NOT MEASUREMENT SENSITIVE

MIL-STD-3078
14 NOV 2024

DEPARTMENT OF DEFENSE INTERFACE STANDARD

INTEROPERABILITY STANDARD FOR BATTERIES UTILIZED IN ARMY EQUIPMENT

AMSC N/A

FSG 61GP

DISTRIBUTION STATEMENT A: Approved for public release. Distribution is unlimited

FOREWARD

1. This standard is approved for use by the Department of the Army and is available for use by all Departments and Agencies of the Department of Defense.

2. This standard provides information to ensure interoperability between systems and batteries utilized in the Army.

3. Additional information can be found at https://battery.army.mil

4. Comments, suggestions, or questions on this document should be addressed to emailed to usarmy.apg.cecom.mbx.ilsc-pe-pscoe-support@army.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at https://assist.dla.mil.

CONTENTS

LIST OF TABLES

1 SCOPE

1.1 Scope. This document provides the interface standard for Army systems utilizing replaceable batteries. It provides information to ensure interoperability of batteries across systems within the Army.

2 APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 of this Standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, or 5 of this standard, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, 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 cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-PRF-32143	-	Batteries, Storage: Automotive, Valve Regulated Lead Acid (VRLA)
MIL-PRF-32271	-	Non-Rechargeable, Lithium General Specification for
MIL-PRF-32271/1	-	Battery, Non-Rechargeable, Lithium
MIL-PRF-32383	-	Batteries, Rechargeable, Sealed General Specification for
MIL-PRF-32383/4	-	Battery, Rechargeable, Sealed, Conformal Wearable Battery (CWB), BB-2525
MIL-PRF-32383/5	-	Battery, Rechargeable, Sealed, BB-2590B/U
MIL-PRF-32383/7	-	Battery, Rechargeable, Sealed, Small Tactical Universal Battery (STUB), BB-251X/U and BB-252X/U
MIL-PRF-32565	-	Battery, Rechargeable, Sealed, 6T Lithium-Ion

(Copies of these documents are available online at https://quicksearch.dla.mil.)

2.3 Non-Government publications 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 cited in the solicitation or contract.

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C18.3M - Portable Lithium Primary Cells and Batteries — General and Specifications

(Copies of this document is available online at https://www.nema.org.)

3 DEFINITIONS

3.1 Battery. A packaged electrochemical energy storage device consisting of one or more cells used to provide electrical power to an end item.

3.2 Cell. The basic building block of a battery and where an electrochemical reaction takes place to convert chemical to electrical energy.

3.3 Charge (noun). The amount of electrical energy stored in a cell or battery, often presented as a percentage of the maximum energy available.

3.4 Charge (verb). To increase the available energy in a battery or cell via externally applied electrical energy.

3.5 Charger. A device used to charge rechargeable batteries using electrical current.

3.6 Chemistry (battery). The basic chemical(s) that react to produce energy within a cell is called its chemistry. Lithium ion, Lithium - sulfur dioxide, and lithium - manganese dioxide are examples of battery cell chemistries.

3.7 Commercial of the Shelf (COTS). An item that is ready-made and commercially available to the general public.

3.8 Form factor.The physical and electrical interface of a battery is referred to its form factor. Multiple technologies are often produced in the same form factor and can be used interchangeably. The form factor is sometimes referred to as the battery configuration.

3.9 Military standard battery. Batteries defined by open and published Military Performance (MIL-PRF) Specification.

3.10 Non-rechargeable battery. A battery that cannot be re-used after its available energy has been depleted. Also known as a primary battery (see 3.13).

3.11 Open standard. A technical standard which available for use by the general public and free from proprietary restrictions.

3.12 Preferred military battery. A subset of military standard batteries (see 3.9) that have been selected due to their availability and ability to reduce battery proliferation and life cycle costs (see 5.2)

3.13 Primary battery. A battery that cannot be re-used after its available energy has been depleted. Also known as a non-rechargeable battery (see 3.10).

