

METRIC

MIL-B-11188H

13 September 1994

SUPERSEDING

MIL-B-11188G

3 January 1991

MILITARY SPECIFICATION

BATTERIES, STORAGE: LEAD-ACID,
GENERAL SPECIFICATION FOR (METRIC)

This specification is approved for use within the U.S. Army Tank-Automotive Command, Department of the Army, and is available 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 conditions, for starting, lighting and ignition service in military vehicles.

1.2 Classification. Storage batteries covered by this specifications shall be of the following types and conditions, as specified (see 3.5 and 6.2).

<u>Type</u>	<u>Voltage</u>	<u>Rated capacity at 20-hour rate Ampere - hours</u>
2HN	12	45
4HN	24	21

Condition

- A - Charged and dry
- B - Charged and wet

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

AMSC N/A

FSC 6140

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

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2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specification, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

FEDERAL

- | | |
|-----------|---|
| O-S-801 | - Sulfuric Acid, Electrolyte (for Storage Batteries). |
| PPP-B-140 | - Battery, Storage, Industrial, Automotive and Navy Portable (Except Aircraft), Packaging of. |

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|---------------|---|
| MIL-B-11188/1 | - Battery, Storage, Lead-Acid, Waterproof, 12 Volt (2HN). |
| MIL-B-11188/2 | - Battery, Storage, Lead-Acid, Waterproof 24 Volt (4HN). |
| MIL-B-22191 | - Barrier Material, Transparent, Flexible, Heat Sealable. |

STANDARDS

FEDERAL

- | | |
|-------------|--|
| FED-STD-313 | - Material Safety Data, Transportation Data and Disposal Data for Hazardous Materials Furnished to Government. |
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|-------------|---|
| MIL-STD-129 | - Marking for Shipment and Storage. |
| MS52149 | - Battery, Storage, Lead-Acid (Low Maintenance) Type 6TL. |

(Unless otherwise indicated, copies of federal and military specifications, and standards, are available from the Defense Printing Service Detachment Office, Bldg. 4D, 700 Robbins Ave., Philadelphia, PA 19110-5094.)

2.1.2 Other Government documents. The following other Government documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

DEPARTMENT OF TRANSPORTATION (DOT)

- | | |
|--------|--|
| 49 CFR | - Federal Motor Carrier Safety Regulations (FMCSR) |
|--------|--|

(Copies of FMCSR are available from the Department of Transportation, Washington, DC 20590.)

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2.2 Non Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issue of the documents which are DOD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the document cited in the solicitation (see 6.2).

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

- | | |
|-----------|---|
| SAE J537 | - Storage Batteries. |
| SAE J1495 | - Test Procedure for Battery Flame Retardant Venting Systems. |

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

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

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for related associated detail specifications, specifications sheets, or MS standards), the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Specification sheets. The individual item requirements shall be as specified herein and in accordance with the applicable specification sheets. In the event of any conflict between requirements of this specification and the specification sheets, the latter shall govern.

3.2 First article. When specified (see 6.2), a sample shall be subjected to first article inspection (see 4.4).

3.3 Materials. Materials shall be as specified herein and in referenced specifications, standards, and drawings. Material shall be free of defects which would adversely affect performance (see 4.8.1).

3.3.1 Active material. Active material reclaimed from plates of other batteries shall not be used (see 4.8.1).

3.3.2 Electrolyte. The electrolyte, used in filling batteries procured in the charged and wet condition and for test purposes, shall conform to class 3 of O-S-801 (see 4.8.1).

3.3.3 Recycled, virgin and reclaimed materials. Unless otherwise specified herein, there are no requirements for the exclusive use of virgin materials. The use of recycled or reclaimed (recovered) materials is acceptable provided that all other requirements of this specification are met (see 6.6.2).

3.4 Design and construction. Batteries shall be designed and constructed in accordance with MIL-B-11188/1 or MIL-B-11188/2, as specified. Batteries shall be

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furnished as complete, integral assemblies, with no loose parts permitted, except for the vent filler plugs as specified in 3.4.5 (see 4.8.2).

3.4.1 Containers. Containers shall be molded to the dimensions specified on drawings MIL-B-11188/1 or MIL-B-11188/2, as applicable. The containers shall be free of leaks, cracks, or other defects that could adversely affect the performance of the battery. Container color shall be black. The container shall be made from non-absorbent, acid resistant, thermoplastic material meeting the physical requirements specified in 3.4.1.1 (see 4.8.2).

3.4.1.1 Physical requirements.

3.4.1.1.1 Electrical breakdown. The battery container shall withstand an alternating current potential of 100 volts (V) root mean square (rms) per 2.54×10^{-2} mm of thickness without damage (see 4.8.4.1).

3.4.1.1.2 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 65 ± 1 degrees Celsius ($^{\circ}\text{C}$) for a period of seven days (see 4.8.4.2).

3.4.1.1.3 Impact resistance. Twenty-four hours or more after manufacture, the sample battery case shall exhibit a minimum impact resistance after four hours pre-test conditioning at temperatures in Table I (see 4.8.4.3).

TABLE I. Impact resistance.

Pre-Test Conditioning Temperature	Impact Resistance (Drop height of 1-kg weight)
66 $^{\circ}\text{C}$	2100 millimeter (mm)
-18 $^{\circ}\text{C}$	1400 mm
-40 $^{\circ}\text{C}$	700 mm

3.4.1.1.4 Bulge resistance. Battery container shall exhibit no more than 6.4 mm bulge after exposure to $93 \pm 3^{\circ}\text{C}$ for one hour (see 4.8.5).

3.4.2 Battery cover. Battery cover shall meet the same physical and chemical 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 1.5 mm total. The seal shall maintain an acid tight joint between case and cover under all test conditions specified herein (see 4.8.6).

3.4.2.1 Filler plug openings. The cell covers shall contain a threaded vent filler plug opening for each cell (see 3.4.5). 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 (see 4.8.2).

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3.4.3 Terminal post seals. Post seals shall maintain an unbroken seal between the post and cover and shall show no indication of leakage under any of the test conditions specified herein (see 4.8.2).

