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MILITARY SPECIFICATION

BATTERIES, STORAGE: LEAD-ACID

This specification is approved for use by all departments and agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers waterproof, lead-acid storage batteries, furnished in charged and dry or charged and wet condition, for starting, lighting and ignition service in military vehicles.

1.2 Classification. Storage batteries covered by this specification shall be of the following types, as specified (see 6.2 and 6.5).

SAE type designation	Voltage	Rated capacity at 20-hour rate Ampere - hours
2HN	12	45
6TN	12	100
4HN	24	21

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: US Army Tank-Automotive Command, ATTN: AMSTA-GDS, Warren, MI 48397-5000, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document, or by letter.

AMSC N/A FSC 6140

2. APPLICABLE DOCUMENTS

2.1 Issues of documents. The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

SPECIFICATIONS
FEDERAL

O-S-801	- Sulfuric Acid, Electrolyte; for Storage Batteries.

MILITARY

MIL-B-22191	- Barrier Material, Transparent, Flexible, Heat Sealable.

STANDARDS
FEDERAL

FED-STD-601	- Rubber: Sampling and Testing.

MILITARY

MIL-STD-105	- Sampling Procedures and Tables for Inspection by Attributes.
MIL-STD-129	- Marking for Shipment and Storage.
MS35000	- Battery, Storage, Lead-Acid, Waterproof.
MS75047	- Battery, Storage, Lead-Acid, Waterproof, 24 Volt.

2.1.2 Other Government documents, drawings, and publications. The following documents, drawings, and publications form a part of this specification to the extent specified herein.

DRAWINGS
ARMY

D7070340	- Vibrating Machine.

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

2.2 Other publications. The following document(s) form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

UNIFORM CLASSIFICATION COMMITTEE

Consolidated Freight Classification Ratings, Rules, and Regulations.

(Application for copies should be addressed to the Uniform Classification Committee, 222 South Riverside Plaza, Chicago, Illinois 60606.)

2.3 Order of precedence. In the event of a conflict between the text of this specification and the reference cited herein, the text of this specification shall take precedence.

3. REQUIREMENTS

3.1 First article. Sample batteries and parts shall be furnished for first article inspection and approval in accordance with table II prior to the production of batteries in quantity. The samples shall be representative of batteries and parts proposed to be furnished to the Government and shall be produced with the use of equipment and procedures that are normally used in production. All sample parts shall be marked properly with identifying information, including such data as separator type, make, and composition (see 4.6 and 6.3).

3.2 Materials. Materials shall be as specified herein and on applicable drawings or standards and shall be free of defects which would adversely affect performance (see 6.7).

3.2.1 Sealing compound. If required, the sealing compound shall provide an acid-tight joint between containers and cell covers and shall not shrink, crack, or separate from holding surfaces under any of the test conditions specified herein. The sealing compound or heat seal shall maintain an unbroken seal between the cover and the container after exposure to a temperature range of minus 65 to plus 190 degrees Fahrenheit (°F) [minus 54 to plus 88 degrees Celsius (°C)] as required in 3.5.5.

3.2.2 Electrolyte. The electrolyte, used in filling batteries procured in the charged and wet condition and for test purposes, shall confom to class 3 of O-S-801.

3.2.3 Active material. Active material reclaimed from plates of other batteries shall not be used.

3.3 Design and construction. Batteries shall be designed and constructed in accordance with MS35000 or MS75047 as specified.

3.3.1 Containers. Containers shall be molded to the dimensions specified on drawings MS35000 or MS75047, as applicable. The containers shall be free of leaks, cracks, or other defects that could adversely affect the performance of the battery. The container shall be made from nonabsorbent, acid-resistant hard rubber or other material meeting the physical requirements specified in 3.3.1.1.1 and 3.3.1.1.2.

3.3.1.1 Physical requirements.

3.3.1.1.1 Impact resistance. The battery case shall exhibit a minimum impact resistance of 16 inch-pounds [1.8 newton meters (N m)]. A minimum average impact resistance of 12 inch-pounds (1.3 N m) with no single value below 10 inch-pounds (1.1 N m) shall be exhibited for the 4HN battery.

3.3.1.1.2 Bulge resistance. When tested as specified in FED-STD-601, method 11321, no single bulge value shall exceed 1/16 inch [1.6 millimeters (mm)]. Bulge resistance for materials other than hard rubber not to exceed 1/4 inch (6.4 mm).

3.3.2 Covers. Covers shall meet the same physical and chemical requirements as the container material. Covers shall be of one-piece design and shall be sealed to the container. Sealing compound as specified in 3.2.1 may be used. Covers shall be properly seated and level before sealing.

3.3.2.1 Filler plug openings. The cell covers shall contain a threaded vent filler plug opening for each cell (see 3.3.5). The vent filler plug openings shall be designed to permit easy determination of the electrolyte level. Electrolyte level instructions shall be plainly marked either on the cell covers or on the vent filler plugs.

3.3.3 Terminal post seals. Post seals shall maintain an unbroken seal between the post and cover.

3.3.4 Cell seals. Cells shall be sealed air-tight and moisture-proof, and shall retain their seal and hold firmly in place until the seal is intentionally removed. Mylar tape, MIL-B-22191, type II, or other material which will retain a seal regardless of age or environmental conditions, as specified herein, shall be used. Dummy vent filler plugs may be used to form the required seal, provided the proper plugs are packaged with the battery. When stored and tested as specified in 4.10.19, the dry internal resistance of the battery shall be not less than 300,000 ohms and shall meet the filled discharge requirements of MS35000 or MS75047 as applicable.

