U.S. Department of Transportation

Federal Aviation Administration

SPECIFICATION

BATTERY, STORAGE, LEAD-ACID

1. SCOPE AND CLASSIFICATION 1

1.1 SCOPE 1

1.2 CLASSIFICATION 1
1.2.1 Type 2
1.2.2 Class 2
1.2.3 Style 3

1.3 DEFINITIONS 3
1.3.1 Ambient temperature and ambient relative humidity 3
1.3.2 Damage 3
1.3.3 Distilled water 3
1.3.4 Figures 3
1.3.5 Float 3
1.3.6 Free electrolyte 3
1.3.7 Government inspection 3
1.3.8 Nominal load 4
1.3.9 Paragraph number references 4
1.3.10 Permanent 4
1.3.11 Standard 4
1.3.12 Tolerances 4

2. APPLICABLE DOCUMENTS 4

2.1 FAA DOCUMENTS 4

2.2 FEDERAL SPECIFICATIONS AND STANDARDS 4
2.2.1 Federal Specifications 5
2.2.2 Federal Standards 5

2.3 MILITARY SPECIFICATIONS AND STANDARDS 5
2.3.1 Military Specifications 5
2.3.2 Military Standards 5

2.4 OTHER GOVERNMENT DOCUMENTS 5
2.4.1 Code of Federal Regulations, Title 29 5
2.4.2 Code of Federal Regulations, Title 46 5
2.4.3 Code of Federal Regulations, Title 49 5

2.5 NON-GOVERNMENT DOCUMENTS 5
2.5.1 American Society for Testing and Materials 5

2.5.2 International Conference of Building Officials 5
2.5.3 National Electrical Manufacturers Association 5
2.5.4 Society of Automotive Engineers 6

2.6 ORDER OF PRECEDENCE 6

2.7 DOCUMENT SOURCES 6

3. REQUIREMENTS 7

3.1 GENERAL 7

3.2 GENERAL FUNCTIONAL REQUIREMENTS 7
3.2.1 Battery voltage 7
3.2.2 Battery Capacity, Discharge Rates, and Charge Rates 7
3.2.3 Battery Condition 8
3.2.4 Efficiency 9
3.2.5 Float charging 9
3.2.6 Battery Life 9
3.2.7 Charge retention 12
3.2.8 Dimensions 12
3.2.9 Weight 13
3.2.10 Vents 13
3.2.11 Terminals 13
3.2.12 Electrolyte 14
3.2.13 Bulge characteristics and acid absorption 15
3.2.14 Impact resistance 15
3.2.15 Electrolyte retention 15
3.2.16 Insulation resistance 15
3.2.17 Handling provisions 15
3.2.18 Mounting provisions 17
3.2.19 Maintainability 18
3.2.20 Interchangeability 20
3.2.21 Battery item level 20
3.2.22 Defects manifested during life 21

3.3 ENVIRONMENTAL REQUIREMENTS 21

3.4 WORKMANSHIP AND PROCESSES 23
3.4.1 Lead-burning 23
3.4.2 Welding and brazing 23
3.4.3 External surfaces 23
3.4.4 Threaded parts or devices 23

3.4.5 Riveting 23
3.4.6 Assembly 23
3.4.7 Cleaning 23

3.5 SAFETY 23
3.5.1 Mechanical Safety 23
3.5.2 Toxic Product Safety 24
3.5.3 Flammability 24

3.6 A.C. SUPPLY LINE 24

3.7 ELECTRICAL OVERLOAD PROTECTION 24

3.8 FINISHES 24
3.8.1 Cell containers 24
3.8.2 Acid resistance 24

3.9 COOLING 24

3.10 WIRE AND CABLE 24

3.11 REFERENCE DESIGNATIONS 24

3.12 MARKINGS 24
3.12.1 Polarity 25
3.12.2 Electrolyte levels 25
3.12.3 Electrolyte class 25
3.12.4 Precautionary labels 25
3.12.5 Additional markings 26

3.13 NAMEPLATE 26

3.14 MATERIALS AND PARTS 27

3.15 FCC TYPE ACCEPTANCE 27

3.16 TEST POINTS, TEST FACILITIES AND TEST EQUIPMENT 27

3.17 BATTERY-ASSOCIATED ITEMS 27
3.17.1 Stick-on number labels 27
3.17.2 Battery racks 27
3.17.3 Manuals, Instructions, and data 27

3.18 BATTERY DISASSEMBLY 28

4. QUALITY ASSURANCE PROVISIONS 28

4.1 QUALITY CONTROL PROVISIONS 28
4.1.1 Responsibility for inspection 28
4.1.2 Inspection facilities 28
4.1.3 Government testing 28

4.2 CONTRACTOR'S DETAILED LIST OF TESTS 28
4.2.1 Submission of test Documentation 28
4.2.2 Notification of readiness for inspection 29
4.2.3 Submission of Certified Test Data 29

4.3 CLASSIFICATION OF TESTS 29
4.3.1 Inspection Conditions 31
4.3.2 Inspection of preparations for delivery 32
4.3.3 Inspection of battery condition 32
4.3.4 Inspection of battery dimensions 32
4.3.5 Inspection of battery weight 32
4.3.6 Inspection of battery terminal configurations 32
4.3.7 Inspection of battery terminal locations 32
4.3.8 Inspection of battery mounting provisions 32
4.3.9 Inspection of battery item level 32
4.3.10 Inspection of workmanship 33
4.3.11 Inspection of Type I battery cell container finish 33
4.3.12 Inspection of markings 33
4.3.13 Inspection of nameplate 33
4.3.14 Inspection of materials and parts 33
4.3.15 Inspection of battery associated items 33
4.3.16 Battery storage test 34
4.3.17 Activation of charged and dry battery 34
4.3.18 Battery voltage 35
4.3.19 Charge Rates, Discharge Rates, and Battery Capacity 35
4.3.20 Efficiency 35
4.3.21 Float Charging 36
4.3.22 Battery Life 36
4.3.23 Charge retention 37
4.3.24 Vents 37
4.3.25 Terminal Corrosion Protection 38
4.3.26 Terminal Electrical Resistance 38
4.3.27 Terminal Strength (Mechanical) 39
4.3.28 Terminal Strength (Electrical) 39

4.3.30 Electrolyte 39
4.3.31 Bulge Characteristics and Acid Absorption 40
4.3.32 Impact Resistance 40
4.3.33 Electrolyte Retention 41
4.3.34 Insulation Resistance 41
4.3.35 Handling Provisions 41
4.3.36 Maintainability 42
4.3.37 Interchangeability 42
4.3.38 Defects Manifested 42
4.3.39 Safety 42
4.3.40 Electrical Overload Protection 43
4.3.41 Acid Resistance of Finishes 43
4.3.42 Battery Cooling 44
4.3.43 Battery Disassembly 44

4.4 TEST EQUIPMENT 44
4.4.1 Furnishing of test equipment 44
4.4.2 Basic Instrument Accuracy 44

4.5 CERTIFICATION OF JAN/MIL TYPE PARTS AND MATERIALS 46

4.6 AVAILABILITY OF APPLICABLE DOCUMENTS 46

4.7 INSPECTION OF DESIGN AND PRODUCTION STATUS 46

4.8 AC LINE FREQUENCY 46

4.9 BAROMETRIC PRESSURE 46

4.10 WIND AND ICE LOADING 46

4.11 AC LINE TRANSIENT 46

4.12 ENVIRONMENTAL TEST PROCEDURE 46
4.12.1 Ambient conditions Tests 47
4.12.2 Vibration and Shock Tests 48
4.12.3 Shipping and handling environmental conditions tests 48
4.12.4 Operating environmental conditions tests 49

5. PREPARATION FOR DELIVERY 50

5.1 PREPARATION REQUIREMENTS FOR DRY CHARGED BATTERIES

5.2 PREPARATION REQUIREMENTS FOR WET, CHARGED BATTERIES (ALL TYPES) 50

6. NOTES 50

6.1 NOTE ON INFORMATION ITEMS 50

6.2 INTENDED USE 51

6.3 ADDITIONAL DATA REQUIRED 51

6.4 TAILORING THIS SPECIFICATION 52

6.5 BATTERY SELECTION AND APPLICATION GUIDANCE 52

6.6 BATTERY MAINTENANCE GUIDANCE 52

6.7 FEATURES TO BE INCLUDED IN BIDS OR IN THE CONTRACT 52

TABLE I ENVIRONMENTAL CONDITIONS FOR LEAD-ACID BATTERIES 22

TABLE II QUALITY CONFORMANCE INSPECTIONS 30

TABLE III TEST SAMPLE SELECTION QUANTITIES 31

BATTERY, STORAGE, LEAD-ACID

1. SCOPE AND CLASSIFICATION

1.1 SCOPE. - This specification contains requirements which are applicable, alone or in conjunction with other specifications, to all types of lead-acid secondary (rechargeable) batteries composed of one or more cells and applied in Federal Aviation Administration (FAA) facilities and equipment. The document identifies the standard nomenclature that will be used within the FAA to reference lead-acid batteries for typical applications. Though this specification is mostly applicable to sizeable procurements, it is intended for the battery nomenclature and requirements to be applied to all battery purchases. In select circumstances, this specification may be used without the specific test requirements of section 4. However, in any event, all FAA battery procurements shall be in concert with this specification.

1.2 CLASSIFICATION. - Using FAA nomenclature, six types, three classes, and two styles of lead-acid batteries are covered by this specification. Type will indicate the intended application, Class will indicate maintainability, and Style will indicate position sensitivity. The type, class, and style designations

applications to provide emergency or backup power when the primary power (normally commercial electric line) fails. The equipment that these (Type I) batteries will power normally consists of uninterruptible power supplies, switch gear , and communication receivers and transmitters.

(b) Type II Stationary Engine Generator Starting. Used for starting stationary internal combustion engines that power electric generators.

(c) Type III Vehicle Starting and Auxillary Power. Type III batteries are sometimes referred to in literature as automotive starting, lighting and ignition (SLI) batteries, or simply car batteries. Under this (Type III) grouping are included recreational vehicle (RV) batteries and marine batteries. Farm machinery batteries, lawn tractor batteries, motorcycle batteries, and construction and industrial machinery (CIM) batteries are also included, in addition to automobile SLI batteries.

(d) Type IV Deep Discharge Cycle Motive. Used in vehicles requiring batteries for motive power. These vehicles include industrial electric trucks and forklifts/transporters, golf carts, and "electric vehicles".

(e) Type V Emergency Lighting, Portable Test Equipment. Used to provide electric power to emergency building lights that operate when commercial power fails or to operate portable test equipment.

(f) Type VI Renewable Energy Storage. Used for electrical energy storage with solar cells, wind-driven generators, or other renewable energy sources and conversion devices.

1.2.2 Class. - Lead-acid batteries obtained under this specification shall be of the following classes (FAA nomenclature):

cation shall be of the following styles (FAA nomenclature):
Note: Style B is applicable only to class 3 batteries.

(a) Style A Free Electrolyte, or Orientation or Attitude Sensitive.

(b) Style B Non-Spillable Electrolyte, and Not Orientation or Attitude Sensitive.

1.3 DEFINITIONS

1.3.1 Ambient temperature and ambient relative humidity. - The terms "ambient temperature" and "ambient relative humidity" are defined as the temperature and relative humidity of the air surrounding the equipment.

1.3.2 Damage. - Impairment that prevents a battery from meeting its requirements, unless repaired or rebuilt.

1.3.3 Distilled water. - The term "distilled water" shall mean water that conforms to the requirements of Federal Specification O-B-41.

1.3.4 Figures. - The term "figures" as used herein shall denote data sheets, graphs, sketches, or pictures used in conjunction with specification documents.

1.3.5 Float. - The condition of a battery being maintained in the fully charged state by steady application of charging power sufficient to overcome internal battery power losses at the applied voltage but not sufficient to cause significant gas evolution within the battery cells.

