INCH-POUND
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PERFORMANCE SPECIFICATION

BATTERIES, RECHARGEABLE, SEALED
General Specification For

This specification is approved for use by U.S. Army Communications Electronics Command, Department of the Army, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers portable, sealed rechargeable batteries. Detailed electrical and physical requirements for individual batteries are specified on specification sheets.

1.2 Classification.

1.2.1 Type designation. The type designation, sealed rechargeable batteries will be in the following form (see 3.1). For example,

BB -	XX90	/U
Component (1.2.1.1)	Battery number (1.2.1.2)	Installation indicator (1.2.1.3)

1.2.1.1 Component. Rechargeable batteries are identified by the two-letter symbol "BB" followed by a hyphen.

Beneficial comments (recommendation, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, US Army CECOM, ATTN: AMSEL-LC-LEO-E-EP, Fort Monmouth, New Jersey 07703, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

1.2.1.2 Battery type number. The battery type number identifies the basic design of the battery (see 3.1) and consists of a three or four digit number depending upon the chemistry of the battery.

1.2.1.3 Installation indicator. The installation indicator identifies equipment the battery is used in, i.e. /TAS or if "universal", i.e. /U indicates use in various equipment.

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 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 listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation (see 6.2).

Department of Defense Standards

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

(See supplement 1 for list of specification sheets)

(Unless otherwise indicated, copies of the above specifications and standards are available from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.2 Non-Government publications. The following document forms a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DoDISS cited in solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS are the issues of the documents cited in the solicitation (see 6.2).

UL-1642 Lithium Batteries

(Applications for copies should be addressed to the Underwriters Laboratories, Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for related associated detail specifications or specification sheets), the text of this specification 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 4.3.

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.

3.3.1.1 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.

3.3.2. Electrical connection wires and tabs. All electrical connecting wires and tabs for the cells and the battery shall be able to carry the current specified in specification sheet and shall be covered by an insulation with the following characteristics:

Softening temperature: 302^{o}F (150^{o}C) minimum
Lengthwise shrinkage: 3% maximum after application
Thickness: 0.005 inch minimum

The material shall be non-flammable and non-toxic.

3.3.3 Insulation resistance. Terminals shall be as specified on the applicable specification sheet (see 3.1) and insulation resistance shall be less than 25 megohms when tested as specified in 4.6.

3.4 Visual and mechanical. Batteries shall be inspected to meet the requirements of 3.4.1 through 3.4.7, and 3.5 (see 4.4.2.1).

3.4.1 Hardware. Hardware shall be in accordance with the following subparagraph.

3.4.1.1 Mounting screws for connector. When applicable (see 3.1), two (2) mounting screws shall be furnished with the battery connector. Mounting screws shall be tightened so as not to impede the sideways movement of the connector.

3.4.2 Pressure release device. Unless specified otherwise in the applicable specification sheet a pressure release device shall be incorporated into the battery. This device shall be designed to release below the bursting pressure of the container and above the normal operating pressure of the battery. The device is intended to function only as an emergency release to protect the battery against abnormal pressure build-up. 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 (see 4.10).

3.4.3 Battery Case, (see 3.1). Battery case shall be capable of maintaining the specified dimensions during the life of the battery. The surfaces of cases 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. The battery case shall be a material that does not support combustion when subjected to flame.

3.4.4 Marking. Each battery shall be provided with a permanent, legible hot-stamped or printed identification label. Direct printing on the battery is the preferred method. For rectangular batteries, the marking may be placed on more than one surface.

3.4.4.1 Identification label. The identification label shall contain the following information. The information in parentheses shall be filled in by the manufacturer.

BATTERY, RECHARGEABLE, (Battery Nomenclature)
(Chemistry)
(Battery Voltage) (Full Capacity Rating)
(NSN)
(Contract Number)
(Date Code) (Serial Number)
(Manufacturer)
(Location)
(Charging Instructions)
BATTERY TEMPERATURE SHOULD BE BETWEEN
40°F (5°C) AND 100°F (38°C) DURING CHARGE.
LOWER TEMPERATURE CHARGING IS PERMITTED
BUT RUNTIMES WILL BE LOWER.

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

3.4.4.2 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 "O". 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.

3.4.4.3 Terminal marking. Where applicable, 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. A schematic drawing shall be placed as close as possible to the receptacle as shown on the applicable specification sheet.

3.4.4.4 Instructions. Each battery shall be furnished with complete instructions for operation and charging of the battery either on a label or printed on the battery. Direct printing on the battery is the preferred method.

3.4.5 Connector. Battery connector shall be as shown on the applicable specification sheet.

3.4.6 Color. The color of the battery container shall be lusterless green, closest to chip No. 34087 or 34088 per FED-STD-595 or as otherwise stated on individual battery drawings or on the applicable specification sheet (see 3.1). Additional battery case marking may be required (see 6.2).

