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SUPERSEDING
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MILITARY SPECIFICATION

BATTERY STORAGE, AIRCRAFT GENERAL SPECIFICATION FOR

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

1. **SCOPE.** This specification covers the general requirements for rechargeable storage batteries for use in aircraft. The batteries are nominal 24-volt batteries.

1.1 Classification. Batteries shall be classified as follows:

Type 1	Medium Rate	Batteries generally used for medium current engine starting/utility applications, having non-removable covers, designed for maintenance-free operation.
Type 2	High Rate	Batteries generally used for high current engine start applications having removable covers to allow access for scheduled maintenance.

1.2 Part numbers. Part numbers for batteries furnished under this specification shall be as follows: D8565/X-Y with "X" being the specification sheet number and "Y" being any variation of the battery on a specific specification sheet.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards and handbooks. The following specifications, standards and handbooks form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of these documents shall be those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Systems Engineering and Standardization Department (Code 53), Naval Air Engineering Center, Lakehurst, NJ 08733-5100, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A

FSC 6140

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SPECIFICATIONS

FEDERAL

- FF-N-836 Nut, Square, Hexagon, Cap, Slotted, Castle, Knurled, Welding and Single Ball Seat
- FF-S-92 Screw, Machine, Slotted, Cross Recessed or Hexagon Head
- QQ-C-502 Copper Rods and Shapes and Flat Products with Finished Edges (Flat Wire Strips and Bars)
- QQ-N-290 Nickel Plating (Electrodeposited)

MILITARY

- MIL-M-14 Molding Plastics and Molded Plastic Parts, Thermosetting
- MIL-P-6063 Packaging of Batteries Storage, Charged and Dry Uncharged and Moist, General Specification for
- MIL-M-13231 Marking of Electronic Items
- MIL-C-16173 Corrosion Preventive Compound, Solvent Cutback, Cold-Application
- MIL-C-45662 Calibration Systems Requirements

(See Supplement 1 for list of associated documents.)

STANDARDS

FEDERAL

- FED-STD-595 Colors

MILITARY

- MIL-STD-105 Sampling Procedures and Tables for Inspection by Attributes
- MIL-STD-129 Marking for Shipment and Storage
- MIL-STD-130 Identification Marking of U. S. Military Property
- MIL-STD-810 Environmental Test Methods and Engineering Guidelines
- MIL-STD-889 Dissimilar Metals
- MS3509 Receptacle, Electric, Aircraft Storage Battery

STANDARDS (Continued)

MILITARY (Continued)

MS3349	Plug, Electric, Two-Wire, Aircraft Storage Battery
MS18015	Catch, Clamping and Strike (Concealed Spring Type)

(Copies of specifications, standards, drawings and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.1.2 Other Government documents, drawings and publications. The following other Government documents, drawings and publications form a part of this specification to the extent specified herein. Unless otherwise specified, the issues shall be those in effect on the date of the solicitation.

DEPARTMENT OF DEFENSE

SD-6	Provisions Governing Qualification (Qualified Products List)
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2.2 Other publications. The following document(s) form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted shall be those listed in the issue of the DODISS specified in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS shall be the issue of the nongovernment documents which is current on the date of the solicitation.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 4066-82	Materials, Nylon Injection and Extrusion (PA)
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(Application for copies of ASTM publication should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

(Nongovernment standards and other publications are normally available from the organizations which prepare or which distribute the documents. These documents also may be available in or through libraries or other informational services.)

3. REQUIREMENTS

3.1 Detail specification. The individual item requirements shall be as specified herein and in accordance with the applicable detail specification. In the event of any conflict between the requirements of this specification and the detail specification, the latter shall govern. (If a specific requirement specified herein is not required for an item, it shall be so indicated on the specification sheet, e.g., Shock - N/A.)

3.2 Qualification. Qualification under this specification is required. The batteries furnished under this specification shall be products which have been tested and have passed the qualification tests specified herein and approved for listing on the applicable Qualified Products List (see 4.2.1 and 6.4) unless agreement is obtained in writing from the cognizant engineering activity that no qualified product is practical for the application. In the latter case, a product which has been tested and has qualified to a detail specification accepted in writing by the cognizant engineering activity may be utilized. In either case, each unit delivered shall fully meet all the requirements of the applicable detail specification and shall be capable of successfully completing the tests required by the detail specification for acceptance and for any one of the qualification samples.

3.3 Materials and components. When a definite material or component is specified, it shall be in accordance with the applicable specification (see 6.5). When deemed necessary by the Government, certification from the source of the material or component will be required. In the absence of certification from the source, a certificate of analysis or certified inspection data will be required (see 4.2.1).

3.4 Dissimilar metals. Unless suitably protected against electrolytic corrosion, dissimilar metals shall not be employed in intimate contact with each other. Dissimilar metals are defined in MIL-STD-889.

3.5 Design and construction. Each type of storage battery covered by this specification is listed in the supplement and shall be designed and constructed in conformance to the requirements specified herein. Detailed requirements for the individual battery types are as specified in the applicable specification sheets.

3.5.1 Batteries. Batteries shall be furnished in a fully formed state and shall not require the addition of any substance before being put into service. The no-maintenance Type 1 battery shall not require any maintenance in meeting the provisions of this specification. Type 2 batteries shall be furnished in a wet-discharged state with a shorting strap across receptacle terminals.

3.5.2 Battery container and cover.

3.5.2.1 Type 1 battery. The battery container and cover shall be free of rough spots, pits, blow holes and other deformations. The cover shall be non-removable from the container. The dimensions and locations of receptacles, hold-downs, vent tubes, name and instruction plates shall conform to the applicable specification sheet (see 3.1).