1.3.6 Free electrolyte. - Liquid sulfuric acid electrolyte, contained within the cell jar but not constrained or immobilized between the cell plates, will drain if the cell jar is opened below the electrolyte level.

1.3.7 Government inspection. - The term "Government inspection" as used in this specification, means that an FAA or other delegated Government agency representative will witness or conduct testing and inspection and will carry out such visual and other inspection as deemed necessary to assure compliance with

referenced (without qualification) herein, only the specific paragraph so numbered shall apply. Where a group of paragraphs is referenced, such as "3.2 to 3.2.9", the word "inclusive" is implied whether or not actually stated. For example, "3.2 to 3.2.9" means "3.2 to 3.2.9 inclusive".

1.3.10 Permanent. - A duration equal to or greater than the useful life of the relevant battery.

1.3.11 Standard. - The term FAA "standard" as used herein shall denote a document that establishes engineering or technical limitations and applications for materials, processes, methods, design, drafting room, and other engineering practices, or any related criteria essential to achieve uniformity in materials or products, or interchangeability of parts used in those products.

1.3.12 Tolerances. - Where tolerance is specified as a percentage indicating a total variation without reference to a center value, this percentage shall be determined from the highest (H) and lowest (L) values obtained over the specified range, as follows:

$$\% = 200\ (H-L)/(H+L)$$

2. APPLICABLE DOCUMENTS

2.1 FAA DOCUMENTS

FAA-STD-013 Quality Control Program Requirements

ORDER 6980.24 Battery Theory and Selection Guidelines

ORDER 6980.25 Maintenance of Batteries for Standby Power

2.2 FEDERAL SPECIFICATIONS AND STANDARDS. - The following Government publications of the issues in effect on the date of the solicitation, form a part of this specification and are applicable to the extent specified herein.

2.2.2 Federal Standards.

FED-STD-H28 Screw Thread Standards For Federal Services

2.3 MILITARY SPECIFICATIONS AND STANDARDS.

2.3.1 Military Specifications.

MIL-E-17555 Electronic and Electrical Equipment, Accessories, and Provisioned Items (Repair Parts): Packaging of

2.3.2 Military Standards.

MIL-STD-202 Test Methods for Electronic and Electrical Component Parts

MIL-STD-810 Environmental Test Methods and Engineering Guidelines

2.4 OTHER GOVERNMENT DOCUMENTS.

2.4.1 Code of Federal Regulations, Title 29, Part 1910

2.4.2 Code of Federal Regulations, Title 46, Part 146

2.4.3 Code of Federal Regulations, Title 49, Part 171-178

2.5 NON-GOVERNMENT DOCUMENTS.

2.5.1 American Society for Testing and Materials. (ASTM)

ASTM D639 Battery Containers Made From Hard Rubber Or Equivalent Materials

2.5.2 International Conference of Building Officials
Uniform Building Code (1985)

2.5.3 National Electrical Manufacturers Association. (NEMA)

IB 3 Cycle Life Testing of Lead-Acid Industrial Storage Batteries for Motive Power Service

SAE J 240 Life Test for Automotive Storage Batteries

SAE J 537 Storage Batteries

2.6 ORDER OF PRECEDENCE. - In the event of a conflict between the text of the solicitation and the text of this specification, the text of the solicitation shall take precedence. In the event of a conflict between the text of this specification and the references cited herein, the text of this specification shall take precedence.

2.7 DOCUMENT SOURCES. - A limited number of copies of this FAA specification and other applicable FAA documents may be obtained from the Contracting Officer in the Federal Aviation Administration office issuing the invitation for bids or request for proposals. Requests should fully identify material desired and should identify the invitation for bids, requests for proposals, contract involved, or other use to be made of the requested material. Other listed publications can be obtained as indicated.

Federal Specifications and Standards - General Services Administration Business Service Centers in Atlanta; Seattle, Washington; Boston; Chicago; Denver; Fort Worth; Kansas City, MO; Los Angeles; New York; San Francisco; and Washington, D.C.

Military Specifications and Standards - Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120

Other Government Documents - Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402

ASTM Documents - American Society For Testing And Materials, 1916 Race STreet, Philadelphia, PA 19103

International Conference of Building Officials Documents - 5360 South Workman Mill Road, Whittier, California 90601

NEMA Publications - National Electrical Manufactures

3.1 GENERAL. - Lead-acid batteries provided under this specification shall be of the type, class, style, voltage, capacity, dimensions, weight, condition, terminal configurations and locations, charge rates, and discharge rates as specified. Instruction manuals or data shall be supplied with the batteries and shall meet the requirements of 3.17. Batteries shall be delivered as individual cells or as completely assembled batteries as specified for battery item level or, if not specified, as specified in 3.2.21. When dry charged batteries with electrolyte are specified, the necessary electrolyte, suitable for installation in the battery, must be furnished with the batteries, but in separate container or containers. When specified, seismic battery racks shall be delivered with the batteries (see 3.17). Terminal locations, handling provisions, mounting provisions, and environmental requirements shall be as specified, or, if not specified, shall be as specified in 3.2.11(b), 3.2.18, 3.2.19, and 3.3 respectively. Unless otherwise specified, the battery shall include flame arresting vent provisions.

3.2 GENERAL FUNCTIONAL REQUIREMENTS.

3.2.1 Battery voltage. - The battery shall operate at the voltages specified. The battery terminal voltage of a fully charged, wet battery, after standing open circuit for more than 24 hours and less than 7 days at 77 ^{o}F, $\pm$5F^{o} shall not be less than 2.04 volts times the number of cells in the battery or greater than 2.15 volts times the number of cells in the battery.

3.2.2 Battery Capacity, Discharge Rates, and Charge Rates.

(a) Capacity. - When the battery capacity is specified in the solicitation without an associated temperature-corrected value or correction factor, the battery capacity, without temperature correction and when tested at the lowest temperature, charge rate values, and discharge rate values given, shall be the value specified, or greater value; and the temperature correction factor for battery capacity shall not be greater than 0.8 percent per fahrenheit degree for corrections to 77°F at the 8-hour discharge rate. When capacity is specified with an associated temperature corrected value or correction factor, the capacity value measured, when corrected for temperature, shall be the value specified, or greater value. When discharged to the

damaged, the battery capacity shall be the value specified or greater value (allowing for applicable temperature correction), and the battery terminal voltage shall remain within the operating voltage range specified for the operating environments of paragraph 3.3. Individual cell voltages shall not show voltage polarity reversal at any time within the capacity value and discharge rates specified. The battery shall be suitable for discharge by the constant current method, fixed resistance method, variable resistance or profile method, and constant power method. The battery shall be suitable for continuous and intermittent discharge load applications.

(c) Charge Rates. - The battery shall not be damaged and shall meet or exceed the capacity value specified when charged in the operating environment of paragraph 3.3 using the charge rates specified. The battery shall be suitable for charging and recharging by the method of constant current with voltage limit or duration limit and by the method of constant potential with current limit or duration limit, limits as specified. The battery shall be suitable for complete (100%) recharging, based on the ampere-hours of recharge current and the battery charge efficiency specified in 3.2.4 versus the ampere-hours of battery capacity withdrawn by discharging, in the duration specified, or, when not specified in the solicitation, in less than 24 hours after the beginning of continuous recharge.

3.2.3 Battery Condition. - The battery shall be furnished in one of the following conditions. If no condition is specified, the battery shall be furnished in the charged and wet condition.

(a) Charged and wet. - The battery shall be maintained fully charged prior to shipment with the necessary electrolyte (see 3.2.12) installed to the full electrolyte level and shall be ready to be placed in operation when shipped. The charged battery shall not be damaged by storage for a continuous period of 90 days after delivery in the storage environment conditions of paragraph 3.3. The battery shall not require maintenance or charging during storage. The charged and wet battery condition is applicable to all battery classes and styles.

(b) Charged and dry. - The charged and dry (may also be referred to as dry charged) battery condition is appli-

continuous period of 1 year in the storage environments of 3.3. The battery shall not require maintenance or charging during storage. The electrolyte shall remain inside its container during storage.

(3) Activation. - The dry, charged battery shall be suitable for activation when the battery and electrolyte (see 3.2.12) are temperature stabilized within the applicable operating temperature range of paragraph 3.3 (battery and electrolyte not necessarily at the same temperature). The dry, charged battery shall be suitable for manual preparation to receive electrolyte. Preparation shall not require the use of tools or other devices, except a blade-type screwdriver or pliers may be used for removing seals from the cell openings. Preparation of the electrolyte container and addition of the electrolyte to the battery shall not require the use of tools or devices other than the electrolyte container. Addition of the electrolyte to each cell of the battery and replacement of the cell plug or cap shall complete the activation of the battery.

(4) Operation. - The battery shall be ready for operation immediately after activation. The battery shall not require charging at any rate other than that rate specified in the solicitation (See paragraph 3.2.2) or at any rate greater than 6 amperes per 100 ampere-hours of specified battery capacity, whichever rate is the greater current. Additionally, the battery shall not require initial charging at any voltage greater than 2.7 volts multiplied by the number of battery cells connected in series.

3.2.4 Efficiency. - When tested for ampere-hour efficiency, the ratio of the ampere-hours of discharge to the ampere-hours of recharge shall not be less than 0.85.

3.2.5 Float charging. - The battery shall not be damaged by float charging and shall accept float charging.

3.2.6 Battery Life.

(a) Measurement of battery life. - Battery life shall be

battery life test of 4.3.22, or the life tests of SAE J 240, NEMA IB3, or NEMA IB5 can be made available by the manufacturer for inspection by authorized government representatives prior to the closing date specified in the solicitation to show that batteries of like design will have the following minimum useful life:

(1) Type I Battery Life. - 20 years

(2) Type II Battery Life - 14 years

(3) Type III Battery Life. - 5 years

(4) Type IV Battery Life. - 5 years

(5) Type V Battery Life. - 10 years

(6) Type VI Battery Life. - 4 years

(c) Life cycle capability (battery use). - When operated within the electrical parameters of 3.2.2 and in the environments of 3.3, the battery shall have the following cycle capability, or greater cycle capability, during useful battery life, given the stipulations that; when environmental conditions during battery life include temperature extremes varying by more than 40 fahrenheit degrees, not more than 10 percent of the battery lifetime is spent in ambient temperatures that are within 10 percent of either (highest or lowest) extreme temperature value.

(1) Type I battery life cycle capability - 100 cycles total, of which 50 cycles are discharges of from 90% to 100% of specified capacity, 30 cycles are discharges of from 75% to less than 90% of specified capacity, and 20 cycles are discharges of from 40% to less than 75% of specified capacity. Recharges for Type I batteries shall be initiated within 2 hours after the end of discharging, except that one recharge per year may be delayed 48 hours. All recharges shall be complete, based on the ampere-hours of recharge current and the battery charge efficiency specified in 3.2.4 versus the ampere-

end of discharging, except that one recharge per year (following a one-minute engine cranking discharge) may be delayed 12 hours. All recharges shall be complete, based on the ampere-hours of recharge current and the battery charge efficiency specified in 3.2.4 versus the ampere-hours of battery capacity withdrawn by discharging.

(3) Type III battery life cycle capability - 3650 cycles total, of which 3585 are 5-second engine cranking discharges, 60 are 10-second engine cranking discharges, and 5 are 90-second engine cranking discharges. Recharges for Type III batteries shall be initiated within 2 hours after the end of discharging, except that one recharge per year (following a 90-second engine cranking discharge) may be delayed 12 hours. All recharges shall be complete, based on the ampere-hours of recharge current and the battery charge efficiency specified in 3.2.4 versus the ampere-hours of battery capacity withdrawn by discharging.