3.4.7 Battery condition for shipping. The battery shall be furnished in a charged state (see 6.3.1) with instructions attached to each battery and a dust cap or cover over the receptacle.

3.4.8 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.

3.5 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. First Article requirements are outlined in Table III. When two or more cells are connected in parallel together in the battery, they are considered a single cell.

3.5.1 Cell balance. The capacities of the individual cells used in each battery shall not vary by more than 5% from the average capacity value of the cells in that particular battery (see 4.2).

3.5.2 Protective coverings. Batteries shall be fabricated of cells, which have an individual protective sleeving or coating.

3.5.3 Cell safety A single cell that does not contain any electronics shall meet all the safety requirement listed below:

3.5.3.1 Cell overcharge . After being subjected to the test as specified in 4.4.2.3.1 the cell shall not explode or catch fire or spark. No electrodes or separator material of the cell shall be outside of the cell case.

3.5.3.2 Cell short circuit. After being subjected to the test as specified in 4.4.2.3.2 the cell shall not explode or catch fire or spark.

3.5.3.3 Cell Forced-Discharge. After a single cell in the string has been subjected to the test as specified in paragraph 4.4.2.3.3 , there shall be no leaking, venting, fire or explosion.

3.6 Dimensions and weights. The dimensions and weights of batteries shall be as shown on the applicable specification sheets. Dimensions shall be gauged or measured accurately to determine conformance (see 4.5.6).

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

3.8 Chemical requirements.

3.8.1 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.

3.8.2 Resistance of elastomer materials. All elastomer materials used in the battery shall show no cracks, blisters or other deterioration, nor cause degradation of battery performance.

3.9 Temperature requirements.

3.9.1 Operating. The battery shall meet the temperature performance requirements of the applicable specification sheet (see 3.1).

3.9.2 Non-operating. The battery shall show no evidence of breaking or cracking of the case or cover when subjected to thermal shock temperature cycling in the range of 160°F (71°C) to -75°F(-59°C) (see 4.8.1).

3.10 Electrical requirements.

3.10.1 Electrical leakage. Unless otherwise specified (see 3.1), no potential in excess of 0.5 volts shall be obtained from the case or non-connected terminal to any terminal when tested in accordance with 4.9.

3.10.2 Battery voltage. When charged briefly (4.4.2.2), the battery voltage at 10 seconds of charge shall be no greater than the number of cells in series per battery, (N), times 1.5 V/cell for alkaline base battery or N times 4.2V/cell for lithium base battery nor less than N times 1.2 V/cell for alkaline base battery or N times 2.5 V/cell for lithium base battery(see 4.4.2.2).

3.11 Performance. The discharge current in amperes for each discharge shall be the value listed in the applicable sheet. The temperature of discharge and the minimum end voltage shall be the

value listed in the applicable specification sheet. Inability to meet the specified minimum requirements shall constitute a failure.

3.12 Environmental requirements. The battery when subjected to the tests listed in Table I that are required by the applicable specification sheet shall show no:

a. Dimensional distortion beyond specified limits.

b. Sharp current over voltage fluctuations during any charge or discharge period.

c. Mechanical failure of any part.

d. Failure to mate with a corresponding part.

e. Diminution of the rated capacity specified in the applicable specification sheet following the performance of each test.

f. Electrical leakage (3.10.1).

g. Safety hazard.

h. Battery case cracked.

TABLE I. Environmental requirements.

Tests	Test Paragraph
Thermal Shock	4.8.1
Mechanical Shock	4.8.2
Vibration	4.8.3
Transient Drop Test	4.8.4
Overcharge	4.7.1.1

3.13 Immersion. The batteries shall show no evidence of leakage of water into cases or leakage of gas from the cases after being subjected to the immersion or alternate leakage tests of 4.8.5.

3.14 Battery case expansion. The battery shall be designed to prevent dimensional expansion that will prevent its removal from equipment during and after battery case venting. The battery shall not require more than 12 pounds of force for removal when tested per Battery Case-Vent Test (see 4.10).

3.15 Battery storage life. The battery shall be capable of at least 5 years of warehouse storage during which storage temperatures may vary between the limits of -20°C (-4°F) to 50°C (122°F). The battery when removed from storage shall show no:

a. Dimensional distortions beyond the specified limits.

b. Mechanical failure of any part.

c. Evidence of marking, pitting, chipping, scaling, corrosion or other deleterious effects on external parts of battery.

d. Electrical leakage (3.10.1).

e. Cell leakage (3.5.3).

f. Inability to provide the rated capacity specified in the applicable specification sheet after a full charge for 2 hours for alkaline or 2 hours for lithium batteries followed by discharge per 4.7.2.1.