3.3.5 Vent filler plugs. Nonabsorbent, acid-resistant, static-proof filler plugs shall be provided for each cell. The plugs shall have nominal 7/8-inch 9-UNC-2A threads (5/8-inch 11-UNC threads for the 4HN) for mating with the threaded openings in the cover. The vent filler plugs shall be of the submersible type, shall incorporate a vent with a check valve to permit the escape of gases from the battery, and shall be dual colored (red top and natural body without pigment). The check valves shall not leak more than 2 drops of water in 10 seconds when under a four foot head of water and shall be designed to open before internal pressure reaches 0.5 pound per square inch (psi) [3.45 kilopascals (kPa)] in excess of the external pressure. The plugs shall withstand temperatures from minus 65 to plus 250°F (-54 to 121.2°C) without cracking, melting, or other damage.

3.3.6 Handles. Handles shall be rope-type plastic of the developed length specified on the applicable MS drawing. Handles shall withstand the effects of electrolyte conforming to class 3 of O-S-801 (see 3.2.2). Each handle shall be attached to the battery case in such a manner as to withstand, without damage, a force equal to twice the filled weight of the battery, but not to exceed 200 pounds [890 newtons (N)], at temperatures of 190 ± 2°F (88 ± 1°C), minus 65 ± 2°F (-54 ± 1°C) and 80 ± 10°F (26.7 ± 6°C).

3.3.6.1 Optional handles. Optional handles shall be steel coated with lead or otherwise treated to resist acid. Screw holes shall not penetrate into the nominal thickness of the container walls. The handles shall fit freely in their retainers, and the steel retainer plates and battery container shall be designed so that the battery weight during lifting is supported independently of the screws. Handles and other metal parts shall evidence no corrosion affecting the function of the handles.

3.3.7 Grids and plates. Grids shall have not more than three bars cracked, broken, or missing (none adjacent). Grids shall have no outside (framing) bars cracked, broken, or missing. Plates shall be of the pasted type. After pasting of active material, no plate shall evidence more than three through-holes in the active material. Plates shall have no open window. 1/

3.3.8 Plate connections and intercell connectors. Plates of like polarity in each cell shall be integrally burned-on, welded, or cast-on to a connecting strap. Each strap shall be the pillar post type and of such size and strength as to provide both electrical conduction and support for each group of like polarity plates. Plate-connecting straps and intercell connectors shall be of lead alloy. The intercell connectors shall not be exposed. The intercell connectors shall be integrally burned-on, welded or cast-on, located so as not to obstruct the filling apertures.

3.3.9 Separators and protectors. At the time of assembly of the plate groups (elements), the separators shall have dimensions as follows:

a. Width of plates, plus minimum of 1/8 inch (3.2 mm).
b. Height of plates, plus minimum of 3/32 inch (2.9 mm).

Each cell shall be provided with a perforated acid-resisting protector placed directly on top of the assembled plate groups to prevent damage to the separators while water is being added to the battery. Envelope separators may be used. If envelope separators are used, the protector is not required.

3.3.10 Terminal posts. Terminal posts shall be of a design and location specified on the applicable military standard. The positive terminal post location shall be identified by a "+", a "POS", or a "P" on the battery cover. The negative terminal post location shall be identified by a "-", a "NEG" or, a "N" on the battery cover.

3.3.10.1 Terminal post torque resistance. The terminal posts shall withstand a torque of 250 pound-inches (28.2 N·m) except for 125 pound-inches (14.1 N·m) for the 4HN without damage or distortion to the battery.

1/ Open window is void waffle section.

3.4 Battery conditions. Batteries shall be furnished in one of the following conditions, as specified (see 6.2):

a. Charged and dry.
b. Charged and wet.

3.4.1 Charged and dry moisture content. Batteries furnished in the charged and dry condition shall contain dry plates and separators. The moisture content of the separators shall not exceed 1.7 percent. The moisture content of envelope separators (if used) shall not exceed 3.0 percent. The moisture content of the plates shall not exceed 0.2 percent. No electrolyte shall be furnished.

3.4.1.1 Dry cell internal resistance. The internal resistance of each cell, measured after assembly in the container with the top off, shall be not less than 50,000 ohms. The terminal to terminal resistance (positive terminal to negative terminal) of the completed battery shall be not less than 300,000 ohms.

3.4.2 Charged and wet. Batteries furnished in the charged and wet condition shall be filled with electrolyte as specified in 3.2.2 and shall be fully charged when shipped. When fully charged, the specific gravity of the electrolyte shall be 1.280 $\pm$ .010, corrected to electrolyte temperature of 80°F (26.7°C) and the open-circuit, terminal-to-terminal voltage shall be not less than 2 volts per cell corrected to 80°F (26.7°C).

3.5 Performance.

3.5.1 General. The electrical performance of each battery shall be in accordance with the values specified on the applicable military standard.

3.5.2 Capacities.

3.5.2.1 Filled discharge capacity (without supplementary charge) (80°F) (26.7°C). All charged and dry batteries, when tested to determine their filled discharge capacities, shall yield the filled discharge specified current for not less than the period of time specified on MS35000 (2HN, 6TN) or 5.5 minutes for the 4HN.

3.5.2.2 Full charge capacity (80°F) (26.7°C). When tested for full charge capacity as specified in 4.10.10, each battery shall yield a capacity (ampere-hours) of not less than that specified on MS35000 (2HN, 6TN) or 21 ampere-hours for the 4HN.

3.5.2.3 Reserve capacity (80°F) (26.7°C). When tested for reserve capacity as specified in 4.10.11, the time of discharge shall be 75 minutes for the 2HN battery, 180 minutes for the 6TN battery, and 28 minutes for the 4HN battery.

3.5.2.4 Low temperature capacity (-40°F) (-40°C). When tested as specified in 4.10.12, batteries shall maintain their terminal voltage above 1 volt per cell for not less than the time specified on MS35000 (2HN, 6TN) or 1.75 minutes for 4HN, except 5-second voltages do not apply.

3.5.3 Retention of charge. When tested for retention of charge, batteries shall yield capacities not less than those specified on MS35000 or MS75047 as applicable.

