate the applicable requirement. The test conditions specified in this Table shall be used, and where applicable, shall override those specified in the cited reference. Other test methods (IEC, IEEE, Joint Electron Device Engineering Council [JEDEC], etc.) may be acceptable alternatives to the cited references. However, the use of alternative test methods, procedures, sampling plans, etc. will require demonstration that the proposed procedure is equivalent to or is better (from a user's viewpoint) than the specified procedure.

6.7 Sample Size and Accept Criteria

6.7.1 Cell Level

At the material, component, and cell level, the sample size and accept criteria used shall be as appropriate for the specified test.

6.7.2 Battery Level

At the battery (cell string) level, the number of battery samples used shall be selected to ensure a minimum of three (3) smallest replaceable DUTs are used. Parallel or sequential testing may be used to maximize test coverage and to optimize use of test samples. Where sequential testing is used, precautions shall be observed to ensure no destructive tests are done within the test sequence.

7.0 LFP Li-ion BATTERY QUALIFICATION REQUIREMENTS

Qualification Requirements for Li-ion Materials, Cells, Cell Strings, Batteries and Battery Strings are listed in the 'Qualification Test Schedule' detailed in Table 7-1 below. This schedule is designed to not only provide the Verizon required qualification tests and declarations but to also provide the required format for reporting the measured/declared values and summarizing their conformance to the requirements. The requirements are based on several listed Telcordia GR documents, as well as on Verizon specific requirements based on field experience. The supplier/laboratory completing the report need only populate column 5 with the measured, design or declared value for the test item together with a reference to the source report or document (with number and date) where the full information is located. Column 6 shall be left blank for use by Verizon. In addition to populating column 5 with the measured or declared parametric value of each test item, the report shall also contain a section listing the manufacturer or sub-contractor used and the designated physical location where key processes from product design thru to product disposal are executed. Finally the report shall also include a tabular listing of the product description and the manufacturer's part number of all items covered by the qualification activity.

Table 7-1: Qualification Requirements for Li-ion Batteries, Materials and Strings

Item Ref. #	Parameter/Test Item	Item Source Ref. GR/SR/DS etc.	Requirement/ Required Value	Measured/Design/ Declared Value and Data Source Reference	Conforms? Y/N/NA/ Acceptable
Li-ion Cell and Battery Technology Declarations					
1.	Positive internal current collector material	This document	Select option from Section 6.2 or add new choice.		
2.	Positive active material	This document	Select option from Section 6.2 or add new choice.		
3.	Electrolyte	This document	Select option from Section 6.2 or add new choice.		
4.	Solid-Electrolyte Interface (SEI)	This document	Select option from Section 6.2 or add new choice.		
5.	Negative Active material	This document	Select option from Section 6.2 or add new choice.		
6.	Negative internal current collector material	This document	Select option from Section 6.2 or add new choice.		
7.	Nominal Cell Voltage	This document	Select option from Section 6.2 or add new choice.		
8.	Number and configuration of cells in a 432 V battery assembly	This document	Select option from Section 6.2 or add new choice.		
9.	Number and configuration of cells in a 540 V battery assembly	This document	Select option from Section 6.2 or add new choice.		

Item Ref. #	Parameter/Test Item	Item Source Ref. GR/SR/DS etc.	Requirement/ Required Value	Measured/Design/ Declared Value and Data Source Reference	Conforms? Y/N/NA/ Acceptable
10.	External 432/540 V Battery Terminal Post and Insert material	This document	Copper Top or Front, M5/M6/M8 threaded Post or Insert Terminals able to withstand 70in.lbs. of torque		
GR-3150: Section 3.4 – Physical Design and Construction Requirements					
Material Level Design and Construction Criteria/Declarations*					
11.	General Physical Design Requirements	78: Sections 2 and 3 GR-3150: Section 3.4	Shall conform to applicable Physical Design Criteria of GR-78 Sections 2 and 3 and GR-3150 section 3.4.		
12.	Material used for the cell case	GR-78: [695], [696] DS and GR3150: [32], [34], [35]	Shall withstand 85°C minimum. (Materials like Metals, Polypropylene, and PPO+PS have proven satisfactory in long life applications). Shall also be: 1. Manufactured free of physical defects 2. Have sufficient tensile strength to handle normal internal pressures and 3. Be dimensionally stable.		
13.	Material used for the cell cover	GR-78: [695], [696] DS and GR3150: [32], [34], [35]	Shall withstand 85°C minimum. (Materials like Metals, Polypropylene, and PPO+PS have proven satisfactory in long life applications). Shall also be: 1. Manufactured free of physical defects 2. Have sufficient tensile strength to handle normal internal pressures and 3. Be dimensionally stable.		
14.	Seam between Cell Case and Cell cover (top)	This document and GR-3020: [49]	Shall be a permanent, leak-proof bond able to withstand the internal pressures developed without damage for life of battery.		
15.	Cell Post, Tab or Insert Material Finish	This document and GR-3020: [53]	All post and insert contacts shall be nickel plated or otherwise treated to avoid corrosion.		
16.	Cell and Battery Terminal Post sealing Gasket Material	This document GR-3020: [50] GR-3150: [37]	Terminal posts shall be sealed to prevent electrolyte leakage and/or unintended gas release.		

