

METRIC

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SUPERSEDING

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PERFORMANCE SPECIFICATION

BATTERIES, STORAGE, 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 aircraft storage batteries. The batteries are nominal 24-volt batteries that are generally used for medium current engine starting/utility applications, have non-removable covers, and designed for maintenance-free operation (see 6.15.10).

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.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Air Warfare Center Aircraft Division, Code 414100B120-3, Highway 547, Lakehurst, NJ 08733-5100, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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

SPECIFICATIONS

DEPARTMENT OF DEFENSE

MIL-PRF-24236 - Switches, Thermostatic, (Metallic and Bimetallic), General Specification for.

(See supplement 1 for list of specification sheets.)

STANDARDS

FEDERAL

FED-STD-595 - Colors Used in Government Procurement.

DEPARTMENT OF DEFENSE

MIL-STD-202 - Test Method Standard Electronic and Electrical Component Parts.

MIL-STD-704 - Aircraft Electrical Power Characteristics.

MS3509 - Receptacles, Electric, Aircraft Storage Battery.

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

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

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AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME-Y14.38M - Abbreviations and Acronyms.

(Application for copies should be addressed to the American Society of Mechanical Engineers, 345 East 47th Street, New York, New York 10017-2392.)

2.4 Order of precedence. 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 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 Components. Components that are specified shall be in accordance with the applicable specification (see 6.11.1). When specified by the procuring activity or the qualifying activity, the manufacturer shall supply a certification of conformity of the component (see 6.2).

3.4 Dissimilar metals. Unless protected against electrolytic corrosion, dissimilar metals shall not contact each other (see 6.11.2).

3.5 Design. Each type of storage battery 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 4.5.2. Requirements for the individual types of batteries are specified in the applicable specification sheets (see 3.1).

3.5.1 General. The battery shall be free from defects that will affect life, functioning, and appearance. Batteries shall not have 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, nor improper or incorrect marking.

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3.5.2 Batteries. After delivery from the manufacturer, batteries shall not require the addition of any substance before being put into service. The battery shall not require any maintenance in meeting the provisions of this specification (see 6.15.10).

3.5.3 Battery container and cover. The battery container and cover shall be free of pits, blow holes, rough spots, and other deformations. The dimensions and locations of receptacles, hold-downs, vent tubes, and battery identification shall conform to the applicable specification sheet. The cover shall not be removable from the container.

3.5.4 Venting. Each battery shall include two vent tubes, located as shown on the applicable specification sheet. Air shall flow freely into and through any vent tube, across the cells, and exit through the other vent tube (see 3.7.e). Each vent tube shall be capable of supporting the test sample such that the requirements of 3.8.5 are met after being tested in accordance with 4.5.5.

3.5.5 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. The hardness of the wormgear retaining pins within the sockets of receptacles which are dimensionally equivalent to MS3509 receptacles shall be not less than 55 on the Rockwell C Scale when tested in accordance with 4.5.30.

3.5.6 Connectors, intercell. All electrical connections within the battery shall be by surface-to-surface conduction and not through screw threads.

3.5.7 Electrolyte leakage. Evidence of electrolyte leakage during the performance of any of the tests specified in section 4 shall not occur except when tested in accordance with 4.5.18.

3.5.8 Voltage. Unless otherwise specified on the applicable specification sheet, the nominal potential of the battery shall be 24 volts. The battery potential shall be not greater than 29.0 volts at any time, except when constant current charged in accordance with 4.4.3 and when tested in accordance with 4.5.18.

3.5.9 Operating position. The battery shall be capable of operating in any inverted position or altitude without loss of any electrolyte after being tested in accordance with 4.5.13 and 4.5.14.

3.5.10 Heaters. Heaters may be incorporated into batteries to meet the cold temperature charging requirements. Heater power shall not be provided during any discharge performed in section 4. Heater power will be provided during all constant potential charges (see 4.4.2). When heaters are incorporated, the following requirements shall apply:

a. Heaters shall be powered only by 115 volts alternating current (VAC) power in accordance with MIL-STD-704 for batteries weighing not less than 4.0 kg. Other batteries may use heaters powered by 115 VAC or by 28.0 volts direct current (VDC).

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b. The rated current of each heater control device shall be compatible with the current specified in the applicable battery specification sheet.

c. Heater elements and wire assemblies shall be electrically insulated and installed in a manner which minimizes potential battery damage due to electrical shorting, sparking, or other electrical hazards.

d. All electrical switches, controls, circuits, and installations shall be explosion-proof. When operating, they shall not ignite explosive mixtures of hydrogen and oxygen gasses generated inside the battery container.

e. Both primary and secondary (backup) temperature limiting controls shall be incorporated into the battery's electrical circuits to prevent overheating. If the primary heater control fails, the battery shall not reach a damaging temperature.

f. All thermal switches shall be snap-action type in accordance with MIL-PRF-24236.

g. All heater components shall be located inside the battery container.

h. When the battery is operating in accordance with any specified environmental condition, the exterior surface of the battery container shall not be greater than 75°C (167°F) due to the heater operation.

3.6 Color and marking. The batteries shall conform to the requirements listed below and in the applicable specification sheet when examined in accordance with 4.5.2.

3.6.1 Color. The battery shall conform to one of the following color styles (see 6.11.3 and 6.13):

a. The color under natural light of all visible parts of each battery, except the mounting points, hold-down hooks, other external hardware, identification marking, and instructions, shall conform to the range of colors listed in table I, according to whether the battery uses acid or alkaline electrolyte; or

b. Color only the container cover and marking backgrounds in accordance with those listed in table I under natural light; the rest of the container shall be white, gray, or black.

3.6.2 Polarity marking. The container body shall be conspicuously and durably marked "+" in white in the location shown on the applicable specification sheet.

3.6.3 Identification marking. The battery identification marking shall be in white or black print. Unless otherwise specified in the applicable specification sheet, the marking shall use a type

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size of not less than 4.2 mm. The marking shall contain the required titles and information as shown in figure 1 herein and shall be placed in accordance with the applicable specification sheet. The lot code shall be constructed in accordance with 3.6.6. 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 manufacturer shall fill in the applicable information at the indicated areas. Abbreviations in accordance with ASME-Y14.38M and acronyms are permitted.

3.6.4 Battery caution marking. The battery caution marking shall contain the required titles and information as shown in figure 2 herein and shall be placed in accordance with the applicable specification sheet. The lettering height shall be not less than 6.3 mm. The marking shall be in white or black print.

3.6.5 Marking for batteries with heaters. If any exterior surface of the battery container exceeds 49°C (120°F) when all heater elements are energized and all other battery electrical circuits are not functioning for 1 hour, the following caution statement shall be inscribed on the battery identification marking and battery caution marking: CAUTION HOT SURFACE (see figures 1 and 2). The height of all statement letters shall be equal and not less than 6.2 mm. The battery container shall also display an electrical schematic for internal heaters. The height of the letters and numbers shall be equal and not less than 3.8 mm.

3.6.6 Lot code. The month and year that the manufacturer compiled the batteries into a group for inspection and the lot code of the battery shall be clearly shown on the battery identification marking. The information shall be coded such that 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 digits indicate the inspection lot (see 6.15.9) number. Months earlier than the tenth shall be indicated by a single digit preceded by "0". When the inspection lot is compiled during the first three or the last three working days of the month, the manufacturer is permitted to use either that month or the nearest adjacent month as the coded month. For example, lot code 0401-12 indicates the lot was compiled in April 2001 and was the twelfth lot.

3.7 General requirements. The battery, when subjected to any tests specified in section 4, shall not show:

- a. Dimensional distortion beyond specified limits.
- b. Cracking of cases or covers of either cells or batteries.
- c. Radical current or voltage fluctuations during any test. Degradation of electrical performance beyond limits specified by the requirements.
- d. Mechanical failure of any part.

