MIL-B-62346A(AT)
10 January 1983
SUPERSEDING
MIL-B-62346(AT)
1 March 1982

MILITARY SPECIFICATION

BATTERIES, STORAGE: LEAD-ACID (LOW-MAINTENANCE)

This specification is approved for use by the US Army Tank-Automotive Command and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers one type of waterproof, low maintenance, lead-acid batteries, furnished in charged and dry or charged and wet condition, for starting, lighting, and ignition service in military vehicles. Battery designation shall be as follows:

Type designation	Voltage	Rated reserve capacity minutes	Ampere-Hours (20 Hour Rate)
6TL	12	200	120

2. Government documents.

2.1.1 Specifications, standards, and handbooks. Unless otherwise specified, the following specifications, standards, and handbooks of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DoDISS) specified in the solicitation form a part of this specification to the extent specified herein.

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: DRSTA-GSS, Warren, MI 48090, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document, or by letter.

FSC 6140

SPECIFICATIONS

FEDERAL

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

STANDARDS

FEDERAL

FED-STD-595	- Colors
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.
MIL-STD-202	- Test Methods for Electronic and Electrical Component Parts.
MIL-STD-45662	- Calibration System Requirements
MS52149	- Battery, Storage, Lead-Acid (Low-Maintenance).

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

DEPARTMENT OF TRANSPORTATION (DOT)
Federal Motor Carrier Safety Regulations - 49 CFR

(Application for copies should be addressed to the Department of Transportation, Washington DC 20590).

(Copies of specifications, standards, handbooks, 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 documents form a part of this specification to the extent specified herein. The issues of the documents which are indicated as DoD adopted shall be the issue listed in the current DoDISS and the supplement thereto, if applicable.

UNIFORM CLASSIFICATION COMMITTEE

Consolidated Freight Classification Rating, Rules, and Regulations.

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

SOCIETY OF AUTOMOTIVE ENGINEERS, INC. (SAE)
SAE J537i - Storage Batteries.

(Application for copies should be addressed to the Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096).

BATTERY COUNCIL INTERNATIONAL (BCI)

Bulge Characteristics of Storage Battery
Manufacturing Industry Testing Procedures.

(Application for copies should be addressed to Battery Council International, 111 East Wacker Drive, Chicago, IL 60601).

(Industry association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies).

3. REQUIREMENTS

3.1 Qualification. The battery furnished under this specification shall be a product which is qualified for listing on the applicable Qualified Product List (QPL) at the time set for opening of bids (see 4.6, and 6.3).

3.2 Materials. Materials shall be as specified herein and in referenced specifications, standards and drawings. Material shall be free of defects which adversely affect performance or serviceability of the finished product (see 6.4).

3.2.1 Electrolyte. The electrolyte, use in filling batteries procured in the charged and wet condition for test purposes, shall conform to Class 3 of O-S-801.

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

3.3 Construction. Batteries shall be constructed in accordance with MS52149.

3.3.1 Containers. Containers shall be molded to the dimensions specified in MS52149. The containers shall be free of leaks, blisters, cracks, or other defects that could adversely affect the performance of the battery. Container color shall be lusterless olive drab, conforming to color chip number 34087 of FED-STD-595. The container shall be made from nonabsorbant, acid-resistant, thermoplastic material meeting the physical requirements specified in 3.4.1 through 3.4.4.

3.3.2 Battery cover. Battery cover shall meet the same physical and color requirements as the container material. Battery cover shall be of one-piece design and shall be sealed to the container, thereby forming a case. Cover and base are to be parallel within 0.060, total. The seal shall maintain an acid tight joint between case and cover under all test conditions specified herein.

3.4. Physical requirements.

3.4.1 Electrical breakdown. The battery container shall withstand an alternating current potential of 100 volts root mean square (rms) per mil of thickness without damage.

3.4.2 Acid absorption. The battery container material shall exhibit no cracks or blisters, no more than 1.5 percent increase in weight, and no more than 2 percent increase in any physical dimension in a 1.300 specific gravity electrolyte solution at 150° ± 2°F (65.6° ± 1°C) for a period of 7 days.

3.4.3 Impact resistance. Twenty four hours or more after manufacture, the sample battery case shall exhibit minimum impact resistance after four hours pre-test conditioning at temperatures in Table 1.

TABLE I. Impact resistance.