3.5.4 Electrolyte retention. Batteries shall evidence no leakage or spillage when tilted through an angle of 45 degrees from the normal plane of either major/minor axis.

3.5.5 Thermal shock resistance. Batteries shall show no cracking of containers, covers, sealer, filler plugs, or other damage due to temperature change between plus 190°F (88°C) and minus 65°F (-54°C) and not more than 0.10 psi pressure drop in 60 seconds in any peripheral sealing area, at the terminal post area, or between intercells at 80°F (26.7°C). Pressure drop of 0.30 psi in 30 seconds shall be allowed between intercells at minus 65°F (-54°C) and at plus 190°F (88°C).

3.5.5.1 Thermal shock resistance (production). Batteries shall show no cracking of containers, covers, sealer, filler plugs, or other damage due to temperature change between 190°F (88°C) and minus 65°F (minus 54°C) and no more than 0.10 psi pressure drop in 30 seconds when measured at 80°F (26.7°C).

3.5.6 Vibration resistance. Batteries shall maintain a steady voltage and current with no loosening of terminal posts in the cover; flooding of electrolyte at the top; inter-cell leakage; excessive sediment; broken connections, straps or plates; broken or defective separators; or other damage while being subjected to vibration through an amplitude of 0.045 to 0.050 inches (1.1 to 1.3 mm) [0.090 to 0.100 inch (2.3 to 2.5 mm) total excursion] at a frequency of 2000 to 2100 cycles per minute. Vibration shall not decrease the reserve capacity of batteries by more than 5 percent of the values specified in MS35000, MS75047, or this specification as applicable.

3.5.6.1 Vibration resistance (production). Vibration shall not decrease the reserve capacity of the battery to less than 95 percent of the values specified in MS35000 or MS75047, as applicable.

3.5.7 Life cycle capacity performance. Batteries shall complete life cycle performance as specified on MS35000 or MS75047 as applicable.

3.5.8 Overcharge cycle performance. Batteries shall complete overcharge cycles as specified on MS35000 or MS75047 as applicable.

3.5.9 Storage life performance. Charged and dry batteries shall be subjected to the storage life performance test in accordance with 4.10.19.1. At completion of the storage life period, batteries shall yield rated filled discharge capacities as specified on MS35000 or MS75047 as applicable.

3.6 Identification marking. Marking data shall be applied to a permanent, electrolyte-resistant type label or nameplate, or may be molded on the battery container. Labels and nameplates shall be securely and permanently attached to the side of the battery.

3.6.1 Identification data. Identification marking shall show the following:

a. Battery identification (storage, lead-acid, 6TN, 2HN or 4HN).
b. Type designation.
c. MS part number.
d. Voltage.
e. Ampere-hour capacity at 20-hour rate.
f. High discharge capacity and rate at minus 40°F (-40° C).
g. Contract or order number.
h. Date of manufacture (month and year) and lot number.
i. Manufacturer's name followed by letters "US".

3.7 Instruction tags and label. Instruction tags and label which provide complete information for placing battery in service, operating, and charging shall be attached in a conspicuous place on each battery. A permanent label with removable tabs for identifying the "in-service" date (month and year) shall be provided on the battery top, to remain in full view after installation. A "Corrosive-Sulfuric Acid" hazard label shall be permanently attached to the top of each battery. Hazard label shall comply with the Department of Transportation Regulations.

3.7.1 Instructions (charged and dry). Instructions for charged and dry batteries shall contain the following information:

a. Identify the "in-service" date by removing the proper tabs from the permanent label.
b. Remove and destroy the sealing devices which hermetically seal the cells during shipment and storage.

CAUTION: Do not remove the sealing devices until ready to fill the battery.

c. Fill each cell with electrolyte (sulfuric acid and water solution) of 1.280 $\pm$ .005 specific gravity at 80°F (26.7°C) to designated level. Temperature of the battery and the electrolyte must be above 60°F (15.6°C), but preferably not above 100°F (37.8°C).
d. Allow the battery to stand for 30 minutes after filling, then check electrolyte specific gravity of each cell correcting the readings to 80°F (26.7°C). Add electrolyte if necessary to bring the electrolyte up to the designated level.
e. The battery should be charged fully before it is put into service.
f. The battery should be charged constant current at the 20-hour rate until specific gravity becomes constant for three consecutive 30-minute readings. Constant potential may be used if battery electrolyte temperature is maintained below 120°F (48.9°C) by interrupted charging, or by lowering the charging voltage, and the final charging current is equal to

the 20-hour rate. If the specific gravity of battery, temperature corrected, exceeds 1,290, it should be adjusted to 1.280 ± 0.010. After a short period of service (10 to 14 days) the specific gravity should be checked, and if the battery is less than 3/4 charged, it should be charged as in instructions above.

g. Check the elctrolyte levels frequently. Add distilled or drinking water as required to maintain the proper level. Add the water only while the battery is being charged.
h. Keep the top and sides of the battery clean and dry. Make sure the vent filler plugs are clean. When cleaning is required, wash with water.
i. Battery should be charged once a month and kept in cool, dry storage when not in use.
j. Electrolyte volume _____.
k. Charging rate _____.

3.7.2 Instructions (charged and wet). Instructions for charged and wet batteries shall contain the following information:

NOTE: This is a CHARGED and WET storage battery. It was activated at time of manufacture and charged to full rated capacity.

a. Identify the "in-service" date by removing the proper tabs from the permanent label.
b. Check the electrolyte specific gravity and levels in all cells, and adjust to the proper levels by adding distilled water as required. Then charge at the 20-hour rate until the specific gravity of the electrolyte remains constant for three consecutive readings taken at 30-minute intervals.
c. The battery is now ready for use.
d. Constant current charging should always be used, if available. Constant potential charging may be used if the battery electrolyte temperature is not allowed to rise above 120°F (48.9°C) by charging interruptions.
e. Check the electrolyte levels frequently. Add distilled water as required to maintain proper level. Add the water only while the battery is being charged.
f. Keep the top and sides of the battery clean and dry. Make sure the vent filler plugs are clean. When cleaning is required, wash with water.
g. When not in use, battery should be charged once a month and kept in cool, dry storage.
h. Charging rate _____.