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e. Electrolyte leakage or spilling of electrolyte at any time during the test. Corrosive or liquid discharge through the battery vent tubes (see 3.5.4) shall not occur during testing to this specification (except when testing to 4.5.18). 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. After a venting sequence, the venting mechanism within the battery shall automatically revert to its pre-vented configuration. Products of cell venting that are discharged through the vent tubes shall be non-toxic.

f. Breakdown of insulation, flashover, arcing, 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 identification markings.

h. Cracking, pitting, chipping, scaling, corrosion, or other deleterious effects on the external and internal metal or component parts of each battery.

3.8 Detail requirements.

3.8.1 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 (see 6.6).

3.8.2 Visual and mechanical. Batteries shall be in accordance with 3.5, 3.6, table II, and the applicable specification sheet when subjected to the examination of 4.5.2.

3.8.3 Dimensions and weight. The dimensions and weight of batteries shall be as shown on the applicable specification sheet after the inspection of 4.5.3.

3.8.4 Dielectric strength and insulation resistance. The battery and its components shall meet the requirements of 3.7 after being tested in accordance with 4.5.4. The insulation resistance shall be not less than 1 megohm between each of the items listed in 4.5.4.a through 4.5.4.c.

3.8.5 Vent tubes. The vent tubes 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 4.5.5 (see 4.3.4). The battery shall also meet the requirements of 3.7.

3.8.6 Capacity and electrical performance. The capacity (see 6.15.2 and 6.15.11) shall be as shown on the applicable specification sheet. The discharge requirements and associated parameters shall be as shown in table III (see 6.10). The battery shall produce not less than the cutoff voltage (see 6.15.4) at the designated discharge rate (see 6.15.3) for not less than the

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indicated length of time at the listed temperature after being tested in accordance with 4.5.7. Battery capacity shall vary not greater than ± 5 percent within a given inspection lot. The tolerance of the discharge current shall be ± 1 percent of the specified value.

3.8.7 Constant voltage discharge. The battery shall produce not less than the current specified in the applicable specification sheet after being tested in accordance with 4.5.8. The battery shall meet requirement (4) of table III. During group A conformance inspection, the battery shall meet the current requirements specified in the applicable specification sheet for the 0 to 30-second time parameters only; in addition, the 60-second average current and total ampere-hour capacity requirements are not applicable. The battery shall also meet the requirements of 3.7 during and after charge and discharge.

3.8.8 Strength of receptacle. The receptacle and receptacle mounting shall withstand an axial pullout force of 1112 ± 111 newtons (250 ± 25 pounds) and a torsional force of 8.1 ± 0.7 newton-meters (6 ± 0.5 foot-pounds) after being tested in accordance with 4.5.9. The battery shall also meet the requirements of 3.7.

3.8.9 Cycling. Batteries shall successfully complete not less than 100 cycles (see 6.15.5) after being tested in accordance with 4.5.10. The inability of the battery to meet requirement (1) of table III for three consecutive discharges shall constitute a failure.

3.8.10 Functional discharge. The battery potential shall be not less than 14.0 volts at not less than 3 minutes into the discharge after being tested in accordance with 4.5.14, 4.5.15, 4.5.16, 4.5.18, 4.5.19, 4.5.20, 4.5.21, 4.5.23, and 4.5.25.

3.8.11 Temperature rise and float. The battery shall perform as follows after being tested in accordance with 4.5.17. If the charging current rises, its increase (in amperes) compared to the current's minimum value shall be not greater than 10 percent of the battery's rated capacity (for example, 1.5 amperes for a 15-ampere-hour battery) at any time during charge. The battery shall meet requirement (1) of table III and the requirements of 3.7.

3.8.12 Battery gas emission. The percent of hydrogen concentration shall be not greater than 3.5 percent at any time during the test of 4.5.18. The battery shall also meet the requirements of 3.8.10 (see 3.5.7, 3.5.8, and 3.7.e).

3.8.13 Storage.

3.8.13.1 Ground storage. The battery shall be capable of storage in uncontrolled temperature conditions from -40°C to $+50^{\circ}\text{C}$ (-40°F to $+122^{\circ}\text{F}$) for not less than 30 days, after which it shall deliver not less than 50 percent of rated capacity after being tested in accordance with 4.5.22.

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3.8.13.2 Shelf life. In order to maintain qualification, successful completion of the shelf life test of 4.5.26 shall be required. The battery shall be capable of storage in uncontrolled temperature conditions from -40°C to +38°C (-40°F to +100°F) for not less than 18 months without damage (see 6.2). The capacity shall be recoverable after being tested in accordance with 4.5.26. The battery shall also meet the requirements of 3.8.9 after being tested in accordance with 4.5.10.

3.8.13.3 Deep discharge recovery. The battery shall be capable of storage in the fully discharged state (0.0 volts) (see 6.15.7) in uncontrolled temperature conditions from -40°C to +50°C (-40°F to +122°F) for not less than 168 ± 2 hours without damage. After such storage, the battery shall deliver not less than the capacity specified by the applicable specification sheet after being tested in accordance with 4.5.27. The battery shall also meet the requirements of 3.7 during and after charge and discharge.

3.8.14 Impact resistance (nonmetallic battery container only). The nonmetallic battery container shall not crack on the inside opposite the point of impact after being tested in accordance with 4.5.24.

3.8.15 Shock (crash safety). The battery shall perform as follows after being tested in accordance with 4.5.25.

- a. The battery's normal attachment points (such as brackets, flanges, or hold-down bars) shall retain the entire battery intact in the test fixture during and after the test.
- b. Mechanical bending and distortion are acceptable.
- c. The battery shall also meet the requirements of 3.8.10.

3.8.16 Output performance. The battery shall produce not less than the potential specified in the applicable specification sheet during and after each of the tests of 4.5.28.

3.8.17 Cold and hot temperature charge. The battery shall produce not less than the capacity and potential specified in the applicable specification sheet after being discharged in accordance with 4.5.29. The battery shall also meet the requirements of 3.7.

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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 the applicable specification sheet (see 6.4 and 6.5). The specification sheets also list the order in which the tests shall be conducted. 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 of the battery. Three complete batteries and one dry unassembled battery with all parts shall be furnished for inspection (see 6.2 and 6.8). If receptacles which are dimensionally equivalent to MS3509 receptacles are used, then five wormgear retaining pins shall be furnished for inspection. If the outer battery container is nonmetallic, two such containers and a piece of the container material at least 15.24 centimeters (6 inches) by 7.62 centimeters (3 inches) (nominal) shall be supplied as test samples for qualification testing. All samples shall be marked with identifying information in accordance with 3.6.

4.3 Conformance inspection. The conformance inspection shall consist of the tests specified in the applicable specification sheet (see 6.6, 6.7, and 6.8). Batteries produced under this specification shall be identical in every respect to the qualification sample tested and found satisfactory, except for changes previously approved by the Government. Any unapproved changes from the qualification sample shall constitute cause for rejection.

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

4.3.2 Inspection lots. Units shall be compiled into inspection lots (see 6.15.9 and 6.15.13). Unless otherwise specified by the contract or purchase order, the inspection lot size shall be determined as follows:

- a. When the entire stock quantity specified by a contract, delivery order, or purchase order is to be delivered at one specified time, no more than two lot codes (see 3.6.6) shall appear among the units in a particular inspection lot. A specific lot code shall not be found in any more than two inspection lots.

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b. When the entire contract quantity is to be delivered in several shipments over a period of months or years (such as direct vendor delivery style contracts), the inspection lot size and resulting sample quantity shall consist of the quantity of batteries that the Government or contractor estimates will be delivered during a period of up to three months.

(1) If the batteries have slow self-discharge and are normally activated as they are produced, then batteries shall be delivered not later than 6 months after activation (see 6.15.1 and 6.15.6) and shall be delivered with not less than nominal rated capacity (see 6.15.11).

(2) If the batteries, monoblocks, or cells are to be stored in a dry-charged state before such activation, the total time of dry charge and activation shall be not greater than 1 year before delivery and the time since activation shall be not greater than 6 months. Items stored in a dry-charged state before activation shall be stored with each monoblock or cell sealed to prevent moisture intrusion. Dry-charged batteries delivered after activation shall be delivered with not less than nominal rated capacity (see 6.15.11).