(4) Type IV battery life cycle capability - 75 cycles total, of which 30 cycles are discharges of from 95% though 100% of specified capacity, 25 cycles are discharges of from 75% to less than 95% of specified capacity, and 20 cycles are discharges of from 30% to less than 50% of specified capacity. Recharges for Type IV batteries shall be initiated within 24 hours after completion of 95% through 100% discharge (except that one recharge per year, following a 100% discharge, may be delayed 2 days); within 3 days after completion of 75% to less than 95% discharge; and within 14 days after completion of 30% to less than 75% discharges. All recharges shall be complete, based on the ampere-hours of recharge current and the battery charge efficiency specified in 3.2.4 versus the ampere-hours of battery capacity withdrawn by discharging.

(5) Type V battery life cycles capability - 100 cycles total, of which 96 cycles include discharge to 100 percent of specified capacity and 4 cycles include discharge to zero volts. Note: After discharge to

after the end of discharging, except that one recharge per year (after discharge to 100% of specified capacity) may be delayed 24 hours. All recharges shall be complete, based on the ampere-hours of recharge current and the battery charge efficiency specified in 3.2.4 versus the ampere-hours of battery capacity withdrawn by discharging.

(6) Type VI battery life cycle capability - 1460 daily discharges total, no single discharge withdrawing more than 25% of specified capacity, and no discharging after 100% of the specified capacity has been withdrawn without partial (as a minimum) replacement by recharging. Recharging will occur daily, with the completeness of each daily recharge varying between zero percent and 100 percent. The occurrence of daily recharging shall be within 12 hours following the end of daily discharging. The completeness of recharge shall be based on the ampere-hours of recharge current and the battery charge efficiency specified in 3.2.4 versus the ampere-hours of battery capacity withdrawn by discharging that have not been replaced by previous recharging. Per year, fifty five percent of the daily recharges shall be 100% complete. Per year, thirty percent of the daily recharges shall be between 50% and 100% complete. Per year, ten percent of the daily recharges shall be from 20% through 50% complete. Per year, five percent of the daily recharges shall be between 0% and 20% complete. Per year, not more than three consecutive daily recharges shall be between zero percent and 20% complete.

3.2.7 Charge retention. - When tested for charge retention, the ratio of the ampere-hour capacities shall not be less than 0.75. Further, any capacity lost by a fully charged and wet battery after standing open circuit at 70°F ±30 F° for 30 days shall, upon completion of recharge, be recovered to the battery capacity value specified in the contract or order, or greater value.

3.2.8 Dimensions. - Battery dimensions shall be as specified.

vents shall be automatically repeatable in operation. The battery vents shall not cause the battery to exceed its dimensions. Additionally, the battery vents shall comply with the electrolyte retention requirements of 3.2.16.

(a) Flame Arresting. - Unless otherwise specified, the battery vents shall include (flame arresting) means to prevent externally incident flame fronts from entering battery internal parts.

(b) Manifold connections. - When specified, the battery vents shall include provisions as specified for connection to a venting manifold.

3.2.11 Terminals.

(a) Terminal configuration. - The battery terminals shall be of the configuration specified and threaded terminal parts shall conform to FED-STD-H28. The manufacturer shall provide torque requirements.

(b) Terminal location. - The terminals shall be located as specified. If no location is specified, either directly or indirectly through battery part number, figure, or other description, then the terminals shall be located on the top of the battery case, not closer than 0.59 inches (15 mm) to any edge of the battery (battery size permitting), and shall be a sufficient distance apart to prevent terminal-to-terminal contact in the environments of paragraph 3.3.

(c) Terminal corrosion protection. - The terminals and terminal hardware shall be corrosion resistant or treated to resist corrosion, or supplied with a non-toxic corrosion-preventing coating installed that does not require removal prior to battery electrical connection or operation.

(d) Terminal electrical resistance. - The terminal electrical resistance shall be such that, at the discharge rate specified, the temperature of either battery terminal will not increase to more than 30 fahrenheit degrees

cracking, breaking, or resulting damage to the battery case or terminal seal, a force that is equivalent to the lessor value of the wet, charged battery weight or 50 pounds and is applied from any direction to the top or side of the battery terminal. The battery and each terminal shall withstand without damage, the forces associated with making and removing terminal connections.

(2) Electrical. - The terminals shall show no melting, fusing, deformation, or permanent change in characteristics when tested for one minute at a current equivalent to 150 percent of the maximum charge rate or discharge rate (whichever value is the greater current) that is specified in the solicitation.

(f) Terminal clearances. - Terminal clearances shall be provided for accomplishment of terminal connections.

3.2.12 Electrolyte. - The electrolyte of the charged battery, shall be a solution of 1.400 or less specific gravity (at 77°F) of sulfuric acid in water. After delivery, the battery shall not require the addition at any time of any substance other than water conforming to the requirements of Federal Specification O-B-41. Liquid electrolyte which is furnished with the battery but in a separate container at time of delivery shall conform to the requirements of Federal Specification O-S-801, classes 2, 3, or 4. After delivery, electrolyte dilution or mixing, prior to addition to the battery, shall not be required or necessary.

(a) Wet batteries. - The electrolyte shall be installed in wet batteries prior to delivery.

(b) Dry batteries. - Liquid electrolyte, suitable for addition to the dry batteries, shall be delivered with the batteries, but in separate, disposable containers (see 5.1). The separate, disposable electrolyte containers shall be suitable for use to add the electrolyte to the batteries. The separate, disposable electrolyte containers shall contain the electrolyte without loss when the closed container is in any position, including inverted. If it is specified that no electrolyte is to be delivered with the batteries, then the batteries shall meet the requirements of this specification after they

batteries shall be constrained or immobilized within the battery cells. Gelling or immobilizing agents or absorbing materials may be included in or with the electrolyte, provided that these agents and materials or their inclusion does not prevent the battery from complying with the requirements of this specification.

3.2.13 Bulge characteristics and acid absorption. - (Applicable to battery containers composed of hard rubber or plastic material.) When tested for bulge characteristics and acid absorption, the bulge characteristics of the battery container shall not exceed a change in any linear dimension of greater than 2.0% and acid absorption shall not result in a change in weight greater than 1.5%.

3.2.14 Impact resistance. - When tested for impact resistance, the impact resistance shall be the lessor of 60 pound-inches or the value, in pound-inches, determined by multiplying the wet, charged battery weight (in pounds) by 10.

3.2.15 Electrolyte retention.

(a) Style A batteries. - Style A batteries shall evidence no electrolyte leakage or spillage when tilted in any direction through an angle of 45 degrees from the normal upright position. Style A batteries shall at no time evidence any seepage of electrolyte through the battery case.

(b) Style B batteries. - Style B batteries shall at no time evidence any electrolyte seepage, spillage, or leakage, in any position, including inverted.

3.2.16 Insulation resistance. - When tested for insulation resistance, the insulation resistance from either battery terminal to the battery case shall not be less than 1 (one) megohm.

3.2.17 Handling provisions. - Permanently attached, molded or integral battery handling provisions shall not cause the battery to exceed the dimensions specified. If no battery handling provisions are specified either directly or indirectly through battery part number, figure, or other description, then the

batteries weighing less than 50 pounds.

(1) Batteries weighing less than 125 pounds when wet and charged shall not be damaged when handled by means of a non-conducting lifting strap or sling which is temporarily attached to the battery terminals or battery case during handling. Bending of the terminals or other damage to the battery is not acceptable.

(2) At the manufacturer's discretion and in lieu of handling by means of a strap or sling attached to the battery terminals or battery case, handles or lifting eyes shall be provided. If handles are provided, they shall be either molded as an integral part of the battery case or constructed of non-conducting, sulfuric acid-resistant, synthetic cord, plastic, battery case material, or corrosion resistant metal that is permanently attached to the battery case. If handles are provided, each handle shall withstand, without failure or resulting damage to the battery, a force equivalent to 2 times the wet, charged weight of the battery. Corrosion resistant metal handles shall not contact battery terminals, terminal connections, or any other conductor part of the battery, in any position at any time.

(3) If lifting eyes are provided, they shall be an integral part of the battery case. Each lifting eye (considered separately) shall allow unrestricted access or removal of a 1-inch diameter rod and, but not concurrently, allow unrestricted access or removal of a hoist hook with a 1-inch throat opening. Each lifting eye shall withstand, without failure or resulting damage to the battery, a force equivalent to 2 times the wet, charged weight of the battery.

(4) Type I battery cells or cell packs weighing less than 125 pounds when wet and charged may, at the manufacturer's discretion when delivered under battery item level (c) or (d) (see 3.2.21), include a removable lifting sling with spreader in lieu of lifting eyes. The removable lifting sling with spreader shall withstand, without failure or resulting damage to the battery, a force equivalent to 3 times the wet, charged weight of

part of the battery case. Each lifting eye shall allow unrestricted access or removal of a 1-inch diameter rod and, but not concurrently, allow unrestricted access or removal of a hoist hook with a 1-inch throat opening. Each lifting eye shall withstand, without failure or resulting damage to the battery, a force equivalent to 2 times the wet, charged weight of the battery.

(2) Type I battery cells or cell packs weighing 125 pounds or greater when wet and charged may, at the manufacturer's discretion when delivered under battery item level (c) or (d) (see 3.2.21), include a removable lifting sling with spreader in lieu of lifting eyes. The removable lifting sling with spreader shall withstand, without failure or resulting damage to the battery, a force equivalent to 3 times the wet, charged weight of the cell or cell pack. Cell case configuration shall allow removal and installation of the lifting sling when the cell has been installed in the battery.

3.2.18 Mounting provisions. - If no battery mounting provisions are specified, either directly or indirectly through battery part number, figure, or other description, then the following requirements shall apply.

(a) Supporting surface. - Prismatic and cylindrical batteries shall be suitable for mounting in the upright position on a flat, level, supporting surface. Prismatic and cylindrical batteries shall be stable when resting in the normal, upright position on a flat, level, supporting surface.

(b) Top restraint. - Prismatic and cylindrical batteries shall be suitable for restraining in place by means of a bar, plate, or strap placed across the battery top surface; the bar, plate, or strap then being secured to the surface that supports the battery.

(c) Side restraint. - Prismatic and cylindrical batteries shall be suitable for restraining in place by means of a wall, strap or band surrounding the battery vertical wall (cylindrical battery) or walls (prismatic battery); the restraining wall, strap, or band being structurally secured with respect to the surface that supports the

their performance requirements when the group 1 maintenance operation is accomplished at intervals of 6 months and group 2 maintenance operations are accomplished at intervals of 1 year.

(2) Maintenance operations. - Class 1 batteries shall require no maintenance other than the following:

Group 1 maintenance operation, consisting of the addition of distilled water (when the battery temperature is above 34°F) to restore cell electrolyte level.

Group 2 maintenance operations, consisting of cell voltage measurement; cell electrolyte specific gravity measurement; equalize charging; cleaning of battery top surface (when the battery temperature is above 34°F) using clean wiping towels dampened with distilled water followed by wiping with clean, dry wiping towels; cleaning of terminals and application of corrosion preventative substance; and retorquing of the battery terminal connections.

(3) Maintenance provisions. - Class 1 batteries shall provide 1 opening in each cell for the addition of distilled water and for the direct observation and sampling of the cell electrolyte. The opening in each cell shall include observable indication for the full electrolyte level condition and for the low electrolyte level condition. The opening in each cell shall be closed by means of a removable and replaceable plug or cap of the screw, bayonet, gang, or friction-snap cover type. The plug or cap shall include provisions to reduce electrolyte splashing and spraying during removal of the plug or cap from the cell and replacement of the plug or cap. The plug or cap shall be manually removable and replaceable without using tools or other devices. The plug or cap shall not fall out when the battery is wet and inverted. The plug or cap shall be acid resistant, nonabsorbent, and have no deleterious effect on the battery. Removal and replacement of the plug or cap shall not damage the plug or cap or battery. At the

(1) Maintenance schedule. - Class 2 batteries shall meet their performance requirements when maintenance operations are accomplished at intervals of 1 year.