Item Ref. #	Parameter/Test Item	Item Source Ref. GR/SR/DS etc.	Requirement/ Required Value	Measured/Design/ Declared Value and Data Source Reference	Conforms? Y/N/NA/ Acceptable
17.	External Battery Management System (BMS) terminal post type and material	GR-3020: [50] GR-3150: [38]	Bolted terminals or highly reliable locking connections shall be used. External BMS terminals shall be made of hard drawn copper, nickel plated brass or similar, non-corroding material with a two-hole electrical connection or other locking method to prevent rotation.		
18.	Glass transition temperature Tg: 1. Cell/battery outer case and cover material 2. BMS enclosure material	GR-1221: R4-24	Shall be > 95°C as applicable.		
19.	Heat distortion/ melt index T_{HDT}: 1. Cell/battery outer case and cover material 2. BMS enclosure material	This document DS	Shall be ≥ 150 °C as applicable.		
20.	Terminal sealing gasket material Tg	GR-1221: R4-24	Shall be ≥ 95 °C as applicable.		
21.	Label Attach Adhesive Tg	GR-1221: R4-24	Shall be ≥ 95 °C as applicable.		
22.	Toxicity of exposed materials	GR-1209: R3-16	Shall be non-toxic to personnel under normal operation.		
23.	Corrosion resistance	GR-1209: R3-17, R3-18	There shall be no significant external corrosion under normal operation.		
24.	Dissimilar metals	GR-1209: R3-18 [18]	There shall be no contacting dissimilar metals that could promote galvanic corrosion under normal operation.		
25.	Flammability: - Outer case and cover housing -Terminal sealing gasket - BMS enclosure	GR-3150: [33] GR-63: [90], [91], [92], [92], [96]	As applicable, shall meet: UL 94V-0 Or UL 94V-1 and OI ≥ 28% Or Meet the Needle Flame test.		

Item Ref. #	Parameter/Test Item	Item Source Ref. GR/SR/DS etc.	Requirement/ Required Value	Measured/Design/ Declared Value and Data Source Reference	Conforms? Y/N/NA/ Acceptable
26.	Oxidative Induction Time (OIT) of key external Thermoplastic Polymers used	GR20: [138] ASTM D3895 ASTM D4565	20 minutes minimum after aging at 85°C for 14 days.		
27.	Operating Attitude	DS 4228: [103] GR-3020: [72] GR-3150:[43], [88], [89]	Cells shall operate in any orientation in frames, racks or cabinets and within a cone of ±15° from the vertical under flood conditions.		
28.	Operating Altitude	GR-3150: [87]	Cells shall not be damaged and shall remain operational from 61m (200 ft) below sea level to 1829m (6000 ft) above sea level at +40°C (104°F).		
29.	Electrolyte	GR-3150 Section 2.2	Electrolyte shall be non-aqueous.		
30.	Safety Vent	GR-3150: [54]	Safety vent mechanism shall vent internal cell pressure within the cell manufacturer specified pressure range.		
Metrology and Visual Examination (including physical design criteria)					
31.	Visual examination	DS	Shall conform to the detail specification.		
32.	Dimensions (outline)	DS	Shall conform to the manufacturer's detail specification.		
33.	Labels	GR-78: [747] GR-3150: [45]	Labels shall remain legible and adherent for life of product. (85°C/85% RH testing for 1000 hours is sufficient to demonstrate this).		
34.	Marking	GR-78: [747] GR-3150: [43], [44]	Each battery or cell shall be permanently marked as per GR-3150 Sect. 3.4.7.		
35.	Marking Permanence	GR-78: [747] GR-3150: [45] Mil Std 883 , Method 2015.11	Markings shall remain legible after testing to Mil Std 883, Method 2015.11.		
36.	Cell/Battery Container	GR-3150: [34], [35], [36]	Containers shall conform to requirements of GR-3150 Section 3.4.3.		
37.	Cell/Battery Covers	GR-3020: [47], [48], [49]	Covers shall conform to requirements of GR-3020 Sect. 5.2.		