3.8 Workmanship. Batteries shall be processed in such a manner as to be uniform in quality and free of defects that will affect their life, serviceability, or appearance. Containers, covers, and vent filler plugs shall be free of cracks, leaks, and broken parts. Lead-burning shall be homogeneous and free from blow-holes or imperfect bonds between parts which have been burned together. Marking shall be clear and distinct. The sealing compound shall not be cracked or separated from the holding surfaces.

4. QUALITY ASSURANCE PROVISIONS

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

4.2 Inspection of materials and components. All materials and battery components shall be inspected and tested by the contractor, before being assembled into batteries, to the extent necessary to insure that materials and components comply with this specification.

4.2.1 Contractor's inspection records. Contractor's inspection records shall be examined to determine conformance to 3.2, 3.2.1, 3.2.2 and 3.2.3.

4.3 Inspection conditions and equipment.

4.3.1 Standard test condition. Unless otherwise specified herein, all measurement and tests shall be made at a temperature betwen 68° and 95°F (20° and 35°C), and at ambient atmospheric pressure and relative humidity.

4.3.1.1 Temperature of electrolyte. Unless otherwise specified herein, the temperature of the electrolyte at the beginning of the tests shall be within ± 2°F (± 1°C) of the test temperature.

4.3.2 Test equipment. Test equipment shall be of sufficient accuracy and quality to permit performance of the required tests. The contractor shall establish adequate calibration of test equipment to the satisfaction of the Government.

4.3.2.1 Instrument accuracy.

4.3.2.1.1 Test instruments. All instruments, such as pressure gages, voltmeters and ammeters used in testing batteries, shall be accurate within ± 0.5 percent of full scale value. The sensitivity of voltmeters shall be at least 20,000 ohms per volt. The voltmeter and ammeter ranges used shall be such that all readings are taken on the upper half of the scale.

4.3.2.1.2 Hydrometer. The hydrometer shall provide a float accuracy of plus or minus 3 points (.003) specific gravity throughout the specific gravity scale and temperature range.

4.4 Discharging and charging of the batteries.

4.4.1 Discharging. The battery shall be discharged continuously at the 20-hour rate (that current in amperes equal to 1/20 of the battery's rated ampere hour capacity) to a final average terminal voltage equivalent to 1.75 volts per cell unless otherwise specified herein (see 3.5.1).

4.4.2 Charging. Batteries shall be charged at the rate specified on the applicable military standard until three consecutive voltage and specific gravity readings taken at 30-40 minute intervals remain constant. The temperature of the electrolyte during the charging period shall not be allowed to exceed 120°F (48.9°C).

4.4.3 Periodic charging. If the test on any activated battery is temporarily stopped for a period of 48 hours, the battery shall be given a freshening charge at the specified rate until fully charged (see 4.4.2) before testing is resumed. A battery shall never be stored for more than 24 hours after a discharge without being recharged.

4.5 Classification of inspection. Inspections specified herein are classified as follows:

a. First article inspection (see 4.6).
b. In-process inspection (see 4.7).
c. Quality conformance inspection (see 4.8).
d. Special sampling inspection (see 4.9).
e. Inspection Packaging (see 4.10.20).

4.6 First article inspection. First article inspection shall be conducted at a place designated by, or approved by, the Government. First article inspection shall consist of examination for defects listed in table III and tests listed in table II.

TABLE I. First article samples.

Sample description	Quantity required
Batteries, complete	9 each
Container	2 each
Cell covers	3 each
Vent filler plugs	1 set (6 each)

4.6.1 Test failure. Failure of a first article sample to conform to any of the requirements specified, or any deficiency of a workmanship or material nature found as a result of the test, shall be cause for rejection. Further testing shall not be conducted until evidence has been provided by the contractor that corrective action has been taken to eliminate the deficiency.

TABLE II. Order of first article inspection.

Description	Sample 1/ number	Requirement	Test
Impact resistance	CT1	3.3.1.1.1	4.10.1
Bulge resistance	CT2	3.3.1.1.2	4.10.2
Cell covers	CV1-3	3.3.2	4.10.3
Vent filler plugs	V1	3.3.5	4.10.4
Handles	B1	3.3.6	4.10.5
Terminal post torque resistance	B9	3.3.10.1	4.10.6
Dry internal resistance	B9	3.4.1.1	4.10.19.1.a
Filled discharge capacity	B2-6	3.5.2.1	4.10.9
Full charge capacity	B2-6	3.5.2.2	4.10.10
Reserve capacity	B2-6	3.5.2.3	4.10.11
Low temperature capacity	B2-6	3.5.2.4	4.10.12
Retention of charge	B2 & 3	3.5.3	4.10.13
Electrolyte retention	B2 & 3	3.5.4	4.10.14
Thermal shock	B2 & 3	3.5.5	4.10.15
Vibration	B2 & 3	3.5.6	4.10.16
Life cycle capacity	B4 & 5	3.5.7	4.10.17
Overcharge cycle	B6 & 7	3.5.8	4.10.18
Storage life	B8 & 9	3.5.9	4.10.19

1/ B = Battery sample
CT = Container sample
CV = Cover sample
V = Vent plug sample set (6)

NOTE: 4HN batteries are not to be tested to 4.10.1 & 4.10.19

4.7 In-process inspection. Before and during assembly, as applicable, grids and plates, plate connections and internal connectors, separators and protectors and completed assembly shall be examined and measured to determine conformance to 3.3.7, 3.3.8, 3.3.9 and 3.4.1.1.