4.3.3 Sample size and selection for groups A and B inspection. Each unit shall undergo group A inspection (see 6.8). Unless otherwise specified by the contract or purchase order, the sample size for group B shall be as shown in table IV (see 6.2).

4.3.4 Group A inspection. Each unit shall be subjected to the examination and test requirements in the applicable specification sheet (see 6.8). Each unit shall meet the requirements for group A inspection in the applicable specification sheet. Defective units discovered during group A inspection shall be individually rejected. Corrective action for group A strength of vent tube failures (see 3.8.5 and 4.5.5) shall be provided to the qualifying activity for approval before start of manufacture of the next production lot.

4.3.5 Group B inspection. The group B tests shall be performed in accordance with the applicable specification sheet (see 6.8).

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

4.4.1 Temperature and storage conditions. Unless otherwise specified in the description of the test, all measurements, tests, and capacity discharges shall be made at room temperature, ambient atmospheric pressure, and ambient relative humidity. Unless otherwise specified in the description of the test, room temperature for all tests except group A inspection shall be $25^{\circ} \pm 5^{\circ} \text{C}$ ($77^{\circ} \pm 9^{\circ} \text{F}$). Room temperature for group A inspection shall be $24^{\circ} \pm 8^{\circ} \text{C}$ ($75^{\circ} \pm 15^{\circ} \text{F}$). Unless otherwise specified in the description of the test, all high and low temperature charge and discharge tests shall be conducted at the temperature indicated in the applicable test paragraph; a tolerance of $\pm 2^{\circ} \text{C}$ (3.6°F) shall be allowed. Stabilize the battery in the environmental chamber at the specified temperature for 22 ± 2 hours before discharge.

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4.4.2 Constant potential charging method. Unless otherwise specified in the applicable specification sheet, constant potential charge the batteries at 28.25 ± 0.25 volts for 2.0 ± 0.1 hours. 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. If the battery contains a heater circuit, the circuit shall be energized during the complete charge (see 3.5.10).

4.4.3 Constant current charging method. Conditioning during testing to this specification shall consist of constant current charging the battery at a rate of $C/10$ (± 3 percent) for 16 ± 0.1 hours.

4.4.4 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. Unless otherwise specified by the test, all discharges shall be continuous.

4.4.5 Mounting. For the vibration and mechanical shock tests, the mounting shall be by normal aircraft attachment points (see 4.5.15, 4.5.19, and 4.5.25). Vibration isolators shall not be used. For all other tests, the bottom of the battery shall be supported on a rigid surface.

4.4.6 Repeat upon failure of test. Unless otherwise specified in the description of the test, if the battery fails to meet the specified minimum requirements of any electrical test except 4.5.7, 4.5.8, 4.5.28, or 4.5.29, the sample shall have failed the test. If the battery fails 4.5.7, 4.5.8, 4.5.28, or 4.5.29, the battery shall be recharged as described in 4.4.2, after which the test will be repeated. Inability to meet the specified minimum requirements during the repeated test shall constitute a failure of that particular sample. If the battery meets the requirements of the repeated test, the specified test schedule shall be resumed.

4.5 Methods of inspection. The tests on each battery shall be performed in the order listed in the applicable specification sheet. The following tests and examinations (see 6.12) shall be performed as follows.

4.5.1 Incoming inspection. Examine the battery container for the requirements of 3.8.1.

4.5.2 Visual and mechanical examination. Examine the battery for the requirements of 3.8.2.

4.5.3 Dimensions and weight. Examine the battery for the requirements of 3.8.3. Measure the weight of each sample. Examine each dimension of the following samples:

a. Qualification inspection: Each sample.

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b. Group A inspection: On 2 percent of the batteries in the lot or not less than one battery from the lot (whichever is greater).

c. Group B inspection: On one battery from the lot.

4.5.4 Dielectric strength and insulation resistance test. During group A inspection, perform this test on 5 percent of the units. Apply a DC potential of 500 ± 25 volts for 60 +5, -0 seconds to components listed below. Apply an alternating 500 ± 25 volts_{RMS} for 60 +5, -0 seconds to components listed below. Test the following combinations of components:

- a. The current-carrying parts of the battery and the battery case.
- b. The pins of the auxiliary connector and the current-carrying parts of the battery.
- c. The pins of the auxiliary connector and the battery case.

Measure the insulation resistance of the components listed above in accordance with MIL-STD-202, method 302, test condition B, for 60 seconds. Examine the items for the requirements of 3.8.4.

4.5.5 Strength of vent tubes test. Place one battery directly on top of a second, identical, test sample battery. Orient both batteries in the same direction. Lift the test sample (bottom) battery by both vent tubes to a height of 12.7 centimeters (5 inches) (nominal) above the work surface for a period of 10 seconds. Observe any evidence of shearing, binding, or deterioration at the point of connection of the vent tube and the test sample battery. Examine the test sample battery for the requirements of 3.8.5. During group A inspection, perform this test on 5 percent of the units. If a failure occurs during group A inspection, then 100 percent of the units shall be tested in that lot (see 4.3.4).

4.5.6 Electrical test preparation. Discharge the battery at the 1.0 C-rate to 18.0 volts. Condition the battery in accordance with 4.4.3.

4.5.7 Capacity discharge. Stabilize the battery at room temperature (see 4.4.1). Discharge the battery at the 1.0 C-rate to a cutoff voltage (see 6.15.4) of 18.0 volts. Afterwards, for qualification inspection, constant potential charge the battery in accordance with 4.4.2. For group A conformance inspection, any charge method (from 4.4.2, 4.4.3, or other method not listed in section 4) may be selected as long as all batteries are charged by the same method and still meet all the requirements of this specification. Examine the battery for the requirements of 3.8.6 and requirement (1) of table III.

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4.5.8 Constant voltage discharge. This test consists of the following steps.

- a. Constant potential charge the battery in accordance with 4.4.2.
- b. Stabilize the battery for 22 ± 2 hours before discharge at room temperature (see 4.4.1).
- c. Discharge the battery at a constant 14.0 volts. For group A testing only, a voltage tolerance of 14.0 ± 0.5 volts shall be allowed. The length of the discharge shall be 1 minute for qualification inspection and group B conformance inspection; it shall be 30 seconds for group A inspection.
- d. Measure discharge current at the times specified in the applicable specification sheet.
- e. Examine the battery for the requirements of 3.8.7 and the applicable specification sheet.
- f. For qualification inspection and group B conformance inspection: With the battery still in the chamber, constant potential charge the battery in accordance with 4.4.2.
- g. Immediately following charge, stabilize the battery at a temperature of -26°C (-15°F) (see 4.4.1).
- h. Repeat steps 4.5.8.c, 4.5.8.d, and 4.5.8.e.

4.5.9 Strength of receptacle test. Insert a grooved steel shaft that mates with the receptacle socket such that the socket pins are secured in the steel shaft. Exert a tensional force of 1112 ± 111 newtons (250 ± 25 pounds) against the socket pins. Following this test, subject the steel shaft to a torsional force of 8.1 ± 0.7 newton-meters (6 ± 0.5 foot-pounds). Examine the receptacle mounting for the requirements of 3.8.8.

4.5.10 Cycling test. Constant potential charge the battery in accordance with 4.4.2 at room temperature (see 4.4.1). Subject the battery to 100 cycles of discharge and charge under the ambient conditions of 4.4.1. Each cycle shall consist of a 1.0-hour, 1.0 C-rate discharge, followed immediately by a 2.0-hour constant potential charge in accordance with 4.4.2, followed by a 1.0-hour rest period. Examine the battery for the requirements of 3.8.9.

4.5.11 Capacity discharge at 49°C (120°F). Constant potential charge the battery in accordance with 4.4.2. Stabilize the battery at 49°C (120°F) (see 4.4.1). Discharge the battery at the 1.0 C-rate to a cutoff voltage of 18.0 volts. Examine the battery for the requirements of 3.8.6 and requirement (2) of table III.

