INCH-POUND
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PERFORMANCE SPECIFICATION

BATTERIES, RECHARGEABLE, SEALED

GENERAL SPECIFICATION FOR

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1 SCOPE

1.1 Scope. This specification covers sealed rechargeable batteries designed to power portable communications electronics devices used by the US military. Detailed electrical and physical requirements for individual batteries are specified on specification sheets.

1.2 Classification. Batteries described by this specification have the following types:

Type I – Batteries with a nickel cadmium (Ni-Cd) electrochemical system

Type II – Batteries with a nickel metal hydride (Ni-MH) electrochemical system

Type III – Batteries with a lithium ion (Li-ion) electrochemical system

Type IV – Batteries with a lithium polymer (Li-Po) electrochemical system

Part or identifying number (PIN). PINs to be used for batteries described by this specification are created as follows:

M	32383	/1	-3[1]
M prefix	Specification number	Specification sheet number	Type

[1] Roman numeral type numbers are converted to Arabic digits in the PINs to provide a consistent number of characters in the PINs assigned by this specification.

Comments, suggestions, or questions on this document should be addressed to Commander, US Army Communications-Electronics RDEC, ATTN: RDER-PRQ-QE, Aberdeen Proving Ground, MD 21005, or emailed to michael.g.williams31.civ@us.army.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at https://assist.daps.dla.mil.

AMSC N/A FSC 6140

2 APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

FEDERAL STANDARDS

FED-STD-595/34088	-	Green, Flat or Lusterless
FED-STD-595/33446	-	Yellow, Flat or Lusterless
FED-STD-595/33440	-	Brown, Flat or Lusterless

DEPARTMENT OF DEFENSE SPECIFICATIONS

(See ASSIST database for list of specification sheets.)

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD 202	-	Test Methods for Electronic and Electrical Component Parts
MIL-STD-810	-	Environmental Test Methods and Engineering Guidelines

(Copies of these documents are available online at https://assist.daps.dla.mil or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

NAVSEA S9310-AQ-SAF-010	-	Technical Manual for Batteries, Navy Lithium Safety Program Responsibilities and Procedures

(Copies of this document may be obtained from the Naval Ordnance Safety and Security Activity (NOSSA), Farragut Hall Building D-323, 23 Strauss Avenue, Indian Head, MD 20640-5555.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

ASTM-D-1141	-	Standard Practice for the Preparation of Substitute Ocean Water

(Copies of these documents may be obtained from the American Society for Testing and Materials, 100 Bar Harbor Drive West, Conshohocken, PA, USA, 19428-2959, or at www.astm.org)

System Management Bus Specification
Smart Battery Data Specification

System Management Bus, SMBus, Smart Battery, Smart Battery System, SBS, SMBus and SBS logos are trademarks of the System Management Interface Forum (SMIF), Inc.

(Copies of these documents may be obtained from the System Management Interface Forum (SMIF), Inc, on-line at http://powersig.org)

UL 94	-	Standard for Safety, Test for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 1642	-	Standard for Safety, Lithium Batteries

(Applications for copies should be addressed to the Underwriters Laboratories, Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096, or at http://ulstandardsinfonet.ul.com)

UN Manual of Tests and Criteria

(Copies of this document may be obtained from the United Nations Publications Centre, 2 United Nations Plaza, Room DC2-853, New York, NY 10017, or at www.un.org)

2.4 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein (except for related specification sheets), the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3 REQUIREMENTS

3.1 Specification sheets. The individual item requirements shall be as specified herein and in accordance with the applicable specification sheet. In the event of any conflict between the requirements of this specification and the specification sheet, the latter shall govern.

3.2 First Article requirements. When specified (see 6.2), a sample shall be subjected to first article inspection in accordance with 4.4.

3.2.1 Certifications. Certification of conformity shall be provided for the following requirements. The Government reserves the right to verify any or all certifications.

REQUIREMENT	PARAGRAPH
a. Metals	3.3.1
b. Dissimilar metals	3.3.2
c. Resistance of elastomeric materials	3.3.5
d. Electrical connection wires and tabs	3.3.6
e. Electrical contacts	3.4.4.1
f. Battery case	3.4.5
g. State of charge indicator window	3.4.5.1
h. Dust cap or cover	3.4.8.1
i. Transportation requirements	3.9

3.3 Materials.

3.3.1 Metals. All metals which do not enter into the basic electrochemical reaction of the cell shall resist, or be treated to resist, corrosion. Certification is required.

3.3.2 Dissimilar metals. When dissimilar metals which would adversely affect battery performance are used in intimate contact with each other, protection against electrolysis and corrosion shall be provided. Certification is required.

3.3.3 Corrosion resistance. External parts of the battery shall show no evidence of cracking, pitting, chipping, scaling, corrosion or other deleterious effects after being tested as specified herein.

3.3.4 Insulating compounds, flow and shrinking. Insulating, impregnating, potting and sealing compounds used in manufacturing shall be capable of performing their intended purpose under the use conditions described by this specification. Compounds shall not inhibit the operation of any safety features. When tested as specified in 4.7.1.5, the insulating, impregnating, potting and sealing compounds shall not flow at high temperature, and shall not crack or draw away from the sides of a container at low temperature. Any compound used shall be non-flammable and non-toxic (see 6.3.8).

3.3.5 Resistance of elastomeric materials. All elastomeric materials used in the battery shall show no cracks, blisters or other deterioration, nor cause degradation of battery performance after being tested as specified herein. Any elastomeric material used shall be non-flammable and non-toxic (see 6.3.8). Certification is required.

3.3.6 Electrical connection wires and tabs. All points inside a battery that have positive and negative polarity in close proximity shall have not less than one layer of insulation between the positive and negative. Insulating material, or layers of multiple insulating materials between positive and negative points, shall have the following characteristics as a minimum:

a. Softening temperature (see 6.3.7): Not less than 150°C (302°F).
b. Lengthwise shrinkage: Not greater than 3% after application
c. Thickness: Not less than 0.005 inch
d. Material shall not shrink, soften, or crack during any of the tests of this specification.
e. The material shall be non-flammable, non-toxic (see 6.3.8), and impervious to the electrolyte of the battery.
f. Certification is required.

3.4 Physical characteristics.

3.4.1 Visual and mechanical. Each battery shall be free of the visual mechanical defects listed in TABLE VIII.

3.4.2 Cells. The battery shall be made up of the required number of individual series and/or parallel connected cells, which have demonstrated their capability to meet the specified electrical requirements.

3.4.2.1 Protective coverings. Cells used to build batteries shall have an individual protective sleeving or coating. Material selected shall meet the requirements of 3.3.4; and 3.3.5 if applicable.

3.4.3 Dimensions and weight. The dimensions and weights of each battery shall be as shown on the applicable specification sheets.

3.4.4 Battery connector and other electrical interfaces.

3.4.4.1 Electrical contacts. All electrical contacts of each battery shall be resistant to corrosion and shall be capable of withstanding the required number of insertions or connections specified herein. Each contact shall consist of the base metal and finish specified in the applicable specification sheet. Compliance to base metal and finish requirements shall be certified.

3.4.4.1.1 Connector. Unless otherwise specified (see 3.1), the battery shall contain a connector as shown on the applicable specification sheet. The battery connector shall maintain a fully functional interface after 500 insertions and extractions. When tested as specified in 4.7.1.3, battery connector shall not tear, rip, be displaced or separate from the battery case.

3.4.4.1.2 Flat terminal. The battery shall contain flat terminals as specified in the applicable specification sheet. Battery terminals, including data and charge terminals, shall be of sufficient strength to withstand 250 connections without damage that would interfere with connections and shall maintain a fully functional interface. When tested as specified in 4.7.1.4, battery terminals shall not tear, rip, be displaced or separate from the battery case.

3.4.4.1.3 Multilayer finish. When specified (See 3.1), electrical interfaces shall be finished according to the following (or better).

Electrolytic copper flash, not less than 99.5% pure, thickness 10-20 micro inches.

Electroless nickel plate; not less than 800 knoop hardness; not less than 200 micro inches thickness.

Gold plate, not less than 99% pure; 130-200 knoop hardness; not less than 30 micro inches thickness.

3.4.4.1.4 Gold plating. When specified (see 3.1), electrical interfaces shall be finished according to the following (or better): Gold plate, not less than 99% pure, 91-129 knoop hardness, 25 micro-inches thick or better.

3.4.5 Battery case. The battery case shall be capable of maintaining the specified dimensions during the life of the battery. The surface of the case shall have a smooth finish free from pitting, blow-holes, rough spots, or other deformations. The case shall be fabricated of material having sufficient strength to withstand the environmental and electrical tests specified herein. Material shall be nonflammable. When plastics are used for the battery case, the material shall be classified in accordance with UL Standard 94, Test for Flammability of Plastic Materials for Parts in Devices and Appliances, except as otherwise noted herein. Acceptable ratings include: HB; V-0; V-1; V-2; 5VA; 5VB; VTM-0; VTM-1; and VTM-2. If the manufacturer elects to use material classified in accordance with UL 94, certification is required. The government reserves the right to require verification tests to ensure nonflammable battery cases. If the manufacturer elects to use a plastic material that doesn't have UL-94 classification, then the test of 4.7.1.7 shall be performed. When tested as specified in 4.7.1.7, test specimens shall self-extinguish within 5 seconds after removal from flame.

3.4.5.1 State of charge indicator window. The state of charge window shall remain intact, in place, and transparent during the life of the battery. The SOCI window shall have a smooth finish free from pitting, blow-holes, rough spots, or other deformations and shall be fabricated of material having sufficient strength to withstand the environmental and electrical tests specified herein. Certification for transparency during the life of the battery is required.

3.4.5.2 Battery case expansion. Unless otherwise specified (see 3.1), the battery shall be designed to prevent dimensional expansion that will prevent its removal from equipment.

3.4.5.3 Battery case vent. A pressure release device shall be incorporated into the battery case. This device shall be designed to release below the bursting pressure of the container and above the normal operating pressure of the battery. The design of the battery shall be such that the paths from the individual cell units to the battery vent are sufficient to permit the removal of gases. The device shall not permit the entry of liquids into the battery case. When tested as specified in 4.7.1.6, each battery case shall not exhibit any signs of visible damage other than the case vent opening, and each battery shall pass through the test fixture with a force not greater than 12 pounds.