3.16 Battery safety. All protective devices employed shall not adversely affect battery performance or life.

3.16.1 Temporary cut off devices. If required to insure safety under conditions of overcharge and/or misuse, the battery, unless otherwise specified, shall contain at a minimum a normally closed thermoswitch that shall open at 70° ± 5°C and close at 50 ± 5°C. Each two to three single cells in series arrangement shall have at least one temporary cut off devices. The device shall be located as close as possible to the geometric center of the cluster. The devices for a cluster arrangement of three or more cells shall be distributed evenly across at the geometric center of the cluster.

3.16.2 Permanent cut off devices. The battery shall be permanently shut off when the temperature of the battery reaches 90 ± 5°C. Each two to three single cells in series arrangement shall have at least one permanent cut off devices. The device shall be located as close as possible to the geometric center of the cluster. The devices for a cluster arrangement of three or more cells shall be distributed evenly across at the geometric center of the cluster.

3.16.3 Short circuit protection. The battery shall be a short-circuit protected device. When shorted across the battery terminals with a total external resistance less than 50 milliohms, there shall not be any damage to the battery. When the short is removed, the battery shall be able to meet the full discharge capacity requirement after full charge.

3.17 State-of-Charge Display and Power Requirement. All of the batteries shall contain a state of charge display. Unless otherwise specified, the state of charge display location is optional.

3.17.1 Power consumption . The power consumption for the state of charge display and internal charge and discharge circuit shall be less than 50 mah or less than 2% of the battery capacity for seven days operation when the state-of-charge display illuminates at least 5 times a day for 7 days at 20°C, whichever is less.

3.17.2 State-of-charge display characteristics. As a minimum, the state of charge shall be displayed as two distinct ranges of remaining capacity in the battery. The two ranges shall be:

1) between 40 and 70 percent
2) greater than 70 percent

3.18 Altitude. After the batteries have been tested as specified in 4.13, they shall meet the visual and mechanical (see 3.4) and battery voltage (see 3.10.2) requirements.

4. VERIFICATION

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

a. Cell inspection (see 4.2)

b. First article inspection (see 4.3).

c. Quality conformance inspection (see 4.4).

4.2 Cell inspections. The contractor shall measure and record the capacities of individual cells (or subassemblies of cells) showing that they meet the requirements of 3.5.1.

4.3 First article inspection. This inspection shall be performed by the contractor unless otherwise specified in the contract. It shall consist of inspection and testing specified in Table III and shall be performed in the order indicated. If a different test is indicated on the applicable specification sheet (see 3.1) perform that test in place of the established test. Production may start after the samples successfully complete the 112th cycle of the life cycle test. For batteries with cycle requirements less than 112 cycles, all the cycles must be completed prior to start of production.

4.3.1 Order of inspection within first article. First article testing shall be performed in that order shown in Table III.

4.3.2 Sampling plan. Unless otherwise specified, the contractor shall furnish six first article samples selected at random of each cell and battery type on order.

TABLE II - Cell/Component Level Tests.

Inspection	Requirement Paragraph	Test Method Paragraph	Cell No.
Cell balance	3.5.1	4.2	All
Cell overcharge	3.5.3.1	4.4.2.3.1	3,4
Cell short circuit	3.5.3.2	4.4.2.3.2	5,6
Cell force discharge	3.5.3.3	4.4.2.3.3	1,2
Insulating compound, flow and shrinking	3.3.2	4.6.1	
Electrical connection wire and tabs	3.3.2		Certification

4.3.2.1 Cycling schedule. Two samples (nos. 5 and 6) shall be given the cycle life test of 4.7.6 at the start of the first article testing, and shall meet the capacity and number of cycles specified in the applicable specification sheet (see 3.1).

4.3.3 Degree of failure. The batteries shall be considered unacceptable if any of the sample battery numbers 1-6 fail to pass the inspection of Table III as specified in the applicable specification sheet.

4.3.4 Rework and retest provisions. Once a failure has occurred, no rerun can be made of that test on the same or a new sample from the same group of samples unless positive action consisting of design change, modification, or rework actually related to observed failures has been applied to the group. Any subsequent rerun must start at the beginning of the test in which the failure occurred provided aforementioned action will not affect any tests prior to the test in which the failure occurred.

TABLE III. First article testing.