3.14 Rechargeable battery. A battery which is capable of repeated use by of having its energy restored via a charger (see 3.5). Also known as a secondary battery (see 3.15)

3.15 Secondary battery. A battery which is capable of repeated use by of having its energy restored via a charger (see 3.5). Also known as a rechargeable battery (see 3.14)

4 GENERAL REQUIREMENTS

4.1 System requirements. United States Army systems utilizing replaceable batteries shall use either military standard batteries (see 5.1) or select COTS batteries (see 5.3) subject to the requirements listed in this document. Preferred military batteries (see 5.2) shall be given precedence over other military standard batteries (see 5.1.1).

4.1.1 Other battery types. Various policy documents require the use of standard batteries as defined in this document. For more information and questions regarding processes for including non-standard batteries see https://battery.army.mil or contact the author of this document (see FOREWORD 4).

4.2 Non-replaceable batteries. Batteries that are permanently installed in a system and not designed to be replaced are not subject to the requirements of this document. Some examples of non-replaceable batteries are a reserve battery in an armament or a COTS item with an embedded rechargeable battery.

5 DETAILED REQUIREMENTS

5.1 Military standard batteries. Military standard batteries are produced to Government performance requirements and may include commercial open standards. The details of these requirements can be found in published Military Performance Specifications (MIL-PRFs). A single battery form factor (see 3.8) may be available in multiple chemistries (see 3.6) and/or in both rechargeable (see 3.14) and non-rechargeable (see 3.10) formats. System interfaces should be designed to accommodate as many variants as possible. For more information on accommodating multiple variants see Appendix A.

5.1.1 Obsolescence. The United States military has been developing standard batteries for many years. Over time, many of these formats have become obsolete, are nearing obsolescence, or are at risk of obsolescence. To address this issue, this document provides a list of military standard batteries which are recommended for future design (see TABLE I). Prior to choosing a military standard battery not listed, the author of this document should be contacted (see FOREWORD 4) for information on the battery's obsolescence status.

5.2 Preferred military batteries. The military standard batteries listed in TABLE I are recommended for new system design.

TABLE I. Preferred military batteries

Battery Configuration	Example Nomenclatures[1]	Description[2]	Specification	
			Non-Rechargeable	Rechargeable
XX72	BA-5372#	Low power, cylindrical	MIL-PRF-32271/8	N/A
Small Tactical Universal Battery (STUB)	BB-2511# BB-2512# BB-2513# BB-2514# BB-2521# BB-2522# BB-2523# BB-2524#	Family of multiple sized batteries sharing same connectors and voltage characteristics. Regulated voltage output.	N/A	MIL-PRF-32383/7
XX90	BA-5590# BA-5390# BA-5790# BB-2590#	Rectangular box shaped, dual voltage	MIL-PRF-32271/1	MIL-PRF-32383/3 MIL-PRF-32383/5
Conformal Wearable Battery (CWB)	BB-2525#	Flat, flelexible, designed to be Soldier worn	N/A	MIL-PRF-32383/4
6T	N/A	Box shaped, high power	N/A	MIL-PRF-32565 MIL-PRF-32143

NOTES
1. The '#' in nomenclatures is the placeholder for the modification letter (i.e. the generation) and installation indicator of the battery. A full battery nomenclature will be in a form of BA-1234A/U. For more information, see MIL-STD-196.
2. Descriptions are generalized, for full details see referenced specifications.
3. As of the time of publication of this document, there is not yet a common standard battery specifically designed for aviation applications. Work is ongoing to develop this standard.

5.3 Approved open standard commercial off the shelf batteries. The batteries listed in TABLE II are defined by ANSI C18.3M, and have been selected due to their size, performance, and availability within the DoD supply system. Whenever multiples of the items listed below are used to power an item, the number of cells shall be limited to stated number for safety reasons.