3.4.5.4 Color. The color of the battery case shall be as specified below, in accordance with FED-STD-595.

a) Type I (Ni-Cd) and Type II (Ni-MH) batteries shall be lusterless green, chip number 34088.
b) Type III (Li-ion) batteries shall be lusterless "Tan 686A", chip number 33446.
c) Type IV (Li-Po) batteries shall be "Earth Yellow", chip number 33245.

3.4.5.5 Writable label. A writable/erasable label shall be attached to each battery. This rectangular label shall state "User Info" and contain an area that allows writing and erasing multiple times. The label shall be a minimum of 1 inch X 13/16 inch.

3.4.6 Marking. Each battery shall be provided with a permanent, legible hot-stamped or printed marking as specified herein. Direct printing on the battery is the preferred method. For rectangular batteries, the marking may be placed on more than one surface. Lettering shall be without serifs (sans-serif). Additional markings may be required as specified in applicable specification sheets.

3.4.6.1 Identification marking. The identification marking shall contain the following information. The information in parentheses shall be filled in by the manufacturer.

BATTERY, RECHARGEABLE, (Type Designation, PIN)
(Chemistry)
(Battery Voltage)V, (Full Capacity Rating)Ah / (Full Energy Rating)Wh
(NSN)
(Contract Number)
(MFG DATE) (Serial Number)
(MFG Warranty Details)
(Manufacturer)
(Manufacturer's location)

3.4.6.2 Warning marking. The following warning marking shall appear on each battery in capital letters.

WARNING/STORAGE
DO NOT STORE ABOVE 122°F (50°C),
CRUSH, MUTILATE, REVERSE POLARITY,
DISASSEMBLE, OR DISPOSE OF IN FIRE.

3.4.6.3 Date of manufacture code. The code shown shall indicate the month and year of manufacture of the battery by means of a four-digit number in which the first two digits shall indicate the number of the month and the last two digits shall indicate the year. Months earlier than the tenth month shall be a single digit preceded by "0". A forward slash ("/") shall separate the first two digits from the last two. (e.g. 01/13 indicates January 2013) When a battery is completed during the last three working days of a month or the first three working days of the subsequent month, the manufacturer is permitted to use either month as the coded month of manufacture.

3.4.6.4 Terminal marking. Positive terminals shall be legibly indicated by "+", and negative terminals shall be identified by "-". The polarity markings shall be placed as close as possible to the applicable side of the receptacle where required. A schematic drawing shall be placed as close as possible to the receptacle or terminals as shown on the applicable specification sheet.

3.4.6.5 Instructions / notes. Each battery shall be marked with complete instructions for operation and charging of the battery, which shall include the following:

(Preferred charging method)

Specific instructions can be found in the applicable specification sheet.

(Alternate charging method)

Specific instructions can be found in the applicable specification sheet.

SOCI matrix (see 3.5.8)

Self discharge rate

Maintenance (e.g. discharging and charging periodically) where applicable

Other notes when specified (see 3.1)

3.4.6.6 Simplified battery label. The simplified battery label is designed to provide the end user with an easily understandable label containing the most pertinent information. The label size and location shall be as specified (see 3.1). Numeric values shall be for a complete battery, in new condition, at room temperature. The entire label shall be framed by 2 concentric arrows, indicating a rechargeable battery. The statement “For more information see http://battery.army.mil” shall be printed below the label. See FIGURE 1 for a sample representation of the simplified battery label.

The simplified battery label shall contain the following.

a) Type designation
b) Total energy in watt hours (rounded to nearest whole number), presented inside a battery icon
c) The total weight in pounds (rounded to the neares 0.1 pounds), presented inside a barbell icon
d) Energy density shall be calculated in watt hours per kilogram. The value shall be rounded to the nearest 50 wh/kg, and one star icon shall be presented for every 50 Wh/kg. The actual numeric value (rounded to nearest whole number) shall be placed below the stars.
e) Battery chemistry (see 3.1)

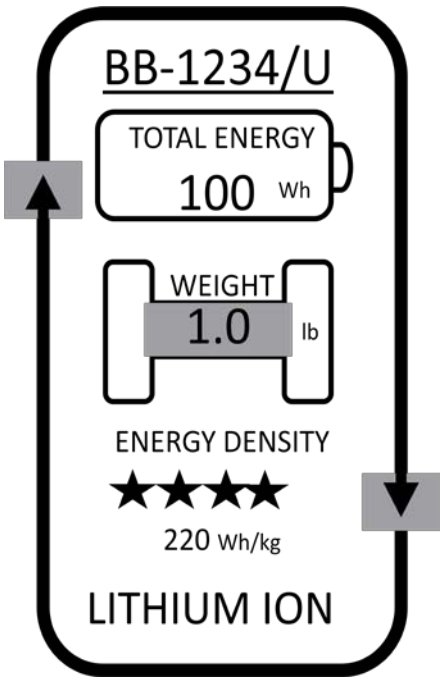

FIGURE 1. Sample simplified battery label
Note: Battery nomenclature and values are fictitious

3.4.6.7 Color. The color of the marking shall be as specified below.

a. Type I (Ni-Cd) batteries – black
b. Type II (Ni-MH) batteries – white
c. Types III & IV (Li-ion & Li-Po) batteries – black

3.4.6.8 Permanency and durability. Marking shall be capable of withstanding all tests of 4.7, except projectile (see 4.7.4.11), without evidence of any of the following:

Blistering	Delamination	Separation	Discoloration
Chipping	Dissolving	Softening	Illegibility
Corrosion	Loosening	Splitting	Flaking
Cracking	Peeling	Warping	Fading

3.4.7 Attitude. Each battery shall be designed for operation in any position and shall meet the specified capacity, voltage and electrolyte leakage requirements (see 3.1).

3.4.8 Battery condition for shipping. Each battery shall be furnished fully charged as indicated by five state of charge segments where applicable. Batteries shall be supplied with instructions cards and a dust cap or cover over the connector.

3.4.8.1 Dust cap or cover. Each battery shall be furnished with a dust cap (see 3.1), the dust cap or cover shall not fall off during normal handling and shall be removable by hand at temperatures from -20 to 55°C (-4 to 131ºF). The material used for the dust cap shall be non-toxic and non-flammable and shall withstand temperatures from -40 to 90°C (-40 to 195ºF) without shrinkage or cracking. The dust cap or cover shall not leave any residue on the battery contacts nor have any adverse affect on the connection interface. Dust cap or cover compliance to these requirements shall be certified (3.2.1).

3.5 Electrical requirements.

3.5.1 Cell balance. Cells used to build each battery shall be matched to the limits specified below in order to avoid shortened cycle life. When tested as specified in 4.7.2.1, the capacity of each cell tested shall not vary from the average capacity obtained by more than the following specified limits:

a. Type I (Ni-Cd) and Type II (Ni-MH) cells: ± 5%
b. Type III (Li-ion) and Type IV (Li-Po) cells: ± 2.5%

3.5.2 Battery voltage. The open circuit voltage shall be within the voltage range specified (see 3.1).

3.5.3 Capacity. The discharge in amperes hours or watt hours as required (see 3.1) for each discharge shall be not less than the value listed in the applicable specification sheet. The minimum final voltage shall be the value listed in the applicable specification sheet. Inability to meet the specified minimum requirements shall constitute a failure.

3.5.4 Cycle life. When tested as specified in 4.7.2.4 batteries shall be capable of retaining the specified capacity during and after 224 cycles (see 3.1).

3.5.5 Motor inrush current. When specified (see 3.1), batteries shall be capable of providing inrush currents required by an electric motor. When tested as specified in 4.7.2.12, battery voltages shall not fall below the specified value. After completion of the test, batteries shall meet the capacity requirements of 3.5.3 and the criteria of TABLE VIII.

3.5.6 Charge enable. When specified (see 3.1), batteries shall be equipped with a charge enable circuit that allows charging (see 3.1) on approved chargers (see 6.3.12) and disallows charging when connected to a charger that doesn't recognize the charge enable circuit protocol. Whenever a charger doesn't recognize the charge enable protocol, the battery shall terminate any charge with current that exceeds the maximum specified (see 3.1). Unless otherwise specified, the charge enable pin shall have an equivalent input circuit of a resistor of specified value in series with a diode of specified V_F (see 3.1). The circuit shall require activation current not less than the value specified (see 3.1). When tested as specified in 4.7.2.6, (1) the charge current shall not exceed the value specified without a charge enable circuit protocol being applied, and (2) battery current shall meet the preferred charging method while the charge enable is connected to a charge circuit equipped to allow the preferred charging method if the charge enable terminal or socket meets specified requirements (see 3.1).

3.5.7 Power consumption. The power consumption for all electronics within the battery shall be less than 350μA, per battery or independent section where applicable, at 20°C. (See 4.7.2.13)

3.5.8 State-of-charge indicator (SOCI). Each battery shall indicate its current state of charge. The state of charge display location shall be as specified (see 3.1). The display shall have five distinct segments showing the ranges of state of charge of the battery. The segments shall be black in color on a white or pale gray background. The display shall be on continuously with no user action required except that it may go blank temporarily as it refreshes the display. Dual section batteries require a separate display for each section. The value displayed shall compensate for use temperature, and discharge rate of the battery. As the battery ages and experiences capacity fade from use, the display shall compensate by showing the fully charged state as a percentage of the original fresh capacity (commonly referred to as "state of health" or "true capacity"). The state of charge ranges displayed shall be as follows (see 4.7.2.14):

SEGMENTS	STATE OF CHARGE
0	= 0% (Fully Discharged)
1	= 1 to 20%
2	= 21 to 40%
3	= 41 to 60%
4	= 61 to 80%
5	= 81 to 100%

3.5.8.1 Accuracy. The state of charge ranges of the SOCI displayed shall be accurate within the tolerances stated above in 3.5.8. When tested as specified in 4.7.2.14, the indicator shall change state of charge indication within +0/-5% of the actual state of charge for the battery under test when compared to the range limits stated above.

3.5.9 SMBus. When specified (see 3.1), each battery shall be compliant with System Management Bus (SMBus) Specification Revision 1.1 and Smart Battery Data (SBData) Specification, version 1.1, with the exception that SBData safety signal hardware requirements therein shall be replaced with a charge enable when a charge enable is specified (see 3.1 and 3.5.6). Certification is required. Batteries shall be compatible with appropriate Level 2 and Level 3 chargers (see 6.3.9). When tested as specified in 4.7.2.14, SMBus data output shall be accurate within +0/-5% of the actual state of charge for the battery under test throughout the discharge. Manufacturer and battery data shall be correctly programmed (see 4.7.2.15).