Req Para	Inspection	Battery No.	Test
3.5	Cell safety (Table II)		
3.4	Visual and Mechanical	1 to 6 1/	4.4.2.1
3.6	Dimensions and Weight	1 to 6 1/	4.5.6
3.10.2	Battery Voltage	1 to 6	4.4.2.2
3.18	Altitude	1 to 6	4.13
3.17.2	State of Charge Display	1 to 6	4.12.2
3.11	Full Capacity Discharge (initial)	1 to 6	4.7.2
3.11	Cycle Life	5, 6	4.7.6
3.11	Overcharge	2,3	4.7.1.1
3.10.1	Electrical Leakage	1 to 6	4.9
3.11	High Rate	1, 3	4.7.3
3.11	Low Temperature	2, 4	4.7.4
3.11	Retention of Charge	1,2,3,4	4.7.5
3.11	High Rate Pulse	1, 3	4.7.7
3.12	Thermal Shock (charge after this test)	1,2,3,4	4.8.1
3.12	Mechanical Shock	1,2,3,4	4.8.2
3.12	Vibration (discharge)	2, 3	4.8.3
3.12	Transient Drop	1,2,3,4	4.8.4
3.13	Immersion	1,2,3,4	4.8.5
3.10.1	Electrical Leakage	1,2,3,4	4.9
3.17	State of Charge	1,2,3,4	4.12
3.10	Full Capacity Discharge	1,2,3,4	4.7.2
3.14	Battery Case-Vent	1,4	4.10
3.16	Battery safety tests	2,3	4.11

1/ If final battery jacket is not available at time of the start of cycle life testing, samples 5 and 6 may be cycled in a simulated case and are not required to meet requirements 3.4 and 3.6.

4.4 Quality conformance inspection.

4.4.1 Quality conformance inspection. Inspection of product for delivery shall consist of groups A, B and C inspections. This does not relieve the contractor of his responsibility for performing any additional inspection which is necessary to control the quality of the product and to assure compliance with all specification requirements. The Government will review and evaluate the contractor's inspection procedures and examine the contractor's inspection records. In addition, the Government at its discretion may perform all or any part of the specified inspection, to verify the contractor's compliance with specified requirements (see 6.4).

4.4.2 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 tables IV and V. All failures shall be removed. Discrete lots shall be formed from batteries that pass these inspections.

Table IV. Group A inspection.

Inspection	Req para.	Test para.
Visual and Mechanical Examination	3.4	4.4.2.1
Battery Voltage	3.10.2	4.4.2.2

4.4.2.1 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 V.

4.4.2.2 Battery voltage. The battery at 23° ±°5 C (73.5°±9°F) shall be given a charge pulse at the C rate for 10 ±3 seconds. The voltage shall be constantly monitored and shall meet the requirements of 3.10.2. For group A inspection, it is not necessary to pulse charge the battery, however, the battery voltage shall meet the requirements of 3.10.2.

4.4.2.3 Cell safety.

4.4.2.3.1 Cell overcharge. A single cell shall be placed in a temperature chamber set at 25°C. A thermocouple shall attach to the side of the cell, and current carrying and voltage monitoring leads shall be attached to the terminals. Using a power supply that provides at least 24 volts, a constant C/2 current charging rate shall be applied for 8 hours continuously. Cell temperature, voltage, and current shall be recorded. A single cell shall meet the requirement for 3.5.3.1.

4.4.2.3.2 Cell short circuit. A single cell shall be shorted by connecting the positive and negative terminals of the cell with a less than 8 inch in length of No. 16 AWG or higher copper wire. The cell shall be completely discharged and the battery case temperature has returned to near ambient temperature. The cell shall meet the requirement of 3.5.3.2.

4.4.2.3.3 Cell forced-discharge. A completely discharged single cell (less than 0.2 volts) is to be forced-discharge in accordance with method 2 of the forced-discharge test of UL-1642. One cell for each cell string shall be discharged at the rate specified (see 3.1) to a test end voltage of two-thirds of its open circuit voltage. It shall then be connected in series with the appropriate number

of charged cells which shall then be discharged at the rate specified (see 3.1) to a test end voltage of the applicable specification sheet. All cells shall comply with requirements (see 3.5.3.3).

TABLE V. Visual and mechanical inspection.

Defects	Method of Insp
Zero (0) voltage.	Voltmeter
Contact surfaces obstructed by insulation compounds so that electrical use is affected.	Visual
Improper assembly causing parts to be inoperative or unsafe in service.	Visual
Weight not within specified limits.	Scale
Location and polarity of receptacle not as specified.	Visual
Terminal markings, identification label and operating instructions not as specified.	Visual
Corrosion which could cause mechanical, operational or electrical failure.	Visual
Particles of solder, flux or other foreign material which could cause mechanical, operational or electrical failure.	Visual
Insulators or insulation missing or damaged so as to cause electrical failure.	Visual
Free movement of floating connector restricted.	Visual
Burrs or imperfections which interfere with proper use in operation, assembly or disassembly or cause an unsafe condition in service.	Visual
Contact surfaces of the terminals obstructed by insulation compounds.	Visual
Insulators or insulation damaged.	Visual
State of charge indicator displays state of charge	Visual

4.4.3 Group B inspection. This inspection shall conform to Table VI. The sample size shall be 6 batteries every 3 months. Group B inspection shall be performed on lots that have passed Group A . Samples for subgroup II may be selected from units that have passed subgroup I inspection.

4.4.3.1 Order of inspection within group B. Group B inspection shall be performed in that order shown in Table VI.

TABLE VI. Group B inspection.