3.4.4 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 when tested as specified in 4.8.3. 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 4.8.22, the dry internal resistance of the battery shall be not less than 300,000 ohms and shall meet the filled discharge requirements of MIL-B-11188/1 or MIL-B-11188/2, as applicable (see 4.8.3).

3.4.5 Vent filler plugs. Non-absorbent, acid resistant, filler plugs shall be provided for each cell. Design shall be as specified in MS52149-3. The vent filler plugs shall be of the submersible type and shall incorporate a vent with a check valve to permit the escape of gasses from the battery. Vent plugs for type 2HN battery shall not permit ignition of flammable gases in the test battery when tested in accordance with 4.8.7.1. The check valves shall not leak more than two drops of water in 10 seconds when under a 1.22 meter head of water and shall be designed to open before internal pressure reaches 3.45 kPa in excess of external pressure. The plugs shall withstand temperatures from -54°C to 121°C without cracking, melting or other damage (see 4.8.2 and 4.8.7).

3.4.6 Handle (4HN battery only). Handles shall be rope-type plastic of the developed length specified on specification sheet MIL-B-11188/2. Handle shall withstand the effects of electrolyte conforming to class 3 of O-S-801 (see 3.3.3). The 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 890 newtons (N), at temperatures of $88 \pm 1^{\circ}\text{C}$, $-54 \pm 1^{\circ}\text{C}$ and $27 \pm 6^{\circ}\text{C}$ (see 4.8.2 and 4.8.8).

3.4.7 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, plates shall evidence not more than three missing pellets, or smaller holes with equivalent total area (see 4.5)

3.4.8 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 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 (see 4.5).

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3.4.9 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 3.2 mm.
- b. Height of plates, plus minimum of 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 (see 4.5).

3.4.10 Terminal posts. Terminal posts shall be of a design and location specified on the applicable specification sheet. The positive terminal post location shall be identified by either a "+", a "POS", or a "P" on the battery cover. The negative terminal post location shall be identified by either a "-", a "NEG" or, an "N" on the battery cover (see 4.8.2).

3.4.10.1 Terminal post torque resistance. The terminal posts shall withstand a torque of 28.2 Newton meters (N.m) for the 2HN battery and 14.1 N.m for the 4HN battery without damage or distortion to the battery (see 4.8.9).

3.5 Battery conditions. Batteries shall be furnished in one of the following conditions, as specified (see 1.2 and 6.2):

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

3.5.1 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 (see 4.8.10).

3.5.1.1 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 (see 4.8.11).

3.5.2 Charged and wet. Batteries furnished in the charged and wet condition shall be filled with electrolyte as specified in 3.3.2 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 27°C and the open-circuit, terminal-to-terminal voltage shall be not less than 2.10 volts per cell corrected to 27°C (see 4.8.2).

3.6 Performance.

3.6.1 General. The electrical performance of each battery shall be in accordance with the values specified in the applicable specification sheet.

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3.6.2 Capacities.

3.6.2.1 Filled discharge capacity (without supplementary charge) (27°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 in MIL-B-11188/1 (2HN) or MIL-B-11188/2 (4HN), as applicable (see 4.8.12).

3.6.2.2 Full charge capacity (27°C). When tested for full charge capacity as specified in 4.8.13, each battery shall yield a capacity in ampere-hours of not less than that specified in MIL-B-11188/1 (2HN) or MIL-B-11188/2 (4HN) (see 4.8.13).

3.6.2.3 Reserve capacity (27°C). When tested for reserve capacity as specified in 4.8.14, the time of discharge shall be 75 minutes for the 2HN battery, and 28 minutes for the 4HN battery (see 4.8.14).

3.6.2.4 Low temperature capacity (-40°C). When tested as specified in 4.8.15, batteries shall maintain their terminal voltage above 1 volt per cell for not less than the time specified in MIL-B-11188/1 (2HN) or 1.75 minutes for MIL-B-11188/2 (4HN), except 5-second voltages do not apply (see 4.8.15).

3.6.3 Retention of charge. When tested for retention of charge, batteries shall yield capacities not less than those specified in MIL-B-11188/1 or MIL-B-11188/2, as applicable (see 4.8.16).

3.6.4 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 (see 4.8.17).

3.6.5 Extreme temperature resistance. Batteries shall show no cracking of containers, covers, sealer, filler plugs, or other damage due to temperature change between plus 88°C and -54°C and not more than 0.69 kPa pressure drop in 60 seconds with 3.45 kPa pressure applied to each cell individually after exposure to extreme temperature test (see 4.8.18).

3.6.6 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 1.1 to 1.3 mm [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 MIL-B-11188/1, MIL-B-11188/2, or this specification, as applicable (see 4.8.19).

3.6.7 Life cycle capacity performance. Batteries shall complete life cycle performance as specified in MIL-B-11188/1 or MIL-B-11188/2, as applicable (see 4.8.20).

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3.6.8 Overcharge cycle performance. Batteries shall complete overcharge cycles as specified in MIL-B-11188/1 or MIL-B-11188/2, as applicable (see 4.8.21).

3.6.9 Storage life performance. Charged and dry batteries shall be subjected to the storage life performance test in accordance with 4.8.22.1. At completion of the storage life period, batteries shall yield rated filled discharge capacities as specified in MIL-B-11188/1 or MIL-B-11188/2, as applicable (see 4.8.22).

3.7 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 (see 4.8.2).

3.7.1 Identification data. Identification marking shall show the following:

- a. Battery identification (storage, lead-acid, 2HN or 4HN).
- b. Type designation.
- c. PIN number.
- d. Voltage.
- e. Ampere-hour capacity at 20-hour rate.
- f. High discharge capacity and rate at minus -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".

3.8 Instruction tags and labels. Instruction tags and labels 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. The manufacturer's standard warning label regarding the hazards of acid and explosive gases shall be permanently attached in a conspicuous place on each battery (see 4.8.2).