Pre-test conditioning temperature	Impact resistance (inch-pounds)
150°F (65.6°C)	180
0°F (-17.8°C)	120
-40°F (-40°C)	60

3.4.4 Bulge resistance. Battery container shall exhibit no more than 1/4 inch bulge after exposure to 200° ± 5°F (93.3° ± 3C°) for 3 hours.

3.4.5 Filler Plug openings. The battery cover shall contain a threaded vent filler plug opening for each cell (See 3.4.8). 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 battery cover or on the vent filler plug.

3.4.6 Post seals. Post seals shall maintain an unbroken seal betweeen post and cover and shall show no indication of leakage under any of the test conditions specified herein.

3.4.7 Cell seals. Cells shall be sealed by easily removable, airtight and moisture-proof seals, not an integral part of battery cover, which shall retain their seal and hold firmly in place until intentionally removed. Dummy vent-filler plugs may be used provided the proper plugs are packaged with the battery.

3.4.8 Vent filler plugs. Nonabsorbent, acid resistant filler plugs shall be provided for each cell. The plugs shall have nominal 7/8-9-UNC-2A threads for mating with the threaded 1/8 inch raised openings in the cell 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 two 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 pounds per square inch (psi) in excess of the external pressure. The plugs shall withstand temperatures from minus 65°F (-53.9°C) to plus 250°F (121°C) without cracking, melting, or other damage.

3.4.9 Handles. Handles shall be rope type plastic of the developed length specified in MS52149. Handles shall withstand the effects of electrolyte conforming to Class 3 of O-S-801 (see 3.2.1). Each handle shall be attached to the battery case in such manner as to withstand, without damage to the case, the handle, or the attachment, a force of 1.4 times the filled weight of the battery when tested in accordance with 4.8.8 at temperatures of 190°F ± 2°F (88° ± 1°C) and minus 65° ± 2°F (-54° ± 1°).

3.4.10 Grids and plates. Grids shall have no framing bars cracked, broken or missing. After pasting of active material, plates shall evidence no holes in the active material.

3.4.10.1 Plates. Plates shall be of the pasted type and the grid lead alloy shall contain no antimony. Optional construction: Negative plate grids shall have non-antimony or low percent (not to exceed 1.0 percent) antimony and positive plate grids (not to exceed 3.5 percent) antimony.

3.4.11 Plate connections and intercell connectors. Plates of like polarity in each cell shall be integrally joined by intercell connectors. The intercell connectors shall be of the burned-on, cast-on, or welded type. Each connector shall be of such size and strength as to provide both electrical conduction and support for each group of like polarity plates. Plate-connecting intercell connectors of the up and over type shall not be used.

3.4.12 Separators. Separators shall be an envelope type, enclosing the positive plates and shall extend a minimum of 3/32 inch above plates after assembly.

3.4.13 Terminal posts. Terminal posts shall be of the design and location specified on the applicable standard. The positive tapered terminal post shall be identified by a "+" a "POS", or a "P" and the negative tapered terminal by a "-" a "NEG", or "N" as shown on the standard. All metal parts of terminal shall be lead or lead-coated. Taper to be 1.33 inches per foot.

3.4.13.1 Terminal post torque resistance. Tapered terminal posts shall be withstand, without damage to the battery, a torque of 250 inch-pounds.

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

Charged and dry - 65 pounds approximate
Charged and wet - 84 pounds approximate

3.5.1 Charged and dry. Batteries furnished in the charged and dry condition shall contain dry plates and separators. The moisture content of the separators shall not exceed 3.0 percent. The moisture content of the plates shall not exceed 0.2 percent. No electrolyte shall be furnished.

3.5.1.1 Dry cell internal resistance. The terminal-to-terminal resistance of each cell, measured after assembly in the container with the top off, shall be no less than 50,000 ohms. If each cell of the battery has a minumum resistance of 5,000,000 ohms after assembly in the container, the moisture test in paragraph 4.8.10 may be omitted.

3.5.2 Charged and wet. Batteries furnished in the charged and wet condition shall be charged and dry batteries filled to the proper level with electrolyte as specified in 3.2.1 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 (27°C) and the open circuit, terminal-to-terminal voltage shall be not less than two volts per cell corrected to 80°F (27°C).

3.6 Battery performance.

3.6.1 Cold activation of dry charged. Batteries furnished in the charged and dry condition shall exhibit a terminal voltage of 7.2 volts or greater following a discharge rate of 450 amps for 60 seconds, after stabilizing the dry charged battery at 30°F ± 2°F (-1°C ± 1°C), and filling the battery with electrolyte also stabilized at the 30°F temperature.

