INCH-POUND

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PERFORMANCE SPECIFICATION

BATTERIES AND CELLS, STORAGE, NICKEL-CADMIUM, AIRCRAFT 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 the general requirements for rechargeable, vented, nickel-cadmium aircraft storage batteries, cells, and all components (electrical and non-electrical) thereof.

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.

Comments, suggestions, or questions on this document should be addressed to: The Naval Air Warfare Center Aircraft Division, Code 4L8000B120-3, Highway 547, Lakehurst, NJ 08733-5100 or by email to michael.sikora@navy.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST online database at http://assist.daps.dla.mil.

2.2 Government documents.

2.2.1 Specifications and standards. The following specifications and standards 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 (see 6.2).

SPECIFICATIONS

DEPARTMENT OF DEFENSE

MIL-PRF-16173	-	Corrosion Preventive Compound, Solvent Cutback, Cold Application.
MIL-D-16791	-	Detergents, General Purpose (Liquid, Nonionic).

(See supplement 1 for list of specification sheets.)

STANDARDS

FEDERAL

FED-STD-595	-	Colors Used in Government Procurement. (Color Numbers 15090, 15092, 15095, 15102, 15107, 15109, 15123, 15125, 15177, 15180, 15182, 15187, 15193 (Blue))

DEPARTMENT OF DEFENSE

MIL-STD-202	-	Test Methods for Electronic and Electrical Component Parts.
MIL-STD-810	-	Environmental Engineering Considerations and Laboratory Tests.
MS3509	-	DELETED

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

2.3 Non-Government publications. The following document forms a part of this document to the extent specified herein. Unless otherwise specified, the issue of this document is the one which is cited in the solicitation or contract (see 6.2).

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME-Y14.38	-	Abbreviations and Acronyms.

(Copies of these documents are available from http://www.asme.org or ASME, 22 Law Drive, P.O. Box 2900, Fairfield, NJ 07007-2900.)

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 associated specifications or 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 Qualification. The batteries, cells, and components furnished under this specification shall be products that are authorized by the qualifying activity for listing on the applicable qualified products list before contract award (see 4.2 and 6.4).

3.3 Sequence of paragraphs. The sequence of requirement and test paragraphs are in the order in which the testing is required.

3.4 Materials and components. Materials or components (see 6.13.3) that are specified shall be in accordance with the applicable specification or requirement listed in table I. Aluminum, polycarbonate, or polyester (see 6.10.1) shall not be used in the construction of any battery, cell, or component covered by this specification. Except for the hold-down pad, neoprene (see 6.10.2) shall not be used in the construction of any battery, cell, or component covered by this specification. Upon request of the qualifying activity, the battery, cell, or component manufacturer shall supply a certification of conformity of the material or component.

3.5 Dissimilar metals. Unless protected against electrolytic corrosion, dissimilar metals shall not contact each other (see 6.10.11).

3.6 General. The batteries, cells, and components shall meet the requirements when examined in accordance with the incoming inspection of 4.5.1 and the visual and mechanical tests of 4.5.6.

3.6.1 Cleanliness. After fabrication, parts and assembled equipment shall be free of smudges; loose, spattered, or excess solder; weld metal; metal chips and mold release agents; or

any other foreign material which might detract from the intended operation, function, or appearance of the equipment.

3.6.2 Fasteners. Fasteners (including screws, nuts, bolts, threaded washers, and lock washers) shall be free of any coating, firmly secured, and shall meet the requirements of 3.10.2 and 3.10.19. Threaded fasteners shall not show evidence of cross threading, mutilation, burrs, or visible plating defects.

3.6.3 Surfaces. All surfaces shall be free of rust, discoloration, and imperfections due to machining processes such as grinding, honing, or lapping. Contacting surfaces shall be free of tool marks, gouge marks, nicks, or other surface-type defects. Interference, binding, or galling shall not be present.

3.6.4 Wiring. Wires and cables shall be positioned or protected to avoid contact with rough or irregular surfaces and sharp edges and to avoid damage to conductors or adjacent parts.

3.6.4.1 Shielding. Shielding on wires and cables shall be insulated and secured to prevent it from contacting or shorting exposed current-carrying parts. The ends of the shielding or braid shall be secured to prevent fraying.

3.6.4.2 Containment method. The harness containment method, such as lacing, ties, or tiedown straps, shall be neat in appearance and uniformly applied to maintain shape and position of breakout locations. The containment shall not cause the wires to bind or deform nor cause the insulation to chafe.

3.6.4.3 Insulation. Burns, abrading, or pinch marks in the insulation that could cause short circuits or leakage shall not be present.

3.6.4.4 Clearance. Clearance shall be provided between wires or cables and heat-generating parts to prevent deterioration of the wires or cables.

3.7 Design. Each type of nickel-cadmium storage battery, cell, and component covered by this specification is listed in the specification sheets. The design shall conform to the requirements specified below when examined in accordance with the visual and mechanical tests of 4.5.6. Requirements for the individual types of batteries, cells, and components are specified in the applicable specification sheets (see 3.1).

3.7.1 Batteries. Batteries shall be in a wet, fully discharged, and fully formed (see 6.13.8, 6.13.9, and 6.13.20) state with a shorting strap across the receptacle terminals.

3.7.2 Battery container and cover. The battery container and cover shall be either made of a material or be protected with a material that is impervious to salt spray and to an aqueous solution of potassium hydroxide of 1.30 ± 0.04 specific gravity (see 6.10.1) and an alternate electrolyte if used. The battery container and cover shall be free of pits, blow holes, rough spots, and other deformations. The container and container cover may be constructed of materials that are not identical. The dimensions and locations of receptacles, hold-downs, latches (catches and strikes), vent tubes, and battery identification shall conform to the applicable specification sheet. The cover shall be fitted with a hold-down pad having an integral gasket positioned so as to match the rim of the container body for a gastight fit and effective fluid seal between the cover and the container body. Metal or wood products (such as cork) shall not be used as the gasket. If elastomers are used as the gasket, the elastomer shall conform to the requirements of 3.10.3 (see 6.10.2).

3.7.3 Materials. The material of hold-down pads, gaskets, and O-rings shall provide a proper seal and minimize compression set. Elastomeric material shall conform to the requirements of 3.10.3 (see 6.10.2). Spacers, liners, and shims used inside the battery container shall be made of nonporous, alkali-resistant sheet material such as polyamide in accordance with table I (see 6.10.1). The sheet shall be not less than 0.015 inch thick, color natural.

3.7.4 Latches. Latches shall fasten the cover to the container body by catches mounted on the container body and strikes mounted on the cover. The latches (catches and strikes) shall be located as shown on the applicable specification sheet. Unless otherwise specified on the applicable specification sheet, the method of mounting the strikes and catches is optional. The catches and strikes shall be free of any coating and shall meet the requirements of 3.10.2 and 3.10.19. The interchangeability requirements of battery containers and battery covers as well as the mating requirements of batteries to battery charger/analyzers, cell scanner fixtures, and cell equalization fixtures require that the latches shall mate with:

a. Catch model number 834PSS and strike model number S834 (manufactured by CCL Security Products, Eastern Company, New Britain, CT 06050) or

b. Catch model number C-83314-2-SS and strike model number S-83314SS (manufactured by Nielsen Hardware, Zero Corporation, Hartford, CT 06141).

3.7.5 Handles. Each battery weighing more than 55 pounds shall have a set of handles (see 6.10.3) for carrying the battery. Handles may be placed on batteries less than or equal to 55 pounds. If handles are used, they shall be in accordance with the following requirements. Flexible or rigid handles are permitted (see 6.10.3).

3.7.5.1 Location and operation. The number and location of handles shall be as shown on the applicable specification sheet. When the battery is installed, the handles shall lay flat

against the battery. The handles shall flip up and extend away from the battery 90° ±10° to permit carrying the battery. The mounted handles shall not interfere with the operation of the cover latches, the removal of the battery lid, the operation of the receptacle(s) and battery cable(s), or the vertical battery hold-down rod of maximum diameter that will fit in the slot of the hold-down bar. Holes shall not be cut in the handle mounting flange to provide clearance for installing the battery hold-down rod.

3.7.5.2 Mounting, coating, and usability. Neither fasteners nor adhesive methods shall be used to mount the handles (see 6.10.3). The handles shall be free of any coating and shall meet the requirements of 3.10.2, 3.10.10, and 3.10.19. Each handle shall include an opening measuring not less than 1.6 inches by not less than 4.375 inches for hand insertion.

3.7.6 Hold-down bar. The outer 7/8-inch of both the top and bottom surfaces of each hold-down bar shall be free of any coating.

3.7.7 Vent tubes. The container body shall be provided with tubular vents to permit purging of the gases liberated by the cells of the battery. These vents shall be located as shown on the applicable specification sheet. Air shall flow freely into and through any vent tube and exit through another vent tube. For storage and shipment, container vent tubes shall be provided with a means that retains free electrolyte within the battery container and excludes foreign material and is easily removable prior to servicing and installing the battery.

3.7.8 Receptacles. Each battery shall include a main power receptacle in accordance with the applicable specification sheet as the battery's interface to the aircraft electrical system. Power and charger/sensor receptacles shall be covered by nonconductive protective caps when transported.

3.7.9 Connectors, intercell. The connectors shall conform to the applicable specification sheet. All electrical connections within the battery shall be surface-to-surface conduction and not through screw threads. Intercell connections shall not interfere with the removal of the cell vented filler caps. On limited repair batteries, intercell connections shall not interfere with the removal of removable charger harnesses. Epoxy or other plastics shall not be used to cover the internal connectors or their fasteners. Tamper-resistant hardware shall not be used on receptacles or harnesses. To impede cell removal, the intercell connectors used in limited repair batteries (see 6.13.12) shall be attached to the cell posts by the use of tamper-resistant means, such as tamper-resistant fasteners, that shall be difficult to remove but which shall not injure the cell upon removal. If a tamper-resistant means other than shear-head screws are used, then perform the test of 4.5.31. If the battery uses more than one type of tamper-resistant fastener, then each type shall be submitted for this test. If two types are used, then each shall be represented on the cell sample of 4.2.1. If three or more types are used, then additional cells shall be submitted (see 6.2). After being tested in accordance with 4.5.31, the tamper-resistance

shall be evidenced by either one of the following: 1) The casting is damaged upon separation from the fastener or 2) the casting is unable to apply torque in the direction of fastener removal. The cell shall not show any evidence of damage after being tested in accordance with 4.5.31. Rivets, welding, or adhesive methods shall not be used to attach the intercell connectors of limited repair batteries.

3.7.10 Corrosion prevention. After the battery has been assembled and all hardware fully tightened, all exposed metal surfaces of the cells, intercell connectors, and associated hardware shall be coated with a corrosion preventive compound which conforms to the requirements of MIL-PRF-16173, grade 4. Vent valve rubber sleeves, vent openings, and the interfaces between current-carrying surfaces shall not be exposed to the corrosion preventive film. The coating shall be applied evenly and without voids.

3.7.11 Cells. The following applies both to cells assembled into batteries and to cells furnished individually for installation and assembly by the end user. All cells within the battery shall be the same part number from the same manufacturer. All cells within a battery shall be from the same production lot. The cells shall be secured in the battery container. The position of the cells shall not shift during the performance of any required test so as to cause a test failure. All cells shall be furnished in a fully discharged, fully formed, and wet state (see 6.13.8, 6.13.9, and 6.13.20).

3.7.11.1 Cell container. The cell container shall be made of non-porous, alkali-resistant material, such as polyamide. The surfaces of containers shall have a smooth finish, free from pits, cracks, blow holes, rough spots, or other deformations.

3.7.11.2 Cell terminals. The size and spacing shall be as specified in the applicable specification sheet. The contact surfaces of the terminals shall not be coated with corrosion preventive compounds (see 3.7.10).

3.7.11.3 Cell seals. The seals between the terminals and cell cover and between the cell cover and cell case shall be formed such that the cell shall conform to the requirements of 3.7.11.7 and 3.10.26. If elastomers are used as the cell terminal seal, the elastomer shall conform to the requirements of 3.10.3. Neoprene (see 6.10.2) shall not be used as the elastomer. Adhesive compounds or solvent welding shall not be used for the cover-to-case seals (see 6.10.1).

3.7.11.4 Gas barrier and separator system. The gas barrier and separator system, a critical safety component of the battery in preventing thermal runaway shall meet the requirements of 3.7.11.4.1 and 3.7.11.4.2 below (see 6.10.4).

3.7.11.4.1 Materials. Celgard 3400 shall not be used as the gas barrier material in a

separator system. Cellophane shall not be used as the gas barrier material in a separator system. Wetting agents shall not be soluble in the electrolyte or in water. If dispersants are used to apply the wetting agents, the dispersants shall not leave any residue that will increase the surfactant's solubility in the electrolyte or in water. Surfactants and dispersants shall not contain any sulfur component that can become soluble in the electrolyte.

3.7.11.4.2 Acceptability for use. Gas barrier and separator systems used in batteries procured in accordance with this specification shall be tested in accordance with 4.5.28 and meet the requirements of 3.10.28. If a gas barrier and separator system is proposed for use in a battery procured under this specification, then the following shall occur. A sample MIL-PRF-81757/16-1 battery incorporating the proposed gas barrier and separator system and containing the M81757/2-7 snorkel-type vented filler cap shall be tested in accordance with 4.5.28. If the sample battery then meets the requirements of 3.10.28, the qualifying activity will determine if the proposed gas barrier and separator system is acceptable for use.

3.7.11.4.3 Other samples. DELETED

3.7.11.5 Cell baffle. The cell baffle shall be used as the reference for electrolyte adjustment (see 3.10.12). The baffle shall be designed to ensure a uniform electrolyte level across the entire cell during a C/3 overcharge rate (see 6.9 and 6.13.2).

3.7.11.6 Vented filler cap. All vented filler caps and covers shall be tightened onto the cells.

3.7.11.7 Electrolyte leakage. Liquid electrolyte, foaming electrolyte, or spilled electrolyte shall not be permitted outside the cells during the performance of any of the tests specified in section 4. Only traces of liquid at the edges of the vented filler cap's vent band or a small amount of white residue around the outside of the band is permitted.