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4.5.12 Charge and discharge test at low temperature. This test consists of the following steps.

- a. Constant potential charge the battery in accordance with 4.4.2 at room temperature (see 4.4.1).
- b. Place the battery in a temperature chamber at -18°C (0°F) and stabilize the battery (see 4.4.1). Perform the following with the battery in the temperature environment.
- c. Discharge the battery at the 1.0 C-rate to a cutoff voltage of 18.0 volts.
- d. Examine the battery for the requirements of 3.8.6 and requirement (3) of table III.
- e. Constant potential charge the battery in accordance with 4.4.2.
- f. Immediately following charge, remove the battery from the test chamber. Discharge the battery at the 1.0 C-rate to a cutoff voltage of 18.0 volts.
- g. Examine the battery for the requirements of 3.8.6 and requirement (3) of table III.

4.5.13 Discharge while inverted. This test consists of the following steps.

- a. Constant potential charge the battery in accordance with 4.4.2 at room temperature (see 4.4.1).
- b. Invert the battery.
- c. Discharge the battery at the 6.5C-rate for 5 minutes or to a cutoff voltage of 14.0 volts, whichever occurs first. At 2.5 minutes into the discharge, place the battery upright.
- d. Examine the battery for the requirements of 3.5.9 and requirement (5) of table III.

4.5.14 Altitude test. This test consists of the following steps.

- a. Constant potential charge the battery in accordance with 4.4.2 and 4.4.1.
- b. Immediately after completion of charge, place the battery inside an environmental chamber.
- c. Within 15 minutes after completing step 4.5.14.b, lower the chamber temperature to -29 °C (-20 °F) and lower the pressure inside the chamber to simulate the ambient pressure at 18,288 meters (60,000 feet) altitude. Perform the remainder of the test with the battery in the

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temperature environment. Invert the battery for 2 minutes while the chamber air pressure is being reduced and then return the battery to its normal upright position (see 6.15.12).

d. Discharge the battery at the 6.5C-rate for 3 minutes. Examine the battery for the requirements of 3.8.10.

e. Constant potential charge the battery in accordance with 4.4.2 for 2 hours. Invert the battery for 5 minutes during the 2-hour charge and then return the battery to its normal upright position.

f. Open-circuit the battery and, within 5 minutes, return the chamber to ground ambient air pressure (see 4.4.1). Invert the battery for 2 minutes while the chamber air pressure is being increased to ground ambient and then return the battery to its normal upright position.

g. Discharge the battery at the 6.5C-rate for 3 minutes. Examine the battery for the requirements of 3.8.10.

h. Repeat step 4.5.14.c. Repeat steps 4.5.14.e, 4.5.14.f, and 4.5.14.g.

i. Examine the battery for the requirements of 3.7 and 3.5.9.

4.5.15 Shock test (basic design). This test consists of the following steps.

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

b. Mount the battery to the test fixture in accordance with 4.4.5.

c. Discharge the battery at the C/2 rate during the test.

d. Subject the battery to the shock pulse of figure 4, where P equals 20 g and D equals 11 milliseconds. Shock the battery in a normal upright position (see 6.15.12) and in two additional mutually perpendicular directions from the vertical. However, the battery shall not be mounted or shocked in the inverted position. Deliver three shocks in both directions of each orthogonal axis for a total of 15 impacts.

e. After each shock, examine the battery for the requirements of 3.7.

f. After the fifteenth impact, discharge the battery at the 6.5C-rate for 3 minutes.

g. Examine the battery for the requirements of 3.8.10.

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4.5.16 Temperature shock test. This test consists of the following steps.

- a. Constant potential charge the battery in accordance with 4.4.2. Upon completion of charge, the battery shall remain on open-circuit through the completion of step 4.5.16.i.
- b. Place the battery in a temperature chamber at 71°C (160°F) and expose the battery for 4.00 ± 0.25 hours. At the end of this exposure period, lift the battery by its vent tubes.
- c. At the conclusion of this time period, transfer the battery, within 5 minutes, to a chamber with an internal chamber temperature of -57°C (-70°F).
- d. Expose the battery to -57°C (-70°F) for 4.00 ± 0.25 hours. At the end of this exposure period, lift the battery by its vent tubes.
- e. At the conclusion of this time period, transfer the battery, within 5 minutes, to a chamber with an internal chamber temperature of 71°C (160°F).
- f. Expose the battery to 71°C (160°F) for 4.00 ± 0.25 hours. At the end of this exposure period, lift the battery by its vent tubes.
- g. Repeat steps 4.5.16.c through 4.5.16.f.
- h. Repeat steps 4.5.16.c and 4.5.16.d.
- i. Return the battery to room temperature and stabilize.
- j. Discharge the battery at the 6.5C-rate for 3 minutes.
- k. Examine the battery for the requirements of 3.7 and 3.8.10.

4.5.17 Temperature rise and float test. This test consists of the following steps.

- a. Constant potential charge the battery in accordance with 4.4.2.
- b. Place the battery in a temperature chamber at 49°C (120°F) for not less than 12 hours. Perform the following with the battery in the 49°C (120°F) temperature environment.
- c. Discharge the battery at the 6.5C-rate for 5 minutes or to a cutoff voltage of 14.0 volts, whichever occurs first.
- d. Immediately after the 6.5C-rate discharge and with the battery still in the temperature chamber, constant potential charge the battery at 28.6 ± 0.10 volts for 24 ± 0.1 hours.

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e. Stabilize the battery temperature at room temperature (see 4.4.1). Discharge the battery at the 1.0 C-rate to a cut-off voltage of 18.0 volts.

f. Record voltage, current, and time throughout the test.

g. Remove the battery from the temperature chamber.

h. Examine the battery for the requirements of 3.8.11.

4.5.18 Battery gas emission test. This test consists of the following steps.

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

b. Obtain a temperature-altitude chamber that has an internal volume of 0.42 ± 0.03 cubic meters (15 ± 1.0 cubic feet) and a 12.7 ± 0.6 millimeter (0.50 ± 0.025 inch) orifice in the chamber wall. The distance between the chamber inside wall and the outside air shall be not greater than 19.8 centimeters (7.8 inches). Stabilize the chamber temperature at 55°C (131°F).

c. Place the battery in the chamber such that the battery is not located in a recessed area or isolated from the orifice by a partition wall. Stabilize the battery at 55°C (131°F) for 12.0 ± 0.25 hours.

d. Once the battery is stabilized, turn off the chamber heaters and coolers but keep the chamber fan energized.

e. Use a gas-tight syringe to remove two 1-cc air samples from a random location within the chamber.

f. Constant potential charge at 32.0 ± 0.1 volts for 1.0 ± 0.1 hours.

g. Repeat step 4.5.18.e, then remove the battery from the chamber.

h. Obtain a gas chromatograph with a thermal ionization detector or equivalent equipment. Inject each air sample into the gas chromatograph or equivalent equipment to determine the percentage of hydrogen.

i. Discharge the battery at the 6.5C-rate for 3 minutes at room temperature.

j. Examine the battery for the requirements of 3.8.12.

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4.5.19 Vibration test. This test consists of the following steps.

- a. Constant potential charge the battery in accordance with 4.4.2.
- b. For all batteries rated 10 ampere-hours or greater: Connect two AN-6 cables to the positive terminal and another two AN-6 cables to the negative terminal. Clamp the cables to the test fixture at a cable length of 46 ± 5 centimeters from the battery.
- c. Mount the battery assembly, including connector and cables, to the test fixture via the normal battery attachment points (see 4.4.5 and figure 3).
- d. Vibrate the battery along each orthogonal axis (in the axis order shown in figure 3) in accordance with the test levels of table V to provide a composite level of 59.62 meters per second squared ($6.08 g_{RMS}$). The random vibration cycling time in each axis shall be 1 hour.
- e. Constant potential charge the battery in accordance with 4.4.2 at 28.25 ± 0.50 volts during vibration. Discharge the battery at the 1.0 C-rate for 10 minutes before beginning each axis.
- f. After completion of the vibration test, constant potential charge the battery in accordance with 4.4.2.
- g. Discharge the battery at the 6.5C-rate for 3 minutes.
- h. Examine the battery for the requirements of 3.7 and 3.8.10.