3.6.2 Full charge capacity (80°F). Each battery shall yield a capacity of not less than 120 ampere hours at a controlled temperature of 80° ± 5°F (27°C ± 3°C).

3.6.3 Reserve capacity. Fully charged batteries stabilized at 80 ± 5°F (27 ± 3°C) shall exhibit a minimum terminal voltage of 10.5 after a discharge rate of 25 amp for 200 minutes.

3.6.4 Low temperature capacity. Fully charged batteries (1.280 specific gravity, minimum) shall exhibit a minimum terminal voltage of 7.2 volts after being discharged for 30 seconds at the rates and temperatures shown below:

Temperature	Discharge rate
0°F	600 amps
-40°F	350 amps

3.6.5 Retention of charge. Following 30 days storage at 105°F (40.6°C), batteries shall successfully survive a discharge rate of 25 amps for 175 minutes to a minimum terminal voltage of 10.5 volts.

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

3.6.6.1 Leakage. Each cell shall independently maintain a pressure of 0.5 psi for a period of 30 seconds with a maximum pressure loss of 0.1 psi.

3.6.7 Extreme temperature 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 (minus 54°C) and no more than 0.1 psi pressure drop in 30 seconds, with 0.5 psi pressure applied to each cell individually after exposure to extreme test temperatures.

3.6.8 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; intercell 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 (0.090 to 0.100 inch total excursion) at a frequency of 2000 to 2100 cycles per minute. Vibration shall not decrease the reserve capacity of batteries below 190 minutes.

3.6.9 Life-cycle capacity. Battery shall withstand 235 discharge/charge cycles. The life cycles attained by each battery shall be taken as the total actual cycles completed on life cycle tests, plus each cycle attained on other tests.

3.6.10 Storage life. After 90 days of storage at standard test conditions the battery shall meet the requirements of 3.6.1.

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

3.7.1 Identification data. Identification marking shall show the following:

a. Battery identification (battery, storage, lead-acid, low maintenance).
b. Designation (Military and SAE, when applicable).
c. MS part number.
d. Voltage.
e. Reserve capacity at 80°F (26.7°C).
f. High discharge capacity and rate at 0°F (-17.8°C) and -40°F (-40°C).
g. Contract or order number.
h. Date of manufacture (month and year) and lot number
i. Manufacturer's name.
j. US

3.7.2 Instruction tag and label. Instruction tag and label which provide complete information for placing battery in service, operation, and charging shall be attached in a conspicuous place on each battery.

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

a. NOTE: This is a charged and dry storage battery. When placing in service, mark top of battery with the date activated.
b. Remove and destroy sealing devices which seals cells during shipment and storage.

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

c. Fill each cell with electrolyte (sulfuric acid and water solution) of 1.280 ± .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 reading to 80°F (26.7°C). Add electrolyte if necessary to bring to designated level.
e. The battery shall be charged fully before it is put into service.
f. The battery should be charged at a constant potential of 15.0 volts until specific gravity becomes constant for three consecutive 30-minute readings. The temperature of the electrolyte during the charging period shall not be allowed to exceed 120°F (48.9°C).
g. Add electrolyte as required to bring to proper level. Add only distilled water or drinking water, after initial charge, to maintain proper level.
h. Keep the top and sides of the battery clean and dry. Make sure vent-filler plugs are clean. When cleaning is required, wash with water.
i. Battery should be charged every 6 months and kept in cool, dry storage, when not in use.
j. Electrolyte volume_____.
k. Charging voltage: 15 volts, constant potential.

3.7.4 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 activitated at time of manufacture and charged to full rated capacity.

a. On the battery cover, indicate the date (month and year) of preparation for service.
b. Check the electrolyte specific gravity and levels in all cells, and adjust to the proper levels by adding distilled or drinking water as required. Charge at a constant voltage of 15 until the specific gravity of the electrolyte remains constant for three consecutive reading taken at 30-minute intervals.
c. Check the electrolyte levels. Add distilled or drinking water, as required, to maintain proper level. Add the water only while the battery is being charged.
d. The battery is now ready for use.
e. 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.
f. Battery should be charged every 6 months and kept in cool, dry storage when not in use.
g. Charging voltage: 15 volts, constant potential.

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 of blow-holes or imperfect bonds between parts which have been burned together. Marking shall be clear and distinct.

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 specifed 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 conform to 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 and 3.2.2.