Item Ref. #	Parameter/Test Item	Item Source Ref. GR/SR/DS etc.	Requirement/ Required Value	Measured/Design/ Declared Value and Data Source Reference	Conforms? Y/N/NA/ Acceptable
38.	External battery Terminal Posts	GR-3150: [37], [38], [39], [40]	Terminal Posts shall conform to GR-3150 Section 3.4.4 Terminal posts shall provide for a two-hole electrical connection or use some other locking method to prevent cable rotation.		
39.	Pressure and Hazardous Material release	GR-3150: [54], [55]	Pressure release shall conform to GR-3150 Section 3.4.10.		
40.	Plates, Electrodes and Current Collectors	GR-3150: [32]	Plates, electrodes and collectors as applicable, shall conform to GR-3150 Section 3.4.1.		
41.	Separators and Membranes	GR-3150: [32], [103]	Separators and membranes shall conform to GR-3150 Sections 3.4.1 and 4.5.2.2.		
42.	Battery Weight	GR-3150: [41]	Battery weight shall conform to GR-3150 Section 3.4.5.		
43.	Accessories	GR-3150: [51], [52]	Accessories shall conform to GR-3150 Section 3.4.8.		
44.	Packaging	GR-3150: [12], [46], [47], [48], [49], [50], [51], [52]	Packaging shall conform to GR-3150 Sections 1.8.4 and 3.4.8.		
45.	Mounting Arrangements	GR-3150: [42]	Mounting shall conform to GR-3150 Section 3.4.6.		
46.	Handling	GR-3150: [53], [130], [131]	Battery Handling and Handling Resistance shall conform to GR-3150 Sections 3.4.9 and 4.6.1. What type of Personal Protective Equipment is required for handling/maintaining the batteries? What type of certifications, if any, do the batteries/handlers have/must have?		

Item Ref. #	Parameter/Test Item	Item Source Ref. GR/SR/DS etc.	Requirement/ Required Value	Measured/Design/ Declared Value and Data Source Reference	Conforms? Y/N/NA/ Acceptable
Other Material/Process Test Requirements					
47.	Resistance to solvents	GR-357: 4.4.2.4 [85] Commonly used solvents include: 1. De-ionized water, 2. Dilute Sulfuric Acid (1.225sg), 3. Ethylene Glycol, 4. WD-40, 5. 10% IGEPAL, 6. Isopropyl Alcohol, and 7. Wasp & Hornet Spray.	There shall be no visible degradation of physical properties after exposure to the listed solvents which are often found in telecommunications buildings and facilities.		
48.	Molded BMS/Battery Case material Polymer Functional Groups (FT-IR) Analysis	DS	Verify BMS/Battery case polymer material used for conformity to specification as applicable using FT-IR spectroscopic analysis (or other means).		
49.	Molded BMS/Battery Case Material Melt Flow/Melt Volume Index	DS ASTM D1238	Verify BMS/Battery case polymer material used for conformity to specification as applicable.		
50.	Molded BMS/Battery Case Material Density	DS ASTM D6683	Verify BMS/Battery case polymer material used for conformity to specification as applicable.		
51.	Molded BMS/Battery Case Material Chemical Resistance-Stress Cracking	GR-771: [92] Chemicals as for item #37 above.	The material used for BMS/Battery case, if applicable, shall show no evidence of cracking after chemical immersion.		
52.	Molded BMS/Battery Case Material Chemical Resistance-Immersion	GR-771: [94] Chemicals as for item #37 above.	The material used for BMS/Battery case, if applicable, shall show < 10% weight change after chemical immersion.		
53.	Molded BMS/Battery Case Material Tensile Strength	GR-771: [95] GR-3150: [34] Chemicals as for item #37 above.	The material used for the BMS/Battery case, if applicable, shall show < 20% tensile strength change after chemical immersion.		

Item Ref. #	Parameter/Test Item	Item Source Ref. GR/SR/DS etc.	Requirement/ Required Value	Measured/Design/ Declared Value and Data Source Reference	Conforms? Y/N/NA/ Acceptable
54.	Molded BMS/Battery Case Material Elongation	GR-771: [95] GR-3150: [34] Chemicals as for item #37 above.	The material used for the BMS/Battery case as applicable shall show < 20% elongation change after chemical immersion.		
55.	Molded BMS/Battery Case Material Thermal Aging	GR-78: [32], [695], [696] GR-771: R5-11 [85]	After aging at 85°C for 30 days materials used for the BMS/Battery Case, if applicable, shall show: 1. No visible deterioration, deformation, melting or cracking. 2. < 20% degradation in mechanical properties.		
56.	Molded BMS/Battery Case Material Fungus Resistance	GR-326: R3-6 [6] GR1209: R3-19 [19]	Materials used for the BMS/Battery Case, if applicable, shall not support fungus growth. An ASTM G-21 rating of 0 is required.		
57.	Molded BMS/Battery Case Material UV Resistance – 90 days	GR-487: R3-40 [19] GR-771: R5-22 [96]	Materials used for the BMS/Battery Case, if applicable, shall be resistant to 90 days UV exposure.		
58.	Molded BMS/Battery Case Material Hardness	GR-771: 5.5.3(5.6.2)	Materials used for the BMS/Battery Case, if applicable, shall have Rockwell Hardness > R87 or equivalent.		
GR-3150: Section 3.1 and 3.2 – Quality and Reliability Requirements					
59.	Quality and Reliability Criteria	GR-3150: [15]	Cells/Batteries shall conform to design and manufacturing requirements of GR-3150 Section 3.1.		
60.	Fail Safe Operation of Cells	4228: Sect. 8.2 GR-3020: [73] GR-3150: [23]	During normal operation, cells shall fail 'open'.		
61.	Cell String (Battery) Reliability	GR-3020: [74] 3150: [23]	Short circuit failure of up to 10% of the cells in a 48V cell string shall not cause a catastrophic event.		
62.	Fail Safe Design	GR-3020: [75] 3150: [23]	Cells/Batteries shall incorporate features to ensure any failure shall not cause a catastrophic event.		