(2) Maintenance operations. - Class 2 batteries shall require no maintenance other than the addition of distilled water (when the battery temperature is above 34°F) to restore cell electrolyte levels.

(3) Maintenance provisions. - Class 2 batteries shall provide 1 opening in each cell for the addition of distilled water and for the direct observation and sampling of the cell electrolyte. The opening in each cell shall include observable indication for the full electrolyte level condition and for the low electrolyte level condition. The opening in each cell shall be closed by means of a removable and replaceable plug or cap of the screw, bayonet, gang, or friction-snap cover type. The plug or cap shall include provisions to impede electrolyte splashing and spraying during removal of the plug or cap from the cell and replacement of the plug or cap. The plug or cap shall be manually removable and replaceable without using tools or other devices, or, it shall be manually removable and replaceable using a blade-type screwdriver. The plug or cap of all cells within the battery shall each be removable and replaceable in the same manner. The plug or cap shall not fall out when the battery is wet and inverted. The plug or cap shall be acid resistant, nonabsorbent, and have no deleterious effect on the battery. Removal and replacement of the plug or cap shall not damage the plug or cap or battery. At the discretion of the manufacturer, all plugs or caps shall include the vent provisions required by 3.2.10.

(c) Class 3 (Sealed, No Maintenance) batteries. - Class 3 batteries shall require no maintenance to meet their performance requirements.

(d) Maintenance equipment measurement accuracies. - Maintenance equipment measurement accuracies acceptable for maintenance operations shall be:

DC Voltmeter: ± 1% of scale

Temperature: $\pm$ 2 F^{o} ($\pm$ 1.1 C^{o})

3.2.20 Interchangeability. - All new batteries from the same manufacturer and bearing the same part number shall be interchangeable in form, fit, and function, without adjustment. New cells of the same part number that are connected in series for delivery as a battery having provisions for individual cell voltage monitoring, or new cells of the same part number that are intended as replacements for series-connected cells shall be of similar characteristics such that, during battery life, the individual cell voltage will vary from the mean average value for all cells in the battery by not more than $\pm$0.05 volts during battery float charge.

3.2.21 Battery item level. - The battery item level shall be as specified . If the battery item level is not specified , then the battery item level shall be: (a) Single-cell battery if the voltage specified is 2 volts; or (b) Multi-cell battery if the voltage specified is a multiple (greater than 1) of 2 volts.

(a) Single-cell battery. - Batteries delivered under battery item level (a) Single-cell battery shall meet all applicable requirements of this specification.

(b) Multi-cell battery. - Batteries delivered under battery item level (b) Multi-cell battery shall meet all applicable requirements of this specification.

(c) Cells or cell packs to be assembled into a multi-cell battery after delivery. - Batteries delivered under battery item level (c) Cells or cell packs to be assembled into a multi-cell battery after delivery shall include all labor, hardware, materials, and equipment necessary to set up the battery for operation. The contractor shall assemble the battery and prepare it for operation in the FAA facilities as specified in the solicitation. The battery shall include flexible intercell connections and plastic covers for the battery cell terminals. The plastic covers shall be acid-resisting, rigid, self-supporting, run continuous through the length of the battery rack, and be manually removable and replaceable without the use of tools or other devices. The battery shall meet the requirements of

packs.

(d) Cells or cell packs for use as replacements or spares (reserves). - Cells or cell packs delivered under battery item level (d) Cells or cell packs for use as replacements or spares (reserves) shall meet all applicable requirements of this specification when individual cells or cell packs are tested as a battery.

3.2.22 Defects manifested during life. - Defective design, manufacture, or material that is manifested during life is unacceptable and will be cause for warranty action. Examples of defective design, manufacture, or material are the appearance during use in the intended application, in the environment of paragraph 3.3, for the lifetime of paragraph 3.2.6, of: case blisters, bulges, decomposition, cracking, breaking, flaking, peeling; seepage of electrolyte through the battery external surfaces; or loosening of permanently secured fasteners; or failure of bonds or seals. Acceptable aging deterioration shall be: abrasion; markings may fade but must remain legible; transparent cases may discolor, but must remain transparent.

3.3 ENVIRONMENTAL REQUIREMENTS. - The battery, when subjected to the environmental tests, shall not evidence any of the following: dimensional distortion beyond the battery dimensional limits specified, or cracking of cases of either cells or batteries; radical current or voltage fluctuations during any test; mechanical failure of any part; electrolyte see page, leakage, or spillage at any time during the tests; breakdown of insulation, stripping of plating from any component part, corrosion of metal parts, or loosening of protective coating from the battery; or deterioration of markings. If no environmental requirements are specified, then the battery (and electrolyte in separate container, if applicable) shall be acceptable when tested for the applicable environmental conditions of Table I (Next Page).

TEMPERATURE (AMBIENT AIR)	DRY,CHARGED BATTERY CONDITION -20oF (-28.9oC) THROUGH 122oF (50oC)	WET,CHARGED BATTERY CONDITION 5oF (-15oC) THROUGH 100oF (37.8oC)	-15oF (-26.1oC) THROUGH 122oF (50oC)	TYPES I, IV, V, AND VI 5oF (-15oC) THRU 122oF (50oC)	TYPE II & III -20oF (-28.9oC) THRU 122oF (50oC)
RELATIVE HUMIDITY (OF AMBIENT AIR)	5% THROUGH 95%		5% THROUGH 100% INCLUDING CONDENSATION DUE TO TEMPERATURE CHANGES	5% THROUGH 100% INCLUDING CONDENSATION DUE TO TEMPERATURE CHANGES	
ALTITUDE (AMBIENT AIR PRESSURE)	SEA LEVEL THROUGH 10,000 FEET (3,048 METERS)		SEA LEVEL THROUGH 15,000 FEET (4,572 METERS)	SEA LEVEL THROUGH 10,000 FEET (3048 METERS)	
VIBRATION	-------		RANDOM VIBRATION, POWER SPECTRAL DENSITY THROUGH 0.015 G2/HZ, 10HZ THROUGH 500HZ, 1 HOUR IN EACH AXIS OF 3 MUTUALLY PERPINDICULAR AXES APPLIED TO BATTERY MOUNTS	TYPE I, II, V, AND VI BATTERY ---------	TYPE III BATTERY 5G, 2HR 30-35HZ, APPLIED TO BATTERY MOUNTS / TYPE IV BATTERY 5G, 1/2 HR 30-35HZ, APPLIED TO BATTERY MOUNTS
SHOCK	-------		4-INCH TILT DROP TILT FROM NORMAL BOTTOM SURFACE NOT EXCEEDING 45o AND LESS THAN PERFECT BALANCE, 4 DROPS FROM EACH OF 4 BOTTOM EDGES OF BATTERY,NOT IN SHIPPING PACKAGE	TYPE I, II, III, IV, AND VI BATTERY --------	TYPE V BATTERY THREE SHOCKS IN EACH DIRECTION ALONG 3 MUTUALLY PERPENDICULAR AXES (18 SHOCKS) 40G PEAK, 11 MILLISECONDS, TERMINAL SAW-TOOTH,CROSSOVER AT 45 HZ, APPLIED TO BATTERY MOUNTS

3.4.2 Welding and brazing. - All welds and brazes shall be free of harmful defects such as cracks, porosity, undercuts, voids, and gaps. There shall be no burn-through. Fillets shall be uniform and smooth. Angular or thickness misalignment, warping, or dimensional change due to heat from the operation shall be within permitted tolerances. There shall be no damage to adjacent parts resulting from the welding or brazing.

3.4.3 External surfaces. - External parts and surfaces of the battery and racks shall be free of burrs, sharp edges, dents, cracks, blisters, pitting, scales, and corrosion.

3.4.4 Threaded parts or devices. - Threaded parts or devices shall show no evidence of cross threading, mutilation, or detrimental or hazardous burrs.

3.4.5 Riveting. - The riveting operation shall be carefully performed in order to assure that rivets are tight and satisfactorily headed with the rivet heads tightly seated against their bearing surface.

3.4.6 Assembly. - Assembly of the battery and racks and securing of parts shall be complete, except that the electrolyte shall not be installed in a battery that is to be shipped dry. Any battery having missing, inoperative, defective, bent, broken, or otherwise damaged parts will not be acceptable.

3.4.7 Cleaning. - External battery and rack surfaces shall be cleaned to remove contaminants such as oil, corrosion products, dust, and other foreign material. All corrosive material shall be removed from the external surfaces of the battery and racks. Internal battery parts and assemblies shall be free of: loose, spattered, weld or lead burning material; excess sealing material; metal chips; or any foreign material which might detract from the intended operation or function of the battery. Cleaning processes and materials shall have no deleterious effect on the battery, racks, or components.

3.5 SAFETY.

3.5.1 Mechanical Safety. - The battery shall withstand, without fragmenting, the maximum possible internal pressure buildup when over-charged at high rates in the environments specified in the

unprotected personnel to toxic substances, including carcinogens, mutagens, and teratogens in amounts greater than the threshold values listed in the Code of Federal Regulations (CFR), Title 29, Part 1910.

3.5.3 Flammability. - The battery when tested for flammability in the ambient environments specified in the solicitation or contract, or when not specified, in the environments of paragraph 3.3, shall not propagate flame at a rate greater than 1 inch per minute in any direction on a horizontal surface or in any horizontal direction on a vertical surface. The battery and racks shall evidence no violent burning or explosive fire. The racks, when tested for flammability, shall be self extinguishing within 15 seconds, without propagation of the flame or burning area.

3.6 A.C. SUPPLY LINE. - Not applicable

3.7 ELECTRICAL OVERLOAD PROTECTION. - The battery shall contain no protective devices or provisions intended to interrupt current or voltage during electrical overload, during discharge below 1.75 volts per cell, or during overcharge.

3.8 FINISHES.

3.8.1 Cell containers (Applicable to type I batteries). - All Type I battery cases and cell jars shall be transparent or translucent to permit viewing of the electrolyte level without any instruments or aids other than ambient light of illuminance as low as 325 lux.

3.8.2 Acid resistance. - All battery coatings or finishes shall be acid resistant when tested for acid resistance.

3.9 COOLING. - The battery shall be self cooled by natural draft convection in the environments specified , or, when not specified, in the environments of paragraph 3.3.

3.10 WIRE AND CABLE. - Not applicable

3.11 REFERENCE DESIGNATIONS. - Not Applicable

3.12 MARKINGS.

negative battery terminal shall be the source of electrons to the external load circuit during discharge of a charged battery.

3.12.2 Electrolyte levels.

(a) Style A, Class 1 and class 2 batteries: The full and low electrolyte levels shall be conspicuously and durably marked on all sides of Type I, Class 1 and Class 2, of style A batteries. All other types of style A batteries of class 1 and class 2 shall have a full level indicator in each cell; this indicator shall be functionally visible through the maintenance opening for each cell.

(b) Style A, class 3 batteries: No requirement.

(c) Style B, all classes: No requirement.

3.12.3 Electrolyte class (Applicable to dry, charged batteries). - If either class 2, class 3, or class 4 electrolyte conforming to the requirements of O-S-801 is to be used exclusively in activating the battery (see 3.2.12(b)), then the battery shall be conspicuously marked in the area of the cell maintenance openings to indicate the required class of electrolyte. Using Class 4 as an example, the following statement format is preferred, but not mandatory, for marking: "Activate using O-S-801, Class 4 Electrolyte". This marking shall not be damaged by the storage environments of 3.3. This marking shall be permanent, or, at the manufacturer's discretion, shall be manually removable (such as a marked or labeled sealing tape that is removed in preparation for activation) without tools, devices, or materials.

3.12.4 Precautionary labels. - Each battery shall have the following information legibly and permanently marked or labeled on the battery top or one or more sides.

(a) Electrolyte hazard label.