4.8 Quality conformance inspection.

4.8.1 Sampling.

4.8.1.1 Lot formation. An inspection lot shall consist of completed batteries of any one type and condition (see 3.4) from an identifiable production period offered for delivery at one time. Molded or epoxied components and seals shall be fully cured prior to submission of the lot.

4.8.1.2 Samples. A sample unit shall consist of a fully completed battery.

4.8.1.3 Sampling for examination. Samples selected for quality conformance examination (see 4.8.2) shall be in accordance with level S4, AQL 2.5 for major defects and AQL 4.0 for minor defects, MIL-STD-105.

4.8.1.4 Sampling for testing. Batteries that have satisfactorily passed examinations specified in 4.8.1.3 shall then be subjected to quality conformance testing.

4.8.2 Quality conformance examination. Samples selected in accordance with 4.8.1.3 shall be examined to determine conformance to classification defects for batteries, table III.

TABLE III. Classification of defects.

Categories	Defects	Requirement	Test Method
Critical	None		
Major	AQL 2.5 percent defective		
101	Dimensions out of tolerance	3.3.1	Scale
102	Vent openings not as specified	3.3.2.1	Visual
103	Electrolyte level instructions not as specified	3.3.2.1	Visual
104	Vent filler plugs not as specified	3.3.5	Visual
105	Dimensions of terminal posts not as specified	3.3.10	Scale
106	Terminal markings not as specified	3.3.10	Visual
107	Low electrolyte level	3.4.2	Visual
108	Missing or improper instructions	3.7	Visual
109	Workmanship defects	3.8	Visual
110	Cover not properly sealed to container	3.2.1	Visual
111	Leaks or cracks in container	3.3.1	4.8.3
112	Post seals not as specified	3.3.3	Visual
113	Location or polarity of terminal posts not as specified	3.3.10	Visual/ voltmeter
114	Open circuit to terminal voltage less than 2 VDC per cell	3.4.2	Voltmeter
115	Specific gravity of electrolyte out of limits.	3.4.2	Hydrometer
Minor	AQL 4.0 percent defective		
201	Handles not as specified	3.3.6	Visual
202	Improper marking	3.6	Visual

4.8.2.1 Failure. Failure of the test samples to meet the specified AQL's shall be cause for rejection of the lots represented by the samples.

4.8.3 Pressure test. Each cell of samples selected for testing shall be subjected to 0.5 psi (3.45 kPa) using dry nitrogen gas for a period of 30 seconds. A drop in pressure of 0.10 psi (0.69 kPa) in any cell shall be considered a failure of the sample battery.

4.9 Special sampling inspection. Samples shall be selected at the rate of two fully completed batteries per each production week. One battery shall be tested as shown in table IV for group A and the other to the group B tests. Samples shall be examined for the defects specified in 4.8.2.

TABLE IV. Special sampling inspection.

Description	Requirement	Test
I. Group A Tests		
A. Handles	3.3.6	4.10.5.1
B. Terminal post torque resistance	3.3.10.1	4.10.6
C. Filled discharge capacity	3.5.2.1	4.10.9
D. Reserve capacity	3.5.2.3	4.10.11
E. Thermal shock	3.5.5.1	4.10.15
II. Group B Tests		
A. Filled discharge capacity	3.5.2.1	4.10.9
B. Reserve capacity	3.5.2.3	4.10.11
C. Low temperature capacity	3.5.2.4	4.10.12
D. Vibration	3.5.6.1	4.10.16

4.9.1 Failure. Failure of a sample to pass any of the tests outlined under table IV - Special sampling inspection, shall be cause for rejection by the Government of the lot or lots represented by those samples.

4.10 Methods of inspection.

4.10.1 Impact resistance test. An undamaged specimen container shall be permitted to rest not less than 24 hours after manufacture. Before testing, the sample shall be conditioned for one hour at 80 $\pm$ 2°F (26.7 $\pm$ 1°C) in a water bath. The test shall be conducted in an 80 $\pm$ 2°F (26.7 $\pm$ 1°C) atmosphere. Impact resistance shall be determined by 2 $\pm$ 0.05 pound (0.91 $\pm$ 0.02 kilogram) solid steel ball used as a free falling weight. When testing, the height of drop necessary to crack the container on the inside opposite the point of impact is the impact value for that selection. The height shall be found by dropping the weight at one inch (25.4 mm) intervals starting at seven inches (178 mm). The weight shall hit the container only once for each drop. During the test, the container shall be positioned on a flat steel plate, about an inch longer and wider than the container. The container shall be positioned on the flat steel plate at the approximate vertical centerline, on two opposite sides of the container. The resistance of the container shall be calculated to determine conformance to 3.3.1.1.1.

4.10.2 Bulge resistance. The bulge resistance of battery container shall be determined by method 11321 of FED-STD-601. Only one sample shall be tested. The bulges in the container shall be measured to determine conformance to 3.3.1.1.2.

4.10.3 Cover physical and chemical characteristics test. Covers shall be tested as specified in 4.10.1 through 4.10.3 and 4.10.5, with appropriate modifications in equipment, samples and procedures to accommodate different characteristics of covers. Results shall be evaluated as specified in referenced paragraphs to determine conformance to 3.3.2.

4.10.4 Vent filler plug thermal and pressure resistance test. To determine conformance to 3.3.5, each vent filler plug from the battery under test shall be placed in an ambient air temperature of minus 65 ± 2°F (-54 ± 1°C) for 2 hours. At the end of the cooling period, the plugs shall be removed and immediately placed in an oven at an ambient air temperature of plus 250 ± 5°F (121.2 ± 3°C) for 90 minutes. The plugs shall then be removed and inspected for evidence of damage such as cracking or melting. After a cooling period of 1 hour, each vent filler plug shall be inserted in a fixture arranged so that water pressure can be applied on the upper side of the plug, and air pressure on the lower side. Using this fixture, the upper side of each plug shall be subjected to a water pressure which exceeds the air pressure on the lower side by 1.75 psi (12.07 kPa) [water head of 4 feet (1.22 m), if air pressure is atmospheric]. The number of drops of water that leak through each vent filler plug and the time required therefore (not to be less than one minute) shall be recorded. The water pressure shall then be released and the air pressure on the lower side increased to 0.5 psi (3.45 kPa) above the pressure existing on the upper side. Plug shall open under specified pressure.