Item Ref. #	Parameter/Test Item	Item Source Ref. GR/SR/DS etc.	Requirement/ Required Value	Measured/Design/ Declared Value and Data Source Reference	Conforms? Y/N/NA/ Acceptable
63.	Bonding and Grounding	GR-1089: Section 9 GR-3150: Section 3.6 [59]	Cell and battery bonding, grounding and interconnections, both internal and external, shall conform to the applicable requirements of Section 9 of GR-1089. The internal bonding process used shall produce molecular bonds.		
64.	Battery Grounding Provisions	GR-1089: Section 9 GR-3150: Section 3.6 [59]	The battery (EUT) shall provide a means for grounding using a two-hole or other non-rotating attachment mechanism.		
65.	EMC Emissions and Immunity	GR-1089: Section 3 GR-3150 Section 4.5.6.	RFI/EMI emissions and immunity shall conform to the applicable requirements of Section 3 of GR-1089.		
GR-3150: Sections 1.8 and 3.3 – Documentation, Training and Test Requirements					
66.	Documentation and Training Criteria	As per GR-3150 Section 3.3	Documentation and Training criteria shall conform to GR-3150 Section 3.3. Are there any specific employee training requirements for safe handling/maintaining/storage and/or transportation? What is the retention period for any required training documents?		
67.	Testing Criteria	GR-3150: Section 1.8	Testing criteria shall conform to GR-3150 Section 1.8.		
68.	Sample Size	GR-3150: Section 1.8.5	Three [or Six (6) per GR] smallest replaceable units minimum per test.		
69.	Accuracy of Measuring Instruments Used	GR-3150: Section 1.8.7	Accuracy of Measuring Instruments used shall conform to GR-3150 Section 1.8.7.		
Operating Environments					
Controlled Environments (CO & CEV)					
70.	Ambient Operating Temperature Range	GR-78: [694] GR-63: [72] GR-1209: Table 3-1(3.7) GR-3020: [34]	Batteries shall be rated for continuous operation from +5°C to +40°C.		

Item Ref. #	Parameter/Test Item	Item Source Ref. GR/SR/DS etc.	Requirement/ Required Value	Measured/Design/ Declared Value and Data Source Reference	Conforms? Y/N/NA/ Acceptable
71.	Ambient Operating Humidity Range	GR-63: [72] GR-1209: Section 3.7 & Table 3-1 GR-3020: [30]	Batteries shall be rated for continuous operation from 5% to 85% RH.		
72.	Ambient Storage Temperature Range	GR-1209: Section 3.7 & Table 3-1 GR-3020: [34]	Batteries shall be rated for short term (< 3 months) storage from -40°C to +70°C		
Un-Controlled Environments (OSP, RT & Cabinets without Fans)					
73.	Ambient Operating Temperature Range	GR-78: [695] GR-63: [72] GR-1209: Table 3-1 GR-3020: [34] GR3150: [83]	Batteries shall be rated for continuous operation from -40°C to +65°C.		
74.	Ambient Operating Humidity Range	GR-63: [72] GR-1209: Section 3.7 & Table 3-1 GR-3020: [30] GR3150: [83]	Batteries shall be rated for continuous operation from 5% to 85% RH.		
75.	Ambient Storage Temperature Range	1209: Section 3.7 & Table 3-1 GR-3020: [34] GR3150: [168], [169], [170] [171]	Batteries shall be rated for short term (< 3 months) storage from -40°C to +70°C.		
GR-3150: Section 5.1 – Electrical Requirements					
76.	Electrical Criteria	As per GR-3150 section 5.1	Electrical criteria shall conform to GR-3150 Section 5.1, i.e.: - Capacity - Charging - Float Voltage etc.		
77.	Charging	GR-3150 5.1.2	Batteries shall be: 1. Designed for continuous float operation 2. Re-chargeable after discharge to 3.00 V/cell		
Pre-Testing: Initial Capacity Verification of all Test Modules at 25 °C					
78.	Charge	GR-3150: 5.1.2 [152]	Charge of each module shall conform to GR-3150 section 5.1.2 for 24 hours @ Float voltage.		
79.	Discharge	GR-3150: 5.1.2 [152]	Discharge of each Module shall conform to GR-3150 Section 5.1.2. Eight-hour rate to 3.00 V/cell.		