ACID - POISON

Can cause severe burns. Contains sulfuric acid. In case of contact, flush immediately and thoroughly with water. Obtain prompt medical attention when eyes are affected.

connections can cause sparks.

(c) Electric shock hazard label (applicable to batteries having 19 or more cells connected in series).

DANGER - ELECTRIC SHOCK

Touching Conductors can cause burns or death.

3.12.5 Additional markings. - At the manufacturer's discretion, additional markings may be included, provided that these additional markings convey information regarding item identification, storage, handling, performance, or operation; do not interfere with the required markings; and do not conflict with the requirements of this specification.

3.13 NAMEPLATE. - Each battery shall have the following information legibly and permanently marked on the battery cover or battery container (except the container bottom or terminals) or a nameplate having the required information legibly and permanently shall be permanently attached to the battery top or one side.

(a) Item descriptive nomenclature (Lead-Acid Storage Battery ((if item level a or b)), Lead-Acid Storage battery cell or cell pack (as applicable if item level c or d), type, class and style in accordance with FAA nomenclature in 1.2).

(b) Name or registered trade mark of the manufacturer

(c) Manufacturer's part number

(d) Plate grid alloy (Lead-antimony, lead-calcium, or Hybrid)

(e) Voltage under nominal load

(f) Ampere-hour capacity and hour rating or cold cranking current, rating temperature, and reserve capacity minutes.

(g) Wet, charged weight in pounds

(h) Fully charged electrolyte specific gravity (applicable to Class 1 and Class 2 batteries).

(h) Material Stock Number (if identified in the solicitation

3.14 MATERIALS AND PARTS. - The battery shall contain no critical or strategic parts, materials, or components. All parts, materials and components shall be compatible and designed for use in and with lead-sulfuric acid batteries.

3.15 FCC TYPE ACCEPTANCE. - Not applicable.

3.16 TEST POINTS, TEST FACILITIES AND TEST EQUIPMENT.- Not applicable.

3.17 BATTERY-ASSOCIATED ITEMS.

3.17.1 Stick-on number labels. - (Applicable to batteries delivered under battery item level (c) Cells and cell packs to be assembled into a battery after delivery). Cells and cell packs delivered for assembly into a battery shall include 1 set of stick-on number labels or decals that can be manually applied to the case of the cells or cell packs. The number set shall include all integers from 1 through the total number of cells included in the battery .

3.17.2 Battery racks. - When battery racks are specified in the solicitation, battery racks shall be delivered with the batteries. If seismic racks are specified, the seismic battery racks shall be designed for Uniform Building Code seismic zone 4. The battery racks shall be corrosion resistant and acid resistant or coated to resist corrosion and the effects of sulfuric acid. The rack structure parts that directly support the battery shall be nonconducting or electrically insulated with insulating material other than paint. The battery racks shall also comply with 3.4.2 through 3.4.7, 3.5.2, and 3.5.3 as applicable.

3.17.3 Manuals, Instructions, and data. - Information necessary to prepare, operate, and maintain the batteries and racks within the parameters and requirements specified in the solicitation and this specification shall be delivered with the batteries and racks unless otherwise specified. The manufacturer shall include battery performance data. Additionally, the manufacturer shall deliver with the batteries a parts, materials, and components list that describes and lists all substances, parts, materials, and components present in the delivered battery and racks.

4. QUALITY ASSURANCE PROVISIONS.

4.1 QUALITY CONTROL PROVISIONS. - The contractor shall provide and maintain a quality control program in accordance with FAA-STD-013 or other program as specified in the contract. All tests and inspection made by the contractor shall be subject to government inspection.

4.1.1 Responsibility for inspection. - Unless otherwise specified , the contractor is responsible for accomplishing all inspection requirements as specified herein.

4.1.2 Inspection facilities. - Except as otherwise specified in the contract, the contractor may use his own or any other facilities suitable for the performance of the tests and inspection requirements specified herein, unless disapproved by the Government.

4.1.3 Government testing. - The Government reserves the right to perform any or all of the test and inspections set forth in this specification when such inspections are deemed necessary to assure that delivered supplies and services conform to contract requirements. Any or all of these tests and inspections may be repeated at government expense at a government designated laboratory to determine acceptability of the delivered product.

4.2 CONTRACTOR'S DETAILED LIST OF TESTS. - The contractor shall prepare a list of the tests and inspections he proposes to conduct as a means of proving compliance with the performance requirements of this specification. The list shall identify all detailed tests and inspections to be performed and shall be submitted to the government for formal review and approval. All test procedures shall reference the specific specification paragraph number being demonstrated. In addition to the tests proposed by the contractor, his list shall include the tests of paragraph 4.3 unless they are specifically excluded in the contract schedule.

4.2.1 Submission of test Documentation. - Submission for approval of the test list, test procedures, and test data forms shall be as specified in FAA-STD-013 or the contract schedule.

work days before the contractor desires inspection to start.

4.2.3 Submission of Certified Test Data. - The contractor shall furnish to the Government Contracting Officer certified test data covering all the contractor's tests. This test data shall be documented on approved (see 4.2.1) test data forms. Submission of the test data shall occur within 15 calendar days after the completion of all tests or in accordance with the contract schedule.

4.3 CLASSIFICATION OF TESTS. - The inspections and tests set forth herein are classified as quality conformance inspections. The purpose of these inspections is to demonstrate product compliance with all specification requirements. The quality conformance inspections will be conducted in the sequence shown and on the test samples indicated in Table II, or as otherwise directed by the procuring activity. Test Samples shall be selected at random from production units. Test sample selection quantities shall be in accordance with Table III. Test samples selected for the contractor's testing in accordance with 4.2 shall not be counted as part of the deliverable quantity specified in the solicitation. If a test sample fails to pass quality conformance inspection, the test laboratory shall notify the contractor and procuring activity of such failure. The contractor shall take corrective action on the materials or processes, or both, as warranted, and on all units of product which can be corrected and which are considered subject to the same failure. Acceptance and shipment of the product shall be discontinued until corrective action, acceptable to the procuring activity, has been taken. After the corrective action has been taken, quality conformance inspection shall be repeated on additional sample units (all tests and examinations, or the test which the original sample failed, at the option of the procuring activity). Final acceptance and shipment shall be withheld until the quality conformance inspection has shown that the corrective action was successful. In the event of failure after reinspection, further rework and resubmission may or may not be allowed, at the option of the procuring activity.

Inspection or Test	Ref. Para.	Test Para.	Test Sample 1	2	3
Visual Inspections & Measurements:					
Preparation for Delivery	5.	4.3.2	X	X	X
Battery Condition	3.2.3	4.3.3	X	X	X
Dimensions	3.2.9	4.3.4	X	X	X
Weight	3.2.10	4.3.5	X	X	X
Terminal Configuration	3.2.11(a)	4.3.6	X	X	X
Terminal Location	3.2.11(b)	4.3.7	X	X	X
Mounting Provisions	3.2.18	4.3.8	X	X	
Item Level	3.2.21	4.3.9	X	X	X
Workmanship	3.4	4.3.10	X	X	X
Type I Cell Container Finish	3.8.1	4.3.11	X	X	
Markings	3.12	4.3.12	X	X	X
Nameplate	3.13	4.3.13	X	X	X
Material and Parts	3.14	4.3.14	X		
Battery-Associated Items	3.17	4.3.15	X		
Shipping and Handling Battery Environmental Conditions	3.3	4.12.3		X	
Storage of Dry, Charged Battery	3.2.4(b)(2)	4.3.16			X
Activation of Dry, Charged Battery	3.2.4(b)(3)	4.3.17	X	X	X
Battery Voltage	3.2.1	4.3.18	X	X	X
Charge Rates, Discharge Rates and Battery Capacity	3.2.2	4.3.19	X	X	X
Efficiency	3.2.4	4.3.20	X		
Float Charging	3.2.5	4.3.21		X	
Battery Life	3.2.6	4.3.22			X
Charge Retention	3.2.7	4.3.23	X		
Vents	3.2.10	4.3.24			X
Terminal Corrosion Protection	3.2.11(c)	4.3.25			X
Terminal Electrical Resistance	3.2.11(d)	4.3.26			X
Terminal Strength (Mechanical)	3.2.11(e)(1)	4.3.27			X

Terminal Strength (Electrical)	3.2.11(e)(2)	4.3.28			X
Terminal Clearances	3.2.11(f)	4.3.29			X
Electrolyte	3.2.12	4.3.30			X
Bulge Characteristics & Absorption	3.2.13	4.3.31			X
Impact Resistance	3.2.14	4.3.32			X
Electrolyte Retention	3.2.15	4.3.33		X	
Insulation Resistance	3.2.16	4.3.34		X	
Handling Provisions	3.2.17	4.3.35	X		
Maintainability	3.2.19	4.3.36	X	X	X
Interchangeability	3.2.20	4.3.37	X	X	X
Defects manifested	3.2.22	4.3.38	X	X	X
Environmental Test Procedures	3.3	4.12	X	X	
Safety	3.5	4.3.39	X		
Electrical Overload Protection	3.7	4.3.40	X	X	X
Acid Resistance of Finishes	3.8.2	4.3.41			X
Cooling	3.9	4.3.42	X	X	X
Battery Disassembly	3.18	4.3.43	X	X	X

TABLE III

TEST SAMPLE SELECTION QUANTITIES

CONTRACT QUANTITY	TEST SAMPLE 1	TEST SAMPLE 2	TEST SAMPLE 3
1-50	1	1	1
51-250	2	2	2
251-450	3	3	3
451 AND UP	AS SPECIFIED IN THE PROCUREMENT DOCUMENT		

4.3.1 Inspection Conditions. - Unless otherwise specified, all inspections and tests shall be accomplished in an indoor laboratory environment. Except where otherwise specified, ambient air temperature shall be 77°F (25°C) ± 5F° (2.8C°), ambient atmospheric pressure shall be local ambient, and ambient relative humidity shall not be outside the range of 5% through 95%. Ambient temperature shall be determined by measurements of the air temperature at several points surrounding, but not all above the test sample, and averaging the results. Charge and discharge

4.3.2 Inspection of preparations for delivery. - The delivery package shall be inspected to verify compliance with the contract and, as applicable, MIL-E-17555 (dry batteries and electrolyte) or the Code of Federal Regulations 46CFR, part 146, and 49CFR, Parts 171-178 (wet batteries). Failure of the delivery package to comply with the requirements shall be cause for rejection.

4.3.3 Inspection of battery condition. - The battery shall be unpackaged and inspected to determine if its condition is as specified in the contract, or, if not specified in the contract, if the battery is in the charged and wet condition. Failure to be in the correct condition shall be cause for rejection.

4.3.4 Inspection of battery dimensions. - The battery dimensions shall be determined and compared with the dimensions specified in the contract. If the battery dimensions are not as specified in the contract, it shall be cause for rejection.

4.3.5 Inspection of battery weight. - The wet, charged battery weight shall be determined. If the battery weight is not as specified in the contract, or in accordance with this specification (see 3.2.9) when the weight is not specified in the contract, it shall be cause for rejection.

4.3.6 Inspection of battery terminal configurations. - The battery terminal configurations shall be determined and compared with the terminal configurations specified in the contract. If the battery terminal configurations are not as specified in the contract, it shall be cause for rejection.

4.3.7 Inspection of battery terminal locations. - The battery terminal locations shall be determined. If the battery terminal locations are not specified in the contract, or in accordance with this specification (see 3.2.11(b)) when not specified in the contract, it shall be cause for rejection.

4.3.8 Inspection of battery mounting provisions. - The battery mounting provisions shall be determined. If the battery mounting provisions are not as specified in the contract, or in accordance with this specification (see 3.2.18) when not specified in the contract, it shall be cause for rejection.

4.3.9 Inspection of battery item level. - The battery item level shall be determined. If the item level is not as specified in

as applicable, shall be cause for rejection. Note: Inspection of certain aspects of workmanship, such as cleaning, may not be feasible until the battery has been disassembled.