Subgroup I	Req Para	Test Para
Dimensions and Weight	3.6	4.5.6
Capacity Discharge	3.11	4.7.2
High Rate Discharge	3.11	4.7.3
Subgroup II		
Low Temperature Discharge	3.11	4.7.4
Pulse Discharge	3.11	4.7.7
Overcharge	3.12	4.7.1.1
Electrical Leakage	3.10.1	4.9

4.4.4 Group C inspection. This inspection shall consist of the tests listed in Table VII. Inspection shall be performed in the order shown.

TABLE VII. Group C inspection.

Inspection Paragraph	Requirement Paragraph	Test Paragraph	Battery Sample
Thermal Shock	3.12	4.8.1	1-4
Altitude	3.18	4.13	1-4
Shock, mechanical	3.12	4.8.2	1-4
Vibration	3.12	4.8.3	2,3
Transient Drop	3.12	4.8.4	1-4
Immersion	3.13	4.8.5	1-4
Full capacity discharge	3.11	4.7.2	1-4
Retention of charge	3.11	4.7.5	1-4
Cycle life	3.11	4.7.6	5,6
Electrical leakage	3.10.1	4.9	1-4
Battery Vent-Case	3.4.2, 3.14	4.10	1,4
Battery Safety tests	3.16		2,3

4.4.4.1 Sampling for group C inspection. Four samples shall be selected every twelve months and subjected to the inspections of table VII, with the exception of the cycle life inspection. An additional two samples shall be subjected to the cycle life inspection for 28 cycles.

4.4.4.2 Group C failures. Actions required relative to group C failures shall be as specified in the contract or purchase order.

4.5 Inspection conditions and equipment.

4.5.1 Normal temperature. Unless otherwise specified herein, all measurements and tests shall be made at 23 ± 5°C (73.4 ± 9°F) at ambient atmospheric pressure and relative humidity with a minimum storage time of 2 hours between charge and discharge except for cycle life test.

4.5.2 Low temperature. Low temperature charged storage and discharge tests shall be conducted at the temperature indicated in the applicable specification sheets, with a minimum storage time of 16 hours between charge and discharge. Tolerances of specified temperatures shall be kept within ± 1.1°C (2°F).

4.5.3 High temperature. High temperature charged storage and discharge tests shall be conducted at the temperature and for the length of time indicated in the applicable specification sheet. A minimum storage time of 16 hours at the specified temperature shall be required to achieve temperature stability before any high temperature charge or discharge or for a discharge following high temperature storage. Tolerances of specified temperatures shall be kept within ± 1.1°C (2°F).

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

4.5.5 Instrument accuracy.

4.5.5.1 Electrical indicating instruments. All voltmeters and ammeters shall be accurate within ± 1 percent of the full scale reading. The range shall be such that the readings are taken on the upper half of the scale. The sensitivity of voltmeters shall be at least 1000 ohms per volt.

4.5.5.2 Resistor and current tolerances. In all tests involving discharge through 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% of the specified value.

4.5.5.3 Timing. The timing of discharges one minute or less shall be maintained within 5 percent. All others shall be accurate within 1 percent.

4.5.6 Dimensions and weight. The battery shall be weighed and measured for conformance to the requirements of the specification sheets. A gauge or other suitable measuring device shall be used to determine dimensional conformance.

4.6. Insulation resistance (battery terminals and cell series string). Insulation resistance test shall be performed, except as otherwise specified (see 3.1). Batteries and cell series strings shall be stored for a period of 48 hours at +70 ±5 ^{o} F and a relative humidity of 50 ±15 percent. After

storage and while at these conditions, the insulation resistance shall be measured by applying a direct-current potential of 500 ±20 volts between any two battery terminals or cell series string terminations not electrically connected and between all ungrounded terminals and the container of the battery. The insulation resistance of batteries and cell series strings having non-metallic containers shall be measured by the use of an appropriately sized copper plate making physical contact with the container or cell series string. The plate shall be placed with the broad surface against any areas of any surface other than that on which the battery terminals or cell series strings terminations are located (see 3.3.2).

4.7 Electrical performance tests.

4.7.1 Charging. All batteries shall be charged by a constant current method or constant potential (voltage) at normal temperature conditions per 4.5.1 at a minimum C/2 rates and for the length of two hours specified in the applicable paragraphs and specification sheet (see 3.1) except as provided for in paragraph 4.7.1.2.

4.7.1.1 Overcharge. Batteries shall be charged per 4.5.1 at the rate specified in the applicable specification sheet for the specified number of hours. Voltage readings shall be recorded and meet the requirements of 3.12.b. The battery shall then be discharged and meet the overcharge test of the applicable specification sheets. The battery shall be examined to insure compliance with all requirements of paragraph 3.12.