3.8.1 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 27°C to designated level. Temperature of the battery and the electrolyte must be above 16°C , but preferably not above 38°C .

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- d. Allow the battery to stand for 30 minutes after filling, then check electrolyte specific gravity of each cell correcting the readings to 27°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 at 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 49°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 electrolyte 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 _____.

3.8.2 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 49°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 _____.

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3.9 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 (see 4.8.2).

3.10 Material safety data sheets (MSDS). An MSDS shall be prepared in accordance with FED-STD-313 (see 4.8.24, 6.2, and 6.12).

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

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

4.2 Classification of inspection. The inspection requirements specified herein are classified as follows:

- a. First article inspection (see 4.4).
- b. In process inspection (see 4.5).
- c. Quality conformance inspection (QCI) (see 4.6).
 1. Examination (see 4.6.2).
 2. Tests (see 4.6.3).
- d. Control tests (see 4.7)

4.3 Inspection conditions. Unless otherwise specified herein, all inspections shall be performed under the following standard (room ambient) conditions:

Temperature: 20 to 35°C.

Relative humidity: (Uncontrolled room ambient).

Atmospheric pressure: (Site pressure).

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4.3.1 Temperature of electrolyte. Unless otherwise specified herein, the temperature of the electrolyte at the beginning of the tests shall be within $\pm 1^{\circ}\text{C}$ of the test temperature.

4.3.2 Instrument accuracy.

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

4.3.2.2 Electrical indicating. 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.

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

4.3.3 Discharging and charging of the batteries.

4.3.3.1 Discharging. The fully charged battery shall be at a temperature of $27 \pm 3^{\circ}\text{C}$ and 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 3.6.1).

4.3.3.2 Charging. Batteries shall be charged at the rate specified in the applicable specification sheet 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 49°C .

4.3.3.3 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 4.3.3.2) before testing is resumed. A battery shall never be stored for more than 24 hours after a discharge without being recharged.

4.4 First article inspection. Unless otherwise specified (see 6.2), the Government shall select batteries, in accordance with table II, produced under the production contract for first article inspection. First article samples shall be inspected as specified in table III and IV. Approval of the first article sample by the Government shall not relieve the contractor of his obligation to supply batteries that are fully representative of those inspected as a first article sample. Any changes or deviations of the production units from the first article sample shall be subject to the approval of the contracting officer.

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TABLE II. First article samples.

Sample description	Quantity required
Batteries, complete	10 each
Container	3 each
Cell covers	3 each
Vent filler plugs	6 each - 2HN 12 each - 4HN

4.4.1 First article inspection failure. Deficiencies found during, or as a result of the first article inspection shall be cause for rejection of the items until evidence has been provided by the contractor that corrective action has been taken to eliminate the deficiency. Any deficiency found during, or as a result of the first article inspection, shall be evidence that all items already produced prior to completion of the first article inspection are similarly deficient unless contrary evidence satisfactory to the contracting officer is furnished by the contractor. Such deficiencies on all items shall be corrected by the contractor. The Government will not accept products until first article inspection is completed to the satisfaction of the Government.

TABLE III. Classification of inspection.

Title	Requirement	Inspection	In-process inspection	First article	QCI		Control test
					Exam	Test	
Materials and construction Examination	3.3, 3.3.2, 3.3.1, 3.4, 3.4, 3.4.1	4.8.1 4.8.2		X X		X	
Physical characteristics	3.4.2.1, 3.4.3, 3.4.5, 3.4.6, 3.4.10, 3.5.2, 3.7, 3.8, 3.9						
Cell seals	3.4.4	4.8.3		X		X	
Electrical breakdown	3.4.1.1.1	4.8.4.1		X	X		
Acid absorption	3.4.1.1.2	4.8.4.2		X	X		
Impact resistance	3.4.1.1.3	4.8.4.3		X	X		
Bulge resistance	3.4.1.1.4	4.8.5		X	X		
Covers	3.4.2	4.8.6		X	X		
Vent filler plugs	3.4.5	4.8.7		X	X		
Flame retardancy	3.4.5	4.8.7.1		X			
Handles	3.4.6	4.8.8		X	X		X
Grids and plates	3.4.7	4.5	X	X			

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TABLE III. Classification of inspection - Continued.

Title	Requirement	Inspection	In-process inspection	First article	QCI		Control test
					Exam	Test	
Plate connections & intercell connectors	3.4.8	4.5	X	X			
Separators and protectors	3.4.9	4.5	X	X			
Terminal post torque resistance	3.4.10.1	4.8.9		X	X		X
Charged and dry moisture content	3.5.1	4.8.10		X			
Dry cell internal resistance	3.5.1.1	4.8.11	X	X	X		
Performance							
Filled discharge capacity	3.6.2.1	4.8.12		X	X		X
Full charge capacity	3.6.2.2	4.8.13		X		X	
Reserve capacity	3.6.2.3	4.8.14		X		X	X
Low temperature capacity	3.6.2.4	4.8.15		X		X	X
Retention of charge	3.6.3	4.8.16		X		X	
Electrolyte retention	3.6.4	4.8.17		X		X	
Extreme temp. resistance	3.6.5	4.8.18		X		X	X
Vibration resistance	3.6.6	4.8.19		X		X	X
Life cycle capacity	3.6.7	4.8.20		X		X	
Overcharge cycle	3.6.8	4.8.21		X		X	
Storage life	3.6.9	4.8.22		X		X	
Packaging	5.1	4.8.23		X	X		

TABLE IV. Order of first article inspection.