4.3.11 Inspection of Type I battery cell container finish. - Type I battery cases and cell jars shall be inspected to determine if they are sufficiently transparent or translucent to permit viewing of the electrolyte level without any instruments or aids other than ambient light of illuminance of 325 lux. If the electrolyte level cannot be viewed in ambient light of illuminance of 325 lux without instruments or other aids, it shall be cause for rejection.

4.3.12 Inspection of markings. - The battery markings shall be determined. If the battery markings are not in accordance with 3.12.1 through 3.12.5, as applicable, it shall be cause for rejection. The battery markings shall be inspected for permanency and legibility during the duration of the quality conformance inspections. Failure to legibly retain the required markings throughout the quality conformance inspections (as applicable) shall be cause for rejection.

4.3.13 Inspection of nameplate. - The battery nameplate shall be inspected for content and legibility. The permanency of the markings and nameplate attachment (when a nameplate is utilized) shall be determined during the duration of quality conformance inspections. Failure to legibly retain the required information throughout the quality conformance inspections and tests shall be cause for rejection. Failure of the nameplate to remain attached to the battery throughout the quality conformance inspections and tests shall be cause for rejection.

4.3.14 Inspection of materials and parts. - The battery parts, materials and components shall be observed to the maximum extent practicable. The manufacturer's list of parts, materials, and components shall be reviewed. The determination that critical or strategic parts, materials, or components are contained by the battery, or the appearance of incompatibility or unsuitability for use in or with lead-acid batteries shall be cause for rejection. Note: Observation of internal parts, materials, and components may not be feasible until the battery has been disassembled.

4.3.15 Inspection of battery associated items. - Determine if the battery associated items of 3.17.1 through 3.17.3 as applica-

4.3.16 Battery storage test. - Within 60 days after delivery, the test sample battery (and electrolyte in separate container, if applicable) shall be placed in storage in the following controlled ambients in the sequence shown for the durations indicated (Note: The time to achieve a new sequential ambient shall not exceed 24 hours). See 4.12 for environmental test procedures. Note: at the option of the procuring activity, the storage test duration for a battery in the charged and dry condition shall be extended to total 1 year. The test sample battery shall not be in a shipping container.

(1) Duration of 48 hours at the minimum applicable storage temperature, humidity uncontrolled within the range of 5% through 95% and altitude within the range of sea level through 1,000 feet.

(2) Duration of 240 hours at the maximum applicable storage temperature, humidity uncontrolled within the range of 5% through 95%, and altitude at 10,000 feet.

(3) Remove the test sample from storage and visually inspect for damage, defects, and electrolyte outside its container. Observation of damage, defects, or electrolyte outside its container shall be cause for rejection. Note: A charged and wet storage battery must be placed on charge within 90 days after delivery.

4.3.17 Activation of charged and dry battery (Applicable to charged and dry batteries). - Prepare the charged and dry battery to receive electrolyte. If electrolyte was included in the contract, prepare the electrolyte container for activating the battery. If no electrolyte was included in the contract, determine if a particular class of electrolyte is necessary (see 3.2.12(b) and 3.12.3) and obtain the necessary class of electrolyte. If no particular class of electrolyte is necessary, utilize electrolyte conforming to the requirements of Federal Specification O-S-801, class 2, 3, or 4 as available. Add electrolyte to each cell of the battery, filling to the full level indication. If special tools or devices other than a blade-type screwdriver are necessary for activation, or if the battery is not suitable for manual preparation to receive electrolyte, it shall be cause for rejection. If the addition of electrolyte to each cell of the battery and replacement of the cell plugs or caps does not complete activation of the battery,

2.15 volts times the number of cells in the battery, it shall be cause for rejection.

4.3.19 Charge Rates, Discharge Rates, and Battery Capacity. - Connect the test sample battery to the charge-discharge test equipment. Apply to the battery a topping charge within the specified rates and voltages to ensure a fully charged battery condition. See paragraph 4.12 for environmental test procedures. The altitude (low ambient air pressure) shall be local laboratory ambient within the range of sea level through 10,000 feet. The humidity shall be uncontrolled within the range of 5% through 100%, including condensation due to temperature changes. If the battery capacity was specified (see paragraph 3.2.2) in terms of Cold Cranking amperes or minutes of reserve capacity, test the battery in accordance with SAE J 537, except that the test sample battery shall provide the capacity value specified in the contract. If the battery capacity was specified (see paragraph 3.2.2) in ampere-hours or discharge duration at a "C" rate or other rates, test the battery as follows. When the battery has been allowed to temperature stabilize for 24 hours in the maximum applicable ambient operating temperature specified in paragraph 3.3, discharge the battery at the specified (see paragraph 3.2.2) rate and voltages. Determine the battery capacity. If the battery capacity is not the value specified in the contract or greater value, it shall be cause for rejection. Recharge the battery at the rates and voltages specified in the contract. Repeat the topping charge, discharge, and recharge cycle when the battery has been allowed to stabilize for 24 hours in the minimum applicable ambient operating temperature specified in paragraph 3.3. Determine the battery capacity. If the battery capacity is not the value specified in the contract or greater value, it shall be cause for rejection. Recharge the battery at the rates and voltages specified in the contract. At the option of the procuring activity, this test may be repeated after completion of the electrolyte retention test with style A batteries tilted in any direction at an angle of 45 degrees from the normal upright position or style B batteries tilted at any angle in any direction or inverted.

4.3.20 Efficiency. - Stabilize the battery test sample for 24 hours in the minimum applicable ambient operating temperature specified in paragraph 3.3. See paragraph 4.12 for environmental test procedures. The humidity shall be uncontrolled within the range of 5% through 100%, including condensation due to

(except that discharging shall be terminated when the specified value of capacity has been discharged) and recharge at the specified (see paragrapg 3.2.2) rates and voltages while monitoring the ampere-hours of discharge and recharge. Determine the ratio (efficiency) of ampere-hours of discharge to the ampere-hours of recharge. If the ratio (efficiency) of ampere-hours of discharge to ampere-hours of recharge is less than 0.85, it shall be cause for rejection. Repeat the cycle using the maximum applicable ambient operating temperature specified in paragraph 3.3 and determine the efficiency. If the efficiency is less than 0.85, it shall be cause for rejection.

4.3.21 Float Charging. - See paragraph 4.12 for environmental test procedures. The humidity shall be uncontrolled within the range of 5% through 100%, including condensation due to temperature changes. The altitude (low ambient air pressure) shall be local laboratory ambient if within the range of sea level through 10,000 feet. Subject the test sample battery to continuous float charging for 30 days at the maximum applicable ambient operating temperature specified in paragraph 3.3. Then subject the battery to continuous float charging for 30 days at the minimum applicable ambient operating temperature specified in paragraph 3.3. Discharge the battery at the specified rate and voltages. Determine the battery capacity. If the battery capacity is not the value specified in the contract or greater value, it shall be cause for rejection. Recharge the battery.

4.3.22 Battery Life. - The test sample battery shall be tested for life capability in accordance with (as applicable) SAE J 240, NEMA IB3, NEMA IB5, other accelerated life test as approved by the procuring activity. Note: When Industry Standard tests are utilized, the required capacity shall be based on the capacity value specified in the contract (100%, not values such as 80% of rated capacity). At the option of the procuring activity, the test sample battery shall be tested in real time for battery life as follows: The wet, charged battery shall be discharge-recharge cycle tested at the rates and voltages specified in the solicitation. Altitude (low ambient air pressure) and relative humidity values shall be varied sequentially from 1 group of test cycles to the next group such that the maximum value, minimum value, and 5 values at uniform intervals between the maximum and minimum values specified in paragraph 3.3 are included in the test ambient conditions. Ambient air temperatures shall be varied sequentially from 1 group of test cycles to the next group such that the maximum value, minimum value, and (when the operating

temperature value. Discharge depths shall vary (when applicable) in sequence within each group of test cycles such that the maximum value, minimum value, and (when the group variation is greater than 10 percentage points and the number of cycles to be accomplished within the group is 5 or greater) 5 values at uniform intervals between the maximum and minimum values are tested. Discharge depths chosen shall be in accordance with paragraph 3.2.6(c). Discharge depth percentages calculated shall be based on the capacity value specified in the contract. Recharges shall be initiated as quickly as practicable, within the limits allowed by paragraph 3.2.6(c), however the maximum delays in accordance with paragraph 3.2.6(c) shall be included in the test parameters. The completion of recharge shall be based on the ampere-hours of recharge current and the battery charge efficiency specified in paragraph 3.2.4. All recharges except for type VI batteries shall be complete. The recharges for type VI batteries that are not complete shall vary sequentially such that 5 values at uniform intervals between the maximum value and minimum value of each range specified in paragraph 3.2.6(c) are tested. If the test sample does not provide the required capacity for the applicable years of use specified in paragraph 3.2.6(b), or if defects are manifested in accordance with paragraph 3.2.22, it shall be cause for rejection.

4.3.23 Charge retention. - See paragraph 4.12 for environmental test procedures. Stabilize the test sample battery for 24 hours in an ambient temperature of 77°F ± 3F°. Maintain the battery in an ambient temperature of 77°F ± 3F° for the duration of the charge retention test. Apply to the battery a topping charge to ensure a fully charged battery condition. Discharge the battery and determine battery capacity. Recharge the battery. Allow the battery to stand open circuit for 30 days. Discharge the battery and determine battery capacity. If the ratio of the battery capacity before open circuit stand to the battery capacity after open circuit stand is less than 0.75, it shall be cause for rejection. Recharge the battery. Discharge the battery and determine battery capacity. If the capacity is not the value specified in the solicitation, or greater value, it shall be cause for rejection. Recharge the battery.

4.3.24 Vents. - Observe the test sample battery during charging operations during the quality conformance inspections. Any evidence of internal pressure buildup (such as case swelling, blowout of seals, etc.), liquid electrolyte loss, or visually observable (with the unaided eye) aerosol electrolyte loss shall

externally incident flame fronts from entering battery internal parts are an applicable requirement, the (flame arresting) means shall be subjected to the test for arrester vents in accordance with NEMA IB7, or, at the option of the procuring activity, the entire battery with vents in place shall be subjected to externally incident flame fronts during high rate overcharge. If externally incident flame fronts pass through the flame arresting means, or a battery explosion or fire results, it shall be cause for rejection. Note: The flame arresting tests are very dangerous and precautions in accordance with local laboratory policy must be taken to safeguard personnel, equipment, and facilities from explosion hazards, fragmentation and burns (acid and heat). Note: Internal vents or valves may not be available for inspection until battery disassembly has been accomplished.

(b) Manifold connections. - When manifold connection provisions are specified in the solicitation, inspect the vent manifold connection provisions. If the vent manifold connection provisions are not as specified in the solicitation, it shall be cause for rejection.

4.3.25 Terminal Corrosion Protection. - Observe the test sample battery terminals during the quality conformance inspections. If terminal corrosion occurs, it shall be cause for rejection. Apply to each terminal several drops of electrolyte conforming to federal specification O-S-801, class 4 and allow to stand for 72 hours. If terminal corrosion occurs, it shall be cause for rejection. Apply to each terminal several drops of electrolyte conforming to Federal Specification O-S-801, class 2 and allow to stand for 72 hours. Inspect the terminals for corrosion. If terminal corrosion occurs, it shall be cause for rejection. Remove the electrolyte from the battery terminals by blotting or wiping with a clean, dry absorbent towel. Then clean the terminals with a clean wiping towel dampened with distilled water and wipe dry. If a non-toxic protective coating was supplied installed on the terminals, reapply the non-toxic protective coating.