TABLE II. Approved open standard COTS batteries

ANSI Designation	Common Designation	CHEMISTRY	NSN[1]	CELL LIMIT
ANSI 15LF	'Lithium' AA	Lithium Iron Disulfide[2]	6135-01-333-6101	4
ANSI 24LF	'Lithium' AAA	Lithium Iron Disulfide[2]	6135-01-521-0378	4
5018LC	xx123	Lithium Manganese Dioxide	6135-01-351-1131	4
5004LC	xx2032	Lithium Manganese Dioxide	6135-01-210-8715	2

NOTES

1. NSNs are provided as examples and for informational purposes only and should not be considered as a definitive description of the battery interface. Full interface parameters shall be as described in the referenced specifications.
2. While these batteries are also available in alkaline and nickel metal hydride (NiMH) variants, these chemistries are not well suited to a tactical environment.

6 NOTES

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

6.1 Intended use. This standard is to be used by system developers when selecting a battery for a system under development.

6.2 Acquisition requirements. Acquisition documents for systems utilizing batteries should specify the following:

a. Title, number, and date of this standard.
b. System level parameters that can affect battery selection, including but not limited to
   i. Weight
   ii. Runtime
   iii. Operating environment
   iv. Availability of charging infrastructure
   v. Battery/batteries already in use by complimentary or existing systems

6.3 Supersession data. This document supersedes the *Preferred Battery List* published by the Power Sources Center of Excellence (PSCOE).

6.4 Key word listing.

Electronics
Lithium
Smart battery
System development
Vehicle

APPENDIX A

1 SCOPE

1.1 Scope. This appendix provides an overview of selecting a battery and properly integrating the battery into a system's design. It is a collection of general information, best practices, and lessons learned; but should not be viewed as an exhaustive authority on system development. Specific measurements, values, and limits are not discussed here as they vary from battery to battery. The reader is encouraged to do their due diligence in researching the chosen battery and assuring the system meets all safety, performance, logistical, and interoperability requirements. Additional information is located on https://battery.army.mil.

2 BATTERY SELECTION

2.1 Choosing a battery. Battery selection is based on meeting system requirements for size, weight, voltage, and runtime. Rechargeable batteries reduce life cycle costs, eliminate resupply logistics, but require tactical environment recharging. Primary (throwaway) batteries can provide longer runtimes and power in tactical environments where recharging is not possible. Some batteries (form, fit, function) are available in both rechargeable and non-rechargeable versions.

It is strongly recommended that the battery and charger selection/design process begin early in the end item development to avoid complications in integrating the battery into the end item or getting approvals for use.

2.1.1 Joint platforms. The Navy's Naval Sea Systems Command maintains a list of preferred batteries by domain. Developers for Army systems that will also be utilized by Navy or USMC personnel or platforms should consult with Naval Sea Systems Command when making a battery selection.

2.2 Battery characteristics. Batteries have unique physical, environmental, and electrical parameters to consider when selecting the battery configuration. It is worth noting that a given configuration may contain multiple technologies/chemistries with differing performance. To understand the characteristics and limitations of a given battery, developers should reference the source documentation and specifications for each battery considered.

2.3 Battery specifications

2.3.1 'Base specifications' and 'slash sheets'. Military standard batteries are specified by a combination of documents compromising a Military Performance (MIL-PRF) specification. The main document, often referred to as the 'base specification' or 'base spec' contains the characteristics that multiple different battery form factors share based on the same technology(ies) they have in common. Commonalties include such characteristics as environmental and safety. Base specifications also contain optional characteristics that are still common but not present in all form factors. An example of this would be what communication protocol (if any) the battery uses or how deep of immersion the battery is expected to survive. Unique characteristics of each battery are defined in the 'slash sheets'. (Slash sheets get their name because they share the same specification number with their base specification followed by a slash '/' and then a number indicating their order of publication.) The slash sheet will contain the battery's form, fit, and function characteristics, battery-configuration-specific performance requirements, and specify which optional characteristics are applicable. It will also contain detailed pass/fail criteria to ensure specification compliance. Multiple chemistries having the same form factor may be on the same slash sheet.