3.7.11.8 Electrolyte. The cells shall contain the amount of electrolyte that will align the electrolyte level in accordance with 4.4.4 immediately after the end of charge. The electrolyte chosen for use shall enable the battery to meet the requirements specified herein (see 6.10.5). Upon request of the qualifying activity, the battery, cell, or component manufacturer shall supply a certification of conformity of the electrolyte. If the electrolyte chosen for use is potassium hydroxide, then the electrolyte shall have a specific gravity of 1.25 to 1.30 for batteries with a standard reserve of electrolyte. Batteries with a high reserve of electrolyte shall have a specific gravity of 1.25 to 1.27.

3.7.12 Vented filler cap. The vented filler cap shall meet the requirements of the applicable specification sheet. Each vented filler cap shall be made entirely of electrically nonconductive materials that comply with 3.10.3. The body of the vented filler cap, including any attached

electrolyte deflector, shall be made of nonporous, alkali-resistant material, such as polyamide in accordance with table I (see 6.10.1). If elastomeric material is used for the O-ring or check valve, the elastomer shall conform to the requirements of 3.10.3. Neoprene shall not be used as the elastomer (see 6.10.2). The durometer hardness rating of the O-ring shall be not greater than 55 on the Shore A scale. The finish on all surfaces of the vented filler cap shall be free of any manufacturing flaws, irregularities, or mold part lines that will inhibit installation or an airtight seal when mated with the cell. The surfaces shall have a smooth finish, free from pits, cracks, blow holes, rough spots, or other deformations.

3.7.13 Voltage. Unless otherwise specified on the applicable specification sheet, the nominal voltage of the battery shall be 24 volts.

3.7.14 Thermal runaway. The battery, when properly maintained, shall not go into thermal runaway (see 6.10.4 and 6.13.18) during its lifetime. The battery shall not go into thermal runaway during any qualification or group C testing.

3.8 Color and marking. The batteries, cells, and components shall conform to the requirements listed below and in the applicable specification sheet when examined in accordance with the visual and mechanical tests of 4.5.6.

3.8.1 Color. The color of the container and cover except latches, hold-down hooks, other external hardware, hold-down pads and liners, and identification marking of each battery shall conform to FED-STD-595 within the range of color numbers 15090 to 15193 (blue) under natural light. The coloring material or coating shall be an electrical insulator and shall be impervious to an aqueous solution of potassium hydroxide of 1.30 ± 0.04 specific gravity when tested in accordance with 4.5.2. If the battery container body has not been coated with a protective material (see 3.7.2), the battery shall be identified as an alkaline battery by coloring only the container cover and label backgrounds a blue color which is in accordance with FED-STD-595 within the range of color numbers 15090 to 15193 (blue) under natural light; the rest of the container shall be the natural color of the container material (see 6.10.7 and 6.12). The color of the cell container shall be the natural color of the material (other than red) with no pigments added, except as noted in 3.8.3.2.

3.8.2 Date/lot code. The date/lot code shown shall indicate the month and year of manufacture and the lot code of the battery and cells. The code shall consist of a six-digit number in which the first two digits indicate the month of the year, the middle two digits indicate the year (followed by a dash), and the last two the inspection lot (see 6.13.11) number. Months earlier than the tenth shall be indicated by a single digit preceded by "0". For example, date/lot code 0498-12 indicates the item was manufactured in April 1998 and was part of the twelfth inspection lot. The date of manufacture for a cell shall be the date when the cell jar is permanently sealed. When the manufacture of a battery and cell is completed during the last

three working days of the month or the first three working days of the next month, the manufacturer may use either month as the coded month of manufacture.

3.8.3 Polarity markings.

3.8.3.1 Batteries. The polarity shall be conspicuously and durably marked on the battery container and adjacent to the terminals as shown on the applicable specification sheet.

3.8.3.2 Cells. Positive terminal markings shall be impressed or embossed with a "+". Negative terminal markings shall be impressed or embossed with a "-". The polarity marking shall be placed on the cover of the cell as close as possible to the terminal. For cells furnished separately from a battery or contained in batteries with removable cells, the positive half of the cell cover shall be permanently dyed red. The width of the red band shall be not less than 0.5 inch.

3.8.4 Battery identification. Each battery shall have its identification marking as specified in the following paragraphs and the applicable specification sheet. The marking (see 6.10.8) shall be impervious to the indicated test solutions when tested in accordance with 4.5.2. The marking shall be in white print. Label plates, if used, shall not be mounted with fasteners, such as screws or rivets. Unless otherwise specified, the marking shall use a type size of not less than 12 points.

3.8.4.1 Limited-repair batteries. The marking for limited-repair (see 6.13.12) batteries shall contain the required titles and information in a two-column format as shown on figure 1. The manufacturer shall fill in the applicable information at indicated areas. Abbreviations in accordance with ASME-Y14.38 and acronyms are permitted. The date/lot code shall be constructed in accordance with 3.8.2. The blank area following the entry Date First Placed in Service shall be capable of being written on with a felt tip permanent marker. The battery's serial number shall either be included as part of the label as shown on figure 1 or placed elsewhere on the battery.

3.8.4.2 Repairable batteries. The marking for repairable (see 6.13.16) batteries shall contain the required titles and information in a two-column format as shown on figure 2. The manufacturer shall fill in the applicable information at indicated areas. Abbreviations in accordance with ASME-Y14.38 and acronyms are permitted. The date/lot code shall be constructed in accordance with 3.8.2. The battery's serial number shall either be included as part of the label as shown on figure 2 or placed elsewhere on the battery.

3.8.4.3 Battery caution and receptacle marking. The battery caution and receptacle marking shall be located as shown on the applicable specification sheet. The marking shall be in

accordance with figure 3 in terms of required information and sequence of information. The lettering height shall be not less than that specified on figure 3.

3.8.5 Cell identification. Each cell shall be provided with permanent identification impervious to an aqueous solution of potassium hydroxide of 1.30 ± 0.04 specific gravity when tested in accordance with 4.5.4. Each cell shall have the manufacturer's name, the date/lot code (see 3.8.2), the polarity, and the type of gas barrier and separator system (e.g., "GSS"; see 6.10.4) impressed or embossed on the top of the cell. Cells contained in batteries with removable cells or cells furnished separately from a battery shall also have the military Part or Identifying Number (PIN) impressed or embossed on the top of the cell and shall require on the side of the cell the required titles and information in a two-column format as shown on figure 4 and the applicable specification sheet. The cell shall include all the applicable information at indicated areas. Abbreviations and acronyms are permitted. The marking shall be placed on one of the two largest vertical surfaces of the cell and shall be in black print. Label plates, if used, shall not be mounted with fasteners, such as screws or rivets. The marking shall use a lettering height of 0.150 ± 0.040 inch (for example, 8 to 12 point type).

3.8.6 Vented filler cap identification. The vented filler caps shall conform to the requirements listed below. The identification and color shall be impervious to an aqueous solution of potassium hydroxide of 1.30 ± 0.04 specific gravity when tested in accordance with 4.5.3.

3.8.6.1 Part or identifying number. The assigned PIN shall be impressed or embossed on each vented filler cap. This marking shall be located as shown on the applicable specification sheet. If necessary due to space limitations, the PIN may be broken or separated at the slash and the slash omitted. The height of the numerals after the slash shall be not less than 0.10 inches.

3.8.6.2 Date code. A date code consisting of at least the last two numerals of the year manufactured shall be impressed into the top of the vented filler cap. The height of the numerals shall be not less than 0.10 inches. The date code shall be underlined.

3.8.6.3 Manufacturer identification. The manufacturer's CAGE code shall be impressed or embossed on each vented filler cap. The preferred location for this marking is the area between any two splines except the area used for the PIN marking.

3.8.6.4 Cap color. The color of each vented filler cap shall be in accordance with the applicable specification sheet.

3.8.7 Cell electrolyte level marking (low-maintenance vented batteries only). Each cell of a low-maintenance vented battery (see 6.13.13) shall contain permanent marking(s) that identify the correct electrolyte level when adjusting the electrolyte in accordance with 4.4.4. The

marking(s) may be a black line 1/32-inch (nominal) thick or by another permanent easily identifiable means, such as a step, notch, or slot in the baffle wall. Additional wording shall not be added. The marking(s) shall be inscribed on the cell container side wall(s) or the cell baffle. The marking(s) may be inscribed on both. The marking(s) shall be plainly visible when sighting through the cell's vented filler cap top opening once the cell is installed in the battery.

3.9 Environmental requirements. The battery, cell, or component, when subjected to any tests specified herein, shall not show:

a. Dimensional distortion or bulging beyond specified limits.

b. Cracking of cases or covers of either cells or batteries.

c. Radical current or voltage fluctuations.

d. Mechanical failure of any part.

e. Electrolyte leakage (see 3.7.11.7).

f. Breakdown of insulation, stripping of metal plating from any component part, corrosion of metal parts, or loosening of protective coating from the battery container or cover.

g. Deterioration of battery, cell, or component identification markings.

h. Thermal runaway (see 3.7.14).

i. Thermal switches not as specified nor operating as specified in the applicable specification sheet.

3.10 Examination and test requirements.

3.10.1 Condition of battery. The battery container shall not exhibit scratches, gouges, dents, torn material, leakage, or other damage when inspected in accordance with 4.5.1. Any such damage may justify termination of further test and inspection.

3.10.2 Electrolyte resistance (metal parts). External and internal metal parts of each battery, cell, and component shall not show cracking, pitting, chipping, scaling, corrosion, or other deleterious effects during or after the testing specified in 4.5.2. Identification markings shall not exhibit smudging, smearing, chipping, crazing, or other deleterious effects during or after the testing specified in 4.5.2. The item shall also meet the requirements of 3.8.1, 3.8.4, and 3.9.

3.10.3 Electrolyte resistance (components and elastomeric materials). Components (see 6.13.3) and elastomeric materials used in the battery shall not show cracks, blisters, or other deterioration after being tested in accordance with 4.5.3. Electrical parts shall perform with no evidence of functional degradation after being tested in accordance with 4.5.3. All the components of the charger harness including thermal switches, transducers, and internal heaters shall meet the requirements herein and of the respective specification sheet after being subjected to the soak test of 4.5.3. If the component is integral to the battery, that is, if the component is nonremovable, the contractor shall provide a unit (see 6.13.19) to soak separately from the battery. The components and elastomeric materials shall also meet the requirements of 3.9.

3.10.4 Electrolyte absorption by plastic material. Plastic materials shall not show cracks or blisters and shall change not more than 2.5 percent in weight or 2.0 percent in any dimension after being tested as specified in 4.5.4. Identification markings shall not exhibit smudging, smearing, chipping, crazing, or other deleterious effects during or after the testing specified in 4.5.4. The item shall also meet the requirements of 3.8.5 and 3.9.

3.10.5 Vented filler caps. Vented filler caps conforming to the applicable specification sheet shall vent at 6 ± 4 psig when tested to 4.5.5. For aerobatic vented filler caps, air shall vent only from the vent band when tested to 4.5.5. The vented filler caps shall also meet the requirements of 3.6, 3.7.12, 3.8.6, 3.9, table II, and the applicable specification sheet.

3.10.6 Visual and mechanical. All items supplied under this specification shall be in accordance with 3.6 through 3.8, table II, and the applicable specification sheet when subjected to the examination of 4.5.6.

3.10.7 Cell insertion force (repairable batteries only). Unless otherwise specified in the applicable specification sheet, the cell insertion force shall be 20 ± 10 pounds. The batteries and cells shall meet all the requirements specified herein after shimming and the test of 4.5.7.

3.10.8 Dimensions and weights. The dimensions and weights of batteries, cells, and components shall be as shown on the applicable specification sheet after the inspection of 4.5.8. All dimensions shall be measured after the item has been completely coated, if coating is used.

3.10.9 Bulging. Unless otherwise specified in the applicable specification sheet, bulging of the battery container shall be not greater than 2 percent of the distance between corners, edges, or weldments in a direction normal to the measured surface after the inspection of 4.5.8. The maximum specified for battery dimensions shall not be exceeded. Bulging of the partitions in the battery container is a possible result of electrical or environmental testing.

3.10.10 Handle strength. Each handle shall not show any evidence of breaking away from the container or other damage after being tested in accordance with 4.5.9. The handles and battery shall also meet the requirements of 3.9.

3.10.11 Cover seal. The seal between the battery container body and container cover shall not leak after being tested in accordance with 4.5.10. The battery container and cover shall meet the requirements of 3.9.

3.10.12 Cell baffle. The variance in the electrolyte level across the entire cell during a C/3 overcharge rate shall be not greater than 0.05 inch. The cell baffle shall not impede the flow of electrolyte when the cell is returned upright after being tested in accordance with 4.5.11. The cell baffle shall also meet the requirements of 3.7.11.5.

3.10.13 Cell vents. Cells shall not have gases venting from any location other than from the cell vented filler cap vents after being tested in accordance with 4.5.12.

3.10.14 Capacity. The initial capacity and the minimum capacity (see 6.9, 6.13.1, 6.13.2, 6.13.10, and 6.13.14) shall be as shown on the applicable specification sheet.

3.10.14.1 Initial capacity. To meet the initial capacity requirement, each cell shall produce a potential of not less than 1.0 volt at the time shown on the applicable specification sheet during the C-rate discharge after being tested in accordance with 4.5.13 at room temperature (see 4.4.1).

3.10.14.2 Minimum capacity. The minimum capacity requirement shall be met as follows.

3.10.14.2.1 Low-maintenance vented batteries. Each cell of a low-maintenance vented battery (see 6.13.13) shall produce a potential of not less than 1.0 volt and each battery shall produce a potential of not less than 20.0 volts at not less than 60 minutes into the C-rate discharge after being tested in accordance with 4.5.13 at room temperature (see 4.4.1).

3.10.14.2.2 Other batteries. Each cell shall produce a potential of not less than 0.95 volts and each battery shall produce a potential of not less than 18.0 volts at not less than 60 minutes into the C-rate discharge after being tested in accordance with 4.5.13 at room temperature (see 4.4.1).