3.5.2.2 Type 2 battery. The battery container and cover shall be of alkali-resistant high strength steel, free of rough spots, pits, blow holes and other deformations. The container and cover shall be completely coated by an epoxy resin to a minimum thickness of 0.007 inch. The dimensions and locations of receptacles, hold-downs, latches and latch hooks, vent tubes, name and instruction plates shall conform to the applicable specification sheet (see 3.1). The cover shall be fitted with a hold-down pad having an integral elastomer gasket (see 3.1) positioned so as to match the rim of the container body for a gas-tight fit and effective fluid seal between the cover and the container body and shall conform to 3.6.6.

3.5.3 Latches (Type 2 battery only). The cover shall be secured to the container body by latches mounted on the container body and latch hooks mounted on the cover. The latches shall conform to Corbin Cabinet Lock Division, American Hardware, Item Number 15834, or Nielson Latch Number C-833314-2-SS-302 or equal and the latches and hooks shall be mounted on the cover and container body as specified on the applicable specification sheet (see 3.1). The applicable military standard is MS18015 for the latches.

3.5.4 Venting. Each battery shall include two vent tubes, located as shown on the applicable specification sheet (see 3.1). The vent tubes shall be made so that air can enter the battery through either vent tube, flow freely across the cells, and exit through the other vent tube. Each vent tube shall be capable of supporting 1.5 times the battery weight. For Type 1 batteries, no corrosive, ignitable, or liquid discharge through the battery vent tubes shall occur during testing to this specification (except when testing to 4.6.22). With the battery vent ports open and the battery operating within design requirements of this specification, cell venting shall not cause corrosive or liquid discharge from the battery. Venting of gasses containing entrained electrolyte is permitted during charge only on Type 2 batteries. After a venting sequence, the venting mechanism within the battery shall automatically revert to its pre-vented configuration. Venting shall not be toxic.

3.5.5 Receptacles. Each battery shall include, as its electric connections, a receptacle(s) as shown on the applicable specification sheet (see 3.1).

3.5.6 Connectors, intercell. The connectors shall conform to the applicable specification sheet (see 3.1). All electrical connections within the battery shall be by surface-to-surface conduction and not through screw threads. Intercell connectors shall not interfere with the removal of the cell vent caps on the Type 2 batteries.

3.5.7 Cells. Type 2 batteries only.

3.5.7.1 Cell mounting. The cells shall be non-removable and securely mounted in the battery container such that they are not adversely affected by tests performed on the battery to determine its compliance with the requirements of this specification. Cell removal shall be impeded by a non-removable fastening means as shown in applicable specification sheet (see 3.1).

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

3.5.7.3 Cell terminals. The size and spacing shall be as specified in the applicable specification sheet (see 3.1). Contact surfaces of the terminals shall not be obstructed by insulating compounds.

3.5.7.4 Cell seals. The seals between cell terminals and cover, and cover to cell container shall be so constructed that the cells shall be capable of meeting the requirements of 3.5.8 and 3.6.21.

3.5.8 Electrolyte leakage. There shall be no evidence of electrolyte leakage during the performance of any of the tests specified in Section 4 except when tested in accordance with 4.6.22. Venting of gasses containing entrained electrolyte is permitted during charge only on Type 2 batteries.

3.5.9 Nominal and maximum potential. The nominal potential of each battery shall be 24 volts unless otherwise specified on the applicable specification sheet (see 3.1). The battery potential shall not exceed 29.0 volts at any time, except when charged in accordance with the procedure defined in 4.5.1.4 and when tested in accordance with 4.6.22 and 4.6.28.

3.5.10 Operating position. The battery shall be capable of operating in an inverted position without loss of any electrolyte when subjected to the tests of 4.6.16 and 4.6.17.

3.5.11 Corrosion prevention (Type 2 battery only). After the battery has been assembled, all exposed metal surfaces of the cells, intercell connectors, and associated hardware shall be coated with a corrosion preventative compound which meets the requirements of MIL-C-16173, Grade 4. Care shall be taken not to expose rubber vent valve sleeves, vent openings, or current carrying surfaces to the corrosion preventative film. Coating shall be applied evenly and without voids.

3.5.12 Reliability. The battery shall have a minimum mean flight hours between failure (MFHBF) of 1500 hours while operating under conditions specified herein.

3.6 Examination.

3.6.1 Corrosion resistance. External and internal metal or component parts of each battery shall show no evidence of cracking, pitting, chipping, scaling, corrosion, or other deleterious effects during the performance of any of the tests specified in Section 4.6.

3.6.2 Venting (Type 2 battery only). Vented filler caps conforming to the applicable specification sheet (see 3.1) shall vent at 8 ± 2 psig when tested in accordance with 4.6.2.

3.6.3 Color and marking.

3.6.3.1 Color. The color of all visible parts except the latches, hold-down hooks, identification marking and instructions, of each battery shall conform to FED-STD-595 for the color number listed in Table I, according to whether the battery uses acid or alkaline electrolyte.

TABLE I. Colors.

Electrolyte	Color Number
Acid	21158 (Pink)
Alkaline	15090, 15102, 15123 or 15193 (Blue)

3.6.3.2 Marking.

3.6.3.2.1 Polarity marking. The container body shall be conspicuously and durably marked "+" in white in the location shown on the applicable specification sheet (see 3.1).

3.6.3.2.2 Identification and warranty marking. The battery shall be marked for identification and warranty in accordance with MIL-STD-130. Marking shall be in white or black print per MIL-M-13231. Marking for Label 1 shown on Figure 1 on the applicable specification sheet shall show the following. The words MAINTENANCE-FREE shall be placed on the Type 1 batteries and the words HIGH-RATE on Type 2 batteries.