2.3.2 Specification paragraphs. Military Performance specifications contain 6 sections:

1. Scope
2. Applicable Documents
3. Requirements
4. Verification
5. Packaging
6. Notes

While most of these sections are self-explanatory, sections 3 and 4 contain the main technical information for the battery. Section 3, requirements, contains all technical attributes that a battery must achieve in terms of threshold values with strict pass/fail criteria. Section 4, verification, prescribes the methodology and test parameters used to verify the requirements of section 3.

2.3.3 Design to the specification (not the hardware). **System developers should design their hardware to accommodate all specification tolerances to include dimensional and electrical. They should avoid designing to a particular physical battery representation (i.e. a manufactured product), regardless of whether it complies to the specification.** Batteries are built to performance specifications and are not built to print. Any battery characteristics outside of specified requirements cannot be relied upon.

Specifications and drawings contain minor dimensional tolerances to allow for flexibility of design for manufacturability. This means that two vendors producing the same battery may have slightly different sizes (i.e. differences measured in thousandths of inch). These variances can even be within the same vendor's battery following an update to their design. **The end item battery compartment design should accommodate the specified dimensional tolerances.**

Performance (capacity, rate capability, temperature range, cycle life, etc) parameters of specifications are in terms of threshold values. For example, a battery may be required to maintain a 10A load. This means that if a battery can carry a 20A load, it meets the requirement. This does not guarantee that other vendors' batteries can meet the 20A load nor does it guarantee that same vendor's future products will as well. **The end item design should only rely on the specified performance of a battery.**

2.3.4 Inspections. Military performance specifications contain multiple levels of inspections for batteries. During the initial qualification of batteries, called First Article Inspection (testing associated with this inspection is known as First Article Test (FAT)), sufficient batteries are produced and tested such that all requirements will be verified. During on-going production, all batteries receive acceptance inspection. Additionally, samples are selected from every production lot for quality control testing.

2.3.5 Configuration control. Batteries procured to Military Performance Specifications are subject to strict configuration control. After passing FAT, the design, processes, and procedures to produce a battery are frozen to ensure batteries do not deviate from the established requirements. **Procuring approved batteries only through the standard supply system will ensure batteries meet specification requirements and undergo all required inspections.**

2.4 Environmental characteristics

2.4.1 Physical. Military batteries are designed to be reliable and safe when subjected to the rigors of a combat environment, but not all batteries are required to meet the same levels of durability. For example, batteries to be used inside a protective battery compartment may be less durable than ones designed mounted externally to an end item. Generally, non-rechargeable batteries are less rugged than their rechargeable counterparts as they only need to survive a single mission. For example, a rechargeable battery may be required to be fully operation following an immersion, whereas its non-rechargeable counterpart may just be required to not pose any hazard to the user following an immersion. System developers should review the requirements for all variants of a chosen form factor.

2.4.2 Thermal. Batteries are optimal when stored and operated at moderate temperature conditions; temperature extremes can be detrimental to the available capacity and/or cycle life.

2.4.2.1 High temperature. Storage at high temperatures can permanently damage batteries and affect their capacity and performance. During operation, in addition to ambient conditions, batteries create their own heat due to internal impedances. This effect is called ‘self-heating’ and is proportional to the load applied.

Charging or operating at too high a temperature can pose safety concerns, and because of this, all batteries feature thermal cutoffs to protect the battery. These may be temporary thermal switches and/or permanent thermal fuses. **These thermal protections are in place for user safety to prevent cell venting, and should not be relied upon as an active form of protection. The end item should self-limit its load on the battery to ensure safe operating conditions.** Smart batteries can communicate their operating temperature to the system being powered (see 7.5).