4.5.20 Humidity test. This test consists of the following steps.

- a. Constant potential charge the battery in accordance with 4.4.2.
- b. Gradually raise the internal chamber temperature to 60°C (140°F) and the relative humidity to 95 ± 5 percent over a period of 2 hours.
- c. Maintain the conditions of step 4.5.20.b for not less than 6 hours.
- d. Maintain not less than 85 percent relative humidity and reduce the internal chamber temperature in 8 hours to 30°C (86°F) and 95 ± 5 percent relative humidity.
- e. Maintain the 30°C (86°F) and 95 ± 5 percent relative humidity for an additional 8 hours.
- f. Repeat steps 4.5.20.b, 4.5.20.c, and 4.5.20.d for a total of 10 cycles (not less than 240 hours).

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- g. Open-circuit the battery for 8.5 ± 7.5 hours.
- h. Examine the battery for the requirements of 3.7.
- i. Discharge the battery at the 6.5C-rate for 3 minutes.
- j. Examine the battery for the requirements of 3.8.10.

4.5.21 Salt fog test. This test consists of the following steps.

- a. Constant potential charge the battery in accordance with 4.4.2.
- b. Open-circuit the battery.
- c. Dissolve 0.91 kilograms (2 pounds) (nominal) of salt into 17.24 kilograms (38 pounds) (nominal) of distilled or demineralized water. The resistance of the water shall be not less than 500,000 ohms per centimeter. The salt shall contain not greater than 0.1 percent sodium iodide per weight and shall contain not greater than 0.5 percent total impurities. The pH of the solution shall range from 6.5 to 7.2. Add the solution to the salt fog test chamber and prepare the chamber for use. Stabilize the temperature of the chamber at $35^{\circ} \pm 5^{\circ}\text{C}$ ($95^{\circ} \pm 3^{\circ}\text{F}$)
- d. Place not less than two salt fog collection receptacles in the chamber, with one placed nearest to the nozzle and one farthest from the nozzle. These shall be approximately 10 cm (4 in) diameter and shall collect from 0.5 to 3 milliliters of solution per hour for each 80 square centimeters of horizontal collecting area in a an average test of not less than 16 hours.
- e. Place the battery in the salt fog chamber. Elevate the battery above the floor of the chamber such that the bottom of the battery does not rest in any liquid.
- f. Continuously atomize the salt solution into the test chamber for 48 ± 2 hours. Measure the salt fog fallout rate and pH of the fallout solution at not less than 24-hour intervals.
- g. Remove the battery from the salt fog chamber.
- h. Open-circuit the battery for 8.5 ± 7.5 hours.
- i. Examine the battery for the requirements of 3.7.
- j. Discharge the battery at the 6.5C-rate for 3 minutes.
- k. Examine the battery for the requirements of 3.8.10.

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4.5.22 Ground storage test. This test consists of the following steps.

- a. Constant potential charge the battery in accordance with 4.4.2.
- b. Place the battery in a temperature chamber at 50°C (122°F) for 30 days on open-circuit.
- c. After the storage period, remove the battery from the chamber and let it stand open-circuit for 8 ± 2 hours.
- d. Discharge the battery at the 1.0 C-rate to 18.0 volts.
- e. Examine the battery for the requirements of 3.8.13.1.
- f. Constant potential charge the battery in accordance with 4.4.2.
- g. Place the battery in a temperature chamber at -40°C (-40°F) for 30 days on open-circuit.
- h. After the storage period, remove the battery from the chamber and let it stand open-circuit for 8 ± 2 hours.
- i. Discharge the battery at the 1.0 C-rate to 18.0 volts.
- j. Examine the battery for the requirements of 3.8.13.1.

4.5.23 Physical integrity at high temperature test. This test consists of the following steps.

- a. Constant potential charge the battery in accordance with 4.4.2.
- b. Discharge the battery at the 1.0C-rate to a cutoff voltage of 18.0 volts.
- c. Constant potential charge the battery in accordance with 4.4.2.
- d. Place the battery in a temperature chamber at 85°C (185°F) for 16 ± 0.1 hours.
- e. Remove the battery from the temperature chamber. Lift the battery by its vent tubes.
- f. Expose the battery to room temperature for 1 hour.
- g. Discharge the battery at the 6.5C-rate for 3 minutes.
- h. Examine the battery for the requirements of 3.8.10.
- i. Stabilize the battery at room ambient conditions (see 4.4.1).

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- j. Constant potential charge the battery in accordance with 4.4.2.
- k. Discharge the battery at the 1.0C-rate to a cutoff voltage of 18.0 volts.
- l. Examine the battery for the requirements of 3.7 and requirement (1) of table III.

4.5.24 Impact resistance test (nonmetallic battery container). This test consists of the following steps.

- a. Rest an undamaged nonmetallic container for not less than 24 hours after manufacture.
- b. Place the container on a flat steel plate, approximately 25 centimeters (1 inch) longer and wider than the container. Position the container such that the ball will strike one-third down from the top of the container and near the centerline of the sides.
- c. Condition the container for 4 hours at $71^{\circ} \pm 3^{\circ} \text{C}$ ($160^{\circ} \pm 5^{\circ} \text{F}$).
- d. Drop a free-falling 0.907 ± 0.023 -kilogram (2.00 ± 0.05 -pound) solid steel ball one time on the container from a height of 2.29 meters (90 inches) (nominal).
- e. Examine the containers for the requirements of 3.8.14.
- f. Repeat step 4.5.24.c but use a temperature of $-18^{\circ} \pm 1^{\circ} \text{C}$ ($0^{\circ} \pm 2^{\circ} \text{F}$). Repeat step 4.5.24.d but use a height of 1.52 meters (60 inches) (nominal). Repeat step 4.5.24.e.
- g. Repeat step 4.5.24.c but use a temperature of $-40^{\circ} \pm 1^{\circ} \text{C}$ ($-40^{\circ} \pm 2^{\circ} \text{F}$). Repeat step 4.5.24.d but use a height of 1.27 meters (50 inches) (nominal). Repeat step 4.5.24.e.

4.5.25 Shock test (crash safety). This test consists of the following steps.

- a. Constant potential charge the battery in accordance with 4.4.2.
- b. Mount the battery to the test fixture in accordance with 4.4.5.
- c. Subject the battery to the shock pulse of figure 4, where P equals 40 g and D equals 11 milliseconds. Shock the battery in a normal upright position (see 6.15.12) and in two additional mutually perpendicular directions from the vertical. However, the battery shall not be mounted or shocked in the inverted position. Deliver two shocks in both directions of each orthogonal axis for a total of 10 impacts.
- d. After each axis of shock, dismount the battery from the test fixture.

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- e. Examine the battery and its attachment points for the requirements of 3.8.15.
- f. After the last impact, remove the battery from the test fixture. Discharge the battery at the 6.5C rate for three minutes.
- g. Examine the battery for the requirements of 3.8.15.

4.5.26 Shelf life test. Constant potential charge the battery in accordance with 4.4.2. Store the battery for not less than 18 months in an uncontrolled temperature environment (such as an unheated, uncooled warehouse) where the ambient air temperature shall be within the range of -40 °C to +38 °C (-40 °F to +100 °F). Bring the battery to the test facility. Constant current charge the battery in accordance with 4.4.3. Stabilize the battery at room temperature (see 4.4.1). Discharge the battery at the C-rate to 18.0 volts. Constant current charge the battery in accordance with 4.4.3. Subject the battery to the cycling test of 4.5.10. Examine the battery for the requirements of 3.8.9 and 3.8.13.2.