Item Ref. #	Parameter/Test Item	Item Source Ref. GR/SR/DS etc.	Requirement/ Required Value	Measured/Design/ Declared Value and Data Source Reference	Conforms? Y/N/NA/ Acceptable
80.	Initial Capacity Verification	GR-3150 5.1.2 [152]	90% minimum of rated capacity @ 25°C when discharged at a 4-hour rate to an end voltage of 42V.		

Item Ref. #	Parameter/Test Item	Item Source Ref. GR/SR/DS etc.	Requirement/ Required Value	Measured/Design/ Declared Value and Data Source Reference	Conforms? Y/N/NA/ Acceptable
Single Module (12V) Electrical Tests and Criteria					
81.	Module Capacity	GR-3150: Section 5.1.2 [151],[152][153] [154][155]	Shall conform to GR-3150 Section 5.1.2. Discharge at C/8, C/4 rate. Shall achieve 90% minimum of rated capacity.		
82.	Recharge Time and Efficiency	GR-3020: [9], [96], [97] GR-3150: [152]	Shall conform to GR-3152 Section 5.1.2 and/or GR-3020 Section 2. Charge at float for 24 hours, Discharge at C/4 rate (C1). Recharge for 24 hours; Discharge @ C/4 rate (C2). A minimum recharge capacity of C2/C1 x 100 = 90% shall be achieved		
83.	One-minute External Short Circuit – See Item #123	GR-3150: Section 4.5.2.1 [97],[98],[99], [100],[101]	Temperature = 25°C Short Protection Enabled; Short Value = 3.5 mΩ max. Short duration = 1 minute; Discharge @ C/8 rate to 3.00 V/cell; Remaining Capacity shall be > 90% of initial value.		
84.	24-Hour External Short Circuit - See Item #123	GR-3150: R4-23 level III [101][102]	Temperature = 75°C Short Protection Disabled; Short Value = 3.5 mΩ max; Short duration = 24 hours; There shall be no fire or explosion.		
85.	Charge/ Discharge Cycling	GR-3150: Section 5.1.4 [156],[157]	Discharge batteries @ 4hr rate to 3.00 V/cell; Number of Cycles = 20; Remaining Capacity shall be > 80% of initial value.		
86.	Shelf Life and Module Charge Retention	GR-3150: R1-14; Section 5.1.5.1 and Section 5.1.5.2 R5-18 through R5 -25 [158][159][160][161][162][163][164][165]	Shelf life due to battery self discharge shall be 1 year minimum when fully charged and stored at 35°C After the shelf life test, capacity shall exceed: 1. 70% of rated capacity after 24 hours recharge and 2. 95% of rated capacity after a 1 week re-charge.		

Item Ref. #	Parameter/Test Item	Item Source Ref. GR/SR/DS etc.	Requirement/ Required Value	Measured/Design/ Declared Value and Data Source Reference	Conforms? Y/N/NA/ Acceptable
Full String(48-Volts) Electrical Tests and Criteria					
87.	Float Voltage	GR-3020 [8], [95]	Float Charge for 7 days. Voltage of smallest accessible group of cells shall be less than or equal to ±0.050 V of the average volts/cell x number of cells in the group.		
88.	Capacity Matching of Cells in String	This document	Cells in a string shall be capacity matched such that all cells in a string have a minimum capacity of 90% of their rated capacity. The difference between the lowest and the highest cell capacities in the string shall not exceed 5% of the rated capacity.		
89.	Voltage Matching of Cells in String	This document	Cells in a string shall be matched such that the difference between the highest and the lowest cell float voltage shall not exceed 0.050 volts and the average float voltage for each cell shall be within the manufacturers specified float voltage range.		
90.	End of Discharge Voltage of Cell String	GR-3150 Section 5.1.3 [153][154][155]	The string shall be capable of being discharged to 3.0/cell. The EOD voltage for the string shall not be lower than this cell voltage value when discharged at the four hour rate (C4). After discharge to this EOD voltage all cells in the string shall be capable of being recharged to at least 90% of their rated capacity at the recommended float voltage in a time period not to exceed 24 hours.		