Description	Sample number <u>1/</u>	Requirement	Test
Electrical breakdown	CT1	3.4.1.1.1	4.8.4.1
Acid absorption	CT1/CV1	3.4.1.1.2	4.8.4.2
Impact resistance	CT2	3.4.1.1.3	4.8.4.3 <u>2/</u>
Bulge resistance	CT3	3.4.1.1.4	4.8.5

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TABLE IV. Order of first article inspection. (Continued)

Description	Sample number 1/	Requirement	Test
Cell covers	CV1-3	3.4.2	4.8.6
Vent filler plugs	V1	3.4.5	4.8.7
Flame retardancy	B10	3.4.5	4.8.7.1
Handles	B1	3.4.6	4.8.8
Terminal post torque resistance	B9	3.4.10.1	4.8.9
Dry cell internal resistance	B9	3.5.1.1	4.8.11
Filled discharge capacity	B2-6	3.6.2.1	4.8.12
Full charge capacity	B2-6	3.6.2.2	4.8.13
Reserve capacity	B2-6	3.6.2.3	4.8.14
Low temperature capacity	B2-6	3.6.2.4	4.8.15
Retention of charge	B2 & 3	3.6.3	4.8.16
Electrolyte retention	B2 & 3	3.6.4	4.8.17
Extreme temperature	B2 & 3	3.6.5	4.8.18
Vibration	B2 & 3	3.6.6	4.8.19
Life cycle capacity	B4 & 5	3.6.7	4.8.20
Overcharge cycle	B6 & 7	3.6.8	4.8.21
Storage life	B8 & 9	3.6.9	4.8.22 2/

1/ B = Battery sample
 CT = Container sample
 CV = Cover sample
 V = Vent plug sample set (6 each - 2HN, 12 each-4HN)

2/ 4HN batteries are not
 to be tested to 4.8.4.3
 & 4.8.22

4.5 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 3.4.7, 3.4.8, 3.4.9, and 3.5.1.1. Nonconforming items shall not be used in the battery assembly.

4.6 QCI. QCI shall include the examination of 4.6.2 and the tests of 4.6.3. Noncompliance with any of the specified requirements in sections 3 and 5 shall be cause for rejection of the sample and the inspection lot.

4.6.1 Sampling plan. Unless otherwise specified (see 6.2), the sampling plan specified herein shall be used. See 6.6.1 for definitions of sampling inspection terms.

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

4.6.1.2 Sample. The sample for QCI examination and test shall selected at the rate of four fully completed batteries per each production lot. When production lots exceed 5000 per week, four additional test samples shall be selected and tested.

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4.6.2 Examination. The sample selected in accordance with 4.6.1.2 shall be examined and defects classified as specified in table V (see 4.8.2). The acceptance number in all cases is zero.

TABLE V. Classification of defects.

Category	Defect	Method of inspection
Critical	None	
<u>Major</u>		
101	Maximum dimensional limitations exceeded (see 3.4, 3.4.1, and 3.4.2).	Scale
102	Location and polarity of terminal posts not as specified (see 3.4.10).	Visual
103	Loose terminal posts.	Manual
104	Terminal markings not as specified (see 3.4.10).	Visual
105	Dimensions of terminal posts not as specified (see 3.4.10).	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 2.10 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 3.4.4).	Visual
110	Vent filler plugs and filler caps not as specified (see 3.4.5).	Visual and 4.8.7.1
111	Post seals not as specified (see 3.4.5)	Visual
112	Leaks or cracks in container (see 3.4.1).	4.8.3
113	Cover not proper sealed to container (see 3.4.2).	Visual
114	Vent openings in cover not as specified (see 3.4.2.1).	Visual/ Scale
115	Missing or improper instructions (see 3.8.1 and 3.8.2).	Visual
<u>Minor</u>		
201	Improper marking (see 3.7).	Visual
202	Handles not as specified (see 3.4.6).	Visual
203	Workmanship defects (see 3.9).	Visual

4.6.3 Test. The sample selected in accordance with 4.6.1.2 shall be subjected to the pressure test specified in 4.8.3. The acceptance number in all cases is zero.

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4.6.4 QCI failure. Any item that fails to conform to any specified requirement shall be rejected; any failure (one or more) of the selected sample in either the Major/Minor categories or test for the appropriate inspection lot size shall constitute a failure of the entire lot. The rejected item(s) may be repaired or corrected and resubmitted for inspection. If the contractor utilizes sampling inspection as an element of his inspection system, rejected inspection lots may be resubmitted for acceptance if the contractor performs 100 percent inspection on the lot for those characteristics which were defective and resulted in rejection of the lot and removes all defective units or obtains procuring activity approval to resample the lot due to the insignificance of the defects. Resubmitted lots shall be kept separate from new lots and shall be clearly identified as resubmitted lots.

4.7 Control tests. Control tests shall be done by using one of the following procedures:

a. Samples shall be selected at the rate of four fully completed batteries per each production lot. One battery shall be tested as shown in table VI for each group. Samples shall be examined for the defects specified in table V. When production lots exceed 5,000 per week, four additional test samples shall be selected and tested.

TABLE VI. Control tests (a).

SAMPLE	DESCRIPTION	REQUIREMENT	TEST
I.	<u>Group A tests</u>		
	a. Reserve capacity	3.6.2.3	4.8.14
	b. Low temperature capacity	3.6.2.4	4.8.15
II.	<u>Group B tests</u>		
	a. Filled discharge capacity	3.6.2.1	4.8.12
	b. Reserve capacity	3.6.2.3	4.8.14
	c. Low temperature capacity	3.6.2.4	4.8.15
III.	<u>Group C tests</u>		
	Extreme temperature resistance	3.6.5	4.8.18
IV.	<u>Group D tests</u>		
	a. Terminal post torque resistance	3.4.10.1	4.8.9
	b. Reserve capacity	3.6.2.3	4.8.14
	c. Vibration	3.6.6	4.8.19

b. Samples shall be selected from completed batteries each production day as detailed in table VII. Samples shall have been examined as specified in table V and determined to be acceptable.

TABLE VII. Control tests (b).