BATTERY STORAGE, AIRCRAFT
24 VOLTS, MAINTENANCE-FREE (when applicable)
or
HIGH-RATE (when applicable)

<u>Information Required</u>	<u>Example</u>
MIL Part No.	D8565/5-1
Replaces (include replacement data from applicable battery specification sheet)	Replaces M83769/5-1
Maximum Weight	36 kg
Military "C" Rated Capacity	30 Ah/1 HR/21°C/18.0V
National Stock Number	6140-**-***-****
Contract Number	***
Date and Lot Code	0884-02
Battery S/N	***
Manufacturer's Name	****
Date Battery Placed in Service	
Warranty Expiration Date	****

***Fill in applicable information.

3.6.3.2.3 Battery caution marking (Type 1 battery only). Marking for Label 2 shown on Figure 1 on the applicable specification sheet shall show the following for Type 1 batteries. Lettering height shall be 0.25 inch minimum except for the "WARRANTED ITEM" line which shall be 0.375 inch minimum. Marking shall be in white or black print per MIL-M-13231.

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WARRANTED ITEM

MAINTENANCE-FREE BATTERY

DO NOT REMOVE COVER

THIS BATTERY SHALL BE PROCESSED

IN ACCORDANCE WITH NAVAIR 17-15BAD-1

THIS BATTERY IS TO BE REMOVED FROM

SERVICE ** YEARS FROM DATE FIRST PLACED

IN SERVICE

**Fill in information from applicable specification sheet.

3.6.3.2.4 Battery caution marking (Type 2 battery only). Marking for Label 2 shown on Figure 1 on the applicable specification sheet shall show the following for Type 2 batteries. It shall be in white printing in accordance with MIL-M-13231, and shall be impervious to the 1.300 ± 0.025 specific gravity KOH electrolyte.

WARRANTED ITEM	0.375 ± 0.030 inch lettering height
"CAUTION"	0.375 ± 0.030 inch lettering height
THE CELLS IN THIS BATTERY ARE NOT TO BE REMOVED	0.200 ± 0.030 inch lettering height
THIS BATTERY SHALL BE PROCESSED IN ACCORDANCE WITH NAVAIR 17-15BAD-1	0.200 ± 0.030 inch lettering height
RECEPTACLE	0.500 ± 0.030 inch lettering height

3.6.3.2.5 Date and lot code. The date of manufacture and lot number shall be clearly shown on the nameplate in a code which shall indicate the month and year of manufacture by a four digit number, followed by a dash and the lot number. The first two digits shall indicate the month and the next two indicate the year. Months earlier than the 10th month shall be a single digit preceded by "0." When a battery is completed during the last three working days of a month, the manufacturer is permitted to use either month as the coded month of manufacture. Example code, 0484-12, indicates the battery was manufactured in April 1984 and was the twelfth lot. The lot code shall also be marked on all interior packages and exterior shipping containers (see 5.2).

3.6.4 Dielectric strength. All current carrying parts shall be insulated from the battery container. The insulation resistance between any current carrying part and the battery container shall be above one megohm when tested for one minute in accordance with 4.6.5.

3.6.5 Dimensions and weights. The dimensions and weights of batteries shall be as shown on the applicable specification sheet (see 3.1).

3.6.6 Container body to container cover seal (Type 2 battery only). The battery container body and container cover when latched correctly shall maintain a seal such that the loss in pressure shall be less than 3.0 inches of water when tested in accordance with 4.6.6.

3.6.7 Vent tubes. The vent tubes shall show no evidence of breaking, bending or cracking when tested in accordance with 4.6.7.

3.6.8 Capacity and electrical performance. The discharge current in amperes for each discharge time shall be equal to the nominal rated capacity (C-rating) in ampere-hours multiplied by the factor listed in Table II. The minimum end voltage for each discharge time shall be the value listed in Table II. The temperatures for each discharge time shall be the value listed in Table II unless otherwise specified in the description of the test. Upon failure of the battery to meet the specified minimum requirements of any electrical test, unless otherwise specified in the description of the test, it shall be recharged as described in 4.5.1.3, after which the test will be repeated. Inability to meet the specified minimum requirements during the repeated test constitutes a failure. Should the battery meet the test requirements, the specified test schedule shall be resumed. For discharges conducted at various C-ratings, the current shall be maintained within a tolerance of ± 1 percent of the specified value. For Type 2 batteries only, one unscheduled conditioning in accordance with 4.5.1.4.2 shall be allowed during the entire electrical capacity testing.

TABLE II. Capacity performance requirements.

Type 1 battery

Requirement Number	Discharge Cutoff Volts & Temperature	Rate of Discharge Factor	Minimum Time to Cutoff Voltage
(1)	18.0 volts at $24^{\circ} + 3^{\circ}\text{C}$	1.0C	1 hour
(2)	18.0 volts at $49^{\circ} \mp 2^{\circ}\text{C}$	1.0C	1.1 hours
(3)	18.0 volts at $-18^{\circ} + 2^{\circ}\text{C}$	1.0C	30 minutes
(4)	14.0 volts at $24^{\circ} \& -26^{\circ} \pm 2^{\circ}\text{C}$	See 1/	1 minute
(5)	14.0 volts at $24^{\circ} + 3^{\circ}\text{C}$	6.5C	5 minutes

Type 2 battery

Requirement Number	Discharge Cutoff Volts & Temperature	Rate of Discharge Factor	Minimum Time to Cutoff Voltage
(1)	18.0 volts at $24^{\circ} + 3^{\circ}\text{C}$	1.0C	1 hour
(2)	18.0 volts at $49^{\circ} \mp 2^{\circ}\text{C}$	1.0C	1.1 hours
(3)	18.0 volts at $-30^{\circ} + 2^{\circ}\text{C}$	1.0C	45 minutes
(4)	14.0 volts at $24^{\circ} \& -30^{\circ} \pm 2^{\circ}\text{C}$	See 1/	1 minute
(5)	14.0 volts at $24^{\circ} + 3^{\circ}\text{C}$	9.0C	5 minutes

1/ A 14.0 volt constant voltage discharge for 1 minute shall be performed on the battery. The discharge shall be performed at the two temperatures specified. The current requirements shall be specified in the applicable specification sheet (see 3.1).