3.10.15 Humidity and charge retention. The battery shall perform as follows after being tested in accordance with 4.5.14.

a. Capacity requirements:

(1) Low-maintenance vented batteries. Each cell shall produce a potential of not

less than 1.0 volt at not less than 60 minutes into the C-rate discharge.

(2) All other batteries. Each cell shall produce a potential of not less than 0.95 volts at not less than 45 minutes into the C-rate discharge.

b. The battery shall also meet the requirements of 3.9 during and after testing and discharge.

3.10.16 Shock (basic design). The battery shall perform as follows after being tested in accordance with 4.5.15.

a. The battery shall produce a potential of not less than 0.758 volts times the number of active cells that the battery contains at not less than 5 minutes into the 9C-rate discharge.

b. The battery shall also meet the requirements of 3.9 during and after testing and discharge.

3.10.17 Temperature shock. The battery shall perform as follows after being tested in accordance with 4.5.17.

a. The battery shall produce a potential of not less than 0.758 volts times the number of active cells that the battery contains at not less than 5 minutes into the 9C-rate discharge.

b. The battery shall also meet the requirements of 3.9 during and after testing and discharge.

3.10.18 Altitude. The battery shall perform as follows after being tested in accordance with 4.5.18.

a. The battery shall produce a potential of not less than 0.758 volts times the number of active cells that the battery contains at not less than 3 minutes into each of the two 9C-rate discharges.

b. The battery shall also meet the requirements of 3.9 during and after testing and discharge.

3.10.19 Salt fog. The battery shall not show any evidence of corrosion after being tested in accordance with 4.5.19. The battery shall also meet the requirements of 3.9.

3.10.20 Twenty-second pulse discharge. The battery shall perform as follows after being tested in accordance with 4.5.20.

a. The battery shall produce a potential of not less than 12.0 volts at not less than 5 seconds into the discharges.

b. The battery shall produce a potential of not less than 18.0 volts at not less than 20 seconds into the discharges.

c. The battery shall also meet the requirements of 3.9 during and after charge and discharge.

3.10.21 Medium-rate discharge, operating position. The battery shall perform as follows after being tested in accordance with 4.5.21.

a. The battery shall operate in an inverted position without the loss of any electrolyte from the cells.

b. The battery potential at any point during the discharge shall be not less than 0.758 volts times the number of active cells that the battery contains.

c. The battery shall also meet the requirements of 3.9 during and after charge and discharge.

3.10.22 Constant voltage discharge. The battery shall produce not less than the current specified in the applicable specification sheet after being tested in accordance with 4.5.22. The battery shall also meet the requirements of 3.9 during and after charge and discharge.

3.10.23 Cycling. Batteries shall meet the following requirements when cycled (see 6.13.5) in accordance with 4.5.23 under the ambient conditions of 4.4.1.

a. The battery shall produce a potential of not less than 14.0 volts at 5 seconds into each 20-second duty cycle discharge.

b. The battery shall produce a potential of not less than 12.0 volts at 20 seconds into each 20-second duty cycle discharge.

c. The battery shall produce not less than its specified minimum capacity when discharged in 4.5.23.d. During group C inspection, each cell shall produce a potential of not less than 0.95 volts at not less than 60 minutes into the room temperature discharge of 4.5.23.d.

d. Unless otherwise specified in the applicable specification sheet, the battery shall successfully complete the number of duty cycles shown below:

(1) A total of 700 duty cycles for qualification inspection of low-maintenance vented batteries. A total of 50 duty cycles for qualification inspection for all other batteries.

(2) A total of 200 duty cycles for group C inspection of low-maintenance vented batteries. A total of 50 duty cycles for group C inspection for all other batteries.

e. The battery shall also meet the requirements of 3.9 during and after charge and discharge.

3.10.24 Temperature rise and float. The battery shall perform as follows after being tested in accordance with 4.5.24.

a. If the charging current rises, its increase (in amperes) compared to the current's minimum value shall be not greater than 3 percent of the battery's rated minimum capacity on any of the cycles.

b. The battery shall produce a potential of not less than 0.758 volts times the number of active cells that the battery contains at not less than 5 minutes into the 9C-rate discharge.

c. The temperature of the battery's central cells shall be not greater than 74 °C (165 °F) at not less than 1 hour after the start of the charge that follows the 9C-rate discharge.

d. Capacity discharge. The battery shall produce a potential of not less than 0.95 volts times the number of active cells that the battery contains at not less than 60 minutes into the C-rate discharge. The battery shall not undergo reconditioning during the three cycles of the test.

e. The battery shall also meet the requirements of 3.9 and 3.10.9 during and after testing and discharge.

3.10.25 Physical integrity at high temperature. The vent tubes and handles shall support the load without shearing, breaking, bending, or deterioration at the point of connection with the battery or other distortion of the case after being tested in accordance with 4.5.25. The battery shall also meet the requirements of 3.9.

3.10.26 Internal pressure. Cells shall not leak after being tested in accordance with 4.5.26. The battery shall also meet the requirements of 3.9.

3.10.27 Dielectric strength and insulation resistance. The battery and its components shall perform as follows after being tested in accordance with 4.5.27.

a. Components that are powered by DC shall withstand a DC potential of 500 ± 25 volts for 60 +5, -0 seconds.

b. Components that are powered by AC shall withstand an alternating 500 ± 25 $volts_{RMS}$ for 60 +5, -0 seconds.

c. The resistance shall be not less than 1 megohm between each of the items listed in 4.5.27.a through 4.5.27.e.

d. Sensors that supply a current signal shall also have a resistance between their connector pins and saline solution that is greater than the application's maximum voltage applied to the sensor divided by 10 percent of the sensor's signal tolerance.

3.10.28 Charge stability test. This requirement is for qualification of batteries that contain a gas barrier and separator system which is not listed in 6.10.4. The requirement may be applied to other purposes as well. The battery shall perform as follows after being tested in accordance with 4.5.28.

a. If the charging current rises, its increase (in amperes) compared to the current's minimum value shall be not greater than 3 percent of the battery's rated minimum capacity on any of the cycles.

b. The temperature of the battery's central cells shall be not greater than 74 °C (165 °F) at not less than 1 hour after the start of the charge that follows the 9C-rate discharge.

c. Capacity discharge: The battery shall produce a potential of not less than 0.95 volts times the number of active cells that the battery contains at not less than 60 minutes into the C-rate discharge.

d. The battery shall also meet the requirements of 3.9 and 3.10.9 during and after testing and discharge.

e. The gas barrier and separator system shall meet the requirements of 3.7.11.4. The gas barrier material in each cell shall be intact and shall be removable in one complete piece after being tested in accordance with 4.5.28.

3.10.29 Storage effects. The battery and its components shall perform as follows after being tested in accordance with 4.5.29.

a. By the end of the third iteration of the initial capacity discharge of 4.5.13, the battery's capacity shall be not less than 95 percent of the initial capacity requirement.

b. The battery's capacity after the temperature rise and float test of 4.5.24 shall meet the requirements of 3.10.24.

c. The battery shall also meet the requirements of 3.9 during and after testing and discharge.

3.10.30 Shelf life. In order to maintain qualification, successful completion of the shelf life test of 4.5.30 shall be required (see 6.2.g and 6.22). The battery shall perform as follows after being tested in accordance with 4.5.30.

a. The battery shall be capable of storage in uncontrolled temperature conditions from -40 °C to +60 °C (-40 °F to +140 °F) for not less than 3 years without damage. The battery shall meet the requirements of 3.9.

b. The capacity of batteries in storage for 3 years at –40 °C to +60 °C (-40 °F to +140 °F) shall be recoverable. By the end of the third iteration of the initial capacity discharge of 4.5.13, the battery's capacity shall be not less than 95 percent of the initial capacity requirements.

c. By the end of the third iteration of the initial capacity discharge of 4.5.13, each cell shall produce a potential of not less than 1.00 volt at not less than the time shown in 4.5.13 of the applicable specification sheet.

d. The battery shall also meet the requirements of 3.9 during and after testing and discharge.

4. VERIFICATION

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

a. Qualification inspection (see 4.2).

b. Conformance inspection (see 4.3).

4.2 Qualification inspection. Qualification inspection shall consist of the examinations and tests specified in table III. The samples shall be representative of the items intended to be supplied under this specification. The samples shall not be produced with the use of any equipment or procedure not normally used in production.

4.2.1 Inspection of batteries. Five complete batteries and one cell with intercell connector and tamper-resistant fastener (see 3.7.9) shall be furnished for inspection. Tables III and IV list the qualification inspection tests and the order in which the tests shall be conducted.

4.2.2 Inspection of cells, components, and materials. The quantity of sample cells to be provided for qualification inspection shall be the quantity used in assembling five batteries (see 6.2). Unless otherwise specified, the qualification cell samples shall be delivered as separate cells and tested as five complete batteries in accordance with table III, except that the physical inspections will be limited to the physical requirements specified for cells. Three

samples each of applicable components and materials, treated and processed as they would be for fabrication of finished batteries or cells, shall be furnished for inspection in accordance with table IV. All samples shall be marked properly with identifying information.

4.2.3 Inspection of new gas barrier material and separator system. When a manufacturer proposes the use of a gas barrier material and separator system other than those listed in 6.10.4, the following shall occur.

4.2.3.1 New candidate gas barrier material and separator systems. Manufacturers shall submit the proposed gas barrier material and separator system in one MIL-PRF-81757/16 battery with the M81757/2-7 snorkel-type vented filler cap to the qualifying activity for the test of 4.5.28. If this gas barrier and separator system passes the test of 4.5.28, it may then be used in any MIL-PRF-81757 battery submitted for qualification testing. Three samples each of the proposed gas barrier material and separator system material, treated and processed as they would be for fabrication of finished batteries or cells, shall be provided. All samples shall be marked with identifying information. The dimension of each sample shall be not less than one linear foot from the roll of material.

4.2.3.2 Currently qualified batteries. If the proposed gas barrier material and separator system has passed the test of 4.5.28 and was granted approval for use by the qualifying activity, batteries currently on the Qualified Products List may be manufactured with that gas barrier material and separator system and retain qualified status without repeating qualification testing.

4.2.3.3 New battery models proposed for qualification. If the proposed gas barrier material and separator system has passed the test of 4.5.28 and was granted approval for use by the qualifying activity, then that gas barrier material and separator system may be used in new battery models submitted for qualification tests for any MIL-PRF-81757 specification sheet. All qualification tests shall be performed (except for the test of 4.5.28 since the gas barrier and separator system has previously passed the test) and all qualification requirements shall be met.

4.2.4 Changes to qualified battery models. Any changes to the configuration, design, or materials of the battery or its components (including the gas barrier material/separator system and wetting agents) will require re-testing of applicable requirements and tests at the manufacturer's expense except as indicated in 4.2.3.2.

4.2.5 Failure and retest. A qualification sample that fails any of the examinations or tests specified herein shall be cause for the qualifying activity to refuse to conduct additional testing until the defects revealed by the inspection have been corrected.

4.3 Conformance inspection. The conformance inspection shall consist of the tests specified in tables VI, VII, and VIII.

4.3.1 Inspection of product. Every battery, cell, or component shall be subjected to and pass group A tests; each shall also have been part of the same inspection lots from which groups B and C samples were selected and which passed groups B and C testing. Batteries, cells, and components produced under this specification shall successfully complete groups A, B, and C inspection (see 4.3.4, 4.3.5, 4.3.6, 6.7, and 6.8).

4.3.2 Inspection lots. Units shall be formed into inspection lots (see 6.13.11 and 6.13.19). No more than two consecutive date/lot codes shall appear among the units in a particular inspection lot. A specific date/lot code shall not be found in any more than one inspection lot. For a cell inspection lot, the total number of cells shall be divided by the number of cells used in the end product battery (usually 19 or 20) to determine the lot size for groups B and C inspections.

4.3.3 Sample size and selection for groups A, B, and C inspection. Each unit shall undergo group A inspection. Unless otherwise specified by the contract or purchase order, the sample size for groups B and C shall be as shown in table V.

4.3.4 Group A inspection. Each unit of batteries, cells, or components shall be subjected to the examination and test requirements in table VI. Each unit shall meet the requirements for group A inspection in table VI. Defective units discovered during group A inspection shall be individually rejected.

4.3.5 Group B inspection. The inspections shall conform to table VII. There shall be no failures.

4.3.6 Group C inspection. The group C tests shall be performed in accordance with table VIII.

4.4 Inspection conditions. Unless otherwise specified, all inspections shall be performed in accordance with the following test conditions.

4.4.1 Temperature and storage conditions. Cells, components, and materials that will undergo testing shall be temperature-stabilized for not less than 2 hours before electrical tests are initiated. Batteries undergoing temperature stabilization shall have their covers removed before storage at the specified temperature. Place the battery in the environmental chamber at the specified temperature for not less than 16 hours before testing. During the entire period in the environmental chamber, elevate the item (battery, cell, component, or material) by not less than

0.75 inch from the floor of the chamber for full air circulation. Unless otherwise specified, room temperature shall be 25° ± 5 °C (77° ± 9 °F), high temperature shall be 49° ± 1.1 °C (120° ± 2 °F), and low temperature shall be -30° ± 1.1 °C (-22° ± 2 °F). Unless otherwise specified, all measurements, tests, and capacity discharges shall be made at room temperature, ambient atmospheric pressure, and ambient relative humidity.

4.4.2 Constant potential charging method. Unless otherwise specified in the applicable specification sheet, the method for constant potential charging shall be as follows. The power source used for charging shall have a current capacity of not less than 8 times the capacity rating of the battery being tested. Remove the cover from the battery. Constant potential charge the batteries at the voltage shown below. The tolerance on the potential shall be +0.0, -4.0 volts per battery during the first 5 minutes and ± 0.1 volts per battery after 5 minutes.

a. Low-maintenance vented batteries. Constant potential charge the batteries at 28.25 volts for 1 hour 55 minutes.

b. All other batteries. Constant potential charge the batteries at 1.5 volts per cell for 1 hour 55 minutes.