4.2.2 In-process inspection. Samples for in-process inspection shall be selected at the rate of two per week. One sample shall be subjected to the Group 1 tests, and the other sample shall be subjected to the Group 2 tests.

Description	Requirement	Test
Group I		
In-process inspection	3.4.10 - 3.4.12	Visual
Dry cell internal resistance	3.5.1.1	4.8.11
Cold activation	3.6.1	4.8.5
Group II		
Terminal post torque resistance	3.4.13.1	4.8.9
Reserve capacity	3.6.3	4.8.13
Low temperature capacity	3.6.4	4.8.14

4.3 Classification of inspections. Inspections specified herein are classified as follows:

a. Qualification inspection (see 4.6).
b. Quality conformance inspection (see 4.7).

4.4 Inspection conditions and equipment.

4.4.1 Standard test conditions. Unless otherwise specified herein, all measurements and tests shall be made at a temperature between 68° (20°C) and 95°F (35°C), and ambient atmospheric pressure and relative humidity.

4.4.2 Temperature of electrolyte. Unless otherwise specified herein, the temperature of the electrolyte at the beginning of the tests shall be within ± 2°F of the test temperature.

4.4.3 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. Precision measuring instruments shall conform to the requirements of MIL-STD-45662.

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

4.4.4 Instrument accuracy.

4.4.4.1 Electrical indicating instruments. All 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.

4.4.4.2 Resistor tolerances. In all tests involving discharge through a resistance, such resistance shall be accurate within ± 0.5 percent.

4.5 Discharging and charging of test batteries.

4.5.1 Discharging. The fully charged battery shall be at a temperature of 80° ± 5°F (26.7 ± 3°C) and shall be discharged at the 20 hour rate (that current in amperes equal to 1/20th of the battery's rated ampere hour capacity), to a final average terminal voltage equivalent to 1.75 volts per cell, unless otherwise specified.

4.5.2 Charging. Batteries shall be charged at a constant voltage of 15.0 volts until specific gravity reading taken at 30 minute intervals remains constant. The temperature of the electrolyte during the charging period shall not be allowed to exceed 120°F (48.9°C). Optional: Batteries shall be charged as specified in SAE Standard J537.

4.5.3 Periodic charging. If the testing 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 4.5.2) before testing is resumed. A battery shall never be stored for more than 24 hours after a discharge, without being recharged.

4.6 Qualification. Qualification inspection shall be conducted at a place designated by, or approved by, the Government. Qualification inspection shall consist of examination for defects listed in Table IV and tests listed in Table III.

TABLE II. Qualification samples.

Sample description	Quantity required
Batteries, complete	8 each
Container	2 each
Covers	2 each
Vent-filler plugs	1 set (6 each)

TABLE III. Order of QPL inspection.

Description	Sample 1/ number	Requirement	Test
Electrical breakdown	CT1	3.4.1	4.8.1
Acid absorption	CT2 and CV1	3.4.2	4.8.2
Impact resistance	CT2	3.4.3	4.8.3
Bulge resistance	CT2	3.4.4	4.8.4
Cold activation dry charged batteries	B2-6	3.6.1	4.8.5
Covers	CV2	3.3.2	4.8.6
Vent filler plugs	V1	3.4.8	4.8.7
Handles	B1	3.4.9	4.8.8
Terminal post torque resistance	B7	3.4.13.1	4.8.9
Moisture content dry charged batteries	B7	3.5.1	4.8.10
Dry cell internal resistance	B7	3.5.1.1	4.8.11
Full charge capacity	B4 and 5	3.6.2	4.8.12

TABLE III. Order of QPL inspection
(Continued)

Description	Sample 1/ number	Requirement	Test
Reserve capacity	B2-6	3.6.3	4.8.13
Low temperature capacity	B2-6	3.6.4	4.8.14
Retention of charge	B6	3.6.5	4.8.15
Electrolyte retention	B2 and 3	3.6.6	4.8.16
Extreme temperature	B2 and 3	3.6.7	4.8.17
Vibration	B2 and 3	3.6.8	4.8.18
Life cycle capacity	B4 and 5	3.6.9	4.8.19
Storage life	B8	3.6.10	4.8.20

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

4.6.1 Failure. Failure of a qualification 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.

4.7 Quality Conformance Inspection.

4.7.1 Sampling.

4.7.1.1 Lot formation. An inspection lot shall consist of a quantity of batteries of any one part number, from an identifiable production period, from one manufacturer, submitted at one time for acceptance.