4.5.27 Deep discharge recovery test. This test consists of the following steps.

- a. Discharge the battery at the C-rate to 20.0 volts at room temperature (see 4.4.1).
- b. Connect a resistive load of 1.0 ohms across the battery terminals. Place the battery in a 50°C (122°F) environment for 168 ± 2 hours.
- c. Place the battery in the ambient conditions of 4.4.1 for not less than 24 hours.
- d. Constant current charge the battery at a rate of C/10 (± 3 percent) until one of the following events occurs:
 - (1) 30 ± 0.1 hours.
 - (2) The battery voltage levels out or decreases for three consecutive hourly readings after not less than 16 hours of charging.
 - (3) The battery temperature reaches 35°C (95°F) after not less than 16 hours of charging.

The charging source shall have a voltage output capability of not less than 100 volts. If excessive heating occurs during the charge cycle, terminate the charge current until the battery cools to ambient conditions.

- e. Discharge the battery at the C-rate to 20.0 V.

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- f. Constant current charge the battery at a rate of C/10 (± 3 percent) for 18 ± 0.1 hours.
- g. Discharge the battery at the C-rate to 20.0 V.
- h. Examine the battery for the requirements of 3.8.13.3.

4.5.28 Output performance test. This test consists of the following steps.

- a. Constant potential charge the battery in accordance with 4.4.2.
- b. Stabilize the battery's temperature at the test temperature specified in the applicable specification sheet (see 4.4.1).
- c. With the battery still in the temperature chamber at the test temperature specified in the applicable specification sheet, discharge the battery in accordance with the specification sheet.
- d. Examine the battery for the requirements of 3.8.16.

4.5.29 Cold and hot temperature charge test. This test consists of the following steps.

- a. Constant potential charge the battery in accordance with 4.4.2.
- b. Stabilize the battery's temperature at the test temperature specified in the applicable specification sheet (see 4.4.1). Perform steps 4.5.29.c through 4.5.29.e with the battery in the environmental chamber at the specified temperature.
- c. Discharge the battery in accordance with the specification sheet.
- d. Stabilize the battery's temperature at the test temperature specified in the applicable specification sheet.
- e. Constant potential charge the battery in accordance with 4.4.2.
- f. Immediately after completing 4.5.29.e, place the battery in a room temperature environment (see 4.4.1) and discharge the battery in accordance with the specification sheet.
- g. Examine the battery for the requirements of 3.8.17.

4.5.30 Wormgear retaining pin hardness. Mount and polish five samples of the wormgear retaining pins, making polished metallurgical cross-sections. Use a 100-gram load and a Knoop micro-hardness tester to make 6 indentions on each of the five pins. Average the results for each pin. Calculate the hardness of the pins and convert the results to the Rockwell C scale. Examine the pins for the requirements of 3.5.5.

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4.5.31 Final examination. Without dissecting the battery, examine it for the requirements of 3.7. Subject the battery to the dielectric strength test of 4.5.4. Examine the battery for the requirements of 3.8.4.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of materiel is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department or Defense Agency, or within the Military Department's 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 storage batteries 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 aircraft emergency loads, aeronautical and ground systems, and associated equipment. Commercial batteries have a separate charger. Most of the batteries under this specification, 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 must specify the following:

- a. Title, number, and date of the specification and applicable specification sheet.
- b. Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.2.1 and 2.3).
- c. Packaging requirements (see 5.1).
- d. Battery required, including quantity, NSN, and part or identifying number (PIN; see 6.16).
- e. Qualification under this specification is required unless agreement is obtained in writing from the qualifying activity. Qualification testing and conformance inspections are required as indicated herein (see 4.2, 4.3.3, 6.8, and table IV for the quantity of samples required).

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- f. Whether certification of conformity is required (see 3.3).
- g. Shelf-life coding for a 18-month shelf life period (see 3.8.13.2 and 6.15.6).
- 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-8565, 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, Electronics Development Directorate, Power Systems Department, Code 6097, 300 Highway 361, Crane, IN 47522-5001 or the Electrical Power Systems Division, AIR-4.4.4.1, Bldg. 1461, Naval Air Warfare Center Aircraft Division, 48298 Shaw Road, Unit 4, Patuxent River, MD 20670-1900.

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 (see 6.11.6).

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 B 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. When only one sample is received for group B inspection, the qualifying activity will decide which one of the test sequences indicated by the specification sheet will be performed. If a sample does not meet the requirements of 3.8.1, the qualifying activity may terminate further test and inspection.

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6.7 Group B 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, Electronics Development Directorate, Power Systems Department, Code 6097, 300 Highway 361, Crane, IN 47522-5001.

6.8 Responsibility for inspection and sample selection. The qualifying activity (see 4.2, 6.2, and 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 group B conformance inspection in accordance with 4.3.3. The qualifying activity conducts group B conformance inspection (see 4.3.5). The Government reviews and examines the contractor's inspection procedures and inspection records as necessary.

6.9 Cross-reference. All products which were qualified to MIL-B-8565J are considered qualified to MIL-PRF-8565K.

6.10 Charge/discharge rate discussion. The designated discharge rate is determined by multiplying the nominal rated capacity (C-rating) (see 6.15.11) in ampere-hours times the rate of discharge factor listed in a test or table III. Some examples of charge and discharge rates (see 6.15.3) are explained below.

A battery undergoing a 1C or C-rate discharge must produce 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 nominal capacity rating of 35.0 Ah/1 hr/25 °C/18.0 V undergoing a 1C or a C-rate discharge must produce a current of:

$$\begin{aligned} 1C \text{ or C-rate} &= 1 \times 35 \text{ ampere-hours} \\ &= 35 \text{ amperes for at least 60 minutes at } 25 \text{ }^{\circ}\text{C ambient} \\ &\quad \text{temperature before the battery potential drops} \\ &\quad \text{below the cutoff or end voltage of 18.0 volts} \end{aligned}$$

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:

$$\begin{aligned} C/5\text{-rate} &= 35 \text{ ampere-hours} \div 5 \\ &= 7 \text{ amperes delivered to the battery for 3 hours} \end{aligned}$$

6.11 Design practices and lessons learned.

6.11.1 Design guide. Table VI contains design guidelines based on actual experience and should be addressed and considered by the contractor when batteries are to be proposed or developed to this specification (see 3.3).

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6.11.2 Dissimilar metals. MIL-STD-889 provides methods for protecting joined dissimilar metals (see 3.4).

6.11.3 Color. For safety reasons (see 6.13), 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 3.6.1). The colors reflect the litmus paper indications for acid and alkaline substances, respectively. The electrolyte solution used in lead-acid batteries is an aqueous solution of sulfuric acid; that used in nickel-cadmium batteries is an aqueous solution of potassium hydroxide.

6.11.4 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.

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

6.11.6 Additional qualification information. See SD-6, Provisions Governing Qualification - Qualified Products Lists for guidance on obtaining qualification. The document describes the manufacturer's obligations to:

- a. Maintain process and quality control procedures that ensure that the items comply with all specification requirements.
- b. Immediately report any discrepancies disclosed during testing or periodic reexamination of the product and his production process controls.

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c. Ensure that delivered items conform to all specified product characteristics (in no way relieving manufacturers of contractual obligations to ensure delivered items comply with all specification requirements).

The qualification applicant must certify, among other items, that the applicant agrees to notify the responsible activity of any change in design, material, manufacturing processes (including quality control), or plant location after qualification approval. Copies are available from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.

6.12 Test equipment and facilities. Measurements should be performed (see 4.5) with equipment that has the following characteristics. Test equipment and inspection facilities should have sufficient accuracy, 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 ± 1.0 percent. For all discharges, the current or voltage (whichever is applicable) should be maintained within ± 1 percent of the specified value at all times, and the duration of the discharges should be within ± 2 percent of the nominal discharge time. All discharges will be continuous unless otherwise stated.