4.7.1.2 Rapid Charging. The battery shall be charged within 2 hours or less by an approved charger or when permitted in specific tests and approved by the Government, batteries may be charged by a quick charge method (2 hours or less) employing control methods relying on sensing changes in voltage with time (negative delta V) or temperature sensing or both or equivalent.

4.7.1.3 Charging Acceptance. Batteries shall be capable of accepting charge at temperature from 4°C to +45°C. The battery shall be conditioned in accordance with the requirement of paragraphs 4.5.2 and 4.5.3.

4.7.2 Full capacity discharge. After being charged in accordance with 4.7.1 the battery shall be stabilized per 4.5.1. It shall then be discharged at the rate specified on the applicable specification sheet to the specified final voltage, and meet full capacity discharge test of the applicable specification sheet.

4.7.2.1 Initial full capacity discharge. For initial full capacity discharge, the battery, when subjected to the test specified in 4.7.2 shall meet the performance specified in the applicable specification sheet within any one of the first three cycles. Any cycle in which less than initial full capacity is achieved is not counted as part of cycle life requirement.

4.7.3 High rate discharge.

a. The battery shall be charged per 4.7.1 or per 4.7.1.2 and stored under the specified temperature and storage conditions.

b. The battery shall then be discharged at the rate specified in the applicable specification sheet.

c. The following shall be recorded:

(1) The terminal voltage, 5 seconds after the start of discharge.

(2) The elapsed time for the voltage to drop to the final voltage specified on the specification sheet after the start of discharge. The battery shall meet the high rate discharge test of the applicable specification sheet.

4.7.4 Low temperature discharge. Charge as specified in 4.7.1 or 4.7.1.2. The battery shall then be stored per 4.5.2. Discharge as specified at the low ambient temperature to the specified final voltage, and meet low temperature discharge test of the applicable specification sheet.

4.7.5 Retention of charge (at high temperature). The battery shall be charged as specified in 4.7.1. It shall then be stored under high temperature conditions (4.5.3) for the number of days specified in the applicable specification sheet. It shall then be discharged at ambient temperature at the rate specified on the applicable specification sheet to the specified final voltage and meet retention of charge test of the applicable specification sheet. The subsequent discharge capacity shall be at least 94% of the full discharge capacity as specified on the applicable specification sheet.

4.7.6 Cycle life test. The battery shall be tested as follows at the temperature specified in 4.5.1:

a. Cycle 1 - Charge per 4.7.1, discharge at $0.5C_5$ to the discharge cutoff voltage.

b. Cycles 2-26 - Charge at C/2 or higher for 2 hours or per 4.7.1.2, discharge at the rate specified on the applicable specification sheet for 100% of initial full discharge capacity. Allow 5 minutes maximum rest time between charge and discharge. Allow 30 minutes maximum rest time between discharge and charge.

c. Cycle 27 - Charge per b above. Discharge per 4.7.2. Allow minimum of two hours of storage time at ambient temperature between charge and discharge.

d. Cycle 28 - Charge per 4.7.1, discharge per 4.7.2. Allow minimum of two hours of storage time at ambient temperature.

e. Check for electrical leakage (4.9).

f. Repeat cycles 1-28 until any of the following conditions occur:

(1) The capacity on any 28th cycle is lower than that specified on the cycle life test of the applicable specification sheet (see 3.1).

(2) The battery fails to pass the electrical leakage inspection of 4.9.

(3) The number of satisfactory cycles completed equals that specified on the applicable specification sheet.

4.7.7 Pulse discharge.

a. The battery shall be charged as specified in 4.7.1 or 4.7.1.2 and stored under the specified temperature and storage conditions (see 4.5.1).

b. The battery shall then be discharged at the rate and for the times specified in pulse discharge test of the applicable specification sheet until the end voltages specified are reached.

4.8 Environmental tests.

4.8.1 Thermal shock. With the battery in a discharged condition, it shall be subjected to temperature shock per Method 503, Procedure 1 of MIL-STD-810 at the temperature specified in 3.9.2, except the time at the temperature extremes shall be 2 hours and diurnal cycling not required. The container shall be examined for breaks, cracks, or other defects resulting from this storage. The requirements of 3.12 shall be met.

4.8.2 Mechanical shock tests (see 3.12).The batteries in a charged condition shall be rigidly attached to the test carriage by the mounting screws and shock tested at 40g for an 18 millisecond pulse duration in accordance with test Method 516, Procedure 1, of MIL-STD-810. Three shocks per axis, on each of the three orthogonal axis, shall be applied.