4.7.1.2 Sampling for examination. Samples for quality conformance examination shall be selected at the rate of 2 per 1000 batteries produced; except that not more than twenty, nor less than ten, batteries shall be selected in a 30 day period.

4.7.1.3 Sampling for acceptance testing. Samples for acceptance testing shall be selected from batteries that have passed the examination specified in 4.7.2.2. Two samples per week shall be subjected to acceptance testing.

4.7.2. Quality conformance examination.

4.7.2.1 Acceptable quality level. Each sample, selected in accordance with 4.7.1.2, shall be subjected to the following acceptable quality levels (AQLs), as defined in MIL-STD-105, on the basis of percent defective:

Classification	AQL
Major	2.5
Minor	4.0

4.7.2.2 Classification of defects. For examination purposes, defects shall be classified as specified in Table IV.

TABLE IV. Classification of defects.

Categories	Defects	Method of Inspection
Critical:	None defined	
Major:		
101	Maximum dimensional limitations exceeded (see 3.3, 3.3.1, and 3.3.2).	Scale
102	Location and polarity of terminal posts not as specified (see 3.4.13).	Visual
103	Loose terminal posts.	Manual
104	Terminal markings not as specified (see 3.4.13).	Visual
105	Dimensions of terminal posts not as specified (see 3.4.13).	Scale
106	Low electrolyte level (charged and wet batteries only) (see 3.5.2).	Visual
107	Specific gravity of electrolyte out of limits (charged and wet batteries only) (see 3.5.2).	Hydrometer
108	Open-circuit, terminal to terminal voltage less than 2 volts per cell (charged and wet batteries only) (see 3.5.2).	Voltmeter
109	Vent holes not properly sealed (charged and dry batteries only)(see 3.4.7).	Visual
110	Vent filler plugs and filler caps not as specified (see 3.4.8).	Visual
111	Post seals not as specified (see 3.4.6).	Visual
112	Leaks or cracks in container (see 3.3.1).	Visual
113	Cover not properly sealed to container (see 3.3.2).	Visual

TABLE IV. Classification of defects (Continued)

Categories	Defects	Method of Inspection
Major		
114	Vent openings in cover not as specified (see 3.4.5).	Visual and Scale
115	Electrolyte level instructions not as specified (see 3.7.3).	Visual
116	Missing or improper instructions (see 3.7.2).	Visual
Minor:		
201	Improper marking (see 3.7.1).	Visual
202	Handles not as specified (see 3.4.9).	Visual
203	Workmanship defects (see 3.8).	Visual

4.7.3 Classification of tests. Classification of tests shall be as follows:

a. Acceptance tests (see 4.7.4).
b. Control tests (see 4.7.5).

4.7.4 Acceptance tests. Samples selected in accordance with 4.7.1.3 shall be subjected to the tests specified in Table V. One half of the samples shall be subjected to group I tests, and one half to group II.

4.7.4.1 Failure. Failure of an acceptance test sample to pass any specified examination or test may be cause for the Government to refuse to accept subsequent lots until it has been proven, to the satisfaction of the Government, that the results revealed by the failure have been corrected. Lots shall be identified and shipped on a regular basis without waiting for test results.

TABLE V. Acceptance tests.

Description	Requirement	Test
Group I		
In-process inspection	3.4.10, 3.4.10.1, 3,4,11 and 3.4.12	Visual
Dry cell internal resistance	3.5.1.1	4.8.11
Leakage	3.6.6.1	4.8.16.1
Cold activation test	3.6.1	4.8.5
Group II		
Cold activation test	3.6.1	4.8.5
Low temperature capacity	3.6.4	4.8.14
Terminal post torque resistance	3.6.13.1	4.8.9

4.7.5 Control tests. Control test samples shall be selected at the rate of two of each 5,000 batteries produced, except that not less than two nor more than four shall be selected in a 30 day period. Samples shall be examined for the defects specified in Table VI.

4.7.5.1 Failure. Failure of a control test sample to pass any specified examination or test may be cause for the Government to refuse to accept subsequent lots until it has been proven, to the satisfaction of the Government, that the faults revealed by the failure have been corrected. Lots shall be identified and shipped on a regular basis without waiting for test results.