3.5.10 Normal operating temperatures. Batteries shall be capable of operating over a temperature range of -20°C (-4°F) to 50°C (122°F). When tested as specified in 4.7.2.7 and 4.7.2.8 batteries shall meet the capacity requirements of 3.5.3 and the visual mechanical requirements of TABLE VIII.

3.5.10.1 Charge acceptance. When tested as specified in 4.7.2.9, batteries shall meet the capacity requirements 3.5.3 and the visual mechanical requirements of TABLE VIII.

3.5.10.2 Retention of charge. Batteries shall be capable of maintaining the required minimum capacity after storage at 50°C (122°F) for 7 days. When tested as specified in 4.7.2.10, batteries shall meet the capacity requirements 3.5.3 and the visual mechanical requirements of TABLE VIII.

3.6 Environmental requirements. Each battery when subjected to specified environmental tests of TABLE I below shall show no:

a. Defects listed in TABLE VIII
b. Dimensional distortion beyond specified limits (see 3.1).
c. Sharp current or over voltage fluctuations during any charge or discharge period.
d. Mechanical failure of any part.
e. Failure to mate with a corresponding part.
f. Diminution of the rated capacity below the minimum specified in the applicable specification sheet following the performance of each test.
g. Electrical leakage.
h. Evidence of rupturing, burning or exploding.

TABLE I. Environmental Requirements

Tests	Req't Paragraph	Test Paragraph
Extreme low temperature discharge	3.6.1	4.7.3.2
Extreme high temperature discharge	3.6.1	4.7.3.3
Altitude	3.6.2	4.7.3.4
Thermal Shock	3.6.3	4.7.3.5
Mechanical Shock	3.6.4	4.7.3.6
Vibration	3.6.5	4.7.3.7
Immersion	3.6.6	4.7.3.8
Transit drop	3.6.7	4.7.3.9
Battery storage life	3.6.8	4.7.3.10

3.6.1 Extreme discharging temperatures. Type III (Li-ion) and Type IV (Li-Po) batteries shall be capable of discharging over a temperature range of -30°C (-22°F) to 55°C (131°F). When tested as specified in 4.7.3.2 and 4.7.3.3 the batteries shall meet the capacity requirements of 3.5.3 and the requirements of 3.6.

3.6.2 Altitude. Batteries shall experience no deleterious effects from high altitude. When tested as specified in 4.7.3.4, batteries: (1) shall meet the requirements of 3.6; (2) batteries in the fully charge state shall meet the battery voltage requirements of 3.5.2.

3.6.3 Thermal shock. Batteries shall not bulge, crack, break, leak electrolyte, rupture, burn, or explode as a result of varying rates of thermal expansion or contraction of cell and battery components when subjected to thermal shock temperature cycling in the range of 75°C (167°F) to -59°C (-75°F). When tested as specified in 4.7.3.5, batteries shall meet the capacity requirements of 3.5.3 and the requirements of 3.6.

3.6.4 Mechanical shock. Batteries shall be capable of withstanding mechanical shock environments without sustaining physical or electrical damage. When tested as specified in 4.7.3.6, batteries shall meet the capacity requirements of 3.5.3 and the requirements of 3.6.

3.6.5 Vibration. Batteries shall be capable of withstanding vibration environments without sustaining physical or electrical damage. When tested as specified in 4.7.3.7: (1) batteries shall exhibit no voltage fluctuations during vibration; (2) shall meet the requirements of 3.6; (3) shall meet the capacity requirements of 3.5.3.

3.6.6 Immersion. Batteries shall be capable of withstanding water immersion without sustaining physical or electrical damage. When tested as specified in 4.7.3.8.1 or 4.7.3.8.2, batteries shall: (1) show no evidence of leakage of water into cases; (2) exhibit weight gain of not greater than 0.01 oz (0.3 g); (3) shall meet the requirements of 3.6.

3.6.7 Transit drop. Batteries shall be capable of withstanding drops at severe temperature conditions without sustaining physical or electrical damage. When tested as specified in 4.7.3.9.1 or 4.7.3.9.2, batteries shall meet the capacity requirements of 3.5.3 and the requirements of 3.6 (with the exception of defects in 106 of TABLE VIII).

3.6.8 Battery storage life. Each battery shall be capable of not less than 3 years of warehouse storage, without any maintenance during storage, during which storage temperatures may vary between the limits of -20°C (-4°F) to 50°C (122°F). When tested as specified in 4.7.3.10, batteries shall, after 3 full cycles of charge and discharge, meet the capacity requirements of 3.5.3 and the requirements of 3.6.

3.7 Safety. All protective devices employed shall not adversely affect battery performance or life.

3.7.1 Cell safety

3.7.1.1 Cell electrical safety. Each cell when subject to the specified electrical tests of TABLE II shall not:

a. Explode
b. Catch Fire
c. Rupture
d. Spark
e. Leak any material
f. Have a loss of mass greater than 0.1%

TABLE II. Cell electrical safety tests

Tests	Req't Paragraph	Test Paragraph
Cell overcharge	3.7.1.1.1	4.7.3.4
Cell short circuit	3.7.1.1.2	4.7.3.5
Cell forced discharge	3.7.1.1.3	4.7.3.6

3.7.1.1.1 Cell overcharge. Cells used to build batteries shall be capable of withstanding overcharge. When tested as specified in 4.7.4.1, surface temperatures shall not exceed 93°C (200°F).

3.7.1.1.2 Cell short circuit. Cells used to build batteries shall be capable of withstanding short circuiting (see 4.7.4.2).

3.7.1.1.3 Cell forced discharge. Cells used to build batteries shall be capable of withstanding forced discharge (see 4.7.4.3).

3.7.1.2 Nail penetration, cell. When specified (see 3.1), cells shall not react violently when cell containers are penetrated by sharp objects. Cells tested in accordance with 4.7.4.4 shall not burn or explode, and the external temperature of each test sample shall be not greater than 170°C (338ºF).

3.7.1.3 Crush, cell. When specified (see 3.1), cells shall not react violently when crushed. When subjected to the test of 4.7.4.5, no cell shall burn or explode.

3.7.2 Battery safety

3.7.2.1 Insulation resistance. Terminals or contacts shall be as specified on the applicable specification sheet (see 3.1) and insulation resistance shall be not less than 25 megohms when tested as specified in 4.7.4.6.

3.7.2.2 Overcharge/electrical leakage. Batteries shall be capable of withstanding overcharge conditions without failure. When tested as specified in 4.7.4.7: batteries shall not exceed the voltage limit specified during overcharge (see 3.1); no potential in excess of 0.5 volts shall be obtained from the case or non-connected terminal to any terminal; and batteries shall meet the visual mechanical requirements of TABLE VIII and 3.6, and shall meet the capacity requirements of 3.5.3.

3.7.2.3 Short circuit protection. Each battery shall be protected against short circuits. When tested as specified in 4.7.4.8, there shall not be any damage to the battery, and the battery shall be able to meet the full discharge capacity requirement of 3.5.3 after full charge.

3.7.2.4 High temperature temporary cut off devices. Each battery shall contain a minimum quantity of normally closed thermoswitches that shall open at 70 ± 5°C (158°F) and close at 50 ± 5°C (122°F) to insure safety under conditions of high temperature, overcharge, misuse, or any combination thereof. The minimum quantity shall be as specified in the applicable specification sheet. When tested as specified in 4.7.4.9, battery voltage shall be zero volts after each high temperature storage and batteries shall meet the voltage requirement of 3.5.2 after cooling. After completion of the test the battery shall be able to meet the full discharge capacity requirement of 3.5.3 after full charge.

3.7.2.5 High temperature permanent cut off devices. Each battery shall be permanently shut off when the temperature of the battery reaches 93 ± 5°C (199°F). The device shall prevent charging and discharging of the battery. The minimum quantity shall be as specified in the applicable specification sheet. When tested as specified in 4.7.4.10, battery voltage shall be zero volts after high temperature storage and shall remain at zero after 40°C storage. Additionally, batteries shall not accept charge current during this test.

3.7.2.6 Projectile. When specified (see 3.1), batteries shall not produce shrapnel when subjected to a flame. When tested as specified in 4.7.4.11, no part of a battery under test shall penetrate the wire screen such that some or all of the battery passes through the screen. When tested, the production of smoke and flames and the passing of small particles through the wire mesh are permitted; heat damage to the wire mesh is also permitted.

3.7.2.7 Lithium Battery Safety Program (US Navy). When specified (see 3.1), Types III and IV batteries shall be designed and built in a manner that provides protection from bulging, leaking, venting, rupturing, burning and exploding under conditions of extreme electrical abuse. Additionally, batteries shall be designed in a manner that prevents the production of shrapnel in the event of failure of internal protection devices under extreme conditions.

3.7.2.7.1 Destructive Lithium Battery Safety Program tests, When tested in accordance with 4.7.5.1 through 4.7.5.3, the battery case shall not fragment. Case distortion, cracking, or bulging, and venting of gases or liquids through purposely designed cell vents, are permitted.

3.7.2.7.2 Non-destructive Lithium Battery Safety Program tests When tested in accordance with 4.7.5.4 or 4.7.5.5, no battery shall bulge, leak, vent, rupture, burn, or explode.

3.8 Electromagnetic compatibility. When specified (see 3.1), the battery shall be electromagnetically compatible with the system specified in the applicable specification sheet. When tested as specified in 4.7.7, batteries connected to the system shall meet the requirements of MIL-STD-461 for each of the following: CS114; CS115; CS116; RE101; RE102; RS101; RS103.

3.9 Transportation requirements. Batteries and cells shall be tested per applicable US DOT and UN Manual of Tests and Criteria shipping regulations and meet requirements therein. Certification is required.

3.10 Interchangeability. Batteries shall be capable of charging correctly on fielded chargers and adapters (see 4.7.6).

4 VERIFICATION

4.1 Classification of Inspection. The inspection requirements specified herein are classified as follows:

a. First article inspection (see 4.4).
b. Conformance inspection (see 4.5).

4.2 Test equipment and facilities.

4.2.1 Electrical indicating instruments. All voltmeters and ammeters shall be accurate within 1 percent of the full scale reading. The sensitivity of voltmeters shall be not less than 10 megohms per volt.

4.2.2 Resistor and current tolerances. In all tests involving a resistor, such resistance shall be accurate within ± 0.5 percent. During the charging and discharging of batteries, conducted at various rates specified herein, the current shall be maintained within a tolerance of ± 3 percent of the specified value.

4.2.3 Timing. The timing of discharges lasting not greater than one minute shall be maintained within ± 5 percent. All others shall be accurate within ± 1 percent.