Day	Weekly Production Test Group	Batteries
First	B, C	2
Second	B, D	2

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TABLE VII. Control tests (b). (Continued)

Day	Weekly Production Test Group	Batteries
Third	A	1
Fourth	A	1
Fifth	A	1
Sixth	A	1
Seventh	A	1

Once successfully completed tests cover each group (A, B, C, D) of table VII, production lots from those days may be released prior to completion of testing on all Group A batteries, provided all other examinations/tests are acceptable. Alternately, if a manufacturer meets the requirements of the In Plant Quality Evaluation (IQUE) program, then lots shall be identified and shipped on a regular basis without waiting for examination and test results. Examination and testing for each lot shall be completed no later than 21 days from the final day of manufacture of the lot. In either case, the contractor shall be responsible for return/retesting of shipped lots which contain samples that subsequently fail examination and/or testing. Failure of any sample during examination or testing may be cause for the government to refuse to accept subsequent lots until it has been proven to the government's satisfaction that appropriate corrective actions have been implemented.

4.7.1 Control test failures. Failure of a sample to pass any of the tests specified in table VI or VII requires special sampling inspection per the following:

- a. Samples which failed the initial test shall be selected at the rate of two batteries per day.
- b. Retest samples shall be subjected to only the tests required to mode of failure.

4.8 Methods of inspection.

4.8.1 Materials and construction. Conformance to 3.3, 3.3.1 and 3.3.2 shall be determined by inspection of contractor records providing proof or certification that design, construction, processing, and materials conform to requirements. Applicable records shall include drawings, specifications, design data, receiving inspection records, processing and quality control standards, vendor catalogs and certifications, industry standards, test reports, and rating data.

4.8.2 Defects. Conformance to 3.4, 3.4.1, 3.4.2.1, 3.4.3, 3.4.5, 3.4.6, 3.4.10, 3.5.2, 3.7, 3.8 and 3.9, shall be determined by examination for the defects listed in table V. Examination shall be visual or by measurement with standard inspection equipment.

4.8.3 Pressure test. To determine conformance to 3.4.4, each cell of samples to be tested shall be subjected to 3.45 kPa using dry air or nitrogen gas for a period of 30 seconds. A drop in pressure of 0.69 kPa in any cell shall

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be considered a failure of the sample battery. Optional methods of leakage testing may be used if approved by the procuring activity.

4.8.4 Container tests.

4.8.4.1 Electrical breakdown test. To determine conformance to 3.4.1.1.1, the battery container shall be filled with lead or aluminum shot or fitted with a close fitting mandrel or other electrode to within 12.5 mm of the top of the lowest point on the sides, ends, or partitions of the containers. An alternating current potential of 100 V rms per 2.54×10^{-2} mm 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.

4.8.4.2 Acid absorption test. To determine conformance to 3.4.1.1.2, two specimens, each 76 by 76 mm, shall be cut from the partitions of the container. After being measured with calipers and weighed in the dry condition at plus $27 \pm 6^\circ\text{C}$, each specimen shall be immersed in a covered vessel containing 150 ml of sulfuric acid solution of 1.300 specific gravity at 27°C . The vessel shall be held for seven days in an oven at $66 \pm 3^\circ\text{C}$. At the end of the heating period, the 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.

4.8.4.3 Impact resistance test. To determine conformance to 3.4.1.1.3, 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 a $66^\circ\text{C} \pm 3^\circ\text{C}$, -18°C and -40°C atmosphere. Impact resistance shall be determined by a one 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 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 25 mm longer and wider than the container. The container shall be positioned in such a manner that the ball will strike 1/3 down from the top of the container on the centerline of the sides of each cell and on the center of each cell area (where thickness is uniform). Testing of post cells is not required.

4.8.5 Bulge resistance. To determine conformance to 3.4.1.1.4, the bulge resistance of the battery container shall be measured and determined as follows:

- a. Place an empty container, to be tested, in an appropriate rigid metal tray.
- b. Fill the container to within 25 mm of the top with commercial grade polyethylene glycol at $93^\circ\text{C} \pm 3^\circ\text{C}$.
- c. Place the tray, containing the container to be tested, in an oven and maintain the polyethylene glycol at $93^\circ\text{C} \pm 3^\circ\text{C}$.

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- d. When the liquid in the end cell adjacent to the end wall, to be measured, reaches a temperature of $93^{\circ}\text{C} \pm 3^{\circ}\text{C}$, start a one hour soak time.
- e. At the end of the soak period, remove the tray containing the container being tested, from the oven and within five minutes, measure the end wall bulge, using the spider arrangement. The polyethylene glycol is to remain in the test container until the completion of the measurements.
- f. The bulge shall be determined by comparing the center of the end wall with the plane of the four corners exposed. The center of the end wall is defined as a point half way between the horizontal parting line at the bottom and the bottom of the top band.
- g. Bulge is to be reported as the difference as determined in subparagraph f.
- h. The bulges in the container shall be measured to determine conformance to 3.4.1.1.4.

4.8.6 Battery cover physical characteristics test. To determine conformance to 3.4.2, covers shall be tested as specified in 4.8.4.1, 4.8.4.2, and 4.8.4.3 with appropriate modifications in samples and procedures to accommodate different characteristics of covers. Results shall be evaluated as specified in referenced paragraphs.

4.8.7 Vent filler plug thermal and pressure resistance test. To determine conformance to 3.4.5, each vent filler plug from the battery under test (see footnote to table IV) shall be placed in an ambient air temperature of $-54 \pm 1^{\circ}\text{C}$ for two 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 $121 \pm 3^{\circ}\text{C}$ 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 12.07 kPa (water head of 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 3.45 kPa above the pressure existing on the upper side. Plug shall open under specified pressure.

4.8.7.1 Vent plug flame retardancy test. To determine conformance to 3.4.5, type 2HN battery and vent plugs shall be tested for flame retardancy per SAE J1495.

4.8.8 Handle test (4HN battery only). To determine conformance to 3.4.6, the handle and bond areas shall be saturated with electrolyte conforming to 3.3.2 and air dried twice daily for two days. The handle and bond areas shall again be saturated. The battery shall then be placed in an ambient air temperature of $88^{\circ} \pm 2^{\circ}\text{C}$ for 60 minutes, allowed to cool to room temperature, and again heated at $88^{\circ} \pm 2^{\circ}\text{C}$ for 60 minutes. The battery shall then be removed from the oven and immediately lifted once by the handle in a vertical direction with a

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force of two times the filled battery weight, but not to exceed 890 N. The supporting rope shall be taut prior to the application of the force. The handle shall be supported over a length of 114 mm during test. The handle support shall have a radius of 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 3.4.6. After the test, the battery shall be placed in an ambient air temperature of $-54 \pm 2^{\circ}\text{C}$ for 24 hours. The battery shall be removed from the cold box and immediately subjected to three lifts as previously specified.