4.8.3 Vibration (see 3.12). With the battery fully charged, it shall be tested in accordance with Method 201 for low frequency conditions and Method 204, Test Condition C, Part 2 only for high frequency conditions of MIL-STD-202, with the following exceptions:

a. The battery may be vibrated in one plane through both low and high frequencies before being changed to the next plane on the vibration table.

b. The low frequency vibration may be varied either uniformly or logarithmically between the limits of 10 and 55 Hz and return to 10 Hz. The entire frequency range from 10 to 55 Hz and back to 10 Hz shall be traversed in approximately one (1) minute.

c. The length of time for low frequency vibration in one plane shall be 90-100 minutes (270-300 minutes for the complete test).

d. The battery shall be discharged at the rate specified on the applicable specification sheet in each plane during the low frequency vibration and the discharge continued to the specified final voltage. The capacity specified in the applicable specification sheet shall be met (see 3.1).

e. The voltage shall be recorded on a recording voltmeter during both high and low frequency vibration, and shall meet the requirements of 3.12.

4.8.4 Transient Drop Test. With the battery fully charged, it shall be dropped once, for each temperature, from a height of 30 ±2 inches onto a hard surface consisting of 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. The drop test shall be performed on batteries preconditioned at 130°F and -20°F. The batteries shall be stabilized a minimum of 4 hours at each test temperature and dropped within 10 minutes after removal from the temperature chamber. The battery shall meet all the requirement per paragraph 3.12. upon completion of the drop test.

4.8.5 Immersion. The battery shall be tested for leakage by either one of the test methods below and shall meet the requirements of 3.13 and the applicable specification sheet (see 3.1).

a. Method One - The battery with terminals protected against electrolytic action shall be immersed to a depth of 3 feet in fresh water for 2 hours. After 2 hours of immersion, the battery shall be removed and wiped dry on exterior surfaces. There shall be no evidence of leakage.

b. Method Two - Pressurize the battery with a minimum of 1.3 psig of gaseous N_2 for a minimum of 2 hours. Release the pressure and immediately transfer the battery into an immersion vessel. The battery shall be immersed in an upright position to a depth of 3 inches in fresh water. Carefully observe the battery (particularly the seals) for a total of 5 minutes for indication of leakage. Leakage shall be indicated by the emission of gas bubbles from the interior of the battery.

4.9 Electrical leakage. Electrical leakage shall be performed where indicated in Table III, VI, and VII. Voltage readings shall be taken from the case or ground to either terminal and between all electrically isolated terminals with a voltmeter having a 1 Megohm impedance. For example, on a battery with two parallel sections measure voltage from pin 1 to pins 2 to 5, etc. The battery shall meet the requirements of 3.10.1.

4.10 Battery case-vent test. Unless specified otherwise (see 3.1), a fully assembled battery shall be inserted 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. An air line shall be tapped into the battery and the internal pressure of the battery shall be increased 1.0 psia every 60 seconds until the battery case vent opens. The battery shall meet the requirement of 3.4.2. The fixture with the pressurized battery shall be lifted or positioned to allow the battery to slide out through the bottom of the fixture. If the pressurized battery cannot slide out of the fixture, weights shall be placed on top of the battery. The total force required (weights plus the weight of the battery) to allow the battery to slide out of the mount shall not exceed 12 pounds, and the battery shall meet the requirements of 3.14.

4.11 Battery safety tests.

4.11.1 High temperature Temporary Cutoff Charge as specified in 4.7.1 or 4.7.1.2. The battery shall then be stored per 4.5.3 at 75±5 ^{o}C. Measure and record the battery voltage. Allow the battery to cool down to 50±5 ^{o}C . The battery voltage shall return as specified in specification sheet. The battery shall meet the para 4.5.6 full capacity discharge.

4.11.2 High temperature Permanent Cutoff Charge as specified in 4.7.1 or 4.7.1.2. The battery shall then be stored per 4.5.3 at 90 ^{o}C. Measure and record the battery voltage. Allow the battery to cool down to 50 ^{o}C . The battery shall be less than 1 volt.

4.11.3 Short circuit protection. The battery shall be shorted across all the positive and negative terminals with a total external resistance less than 50 milliohms for one hour Then remove the short across the terminals. The battery shall meet the full discharge requirement of 3.11.

4.12 State-of-charge.

4.12.1 Power consumption. Connect the ammeter between the electronics within the battery and the battery. Measure and record the current flow between the battery and internal control and state of charge device. If it is a push ON state-of-charge display, push ON to display the state of charge device for 35 minutes, and record the current flow. Add the total ampere hour. The total ampere-hour shall be less than 50 milliamperes or less than 2% of the battery initial capacity whichever is less. If it is continue ON LCD measure the current flow between the internal control circuit and battery and state of charge display circuit and the battery. Use the I current X24 hours X 7 days = total ampere hour loss. The total ampere-hour shall meet the paragraph 3.17.1.

4.12.2 State of charge display characteristics. Charged as specified in 4.7.1 or 4.7.1.2. The battery shall then discharge at C/5 rate. The displays shall meet paragraph 3.17.2.