4.3 Inspection conditions. Unless otherwise specified herein, all examinations and tests shall be performed under ambient temperature, humidity, and atmospheric pressure conditions.

4.3.1 Normal conditions. When normal conditions are specified, tests shall be conducted and measurements taken at 23 ± 5°C (73.4°F) and ambient atmospheric pressure and relative humidity with not less than 2 hours between charge and discharge except for cycle life test.

4.4 First article inspection. First article inspection shall consist of the examinations and tests specified in TABLE III and TABLE IV. Testing shall be performed in the order shown. TABLE III tests require not greater than ten sample cells, the requisite amount of compound (see 4.7.1.5), two electronic component assemblies (ECA), two complete cell assemblies (CCA), (see 6.3.10 and 6.3.11 for definitions), and 40 sample batteries. Five pieces of battery cases may be required as well (see 3.4.5). These quantities may be less for some battery types based on applicability of the tests. All samples shall meet the requirements specified herein for each examination and test. Battery samples shall be as follows:

a. Group 1 (GR1) – Functional tests, shall contain 12 samples
b. Group 2 (GR2) – Electromagnetic interference tests, when specified (see 3.1) shall contain five samples
c. Group 3 (GR3) – Interchangeability tests, shall contain eight samples
d. Group 4 (GR4) – Lithium safety tests, when specified (see 3.1) shall contain 15 samples

TABLE III. First article tests and certifications; cells, assemblies, and components

Inspection	Requirement Paragraph	Test Method Paragraph	Samples
Cell balance 2/	3.5.1	4.7.2.1	Cells: All
Cell overcharge 2/	3.7.1.1.1	4.7.4.1	Cells: 1, 2
Cell short circuit 2/	3.7.1.1.2	4.7.4.2	Cells: 3, 4
Cell force discharge 2/	3.7.1.1.3	4.7.4.3	Cells: 5, 6
Crush 1/ 2/	3.7.1.3	4.7.4.5	Cells: 7, 8
Nail penetration 1/ 2/	3.7.1.2	4.7.4.4	Cells: 9, 10
Power consumption 2/	3.5.7	4.7.2.13	2 ECA & 2 CCA
Insulating compounds, flow and shrinking 2/	3.3.4	4.7.1.5	By volume
Battery case 2/	3.4.5	4.7.1.7	5 pieces or certification
Metals	3.3.1		Certification
Dissimilar metals	3.3.2		Certification
Resistance of elastomeric materials	3.3.5		Certification
Electrical connection wires and tabs	3.3.6		Certification
Electrical contacts	3.4.4.1		Certification
State of charge indicator window	3.4.5.1		Certification
Dust cap or cover	3.4.8.1		Certification
Transportation requirements	3.9		Certification

NOTES
1/ Only when specified (see 3.1)
2/ Must be completed prior to tests of TABLE IV

TABLE IV. First article tests, complete batteries

Inspection	Req't	Test Method	Samples or Group (GR)										
			GR1								GR2 (5 ea)	GR3 (8 ea)	GR4 (15 ea)
			1	2	3	4	5,6	7,8	9,10	11,12			
Visual and mechanical	3.4	4.7.1.1	✓	✓	✓	✓	✓	✓	✓	✓	☑	✓	☑
Dimensions and weight	3.4.3	4.7.1.2	✓	✓	✓	✓	✓	✓					
Battery open circuit voltage	3.5.2	4.7.2.2	✓	✓	✓	✓	✓	✓	✓	✓	☑	✓	☑
Insulation resistance	3.7.2.1	4.7.4.6	✓	✓	✓	✓	✓	✓	✓	✓			
Altitude	3.6.2	4.7.3.4	✓	✓	✓	✓	✓	✓	✓	✓			
Charge enable 1/	3.5.6	4.7.2.6								☑			
Charge acceptance	3.5.10.1	4.7.2.9								✓			
Capacity discharge (initial)	3.5.3	4.7.2.3	✓	✓	✓	✓	✓	✓	✓	✓			
Cycle life	3.5.4	4.7.2.4					✓						
Battery storage life	3.6.8	4.7.3.10						✓					
Overcharge/electrical leakage	3.7.2.2	4.7.4.7							✓				
Low temperature discharge	3.5.3	4.7.2.7							✓				
High temperature discharge	3.5.3	4.7.2.8							✓				
Projectile 1/	3.7.2.6	4.7.4.11							☑				
High rate discharge	3.5.3	4.7.2.5	✓		✓								
Retention of charge	3.5.10.2	4.7.2.10	✓	✓	✓	✓							
Pulse discharge	3.5.3	4.7.2.11	✓		✓								
Motor inrush current 1/	3.5.5	4.7.2.12								☑			
Thermal shock	3.6.3	4.7.3.5	✓	✓	✓	✓							
Mechanical shock	3.6.4	4.7.3.6	✓	✓	✓	✓							
Vibration (discharge)	3.6.5	4.7.3.7	✓	✓	✓	✓							
Connector insertion	3.4.4.1.1	4.7.1.3	✓			✓							
Flat terminal strength	3.4.4.1.2	4.7.1.4	✓			✓							
Immersion, shallow	3.6.6	4.7.3.8	✓	✓	✓	✓							
Transit drop, normal 1/	3.6.7	4.7.3.9.1	☑	☑	☑	☑							
Transit drop, severe 1/	3.6.7	4.7.3.9.2								☑		☑	
Immersion, shallow (post drop) 1/	3.6.6	4.7.3.8.1	See note 2/										
Immersion, deep (post drop) 1/	3.6.6	4.7.3.8.2	See note 2/										
State of charge	3.5.8	4.7.2.14								✓			
SMBus 1/	3.5.9	4.7.2.15	☑	☑	☑	☑							
Full capacity discharge	3.5.3	4.7.2.3	✓	✓	✓	✓							
Extreme low temp. discharge 3/	3.5.3	4.7.3.2		☑		☑							
Extreme high temp. discharge 3/	3.5.3	4.7.3.3	☑		☑								
Battery case vent	3.4.5.3	4.7.1.6	✓			✓							
Short circuit protection	3.7.2.3	4.7.4.8		✓	✓								
High temperature temporary cut-off	3.7.2.4	4.7.4.9		✓	✓								
High temperature permanent cut-off	3.7.2.5	4.7.4.10		✓	✓								
Electromagnetic interference 1/	3.8	4.7.7									☑		
Interchangeability	3.10	4.7.6										✓	
Lithium Battery Safety Program (US Navy) Tests 1/	3.7.2.7	4.7.5											☑

NOTES

1/ Only when specified (see 3.1) (indicated in table as ☑)

2/ Immersion samples shall be the same samples having undergone transit drop

3/ Only Type III (Li-ion) and Type IV (Li-Po) batteries

4.5 Conformance inspection. Inspection of product for delivery shall consist of groups A and B inspections, as well as Group C inspections when specified (see 4.5.3.1).

4.5.1 Group A inspection. Each battery on contract or delivery order shall be 100 percent inspected for conformance to the inspections in the order specified in TABLE V. All failures shall be removed. In the event of failure, rework is permitted only as specified in TABLE VIII. Reworked batteries must be fully compliant after rework. Discrete lots shall be formed from batteries that pass these inspections.

TABLE V. Group A inspection

Inspection	Requirement Paragraph	Test Method paragraph
Visual and mechanical examination	3.4	4.7.1.1
Battery open circuit voltage	3.5.2	4.7.2.2

4.5.2 Group B inspection. Group B inspections shall be performed on inspection lots that have passed Group A inspection (see 4.5.1) and on samples selected from units that have been subjected to and met the Group A inspection. Group B samples selection shall be on not less than ten percent of the inspection lot or monthly quantity. Group B inspection shall consist of the test specified in TABLE VI and shall be conducted in the order shown. The sample size shall be four batteries for each inspection lot (see 6.5) or each month of production if an inspection lot spans more than one month. Samples 3 and 4, having successfully completed testing, are deliverable against the quantity on contract.

TABLE VI – Group B inspection

Inspection	Requirement Paragraph	Test Method Paragraph	Sample Number			
			1	2	3	4
Capacity discharge (initial)	3.5.3	4.7.2.3	✓	✓	✓	✓
Thermal shock	3.6.3	4.7.3.5	✓	✓		
High rate discharge	3.5.3	4.7.2.5	✓	✓		
Immersion, shallow	3.6.6	4.7.3.8.1	✓	✓	✓	✓

4.5.3 Group C inspection. Group C inspections shall be performed on inspection lots that have passed Group A inspection (see 4.5.1) and on samples selected from units that have been subjected to and met the Group A inspection. Group C samples selection shall be on not less than ten percent of the inspection lot or monthly quantity. This inspection is required during conformance inspection for the first inspection lot and repeated in accordance with 4.5.3.1. It shall consist of the tests listed in TABLE VII. Inspection shall be performed in the order shown. The sample size shall be six batteries and six cells each time Group C is required.

4.5.3.1 Group C frequency. Group C testing, or a complete first article inspection (see 4.4), shall be performed within the 12 months prior to presenting the current inspection lot for acceptance.

TABLE VII. Group C inspection

Inspection Paragraph	Requirement Paragraph	Test Paragraph	Sample Number			
			1	2	3	4
Dimensions and weight	3.4.3	4.7.1.2	✓	✓	✓	✓
Capacity discharge (initial)	3.5.3	4.7.2.3	✓	✓	✓	✓
High temperature discharge	3.5.3	4.7.2.8	✓	✓		
Low temperature discharge	3.5.3	4.7.2.7			✓	✓
Thermal shock	3.6.3	4.7.3.5	✓	✓	✓	✓
Mechanical shock	3.6.4	4.7.3.6	✓	✓	✓	✓
Vibration	3.6.5	4.7.3.7	✓	✓	✓	✓
Immersion, shallow	3.6.6	4.7.3.8.1	✓	✓	✓	✓
Transit drop, normal	3.6.7	4.7.3.9	✓	✓	✓	✓
Immersion, shallow (post drop)	3.6.6	4.7.3.8.1	✓	✓	✓	✓
Capacity discharge (final)	3.5.3	4.7.2.3	✓	✓	✓	✓
Extreme low temp. discharge 1/	3.5.3	4.7.3.2	☑			☑
Extreme high temp. discharge 1/	3.5.3	4.7.3.3	☑			☑
Battery case vent	3.4.5.3	4.7.1.6	✓			✓
High temperature temporary cut-off	3.7.2.4	4.7.4.9		✓	✓	
High temperature permanent cut-off	3.7.2.5	4.7.4.10		✓	✓	
Cell balance	3.5.1	4.7.2.1	6 cells			

NOTES
1/ Only Type III (Li-ion) and Type IV (Li-Po) batteries

4.6 Charge methods.

4.6.1 Constant potential, current limited. Where specified herein, Type III (Li-ion) and Type IV (Li-Po) batteries shall be charged by a constant potential (voltage) method with limited current at normal conditions in accordance with 4.3.1 at a rate not less than specified (see 3.1) and for not greater than three hours. Voltages, current limits, and cut-off parameters are specified in the applicable specification sheet (see 3.1).