4.3.26 Terminal Electrical Resistance. - During one cycle of battery charge and discharge at the maximum rates specified in the contract, the surface temperatures of the battery case sides, top, and terminals shall be monitored. If the temperature of either battery terminal increases to more than 30 fahrenheit degrees above the battery case temperature, it shall be cause for rejection. The voltage drop through each battery terminal at the

a suitable DC power supply shall be used to provide current through the terminals at the maximum discharge rate; this test shall be accomplished at the time the battery is disassembled.

4.3.27 Terminal Strength (Mechanical). - A force that is equivalent to the lessor value of the wet, charged battery weight or 50 pounds shall be applied first to the top of each battery terminal and then to one side of the battery terminal. Any cracking or breaking of the battery terminal or resulting damage to the battery case or terminal seal shall be cause for rejection. The battery and terminals shall be inspected for damage after making and removing terminal connections. Any damage to the battery or terminals resulting from the torque forces experienced during the making and removing of terminal connections shall be cause for rejection. Battery terminal hardware torque values necessary to make and remove battery terminal connections shall be determined. If the threaded terminal hardware torque values are not in accordance with SAE AS 1310-75, it shall be cause for rejection.

4.3.28 Terminal Strength (Electrical). - Each battery terminal shall be subjected for one minute to a current that is equivalent to 150 percent of the maximum charge rate or discharge rate (whichever value is the greater current). If either terminal shows melting, fusing, deformation, or permanent change in characteristics, it shall be cause for rejection.

4.3.29 Terminal Clearances. - During the quality conformance inspections and tests, the terminal clearances shall be observed. If the terminal clearances do not allow accomplishment of terminal connections, it shall be cause for rejection.

4.3.30 Electrolyte. - (Applicable to electrolyte delivered installed or in separate containers with the batteries.) Verify that the electrolyte is present as applicable (installed in wet batteries or in separate containers when specified for delivery with charged and dry batteries). If the electrolyte is not present as applicable, it shall be cause for rejection. Inspect the electrolyte. Determine if the electrolyte is a solution of 1.400 or less specific gravity (at 77°F) of sulfuric acid in water by review of the battery parts, materials, and components list or, at the option of the procuring activity, by chemical analysis of an electrolyte sample. If the electrolyte is not a solution of 1.400 or less specific gravity (at 77°F) of sulfuric acid in water, it shall be cause for rejection. If, after

if the container, in all positions, does not contain the electrolyte without loss, it shall be cause for rejection. If the electrolyte of Style B batteries is not constrained or immobilized within the battery cells, it shall be cause for rejection. Note: The electrolyte of class 3 batteries and style B batteries cannot be sampled until the accomplishment of battery disassembly.

4.3.31 Bulge Characteristics and Acid Absorption. - (Applicable to battery containers composed of hard rubber or plastic materials) This test shall be accomplished in accordance with ASTM D 639, Acid Resistance Test, except that an entire battery container shall be utilized as the test specimen, electrolyte conforming to the requirements of Federal Specification O-S-801, Class 2 shall be used for the sulfuric acid reagent, and the period of immersion shall be 7 days. If the container bulge characteristics and acid absorption exceed a change in any linear dimension of greater than 2.0% or a change in weight greater than 1.5%, it shall be cause for rejection. Note: The acid resistance test (see 4.3.41) may also be accomplished during this test.

4.3.32 Impact Resistance. - The test sample battery shall be tested for impact resistance in accordance with ASTM D 639, Impact Resistance-Container Specimen, except that the test sample shall be a complete, wet battery. The battery shall be tested for impact resistance when stabilized at the minimum operating temperature specified and again when stabilized at the maximum operating temperature specified. Provisions shall be included for the containment and neutralization of spilled electrolyte. And the report shall include only drop height, impact area location, test temperatures, and observations of damage. The ball weight shall be 2.0 $\pm$ 0.05 lb (0.91$\pm$0.02 kg). The drop height shall be determined by dividing the required value of pound-inches by 2 pounds. The area of impacts shall include the midpoint of each side (prismatic case) or the side wall (cylindrical case) and the midpoint of the battery top. Note: The impact area shall be relocated as necessary to prevent impact on the battery terminals or vent caps. One impact at each test temperature shall be applied to each impact area. Any observed blistering, cracking, or breaking or the battery case shall be cause for rejection. Note: Precautions in accordance with local laboratory policy shall be taken to protect personnel, equipment and facilities from exposure to battery electrolyte, battery case fragments, and battery short circuiting.

position. Style B batteries shall be tilted in various directions through 360 degrees (including the inverted position). Style A batteries shall be allowed to remain for one hour at an angle of 45 degrees from the normal upright position (any axis). Style B batteries shall be allowed to remain for one hour at an angle of 90 degrees from the normal upright position (any axis) and 1 hour in the inverted position. Leakage or spillage of electrolyte shall be cause for rejection. Note: Precautions in accordance with local laboratory policy should be taken to protect personnel, facilities, and equipment from exposure to electrolyte.

4.3.34 Insulation Resistance. - Connect a 500 volt D.C. power supply (D.C. current output capability not exceeding 0.05 amperes) to any area of the battery case and 1 battery terminal. Note for batteries with metal case: If the battery case is covered with insulating paint or other insulating material, remove the paint or insulating material from an area large enough to make probe contact before making connections. Energize the power supply and measure the applied voltage and current. Shut off the power supply and change the terminal connection to the other battery terminal. Energize the power supply and measure the applied voltage and current. Shut off the power supply and remove the connections to the battery. Using Ohms's law, calculate the insulation resistance for each battery terminal. If the insulation resistance from either battery terminal to the battery case is less than 1 megohm, clean the battery surfaces using clean wiping towels dampened with distilled water and then wipe the battery surfaces dry. Wait at least 15 minutes to permit evaporation of dampness before repeating the insulation resistance measurements and calculations. If the insulation resistance from either battery terminal to the battery case remains less than 1 megohm, it shall be cause for rejection. If insulating paint or other insulating material was removed from an area of a metal battery case, re-coat the area with an insulating, acid resistant, corrosion preventative substance.

4.3.35 Handling Provisions. - The battery handling provisions shall be inspected and tested. Determine by inspection if battery handling provisions that are in accordance with applicable requirements have been provided. Test each handling provision for capability at the required weight (multiple of wet, charged battery weight). If the battery handling provisions are not as specified in the contract, or in accordance with this specification (see paragraph 3.2.17) when not specified in the

specified). Records of maintenance performed shall be included with test data. The battery maintenance provisions shall be determined. If the maintenance provisions are not in accordance with this specification (see paragraph 3.2.19), it shall be cause for rejection. Note: If a style A, class 1 or class 2 battery is inverted when wet, in order to test cell (vent) plug or cap retention in the battery, any electrolyte lost through the cell vents shall be replaced; also precautions in accordance with local laboratory policy shall be taken to protect personnel, facilities, and equipment from contact with electrolyte. The manufacturer's recommendations for maintenance operations, schedules, and maintenance equipment measurement accuracies shall be determined by reviewing manufacturer's information delivered with the batteries. If the manufacturer's recommendations for maintenance operations, schedules, and maintenance equipment measurement accuracies are excessive when compared with the requirements of this specification, it shall, at the option of the procuring activity, be cause for rejection.

4.3.37 Interchangeability. - All test sample batteries from the same manufacturer that have the same part number shall be compared to determine interchangeability of form, fit, and function. If the compared test sample batteries are not interchangeable in form, fit, and function, without adjustment, it shall be cause for rejection.

4.3.38 Defects Manifested. - The battery condition shall be observed during the quality conformance inspections and tests. Observation of defective design, manufacture, or material shall be cause for rejection.

4.3.39 Safety.

(a) Mechanical safety. - The battery shall be subjected to overcharge for one hour at the maximum ambient operating temperature and monitored for indications of excessive internal pressure or fragmenting. If the battery fragments due to internal pressure buildup, it shall be cause for rejection. Note: This is a very dangerous test, especially for sealed (class 3) batteries. Precautions in accordance with local laboratory policy must be taken to safeguard personnel, equipment, and facilities from explosion hazards, fragmentation, and burns (acid and heat).

greater than the threshold limit values listed in the Code of Federal Regulations (CFR), Title 29, Part 1910, it shall be cause for rejection.

(c) Flamability. - The battery and racks shall be tested for flammability in accordance with MIL-STD-202, Method 111, Flammability (External Flame). The direction of the axis of the external flame shall be horizontal when applied to test sample vertical surfaces, and vertical when applied to test sample horizontal surfaces. The point of impingement of the applied flame shall be within any area of the battery or rack external surfaces. The external flame shall be applied for 15 seconds. The allowable time for burning of visible flame shall be 15 seconds on the rack and no time limit on the battery. Burning of the battery or racks shall be extinguished in accordance with local laboratory policy one minute after removal of the external flame. When all burning has been extinguished, the rate of flame spread shall be determined. If the battery rack is not self extinguishing within 15 seconds or if the flame or burning area propagates on the battery rack, it shall be cause for rejection. If the battery surfaces propagate flame at a rate greater than 1 inch per minute in any direction on horizontal surfaces or at a rate greater than 1 inch per minute in any horizontal direction on vertical surfaces, it shall be cause for rejection. If the battery or rack evidences violent burning or explosive fire, it shall be cause for rejection. Note: The flammability tests are very dangerous and precautions in accordance with local laboratory policy must be taken to safeguard personnel, equipment, and facilities from explosion hazards, fragmentation, and burns (acid and heat).

4.3.40 Electrical Overload Protection. - Battery performance and characteristics shall be observed during the quality conformance inspections and tests. If it is determined that the battery contains any protective devices or provisions intended to interrupt current or voltage, it shall be cause for rejection.

4.3.41 Acid Resistance of Finishes. - (Applicable to battery coatings or finishes) Note: this test may be accomplished in conjunction with the bulge characteristics and acid absorption test. This test shall be accomplished in accordance with ASTM D 639, Acid Resistance Test, except that an entire battery container shall be utilized as the test specimen, electrolyte conforming to the requirements of Federal Specification O-S-801,

characteristics (for example, becoming sticky or cracking), the coatings or finishes shall be considered as not acid resistant and it shall be cause for rejection.

4.3.42 Battery Cooling. - During the quality conformance inspections the battery shall not be provided with cooling other than the ambient environments specified. If battery damage is observed due to excessive internal temperature, it shall be cause for rejection.

4.3.43 Battery Disassembly. - The test sample battery shall, at the option of the procuring activity, be disassembled as necessary to complete the quality conformance inspections. Rejection criteria shall be as described in the applicable quality conformance inspections. Note: During disassembly, unprotected personnel may be exposed to hazardous conditions and toxic materials. Precautions shall be taken in accordance with local laboratory policy to protect personnel, facilities, and equipment from exposure to hazardous battery conditions and toxic battery materials. Exposure of hazardous conditions, toxic materials, or electrolyte during battery disassembly shall not be cause for rejection.

4.4 TEST EQUIPMENT.

4.4.1 Furnishing of test equipment. - The contractor shall supply all test equipment necessary for the tests required by this specification, unless otherwise specified in the contract. The contractor shall provide and maintain all measuring and test equipment in accordance with FAA-STD-013, unless otherwise specified in the contract, including equipment for on-site testing, if installation is a requirement of the contract.

4.4.2 Basic Instrument Accuracy. - Equipment having the following measurement accuracies, or better accuracies, shall be utilized for conducting the inspections and tests of the specification. Equipment for the measurement of quantities other than those specified below shall have actual calibrated accuracies greater by a factor of three (as a minimum) with reference to the tolerance specified for each quantity.