2.4.2.2 Low temperature. Storage at low temperatures will not damage batteries. Operating at low temperatures will decrease the battery capacity available (runtime) and lower the operating voltage. At extreme temperatures, the battery’s cells may cease to be functional. Low temperature performance is based on battery chemistry and the size of the battery. System developers should understand the low temperature performance of their system battery. Low temperature charging of lithium-ion batteries is dangerous. **When operating at extreme cold temperatures, the electronic components in the battery may malfunction leading to erratic and/or unsafe operating conditions.**

2.5 Electrical characteristics. The electrical characteristics of a battery are determined by the cell technology, the series and parallel cell configuration, safety components (thermal and electrical fuses, diodes, etc.), the current (amperage) rating of the connector, and other design choices. Batteries are rated with nominal voltages which represent the average battery voltage under a “medium” load. Batteries do not have a constant output voltage unless there is a voltage regulator integrated into the battery (which is rare). End items should be designed to use the entire operating voltage range of the battery as outlined in the battery specification.

A cell’s chemistry determines the voltage of an individual cell, while its power output is a function of both the technology and design choices made. These cells are then packaged together to create a battery. Because the chemistry determines the voltage, battery voltages are limited to multiples of cell voltages (unless there are regulating electronics on the output). If a target voltage of 10V is desired, and the cell were to have a 3V output, a battery would have to be either 9V or 12V but could not be 10V. This is why battery form factors that are available in multiple chemistries have slightly different voltages. Systems should be designed, at a minimum, to accept output voltages of all battery chemistries available for the chosen form factor. Additional leeway should be designed into the system to accept wider voltages and accommodate future technologies.

2.5.1 Open-circuit voltage (OCV). *Open-circuit voltage (OCV) is the difference in electrical potential between two battery terminals when disconnected from any circuit and there in no current flowing.*

The cell chemistry and internal cell configuration drives the battery OCV. Normally, OCV is the highest voltage produced by a battery, and end item input circuitry should be designed accordingly.

2.5.2 Closed-circuit voltage (CCV). *Closed-circuit voltage (CCV) is the difference of electrical potential between two battery terminals when discharging through a specified load circuit.*

The cell chemistry and internal cell configuration drive the CCV. While the CCV is specified for a given load, it can be taken as an approximation of the highest operating voltage for a given battery. As the battery's capacity is consumed, the operating voltage of the battery will continue to decrease until the cutoff voltage (see Appendix A 2.5.3).

2.5.3 Cutoff voltage. *The cutoff voltage for a battery is used for capacity and initial voltage delay (see Appendix A 2.5.7) measurements of batteries.*

Capacity tests generally terminate when the battery voltage falls below this threshold. Because batteries are described by performance specifications, a battery's behavior below cutoff voltage is often not specified and cannot be relied upon to be consistent across vendors or even different iterations of the same vendor's product. Some load condition/battery chemistry combinations of discharging a battery beyond its cutoff voltage can be abusive and result in a safety event. Batteries should not be operated below their cutoff voltage.

2.5.4 Nominal voltage. *The nominal voltage of a battery is the average voltage of a battery discharged under a specified load*.

While nominal voltage is useful to describe a particular battery, it does mean that the battery will maintain a single voltage throughout its discharge. In reality, the voltage will follow a particular curve following an overall downward trend from CCV (see Appendix A 2.5.2) to cutoff voltage (see Appendix A 2.5.3). The precise shape of the curve will depend on the battery technology.

2.5.5 Regulated voltage output. Some batteries may contain voltage-regulating electronics on their outputs. These allow the battery to behave more like a power supply than a battery that can provide a fixed voltage output regardless of the state of charge of the internal cells (while capacity is available) thereby separating the end item from the OCV, CCV, and cutoff voltages of the internal cells. The battery's specification will describe the characteristics and/or reference documentation for the output characteristics and protocol for batteries with a regulation voltage output.