3.6.9 Strength of receptacle. The receptacle and receptacle mounting shall withstand a pullout force of 250 ± 25 pounds and a torsional force of 6 ± 0.5 foot-pounds when tested in accordance with 4.6.12.

3.6.10 Life. Batteries delivered under this specification shall be capable of at least 2.5 years of service life, demonstrated by successfully completing the service life test specified herein. At the option of the qualifying activity, batteries may instead be subjected to the applicable cycling test.

3.6.10.1 Life cycling (Type 1 battery). Batteries, when cycled in accordance with 4.6.13.1 at the ambient conditions of 4.5.1.1, shall provide no less than eighty-five (85) cycles of charge and discharge. During the life test, inability to meet the 1-hour rate discharge requirement for three (3) consecutive discharges shall constitute a failure.

3.6.10.2 Life cycling (Type 2 battery). Batteries, when cycled per 4.6.13.2 at the ambient conditions of 4.5.1.1, shall meet the minimum requirements as follows.

- a. The 5-second voltage for each 20-second discharge shall be 14.0 volts or above (during any duty cycle discharge).
- b. The 20-second voltage shall be 12.0 volts or above (during any duty cycle discharge).
- c. The capacity on the 46th cycle shall equal or exceed 85 percent of that specified in requirement (1) of Table II.
- d. The battery shall successfully complete 46 cycles without the addition of water or conditioning.

3.6.10.3 Service life. Batteries, when service life cycled per 4.6.13.3 under the stated temperature and vibration conditions, shall provide no less than seventy-two (72) cycles of charge and discharge. During the life test, inability to meet the discharge requirement for three (3) consecutive discharges shall constitute a failure. The battery shall also meet the specified requirements of 3.6.12.

3.6.11 "Evaluation of Equipment" test. After all environmental tests, the battery shall be subjected to a (6.5C for Type 1, 9.0C for Type 2) rate discharge for three (3) minutes as the test for "Evaluation of Equipment." The battery voltage shall be 14.0 volts or greater at the end of three minutes.

3.6.12 Environmental requirements. The battery, when subjected to the requirements listed in Tables II and III, shall show no:

- a. Dimensional distortion beyond specified limits or cracking of cases or covers of either cells or batteries.
- b. Radical current or voltage fluctuations during any test.

- c. Mechanical failure of any part.
- d. Electrolyte leakage or spilling of electrolyte at any time during the test. Venting of gasses containing entrained electrolyte is permitted during charge only on Type 2 batteries.
- e. 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.
- f. Deterioration of battery identification markings.

TABLE III. Battery environmental requirements.

Examinations and Tests	Test Paragraph
Altitude	4.6.17
Mechanical shock	4.6.18
Temperature shock	4.6.19
Temperature rise and float test	4.6.21
Vibration	4.6.23
Humidity	4.6.24
Salt fog	4.6.25

3.6.13 Temperature rise and float. When tested in accordance with 4.6.21, the charging current shall be recorded at intervals not to exceed 30 minutes. The charging currents shall not exhibit increasing values of more than a total of .10 ampere per rated ampere-hour (Example: 1.5 amperes for a 15-ampere-hour battery) at any time during charge. The battery shall meet the 1-hour discharge requirement (1) of Table II.

3.6.14 Battery gas emission (Type 1 battery only). The percent of hydrogen concentration shall be less than 3.5 percent at all times when tested in accordance with 4.6.22.

3.6.15 Storage.

3.6.15.1 Ground storage. The battery shall be capable of storage at temperature conditions from -26°C to 50°C for up to 30 days and maintain a sufficient state of charge to deliver 50 percent of rated capacity when discharged at the 1-hour rate. The battery shall meet these requirements when tested in accordance with 4.6.26.

3.6.15.2 Shelf life. The battery shall be capable of storage at temperature conditions from -60°C to +38°C for 1-year minimum without damage. Capacity of batteries in storage for 1 year at -60°C to +38°C shall be recoverable when charged in accordance with 4.5.1.4. The Government reserves

the right to perform a 1-year storage test within the specified temperature range and remove the battery from the Qualified Products List if the rated battery capacity is not recoverable.

3.6.16 Vibration. The battery shall meet the requirements of 3.6.11 and 3.6.12 when subjected to the vibration test of 4.6.23.

3.6.17 Humidity. The battery shall meet the requirements of 3.6.11 and 3.6.12 when subjected to the humidity test of 4.6.24.

3.6.18 Salt fog. The battery shall meet the requirements of 3.6.11 and 3.6.12 when subjected to the salt fog test of 4.6.25.

3.6.19 Impact resistance (nonmetallic battery container only). Two outer nonmetallic battery containers shall be supplied as test samples for qualification testing. When tested as specified in 4.6.27.1, the minimum impact resistance values for nonmetallic battery containers shall be as follows.

<u>Temperature</u>	<u>Minimum Impact Resistance Value</u>
71.1°C	180 inch-pounds
-17.8°C	120 inch-pounds
-40.0°C	100 inch-pounds

3.6.20 Gas barrier material (Type 2 battery only). When tested in accordance with 4.6.28, the charging current in step g shall not exhibit increasing values of more than 0.2 times the C-rate capacity of the battery (from the lowest current value reached) during the charge. The gas barrier material in each cell shall be intact and shall be removable in one complete piece during the examination of 4.6.28.