4.8.9 Terminal post torque resistance test. To determine conformance to 3.4.10.1, an increasing torque up to 28.2 N m (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 strap and connecting plates or of the seal between the posts and the cell cover.

4.8.10 Charged and dry moisture test. To determine conformance to 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 74 to 77°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. To determine conformance to 3.5.1.1, the cell terminal-to-terminal resistance shall be measured with an ohmmeter, bridge, or other test instrument.

4.8.12 Filled discharge capacity test (high discharge rate at 27°C without supplementary charge). To determine conformance to 3.6.2.1, this test shall apply only to batteries furnished in charged and dry condition. After battery and electrolyte have been stabilized at a temperature of $27 \pm 3^{\circ}\text{C}$, the battery shall be filled with electrolyte. The electrolyte shall conform to 3.3.2. 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 150 amperes for 2HN, and at 75 amperes for 4HN with the battery in a water bath or controlled air temperature of $27 \pm 3^{\circ}\text{C}$ 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.

4.8.13 Full charge capacity test at 27°C. To determine conformance to 3.6.2.2, the test battery, full charge capacity rating (ampere-hours) shall be determined as follows:

- a. Charge battery before each discharge in accordance with 4.3.3.2.
- b. The temperature of the battery at the beginning of each discharge shall be $27 \pm 3^{\circ}\text{C}$, and the temperature shall be maintained within this range by means of a water bath or controlled air temperature condition during discharge.

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- c. Discharge battery in accordance with 4.3.3.1, 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 of the battery under test. Exception: If the ampere-hour capacity is met in step c or d, extra steps are not required.

4.8.14 Reserve capacity test. To determine conformance to 3.6.2.3, reserve capacity tests shall be conducted as follows:

- a. Charge battery before each discharge in accordance with 4.3.3.2.
- b. The temperature of the battery at the beginning of each discharge shall be $27 \pm 3^{\circ}\text{C}$, 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 an average terminal voltage of 1.75 volts per 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. Exception: If the reserve capacity requirement is met in step c or step d, remaining steps through step e are not required.

The following correction factor shall be used to compensate for electrolyte temperature variation from the stabilized $27 \pm 3^{\circ}\text{C}$.

$M_c = M_r (1 - 0.009 (T_c - 27))$
 M_c = Corrected minutes
 M_r = Minutes run
 T_c = Temperature at one end of discharge, $^{\circ}\text{F}$ 1/
 0.009 = Temperature correction factor

1/ Results not valid if electrolyte temperature is above 32°C or below 21°C at completion of test.

4.8.15 Low temperature capacity test. To determine conformance to 3.6.2.4, the test for high discharge rate at -18°C and -40°C shall be performed as follows:

- a. Charge battery in accordance with 4.3.3.2.
- b. Place battery in cold chamber having a temperature of $-40 \pm 1^{\circ}\text{C}$.
- c. When the electrolyte has stabilized for one hour at $-40 \pm 3^{\circ}\text{C}$ and immediately upon removal from the cold chamber, the battery shall be discharged 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. At this time, the voltage shall be measured to determine conformance to 3.6.2.4.

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- e. If a battery fails the test, it shall be retested. The retested battery shall be charged in accordance with 4.3.3.2, with electrolyte stabilized at $27 \pm 3^{\circ}\text{C}$, 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.

4.8.16 Retention of charge test. To determine conformance to 3.6.3, the retention of charge test shall be performed as follows:

- a. Charge battery as specified in 4.3.3.2. Store battery for 30 days at a temperature maintained at $40 \pm 3^{\circ}\text{C}$.
- b. Discharge battery as specified in 4.3.3.1.
- c. Record time of discharge in minutes.

4.8.17 Electrolyte retention test. To determine conformance to 3.6.4, the batteries shall be tilted through 45 degrees from a plane normal to the bottom of 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.

4.8.18 Extreme temperature resistance test. To determine conformance to 3.6.5, batteries shall be subjected to two thermal cycles. An internal pressure of 3.45 kPa shall be applied to each cell individually, in parallel with a manometer at $27 \pm 3^{\circ}\text{C}$ for 30 seconds before and after each complete cycle. Drop in pressure in individual cells shall be regarded as an indication of leakage. The following procedure for one cycle shall be used:

- a. Battery shall be placed in an ambient air temperature of minus $-54 \pm 1^{\circ}\text{C}$ for 24 hours or until electrolyte is stabilized.
- b. The battery shall then be placed in an ambient air temperature of $88 \pm 1^{\circ}\text{C}$ for 24 hours.
- c. The battery shall be allowed to cool gradually to $27 \pm 6^{\circ}\text{C}$ for 24 hours.

4.8.19 Vibration resistance test. To determine conformance to 3.6.6, the test battery that has been tested as specified in 4.8.12 and 4.8.13 shall be stabilized, then subjected to 4.8.13a, b, and c in an ambient air temperature of $27 \pm 6^{\circ}\text{C}$ 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 $27 \pm 6^{\circ}\text{C}$ 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 amplitude of 1.1 to 1.3 mm (total vertical excursion 2.3 to 2.5 mm). During this test the battery shall be discharged as specified in 4.8.13c. The test shall be repeated for one hour, except that the battery shall be chilled to, and the electrolyte stabilized at, a temperature of $-40 \pm 0.5^{\circ}\text{C}$ for one hour 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

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27 \pm 6°C until the electrolyte is stabilized, then charged and discharged at the reserve capacity rate and the time recorded to reach 1.75 volts per cell. After testing, the battery shall be disassembled and examined for damage.