6.13 Safety and storage. Lead-acid batteries must not be stored in the same area as nickel-cadmium batteries (see 3.6.1 and 6.11.3). The components of the two types of batteries will react violently in case of fire or puncture. Less drastically, individual lead-acid batteries will be damaged or destroyed if contacted by the electrolyte of nickel-cadmium batteries, and vice versa.

6.14 Disposal. End users will comply with federal, state, and local regulations for disposal of used batteries. 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.

6.15 Definitions.

6.15.1 Activation. The addition of electrolyte to cells or monoblocks (see 4.3.2.b).

6.15.2 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 3.8.6 and 6.15.11). An example of a shorthand way of stating capacity is 35.0 Ah/1 hr/25 °C/18.0 V, which means the battery

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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 18.0 volts at the battery terminals, all of which occurs in an ambient air temperature of 25 °C.

6.15.3 Charge or discharge rate. The amount of current and length of time required to charge or discharge a battery or cell (see 3.8.6 and 6.10). Unless otherwise specified herein or in the specification sheet, the rate is expressed as $x\text{C}$, where x is a multiplier and C is the capacity required by the specification sheet. When stated as the C -rate, x equals 1.

6.15.4 Cut-off voltage. A specified voltage during the discharge of a cell or battery at which point the discharge will be terminated (see 3.8.6 and 4.5.7).

6.15.5 Cycle. A combination of a charge and discharge (see 3.8.9).

6.15.6 Date of manufacture. For the purposes of establishing the start of shelf life and the cutoff point for delivering batteries (see 4.3.2 and 6.2), the date of manufacture is the latter date of the following:

- a. The date the manufacturer activated the battery (added electrolyte to the cells or monoblocks), or
- b. The date the manufacturer (not any subsequent reseller or user) gave a final boost charge to the battery. However, the final boost charge must be given not later than six months after activation.

6.15.7 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 3.8.13.3).

6.15.8 Inactive for new design. A specification designation that indicates an item or process is prohibited for use in new design and is used only in existing assemblies or units. Items or processes so designated may be used for new assemblies or units developed for existing design contracts where the inactive item or process is being used for existing designs in the same contract, or in assemblies for existing units or systems required under future contracts. The QPL associated with an inactive for design specification will be maintained until acquisition of the product is no longer required whereupon the specification and QPL will be canceled (see 6.17).

6.15.9 Inspection lot. The quantity of batteries, harnesses, or components of any one type, produced at any one place of manufacture, submitted at one time to conformance inspection (see 3.6.6 and 4.3.2).

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6.15.10 Maintenance-free. A maintenance-free battery will not require any electrolyte additions. However, they still require a conditioning charge before initial issue because of long storage times and self-discharge. Such a battery may require exterior cleaning, capacity checks, charging before initial issue, and recharging after deep discharge (see 1.1 and 3.5.2).

6.15.11 Nominal rated capacity (C-rating). The capacity listed on the battery identification marking in accordance with the specification sheet; sometimes called end-of-life or minimum capacity (see 6.10). Note that when batteries and cells produce less than this amount of capacity (see 3.8.6 and 6.15.2) 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.

6.15.12 Normal upright position. The battery cover is on top of the battery with respect to the earth's surface (see 4.5.14, 4.5.15, and 4.5.25).

6.15.13 Unit. One single, individual battery (see 4.3.2).

6.16 Part or identifying number (PIN). The PIN (see 6.2) for batteries acquired to this specification is created as follows: D8565/X-Y with "D8565" representing the specification number, "X" signifying the specification sheet number, and "Y" indicating any variation of the battery on a particular specification sheet.

6.17 Inactive for new design specification sheets. Specification sheets which are inactive for new design (see 6.15.8) should use MIL-B-8565J as their procurement specification.

6.18 Subject term (key word listing).

Capacity
Charging
Discharging
Electrolyte
Heaters
Lead-acid
Nickel-cadmium
Potassium hydroxide (KOH)
Power sources
Receptacle
Rechargeable
Sulfuric acid
Terminal

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6.19 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.

TABLE I. Colors.

Electrolyte	Color
Acid	Red family (including scarlet, crimson, orange-reds, burgundy, and medium to dark shades of pink) (Mauve, lavender, purple, violet, and bluish-reds shall not be used)
Alkaline	FED-STD-595 color numbers: 15090, 15102, 15123 or 15193 (Blue)

TABLE II. 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.	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	Welds containing blow holes, cracks, or slag inclusions.	Visual
10	Burrs on battery container or cover.	Visual
11	Improper color on outside of container and cover.	Visual

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TABLE III. Capacity performance requirements.

Requirement Number	Discharge Cutoff Volts & Temperature (see 4.4.1)	Rate of Discharge Factor	Minimum Time to Cutoff Voltage
(1)	18.0 volts at room temperature	1.0C	1 hour
(2)	18.0 volts at 49°C	1.0C	1.1 hours
(3)	18.0 volts at -18°C	1.0C	30 minutes
(4)	14.0 volts at room temperature & -26°C	See <u>1/</u>	See <u>1/</u>
(5)	14.0 volts at room temperature	6.5C	5 minutes

1/ During qualification inspection and group B conformance inspection, a 14.0-volt constant voltage discharge for 1 minute at each of the two temperatures specified shall be performed on the battery. During group A conformance inspection, a 14.0-volt constant voltage discharge for 30 seconds at room temperature (see 4.4.1) shall be performed on the battery and only the 0-30 second current requirements shall be imposed. The current requirements shall be as specified in the applicable specification sheet.

TABLE IV. Sample sizes for group B inspection.

Inspection Lot Size	Total Number of Samples
1 through 20	1
21 through 200	2
201 through 500	4
501 through 1000	6
1001 through 3000	8

TABLE V. Broadband random background for vibration.

Frequency (Hz)	Amplitude (g^2/Hz)
10 to 40	0.002 to 0.04 (slope of ± 6 dB/octave)
40 to 500	0.04
500 to 2000	0.04 to 0.002 (slope of ± 6 dB/octave)

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TABLE VI. Component specification guidelines.

Components	Application Specification Guidelines
Metals Receptacle	3.7 MS3509 Receptacle, Electric, Aircraft Storage Battery

BATTERY, STORAGE, AIRCRAFT 24-VOLT, MAINTENANCE-FREE	
<u>Information Required</u>	<u>Example</u>
MIL Part No.	D8565/7-2
Replaces (include replacement data from applicable battery specification sheet)	Replaces D8565/7-1
Maximum Weight	29.0 kg
Military "C" Rated Capacity	24.0 Ah/1.0 HR/24°C/20.0 V
National Stock Number	6140-**-***-*****
Contract Number	***
Lot Code	0899-02
Date of Manufacture	30 June 2001
Battery S/N	***
Manufacturer's Name	***
Date Battery Placed in Service	
CAUTION HOT SURFACE	
*** Fill in applicable information. To be filled in by user (see 3.6.3) Applies to certain batteries with heaters (see 3.6.5)	

FIGURE 1. Battery identification marking.

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MAINTENANCE-FREE BATTERY

DO NOT REMOVE COVER

THIS BATTERY SHALL BE SERVICED
ONLY IN AN AUTHORIZED BATTERY SHOP.