3.6.21 Internal pressure (Type 2 battery only). A cell, when tested in accordance with 4.6.29, shall be capable of withstanding an internal pressure of 20 \pm 1 psig for 15 seconds.

3.6.22 Workmanship. The battery shall be processed in such a manner as to be uniform in quality and shall be free from defects that will affect life, functioning and appearance. There shall be no evidence of loose contacts, poor or improper molding or fabrication, damaged or improperly assembled contacts, peeling, flaking or chipping of plating or finish, mechanical damage due to testing environments, nicks or burrs of metal parts of surfaces, improper or incorrect marking.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items must meet all requirements of Sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of assuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling in quality conformance does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to acceptance of defective material.

4.2 Classification of inspection.

- a. Qualification inspection. A qualification inspection shall consist of tests accomplished on batteries, battery components and materials submitted for qualification (see 4.2.1).
- b. Quality conformance inspection. The quality conformance inspection shall consist of tests conducted on production samples to determine compliance with specification requirements and for qualification verification (see 4.3.1 and 4.4).

4.2.1 Qualification inspection. Qualification inspection shall be performed by the Government on samples of components, materials and batteries furnished by the supplier. The samples shall be representative of the components, materials and batteries proposed to be furnished the Government under contract and shall not be produced with the use of any equipment or procedure that will not normally be used in production. Qualification inspection on these samples shall be conducted at a Government test facility (see 6.4) and shall consist of the examinations and tests specified herein and the evaluation of inspection results in relation to applicable requirements. The batteries will be considered qualified and will be placed on the Qualified Products List upon successful completion of the qualification inspection tests of Table I of the applicable specification sheet in essentially the order shown. The batteries shall be retained on the Qualified Products List as long as the Group B samples continue to demonstrate conformance to the requirements of the specification. The cost of the qualification inspections shall be borne by the Government for the period of time required to establish a minimum of two qualified suppliers on the applicable Qualified Products List and except as noted in 4.2.1.4. The requirements of the Department of Defense Document, SD-6, apply.

4.2.1.1 Inspection of battery components and materials (Type 2 battery). Three (3) samples each of applicable battery components and materials, treated and processed as they would be for fabrication of finished batteries, shall be furnished for inspection in accordance with Table IV. All samples shall be marked properly with identifying information.

4.2.1.2 Inspection of batteries. Three (3) samples each of complete batteries shall be furnished for inspection in accordance with Table I of the applicable specification sheet and in the order shown. One (1) dry unassembled battery with all parts shall be supplied and will be retained at the Government agency which did the testing.

TABLE IV. Qualification inspection of components and materials.

Test	Part	Requirement Paragraph	Method Paragraph
Corrosion resistance	Metal parts <u>1/</u>	3.6.1	4.6.1
Venting test	Vented filler caps	3.6.2	4.6.2

1/ Container, cover and latches, external cell terminal hardware, intercell connectors and hardware, etc.

4.2.1.3 Retention of samples. If the manufacturer becomes qualified, the sample batteries on which the qualification is based will be retained at the Government agency which did the testing as long as he is qualified.

4.2.1.4 Failure and retest. Failure of a qualification sample to pass any of the examinations or tests specified herein shall be cause for the Government to refuse to conduct additional testing until the defects revealed by the inspection have been corrected. With the approval of the Government, a retest may be allowed with an increase in the number of qualification samples as specified by the qualifying activity. The cost of retesting shall be borne by the supplier.

4.3 Quality conformance testing.

4.3.1 Inspection of product for delivery. The supplier shall perform the inspections specified for Quality Conformance Inspection. This does not relieve the supplier of his responsibility for performing any additional inspection which is necessary to control the quality of the product and to assure compliance with all specification requirements. The Government will review and evaluate the supplier's inspection procedures and examine his inspection records. Batteries produced under this specification will be accepted upon successful completion of Quality Conformance (Group A) Inspection as outlined in Table I of the applicable specification sheet and provided that Group B samples have been shipped to the qualifying activity in accordance with 4.4.

4.3.1.1 Inspection lot definition. An inspection lot shall be defined as the quantity of batteries of any one type, produced at any one place of manufacture on any one contract, submitted at one time for quality conformance inspection. Batteries with no more than two consecutive date codes shall appear in a particular inspection lot. A specific date and lot code shall not be found in any more than one inspection lot.

4.3.1.2 Quality conformance (Group A) inspection. Each unit of each inspection lot of batteries shall be subjected to the examination and test requirements (Group A tests) of Table I of the applicable specification sheet.

4.4 Group B inspection. The Group B inspection shall be conducted for qualification verification by the qualifying activity on samples furnished by the contractor at no cost to the government in accordance with Table I of the applicable specification sheet in the order shown. Sample batteries in quantities conforming to Table V shall be shipped by the supplier to the qualifying activity within three (3) working days after acceptance of the applicable inspection lots by the Government inspector. Samples shall be selected at random by the Government inspector (QAR) from inspected lots so as to be representative of all batteries that have passed Quality Conformance (acceptance) Inspections. Additionally, the samples shall be in quantities specified in Table V and shall not be included in the contract lot size. Shipment of inspection lots that have passed Group A (acceptance) inspection requirements shall be held up pending results of the first 14 days of Group B inspection performed on samples representing these lots. Once qualified, production samples successfully passing the acceptance criteria are to be accepted until qualification is officially rescinded. Unless otherwise specified in the contract, the cost of Government testing shall be borne by the Government (see 6.3).

TABLE V. Group B inspection.