4.10.5 Handle test. The handle and bond areas shall be saturated with electrolyte conforming to 3.2.2 and air dried twice daily for two days. The handles and bond areas shall again be saturated. The battery shall then be placed in an ambient air temperature of plus 190 ± 2°F (88 ± 2°C) for 60 minutes, allowed to cool to room temperature, and again heated at 190 ± 2°F (88 ± 2°C) for 60 minutes. The battery shall then be removed from the oven and immediately lifted once by each handle in a vertical direction with a force of two times the filled battery weight, but not to exceed 200 pounds (890 N). The supporting rope shall be taut prior to the application of the force. The handles shall be supported over a length of 4-1/2 inches (114 mm) during test. The handle support shall have a radius of 4-1/2 inches (114 mm). The lift shall be repeated three times and the battery shall clear the floor, or stand, on each lift. At the conclusions of the three lifts, the handles and bond shall be examined for conformance to 3.3.6. After the test, the battery shall be placed in an ambient air temperature of minus 65 ± 2°F (-54 ± 2°C) for 24 hours. The battery shall be removed from the cold box and immediately subjected to three lifts as previously specified. At the conclusion of the three lifts, the handles and bond areas shall be examined for conformance to 3.3.6.

4.10.5.1 Handle test (production). Perform two tests for each handle as per the lift test portion of 4.10.5 at 80 ± 10°F (26.7 ± 6°C) (only).

4.10.6 Terminal post torque resistance test. An increasing torque up to 250 pound-inches (28.2 N•m) [125 pound-inches (14.1 N•m) for 4HN] shall be applied in a direction perpendicular to the axes of the terminal posts and parallel to the top of the battery by a torque-indicating wrench, or other torque-indicating device, through a fitted battery terminal or other clamping device. Observation shall be made for evidence of distortion of the seal between the posts and the cell cover to determine conformance to 3.3.10.1.

4.10.7 Charged and dry moisture test. To determine the moisture content (see 3.4.1), the plates and separators shall be removed from the battery and immediately separated and weighed. They shall be dried in an oven at atmospheric pressure and a temperature of 165 to 170°F (73.9 to 76.7°C) for 2 hours, or to a constant weight. The plates and separators shall be reweighed and the percentage of moisture computed.

4.10.8 Individual cell dry internal resistance test. The cell terminal-to-terminal resistance shall be measured with an ohmmeter, bridge, or other test instrument. The average of such resistances, measured with the top off, in both directions, shall be calculated to determine conformance to 3.4.1.1.

4.10.9 Filled discharge capacity test (high discharge rate at 80°F (26.7°C) without supplementary charge). This test shall apply only to batteries furnished in charged and dry condition. After battery and electrolyte have been stabilized at a temperature of 80 ± 5°F (26.7 ± 3°C), the battery shall be filled with electrolyte. The electrolyte shall conform to 3.2.2. Twenty minutes after filling, but without supplementary charging, electrolyte shall be added as required to raise the level to the level specified and then the battery shall be discharged at 300 amperes for 6TN, at 150 amperes for 2HN, and at 75 amperes for 4HN with the battery in a water bath or controlled air temperature of 80 ± 5°F (26.7 ± 3°C) until the battery reaches a terminal voltage equivalent to an average of 1.0 volt per cell. The total time for discharge shall be observed to determine conformance to 3.5.2.1.

4.10.10 Full charge capacity test at 80°F (26.7°C). The test battery, previously subjected to the test specified in 4.10.9 (if required), shall perform as follows:

a. Charge battery before each discharge in accordance with 4.4.2.
b. The temperature of the battery at the beginning of each discharge shall be 80 ± 5°F (26.7 ± 3°C), and the temperature shall be maintained within this range by means of a water bath or controlled air temperature condition during discharge.
c. Discharge battery in accordance with 4.4.1, record the discharge time, and calculate the ampere-hour capacity.
d. Repeat steps a, b, and c.
e. Repeat steps a, b, and c.
f. The ampere-hour capacity obtained from each battery subjected to steps c, d, and e shall represent the performance of the battery type under test to determine conformance to 3.5.2.2. (If the required ampere-hour capacity is met in step c or d, extra steps are not required.)

4.10.11 Reserve capacity test. Reserve capacity tests shall be conducted as follows to determine conformance to 3.5.2.3:

a. Charge battery before each discharge in accordance with 4.4.2.
b. The temperature of the battery at the beginning of each discharge shall be 80 ± 5°F (26.7 ± 3°C), and the temperature shall be maintained within this range by means of a water bath or controlled air temperature condition during discharge.
c. Discharge battery at 25 ± 0.25 amperes to a terminal voltage of 10.5 volts/cell. Record the time of discharge in minutes.
d. Repeat steps a, b, and c.
e. Repeat steps a, b, and c.
f. The longest time of discharge obtained from each battery subjected to steps c, d, and e shall represent the performance of the battery type under test to determine conformance to 3.5.2.3. Exception: If the reserve capacity requirement is met in step c or step d, step e is not required.