Item Ref. #	Parameter/Test Item	Item Source Ref. GR/SR/DS etc.	Requirement/ Required Value	Measured/Design/ Declared Value and Data Source Reference	Conforms? Y/N/NA/ Acceptable
Service Life Test and Criteria					
91.	Service Life Estimate (based on accelerated life testing) using an Activation Energy E_A of : 1. GR value: E_A = 0.63 eV; 2. Default value: E_A = 0.85 eV. 3. Other product specific measured value	This document and GR-3150 Section 6.	Age at 70°C and 20% RH in 28 day increments. Charge at float voltage specified for 25°C. Measure battery capacity @ 25°C Life Requirement = 20 years min. @ 25°C. Activation energy used to estimate service life shall be stated.		
92.	External Load Disconnect Contactor, BMS and Battery Failure Rate	This document and GR-3150: [64]	The calculated failure rate shall be less than: 1. 20 FITS for Contactor 2. 500 FITS for BMS and 3. 2000 FITS for Battery Estimates shall be based on the parts count method of SR-332 using field observed failure values for components used. State source of FIT rates used.		
Safety Valve Pressure Relief Tests and Criteria					
93.	Relief Valve Opening and Closing Pressure	GR-3020: [54], [55], [56] GR-3150:[54]	The manufacturer's valve opening and closing pressures shall be specified and/or conform to: 1. Opening Pressure shall be ≥ 4.0 psi 2. Closing Pressure shall be ≤ 2.0 psi.		
94.	Relief Valve Sealing Against Atmospheric Pressure	GR-3020: [54], [55], [56] GR-3150: [54]	1. Valve shall seal in the closed position 2. Negative(sealing) pressure tests shall incur no damage.		
GR-3150: Section 2 - General Product Information					
95.	Electrolyte	GR-3150 Section 2.2	The electrolyte shall be liquid, gelled or solid to provide low resistance high-rate discharge.		
96.	Terminal Voltage	GR-3150:[56], [57]	The battery design shall facilitate terminal access and enable analog voltage measurements.		

Item Ref. #	Parameter/Test Item	Item Source Ref. GR/SR/DS etc.	Requirement/ Required Value	Measured/Design/ Declared Value and Data Source Reference	Conforms? Y/N/NA/ Acceptable
97.	Hazardous Gassing	GR-3150: R3-41 [55]	Documentation that defines the type and quantity of hazardous gassing products that may be released upon pressure relief valve activation shall be available and provided with each battery shipment .		
98.	Operating Internal Cell Pressure	This document and GR-3150: [54]	Measure the internal cell pressure under normal operating conditions. Pressure shall not crack cell case or cause excessive deformation.		
99.	Thermal Runaway of Cells and Modules	GR-3150 Section 2.5.1 and Section 4.5.1	Thermal runaway shall be minimized by using: 1. Stable and consistent manufacturing, testing and inspection processes 2. Protection devices to mitigate abuse and 3. Thermally stable materials		
100.	Thermal Runaway of Cell/Battery String	GR-3150 Section 2.5.1 and Section 4.5.1	No thermal runaway shall occur: 1. When used normally throughout its useful life 2. When used abnormally at > 4.30 V/cell at 75° C.		
GR-3150: Section 4 – Safety and Environmental Criteria					
101.	Mechanical Shock (Drop Test) – (Packaged for shipping)	GR-3150: [130]	Physical damage shall be limited to that which would not impair proper installation or operation of the battery. Venting and leaking is permitted as long as venting does not lead to external flames.		
102.	Mechanical Shock (Drop Test) – (Un-Packaged for installation)	GR-3150: [131], [132] and [133]	1. The battery shall not sustain any physical damage or deteriorate in functional performance. 2. The battery shall not explode or ignite when subject to the 16-foot drop and for five hours thereafter. 3. Venting and leaking is permitted during the 5-hour monitoring period.		

Item Ref. #	Parameter/Test Item	Item Source Ref. GR/SR/DS etc.	Requirement/ Required Value	Measured/Design/ Declared Value and Data Source Reference	Conforms? Y/N/NA/ Acceptable
103.	Mechanical Vibration – Transportation (Packaged)	GR-3150: [136], [137]	1. Cells and batteries shall not explode, ignite vent or leak during and after testing 2. Cells and batteries shall not be damaged and shall remain operational.		
104.	Mechanical Vibration - Office (Unpackaged)	GR-3150: [138], [139], [140]	1. Cells and batteries shall not explode, ignite vent or leak during and after testing 2. Cells and batteries shall not be damaged and shall remain operational.		
105.	Earthquake Resistance	GR-3150: [135]	Cells and batteries shall not be damaged and shall remain operational when exposed to a Zone 4 Seismic event.		
106.	Temperature/ Humidity Sequence during Transportation and Storage	GR-3150: R5-28 [168] GR-63: 4.1.1 [69]5.1.1.1 GR-3108: [133]	Low Temperature Exposure: Batteries shall remain operational after exposure to -40°C for 96 hours.		
107.		GR-3150: R5-29[169] GR-63:[69],[71] 4.1.2,5.1.1.2	High RH Exposure: Batteries shall remain operational after exposure to +40°Cand 93% RH for 96 hours.		
108.		GR-3150: R5-30[170] GR-63:[70], [72] GR-3108: [133]	High Temperature Exposure: Batteries shall remain operational after exposure to +70°C for 72 hours.		
109.	Capacity after Temperature/ Humidity Sequence	GR-3020: R5-31[171]	After above three exposures, batteries shall provide 90% of its pre-test capacity on discharge to 42V at 25°C.		
110.	Airborne Contaminants	GR-3150: [172] GR-3108[111] GR-63: [127]	Cells and batteries shall not degrade and shall remain operational after exposure to either the indoor or outdoor contamination level. This is indicative of acceptable performance for the intended service life (20 yrs.). State the contamination level used.		