Inspection Lot Size	Total Number of Samples
2 thru 200	2
201 thru 500	4
501 thru 1000	6
1001 thru 3000	8

4.4.1 Non-compliance. Failure of any sample to pass any Group B test may be cause for the qualifying activity to initiate action to remove the supplier from the applicable Qualified Products List. The qualifying activity shall notify the procuring agency and the supplier of each Group B failure, including details of the failure and characteristics affected. Upon notification by the qualifying activity, the supplier shall immediately investigate the cause of failure and further report the results of the investigation and details of the proposed corrective action on (1) the process materials and components as applicable and (2) all units of product which were manufactured under the same conditions and which the qualifying activity considers subject to the same failure. Supplier reports shall be forwarded to the qualifying activity with an information copy to the procuring agency.

4.4.2 Inspection of preparation for delivery. Preparation for delivery shall be examined for conformance to Section 5. The sample unit shall be one item, one package, or one shipping container. The inspection level shall be S-2, and the Acceptable Quality Level (AQL) shall be 4.0 percent as set forth in Military Standard MIL-STD-105.

4.5 Inspection conditions and equipment.

4.5.1 Standard test conditions. All tests of this specification shall be performed in the following conditions unless otherwise specified.

4.5.1.1 Ambient air temperature. Unless otherwise specified, all measurements and tests shall be made in an ambient temperature $24^{\circ} \pm 5^{\circ}\text{C}$ at ambient atmospheric pressure and relative humidity.

4.5.1.2 High and low temperature. Unless otherwise specified, all high and low temperature charge and discharge tests shall be conducted at the temperature indicated in the applicable test paragraph with a storage time of 20-24 hours prior to discharge. A tolerance of $\pm 2.0^{\circ}\text{C}$ shall be allowed.

4.5.1.3 Constant-potential charging. Unless otherwise specified, batteries shall be charged at $28.25 \pm .50$ volts constant-potential for 2.0 ± 0.1 hours with a power source having a current capacity of not less than 8 times the capacity rating of the battery being tested. If the battery contains a heater circuit, the circuit shall be energized during the complete charge. For Type 2 batteries, the electrolyte of each cell shall be checked and deionized or distilled water added, if needed, after each charge except during the cycling test of 4.6.13.2.

4.5.1.4 Constant current charging.

4.5.1.4.1 Conditioning (Type 1 battery only). Conditioning during testing to this specification shall consist of charging the battery at a constant current rate of C/10 (± 3 percent) for 18 hours.

4.5.1.4.2 Conditioning (Type 2 battery only). Conditioning during testing to this specification shall consist of subjecting a fully charged battery, with electrolyte level adjusted, to a C-rate discharge and applying a one-ohm resistor across each cell's terminals when its potential is 0.5 volt. Following a minimum 24-hour stand, the resistance shall be removed and the battery shall be charged constant current at the C-rate to 1.55 ± 0.1 volts per cell, then C/5 for 3 ± 0.1 hours. The electrolyte of each cell shall be adjusted with deionized or distilled water to 0.25 inch above the baffle 2 - 4 hours after charge termination unless otherwise specified.

4.5.1.5 Discharges. For all discharges, the current or voltage (whichever is applicable) shall be maintained within ± 1 percent of the specified value at all times, and the duration of the discharges shall be within ± 2 percent of the nominal discharge time. All discharges shall be continuous unless otherwise stated.

4.5.2 Test equipment and inspection facilities. Test equipment and inspection facilities shall be of sufficient accuracy, quality and quantity to permit performance of the required inspection. Test equipment for Government verification inspection shall be made available by the supplier. The contractor shall establish and maintain a system for the calibration of all measuring and test equipment in accordance with MIL-C-45662.

4.5.3 Instrument accuracy.

4.5.3.1 Electrical indicating instruments. All voltmeters and ammeters shall be accurate within ± 0.5 percent of the full scale reading. The range of analog type meters shall be that the readings are taken on the upper half of the scale. Timers shall be accurate within ± 0.5 percent. The sensitivity of voltmeters shall be at least 5000 ohms per volt.

4.5.3.2 Resistance tolerances. In all tests involving discharge through a resistance, the total circuit resistance shall be accurate within ± 1.0 percent.

4.5.4 Order of tests. The tests on each battery shall be performed in the order of Table I of the applicable specification sheet.

4.5.5 Mounting. For the vibration and mechanical shock tests, the mounting shall be by normal aircraft attachment points. Vibration isolators shall not be used. For all other tests, the bottom of the battery shall be supported on a rigid surface.

4.6 Examination and test methods.

4.6.1 Corrosion resistance (Type 2 battery parts only). Samples of all metal parts of the cells and/or battery shall comply with 3.6.1 after being subjected to this test. A four by six-inch panel of battery case material shall be furnished for this test, coated as it would be supplied on the battery and containing sample identification markings. One-half of each specimen shall be immersed along its horizontal length in a solution of 1.300 + 0.025 specific gravity KOH electrolyte and allowed to stand for 7 days at $65.5^\circ + 1.1^\circ\text{C}$ ($150^\circ + 2^\circ\text{F}$). Specimens shall then be rinsed, dried and observed for the requirements of 3.6.1.

4.6.2 Venting tests (Type 2 battery parts only).

4.6.2.1 Ambient air temperature test (see 4.5.1.1). The vented filler cap shall be attached to an adapter to which a variable pressure source of compressed air is connected. The air pressure shall then be adjusted from the lower limit to the higher limit and returned to the lower limit specified. The vented filler caps shall meet the requirements of 3.6.2.

4.6.2.2 Low temperature test (see 4.5.1.2). The above test shall be repeated at -30°C (-22°F) except that the vented filler cap shall be conditioned at -30°C (-22°F) for 24 ± 2 hours. The vented filler caps shall meet the requirements of 3.6.2.