MEASUREMENT	ACCURACY
DC Voltage	± 0.5 percent of measured value

Electrical Resistance	± 2.0 percent of measured value
Elapsed Time	± 1.0 percent of measured value
Weight	± 2.0 percent of measured value
Linear Dimension	± 0.5 percent of measured value
Angular rotation	± 1°
Temperature	± 2 F^{o} (1.1 C^{o})
Relative Humidity	Within ± 5 percentage points of true relative humidity
Altitude (Ambient Air Pressure)	same as for pressure (gauge)
Pressure (Gauge)	± 5 percent of measured value
Torque (Wrench)	± 10 percent of measured value
Vibration Amplitude	
Sinusoidal	± 10 percent of measured value
Random	± 3 db or the maximum and minimum envelopes of the collapsed acceleration spectral densities, whichever is greater.
Vibration Frequency	± 2 percent of measured value or ± 1/2 Hz below 25 Hz
Shock (Analysis system)	± 5 percent of measured value
Acceleration	±10 percent of measured value
Specific Gravity	± 0.001 (1 point)

4.6 AVAILABILITY OF APPLICABLE DOCUMENTS. - A limited number of copies of this specification, FAA Advisory Circulars, and other applicable specifications, standards and drawings may be obtained from the Contracting Officer in the Federal Aviation Administration Office issuing the invitation for bids or request for proposals. Requests should fully identify material desired, i.e. specification, standard, amendment, and drawing numbers and dates. Requests should cite the invitation for bids, request for proposals, or the contract involved or other use to be made of the requested material.

4.7 INSPECTION OF DESIGN AND PRODUCTION STATUS. - Upon request from the Government, the contractor shall make available for review at his plant, at any stage of the contract, all information regarding the design and production status of the batteries and related items being manufactured under the contract. Such information shall be available at the plant regardless of point of manufacture of the individual components.

4.8 AC LINE FREQUENCY. - Not applicable.

4.9 BAROMETRIC PRESSURE. - See 4.12.

4.10 WIND AND ICE LOADING. - Not applicable.

4.11 AC LINE TRANSIENT. - Not applicable.

4.12 ENVIRONMENTAL TEST PROCEDURE. - Environmental test procedures are applicable during the following Quality Conformance Inspections:

Battery Storage test (4.3.16). Note: This test includes the storage environmental conditions and should not be repeated.

Charge rates, discharge rates, and battery capacity (4.3.19). Note: This test includes operating environment ambient conditions and should not be repeated.

Efficiency (4.3.20). Note: This test includes operating environment ambient conditions and should not be repeated.

Float Charging (4.3.21). Note: This test includes operating environment ambient conditions and should not be

Shipping and Handling Environmental Conditions Tests (4.12.3)

Operating Environmental Conditions Tests (4.12.4)

Detailed procedures (including procedures for interrupted tests) and test equipment requirements for environmental testing shall be in accordance with MIL-STD-810 (or SAE J 537, when applicable). It shall be cause for rejection if, during the environmental tests or post-test inspection, the battery evidences any dimensional distortion beyond the battery dimensional limits specified, or cracking of cases of either cells or batteries; radical current or voltage fluctuations during any test; mechanical failure of any part; electrolyte seepage, leakage or spillage at any time during the test; breakdown of insulation, stripping of plating from any component part, corrosion of metal parts, or loosening of protective coating from the battery; or deterioration of markings. Environmental tests shall be conducted in the sequence presented herein.

4.12.1 Ambient conditions Tests (General Discussion). - For tests involving controlled ambient temperature, ambient relative humidity, or altitude (ambient air pressure) at values other than local laboratory ambient, the test sample shall be placed in an appropriate environmental chamber. Power and test leads shall be connected as necessary to the test sample. The access openings to the environmental chamber shall be closed and the chamber controls shall be adjusted to provide the test ambient environment. Unless otherwise specified, the required ambient environment shall be achieved within 2 hours. The test sample shall be operated as specified in the applicable test. When testing has been completed, the environmental chamber controls shall be adjusted to provide the laboratory ambient conditions. Test sample operation shall be terminated. When the test sample temperature has returned to a level to permit safe handling and the controlled ambient humidity and altitude (ambient air pressure) have returned to laboratory ambient conditions, the environmental chamber door may be opened and test sample connections removed. The test sample may then be removed and inspected. Altitude (low ambient air pressure) testing shall be in accordance with MIL-STD-810, Method 500.2, procedure I (maximum altitude 15,000 feet) and procedure II (maximum altitude 10,000 feet). Procedure I shall be utilized during storage testing and during shipping and handling testing. High ambient air temperature testing shall be in accordance with MIL-STD-810, Method

with MIL-STD-810, Method 507.2, Procedure II. During relative humidity testing, no battery or electrolyte container seals shall be opened for test purposes and the battery shall not be in a shipping container.

4.12.2 Vibration and Shock Tests (General discussion). - Vibration test procedures shall subject the battery to mechanical vibration as specified in paragraph 3.3. Vibration tests require vibration test machines with battery mounting provisions (hard mounts) to generate and apply the vibration inputs specified in paragraph 3.3. Shock test procedures shall subject the test sample to mechanical shock as specified in paragraph 3.3. The type V battery operating shock test requires a shock test machine with battery mounting provisions (hard mounts) to generate and apply the shock input specified in Table I (see 3.3). The shipping and handling shock specified in Table I (see 3.3) for all batteries requires only an impact surface and means for battery positioning and release.

4.12.3 Shipping and handling environmental conditions tests. - The battery shall not be operating and shall not be in a shipping container during exposure to the shipping and handling environments. Rejection criteria shall be as specified in paragraph 4.12.

(a) Shipping and handling temperature and relative humidity. - The test sample battery (and electrolyte in separate container, if applicable) shall be subjected to high ambient air temperature testing in accordance with MIL-STD-810, Method 501.2, Procedure I. The battery (and electrolyte in separate container, if applicable) shall be tested for 48 hours at the maximum shipping and handling temperature condition specified in paragraph 3.3. The battery (and electrolyte in separate container, if applicable) shall then be subjected to low ambient air temperature testing in accordance with MIL-STD-810, Method 502.2, Procedure I. The battery (and electrolyte in separate container, if applicable) shall be tested for 48 hours at the minimum shipping and handling temperature condition specified in paragraph 3.3. The battery (and electrolyte in separate container, if applicable) shall be subjected to humidity testing in accordance with MIL-STD-810, Method 507.2, Procedure II. The battery (and electrolyte in separate container, if applicable) shall be

humidity may be combined if the test equipment provides the appropriate parameters and capability.

(b) Shipping and handling altitude. - The test sample battery (and electrolyte in separate container, if applicable) shall be subjected to altitude (low ambient air pressure) testing in accordance with MIL-STD-810, Method 500.2, Procedure I. The test sample battery (and electrolyte in separate container, if applicable) shall be tested for 24 hours at the maximum shipping and handling altitude condition specified in paragraph 3.3.

(c) Shipping and handling vibration. - The test sample battery shall be subjected to random vibration testing in accordance with MIL-STD-810, Method 514.3, Category 1 (Basic Transportation), Procedure 1. The battery shall be hard mounted in its normal upright position on the vibration test platform. The battery shall be vibrated for 1 hour in each axis of 3 mutually perpendicular axes. The vibration test levels applied to the battery mounts shall be in accordance with MIL-STD-810, figures 514.3-1 through 514.3-3, ranging from 10Hz through 500Hz and having power spectral densities through $0.015G^2/Hz$ as applicable.

(d) Shipping and handling shock. - The test sample battery shall be subjected to shipping and handling shock testing in accordance with MIL-STD-810, Method 516.3, Procedure VI. The battery shall be tilted from the normal upright position, the angle of tilt from the bench horizontal top surface to the battery bottom surface not exceeding 45 degrees, the lifted edge shall not be more than 4 inches above the bench horizontal top surface, and the lifted edge shall be below the point of perfect balance when dropped. The battery shall receive 4 drops from each edge tested. Each bottom edge of a battery with a rectangular bottom surface or the bottom edge at 90 degree intervals of a cylindrical battery shall be tested.

4.12.4 Operating environmental conditions tests(Vibration and shock, when applicable--see 3.3). - The battery shall not be operating during the vibration and shock, but must be operated to complete the tests. Rejection criteria shall be as specified in 4.12. See 4.12 for operating environmental ambient conditions tests.

test sample battery shall be operated after vibration testing. Discharge the battery at the specified rates and voltages to determine the battery capacity. If the battery capacity is not the value specified in the contract, or greater value, it shall be cause for rejection. Recharge the battery at the specified rates and voltages.

(b) Shock (Applicable to type V batteries). - The test sample battery shall be subjected to shock testing in accordance with MIL-STD-810, Method 516.3, Procedure I, Functional Shock, except that the battery shall not be operating during shock. The test sample battery shall be hard mounted to the shock test platform. The shock input shall be through the battery mounts. The shock input shall be in accordance with figure 516.3-4 of MIL-STD-810 (terminal sawtooth pulse, 11 milliseconds nominal duration, effective transient duration 6-9 milliseconds, 40g peak, crossover frequency 45Hz). The test sample battery shall receive 3 shocks in each direction along 3 mutually perpendicular axes. The test sample battery shall be operated after shock testing. Discharge the battery at the specified rates and voltages to determine the battery capacity. If the battery capacity is not the value specified in the contract, or greater value, it shall be cause for rejection. Recharge the battery at the specified rates and voltages.

5. PREPARATION FOR DELIVERY.

5.1 PREPARATION REQUIREMENTS FOR DRY CHARGED BATTERIES (ALL TYPES) AND ELECTROLYTE. - Preservation and packaging, packing, and marking shall be in accordance with MIL-E-17555.

5.2 PREPARATION REQUIREMENTS FOR WET, CHARGED BATTERIES (ALL TYPES). - Wet storage batteries shall be prepared for delivery in accordance with the requirements of the Code of Federal Regulations 46 CFR, Part 146, and 49 CFR, Parts 171-178.

6. NOTES.

6.1 NOTE ON INFORMATION ITEMS. - The contents of this Section 6 are only for the information of the initiator of the procurement

graphs is wholly at the contractor's own risk.

6.2 INTENDED USE. - The batteries specified herein are intended for use in or with FAA facilities and equipment primarily at airport traffic control towers, air route traffic control centers, and flight service stations to provide operating or emergency backup electrical power for maintaining services essential to the safety of aircraft departing from and arriving at airports and enroute.

6.3 ADDITIONAL DATA REQUIRED. - Procurement documents and requests should specify the following information to apply this specification in a solicitation.

(a) The number, date and title of this specification.

(b) The amendment number and date of the latest amendment to this specification, if any.

(c) Battery type, class, style, voltage (range or figure based on 2.00 volts per cell), capacity, discharge rates, charge rates, dimensions, weight, terminal configuration and location, handling provisions, mounting provisions and environmental requirements, National Stock Number (if assigned).

(d) If flame arresting vents are not required, and if vent manifold connection provisions are required. If manifold connection provisions are required, include a description of required vent manifold connection provisions.

(e) Wet or dry charged condition of the battery. For a dry charged battery, procurement documents should specify whether or not electrolyte is to be delivered (see 3.2.17)

(f) Battery item level (to be delivered as individual cells or cell packs or as completely assembled batteries) (see 3.2.21).

(g) Battery associated items (see 3.17).

(h) Inspection responsibility, if other than specified (see 4.1).

(i) Whether or not government quality conformance inspections

(k) Warranty.

(l) Specific application or use.

6.4 TAILORING THIS SPECIFICATION. - Tailoring the requirements and quality assurance provisions of this specification may be necessary for procurement of custom designed batteries or when FAA requirements are known to vary from those contained in this specification.

6.5 BATTERY SELECTION AND APPLICATION GUIDANCE. - Battery selection and application guidance is detailed in FAA Order 6980.24.

6.6 BATTERY MAINTENANCE GUIDANCE. - FAA practices for battery maintenance are detailed in FAA Order 6980.25.

6.7 FEATURES TO BE INCLUDED IN BIDS OR IN THE CONTRACT. - Additional features which may be included in bids consists of information concerning manufacturer's relevant battery performance data, a listing of previous customers which could be contacted by the FAA, recommendations with respect to the relevant battery application, and manufacturer's discretionary choices where permitted by this specification (such as electrolyte class or handling provisions).