Item Ref. #	Parameter/Test Item	Item Source Ref. GR/SR/DS etc.	Requirement/ Required Value	Measured/Design/ Declared Value and Data Source Reference	Conforms? Y/N/NA/ Acceptable
111.	Electrostatic Discharge (ESD)	GR-3150: [119] GR-1089: [3], [4]	1. Apply ±8kV contact and/or ±15 kV air discharges on surfaces likely to be touched during field operation. 2. Cells, Batteries and BMS shall remain operational.		
Other Design, Construction and Manufacturing Tests/Declarations Performed by Manufacturer or NRTL					
112.	Cell hermeticity	This document and GR-357	$1x10^{-7}$ cc/atm/sec using helium leak detector.		
113.	Cell residual moisture content	This document and GR-357	-30°C dew point or 500 ppm.		
114.	Cell wall material	This document	Polymer or Metal Nickel plated cold rolled steel or equivalent non-corroding material.		
115.	Cell wall thickness	This document	Manufacturer's value shall be specified or shall be 0.5 mm minimum.		
116.	Internal operating cell pressure	This document	Manufacturer's value shall be specified or shall be: 1. Less than 25 psi @ 0% SOC 2. Less than 60 psi @ 100% SOC.		
117.	Cell case pressure withstand (burst strength)	This document	Manufacturer's value shall be specified or: 1. Shall withstand 100 psi or 2. Shall withstand a minimum of 150% of the working psi @100% SOC.		
118.	Cell seam sealing process	This document	Cell seam sealing process shall result in a molecular bond. Brazing, TIG or Laser welding is appropriate.		
119.	Cell Case Rupture	This document	Upon case rupture, cells: 1. Shall fail in a safe mode 2. Shall not result in a catastrophic event 3. Shall not cause the temperature of the external battery case to rise greater than +15°C above the ambient.		
120.	Electrical isolation between cells and the external battery case	This document	Shall withstand 1000 V dc for 1 minute minimum.		
121.	Cell Electrode Seals	This document	Electrode seals shall be Glass-metal or Metal-Ceramic.		

Item Ref. #	Parameter/Test Item	Item Source Ref. GR/SR/DS etc.	Requirement/ Required Value	Measured/Design/ Declared Value and Data Source Reference	Conforms? Y/N/NA/ Acceptable
122.	Cell electrical Interconnections	This document	Shall be a nickel bus-bar or equivalent capable of handling at least 50 A.		
123.	Cell External Short Circuit (Shorting resistance value of 3.5 mΩ max.)	GR-1089 –See items #83 & #84	One minute duration – Shall be recoverable without manual intervention. 24 hours duration - Shall not explode or create a fire, fragmentation or electrical safety hazard.		
124.	Material used for Interconnected cell enclosure (external battery box)	This document	Shall withstand 85°C minimum. (Materials like Metals, Polypropylene, and PPO+PS have proven satisfactory in long life applications). Shall also be: 1. Manufactured free of physical defects 2. Have sufficient tensile strength to handle normal internal pressures and 3. Be dimensionally stable.		
125.	Construction of Interconnected cell enclosure (battery box)	This document	Manufacturer's construction shall be specified or: Shall be of a double walled construction.		
126.	Wall thickness of Interconnected cell enclosure (battery box)	This document	Manufacturer's value shall be specified or: Shall be 1.0 mm minimum.		
127.	Hermeticity of Interconnected cell enclosure (battery box)	This document GR-357: R4-87 [91] Mil-Std 883 method 1014	Manufacturer's value shall be specified or: Shall meet the Gross leak requirements using perfluorocarbon (after helium) or equivalent test methods. No bubbles shall be seen.		
128.	Impact Resistance of battery box	This document	Shall meet the applicable impact resistance requirements of UL1642, UL1973 and/or UL-2054.		
129.	Crush Resistance of battery box	This document	Shall meet the applicable crush resistance requirements of UL1642, UL1973 and/or UL-2054.		
130.	Thickness of inter-cell thermal insulation material used	This document	Manufacturer's value shall be specified or: Shall be 50 mm minimum.		