4.4.3 Constant current charging method. Unless otherwise specified in the applicable specification sheet, the method for constant current charging shall be as follows. Remove the cover from the battery. Constant current charge the batteries at room temperature at the C-rate (± 3 percent) to 1.55 ± 0.01 volts per cell, then at C/5 (± 3 percent) for 3.0 ± 0.1 hours (see 6.13.7). Adjust the electrolyte level as follows:

a. Low-maintenance vented batteries. Do not adjust the electrolyte level of any cell. The only exceptions are the adjustments specified in 4.5.8, 4.5.23.a(2), 4.5.24.a, 4.5.28.a, and 4.5.28.c(3), which shall be performed in accordance with 4.4.4.

b. All other batteries. Adjust the electrolyte level of each cell in accordance with 4.4.4.

4.4.4 Electrolyte level adjustment. Electrolyte level adjustment shall consist of adding deionized or distilled water to each cell as necessary to align the electrolyte level with the marking(s) of 3.8.7. If the line is not present, then adjust the electrolyte level to 0.5 inch (nominal) above the bottom of the baffle. Unless otherwise specified, the electrolyte adjustment shall be performed within 0.2 hours of the end of charge. For low-maintenance vented batteries, the only electrolyte level adjustments that shall be performed are the adjustments specified in 4.5.8, 4.5.23.a(2), 4.5.24.a, 4.5.28.a, and 4.5.28.c(3).

4.4.5 Reconditioning.

4.4.5.1 Application and usage. Only one unscheduled reconditioning (see 6.13.17) shall be allowed per test sample during the entire testing sequence. Unless otherwise specified in the test, a battery which fails to meet the specified minimum requirements of any electrical test shall be subjected to this one unscheduled reconditioning, after which the entire test shall be repeated. However, batteries shall not be reconditioned during life cycling (see 4.5.23). The charge efficiency test has a scheduled reconditioning in 4.5.28.f. Inability to meet the specified minimum requirements during the repeated test constitutes a failure. Failure during a repeated test shall constitute a failure of that particular sample. Should the battery meet the requirements of the repeated test, the specified test schedule shall be resumed.

4.4.5.2 Method. The method for reconditioning shall be as follows. Remove the cover from the battery. Discharge the battery at the C-rate to 0.95 volts times the number of active cells contained in the battery. Apply a 1-ohm resistor across each cell's terminals for not less than 24 hours. Remove the resistors. Constant current charge the battery in accordance with 4.4.3 but adjust the electrolyte in accordance with 4.4.5.2.1 and 4.4.5.2.2. Discharge the battery at the C-rate to a terminal voltage equal to 0.95 volts per cell and then give a final charge in accordance with the failed test at room temperature.

4.4.5.2.1 Low maintenance vented batteries. Electrolyte levels shall not be adjusted in conjunction with reconditioning. For low-maintenance vented batteries, the qualifying activity may follow the charge of 4.4.3 with an additional constant current charge at the C/10 rate for 8 hours.

4.4.5.2.2 Other batteries. Electrolyte adjustments shall not be performed before discharge at low temperatures. However, the adjustments are otherwise permitted.

4.4.6 Vented filler caps. Batteries and cells shall contain the vented filler caps specified by the contract. Unless otherwise specified, all inspections shall be performed with all cell vented filler caps securely tightened. Battery and cell inspections shall be conducted only upon test samples that contain the vented filler caps that will be provided under the contract.

4.5 Methods of inspection. The following tests and examinations (see 6.18) shall be performed as follows:

4.5.1 Incoming inspection. Examine the battery container for the requirements of 3.10.1.

4.5.2 Electrolyte soak of metal parts. Subject samples of all metal parts of the batteries, cells, and components to this test. Additionally, a panel whose dimensions shall be 4 inches by 6 inches shall be furnished for this test, coated as it would be supplied on the battery container and containing sample identification markings. Each sample shall be subjected to each test solution as indicated in the following steps:

a. Soak one-half of each specimen along its horizontal length in an aqueous solution of potassium hydroxide of 1.30 ± 0.04 specific gravity and allow to stand for 168 ± 2 hours at 65.5° ± 1.1 °C (150°± 2 °F). Rinse, dry, and examine the specimens for the requirements of 3.10.2.

b. Prepare a solution of 0.5 ± 0.1 ounce MIL-D-16791 type 1 detergent and 1 ± 0.1 gallon of tap water. Soak one-half of each specimen along its horizontal length in the solution and allow to stand for 20 ± 1 hours at room temperature. Rinse, dry, and examine the specimens for the requirements of 3.10.2.

4.5.3 Electrolyte soak of components and elastomeric materials. Subject samples of all components (see 6.13.3) and materials of the cells and batteries and the backshell of any receptacle that is inside the battery case to this test. Obtain three samples each of hold-down pads, gaskets, O-rings, and other items made of elastomeric material used in the battery or cell. Immerse the samples for 168 ± 2 hours in an aqueous solution of potassium hydroxide of 1.30 ± 0.04 specific gravity in a temperature chamber at 65.5° ± 1.1 °C (150° ± 2 °F). Rinse with water and wipe dry. Examine the specimens for the requirements of 3.10.3. Electrical components shall then undergo functional testing as indicated in the applicable specification sheet.

4.5.4 Electrolyte absorption by plastic material. Cut three specimens from each different plastic material submitted by the contractor. The dimensions of each specimen shall be 2 inches by 3 inches. The cut edges may be sealed with the material used in fabrication of the case. Plastic materials normally containing identification markings shall be supplied with sample markings for this test. Dry each specimen in a temperature chamber for 2 ± 0.5 hours at 32.2° ± 1.1 °C (90° ± 2 °F). Measure each specimen with a micrometer. Weigh each specimen on a chemical balance. Immerse each specimen in a covered vessel containing 150 cc of an aqueous solution of potassium hydroxide of 1.30 ± 0.04 specific gravity. Place this vessel in a temperature chamber for 168 ± 2 hours at 65.5° ± 1.1 °C (150° ± 2 °F). At the end of the heating period, rinse the specimens in water and wipe dry. Examine the identification marking sample. Inspect all samples for evidence of cracks or blisters. Measure and weigh the samples. Calculate the percentage change in dimensions and weight. Examine the item for the requirements of 3.8.5 and 3.10.4.

4.5.5 Vented filler cap tests. The vented filler cap shall be subjected to the following inspections and tests. When a battery cell is used in conjunction with performing an inspection or test, a mating MIL-PRF-81757/1 cell shall be used.

4.5.5.1 Room temperature test. Conduct this test in accordance with the temperature and storage conditions of 4.4.1. Attach the vented filler cap to an adapter to which a variable

pressure source of compressed air is connected. With the vented filler cap submerged in shallow water, apply pressure to the vertical axial channel inlet located at the bottom of the vented filler cap. Adjust the air pressure from the lower limit to the higher limit as specified in 3.10.5 in 55 ± 5 seconds. Return to the lower limit specified within 1 minute. Subject the vented filler caps to 4.5.6. Examine the vented filler caps for the requirements of 3.10.5.

4.5.5.2 Low temperature test. Conduct this test in accordance with the temperature and storage conditions of 4.4.1. Condition the vented filler caps by immersing them in an aqueous solution of calcium chloride at -30° ± 1.1 °C (-22° ± 2 °F) for not less than 5 minutes. The concentration of the aqueous solution of calcium chloride is optional; however, the solution shall still be liquid at the indicated temperature [a solution that is 25 percent by weight calcium chloride freezes at -29.5 °C (-21 °F) while a 30 percent solution freezes at -44.4 °C (-48 °F)]. Repeat the test of 4.5.5.1 in the calcium chloride solution at -30° ± 1.1 °C (-22° ± 2 °F). Examine the vented filler cap for the requirements of 3.10.5.

4.5.5.3 High temperature test. Conduct this test in accordance with the temperature and storage conditions of 4.4.1. Condition the vented filler caps by immersing them in hot water at 70° ± 1.1 °C (158° ± 2 °F) for not less than 5 minutes. Repeat the test of 4.5.5.1 in hot water at 70° ± 1.1 °C (158° ± 2 °F). Examine the vented filler cap for the requirements of 3.10.5.

4.5.6 Visual and mechanical examination. Examine samples of the test item for the requirements of 3.10.6.

4.5.7 Cell insertion force test (repairable batteries only). Remove any one cell from a manufacturer-assembled repairable battery (see 6.13.16). Very lightly lubricate the cell's exterior sidewalls with petrolatum. Reinsert the cell in its original position within the battery. Measure the force required to insert cells into repairable batteries. The force shall meet the requirements of 3.10.7. Repeat the above at least once but not more than twice on each battery. Each time, select a cell that does not have sidewall contact with a previously removed cell.

4.5.8 Dimensions and weight. Constant current charge the battery in accordance with 4.4.3. For all types of batteries, adjust the battery's electrolyte level in accordance with 4.4.4 and immediately thereafter weigh the battery. Examine samples of the test item to verify compliance with the requirements of 3.10.8 and 3.10.9 for dimensions, weight, and bulging. Record the specific gravity of the electrolyte of not less than three cells. Discharge the battery at the C-rate to 18.0 volts.

4.5.9 Handle strength test. Swing each handle out from the container against its stop. Apply a force of 600 newtons (135 pounds) at the handle's grasp. Apply the force in a direction of maximum torque acting on the handle stop. Apply the force continuously for not less than 5 minutes. Examine each handle and the battery for the requirements of 3.10.10.

4.5.10 Cover seal test. Secure the cover onto the battery (latches applied normally) and let the battery rest for not less than 24 hours. Attach a manometer or pressure gage to one of the battery vents. Apply air pressure equivalent to 55 ± 5 inches of water (2 psig) through the other battery vent. Immerse the battery in water for 1 minute and observe any bubbles. Examine the battery for the requirements of 3.10.11.

4.5.11 Cell baffle test. One cell shall be examined during this test. This cell shall not be taken out of the qualification sample batteries (see 4.2.1). Restrain the cell. Constant current charge the cell in accordance with 4.4.3. After the electrolyte adjustment, charge at a C/3 rate. Between 15 and 20 minutes into the C/3 charge, measure the difference in electrolyte level in areas of the cell separated by the internal baffle. Terminate the charge. If the cell will be used in a battery with an aerobatic application, immediately install the vented filler cap intended for the cell and invert the cell for 15 ± 2 seconds. Return to a normal upright position (see 6.13.15) and observe the return of electrolyte to the plate stack. Examine the cell for the requirements of 3.10.12.

4.5.12 Cell vent test. Remove the cover from the battery. Ensure the vented filler caps that will be provided under the contract are installed on the cells. Constant current charge the battery in accordance with 4.4.3. Within 5 minutes of the end of charge, fasten the vented filler caps, immerse the battery in tap water, and observe the location from which gases are venting. Discharge the battery at the C-rate to 18.0 volts. Examine all cells for the requirements of 3.10.13.

4.5.13 Initial capacity discharge. Remove the cover from the battery. After constant current charging in accordance with 4.4.3, stabilize the battery at room temperature (see 4.4.1). Perform the discharges shown below.

4.5.13.1 Low-maintenance vented batteries. For low-maintenance vented batteries, discharge the battery at the C-rate to the cut-off voltage (see 6.13.4) of 1.0 volts times the number of active cells that the battery contains and measure the voltage of each cell at the time shown on the applicable specification sheet. Examine the battery for the requirements of 3.10.14.

4.5.13.2 Other batteries. For other batteries, discharge the battery at the C-rate to the cut-off voltage (see 6.13.4) of 0.95 volts times the number of active cells that the battery contains and measure the voltage of each cell at 60 minutes into the discharge. Examine the battery for the requirements of 3.10.14.

4.5.14 Humidity and charge retention test. Remove the cover from the battery. Constant potential charge low-maintenance vented batteries in accordance with 4.4.2. Constant current

charge all other batteries in accordance with 4.4.3. Secure the battery cover. Subject the battery to the humidity test of MIL-STD-810, method 507.1, procedure II, figure 507.1-2 (see 6.2). Conduct ten cycles with the axis of one of the battery air vents parallel to the environmental chamber air flow. Remove the cover from the battery. After completion of the test period, remove accumulated water from the battery. Stabilize the battery at room temperature in accordance with 4.4.1. Discharge the battery at the C-rate to 0.95 volts times the number of active cells that the battery contains. Measure the voltage of each cell at 60 minutes into the discharge (for low-maintenance vented batteries) or at 50 minutes into the discharge (for all other batteries). Examine the battery for the requirements of 3.10.15.

4.5.15 Shock test (basic design). Remove the cover from the battery. Constant potential charge low-maintenance vented batteries in accordance with 4.4.2. Constant current charge all other batteries in accordance with 4.4.3. Secure the cover onto the battery. Subject the battery to the shock test of MIL-STD-810, method 516.2, procedure I, figure 516.2-1, amplitude a, and time duration c (see 6.2). Shock the battery in a normal upright position and in two additional mutually perpendicular directions from the vertical. However, the battery shall not be mounted or shocked in the inverted position. Upon completion of the shock phases of this test, examine the battery for the requirements of 3.9. After examination, remove the cover from the battery. Discharge the battery at the 9C-rate for 5 minutes. Measure the voltage of the battery at 5 minutes after the start of the discharge. Examine the battery for the requirements of 3.10.16.

4.5.16 Vibration test. Remove the cover from the battery. Constant potential charge low-maintenance vented batteries in accordance with 4.4.2. Constant current charge all other batteries in accordance with 4.4.3. Secure the cover onto the battery. Attach the battery (oriented in its normal upright position) to the vibration equipment. Subject the battery to a random vibration power spectral density of 0.04 g^2/Hz from 15 to 2000 Hz along each of three mutually perpendicular axes. The vibration time in each axis shall be 1 hour. The spectral density average of accelerometers located on the fixture shall control the test levels. Discharge the battery at the 0.1 C-rate during vibration. During the vibration test, monitor the battery voltage. Upon completion of the vibration phase of this test, constant potential charge the battery in accordance with 4.4.2. Discharge the battery at the 30C-rate for 60 ± 1 seconds. Examine the battery for the requirements of 3.9.

4.5.17 Temperature shock test. Remove the cover from the battery. Constant potential charge low-maintenance vented batteries in accordance with 4.4.2. Constant current charge all other batteries in accordance with 4.4.3. Subject the battery to the thermal shock test of MIL-STD-810, method 503.1, procedure I (see 6.2), except that exposure periods shall be 4.00 ± 0.25 hours. Upon completion, stabilize the battery to room temperature in accordance with 4.4.1. Discharge the battery at the 9C-rate for 5 minutes. Measure the voltage of the battery at 5 minutes after the start of the discharge. Examine the battery for the requirements of 3.10.17.