4.6.2 Constant current. Where specified herein, Type I (Ni-Cd) and Type II (Ni-MH) batteries shall be charged by a constant current to the designated charge cut-off parameter. Topping charges beyond the charge cut-off parameter shall be as specified. Charge and topping charge current and cut-off parameters are specified in the applicable specification sheet (see 3.1).

4.6.3 Alternate charging.

a. Where permitted herein, batteries may be charged by an approved charger as an alternative to the charge methods described above (see 6.3.12).
b. If an approved charger is not available, the alternate charging method described by the applicable specification sheet may be used whenever charging in accordance with 4.6.3 is permitted.

4.7 Test methods.

4.7.1 Physical characteristics.

4.7.1.1 Visual and mechanical. Samples shall be examined to verify that the basic materials, component materials and parts, design and construction, marking and workmanship are in accordance with all the requirements of 3.4 and TABLE VIII.

TABLE VIII. Visual and mechanical inspection

Categories 1/	Rework Permitted	Defects
001	No	Electrolyte leakage.
002	No	Improper assembly causing parts to be inoperative or unsafe in service.
003	No	Loose parts inside battery.
101	No	Deformed or damaged parts which are inoperative or malfunction in service
102	Yes	Contact surfaces obstructed so that electrical use is affected. Rust, corrosion, or any type of non-conductive material on contact surfaces.
103	No	Battery cases – any hole (not specified), tear, rip, or crack.
104	Yes	Improper case closure.
105	Yes	Sharp edges on exterior of battery.
106	No	Pitting, blow-holes, rough spots, burrs, splits, dents, or other deformations on battery surface.
107	Yes	Terminal, identification, or operating instructions markings not as specified (see 3.1 and 3.4.6).
108	Yes	Marking defects of 3.4.6.8 are visible
109	Yes	State of charge indicator does not display full state of charge (Group A only).
110	No	State of charge indicator does not display correct state of charge.
111	No	State of charge indicator window is warped, punctured, separated from case, not transparent, or has visible condesation on the interior.
201	No	Color not as specified.

NOTE:
1/ Category 0XX defects are critical; category 1XX are major, and category 2XX are minor. These categories are used to qualify the levels of nonconformance. Critical defects affect safety; major categories affect use, batteries with minor defects may be serviceable with limitations.

4.7.1.2 Dimensions and weight. Batteries shall be examined by gauging or measuring and by weighing to determine conformance. All measurements shall include any coating and labels which may be used. Battery dimensions shall be measured during the dimension inspections of first article. Dimensions may be checked by gauging whenever a first article test requires dimensional compliance as passing criteria following tests. Dimension inspections during conformance inspections may be accomplished by gauging. Batteries shall meet the requirements specified (see 3.1).

4.7.1.2.1 Gauging. When box or ring gauges are used, batteries, loaded with a weight not greater than five pounds, shall pass freely through the applicable gauge openings. The dimensions of the box or ring gauge shall be the specified maximum outside dimensions of the battery (see 3.1).

4.7.1.3 Connector insertion test. Unless otherwise specified (see 3.1), the following test shall be performed. Insert and withdraw each battery into a specified adapter or specified mating device (see 3.1) 500 times. Measure insertion and withdrawal force required on the first and last insertion/withdrawal cycles. Inspect the battery to verify that the screws (if any) are retained, the connector remains securely fastened and the connector remains fully functional. Batteries shall meet the requirements of 3.4.4.1.1.

4.7.1.4 Flat terminal strength. The following test shall be performed. Apply force of not less than 10 pounds to each battery terminal using 0.200 ± 0.050 inch diameter rod. Repeat force application for not less than a total of 250 applications. Maintain each application of force for not less than 1 second. Batteries shall meet the requirements of 3.4.4.1.2.

4.7.1.5 Insulating compounds, flow and shrinking. The following test shall be performed on any insulating compounds that may be used in battery construction. Place compound in a container, approximately 3 inches wide by 6 inches long by 3/4 inch high, to within 1/2 inch of the top and allow curing in accordance with the manufacturer's recommended procedures. Place the container in an environmental chamber in an inverted position and raise the temperature to 93.3 ± 2.7ºC (200ºF). Keep the container inverted at these conditions for not less than 24 hours. Visually examine; the test sample shall meet the requirements of 3.3.4. Place the container in an environmental chamber and lower the temperature to -40 ± 2.7ºC (-40ºF); hold these conditions for not less than eight hours. Visually examine; the test sample shall meet the requirements of 3.3.4.

4.7.1.6 Battery case vent. The following test shall be performed. Place a fully assembled battery into a fixture designed to contain possible bulging by the front, back and side faces of the battery case (see applicable specification sheet for face references). The fixture shall allow the battery to expand up to .010 inches over the specified maximum allowable dimensions. The fixture shall not cover the top and bottom of the battery. Tap an air line into the battery and increase the internal pressure of the battery 1.0 psi every 60 seconds until the battery case vent opens. Position the fixture with the pressurized battery so that it allows the battery to slide out through the bottom of the fixture. If the pressurized battery cannot slide out of the fixture, place weights on top of the battery. Measure and record the total weight used including the battery. Visually examine. Batteries shall meet the requirements of 3.4.5.3.

4.7.1.7 Battery case. When specified (see 3.4.5), the following test shall be performed on 5 sample pieces of case material. Use the Horizontal Burning Test method of UL 94 to determine the test apparatus criteria. Expose samples to a flame for not less than 30 seconds. Samples shall meet the criteria of 3.4.5.

4.7.2 Electrical performance tests.

4.7.2.1 Cell balance. The following test shall be performed. Fully charge the cells in any appropriate manner at the normal conditions of 4.3.1. Stabilize cells at normal conditions after charge termination for not less than 1 hour. Discharge cells at the C/5 rate to the cell manufacturer's recommended discharge cutoff voltage. Measure and record total capacity of each cell to final voltage. Cells shall meet the requirements of 3.5.1.

4.7.2.2 Battery open circuit voltage. The open circuit voltage of the battery under test shall be measured. In the case of multi-sectioned batteries, open circuit voltage shall be measured in both series and independent modes (see 3.1). Batteries shall meet the requirements of 3.5.2.

4.7.2.3 Capacity discharge. The following test shall be performed.

a. Charge batteries in accordance with 4.6; use of 4.6.3 is not permitted.
b. Stabilize the batteries at the conditions of 4.3.1 for not less than 2 hours.
c. Discharge at the rate specified; batteries shall meet full capacity discharge test requirement (see 3.1 and 3.5.3).

4.7.2.3.1 Initial capacity discharge. Each battery subjected to the capacity discharge test above (see 4.7.2.3) on its initial charge/discharge cycle is permitted up to three cycles to meet the capacity discharge test requirement (see 3.1). Any battery not meeting the specified capacity discharge requirement (see 3.1) during any of its first three cycles is considered a failure.

4.7.2.4 Cycle life test. The following test shall be performed.

a. Cycles 1 through 26 - Charge the batteries in accordance with 4.6; use of 4.6.3 is permitted. Allow batteries to rest for not less than 5 minutes. Discharge at the rate specified to the specified final voltage (see 3.1). Allow batteries to rest for not less than 5 minutes prior to the start of the next cycle.
b. Cycle 27 – Charge the batteries in accordance with 4.6; use of 4.6.3 is permitted. Allow batteries to rest for not less than 4 hours. Discharge at the rate specified to the specified final voltage (see 3.1). Allow batteries to rest for not less than 4 hours prior to the start of the next cycle.
c. Cycle 28 - Charge the batteries in accordance with 4.6; use of 4.6.3 is permitted. Perform the electric leakage test of 4.7.4.7d. Allow batteries to rest for not less than 4 hours. Discharge at the rate specified to the specified final voltage (see 3.1). Record battery capacity.
d. Repeat steps a through c above until the total number of required cycles is obtained (see 3.1).
e. After completion of the cycle life test, visually examine batteries for the criteria of TABLE VIII. Batteries shall meet the cycle life and visual mechanical requirements (see 3.1 and 3.5.3).

4.7.2.5 High rate discharge. The following test shall be performed.

a. Charge the batteries in accordance with 4.6; use of 4.6.3 is permitted. Stabilize the batteries at ambient temperature for not less than 2 hours.
b. Discharge the batteries at the rate specified (see 3.1).
c. Record the following:
    1. Battery open circuit voltage
    2. The elapsed time for the voltage to drop to the final voltage specified on the applicable specification sheet after the start of discharge.
d. After completion of the test, batteries shall meet the capacity requirements of 3.5.3 and the criteria of TABLE VIII.

4.7.2.6 Charge enable. When specified (see 3.1), the following test shall be performed. Discharge each battery to final voltage. Using an ammeter in the charge circuit to record resultant current slowly increase the charge current until the battery no longer accepts a charge current. Once the charge current has been verified, discharge each battery to final voltage. Apply a charge current to the battery terminals while connected to the charge enable terminal or socket using a charge circuit equipped to provide the specified preferred charge method only if the charge enable terminal or socket complies with requirements (see 3.1). After testing, batteries shall meet the requirements of 3.5.6.

4.7.2.7 Low temperature discharge. The following test shall be performed. Charge batteries in accordance with 4.6; use of 4.6.3 is not permitted. Store the batteries at -20°C (-4°F) ± 1.1°C (± 2°F) for a minimum of 4 hours. Discharge under these conditions at the rate specified to the specified final voltage (see 3.1). After testing, batteries shall meet the requirements of 3.5.3 and 3.6.

4.7.2.8 High temperature discharge. The following test shall be performed. Charge batteries in accordance with 4.6; use of 4.6.3 is not permitted. Store the batteries at 50°C (122°F) ± 1.1°C (± 2°F) for a minimum of 4 hours. Discharge under these conditions at the rate specified to the specified final voltage (see 3.1). After testing, batteries shall meet the requirements of 3.5.3 and 3.6.