TABLE VI. Control tests

Description	Requirement	Test
Vent filler plugs	3.4.8	4.8.7
Handles	3.4.9	4.8.8
Cold activation	3.6.1	4.8.5
Thermal shock	3.6.7	4.8.17
Vibration	3.6.8	4.8.18

4.8 Conformance verification.

4.8.1 Electrical breakdown test for containers. The battery container shall be filled with lead or aluminum shot or fitted with a close fitting mandrel or other electrode to within 1/2 inch of the top of the lowest point on the sides, ends, or partitions of the containers. An alternating current potential of 100 volts root mean square (rms) per mil of thickness shall be applied for 15 seconds after full calculated voltage has been reached. Voltage shall be supplied by a transformer of not less than 1/2 kilovoltampere capacity, using the electrodes in a manner that will subject each outer wall and inner partition of the container to the electrode potential. Containers shall subsequently be examined for leaks, imperfections, or other evidence of perforation or burn-through to determine conformance to 3.4.1.

4.8.2 Acid absorption test for containers. Two specimens, each 3 by 3 inches, shall be cut from the partitions of the container. The cut edges shall be neither polished nor sealed. After being measured with calipers and weighed in the dry condition at plus 80° ± 10°F (26.7° ± 6°C), each specimen shall be immersed in a covered vessel containing 150 cubic centimeters (cc) of sulfuric acid solution of 1.300 specific gravity at 80°F (26.7°C). The vessel shall be held for 7 days in an oven at 150° ± 5°F (65.6°C ± 3°C). At the end of the heating period, the specimens shall be rinsed in water and dried on the surface. Specimens shall be inspected for evidence of cracks or blisters and then measured and weighed. The percentage increase in dimensions and weight shall be calculated to determine conformance to 3.4.2.

4.8.3 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 four hours at each test temperature. The test shall be conducted in an 150°F ± 5°F (65.6°C ± 2.8°C), 0°F ± 2°F (-17.8°C) and -40°F (-40°C) atmosphere. Impact resistance shall be determined by a 2 pound ± 0.05 pound solid steel ball, used as 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 section. The impact resistance shall be found by dropping the weight at the height necessary to produce the minimum impact resistance requirement for the test temperature (see Table I). 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 in such a manner that the ball will strike one-third down from the top of the container on the centerline of the sides of each cell and on the center of each cell cover area (where thickness is uniform). Testing of post cells is not required.

4.8.4 Bulge resistance. The bulge resistance of battery container shall be determined by test 2, Bulge Characteristics of Storage Battery Manufacturing Industry Testing Procedures, Battery Council International (BCI). The bulges in the container shall be measured to determine conformance to 3.4.4.

4.8.5 Cold activation. This test shall apply to batteries furnished in charged and dry condition and without supplementary charge. The battery and electrolyte, 1.280 ± .005 specific gravity at 80°F (26.7°C) shall be placed in a cold chamber at 30°F ± 2°F (-1°C ± 1°C) for at least 18 hours prior to test and held until both battery and acid are at 30°F ± 2°F (-1°C ± 1°C). The electrolyte shall conform to 3.2.1. Remove from cold chamber and immediately fill the battery with the cold electrolyte. Allow battery to stand 30 minutes after filling last cell. Record specific gravity and temperature of the electrolyte. Discharge the battery at 450 amperes. Note and record the terminal voltage at 60 seconds to determine conformance to 3.6.1.

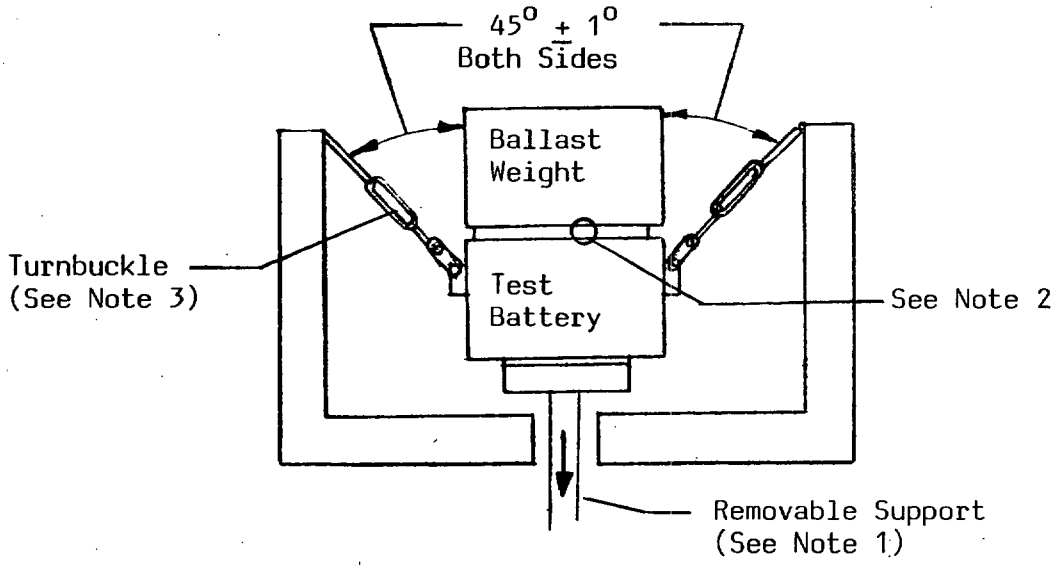
4.8.6 Battery cover physical characteristics. Battery covers shall be tested as specified in 4.8.1, 4.8.2, and 4.8.3 with appropriate modifications in samples and procedures. Results shall be evaluated as specified in referenced paragraphs to determine conformance to 3.3.2.