4.5.18 Altitude test. This test shall consist of the following steps.

a. Remove the cover from the battery. Constant potential charge low-maintenance vented batteries in accordance with 4.4.2. Constant current charge all other batteries in accordance with 4.4.3.

b. Stabilize the temperature inside a temperature/environmental chamber at –40 °C (-40 °F) in accordance with 4.4.1. With the battery cover removed and the battery terminals on open circuit, place the battery inside the chamber.

c. Within 15 minutes after completing step b, lower the pressure inside the chamber to simulate the ambient pressure at 18,500 meters (60,700 feet) altitude.

d. Discharge the battery at the 9C-rate for 3 minutes. Measure the voltage of the battery at 3 minutes after the start of the discharge.

e. Constant potential charge the battery in accordance with 4.4.2.

f. Open circuit the battery and, within 5 minutes, return the chamber to ground ambient air pressure (see 4.4.1).

g. Repeat steps 4.5.18.c, 4.5.18.d, and 4.5.18.f.

h. Examine the battery for the requirements of 3.10.18.

4.5.19 Salt fog test. Secure the cover onto the battery. Ensure all receptacles are uncovered and oriented away from direct salt fog spray. Subject the battery to the salt fog test of MIL-STD-810, method 509.1, procedure I (see 6.2), for 48 ± 2 hours. After completion of the test, clean any salt residue from the receptacles by flushing the receptacles with distilled water and wiping dry. Examine the battery for the requirements of 3.10.19.

4.5.20 Twenty-second pulse discharge test. This test shall consist of the following steps.

a. Remove the cover from the battery. Constant potential charge low-maintenance vented batteries in accordance with 4.4.2. Constant current charge all other batteries in accordance with 4.4.3. Do not perform the electrolyte adjustment of 4.4.4.

b. Stabilize the battery at -17.8° ± 1.1 °C (0° ± 2 °F) in accordance with 4.4.1.

c. While remaining in the -17.8° ± 1.1 °C (0° ± 2 °F) environment, discharge the battery for 20 seconds. Begin the discharge at the 25C-rate and decrease it linearly over a 20-second period to the 5C-rate.

d. Rest the battery on open circuit for 120 seconds.

e. Repeat steps 4.5.20.c and 4.5.20.d immediately.

f. Repeat step 4.5.20.c immediately.

g. The total cycle time for steps c through f shall be not greater than 300 seconds.

h. Measure and record the following:

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

(2) The terminal voltage at the end of each 20-second discharge.

i. Examine the battery for the requirements of 3.10.20.

4.5.21 Medium rate discharge, operating position test. This test shall consist of the following steps.

a. Remove the cover from the battery. Constant potential charge low-maintenance vented batteries in accordance with 4.4.2. Constant current charge all other batteries in accordance with 4.4.3.

b. Invert the battery.

c. Discharge the battery at the 9C-rate for 5 minutes to 0.758 volts times the number of active cells that the battery contains. At 2.5 minutes into the discharge, place the battery upright.

d. Measure and record the following:

(1) The terminal voltage.

(2) The elapsed time.

e. Examine the battery for the requirements of 3.10.21.

4.5.22 Constant voltage discharge. This test shall consist of the following steps.

a. Constant potential charge low-maintenance vented batteries in accordance with 4.4.2. Constant current charge all other batteries in accordance with 4.4.3.

b. Stabilize the battery at 24.0° ± 2.0 °C in accordance with 4.4.1.

c. Subject the battery to a constant potential discharge for 60 seconds. During the 60 seconds, the discharge potential shall be 14.0 ± 0.5 volts for the initial 5 seconds and 14.0 ± 0.1 volts for the remaining 55 seconds.

d. Measure discharge current at 1.0, 5.0, 15.0, and 60.0 seconds after the start of discharge.

e. Examine the battery for the requirements of 3.10.22.

f. Allow the battery to return to room temperature.

g. Constant potential charge low-maintenance vented batteries in accordance with 4.4.2. Constant current charge all other batteries in accordance with 4.4.3.

h. Stabilize the battery at a temperature of -26.0° ± 2.0 °C in accordance with 4.4.1.

i. Repeat steps 4.5.22.c, 4.5.22.d, and 4.5.22.e.

4.5.23 Cycling test. Reconditioning (see 4.4.5) shall not be permitted between any of the duty cycles. This test shall not be repeated. Any noncompliance shall constitute a failure. If the battery fails to meet any one of the specified requirements of 3.10.23 at any point during the progress of the test, then terminate the test. The use of fans for additional convective cooling of the battery is permitted and encouraged. This test shall consist of the following steps.

a. Preparation: Prepare the battery as follows.

(1) Remove the battery cover.

(2) Constant current charge the battery in accordance with 4.4.3. For all types of batteries, adjust the electrolyte levels in accordance with 4.4.4.

(3) Rest the battery on open circuit 2 hours for low-maintenance vented batteries; 1 hour for all other batteries.

(4) When performing qualification inspection, determine and record the battery weight.

b. Duty cycle: Cycle the battery as follows.

(1) Unless otherwise specified by the applicable specification sheet, discharge through a fixed resistance value R_{ohms} for 20 seconds. The value of R shall be that listed in the applicable specification sheet.

(2) Rest the battery on open circuit for 260 seconds.

(3) Repeat step 4.5.23.b(1).

(4) Within 4 seconds after completing step 4.5.23.b(3), constant potential charge the battery in accordance with 4.4.2 as shown below:

(a) For low-maintenance vented batteries, charge at 28.25 ± 0.1 volts for 55 minutes.

(b) For all other batteries, charge at 28.5 ± 0.1 volts for 1 hour 55 minutes.

(5) Rest the battery on open circuit 1 hour for low-maintenance vented batteries; 2 hours for all other batteries.

c. Repeat step 4.5.23.b continuously for the number of cycles shown below:

(1) A total of 700 duty cycles for qualification inspection of low-maintenance vented batteries.

(2) A total of 200 duty cycles for group C inspection of low-maintenance vented batteries.

(3) A total of 50 cycles for all other batteries.

d. Capacity discharge: Discharge at room temperature at the C-rate to 0.95 volts times the number of active cells that the battery contains. When performing qualification inspection, determine and record the battery weight.

e. Measure and record the following:

(1) The battery's current, temperature, and terminal voltage at 5 seconds after the start of each 20-second duty cycle discharge and at the end of each 20-second discharge.

(2) The elapsed time for the battery terminal voltage to decline to the end voltage (see 6.13.6) during the discharge of step 4.5.23.d above.

(3) The voltage of each cell at 60 minutes after the start of the discharge of step 4.5.23.d above.

f. Examine the battery for the requirements of 3.10.23.

g. Recondition the battery in accordance with 4.4.5.

4.5.24 Temperature rise and float test. The temperature rise and float test shall consist of the following steps. Reconditioning (see 4.4.5) shall not be allowed during this test. Record the charging current no less frequently than every 5 minutes during test.

WARNING

Stop the test if the temperature of the battery's central cells is greater than 82.2 °C (180 °F). Stop the test if the current increase exceeds 0.2 amperes per rated ampere-hour capacity at any time during the charge.

a. Remove the cover from the battery. Constant current charge the battery in accordance with 4.4.3. For all types of batteries, adjust the electrolyte levels in accordance with 4.4.4.

b. Place the battery in a temperature chamber at 49° ± 3 °C (120.2° ± 5.4 °F) for not less than 12 hours. Perform the following with the battery in the 49° ± 3 °C (120.2° ± 5.4 °F) temperature environment.

c. First cycle: Discharge the battery at the 9C-rate for 5 minutes +5, -0 seconds. Continuously measure the voltage of the battery during the 9C-rate discharge.

d. Immediately after the 9C-rate discharge and with the battery still in the temperature chamber at 49° ± 3 °C (120.2° ± 5.4 °F), charge the battery using a constant potential charge of 1.50 +0.01, -0 volts per cell for 24 ± 0.1 hours.

e. Discontinue charging the battery. For batteries other than low-maintenance vented types, adjust the electrolyte levels if necessary in accordance with 4.4.4, using deionized or distilled water at a temperature of 49° ± 3 °C (120.2° ± 5.4 °F). Resume the testing sequence immediately.

f. Second cycle: Perform steps 4.5.24.c, 4.5.24.d, and 4.5.24.e.

g. Third cycle: Perform steps 4.5.24.c and 4.5.24.d.

h. Stabilize the battery temperature at 25° ± 5 °C (77° ± 9 °F) in accordance with 4.4.1. Discharge the battery at the C-rate to a cut-off voltage of 0.95 volts times the number of active cells that the battery contains. Measure the voltage of the battery at 60 minutes after the start of the discharge.

i. Record the following:

(1) The temperature of the battery's central cells throughout the steps of 4.5.24.

(2) Charging current at least every 5 minutes.

(3) The elapsed time for the discharge of step 4.5.24.h.

j. Examine the battery for the requirements of 3.10.24.

4.5.25 Physical integrity at high temperature. This test shall consist of the following steps.

a. Constant potential charge low-maintenance vented batteries in accordance with 4.4.2. Constant current charge all other batteries in accordance with 4.4.3.

b. Place the battery in a temperature chamber at 85° ± 5 °C (185° ± 9 °F) in accordance with 4.4.1.

c. Remove the battery from the 85 °C (185 °F) environment. Lift the battery by its handles. Place the battery on a flat surface. Lift the battery by its vent tubes. Place the battery on a flat surface. Observe any evidence of shearing, breaking, bending, or deterioration at the point of connection of the vent tube and the battery, or other distortion of the case.

d. Stabilize the battery at room ambient conditions. Discharge the battery at the 9C-rate for 5 minutes.

e. Examine the battery for the requirements of 3.10.25.

4.5.26 Internal pressure test. Apply dry nitrogen or air to properly restrained cells at an internal pressure of 20 ± 1 psig at room temperature (see 4.4.1) through an airtight adapter to their venting aperture. Place the cells under water, shut off the source of pressure, and maintain the pressure in the cells for not less than 15 seconds. Examine the cells for the requirements of 3.10.26.

4.5.27 Dielectric strength and insulation resistance test. Fill the battery case with a solution of 1 tablespoon of table salt and one gallon of distilled water to a height just below the level of

the power receptacle. Apply a DC potential of 500 volts for 60 seconds to components powered by DC. Apply an alternating 500 $volts_{RMS}$ for 60 seconds to components powered by AC. Test the following combinations of components:

a. The current-carrying parts of the battery and the case.

b. The current-carrying parts of the battery and the saline solution.

c. The auxiliary connector's pins and shell.

d. The pins of the auxiliary connector and the current-carrying parts of the battery.

e. The pins of the auxiliary connector and the saline solution.

Measure the insulation resistance in accordance with MIL-STD-202, method 302, test condition B, for 60 seconds. Examine the items for the requirements of 3.10.27.

4.5.28 Charge efficiency test. The gas barrier shall be in a battery that conforms to MIL-PRF-81757/16 with the snorkel-type vented filler cap of M81757/2-7. Reconditioning (see 4.4.5) shall not be allowed during this test except as described in 4.5.28.2.f. Record the charging current no less frequently than every 5 minutes during this test. The exchange of air within the environmental chamber is encouraged due to safety reasons concerning hydrogen buildup.

4.5.28.1 Other samples. When specified by the procuring activity or the qualifying activity, the battery or cell manufacturer shall supply the indicated activity with samples of the gas barrier and separator system material (see 4.2.3.1 and 6.2). The quantity, dimensions, and other requirements of the supplied samples shall be as specified by the procuring activity or qualifying activity.

4.5.28.2 Test method. The test shall consist of the following steps:

a. Remove the cover from the battery. Constant current charge the battery in accordance with 4.4.3. Adjust the electrolyte levels in accordance with 4.4.4.

b. Place the battery in a temperature chamber at 49º ± 3 ºC (120.2º ± 5.4 ºF) for not less than 12 hours. Perform the following with the battery in the 49º ± 3 ºC (120.2º ± 5.4 ºF) temperature environment.

c. Cycling procedure: Perform the following sequence a total of 99 cycles. The cycles shall run for sets of not more than five cycles, with not less than a two-day break between sets.

(1) Discharge the battery at the 9C-rate for 5 minutes +5, -0 seconds or until the battery potential reaches 14.0 volts, whichever comes first. Continuously measure the voltage of the battery during the 9C-rate discharge.

(2) Immediately after the 9C-rate discharge and with the battery still in the temperature chamber at 49º ± 3 ºC (120.2º ± 5.4 ºF), charge the battery using a constant potential charge of 1.50 + 0.01, -0 volts per cell for 24 ± 0.1 hours.

(3) Discontinue charging the battery. Adjust the electrolyte levels in accordance with 4.4.4 not less than once every seven days, using deionized or distilled water at a temperature of 49º ± 3 ºC (120.2º ± 5.4 ºF). Resume the testing sequence immediately.

d. Cycle #100: Perform steps 4.5.28.c(1) and 4.5.28.c(2).

e. Stabilize the battery temperature at 25º ± 5 ºC (77º ± 9 ºF) in accordance with 4.4.1. Discharge the battery at the C-rate to a cut-off voltage of 0.95 volts times the number of active cells that the battery contains. Measure the voltage of the battery at 60 minutes after the start of the discharge.

f. Scheduled reconditioning: If the battery does not produce the required capacity during 4.5.28.e, then recondition the battery in accordance with 4.4.5 and repeat 4.5.28.e. In contrast with 4.4.5.1, do not repeat 4.5.28 in its entirety. Only two reconditioning and subsequent capacity discharges shall be performed in an attempt to pass the discharge of step 4.5.28.e.

g. Record the following:

(1) The temperature of the battery's central cells throughout the steps of 4.5.28.

(2) Charging current at least every 5 minutes.

(3) The elapsed time for the discharge of step 4.5.28.e.

h. Examine the battery for the requirements of 3.7.11.4 and 3.10.24.

i. Examine the gas barrier material from any cell(s) of the battery for the requirements of 3.10.28.