4.8.20 Life-cycle capacity tests. To determine conformance to 3.6.7, life tests shall consist of a series of cycles of discharge and charge in accordance with the applicable test specified in 4.8.1. Immediately prior to the beginning of the test, the battery shall be fully charged as specified in 4.3.3.2. Tests shall be performed with the battery in a water bath with the temperature maintained at 38 \pm 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 4.3.3.2 and tested as specified in 4.8.13. 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.

4.8.20.1 Life-capacity discharge cycles. To determine conformance to 3.6.7, the test shall consist of a total of 235 discharge/charge cycles including normal and weekly cycles and cycles obtained 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 10 amperes and charge for 5 hours at 2.5 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 per paragraph 4.3.3.2 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.

4.8.21 Overcharge cycle test. To determine conformance to 3.6.8, the test shall be conducted with the specimen in approximately 150 mm of water, and with the water bath maintained within the temperature range of 38 \pm 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 500 ampere-hours shall be applied at a rate of 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.

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- c. The batteries shall be discharged at 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.

4.8.22 Storage life performance.

4.8.22.1 60-day storage life performance. To determine conformance to 3.6.9, 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 per 4.8.12.

4.8.23 Inspection of packaging. Packaging inspections shall be accomplished in accordance with the quality assurance provisions of the applicable packaging sheet as selected from paragraph 5.1 (see 6.2).

4.8.24 Inspection of Material Safety Data Sheet (MSDS). Material Safety Data Sheet shall be inspected to determine conformance to FED-STD-313 (see 3.10).

5. PACKAGING

5.1 Preservation, packaging, and packing. Charged wet and dry batteries shall be cleaned, dried, preserved, packaged, and packed to the desired level of protection in accordance with PPP-B-140 or the applicable packaging sheet as specified (see 6.2).

5.1.1 Marking. 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 packaged and transported in conformance to DOT Regulation 49 CFR.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

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.

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6.2 Acquisition requirements. Acquisition document must specify the following:

- a. Title, number and date of this specification.
- b. Type designation, battery condition, and PIN number required (see 1.2, 3.5 and 6.6).
- c. Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1.1 and 2.2).
- d. If first article is required (see 3.2).
- e. If responsibility for inspection and the place of inspection is other than the contractor's (see 4.1).
- f. Arrangements for first article inspection and rights of the Government (see 4.4 and 6.3).
- g. Sampling plan if other than as specified (see 4.6.1).
- h. Any special marking requirements (see 5.1.1).
- i. Level of preservation, packaging, and packaging in accordance with PPP-B-140 of the applicable packaging data sheet (see 5.1).
- j. Identify activities requiring copies of completed MSDS and specify when the MSDS will be inspected (see 3.10 and 6.11).

6.3 First article. When first article inspection is required, the contracting officer should provide specific guidance to offerers on: whether the sample(s) should be a preproduction sample, a first article sample, and initial production sample, a first production item or a standard production item from the contractor's current inventory; the number of samples to be inspected as specified in 6.2; and (when applicable) the specific tests to be performed on each sample. The contracting officer should also include specific instructions in acquisition documents regarding arrangements for examinations, approval of first article test results, and disposition of first articles. Invitations for bids should provide that the Government reserves the right to waive the requirements for samples for first article inspection to those bidders offering a product which has been previously acquired or tested by the Government, and that bidders offering such products, who wish to rely on such production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending contract. Bidders should not submit alternate bids unless specifically requested to do so in the solicitation.

6.4 Subject term (key-word) listing.

Batteries
Storage Batteries
Lead-Acid Batteries

6.5 Supersession data. Battery type 6TN has been superseded and replaced by type 6TL purchased under military specification MIL-B-62346.

6.6 Definitions.

6.6.1 Definitions of terms used in sampling inspection.

a. Classification of defects. A classification of defects is the enumeration of possible defects of the unit of product classified according to

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their seriousness. A defect is any nonconformance of the unit of product with specified requirements. Defects will normally be grouped into one or more of the following classes: critical, major and minor defects. Also, defects may be grouped into other classes, or into subclasses within these classes.

b. Critical defects. A critical defect is a defect that judgement and experience indicate would result in hazardous or unsafe conditions for individuals using, maintaining, or depending upon the product; or a defect that judgement and experience indicate is likely to prevent performance of the tactical function of a major end item such as a ship, aircraft, tank, missile, or space vehicle.

c. Critical defective. A critical defective is a unit of product which contains one or more critical defects and may also contain major and/or minor defects.

d. Defective. A defective is a unit of product which contains one or more defects.

e. Formation of lots or batches. The product shall be assembled into identifiable lots, sublots, batches, or in such other manner as may be prescribed (see 1). Each lot or batch shall, as far as is practicable, consist of units of product of a single type, grade, class, size, and composition, manufactured under essentially the same conditions, and at essentially the same time.

f. Lot or batch. The term lot or batch shall mean "inspection lot" or "inspection batch", i.e., a collection of units or product from which a sample is to be drawn and inspected and may differ from a collection of units designated as a lot or batch for other purposes (e.g., production, shipment, etc.).

g. Lot or batch size. The lot or batch size is the number of units of product in a lot or batch.

h. Major defect. A major defect is a defect, other than critical, that is likely to result in failure, or to reduce materially the usability of the unit of product for its intended purpose.

i. Major defective. A major defective is a unit of product which contains one or more major defects, and may also contain minor defects but contains no critical defect.

j. Minor defect. A minor defect is a defect that is not likely to reduce materially the usability of the unit of product for its intended purpose, or is a departure from established standards having little bearing on the effective use or operation of the unit.

k. Minor defective. A minor defective is a unit of product which contains one or more minor defects but contains no critical or major defect.