4.8.7 Vent filler plug thermal and pressure resistance test. To determine conformance to 3.4.8, each vent filler plug from the battery under test shall be placed in an ambient air temperature of minus 65° ± 2°F (-54°C ± 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°C ± 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 (water head of 4 feet, 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 above the pressure existing on the upper side. Plug shall open under specified pressure.

4.8.8 Handle test. The handle and bond areas shall be saturated with electrolyte conforming to 3.2.1 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° ± 1°C) for 60 minutes, allowed to cool to room temperature, and again heated at 190° ± 2°F (88° ± 1°C) for 60 minutes. The battery shall then be removed from the oven and immediately placed in a test fixture similar to Figure 1. The battery shall be initially set on the removable support, and the angles and initial tautness of the handles shall be set with the support in place. The ballast weight equal to the weight of the test battery shall be placed on top of the test battery (a second similar battery may be used). The support shall then be slowly removed and the battery and weight be allowed to hang freely by the handles for 60 seconds. The battery shall then be removed and the handles and bond shall be examined for conformance to 3.4.9.

After the test, the battery shall be placed in an ambient air temperature of minus 65° ± 2°F (-54° ± 1C°) for 24 hours. The battery shall be removed from the cold box and immediately subjected to the handle test previously specified.

At the conclusion of the test, the handles and bond shall be examined for conformance with 3.4.9.



NOTES: 1. Support shall allow gradual and even removal so as to minimize shock and insure even loading of both handles.

2. A lightweight (less than 2 lbs. or 1 kg) shim may be used between battery and weight to prevent damage to caps, posts, or cover.

3. Turnbuckles shall be used to establish 45° angle of handles with test weight applied after removal of support. Turnbuckles shall include a device to support rope handles over a length of 4½ inches (114mm) during test.

FIGURE 1. Handle test

4.8.9 Terminal post torque resistance. An increasing torque up to 250 pound-inches shall be applied in a direction perpendicular to the axis 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 strap and connected plates, or of the seal between the posts and the cell cover. If no evidence of distortion or visible damage to post seal is revealed, the leakage test in 4.8.16.1 shall be made to determine conformance to 3.4.13.1.

4.8.10 Charged and dry moisture test. To determine the moisture content (see 3.5.1), 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.

4.8.11 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 3.5.1.1.

4.8.12 Full charge capacity test at 80°F (26.7°C). The battery full charge capacity rating (ampere-hours) shall be determined as follows to determine conformance to 3.6.2:

a. Charge battery before each discharge in accordance with 4.5.2.
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 4.5.1, 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 full charge capacity. Exception: If the ampere-hour capacity is met in step c or d extra steps are not required.

4.8.13 Reserve capacity test. Reserve capacity tests shall be conducted as follows to determine conformance to 3.6.3:

a. Charge battery before each discharge in accordance with 4.5.2.
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. 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 reserve capacity of the battery. Exception: If the reserve capacity requirement is met in step c or step d, step e is not required.

The following correction factor shall be used to compensate for electrolyte temperature variation from the stabilized 80° ± 5°F (26.7 ± 3°C).

Mc = Mr (1 - 0.005 (Tf - 80)).
Mc = Corrected minutes.
Mr = Minutes run.
Tf = Temperature at one end of discharge, °F 1/.
0.005 = Temperature correction factor.

1/ Results not valid if electrolyte temperature is above 90°F (32.3°C) or below 70°F (21°C) at completion of test.