4.5.29 Storage effects test. A battery packaged according to the requirements of the contract or purchase order shall be stored in its original, unopened shipping container at 50° ± 1.1 °C (120º ± 2 ºF) for 60 ± 1 days. Perform the tests of 4.5.24 and 4.5.6. Examine the battery for the requirements of 3.10.1 and 3.10.6. Perform the test of 4.5.13 three times. Perform the test of 4.5.24. Examine the battery for the requirements of 3.10.29.

4.5.30 Shelf life test. Store the battery in an uncontrolled temperature environment (such as an unheated, uncooled warehouse) where the ambient air temperature will be within the range of -40 °C to +60 °C (-40 °F to +140 °F). Store qualification sample number one for not less than one year; store qualification sample number four for not less than three years. Bring the battery to the test facility. Remove the cover from the battery. Perform the test of 4.5.13 three times. Examine the battery for the requirements of 3.10.30.

4.5.31 Tamper-resistant fastener test for fasteners other than shear-head screws. A tamper-resistant fastener shall be installed with an intercell connector on the cell sample of 4.2.1. For each fastener type, obtain a cylinder whose inside diameter is not less than the diameter of the fastener. Place the cylinder over the fastener. Use Cerro or an equivalent metal casting alloy to make a casting of the exposed face of the fastener. Let the casting material cool on the fastener. Attempt removal of the casting. If the casting is undamaged upon removal, then re-mate the casting with the fastener. Apply a torque to the cylinder in the direction of fastener removal. Use the manufacturer's recommended method and tool(s) to remove the fastener. Examine each fastener type and the pertinent cells for the requirements of 3.7.9.

5. PACKAGING

5.1 Packaging. 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 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 System Command. 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

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

6.1 Intended use. The rechargeable, vented nickel-cadmium storage batteries, cells, and components covered by this specification are used in fixed-wing and rotary-wing military

aircraft. The batteries are used for starting engines or auxiliary power units; they also provide electricity to support emergency loads. Commercial batteries have a separate charger. These batteries, however, are designed to be charged directly from the electrical bus without the use of a separate charger. The batteries are also exposed for prolonged periods to extreme seagoing environments not encountered by civilian aircraft.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of the specification and applicable specification sheet.

b. Solicitations and contracts should cite Revision C of MIL-STD-810.

c. Packaging requirements (see 5.1).

d. Battery, cell, or component required, including PIN, NSN, and quantity .

e. Qualification testing and conformance inspections are required as indicated herein (see 3.7.9, 4.2.1, 4.2.2, 4.2.3.1, 4.3.3 and 4.5.28.1 for the quantity of samples required).

f. Whether a certificate of conformity is required (see 3.4, 3.7.11.4, and 3.7.11.8).

g. Shelf-life coding for a 3-year shelf life period (see 3.10.30 and 6.22).

h. Responsibility for inspection and sample selection (see 6.8).

6.3 Material Safety Data Sheets. Contracting officers will identify those activities requiring copies of completed Material Safety Data Sheets prepared in accordance with FED-STD-313. The pertinent Government mailing addresses for submission of data are listed in FED-STD-313. Note that 29 CFR 1910.1200 requires that the Material Safety Data Sheet for each hazardous chemical used in an operation must be readily available to personnel using the material. Contracting officers will identify the activities requiring copies of the Material Safety Data Sheet.

6.4 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Products List QPL-81757, whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to

arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or purchase orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from Crane Division, Naval Surface Warfare Center, Global Deterrence and Defense Department, Power and Circuit Board Technologies Division, Power Systems Science and Engineering Branch, Code GXS, Bldg. 3287, 300 Highway 361, Crane IN 47522-5001, email cran_gxs_brmgr@navy.mil.

6.5 Application for qualification. Applicants obtain the approval of the qualifying activity before submitting samples for qualification inspection. The process starts when the manufacturer applies for qualification by letter to the qualifying activity indicated in 6.4. SD-6 provides guidance concerning the necessary information and certification. Crane Division, Naval Surface Warfare Center is the qualifying activity and conducts both qualification test and conformance inspection (e.g., lot acceptance testing).

6.6 Conformance inspection. Conformance inspection by the qualifying activity 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 conformance inspection by the qualifying activity may be adjusted to make maximum use of the contractor's quality control system and the quality history of the product (see 4.3). Any or all qualification tests may be performed on group C samples if the manufacturer has not supplied the product to the procuring activity for a period greater than 2 years, or if the qualifying activity suspects that the product no longer conforms to prescribed requirements.

6.7 Group C costs. An estimate of the qualifying activity's cost for testing for single service procurements, for use by a contractor at time of preparation of bids, may be obtained from the Crane Division, Naval Surface Warfare Center, Global Deterrence and Defense Department, Power and Circuit Board Technologies Division, Power Systems Science and Engineering Branch, Code GXS, Bldg. 3287, 300 Highway 361, Crane IN 47522-5001, email cran_gxs_brmgr@navy.mil.

6.8 Responsibility for inspection and sample selection. The qualifying activity (see 6.4) performs qualification inspection on samples furnished by the contractor. The contractor performs the inspections specified for group A conformance inspection (see 4.3.4). The Government selects samples for groups B and C conformance inspection in accordance with 4.3.3. The contractor performs group B conformance inspection (see 4.3.5) on the samples selected by the Government. The qualifying activity conducts group C conformance inspection (see 4.3.6). The Government reviews and examines the contractor's inspection procedures and inspection records as necessary.

6.9 Charge/discharge rate discussion. Some examples of charge and discharge rates (see 6.13.2) are explained below.

A battery undergoing a 1C or C-rate discharge ~~must~~ produces a current equal to its ampere-hour capacity for at least 60 minutes at a specified temperature before its potential drops below the cutoff or end voltage. For example, a battery with a minimum capacity rating of 35.0 Ah/1 hr/77 °F/20.0 V undergoing a 1C or a C-rate discharge produces a current of:

1C or C-rate	=	1 × 35 ampere-hours
	=	35 amperes for at least 60 minutes at 77 °F ambient temperature before the battery potential drops below the cutoff or end voltage of 20.0 volts

The charge or discharge may take place over a period other than 60 minutes or may instead continue until a desired voltage level is reached. For example, a 35-ampere-hour battery charged at C/5 for 3 hours would receive:

C/5-rate	=	35 ampere-hours ÷ 5
	=	7 amperes delivered to the battery for 3 hours

As another example, consider a 19-cell 35-ampere-hour battery. The requirement might be a 9C-rate discharge with a cutoff voltage of 0.684 volts times the number of active cells that the battery contains and a time constraint of not less than 3 minutes. The battery must do the following:

9C-rate = 9 × 35 ampere-hours = 315 amperes

0.684 volts per cell × 19 cells per battery = 12.996 volts per battery

The battery is required to produce not less than 315 amperes for not less than 3 minutes before its potential drops below 12.996 volts.

6.10 Design practices and lessons learned.

6.10.1 Corrosive nature of potassium hydroxide. The aqueous solutions of potassium hydroxide used for nickel-cadmium battery electrolyte have high ionic conductivity and low freeze points. These properties give nickel-cadmium batteries their high power and ability to perform well at low temperatures. However, this electrolyte has very reactive and corrosive properties. Potassium hydroxide attacks aluminum, glass, many plastics, rubber compounds, and the corrosion preventive compound used on batteries (see 3.4, 3.7.2, 3.7.3, and 3.7.12). Plastics which are not dissolved may absorb the electrolyte, swell, and lose both mechanical and

dielectric properties. Therefore, 3.7.11.3 bans adhesive compounds and solvent welding as cover-to-case sealing methods. Other methods, such as thermal or ultrasonic weld methods, may be used.

6.10.2 Elastomers and potassium hydroxide. Batteries that have passed the testing required for qualification and have worked acceptably in practice have used ethylene propylene rubber when elastomers are needed, such as for cell seals (see 3.7.2 and 3.7.3). Neoprene (see 3.4, 3.7.11.3, and 3.7.12) is attacked by potassium hydroxide and can soften, swell, and split. It frequently erodes away at the interface between the vent cap and vent band until the neoprene no longer seals. Before erosion occurs, a vent band surface can soften due to electrolyte at the interface between the band and vent cap, dry during a subsequent storage, and literally glue itself to the vent. When this occurs, the pressure will build up in the cell during charge until the vent band breaks free or ruptures or the cell explodes. When cells suddenly vent at these excessive pressures, which can exceed 60 psi, the gas bubbles forming on the plates rapidly expand. The rapid expansion of the bubbles in the electrolyte causes the electrolyte level to rise, expelling electrolyte into the battery case in a sudden jet. The resulting pool of electrolyte will eventually leak out of the case, corrode the surrounding materials and equipment, and present a severe health hazard to maintenance personnel.

6.10.3 Handles. Batteries that have passed the testing required for qualification and have worked acceptably in practice have used handles sold as commercial model number 985SS2-01 manufactured by Nielsen Hardware, Zero Corporation, Hartford, CT 06141 (see 3.7.5) that were welded onto the container. Strap handles are also permitted.

6.10.4 Gas barrier/separator system and thermal runaway.

6.10.4.1 Materials.

6.10.4.1.1 GSS. Batteries with gas barrier and separator systems that have passed all of the testing required for qualification including the 100-cycle test of 4.5.28 of this specification have used GSS. The GSS material is manufactured by Celgard LLC, Charlotte, NC 28723. The system consists of model 3419 gas barrier material (also manufactured by Celgard) coated with CAS 12645-31-7 wetting agent and is used in combination with model A740 separator material (also termed absorber material) (also manufactured by Celgard) coated with CAS 12645-31-7 wetting agent.

6.10.4.1.2 SPSS-1 and SPSS-2. Batteries with gas barrier and separator systems that have passed all of the testing required for qualification including the 100-cycle test of 4.5.28 of this specification have used SPSS-1 or SPSS-2. The SPSS-1 and SPSS-2 materials are manufactured by SAFT America Inc., Valdosta, GA 31601. The systems consist of a proprietary gas barrier material and separator material.

6.10.4.2 Function. The gas barrier and separator system is a critical factor in avoiding the extremely serious hazard of thermal runaway (see 3.7.11.4 and 3.7.14), which is made more likely during military operations in hot environments.

6.10.4.3 Construction. The cell plate separator system has usually consisted of a gas barrier sandwiched between two layers of absorbent cloth-like material and is folded between the plates of the cell to insulate them electrically and mechanically. The gas barrier is either a semi-permeable or micro porous film that allows ions to pass through but not oxygen bubbles.

6.10.4.4 Operation. If oxygen, which is generated on the positive plates, can pass over to the negative plates during charge, it will recombine, generate heat, and cause a dangerous thermal runaway condition. When the electrolyte reserve has been consumed, the top of all of the cell electrodes should still be covered by the electrolyte. Otherwise, oxygen may then circumvent the gas barrier at the top of the electrodes, and thermal runaway will occur.

6.10.5 Electrolyte. Batteries that have passed the testing required for qualification and have worked acceptably in practice have used the electrolyte solutions described below. If the manufacturer proposes using a different electrolyte solution, the manufacturer should consult the qualifying activity before cell manufacture.

6.10.5.1 Standard batteries. Standard batteries have used an electrolyte consisting of an aqueous solution of potassium hydroxide of 1.30 ± 0.04 specific gravity that also contains dissolved cellulose equivalent to not less than 2.5 grams of cellulose oxide per liter of electrolyte (see 3.7.11.8).

6.10.5.2 Low maintenance batteries. Successful low maintenance batteries have used a cell electrolyte consisting of an aqueous solution containing 305 ± 10 grams of potassium hydroxide per liter of electrolyte that also contains 10 ± 4 grams of lithium hydroxide per liter of electrolyte (see 3.7.11.8).

6.10.6 Soak test solution. The soak test solution for determining whether an item will withstand the corrosive environment found around batteries is specified throughout 4.5 as an aqueous solution of potassium hydroxide of 1.30 ± 0.04 specific gravity. If the manufacturer plans to use a different electrolyte or concentration, the manufacturer must notify the qualifying activity (see 3.7.11.8), which may decide to test the items using the proposed electrolyte.

6.10.7 Color. For safety reasons (see 6.11), users must quickly and easily determine whether a battery is a nickel-cadmium or a lead-acid battery. Therefore, a Navy color coding system in place since the 1960s has required that a red container be used for lead-acid batteries and a blue one for nickel-cadmium batteries (see 3.8.1). The colors reflect the litmus paper indications for acid and alkaline substances, respectively.

6.10.8 Identification marking. Batteries that have passed the testing required for qualification and have worked acceptably in practice have used identification markings (see 3.8.4) that were silk-screened with an epoxy overlay.

6.10.9 Intercell connector resistance. For high-powered batteries, the summed electrical resistance of all the intercell connectors should be not greater than 5 percent of the battery's total resistance.

6.10.10 Charging the battery from the aircraft DC bus on the aircraft. Due to such factors as internal impedance, polarization effects, and gassing during charging, batteries do not charge at 100 percent efficiency. Therefore, a nominal 24-volt battery needs a potential of 28.0 ± 0.5 volts for proper charging. The period of time required to reach full charge is affected by charging potential and battery temperature. Charging while at the lower end of the potential range will require a longer period of time than at the higher end. As battery temperatures decrease, higher charging potentials are required for optimum charging efficiency. The characteristics of power provided by the aircraft DC bus, as well as aircraft power characteristics in general, are often specified in accordance with MIL-STD-704. When determining whether the battery can be adequately charged from the bus, designers must consider how heavily the DC bus is loaded, what percentage of the time the potential is outside the charging range, how often batteries will be charging versus supplying the bus, the potential for load growth on a bus that is currently satisfactory, the ambient temperature of the battery compartment, and similar situations. If the power provided to the battery is not sufficient for proper charging, special arrangements (such as a charger or dedicated transformer/rectifier) will be required to ensure that batteries will be properly charged within an acceptable period of time.