4.6.3 Visual and mechanical examination. Samples of batteries shall be examined to verify that the basic materials, component materials and parts, design and construction, marking and workmanship are in accordance with all the requirements of 3.5, 3.6.3 and 3.6.22 and Table VI.

4.6.4 Dimensions and weight. The batteries shall be measured and weighed to determine compliance with the requirements of 3.6.5.

4.6.5 Dielectric strength. The insulation resistance between the current carrying parts of the battery, heater circuit (if applicable), and battery container shall be above one megohm when 500 ± 10 VDC is applied between either battery terminal and exposed metal of the container, between either battery terminal and the heater circuit (if applicable), and between the heater circuit (if applicable) and the container. The battery shall meet the specified requirement of 3.6.4.

TABLE VI. Identification of defects.

Number	Description	Method of Inspection
1	Electrical contact surfaces obstructed by insulation compounds.	Visual
2	Pitting or blow holes on the external cell container.	Visual
3	Electrolyte leakage and quantity of electrolyte.	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	Burr on battery container, cover or interconnecting hardware.	Visual
12	Improper color on outside of container and cover.	Visual

4.6.6 Container body to container cover seal inspection (Type 2 battery only). The battery, with the cover secured (latches applied normally), shall have a calibrated pressure gauge or manometer attached to one of the battery vents and air pressure, equivalent to 55 inches of water, applied through the other battery vent and sealed at that level for 2 minutes. The pressure gauge or manometer shall be read at the instant of attaining and sealing in the required pressure and again at 2 minutes after the sealing. The battery shall meet the requirements of 3.6.6.

4.6.7 Strength of vent tubes. Each battery vent tube shall be subjected to a tension load equal to 1.5 times the battery weight. The tension shall be applied in the vertical, upward direction. There shall not be any damage done to the battery by this test. The battery shall be examined for compliance to the requirement of 3.6.7.

4.6.8 Color and marking. Each battery shall be examined for conformance to 3.6.3.1 and 3.6.3.2. The criterion for conformance to 3.6.3.1 is that the color shall be closer to the specified color than to any other color in FED-STD-595.

4.6.9 Constant current conditioning charge. Each battery shall be given a conditioning charge in accordance with 4.5.1.4. For the medium-rate battery only, the battery shall first be subjected to a 1.0 C-rate discharge to 18.0V.

4.6.10 Capacity discharge. Batteries shall be subjected to a 1.0 C-rate discharge per requirement (1) of Table II to an end-of-discharge voltage of 18.0 volts. For Type 2 batteries only, each cell must read .95 volt minimum at the end of 1 hour. Batteries shall then be charged per 4.5.1.3. For Quality Conformance Testing, any charge method may be selected provided that all batteries are charged by the same method and the storage requirements of 3.6.15 can be met.

4.6.11 Constant voltage discharge (14.0 volts). The battery shall be subjected to a constant voltage (14.0 volts) discharge at two different temperatures. Perform a room temperature discharge and a cold temperature discharge as described below. Perform only the room ambient temperature discharge during Quality Conformance (Group A) testing. During Group A testing only, a voltage tolerance of $14.0 \pm .5$ volts shall be allowed for the manufacturer.

- a. Charge the battery per 4.5.1.3.
- b. Stabilize the battery in a test chamber at $24^{\circ} \pm 2^{\circ}\text{C}$.
- c. The battery shall be subjected to a constant 14.0-volt discharge for 1 minute as specified by requirement (4) of Table II.
- d. With the battery still in the chamber, charge the battery per 4.5.1.3.
- e. Immediately following charge, set the test chamber to the low temperature specified in requirement (4) of Table II and stabilize the battery at this temperature.
- f. Repeat c.
- g. The battery shall meet the minimum current requirements specified in the applicable specification sheet (see 3.1).

4.6.12 Strength of receptacle. A special grooved steel shaft similar to the clamping shaft of the battery quick disconnect plug conforming to MS3349 shall be inserted in the receptacle socket so that the socket pins are secured in the steel shaft. A tensional force of 250 ± 25 pounds shall be exerted against the socket pins. Following this test, the steel shaft shall be subjected to a torsional force of $6 \pm .5$ foot-pounds. The receptacle mounting shall meet the requirements of 3.6.9.

4.6.13 Life cycling.

4.6.13.1 Cycling test (Type 1 battery). The battery shall be subjected to 85 cycles of discharge and charge. Each cycle shall consist of a 1-hour, 1.0 C-rate discharge, followed immediately by a 2-hour charge per 4.5.1.3, followed by a 1-hour rest period. The battery shall meet the specified requirements of 3.6.10.1.

4.6.13.2 Cycling test (Type 2 battery). The battery shall be tested and the temperature of the center cell shall be monitored throughout the test. The charge time shall be one (1) hour and 55 minutes for each cycle.

- a. Test profile. The battery shall be conditioned per 4.5.1.4.2 and then subjected to 45 duty cycles as described below and a 1.0 C-rate capacity discharge (cycle 46).
- b. Duty cycles.
 - (1) Rest on open-circuit for 2 hours.
 - (2) Discharge through a fixed resistance of $R = \frac{0.600}{C}$ as follows:

Discharge for 20 seconds.
Rest on open-circuit for 260 seconds.
Discharge for 20 seconds.
Total time 300 seconds.

NOTES:

Voltage readings shall be taken at 5 seconds and at 20 seconds after start of each discharge.