4.12.3 State of charge accuracy. When specified (see 3.1), four fully charged batteries shall be discharged at the 5±1 hour rate to the minimum voltage specified. If parallel discharge is specified for the battery under test, then two batteries shall be discharged in parallel and two in series configuration. Calculate the average capacity. Discharge four fully charged batteries (2 parallel, 2 series when specified) at the 5 hour rate to 80+0, -5 percent of average capacity.

Record the status indication. Discharge the batteries at the same rate to 50+5, -0 percent of average capacity. Record the indication. Discharge the batteries at this rate to 25+5, -0 percent capacity. Record the status indication. Discharge the batteries to 5+5, -0 percent capacity. Activate the state of charge indicator and record the status indication. Discharge the batteries to the cut-off voltage as specified (see 3.1). Record the status indication (see 3.17).

4.13 Altitude. Batteries shall be placed in an altitude chamber, in which the pressure is maintained at a value corresponding to an altitude of 50,000 feet and the temperature is kept at 75 ± 5^{o}F, for a period of six (6) hours (see 3.18). Upon completion of the altitude test, the battery voltage of 4.4.2.1 shall be tested and the battery shall be examined for visual and mechanical defects per 3.4.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of materiel is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department or Defense Agency, or within the Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

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. 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. Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1).

c. Packaging requirements (see 5.1).

d. When first article inspection and rough handling tests of equipment are not required.

e. If certification of parts, materials, or components are required (see 3.3).

f. Actions required relative to group C inspection failure (see 4.4.4.2).

g. Any additional case markings, dependent upon battery chemistry.

h Whether shipment of batteries may be made after successful completion of 28 cycles of cycle life test of group C inspection.

6.3 Definitions.

6.3.1 Fully charged batteries. Batteries are considered fully charged when charged in accordance with 4.7.1.

6.3.2 Discharged batteries. Batteries are considered discharged when a specified discharge rate was conducted until a specified final voltage was reached. For shipping purposes only the batteries may retain up to 10% of its capacity.

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

$$I = \frac{1}{t} C_5$$

where I = current in amperes
t = hourly rate of discharge
C_5 = rated ampere hour capacity

For example, the expression for the five hour discharge current for a 25 ampere hour battery will be $I = \frac{1}{5}(25) = 5$ 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, is 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., is known as the specified performance.

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 Definition of lot size.

6.5.1 Contract lot. The contract lot is the total of all batteries (exclusive of the number of batteries required as samples) of any one type, delivered in one or more inspection lots, under the terms of any one contract.

6.5.2 Inspection lot. The inspection lot is the quantity of batteries (exclusive of the number of batteries required as samples) of any one type of any one code, and produced at any one place of manufacture on any one contract.

6.6 Test report data. The following requirement applies to First Article and Quality Conformance Test Reports: Whenever there is a service or ampere hour requirement, the following data is to be included:

a. Initial Open Circuit Voltage (IOCV)

b. Initial Closed Circuit Voltage (ICCV)

c. Closed Circuit Voltage and Current are to be recorded at regular intervals. Interval are Service Requirement or shorter.

d. The time elapsed between ICCV and end voltage (EV).

e. Record how low a battery is discharged. Particularly whenever near zero volts.

Date and time of day that any portion of test is initiated are to be recorded in test report including initiation of soak at test temperature.

When a requirement limit is specified, a final quantitative figure should be recorded.

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 3.2), 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 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 Subject term (key word) listing.

Advanced chemistry
Lithium ion
Nickel Cadmium
Nickel metal hydride
Polymer

Custodians:
Army - CR

Preparing activity:
Army - CR

(Project 6140-A913)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.

2. The submitter of this form must complete blocks 4, 5, 6, and 7, and send to preparing activity.

3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:	**1. DOCUMENT NUMBER** MIL-PRF-32052(CR)	**2. DOCUMENT DATE (YYYYMMDD)** 19991207

3. DOCUMENT TITLE **BATTERIES, RECHARGEABLE, SEALED, GENERAL SPECIFICATION FOR**

4. NATURE OF CHANGE *(Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)*

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME *(Last, First, Middle Initial)*	b. ORGANIZATION	
c. ADDRESS *(Include Zip Code)*	d. TELEPHONE (Include Area Code) (1) Commercial (2) AUTOVON *(if applicable)*	**7.DATE SUBMITTED** (YYYYMMDD)

8. PREPARING ACTIVITY

a. NAME US ARMY COMMUNICATIONS-ELECTRONICS COMMAND	b. TELEPHONE *Include Area Code)* (1) Commercial (732) 532-9139 (2) AUTOVON 992-9139
c. ADDRESS *(Include Zip Code)* ATTN: AMSEL-LC-LEO-E-EP, FORT MONMOUTH, NJ 07703-5023	**IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT:** Defense Standardization Program Office (DLSC-LM) 8725 John J. Kingman road, Suite 2533, Ft. Belvoir, VA 22060-2533 Telephone (703) 767-6888 AUTOVON 427-6888