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1. Presentation of lots or batches. The formation of the lots or batches, lot or batch size, and the manner in which each lot or batch is to be presented and identified by the supplier shall be designated or approved by the responsible authority. As necessary, the supplier shall provide adequate and suitable storage space for each lot or batch, equipment needed for proper identification and presentation, and personnel for all handling of product required for drawing of samples.

m. Representative sampling. When appropriate, the number of units in the sample shall be selected in proportion to the size of sublots or subbatches, or parts of the lot or batch, identified by some rational criterion. When representative sampling is used, the units from each part of the lot or batch shall be selected at random.

n. Sample A sample consists of one or more units of product drawn from a lot or batch, the units of the sample being selected at random without regard to their quality. The number of units or product in the sample is the sample size.

o. Sampling plan. A sampling plan indicates the number of units of product from each lot or batch which are to be inspected (sample size or series of sample sizes) and the criteria for determining the acceptability of the lot or batch (acceptance and rejection numbers).

p. Time of sampling. Samples may be drawn after all the units comprising the lot or batch have been assembled, or samples may be drawn during assembly of the lot or batch.

6.6.2 Recovered materials. "Recovered materials" means materials that have been collected or recovered from solid waste (see 6.6.3).

6.6.3 Solid waste. "Solid waste" means (a) any garbage, refuse, or sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility; and (b) other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining and agricultural operations, and from community activities. It does not include solid or dissolved material in domestic sewage, or solid or dissolved material in irrigation return flows, or industrial discharges which are point sources subject to permits under section 402 of the Clean Water Act, (33 U.S.C. 1342 et seq.), or source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954 (42 U.S.C. 2011 et seq.) (Source: Federal Acquisition Regulations, section 23.402).

6.7 Cross-reference. The following tabulation is a cross-reference of the new PIN numbers to the previous MS part numbers (P/N) for interchangeability and substitutability purposes:

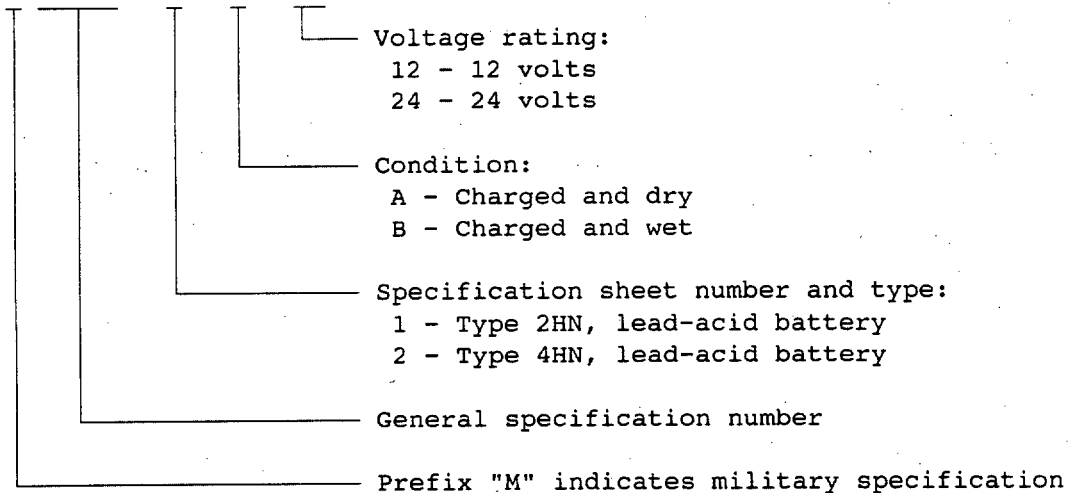
PIN No.	Former MS P/N	Battery
		Type-Condition-Voltage
M11188/1-A-12V	MS35000-1	2HN-charged & dry-12V
M11188/1-B-12V	MS35000-2	2HN-charged & wet-12V
M11188/2-A-24V	MS75047-1	4HN-charged & dry-24V
M11188/2-B-24V	MS75047-2	4HN-charged & wet-24V

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6.8 Batteries for immediate use. Batteries should be procured in the charged and wet condition only when necessary for immediate use since wet batteries are not suitable for storage. Batteries procured for depot stock or which are not for immediate use should be procured in the charged and dry condition.

6.9 Part or Identifying Number (PIN). The following describes the PIN number construction for use with batteries acquired under this specification:

M 11188 / X - X - XX



6.10 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, are covered in MIL-B-11188/1 and MIL-B-11188/2. 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.

6.11 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.

6.12 MSDS. The contracting officer should identify those activities requiring copies of the completed MSDS prepared in accordance with FED-STD-313. Additional pertinent Government mailing addresses for submission of data are listed in appendix B of FED-STD-313 (see 3.10 and 6.2).

6.13 AMC policy on AQLs/LTPDs. This specification is certified to be in compliance with current Army Materiel Command (AMC) policy for the elimination of AQLs/LTPDs (Acceptable Quality Levels/Lot Tolerance Percent Defectives) from military specifications.

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Custodians:

Army - AT
Air Force - 99
Navy - YD1

Preparing activity:

Army - AT

(Project 6140-0756)

Review activities:

Army - ER
Air Force - 80
Navy - AS
DLA - GS

User activities:

Army - MI, ME
Navy - MC

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements. FSC 6140

I RECOMMEND A CHANGE:		1. DOCUMENT NUMBER MIL-B-11188H	2. DOCUMENT DATE (YYMMDD) 94/09/13
3. DOCUMENT TITLE BATTERIES, STORAGE: LEAD-ACID, GENERAL SPECIFICATIONS FOR (METRIC)			
4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)			
5. REASON FOR RECOMMENDATION			
6. SUBMITTER			
a. NAME (Last, First, Middle Initial)		b. ORGANIZATION	
c. ADDRESS (Include Zip Code)		d. TELEPHONE (Include Area Code) (1) Commercial (2) AUTOVON (If applicable)	7. DATE SUBMITTED (YYMMDD)
8. PREPARING ACTIVITY			
a. NAME		b. TELEPHONE (Include Area Code) (1) Commercial (2) AUTOVON	
c. ADDRESS (Include Zip Code)		IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT:	
COMMANDER U.S. ARMY TANK - AUTOMOTIVE COMMAND ATTN: AMSTA-GLC WARREN, MICHIGAN 48397-5000		Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466 Telephone (703) 756-2340 AUTOVON 289-2340	