Item Ref. #	Parameter/Test Item	Item Source Ref. GR/SR/DS etc.	Requirement/ Required Value	Measured/Design/ Declared Value and Data Source Reference	Conforms? Y/N/NA/ Acceptable
131.	Flammability of the thermal insulation of cell enclosure	This document	If applicable, shall be: UL 94V-0 Or UL 94V-1 and OI ≥ 28% Or Meet the Needle Flame test. What impact, if any, would this have to fire system and insurance requirements?		
132.	Operating temperature of 1. Thermal insulating material 2. Electrical insulating material used	This document	If applicable, manufacturer's value shall be specified or shall be: 1. 950°C minimum 2. 550° C minimum.		
133.	Battery Management System (BMS) enclosure material	This document	Manufacturer's withstand value shall be specified or: Shall withstand 85°C minimum.		
134.	Battery Fire Resistance	GR-3150:[81] GR-63 section 4.2	Battery Fire Resistance shall conform to the requirements of GR-63 Section 4.2. What impact, if any, would this have to fire system and insurance requirements?		
135.	Simulated Brush Fire	GR-3150: [82] and Section 4.4.2	If intended for OSP use: 1. The fully charged battery shall not explode or ignite 2. Evaluate condition of the battery and BMS after test.		
136.	Simulated Telecom Environmental Cycles	GR-3150: [[3], [84], [85]	1. Battery shall be operable and shall not explode, ignite, vent or leak during environmental cycling 2. There shall be no visible physical degradation 3. Battery shall not explode, ignite, vent or leak when subsequently overcharged.		

Item Ref. #	Parameter/Test Item	Item Source Ref. GR/SR/DS etc.	Requirement/ Required Value	Measured/Design/ Declared Value and Data Source Reference	Conforms? Y/N/NA/ Acceptable
137.	Immersion flooded condition	GR-3150: [88], [89], [90]	1. Battery shall not explode, ignite, vent or leak during initial conditioning when immersed to a 6-inch depth 2. Battery shall achieve 95% of its pretest capacity when discharged at 4-hr rate to 42V at 25°C 3. Battery shall not explode, ignite, vent or leak when subsequently submerged.		
138.	BMS Printed Board Assemblies (PBAs)	This document	1. Bare PBs used in the BMS shall be solder masked 2. PBAs shall be assembled using SAC-305 Pb-free solder alloy. 3. PBAs shall be conformal coated.		
Other Verizon Tests and/or Requirements					
139.	OSHA Safety Listing by an NRTL	This document GR-1089 Section 7 and GR-487 Section 3.3.2	Batteries for CPE or OSP applications shall be Listed or Recognized by an NRTL. Are there USA/International regulatory certifications (information available)?		
140.	Battery Electrical Features, Functions and Performance (FFP)	This document and GR-3150 [141] thru [167]	Batteries shall conform to the supplier specified electrical features, functions and performance requirements.		
141.	FEA analyses of cell/battery outer enclosures	This document	The supplier shall provide information on FEA simulations of: 1. Mechanical stress and deformation of the cell and battery outer enclosures as a function of temperature and pressure and provide the design limits used for these parameters and 2. Cell temperature as a function of its physical location in the battery and provide the design limits used for this parameter.		

Item Ref. #	Parameter/Test Item	Item Source Ref. GR/SR/DS etc.	Requirement/ Required Value	Measured/Design/ Declared Value and Data Source Reference	Conforms? Y/N/NA/ Acceptable
142.	Cell and/or Battery Packing and Shipping	This document	The supplier shall confirm Li-ion cells, and/or batteries are packed, transported and/or shipped in accordance with the applicable UN, IATA and US-DOT requirements.		
143.	Environmental Stewardship [End-of-Life Processing, Recycling Disposal and Environmental, Health and Safety (EH&S) Practices].	This document	1. Does your company have a Commitment to Environmental Stewardship Policy? 2. Does your company publicly report on its EH&S Policies, Practices and Results? 3. Does your company have a return and recycling program for customer disposal of these batteries? Does your company have, and can you provide a Safety Data Sheet (SDS) for batteries subject to this product qualification testing? What are the limits/amount of battery units (for respective batteries) that would require submittal of annual SARA Title III, Tier II, Hazardous Material Inventory reporting? And, provide example of how they would be reported.		

*Conformance to the tests listed at the Material Level of Table 7-1 above may be declared by the manufacturer based on the manufacturer internal and/or supplier provided data.

END OF Li-ion BATTERY QUALIFICATION REQUIREMENTS