4.7.2.9 Charge acceptance. The following test shall be performed. After testing, batteries shall meet the requirements of 3.1 and 3.5.10.1.

a. Discharge batteries in accordance with 4.7.2.3c.
b. Store the batteries at -20°C (-4°F) ± 1.1°C for a minimum of 4 hours.
c. Charge batteries in accordance with 4.6 at the same condition; use of 4.6.3 is not permitted.
d. Stabilize batteries at the same condition for not less than 2 hours.
e. Discharge batteries in accordance with 4.7.2.3c at the same condition.
f. Store the batteries at 50°C (122°F) ± 1.1°C for a minimum of 4 hours.
g. Repeat steps c through e above.

4.7.2.10 Retention of charge (at high temperature). The following test shall be performed. After testing, batteries shall meet the requirements of 3.1, 3.5.3, and 3.5.10.2.

a. Charge batteries in accordance with 4.6; use of 4.6.3 is permitted.
b. Store batteries under 50°C (122°F) ± 1.1°C conditions for 7 days.
c. Return batteries to the normal conditions of 4.3.1 and stabilize for not less than 2 hours.
d. Discharge batteries at the same conditions at the rate specified to the specified final voltage (see 3.1).

4.7.2.11 Pulse discharge. The following test shall be performed. After testing, batteries shall meet the requirements of 3.1 and 3.5.3.

a. Charge batteries in accordance with 4.6; use of 4.6.3 is permitted. Store batteries under the normal conditions of 4.3.1.

b. Discharge each battery at the rate and for the time specified until the final voltage specified is reached (see 3.1).

4.7.2.12 Motor inrush current. When specified (see 3.1), the following test shall be performed. During and after testing batteries shall meet the motor surge requirement (see 3.1 and 3.5.5).

a. Charge the batteries in accordance with 4.6; use of 4.6.3 is permitted. Stabilize the batteries at ambient temperature for not less than two hours.
b. Discharge the batteries using current values not less than the profile specified (see 3.1)
c. Record the following:
    1. Discharge current
    2. Battery Voltage
d. After completion of the test, visually examine batteries for the criteria of TABLE VIII. Batteries shall meet the motor surge and visual mechanical requirements (see 3.1 and 3.5.5).

4.7.2.13 Power consumption. The following test shall be performed. Connect an ammeter between the ECA for the battery and the full CCA for the battery. Verify the current draw is in accordance with paragraph 3.5.7.

4.7.2.14 State-of-charge indicator. When specified (see 3.1), the following tests shall be performed.

a. Conduct this test at the normal conditions specified in 4.3.1, except that the temperature tolerance shall be ± 1.1°C.
b. Discharge batteries at the C/5 rate to final voltage.
c. Charge batteries as specified in 4.6; use of 4.6.3 is not permitted.
d. Allow batteries to stabilize for not less than two hours.
e. Discharge batteries at the C/5 rate to final voltage.
f. Record capacity for each battery tested.
g. Charge batteries as specified in 4.6; use of 4.6.3 is not permitted.
h. Allow batteries to stabilize for not less than two hours.
i. Discharge batteries at the C/5 rate to final voltage while visually observing the state of charge indicators. Monitor and record SMBus state of charge information throughout the discharge where applicable.
j. Record the time of test when each state of charge indicator segment extinguishes.
k. Batteries shall meet the requirements of 3.5.8, 3.5.8.1 and 3.5.9.

4.7.2.15 SMBus. When specified (see 3.1), verify the following data has been programmed correctly using appropriate interface and software.

a. ManufacturerName
b. DeviceName (DoD type designation, e.g. BB-2590/U)
c. DeviceChemistry
d. SerialNumber
e. ManufactureDate
f. DesignCapacity
g. DesignVoltage
h. ChargingCurrent
i. ChargingVoltage

4.7.3 Environmental tests.

4.7.3.1 Sequential testing. When verification of the requirements of 3.6 or capacity requirements of 3.5.3 are required for multiple environmental tests (see TABLE I) performed in sequence on the same sample, single verifications may be used following the last test performed in that sequence. (Note: reducing inspection frequency may result in increased retesting in the event of a failure.)

4.7.3.2 Extreme low temperature discharge. For Type III (Li-ion) and Type IV (Li-Po) batteries the following test shall be performed. Charge batteries in accordance with 4.6; use of 4.6.3 is not permitted. Store the batteries at -30°C (-22°F) ± 1.1°C (± 2°F) for a minimum of 4 hours. Discharge under these conditions at the rate specified to the specified final voltage (see 3.1). After testing, batteries shall meet the requirements of 3.5.3, 3.6, and 3.6.1.

4.7.3.3 Extreme high temperature discharge. For Type III (Li-ion) and Type IV (Li-Po) batteries the following test shall be performed. Charge batteries in accordance with 4.6; use of 4.6.3 is not permitted. Store the batteries at 55°C (140°F) ± 1.1°C (± 2°F) for a minimum of 4 hours. Discharge under these conditions at the rate specified to the specified final voltage (see 3.1). After testing, batteries shall meet the requirements of 3.5.3, 3.6, and 3.6.1.

4.7.3.4 Altitude. The following test shall be performed. All battery types shall be subjected to the altitude test for lithium batteries of the UN Manual of Tests and Criteria. Prepare and fixture batteries as required by the manual prior to testing. Weigh batteries and record OCV prior to and after the specified conditions. Upon completion, visually examine the batteries in accordance with 4.7.1.1 and subject each battery in the fully charged state to the battery voltage tests of 4.7.2.2. Batteries shall meet the requirements of 3.6 and 3.6.2.

4.7.3.5 Thermal shock. The following test shall be performed. Charge batteries in accordance with 4.6; use of 4.6.3 is permitted. Subject batteries to temperature shock per Method 503, Procedure 1-B of MIL-STD-810 at the temperature extremes of not less than 75°C (167°F) and not greater than -59°C (-75°F), except that the time at the temperature extremes shall be not less than 2 hours and diurnal cycling not required. Perform the capacity discharge test of 4.7.2.3. Batteries shall meet the requirements of 3.5.3, 3.6, and 3.6.3.

4.7.3.6 Mechanical shock. The following test shall be performed. Charge batteries in accordance with 4.6; use of 4.6.3 is permitted. Rigidly attach the batteries to the test carriage by mounting screws or other appropriate hardware and shock test at not less than 40g with a pulse duration of not less than 18 milliseconds in accordance with test Method 516, Procedure 1, of MIL-STD-810. Apply three shocks per axis, on each of three orthogonal axes. Batteries shall meet the requirements of 3.5.3, 3.6, and 3.6.4.

4.7.3.7 Vibration. The following test shall be performed. Charge batteries in accordance with 4.6; use of 4.6.3 is permitted. While discharging at the rate specified (see 3.1), batteries shall be subjected to minimum integrity vibration testing in accordance with MIL-STD-810 Method 514 using the general minimum integrity profile. Batteries shall meet the requirements of 3.6, 3.6.5, and 3.4.7.

4.7.3.8 Immersion.

4.7.3.8.1 Immersion, shallow. When specified (see 3.1) batteries shall be tested as follows. Weigh batteries and record their weight. Immerse the entire batteries to a depth of not less than 3 feet in salt water substitute conforming to ASTM D-1141 for not less than 2 hours. After immersion, remove the batteries and dry exterior surfaces. Reweigh the batteries. Batteries shall meet the requirements of 3.6, 3.6.6, and the applicable specification sheet (see 3.1). For conformance testing (see 4.5.2), deionized water may be substituted for salt water.

4.7.3.8.2 Immersion, deep. When specified (see 3.1) batteries shall be tested as follows.

a. Weigh batteries and record their weight.
b. Immerse the batteries to an equivalent depth of not less than 33 feet in salt water substitute conforming to ASTM D-1141 for not less than 5 minutes.
c. Reweigh the batteries. Batteries shall meet the requirements of 3.6, 3.6.6, and the applicable specification sheet (see 3.1).
d. Repeat steps b and c with a depth of not less than 3 feet and time period of not less than 12 hours.

4.7.3.9 Transit drop.

4.7.3.9.1 Transit drop, normal. When specified (see 3.1), the following test shall be performed.

a. Charge batteries in accordance with 4.6; use of 4.6.3 is permitted.
b. Stabilize batteries for 4 hours at 55 ± 1.1ºC (130ºF).
c. Perform the drop at ambient conditions in not greater than 10 minutes after removal from the preconditioning temperature.
d. Drop each battery once from a height of not less than 30 inches onto cured concrete. The smallest side of the battery perpendicular to the plane of the connector face and nearest to the connector (where applicable) shall be parallel to the concrete surface and facing downward upon release, but need not be parallel upon impact. In the case of cylindrical batteries, the axis of the cylinder shall be parallel to the concrete surface upon release.
e. Visually examine batteries for the criteria in TABLE VIII.
f. Subject batteries to the battery voltage tests of 4.7.2.2 and the electrical leakage test of 4.7.4.7d.
g. Stabilize batteries for 4 hours at -29 ± 1.1ºC (-20ºF).
h. Repeat steps c through f.
i. After test, batteries shall meet the requirements of 3.6 and 3.6.7

4.7.3.9.2 Transit drop, severe. When specified (see 3.1), the following test shall be performed. Batteries shall be dropped on each face, edge and corner (see 3.1) (e.g. total of 26 drops for cubic batteries) for each temperature from a height not less than 30 inches onto cured concrete. When specified (see 3.1), batteries shall be shall be dropped while mated to an object having the same mass, mass distribution, dimensions, and physical interface as the end item. Ten batteries shall be required for this test.

a. Charge batteries in accordance with 4.6; use of 4.6.3 is permitted.
b. Stabilize five of the batteries for 4 hours at 55 ± 1.1ºC (130ºF) and the remaining five batteries for 4 hours at -29 ± 1.1ºC (-20ºF) .
c. Perform drops specified in TABLE IX as follows. Perform the first requisite drop per battery at ambient conditions in not greater than 10 minutes after removal from the preconditioning temperature, and the final requisite drop not greater than 30 minutes after removal from the preconditioning temperature. If greater than 30 minutes are required, stabilize the battery for an additional 4 hours before proceding.
d. Subject batteries to the battery voltage tests of 4.7.2.2 and the electrical leakage test of 4.7.4.7d.
e. After test, batteries shall meet the requirements of 3.6 and 3.6.7