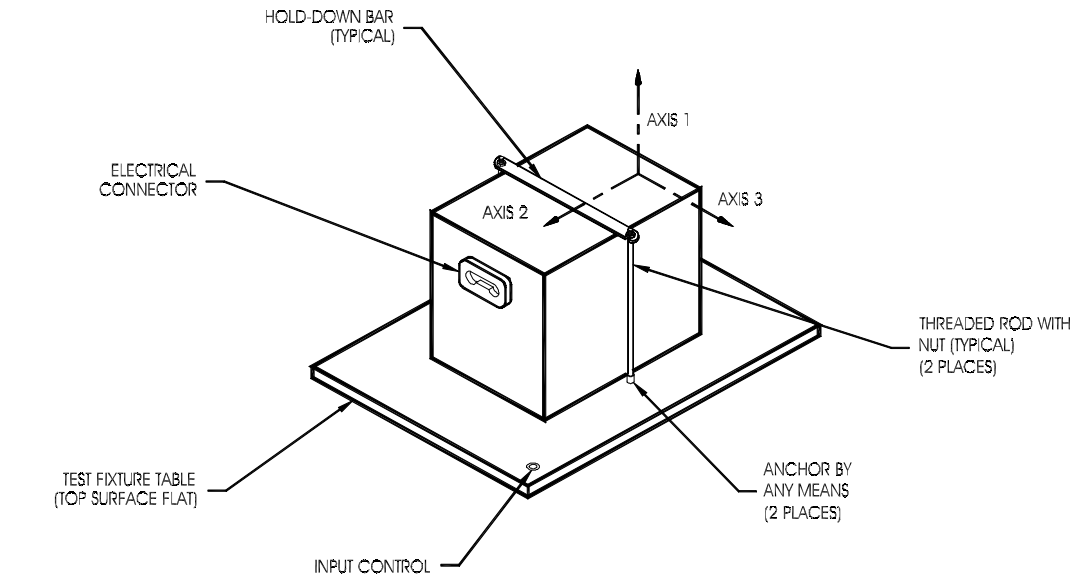
THIS BATTERY IS TO BE REMOVED FROM
SERVICE ** YEARS FROM DATE FIRST PLACED
IN SERVICE.

CAUTION HOT SURFACE

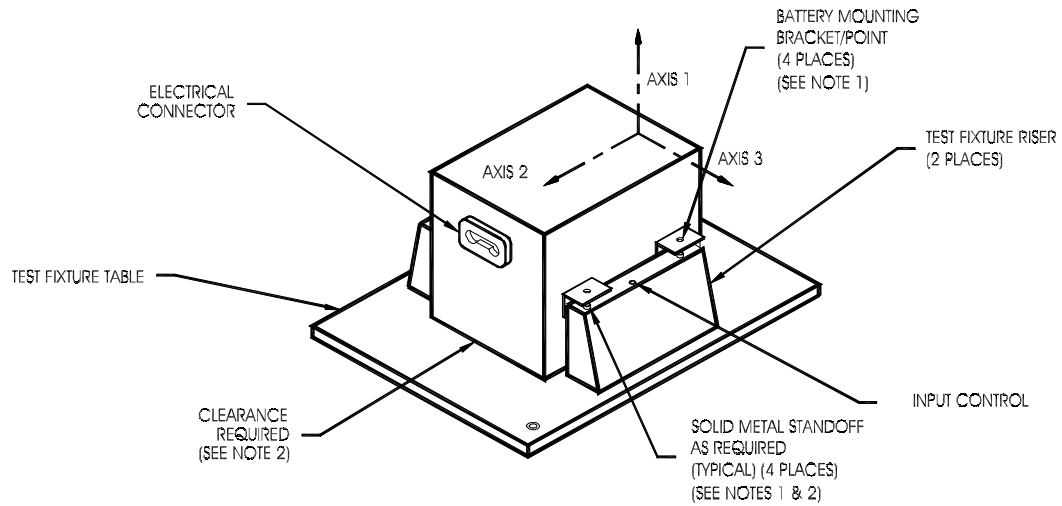
**Fill in information from applicable specification sheet.
Applies to certain batteries with heaters (see 3.6.5)

FIGURE 2. Battery caution marking.

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CONVENTIONAL MOUNTED BATTERY



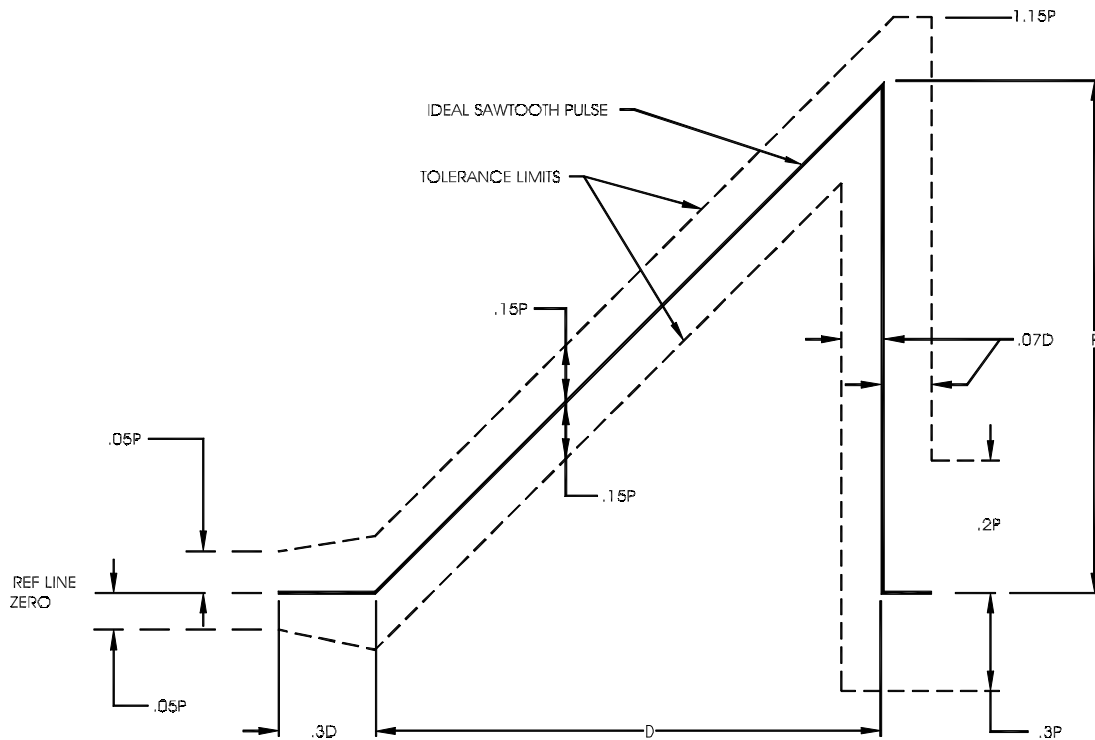
SHOCKMOUNTED BATTERY

NOTES:

1. VIBRATION ISOLATORS SHALL NOT BE USED AT MOUNTING POINTS DURING TESTS SPECIFIED HEREIN.
2. 3.175 MM MINIMUM CLEARANCE REQUIRED BETWEEN BOTTOM SURFACE AND TABLE TOP SURFACE.

FIGURE 3. Battery mounting.

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NOTE: The oscillogram shall include a time about $3D$ long with a pulse located approximately in the center. The peak acceleration magnitude of the sawtooth pulse is P and its duration is D . The measured acceleration pulse shall be contained between the broken line boundaries and the measured velocity change (which may be obtained by integration of the acceleration pulse) shall be within the limits of $V_i \pm 0.1 V_i$, where V_i is the velocity-change associated with the ideal pulse which equals $0.5 DP$. The integration to determine velocity change shall extend from $0.4D$ before the pulse to $0.1D$ after the pulse.

FIGURE 4. Terminal-peak sawtooth shock pulse configuration and its tolerance limits.

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CONCLUDING MATERIAL

Custodians:

Army – CR

Navy - AS

Air Force – 99

Preparing activity:

Navy - AS

(Project 6140-0925)

Review activities:

Army – AV

Air Force – 11, 71

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MIL-PRF-8565K

2. DOCUMENT DATE
(YYYYMMDD)
20010625

3. DOCUMENT TITLE

BATTERIES, STORAGE, AIRCRAFT GENERAL SPECIFICATION FOR

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

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME *(Last, First, Middle Initial)*

b. ORGANIZATION

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d. TELEPHONE *(Include Area Code)*
(1) Commercial
(2) DSN
(If applicable)

**7. DATE
SUBMITTED**
(YYYYMMDD)

8. PREPARING ACTIVITY

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COMMANDER
NAVAL AIR WARFARE CENTER
AIRCRAFT DIVISION

b. TELEPHONE *(Include Area Code)*
(1) Commercial (2) DSN
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