4.8.14 Low temperature capacity test. The test for high discharge rate at 0°F (-17.8°C) and minus 40°F (-40°C) shall be performed as follows to determine conformance to 3.6.4:

a. Charge battery in accordance with 4.5.2.
b. Place battery in cold chamber having a temperature of minus 40° ± 2°F.
c. When the electrolyte has stabilized for one hour at minus 40° ± 2°F and immediately upon removal from the cold chamber the battery shall be discharged at 350 amperes until the battery reaches a terminal voltage of 7.2 volts.

d. The total time of discharge to a terminal voltage of 7.2 volts shall be recorded to determine conformance to 3.6.4.
e. If a battery fails the test, it shall be retested. The retested battery shall be charged, discharged, and charged in accordance with 4.5.2 with the electrolyte stabilized at 80° ± 5°F (26.7° ± 3°C), and then retested as specified in steps a through d. Failure of a battery to pass this second cycle shall be considered as failure to meet the specified requirement.
f. Test as per 4.8.13.
g. Repeat steps a through e, except temperature shall be 0°F ± 1°F (-17.8° ± 1°C) and discharge rate shall be 600 amperes.

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

a. Charge battery as specified in 4.5.2. Store battery for 30 days at a temperature maintained at 105° ± 5°F (40.6° ± 3°C).
b. Discharge battery as specified in 4.8.13c.
c. Record time of discharge in minutes to determine conformance to 3.6.5.

4.8.16 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 thusly 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 3.6.6.

4.8.16.1 Leakage. An internal pressure of 0.5 psi (minimum) shall be applied to each cell individually for 30 seconds. Measure any drop in applied pressure to determine conformance with 3.6.6.1.

4.8.17 Extreme temperature resistance test. Batteries shall be subjected to two thermal shock cycles to determine conformance to 3.6.7. An internal pressure of 0.5 psi shall be applied to each cell individually in parallel with a manometer at 80°F ± 5°F (26.7°C ± 3°C) for 30 seconds before and after each complete cycle. Drop in pressure in the individual cells shall be regarded as indication of leakage The following procedure for one cycle shall be used:

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 be then placed in an ambient air temperature of 190°F ± 2°F (87.8 ± 1°C) for 24 hours.
c. The battery shall be allowed to cool gradually to 80° ± 10°F (26.7 ± 6°C) for 24 hours.

4.8.18 Vibration resistance test. The test specimen shall be subjected to 4.8.13a, b, and c and stabilized in an ambient air temperature of 80° ± 10°F (26.7° ± 6°C) prior to vibration. 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 2 hours at a frequency of 2000 to 2100 cycles per minute through an amplitude of 0.045 to 0.050 inch (total excursion 0.090 to 0.100 inch). 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° ± 2°F (-40° ± 2°C) for one hour immediately before beginning vibration. During the test, the battery shall be observed for maintenance of steady voltage and current, and thereafter 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 vibrating machine, allowed to warm to 80° ± 10°F (26.7° ± 6°C) until the electrolyte is stabilized, then subjected to 4.8.13a, b, and c. After testing the battery shall be disassembled and examined for damage to determine conformance to 3.6.8.

4.8.19 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 4.8.19.1. Immediately prior to the beginning of the test, the battery shall be fully charged as specified in 4.5.2. 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 as required 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 4.5.2 and tested as specified in 4.8.12. 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 cycle 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.

4.8.19.1 Life-capacity discharge cycles. To determine conformance to 3.6.9, the test shall consist of a total of 235 discharge/charge cycles including normal and weekly cycles and cycles attained on other tests:

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.
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 per SAE J537 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.

4.8.20 Storage life test. Specimens shall be stored under standard test conditions (4.4.1) for 90 days. After storage the battery shall be tested per 4.8.5 to determine conformance to 3.6.10.

4.8.21 Inspection of packaging. Packaging inspection shall be accomplished in accordance with the quality assurance provisions of MIL-B-208, and 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, and 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 conformance to 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. Battery condition (see 3.5).
c. Any special marking requirements (see 5.1.1).
d. Level of preservation and packaging, level of packing required (see 5.1.1).

6.3 Qualification. Qualification 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 qualification (see 3.1).

6.4 Recycled materials. The use of recycled materials which meet the requirements of the applicable material specifications without jeopardizing the intended use of the item shall be encouraged (see 3.2).

Custodian:
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Project No. 6140-A582