6.10.11 Dissimilar metals. MIL-STD-889 provides methods for protecting joined dissimilar metals.

6.10.12 Additional information. See NAVSO P-3676, Navy Primary and Secondary Batteries: Design and Manufacturing Guidelines, for additional information on nickel-cadmium batteries. Copies are available from Customer Service (Code 033343), Naval Inventory Control Point, 700 Robbins Avenue, Philadelphia, PA 19111.

6.11 Safety and storage. Do not store nickel-cadmium batteries in the same area as lead-acid batteries (see 3.8.1 and 6.10.7). The components of the two types of batteries will react violently in case of fire or puncture. Less drastically, individual nickel-cadmium batteries will be damaged or destroyed if contacted by lead-acid electrolyte, and vice versa.

6.12 Disposal. End users are required to comply with federal, state, and local regulations for disposal of used nickel-cadmium batteries, cells, and components. Such items should be sent

to the end user's local Defense Reutilization and Marketing Office, which will dispose of the items via contracts for recycling or other means.

6.13 Definitions.

6.13.1 Capacity. A measure of the energy content of a battery, usually stated in terms of ampere-hours. Capacity is computed by multiplying the number of amperes flowing from a cell or battery on discharge (at a given temperature and down to a specified end voltage) by the time in hours the cell or battery will deliver the amperes of current (see 3.10.14). An example of a shorthand way of stating capacity is 35.0 Ah/1 hr/77 °F/20.0 V, which means the battery provides not less than 35.0 ampere-hours of capacity when continuously discharged at 35 amperes for not less than 1 hour while maintaining a voltage of not less than 20.0 volts at the battery terminals, all of which occurs in an ambient air temperature of 77 °F. See the definitions for initial capacity and minimum capacity (6.13.10 and 6.13.14).

6.13.2 Charge or discharge rate. The amount of current and length of time required to charge or discharge a battery or cell (see 3.7.11.5, 3.10.14, and 6.9). Unless otherwise specified, the rate is expressed as xC, where x is a multiplier and C is the required minimum capacity. When stated as the C-rate, x equals 1.

6.13.3 Components. Components will include, but will not be limited to, vented filler caps, intercell connectors, charger harnesses, battery sensor/connector assemblies, temperature sensors, receptacles, and heater blankets (see 3.4, 3.10.3, and 4.5.3).

6.13.4 Cut-off voltage. A specified voltage during the discharge of a cell or battery at which point the discharge will be terminated (see 4.5.13).

6.13.5 Cycle. A combination of a charge and discharge (see 3.10.23).

6.13.6 End voltage. A specified voltage during the discharge of a cell or battery at which point the capacity will be calculated [see 4.5.23.e(2)].

6.13.7 Fully charged batteries. Batteries are considered fully charged when constant current charged in accordance with 4.4.3.

6.13.8 Fully discharged battery. A fully discharged battery or cell will have been discharged to zero volts per cell and then shorted out. Such batteries and cells are entirely capable of recovering the capacity specified by the applicable specification sheet (see 3.7.1 and 3.7.11).

6.13.9 Fully formed. Batteries and cells are considered fully formed when they have been sufficiently overcharged to cause vigorous gassing at both the positive and negative plates (see 3.7.1 and 3.7.11).

6.13.10 Initial capacity. Newly manufactured batteries and cells must produce not less than a specified amount of capacity (see 3.10.14 and 6.13.1).

6.13.11 Inspection lot. The quantity of batteries, cells, harnesses, or components of any one type, produced at any one place of manufacture, submitted at one time to conformance inspection (see 3.8.2 and 4.3.2).

6.13.12 Limited repair battery. A battery that is designed and manufactured in a manner that does not allow its cells, including hardware for installing the cells, to be removed and replaced (see 3.7.9 and 3.8.4.1). The battery's in-service maintenance and repair actions will not include removing and replacing cells.

6.13.13 Low-maintenance vented battery. An aircraft battery that has a one-year maintenance interval and whose gases are vented away from the battery container (see 3.8.7 and 3.10.14.2.1). That is, the battery will satisfactorily meet the aircraft's power and capacity requirements for not less than one year before removal for scheduled inspection, cleaning, capacity determination, cell equalization, electrolyte adjustment, and final charge. This compares to a typical 56-day maintenance interval for older design batteries. In addition, vented batteries contain at least two tubes for venting any electrochemically generated gases that may accumulate inside the battery container. Normally, one tube is used to permit forced air to enter the container while the other tube permits the inlet air and gases to exit the container. Vented batteries normally employ only vented cells; the vented filler caps of such cells permit the exit of the above gases from the cell and prevent the entry of ambient air and contaminants.

6.13.14 Minimum capacity. When batteries and cells produce less than a specified minimum amount of capacity (see 3.10.14 and 6.13.1) after testing and treatment in accordance with the appropriate military technical manual, the batteries and cells are considered to be at the end of their useful life and must be properly disposed of.

6.13.15 Normal upright position. The vented filler caps, intercell connectors, and battery cover are on top of the battery with respect to the earth's surface (see 4.5.11).

6.13.16 Repairable battery. A battery that is designed and manufactured in a manner that does allow its cells, including hardware for installing the cells to be removed and replaced (see 3.8.4.2 and 4.5.7). The battery's in-service maintenance and repair actions may include removing and replacing cells.

6.13.17 Reconditioning. A laboratory procedure performed to equalize the capacity and voltage of the battery's cells, thereby correcting any acquired capacity and voltage imbalances (see 4.4.5).

6.13.18 Thermal runaway. Thermal runaway is manifested during constant current charge by a rise in battery temperature and a drop in battery voltage; during a constant potential charge, by a rise in both battery temperature and charging current.

6.13.19 Unit. A single, individual item, such as one battery, one cell, or one vented filler cap (see 3.10.3 and 4.3.2).

6.13.20 Wet. Electrolyte has been added to the cell(s) (see 3.7.1 and 3.7.11).

6.14 Part or identifying number (PIN). The PIN for batteries, cells, and components acquired to this specification is created as follows: M81757/Y-Z with "M81757" representing the specification number, "Y" signifying the specification sheet number, and "Z" indicating any variation of the battery, cell, or component on a particular specification sheet.

6.15 PIN supersession data. Table IX provides supersession data pertaining to military aircraft batteries and cells that have been superseded by the batteries and cells covered by this specification.

6.16 Subject term (key word) listing.

Baffle
Capacity
Cellulose oxide
Charging
Discharging
Electrolyte
Ethylene propylene rubber
Gas barrier
Potassium hydroxide (KOH)
Power sources
Receptacle
Rechargeable
Terminal
Vented filler cap

6.17 International standardization. Certain provisions of this specification are the subject of international standardization agreement ASCC AIR STANDARD 25/24 and NATO STANAG

3454AE. When amendment, revision, or cancellation of this specification is proposed which will modify the international agreement concerned, the preparing activity will take appropriate action through international standardization channels, including departmental standardization offices, to change the agreement or make other appropriate accommodations.

6.18 Test equipment and facilities. Measurements should be performed with equipment that has the following characteristics. Test equipment and inspection facilities should be accurate, and have quality, and quantity to permit performance of the required inspection. Test and measurement equipment should be calibrated and traceable to the National Institute of Standards and Technology. All voltmeters and ammeters should be accurate within ± 0.5 percent of the full scale reading. The range of analog type meters should be such that the readings are taken on the upper half of the scale. Timers should be accurate within ± 0.5 percent. The sensitivity of voltmeters should be not less than 5000 ohms per volt. In all tests involving discharge through a resistance, the total circuit resistance should be accurate within ± 0.5 percent. For constant current discharges, the current should vary not more than ± 0.1 percent.

6.19 Inactivate for new design specification sheets. Specification sheets which are inactive for new design should use MIL-B-81757C as their procurement specification.

6.20 Changes from previous issue. DELETED

6.21 Amendment notations. The margins of this specification are marked with vertical lines to indicate modifications generated by this amendment. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations.

6.22 Shelf-life. This specification covers items where the assignment of a Federal shelf-life code is a consideration (see 3.10.30). Specific shelf-life requirements should be specified in the contract or purchase order (see 6.2.g), 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/.

TABLE I. Material and component specification requirements.

Material or components	Requirement paragraphs	Test paragraphs
Metals and metallic components (see 6.13.3)	3.9, 3.10.2, and 3.10.19	4.5.2 and 4.5.19
Non-metallic components (see 6.13.3) and elastomeric materials	3.9 and 3.10.3	4.5.3
Plastics (including polyamide and molded plastic parts)	3.9 and 3.10.4	4.5.4
Gas barrier and separator system (other than those listed in 6.10.4)	3.7.11.4 and 3.10.28	4.5.28

TABLE II. Identification of defects.

Number	Description	Method of inspection
1	Electrical contact surfaces obstructed by insulation compounds	Visual
2	Pitting or blow holes	Visual
3	Electrolyte leakage	Visual
4	Location and polarity of terminals not as specified	Visual
5	Terminal and identification markings not as specified	Visual
6	Terminal seal missing or defective	Visual
7	Corrosion	Visual
8	Particles of foreign material	Visual
9	Insulators or insulation missing or damaged	Visual
10	Welds containing blow holes, cracks, or slag inclusions	Visual
11	Burrs	Visual
12	Improper color on outside of container and cover	Visual
13	Loose or missing hardware	Visual
14	Foreign objects inside cells	Visual
15	Thermal switches not as specified nor operating as specified in the applicable specification sheet	Observation

TABLE III. Qualification inspection of batteries (see 6.8).

Test Number	Examinations and tests	Sample number					Requirement paragraph	Test paragraph
		1	2	3	4	5		
1	INSPECTION FOR DAMAGE	X	X	X	X		3.10.1	4.5.1
2	VISUAL AND MECHANICAL	X	X	X	X		3.10.6	4.5.6
3	CELL INSERTION FORCE TEST (REPAIRABLE BATTERIES ONLY)	X	X	X	X		3.10.7	4.5.7
4	DIMENSIONS AND WEIGHT	X		X			3.10.8, 3.10.9	4.5.8
5	HANDLE STRENGTH TEST			X	X		3.9, 3.10.10	4.5.9
6	COVER SEAL TEST			X	X		3.9, 3.10.11	4.5.10
7	CELL VENT TEST	X	X	X	X		3.10.13	4.5.12
8	INITIAL CAPACITY DISCHARGE	X	X	X	X		3.10.14	4.5.13
9	HUMIDITY AND CHARGE RETENTION			X	X		3.9, 3.10.15	4.5.14
10	SHOCK TEST (BASIC DESIGN)			X	X		3.9, 3.10.16	4.5.15
11	VIBRATION TEST			X	X		3.9	4.5.16
12	TEMPERATURE SHOCK TEST			X	X		3.9, 3.10.17	4.5.17
13	ALTITUDE TEST			X	X		3.9, 3.10.18	4.5.18
14	SALT FOG TEST	X	X				3.9, 3.10.19	4.5.19
15	20-SECOND PULSE DISCHARGE			X	X		3.9, 3.10.20	4.5.20
16	MEDIUM-RATE DISCHARGE OPERATING POSITION TEST			X	X		3.9, 3.10.21	4.5.21
17	CONSTANT VOLTAGE DISCHARGE	X	X	X	X		3.9, 3.10.22	4.5.22
18	CYCLING TEST	X	X				3.9, 3.10.23	4.5.23
19	TEMPERATURE RISE AND FLOAT	X	X				3.9, 3.10.9, 3.10.24	4.5.24
20	PHYSICAL INTEGRITY AT HIGH TEMPERATURE (85ºC)	X					3.9, 3.10.25	4.5.25
21	CONSTANT VOLTAGE DISCHARGE		X				3.9, 3.10.22	4.5.22
22	INTERNAL PRESSURE TEST	X					3.9, 3.10.26	4.5.26
23	DIELECTRIC STRENGTH AND INSULATION RESISTANCE TEST	X	X	X	X		3.10.27	4.5.27

TABLE III. Qualification inspection of batteries (see 6.8) – Continued.

Test Number	Examination and tests	Sample number					Requirement paragraph	Test paragraph
		1	2	3	4	5		
24	CHARGE STABILITY TEST (REQUIRED FOR BATTERIES WITH MATERIALS OTHER THAN THOSE LISTED IN 6.10.4)		X	X			3.10.28	4.5.28
25	STORAGE EFFECTS					X	3.9, 3.10.24, 3.10.29	4.5.29
26	SHELF LIFE	X			X		3.9, 3.10.30	4.5.30
27	CELL BAFFLE TEST	SAMPLE CELL OF 4.2.1					3.7.11.5, 3.10.12	4.5.11
28	TAMPER-RESISTANT FASTENER TEST FOR FASTENERS OTHER THAN SHEAR-HEAD SCREWS	SAMPLE CELL OF 4.2.1					3.7.9	4.5.31

TABLE IV. Qualification inspection of components and materials.

Part	Examinations and tests	Requirement Paragraph	Test paragraph
Metal parts 1/	Electrolyte resistance	3.8.1, 3.8.4, 3.9, 3.10.2	4.5.2
Components 2/ and elastomeric materials	Electrolyte resistance; dielectric strength and insulation resistance	3.9, 3.10.3, 3.10.27	4.5.3, 4.5.27
Plastic parts	Electrolyte absorption	3.8.5, 3.9, 3.10.4	4.5.4
Vented filler caps	Electrolyte resistance; vented filler cap test	3.9, 3.10.3, 3.10.5	4.5.3, 4.5.5

1/ Including but not limited to the container, cover, and latches; external cell terminal hardware; and intercell connectors and hardware.

2/ Including but not limited to the vented filler caps, charger harnesses, battery sensor/connector assemblies, temperature sensors, receptacles, heater blankets, and parts made of elastomers.

TABLE V. Sample sizes for groups B and C testing.

Inspection lot size in battery equivalents	Quantity of batteries to be provided for testing	Subgroup sample size		
		I	II	III
Group B:				
2 through 25	2	2	2	N/A
26 through 100	5	5	3	N/A
101 through 280	13	13	5	N/A
281 through 500	32	32	8	N/A
501 through 1,200	54	54	8	N/A
1,201 through 3,200	80	80	13	N/A
Group C:				
1 through 25	1	1/	1/	1/
26 through 49	2	1/	1/	1/
50 through 280	3	1	1	1
281 through 500	6	2	2	2
501 through 3,200	9	3	3	3

1/ The tests to be performed will be chosen from the various subgroups at the qualifying activity's option.