TABLE IX. Transit drop, severe

Drop	Impact 1/		Mated 2/	Sample number	
				-29 ºC	55ºC
1	Corner	top-back-left	YES	1	6
2	Edge	bottom-back	YES	1	6
3	Edge	top-right	YES	1	6
4	Edge	top-front	YES	1	6
5	Surface	right	YES	1	6
6	Corner	bottom-back-left	YES	2	7
7	Edge	front-right	YES	2	7
8	Edge	bottom-front	YES	2	7
9	Corner	top-front-left	YES	2	7
10	Corner	bottom-front-left	YES	2	7
11	Corner	top-back-right	NO	3	8
12	Edge	bottom-left	NO	3	8
13	Edge	top-back	NO	3	8
14	Surface	front	NO	3	8
15	Surface	left	NO	3	8
16	Corner	bottom-back-right	NO	4	9
17	Edge	bottom-right	NO	4	9
18	Edge	back-left	NO	4	9
19	Edge	front-left	NO	4	9
20	Surface	bottom	NO	4	9
21	Surface	back	NO	5	10
22	Surface	top	NO	5	10
23	Edge	top-left	NO	5	10
24	Corner	bottom-front-right	NO	5	10
25	Corner	top-front-right	NO	5	10
26	Edge	back-right	NO	5	10

Note:
1/ To determine surface definitions, the battery shall be oriented with the main connector on the top. If the connector is off-center the battery shall be rotated so that the connector is in the back leftmost position.
2/ When specified

4.7.3.10 Battery storage life. The following test shall be performed.

a. Discharge each battery at the 0.5C rate to the specified final voltage. If the battery is either Type III (Li-ion) or Type IV (Li-Po), proceed to the next step; if the battery is either Type I (Ni-Cd) or Type II (Ni-MH), skip step b and proceed to step c.
b. Charge each Type III or Type IV battery with a constant current of not less than 100 milliamperes to not more than 220 milliampere-hours of capacity.
c. Store batteries at 60 ± 5°C (140°F) and not less than 85% relative humidity for not less than 622 hours (approximately 26 days).
d. Return batteries to the normal conditions of 4.3.1 and store for not less than 2 hours.
e. Charge batteries at normal conditions in accordance with 4.6; use of 4.6.3 is permitted.
f. Perform the electric leakage test of 4.7.4.7d.
g. Discharge each battery at the rate specified for capacity discharge of 4.7.2.3.
h. Repeat steps e, f, and g for two more cycles (a total of three charge/discharge cycles).
i. After test, batteries shall meet the requirements of 3.6 and 3.6.8.

4.7.4 Safety tests.

4.7.4.1 Cell overcharge. The following test shall be performed. Weigh each cell to the nearest tenth of a milligram. Attach a thermocouple to the side of each cell to be tested, and attach current carrying and voltage monitoring leads to its terminals. Place each cell in a temperature chamber set at 25 ± 2.7°C (77°F). Charge each cell at a constant current rate of C/2 for not less than 8 hours continuously. Measure and record cell temperature, voltage, and current. Visually examine the cells. Cells shall meet the requirements of 3.7.1.1and 3.7.1.1.1.

4.7.4.2 Cell short circuit. The following test shall be performed. Weigh each cell to the nearest tenth of a milligram. Fully charge the cells in any appropriate manner at the normal conditions of 4.3.1. Stabilize cells at the same conditions after charge termination for not less than 1 hour. Short each cell individually by connecting the positive and negative terminals of the cell with a copper wire, not greater than 8 inches in length and with a cross-sectional area not less than AWG No. 16 wire. Discharge each cell to not greater than 0.2 volts. Visually examine the cells and weigh each cell to the nearest tenth of a milligram. Cells shall meet the requirements of 3.7.1.1and 3.7.1.1.2.

4.7.4.3 Cell forced-discharge. The following test shall be performed. Weigh each cell to the nearest tenth of a milligram. Discharge each cell at the C/5 rate to not greater than 0.2 volts. Connect each cell in series with a 12-volt DC power supply and force discharge it at the C/5 rate for not less than 5 hours. Visually examine the cells and weigh each cell to the nearest tenth of a milligram. Cells shall meet the requirements of 3.7.1.1and 3.7.1.1.3.

4.7.4.4 Nail Penetration, cell. When specified (see 3.1), the following test shall be performed on cells between 50% and 71% state of charge. Insert a 2.5 mm DIA stainless steel nail with a length that exceeds the width or diameter of the cell to be tested into each cell at right-angles to the electrode surface close to the center of the cell. Drive the nail completely through on one of the samples; Drive the nail to a depth of 2/3 of the width of the cell for the other. Leave the nail in both cells for 24 hours. Monitor the voltage and external temperature of the cell for the duration of the test. Cells shall meet the requirements of 3.7.1.2.

4.7.4.5 Crush, cell. The following test shall be performed. Subject cells designated for the crush test to the crush test of UL 1642. Crush each sample cell with its longitudinal axis parallel to the flat surfaces of the crushing apparatus. Subject each sample cell to a crushing force in only one direction. Cells shall meet the requirements of 3.7.1.3.

4.7.4.6 Insulation resistance. The following test shall be performed. Apply a direct-current potential not less than 500 volts between any two battery terminals not electrically connected and between battery terminals and the case of the battery. Measure the insulation resistance of batteries by the use of a copper plate making physical contact with the case. The plate shall exceed the dimensions of the surface to be tested. Place the battery under test on the plate so that the plate is visible outside all edges of the surface under test. Test each battery in not less than three locations. Test each battery on all surfaces with a case seam other than that on which the battery terminals are located; for cylindrical batteries, test in not less than three locations around the diameter including on seams if present. Batteries shall meet the requirements of 3.7.2.1.

4.7.4.7 Overcharge/electrical leakage. The following test shall be performed. After testing, batteries shall meet the overcharge and electrical leakage requirements (see 3.1).

a. Charge batteries in accordance with 4.6; use of 4.6.3 is not permitted.
b. Overcharge the batteries at the rate specified (see 3.1) for not less than 21 hours. Measure and record battery voltages continuously or at a sampling rate of not less once per 60 seconds during overcharge.
c. Stabilize batteries at ambient conditions for not less than 2 hours.
d. Connect a 1 megohm resistor to the following points: from the case or ground to each battery terminal and between all electrically isolated terminals (example: on a battery with two parallel sections, measure voltage from pin 1 to pins 2 and 5, from pin 4 to pins 2 and 5, and vice versa). Measure and record voltages at each connection point. Batteries shall meet the requirements of 3.7.2.2.
e. Discharge the batteries at the rate specified (see 3.1). Measure and record battery voltages continuously or at a sampling rate of not less once per 60 seconds during discharge.
f. Repeat steps a through e for a total of 10 cycles.
g. Visually examine the batteries for the criteria of TABLE VIII.
h. Examine batteries for the requirements of 3.6.
i. Examine batteries to insure compliance with the requirements of 3.5.3.

4.7.4.8 Short circuit protection. The following test shall be performed. Charge batteries as specified in 4.6; use of 4.6.3 is permitted. Measure and record the OCV. Short each battery across all the positive and negative terminals with a total external resistance not greater than 50 milliohms. After one hour remove the short from across the terminals. Measure and record the OCV. Stabilize batteries at the normal conditions of 4.3.1 for not less than 2 hours. Charge batteries in accordance with 4.6; use of 4.6.3 is permitted. Stabilize batteries at normal conditions for not less than 2 hours, then discharge the battery in accordance with 4.7.2.3. The battery shall meet the requirements of 3.7.2.3.

4.7.4.9 High temperature temporary cutoff. The following test shall be performed. Charge batteries as specified in 4.6; use of 4.6.3 is permitted.

a. Store the batteries at 75 ± 5°C for not less than 2 hours. Measure and record the battery voltage.
b. Allow the battery to cool down to 40, +0/-5°C. Measure and record battery voltage.
c. Repeat steps a and b five (5) times.
d. Perform the capacity discharge test of 4.7.2.3.
e. Batteries shall meet the requirements of 3.7.2.4.

4.7.4.10 High temperature permanent cutoff. The following test shall be performed. Charge batteries as specified in 4.6; use of 4.6.3 is permitted. Store the batteries at 95 ± 5°C for not less than 2 hours. Measure and record the battery voltage. Allow batteries to cool down to 40 +0/-5°C. Attempt to charge the battery in accordance with 4.6 (any specified manner), then attempt to discharge the battery in accordance with 4.7.2.3. Measure and record any resultant current from either attempt. Batteries shall meet the requirements of 3.7.2.5.

4.7.4.11 Projectile. The following test shall be performed. Subject each battery designated for the projectile test to the projectile test of UL 1642. Batteries shall meet the requirements of 3.7.2.6.

4.7.5 Lithium Battery Safety Program (US Navy) tests. When specified (see 3.1) the following tests shall be performed on Types III and IV batteries. Test each battery in a test vessel (see 6.8.2) in order to facilitate pressure readings in lieu of the “complete system” described by NAVSEA S9310-AQ-SAF-010. Battery voltage, charge or discharge current, and test vessel pressure shall be monitored continuously during testing. Test samples will be subjected to testing as follows:

TABLE X. Lithium Battery Safety Program test and sample size

Inspection	Sample size	Requirement Paragraph	Test Method Paragraph
Visual mechanical	15	3.4	4.7.1.1
Battery open circuit voltage	15	3.5.2	4.7.2.2
Short circuit test	3	3.7.2.7	4.7.5.1
Overcharge/discharge test	3	3.7.2.7	4.7.5.2
Overcharge/charge test	3	3.7.2.7	4.7.5.3
Electrical safety device test	3	3.7.2.7	4.7.5.4
Aging safety test	3	3.7.2.7	4.7.5.5

4.7.5.1 Short circuit test. When specified (see 3.1), the short circuit test for rechargeable batteries of NAVSEA S9310-AQ-SAF-010 shall be performed. Batteries shall meet the requirements of 3.7.2.7.1.

4.7.5.2 Overcharge/discharge test. When specified (see 3.1), the overcharge/discharge test for rechargeable batteries of NAVSEA S9310-AQ-SAF-010 shall be performed. Batteries shall meet the requirements of 3.7.2.7.1.

4.7.5.3 Overcharge/charge test. When specified (see 3.1), the overcharge/charge test for rechargeable batteries of NAVSEA S9310-AQ-SAF-010 shall be performed. Batteries shall meet the requirements of 3.7.2.7.1.

4.7.5.4 Electrical safety device test. When specified (see 3.1), the electrical safety device test for rechargeable batteries of NAVSEA S9310-AQ-SAF-010 shall be performed. Batteries shall meet the requirements of 3.7.2.7.2.