2.5.6 Maximum load.The maximum load a battery can maintain is a function of many factors including the battery chemistry, cell construction, ambient temperature, whether the load is dynamic or static, and safety electronics. Different batteries of the same form factor may have different maximum loads they can maintain. The battery Slash Sheets contain the maximum loads the battery can provide. End items should be designed to accept the maximum number of battery technologies for a given form factor without overloading a battery. If this is not possible, the end item should contain a method to only operate with acceptable battery types, such as communicating with the battery (see Appendix A 2.6.5) or via a keyed connector (see Appendix A 2.6.2).

Many batteries contain current-limiting circuitry and/or fuses. **These are in place as a safety device and should not be relied upon as an active form of over-current protection. The end item should not exceed the maximum current of the battery as described in the battery specification**.

2.5.7 Voltage delay. *Voltage delay is the time allowed for the battery voltage under load to recover above the specified cutoff voltage (see Appendix A 2.5.3)*.

A voltage delay is a short delay a resting battery may exhibit after a load is applied until it reaches its proper closed-circuit voltage (see Appendix A 2.5.2). This effect may be more pronounced when the battery is cold. Maintaining a load on the battery may help it recover its operating voltage.

Note: systems should be designed to not repeatedly attempt to recover a battery that exhibits a voltage delay, as a battery discharged beyond cutoff may exhibit similar voltage characteristics to a battery with a voltage delay.

2.6 Battery configuration

2.6.1 Battery compartment requirements. All non-rechargeable and rechargeable lithium batteries can vent (emit smoke, flame, or even a violent rupture) when exposed to abusive conditions. If the end item requires that the battery be contained within the item, the battery compartments need to be designed in such a way to safely release the pressure if a cell venting occurs. For more information on battery compartment design, see TB 43-6135.

2.6.2 Battery output connector. All batteries will have some form of connector to interface with the end item and charger (if applicable). Connectors can be as simple as flat contact points for the battery positive (+) and negative (-), or more complex such as a cable connector with immersion penetration ratings, extra pins for communication (see Appendix A 2.6.5), EMI shielding, physical keying, strain-relief ratings, etc.

Variants of the same connector may be present across different batteries of the same form factor. An example is a keying mechanism preventing non-rechargeable batteries from being placed on a charger but still allowing rechargeable and non-rechargeable batteries to be used on an end item. Connectors may also be shared across different battery form factors that share similar electrical characteristics. This can allow for flexible end-item design, allowing for multiple battery options, thereby allowing the user to make weight, volume, and runtime tradeoffs on a per-mission basis. System developers should research all variants and applications of batteries and connectors when designing a system.

2.6.3 State of charge indicator (SOCI). Some batteries may contain a State of Charge Indicator (SOCI), allowing the user to determine the remaining capacity. This device may be user-activated or always on and may either be a passive display or light-emitting display. Generally, the presence of a SOCI should not make a large impact on system design. Still some things to be cognizant of are the avoidance of inadvertent activation and the ability for the user to view the display while the battery is installed (if possible).

2.6.4 Complete discharge device (CDD). Some non-rechargeable batteries contain a

Complete Discharge Device (CDD). The CDD is designed to consume any remaining lithium in a battery and is used when the battery is processed for disposal. The presence of a CDD will have minimal impact on a system's hardware design, but care should be taken not to inadvertently activate it. The CDD does, however, have an effect on overall system logistics as it affects the disposal process for batteries. For more information on the CDD and battery disposal, please see TB 43-0134.

2.6.5 ‘Smart' batteries. Many batteries today are considered ‘Smart,' meaning they contain a data interface for the battery to report its information and status to its charger and/or end item. Some examples of available data fields are battery chemistry, date of manufacture, voltage, temperature, and remaining capacity. Enabling a smart interface on an end item can allow for much more robust battery management. Battery specifications will reference the relevant communication protocols needed to communicate with the battery.

CONCLUDING MATERIAL

Custodian:
Army – CR

Preparing activity:
Army – CR
(Project 61GP-2024-001)

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using ASSIST Online database at https://assist.dla.mil.