4.10.12 Low temperature capacity test. The test for high discharge rate at minus 40°F (-40°C) shall be performed as follows:

a. Charge battery in accordance with 4.4.2.
b. Place battery in cold chamber having a temperature of minus 40 ± 2°F (-40 ± 1°C).
c. When the electrolyte has stabilized at minus 40 ± 2°F (-40 ± 1°C), the battery shall be removed and discharged at 300 amperes (6TN), at 150 amperes (2HN), or at 75 amperes (4HN), as applicable, until the battery reaches a terminal voltage equivalent to an average of 1.0 volt per cell.
d. The total time of discharge to 1.0 volt per cell shall be recorded to determine conformance to 3.5.2.4.
e. If a battery fails the test, it shall be retested. The retested battery shall be charged, discharged, and charged at the 20-hour rate with the electrolyte stabilized at 80 ± 5°F (26.7 ± 3°C), and then retested as specified in a through d. Failure of a battery to pass this second cycle shall be considered as failure to meet the specified requirements.

4.10.13 Retention of charge test. The retention of charge test shall be performed as follows:

a. Charge battery as specified in 4.4.2.
b. Store battery for 28 days at a temperature maintained at 75 ± 5°F (23.9 ± 3°C).
c. Discharge battery as specified in 4.4.1.
d. Record time of discharge in hours and calculate ampere-hours to determine conformance to 3.5.3.

4.10.14 Electrolyte retention test. Batteries shall be tilted through 45 degrees from a plane normal to the bottom of the battery along the major axis, held thus for 30 seconds, and then, similarly tilted and held along the minor axis. Batteries shall be observed for evidence of leakage, or spillage of electrolyte, to determine conformance to 3.5.4.

4.10.15 Thermal shock resistance test. Batteries shall be subjected to two thermal cycles to determine conformance to 3.2.1 and 3.5.5. An internal pressure of 0.5 psi (3.45 kPa) shall be applied to each cell individually, in parallel with a manometer, before and after each temperature change *. The following procedure a, b, c shall be used for one cycle. *(For production after each complete cycle).

a. Battery shall be placed in an ambient air temperature of minus 65 ± 2°F (-54 ± 1°C) for 24 hours or until electrolyte is stabilized.
b. The battery shall then be placed in an ambient air temperature of plus 190 ± 2°F (87.8 ± 1°C) for 24 hours.
c. The battery shall be allowed to cool gradually to plus 80 ± 10°F (26.7 ± 6°C) for 24 hours.
d. Distilled water shall be added if necessary, and the battery charged as specified in 4.4.2.

4.10.16 Vibration resistance test. The test battery that has been tested as specified in 4.10.9 and 4.10.10 shall be stabilized in an ambient air temperature of 80 ± 10°F (26.7 ± 6°C) prior to vibration. The vibration machine shall provide the required excursions and frequencies with batteries installed. The apparatus shall include a hold-down frame to bear on the top edges of the battery container, but not on the vent plugs or terminal posts. While in an ambient air temperature of 80 ± 10°F (26.7 ± 6°C) and mounted in the vibrating machine, the specimen shall be vibrated for two hours at a frequency of 2000 to 2100 cycles per minute through a vertical amplitude of 0.045 to 0.050 inch (1.1 to 1.3 mm) [total excursion 0.090 to 0.100 inch (2.3 to 2.5 mm)]. During this test the battery shall be discharged at the 20-hour rate. The test shall be repeated for one hour, except that the battery shall be chilled to, and the electrolyte stabilized at, a temperature of minus 40 ± 1°F (-40 ± 0.5°C) immediately before beginning vibration. During the test, the battery shall be observed for maintenance of steady voltage and current, and afterwards shall be examined for evidence of loosening of terminal posts in the covers and flooding of electrolyte at the top. The battery shall be removed from the vibration machine, allowed to warm to 80 ± 10°F (26.7 ± 6°C) until the electrolyte is stabilized, then charged and discharged at the reserve capacity rate and the time recorded to reach 10.5 volts/cell. After testing, the battery shall be disassembled and examined for damage to determine conformance to 3.5.6.

4.10.16.1 Vibration resistance test (production). The test battery that has been tested as specified in 4.10.9 and 4.10.10 shall be stabilized in an ambient air temperature of 80 ± 10°F (26.7 ± 6°C) prior to vibration. The vibration machine conforming to Drawing D7070340 shall provide the required excursions and frequencies with batteries installed. The apparatus shall include a hold-down frame to bear on the top edges of the battery container, but not on the vent plugs or terminal posts. While in an ambient air temperature of 80 ± 10°F (26.7 ± 6°C) and mounted in the vibrating machine,

the battery shall be vibrated for two hours at a frequency of 2000 to 2100 cycles per minute through a vertical amplitude of 0.045 to 0.050 inch (1.1 to 1.3 mm) [total excursion 0.090 to 0.100 inch (2.3 to 2.5 mm)]. During this test the battery shall be discharged at the 20-hour rate. The battery shall be removed from the vibration machine, then charged and discharged per 4.10.11 and the capacity recorded to determine conformance to 3.5.6.

4.10.17 Life-cycle capacity tests. Life tests shall consist of a series of cycles of discharge and charge in accordance with the applicable test specified in 4.10.17.1. Immediately prior to the beginning of the test, the battery shall be fully charged as specified in 4.4.2. Tests shall be performed with the battery in a water bath with the temperature maintained at 100 ± 5°F (37.8 ± 3°C). Water shall be added every second day to each cell to replace evaporation (except during the capacity discharge test cycle for ampere-hour capacity). When the ampere-hour capacity equals or drops below 40 percent of the rated ampere-hour capacity during the capacity discharge test cycle, the battery shall be fully charged as specified in 4.4.2 and tested as specified in 4.10.10. If the capacity is above 40 percent of normal full-charge value, the life test shall be continued. If the capacity equals or falls below 40 percent, the life cycle test shall be terminated. The life cycles attained by a battery shall be taken as the total of the actual cycles completed on the life test, plus each cycle received on other tests.