R = ohms

C = rated capacity in ampere-hours

- (3) Within 3 ± 1 seconds after end of second discharge, charge in accordance with 4.5.1.3. Repeat (1) above, repeat (2) above.
- (4) Repeat (3) continuously for 45 cycles total.
- c. Cycle 46. Charge in accordance with 4.5.1.3. Discharge at the 1.0 C-rate to 18.0V.
- d. Conditioning will not be permitted during the 46 life-cycles.
- e. The test shall be terminated upon failure of the battery to meet any one of the specified requirements of 3.6.10.2.
- f. After the 46 life-cycles have been performed, condition in accordance with 4.5.1.4.2. Record water additions to the battery.

4.6.13.3 Service life test (optional). Instead of the standard life cycling test (4.6.13.1 and 4.6.13.2), the battery may be subjected to the service life test described below. If the service life test is performed, the standard life cycling test, vibration test (4.6.23), capacity discharge at 49°C (4.6.14), and charge and discharge test at low temperature (4.6.15) shall not be performed.

- a. Charge the battery in accordance with 4.5.1.3.
- b. The battery shall be subjected to 72 cycles of discharge and charge while simultaneously subjected to alternating temperature conditions (-26°C, 25°C, 49°C) and vibrated (in accordance with Figure 3) during 2 out of every 6 life cycles. Random vibration shall be performed only during the charge portion of a cycle. Total vibration time per 24-hour period is 4 hours. A total of 48 hours of vibration will be performed during the 72 service life cycles.
- c. Each cycle shall consist of a C-rate discharge, followed by a 2-hour charge per 4.5.1.3, followed by a 1-hour rest period. The battery C-rate discharge shall be for 1 hour at test temperatures of +25 and +49°C and for 30 minutes at the test temperature of -26°C.
- d. The matrix below describes the temperature environment, axis of vibration and whether the battery is vibrating during each particular life cycle.

SERVICE LIFE TEST MATRIX

<u>CYCLE NUMBER</u>	<u>AXIS OF VIBRATION (1, 2 OR 3) (Y for Vibrate, N for No Vibration)</u>	<u>TEMPERATURE (°C) ENVIRONMENT</u>
1, 19, 37, 55	1Y, 1Y, 1Y, 1Y	-26, +25, +49, -26
2, 20, 38, 56	1Y, 1Y, 1Y, 1Y	-26, +25, +49, -26
3, 21, 39, 57	N, N, N, N, N	-26, +25, +49, -26
4, 22, 40, 58	N, N, N, N, N	-26, +25, +49, -26
5, 23, 41, 59	N, N, N, N, N	-26, +25, +49, -26
6, 24, 42, 60	N, N, N, N, N	-26, +25, +49, -26
7, 25, 43, 61	2Y, 2Y, 2Y, 2Y	+25, +49, -26, +25
8, 26, 44, 62	2Y, 2Y, 2Y, 2Y	+25, +49, -26, +25
9, 27, 45, 63	N, N, N, N, N	+25, +49, -26, +25
10, 28, 46, 64	N, N, N, N, N	+25, +49, -26, +25
11, 29, 47, 65	N, N, N, N, N	+25, +49, -26, +25
12, 30, 48, 66	N, N, N, N, N	+25, +49, -26, +25
13, 31, 49, 67	3Y, 3Y, 3Y, 3Y	+49, -26, +25, +49
14, 32, 50, 68	3Y, 3Y, 3Y, 3Y	+49, -26, +25, +49
15, 33, 51, 69	N, N, N, N, N	+49, -26, +25, +49
16, 34, 52, 70	N, N, N, N, N	+49, -26, +25, +49
17, 35, 53, 71	N, N, N, N, N	+49, -26, +25, +49
18, 36, 54, 72	N, N, N, N, N	+49, -26, +25, +49

- e. The battery shall meet the specified requirements of 3.6.10.3.

4.6.14 Capacity discharge at 49°C (120°F). The battery shall be charged as specified in 4.5.1.3 and stored under the specified temperature and storage conditions (4.5.1.2). The battery shall then be discharged at the 1.0 C-rate per requirement (2) of Table II to an end-of-discharge voltage of 18.0 volts. The battery shall meet the requirements of 3.6.8.

4.6.15 Charge and discharge test at low temperature. The battery shall be subjected to a low temperature discharge and charge demonstration test. The test shall be conducted at -18°C (0°F) for type 1 batteries and at -30°C (-22°F) for type 2 batteries as follows.

- a. Charge the battery in accordance with 4.5.1.3 at 24°C ± 5°C.
- b. Place the battery in a test chamber in accordance with 4.5.1.2 at specified temperature, and then discharge at the 1.0 C-rate to 18.0V. The battery shall meet requirement (3) of Table II.
- c. With the battery still in the chamber, charge the battery in accordance with 4.5.1.3.
- d. Immediately following charge, remove battery from test chamber and discharge at the 1.0 C-rate to 18.0V. Battery shall meet requirement (3) of Table II.

4.6.16 Discharge while inverted. The battery shall be charged as specified in 4.5.1.3 and 4.5.1.1. The battery shall be discharged in accordance with requirement (5) of Table II. During the first two and one-half minutes of discharge, the battery shall be in the inverted position. The battery shall meet the requirements of 3.5.8 and shall meet discharge requirement (5) of Table II.

4.6.17 Altitude. The battery shall be subjected to the altitude test as follows:

- a. Charge the battery in accordance with 4.5.1.3 and 4.5.1.1.
- b. Immediately place the battery into an environmental chamber and within 15 minutes lower the chamber temperature to -29°C (-20°F) and chamber pressure to simulate the ambient vacuum conditions at 60,000 feet. The battery (type 1 only) shall be inverted for 2 minutes while the chamber air pressure is being reduced and then returned to its normal upright position.
- c. Discharge the battery in accordance with 3.6.11.
- d. Charge the battery in accordance with 4.5.1.3 for 2 hours. The battery (Type 1 only) shall be inverted for 5 minutes during the 2-hour charge and then returned to its normal upright position.