TABLE VI. Group A inspection (see 6.8).

Test No.	Examinations and Tests	Requirement paragraph	Test paragraph
1	Visual and mechanical	3.10.6	4.5.6
2	Internal pressure test to be performed on all cells. For complete batteries, perform this test before battery is assembled.	3.9, 3.10.26	4.5.26

TABLE VII. Group B inspection (see 6.8).

Test No.	Examinations and tests	Requirement paragraph	Test paragraph
	Subgroup I:		
I-1	Dimensions and weight	3.10.8, 3.10.9	4.5.8
I-2	Vented filler cap test (two vented filler caps per battery)	3.9, 3.10.5	4.5.5.1
I-3	Cover seal test 1/	3.9, 3.10.11	4.5.10
	Subgroup II:		
II-1	Cell insertion force test (repairable batteries only)	3.10.7	4.5.7
II-2	Initial capacity discharge	3.10.14	4.5.13
II-3	20-second pulse discharge test 1/	3.9, 3.10.20	4.5.20

1/ Not applicable to cell procurements.

TABLE VIII. Group C inspection (see 6.8).

TEST NO.	EXAMINATIONS AND TESTS	REQUIREMENT PARAGRAPH	TEST PARAGRAPH
	SUBGROUP I:		
I-1	INSPECTION FOR DAMAGE	3.10.1	4.5.1
I-2	VISUAL AND MECHANICAL	3.10.6	4.5.6
I-3	DIMENSIONS AND WEIGHT	3.10.8, 3.10.9	4.5.8
I-4	CELL INSERTION FORCE TEST (REPAIRABLE BATTERIES ONLY)	3.10.7	4.5.7
I-5	CELL VENT TEST	3.10.13	4.5.12
I-6	INITIAL CAPACITY DISCHARGE	3.10.14	4.5.13
I-7	TEMPERATURE RISE AND FLOAT TEST	3.9, 3.10.9, 3.10.24	4.5.24
I-8	CYCLING TEST	3.9, 3.10.23	4.5.23
I-9	TEMPERATURE RISE AND FLOAT TEST	3.9, 3.10.9, 3.10.24	4.5.24
	SUBGROUP II:		
II-1	VISUAL AND MECHANICAL	3.10.6	4.5.6
II-2	CELL INSERTION FORCE TEST (REPAIRABLE BATTERIES ONLY)	3.10.7	4.5.7
II-3	DIELECTRIC STRENGTH AND INSULATION RESISTANCE TEST 1/	3.10.27	4.5.27
II-4	CELL VENT TEST	3.10.13	4.5.12
II-5	INITIAL CAPACITY DISCHARGE	3.10.14	4.5.13
II-6	HUMIDITY AND CHARGE RETENTION TEST	3.9, 3.10.15	4.5.14
II-7	MEDIUM-RATE DISCHARGE, OPERATING POSITION TEST	3.9, 3.10.21	4.5.21
	SUBGROUP III:		
III-1	VISUAL AND MECHANICAL	3.10.6	4.5.6
III-2	CELL INSERTION FORCE TEST (REPAIRABLE BATTERIES ONLY)	3.10.7	4.5.7
III-3	CELL VENT TEST	3.10.13	4.5.12
III-4	INITIAL CAPACITY DISCHARGE	3.10.14	4.5.13
III-5	ALTITUDE TEST	3.9, 3.10.18	4.5.18
III-6	CONSTANT VOLTAGE DISCHARGE	3.9, 3.10.22	4.5.22
III-7	INTERNAL PRESSURE TEST	3.9, 3.10.26	4.5.26

1/ For cell procurements, perform only lines a and b of the dielectric strength and insulation resistance test.

TABLE IX. Battery and cell supersession data.

Superseded Part or Identifying Number (PIN)	Item	Reason Superseded	Replacement PIN	Item	Supplemental Information
MS3510B	Filler cap	Canceled	M81757/2-2	Filler cap	1/
D8565/2-1	Battery	Canceled	M81757/12-1	Battery	2/, 3/
D8565/2-2	Battery	Canceled	None	---	---
MS18045-44	Battery	Canceled	M81757/7-3	Battery	2/, 3/
MS18045-45	Battery	Canceled	M81757/8-5	Battery	2/, 3/
MS18045-46	Battery	Canceled	M81757/9-3	Battery	2/, 3/
MS18045-48	Battery	Canceled	M81757/7-3	Battery	2/, 3/
MS18045-49	Battery	Canceled	M81757/8-5	Battery	2/, 3/
MS18045-50	Battery	Canceled	M81757/9-3	Battery	2/, 3/
MS18045-75	Battery	Canceled	M81757/13-1	Battery	2/, 3/
MS24496-1	Battery	Canceled	M81757/7-2	Battery	4/, 5/
MS24496-2	Battery	Canceled	M81757/7-2	Battery	4/, 5/
MS24497-3	Battery	Canceled	M81757/8-4	Battery	4/, 5/
MS24497-5	Battery	Canceled	M81757/8-4	Battery	4/, 5/
MS24498-1	Battery	Canceled	M81757/9-2	Battery	4/, 5/
MS24498-2	Battery	Canceled	M81757/9-2	Battery	4/, 5/
MS27307-1	Cell	Canceled	M81757/1-2	Cell	4/, 5/
MS27307-2	Cell	Canceled	M81757/1-4	Cell	4/, 5/
MS27307-3	Cell	Canceled	M81757/1-6	Cell	4/, 5/
MS27307-4	Cell	Canceled	M81757/1-2	Cell	4/, 5/
MS27307-5	Cell	Canceled	M81757/1-4	Cell	4/, 5/
MS27307-6	Cell	Canceled	M81757/1-6	Cell	4/, 5/
MS90321-66W	Cell	Canceled	M81757/7-3	Battery	2/, 3/, 6/
MS90321-66W	Cell	Canceled	M81757/1-2	Cell	2/, 5/, 6/
MS90321-68W	Cell	Canceled	M81757/8-5	Battery	2/, 3/, 6/
MS90321-68W	Cell	Canceled	M81757/1-4	Cell	2/, 5/, 6/
MS90321-69W	Cell	Canceled	M81757/9-3	Battery	2/, 3/, 6/
MS90321-69W	Cell	Canceled	M81757/1-6	Cell	2/, 5/, 6/
MS90321-72W	Cell	Canceled	M81757/7-3	Battery	2/, 3/, 6/
MS90321-72W	Cell	Canceled	M81757/1-2	Cell	2/, 5/, 6/
MS90321-74W	Cell	Canceled	M81757/8-5	Battery	2/, 3/, 6/
MS90321-74W	Cell	Canceled	M81757/1-4	Cell	2/, 5/, 6/
MS90321-75W	Cell	Canceled	M81757/X-X	Battery	2/, 3/, 6/, 7/
MS90321-75W	Cell	Canceled	M81757/1-6	Cell	2/, 5/, 6/

TABLE IX. Battery and cell supersession data - Continued.

Superseded Part or Identifying Number (PIN)	Item	Reason Superseded	Replacement PIN	Item	Supplemental Information
MS90321-77W	Cell	Canceled	M81757/8-5	Battery	2/, 3/, 6/
MS90321-77W	Cell	Canceled	M81757/1-4	Cell	2/, 5/, 6/
MS90321-78W	Cell	Canceled	M81757/8-5	Battery	2/, 3/, 6/
MS90321-78W	Cell	Canceled	M81757/1-4	Cell	2/, 5/, 6/
MS90321-79W	Cell	Canceled	M81757/11-3	Battery	2/, 3/, 6/
MS90321-79W	Cell	Canceled	M81757/1-4	Cell	2/, 5/, 6/
MS90321-84W	Cell	Canceled	M81757/10-1	Battery	2/, 3/, 6/
MS90365-1	Battery	Canceled	M81757/8-5	Battery	2/, 3/
MS90365-2	Battery	Canceled	M81757/8-5	Battery	2/, 3/
MS90377-1	Battery	Canceled	M81757/11-3	Battery	2/, 3/
MS90447-2	Battery	Canceled	M81757/10-1	Battery	2/, 3/
M81757/1-1	Cell	Canceled	M81757/1-2	Cell	4/
M81757/1-2	Cell	8/	M81757/7-3	Battery	3/
M81757/1-3	Cell	Canceled	M81757/1-4	Cell	4/
M81757/1-4	Cell	8/	M81757/8-5	Battery	3/
M81757/1-5	Cell	Canceled	M81757/1-6	Cell	4/
M81757/1-6	Cell	8/	M81757/X-X	Battery	3/, 7/
M81757/7-1	Battery	Canceled	M81757/7-2	Battery	5/
M81757/7-1	Battery	Canceled	M81757/7-3	Battery	3/
M81757/7-2	Battery	8/	M81757/7-3	Battery	3/
M81757/8-1	Battery	Canceled	M81757/8-4	Battery	5/
M81757/8-1	Battery	Canceled	M81757/8-5	Battery	3/
M81757/8-2	Battery	Canceled	M81757/8-4	Battery	5/
M81757/8-2	Battery	Canceled	M81757/8-5	Battery	3/
M81757/8-3	Battery	Canceled	M81757/8-5	Battery	5/
M81757/8-3	Battery	Canceled	M81757/8-4	Battery	3/
M81757/8-4	Battery	8/	M81757/8-5	Battery	3/
M81757/9-1	Battery	Canceled	M81757/9-2	Battery	5/
M81757/9-1	Battery	Canceled	M81757/9-3	Battery	3/
M81757/9-2	Battery	8/	M81757/9-3	Battery	3/
M81757/11-1	Battery	Canceled	M81757/11-3	Battery	3/
M81757/11-2	Battery	Canceled	None	---	---
M81757/11-4	Battery	Canceled	None	---	---
M81757/12-2	Battery	Canceled	None	---	---

TABLE IX. Battery and cell supersession data - Continued.

NOTES:

1/ The superseded part was purchased under MIL-E-81099.

2/ The superseded part was purchased under MIL-B-8565.

3/ The replacement data shown applies only when purchasing the part for use by those military departments that use aircraft nickel-cadmium batteries which are designed so that the cells are not to be removed and replaced. The cell terminals of such batteries are fastened with non-removable shear-head screws which prohibit cell removal and replacement.

4/ The superseded part was purchased under MIL-B-26220.

5/ The replacement data shown applies only when purchasing the part for use by those military departments that use aircraft nickel-cadmium batteries which are designed so that the cells can be removed and replaced. The cell terminals of such batteries are fastened with removable hex-head screws which allow the cells to be removed and replaced.

6/ All variations of each MS90321 cell are included; for example, -66, -66W, and -66R.

7/ Replace with either M81757/9-3 or M81757/13-1, using the correct design for the application.

8/ The superseded part has been determined obsolete and inactive for new designs by some military departments, such as the Navy, which no longer use aircraft nickel-cadmium batteries that allow the cells to be replaced.

NOMENCLATURE:	BATTERY, STORAGE, AIRCRAFT LIMITED-REPAIR, NICKEL-CADMIUM
MILITARY PIN:	M81757/***
TYPE DESIGNATION:	***
NATIONAL STOCK NUMBER:	6140-**-***-****
REPLACES:	***
NOMINAL VOLTAGE:	*** VOLTS
MAXIMUM WEIGHT:	*** POUNDS
INITIAL CAPACITY:	*** AH (*** AMPS/***MINUTES/77ºF/*** V)
MINIMUM CAPACITY:	*** AH/1 HR/77 °F/*** V
CONTRACT AND DELIVERY ORDER NUMBER:	***
MANUFACTURED BY:	***
MANUFACTURER CAGE:	***
MANUFACTURER SERIAL NUMBER:	***
DATE/LOT CODE:	***
DATE FIRST PLACED IN SERVICE:	

FIGURE 1. Marking for limited-repair batteries.

NOMENCLATURE:	BATTERY, STORAGE, AIRCRAFT REPAIRABLE, NICKEL-CADMIUM
MILITARY PIN:	M81757/***
TYPE DESIGNATION:	***
NATIONAL STOCK NUMBER:	6140-**-***-****
REPLACES:	***
CELL REQUIRED:	*** EACH M81757/***, NSN ***
NOMINAL VOLTAGE:	*** VOLTS
MAXIMUM WEIGHT:	*** POUNDS
INITIAL CAPACITY:	*** AH (*** AMPS/***MINUTES/77 °F/*** V)
MINIMUM CAPACITY:	*** AH/1 HR/77 °F/*** V
CONTRACT AND DELIVERY ORDER NUMBER:	***
MANUFACTURED BY:	***
MANUFACTURER CAGE:	***
MANUFACTURER SERIAL NUMBER:	***
DATE/LOT CODE:	***

FIGURE 2. Marking for repairable batteries.

	MINIMUM LETTERING HEIGHT
CAUTION	0.500 inch (for example, uppercase 48 point type size)
THIS BATTERY SHALL BE SERVICED ONLY IN AN AUTHORIZED NICKEL-CADMIUM BATTERY SHOP. ALL CELLS WITHIN THIS BATTERY MUST HAVE THE SAME MANUFACTURER'S PART NUMBER. 1/	0.250 inch (for example, uppercase 24 point type size)
⇩ RECEPTACLE ⇩	0.500 inch (for example, uppercase 48 point type size)

1/ Delete the second sentence for limited-repair batteries.

FIGURE 3. Marking for battery caution and receptacle.

NOMENCLATURE:	BATTERY, STORAGE, (CELL)
MILITARY PIN:	M81757/***
NATIONAL STOCK NUMBER:	6140-**-***-****
INITIAL CAPACITY:	*** AH @ *** AMPS/77 °F/*** V
MINIMUM CAPACITY:	*** AH/1 HR/77 °F/*** V
CONTRACT AND DELIVERY ORDER NUMBER:	***
MANUFACTURED BY:	***
MANUFACTURER CAGE:	***

FIGURE 4. Marking for cell identification.

CONCLUDING MATERIAL

Custodians:
Army - CR
Navy - AS
Air Force - 11

Review activities:
Army - AV
Air Force - 71, 99

Preparing activity:
Navy - AS

Agent:
Navy - NW

(Project 6140-2010-003)

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.