4.10.17.1 Life-capacity discharge cycles. To determine conformance to 3.5.7, the test shall consist of normal and weekly capacity discharge cycles as follows:

a. Normal cycles. The normal cycles shall consist of a series of 6-hour cycles (4 cycles per day or approximately 24 per week). Each cycle shall consist of discharge for 1 hour at 40 amperes and charge for 5 hours at 10 amperes (except 2HN battery shall be discharged for 1 hour at 20 amperes and charged for 5 hours at 5 amperes).
b. Weekly capacity discharge cycles. Ampere-hour capacity shall be determined at the completion of each series of 24 normal cycles. The battery shall be discharged at the ampere rate for normal cycles, until a final average terminal voltage of 1.75 volts per cell has been reached. The ampere-hour capacity shall be calculated as the product of the current rate in amperes and the time of discharge in hours. Following this discharge, the battery shall be fully charged at the 20-hour rate and the normal cycle procedure shall be continued. The battery shall be placed on a discharge cycle which, with the charge cycle, shall constitute a full normal cycle.

4.10.18 Overcharge cycle test. The test shall be conducted with the specimen in approximately 6 inches of water, and with the water bath maintained within the temperature range of 100 ± 5°F (37.8 ± 3°C). Water shall be added to the battery as needed to replace evaporation, except that no water shall be added during the open circuit phase. The battery, initially discharged, shall be subjected to overcharge cycles, each consisting of:

a. Charge phase. In this phase, a continuous charge of 1,000 ampere-hours shall be applied at a rate of 9 amperes for 6TN, 500 ampere-hours at 4.5 amperes for type 2HN and 250 ampere-hours at 2.25 amperes for type 4HN.
b. Open circuit phase. The battery shall then be allowed to stand on open circuit for 48 hours.
c. The batteries shall be discharged at 300 amperes for 6TN, 150 amperes for type 2HN, and 75 amperes for type 4HN to an average terminal voltage of 1.0 volt per cell. The length of time required for such discharge shall be recorded. With no charging of the battery other than as specified in a, the cycle shall be repeated until the discharge time is 30 seconds or less. The test shall then be considered completed, and the number of cycles performed shall be recorded to determine conformance to 3.5.8.

4.10.19 Storage life performance.

4.10.19.1 60-day storage life performance. The dry charged battery shall be stored for 60 days at standard test conditions (see 4.3.1) except that the relative humidity shall not be below 50 percent. The battery shall then be tested as follows:

a. Measure the dry internal resistance of the battery, positive terminal to negative terminal and from negative terminal to positive terminal with an ohmmeter, bridge, or other test instrument. The average of such resistance shall be calculated to determine conformance to 3.4.1.1.

b. Test battery per 4.10.9 to determine conformance to 3.5.9.

4.10.20 Inspection of packaging. Packaging inspections shall be accomplished in accordance with the quality assurance provisions of the applicable packaging data sheet.

5. PACKAGING

5.1 Dry and wet charged batteries.

5.1.1 Preservation, packaging, packing, and marking. Unless otherwise specified, charged, wet and dry batteries shall be cleaned, dried, preserved, packaged, packed, and marked in accordance with the applicable packaging standard or packaging data sheet for the desired level of protection. Marking shall be in accordance with MIL-STD-129, including lot numbers, except for any special marking requirements (see 6.2).

5.1.2 Transportation (charged and wet batteries). Charged and wet batteries shall be transported in compliance with DOT Regulation 49 CFR.

6. NOTES

6.1 Intended use. Batteries covered by this specification are intended primarily for starting, lighting, and ignition service in military vehicles, including tactical and administrative vehicles, internal combustion engine driven industrial trucks and tractors, construction equipment and generator sets. The batteries will also be used for radio operation and as a source of electrical energy for operating vehicular accessories, such as sighting devices and control mechanisms.

6.2 Ordering data. Procurement documents should specify the following:

a. Title, number and date of this specification.
b. Type designation of battery required (see 1.2).
c. Battery condition (see 3.4).
d. Any special marking requirements (see 5.1.1).
e. Level of preservation, packaging, and packing required (see 5.1.1).

6.3 First article. First article samples shall be tested and approved under the appropriate provisions of 7-104.55 of the Defense Acquisition Regulation. The contracting officer should include specific instructions in all procurement instruments regarding arrangements for examination, tests and approval of the first article (see 3.1).

6.4 Batteries for immediate use. When batteries are being procured for immediate use which does not require charged and dry condition, and when so specified, batteries may be procured in the charged and wet condition.

6.5 Change in classification. Due to extensive changes in coverage of this specification, Supplement 1 has been deleted. Also, since all batteries covered are not Class FE, class designation has been deleted.

6.6 International standardization agreement. Certain provisions of this specification are the subject of international standardization agreements as set forth in QSTAG-140 and NATO STANAG 4015. When amendment, revision or cancellation of this specification is proposed, the departmental custodians will inform their respective Departmental Standardization offices so that appropriate action may be taken respecting the international agreement concerned.

6.7 Recycled materials. The use of recycled materials, which meet the requirements of applicable material specifications without jeopardizing the intended use of the item, shall be encouraged.

6.8 Changes from previous issue. Asterisks are not used in this revision to identify changes with respect to the previous issue, due to the extensiveness of the changes.

Custodians:
Army - AT
Air Force - 99
Navy - YD

Review activities:
Army - ER
Air Force - 80
Navy - AS
DLA - GS

User activities:
Army - MI, ME
Navy - MC

Preparing activity:
Army - AT

(Project No. 6140-0617)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE
Mil-B-11188F	Batteries, Storage: Lead-Acid

3a. NAME OF SUBMITTING ORGANIZATION

b. ADDRESS *(Street, City, State, ZIP Code)*

4. TYPE OF ORGANIZATION *(Mark one)*

- ☐ VENDOR
- ☐ USER
- ☐ MANUFACTURER
- ☐ OTHER *(Specify)*: _____

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional	b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional
c. MAILING ADDRESS *(Street, City, State, ZIP Code)* – Optional	8. DATE OF SUBMISSION *(YYMMDD)*

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