4.7.5.5 Aging safety test. When specified (see 3.1), the aging safety test for rechargeable batteries of NAVSEA S9310-AQ-SAF-010 shall be performed. Batteries shall meet the requirements of 3.7.2.7.2.

4.7.6 Interchangeability test. A battery charger interchangeability test shall be performed. Batteries shall be charged on currently fielded standard Army chargers and adapters. Verify no anomalies occur during charging and batteries meet 90% of their rated capacity and meet the requirements of 3.10.

4.7.7 Electromagnetic interference. When specified (see 3.1), the tests specified in MIL-STD-461 for the following parameters shall be performed on batteries connected to the system specified in the applicable specification sheet: CS114, CS115, CS116, RE101, RE102, RS101, and RS103.

5 PACKAGING

5.1 Packaging requirements. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the military service's system commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6 NOTES

6.1 Intended use. Sealed, high energy density, rechargeable batteries covered within this specification are used in military electronic and communications equipment, and for other military power requirements. Some devices use these batteries to run electric motors. These batteries are subjected to severe environmental conditions.

6.2 Acquisition requirements. Procurement documents should specify the following:

a. Title, number, and date of the specification
b. The specific issue of individual documents referenced, if required (see 2).
c. Packaging requirements (see 5.1).
d. When first article inspection and rough handling tests of equipment are required.
e. When certifications are required
f. If certification of parts, materials, or components are required (see 3.2.1).
g. Actions required relative to group C inspection failure.
h. Any additional case markings, dependent upon battery chemistry.

6.3 Definitions.

6.3.1 Fully charged batteries. Batteries will be considered fully charged when charged in accordance with 4.6. In addition, the SOCI must indicate a fully charged battery.

6.3.2 Discharged batteries. Batteries will be considered discharged when a specified discharge rate was conducted until a specified final voltage was reached.

6.3.2.1 Discharge rate. The rate of discharge is defined as:

$$I = C/t$$

Where

I = current in amperes
t = hourly rate of discharge
C = rated ampere hour capacity

For example, the expression for the five hour discharge current for a 25 ampere hour battery will be $I = (1/5)(25) = 5$ amperes

6.3.3 Final voltage. The final voltage of the battery is the specified final voltage reached at the end of discharge.

6.3.4 Cycle. A cycle is a combination of a charge and a discharge.

6.3.5 Measured performance. The data obtained in conducting a test in accordance with section 4 of this specification, such as capacity or cycle life, will be known as the measured performance.

6.3.6 Specified performance. The numerical performance requirement specified in a specification sheet covering parameters such as voltage, capacity, cycle life, storage life, etc., will be known as the specified performance.

6.3.7 Softening temperature. The softening temperature of insulation is the temperature at which it will distort under a reasonable amount of pressure when tested per the Heat Distortion Test of ASTM D 2633.

6.3.8 Non-flammable and non-toxic materials. Non-flammable and non-toxic materials are those materials which will not support combustion, produce smoke, or be capable of emitting toxic fumes, in a cured state, when subjected to the environmental conditions specified herein.

6.3.9 Level 2 and 3 chargers. Smart Battery Charger Types are described by the Smart Battery Charger Specification as:

Level 2 – Smart Battery Controlled Smart Battery Charger
Level 3 – Host Controlled Smart Battery Charger

Refer to the Smart Battery Charger Specification for a more complete description. Copies of this document may be obtained from the System Management Interface Forum (SMIF), Inc, on-line at http://powersig.org.

6.3.10 Electronic component assembly (ECA). An ECA is the total of all electronic components, connectors and mounting boards used within a complete battery.

6.3.11 Complete cell assembly (CCA). A CCA is the total number of cells used within a complete battery along with the intercell connections; for testing purposes, it needs to be connected to the ECA as a separate item in order to facilitate sensing connections between the two assemblies.

6.3.12 Approved chargers. The following are the approved chargers that may be used for the charge method of 4.6.3 above. Note that some of these chargers may be of an older vintage and may not charge every battery described by the associated specification sheets. Users of this document will need to assure compatibility with the products under test prior to charging in accordance with 4.6.3. Individual specification sheets may list other chargers. This listing is provided for reference only and does not constitute an endorsement of the products by the Department of Defense.

TYPE DESIGNATION	NSN	PART NUMBER	CAGEC
PP-8498/U	6130-01-495-2839	BTC-70801	51828
PP-8444A/U	6130-01-443-0970	BTC-UN108	51828
PP-8481B/U	6130-01-527-2726	BTC-70836	51828
PP-8481A/U	6130-01-494-9164	BTC-70840	51828
PP-8481/U	6130-01-467-9465	BTC-70440A	51828

6.4 Verification inspection. Verification by the Government will be limited to the amount deemed necessary to determine compliance with the contract and will be limited in severity to the definitive quality assurance provisions established in this specification and the contract. The amount of verification inspection by the Government will be adjusted to make maximum utilization of the contractor's quality control system and the quality history of the product.

6.5 Inspection lot. The inspection lot is the quantity of batteries (exclusive of the number of batteries required as samples) produced at any one place of manufacture on any one contract presented to the Government for acceptance.

6.6 Test report data. The following data points will be necessary for Government review and should be included in First Article and Conformance Test Reports:

Certifications, where required (see 3.2.1);

Whenever there is a service or ampere hour requirement, include the following:

Initial Open Circuit Voltage (IOCV)

Initial Loaded Voltage (ILV)

Battery or Cell Voltage and Current, recorded at regular intervals. Interval should be Service Requirement or shorter.

The time elapsed between initial voltage and final voltage (FV).

Record how low a battery is discharged in volts, particularly whenever near zero volts.

Record date and time of day that any portion of test is initiated in the test report including initiation of soak at test temperature.

When a requirement limit is specified, record the final quantitative figure.

6.7 First Article. When a first article inspection is required, the contracting officer should provide specific guidance to offerors whether the item(s) should be a preproduction sample, a first article sample, a first production item, a sample selected from the first production items, a standard production item from the contractor's current inventory (see 4.4), and the number of items to be tested as specified in 4.4. The contracting officer should also include specific instructions in acquisition documents regarding arrangements for examinations, approval of first article test results, and disposition of first articles. Invitations for bids or requests for proposal should provide that the Government reserves the right to waive the requirement for samples for first article inspection to those bidders offering a product which has been previously acquired or tested by the Government, and that bidders offering such products, who wish to rely on such production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending contract. Bidders should not submit alternate bids unless specifically requested to do so in the solicitation.

6.8 Lithium Battery Safety Program (US Navy). Potential offerors and contractors should be aware that passing the test criteria specified herein for the US Navy Lithium Battery Safety Program will not constitute a “Safety Approval” for the battery by the US Navy. In accordance with S9310-AQ-SAF-010, Navy department users must still apply for battery safety approvals based on the NSN of the battery intended for use, as well as both the intended Navy platform and each specific using end item.

6.8.1 Test data. The intent of including these test requirements in this specification are primarily to give manufacturers visibility into the essential safety characteristics needed by the Navy. Until now, the tests were performed in evaluating system or device safety without any knowledge of these requirements by battery manufacturers. Additionally, these requirements will provide the Navy with test data on file when assessing applications for safety approvals. The data provided will be used for engineering assessments that are capable of providing recommendations for safer battery compartments in battery-using devices.

6.8.2 Test vessel. Due to the need to record pressure changes during test, the Navy safety tests require use of a test “vessel”, defined as a sealed container larger than the battery under test. A “sealed container” could be something as simple as an unused paint can with the lid on, provided that gaskets, plugs, or sealants are used around the access points for load and sensing leads to preserve the seal. A calculation of the remaining void space inside the vessel containing the battery under test will be needed for proper interpretation of the pressure readings.

6.8.3 Navy test facility. The Department of Defense has a preference for having the tests described by S9310-AQ-SAF-010 (see 4.7.5) conducted in a US Navy test facility. Potential offerors are cautioned to review solicitations for such requirements. Should testing at a Navy facility be required, offerors will need to obtain a quote for Navy testing from the Navy in order to respond to the solicitation. Points of Contact in the Navy for the quote will be identified in the solicitation documentation. Offerors will need to assure that Navy testing costs are covered in their price proposal. Successful offerors will need to establish a Test Service Agreement (TSA) with the Navy after award. Unsuccessful offerors will be under no obligation to pay for anything associated with the quote obtained earlier. TSAs have expiration dates; if an agreement is already established, check to make sure that it will still be in effect at the time when testing may be required.

6.8.4 Interchangeability testing. The Department of Defense has a preference for having the tests described by 4.7.6 conducted in a US Army battery test facility. This test is to ensure backwards compatibility with existing fielded chargers. Potential offerors are cautioned to review solicitations for such requirements.

6.9 Electromagnetic compatibility. Some of the batteries described by this specification are required to be electromagnetically compatible with specific systems (see the applicable specification sheet for system identity). This compatibility is specific to the system identified and should not be assumed for other systems as well. Any other system using such a battery will need to have its electromagnetic compatibility with the battery evaluated separately, and in the event the battery is not compatible, then either system modifications will be needed or the system will need another battery.

6.10 Shelf life. This specification covers items where the assignment of a Federal shelf-life code is a consideration. Specific shelf-life requirements should be specified in the contract or purchase order, and should include, as a minimum, shelf-life code, shelf-life package markings in accordance with MIL-STD-129 or FED-STD-123, preparation of a materiel quality storage standard for type II (extendible) shelf-life items, and a minimum of 85 percent shelf-life remaining at time of receipt by the Government. These and other requirements, if necessary, are in DoD 4140.27-M, *Shelf-life Management Manual*. The shelf-life codes are in the Federal Logistics Information System Total Item Record. Additive information for shelf-life management may be obtained from DoD 4140.27-M, or the designated shelf-life Points of Contact (POC). The POC should be contacted in the following order: (1) the Inventory Control Points that manage the item and (2) the DoD Service and Agency administrators for the DoD Shelf-Life Program. Appropriate POCs for the DoD Shelf-Life Program can be contacted through the DoD Shelf-Life Management website: https://www.shelflife.hq.dla.mil/.

6.11 Subject term (key word) listing.

Advanced chemistry
Lithium ion
Nickel cadmium
Nickel metal hydride
Polymer

Custodians:
Army – CR
Navy – MC
Air Force – 99

Review activities:
Navy – AS,SH
Air Force – 71
DLA – CC

Preparing Activity
Army – CR
(Project Number 6140-2010-009)

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at https://assist.daps.dla.mil.