**DEPARTMENT OF THE NAVY**
Naval Sea Systems Command
1333 ISAAC HULL AVE, SE
WASHINGTON NAVY YARD, DC 20376-71

IN REPLY REFER TO

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18 Oct 10

From: Commanding Officer, Naval Ordnance Safety and Security Activity

Subj: REVISION TWO TO NAVSEA S9310-AQ-SAF-010, "NAVY LITHIUM BATTERY SAFETY PROGRAM RESPONSIBILITIES AND PROCEDURES"

Ref: (a) NOSSA ltr 8020 Ser N311/314 of 19 Mar 03
(b) NOSSA Ser 011731Z of Mar 06
(c) NOSSA ltr 8020 Ser N84/521 of 2 Apr 09

Encl: (1) NAVSEA S9310-AQ-SAF-010, "Navy Lithium Battery Safety Program Responsibilities and Procedures"
(2) Abstract of Significant Changes

1. Enclosure (1), Revision Two of the Naval Sea Systems Command (NAVSEA) Technical Manual for Navy Lithium Battery Safety Program Responsibilities and Procedures, is issued as a replacement for the current Revision One dated 19 August 2004.

2. This revision re-organizes the manual into eleven chapters from the previous two to facilitate ease of use, and incorporates the programmatic changes of references (a), (b), and (c).

3. Enclosure (2) highlights other significant changes occurring in this revision.

4. Point of contact for this manual is John Dow, Naval Ordnance Safety and Security Activity (N841) DSN 354-5640, commercial (301) 744-5640, or email: john.dow@navy.mil.

Laura M. DeSimone

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By direction

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## ABSTRACT OF SIGNIFICANT CHANGES

1. Reorganized the manual into separate chapters covering related subjects, to facilitate use.

2. Updated reporting requirements for mishaps, near-mishaps, ventings, incidents, and malfunctions at paragraphs 1-5.1, 1-5.2, and 10-1.

3. Increased the capacity threshold from 2.0 Ah to 3.0 Ah for small batteries that can be approved by the technical agents at paragraph 3-2.c, primary batteries in COTS equipment that do not require testing at paragraph 3-5.1.b, and primary cells in Navy equipment at paragraph 3-5.2.b.

4. Added paragraph 3-5.1, the small coin cell exemption previously promulgated by NOSSA message 011731Z of March 2006.

5. Added nine volt lithium batteries to the list of secondary batteries that do not require testing, at paragraph 3-5.1.

6. Provided augmented guidance and requirements for battery management systems, in particular large form rechargeable batteries, at paragraph 4-4.

7. Added a prohibition on modifying batteries to allow charging by other than designated and approved charging systems to the charging system failure instructions at paragraph 5-5.3.

8. Added guidance for facilities where large form batteries are handled and charged, at paragraph 5.5.4.

9. Clarified that the prohibition on storage of batteries in inhabited areas does not apply to laptop batteries and other small exempted batteries, at paragraphs 7-1.8 and 7-1.9.

10. Revised the transportation requirements for lithium batteries in Chapter 10 to incorporate by reference, recent Department of Transportation changes to Title 49 of the Code of Federal Regulations.

11. Added a new Short Circuit Electrical Safety Device Test as an option at paragraph 11-3.4.6 for primary batteries, and paragraph 11-3.7.6 for secondary batteries.

12. Added a propagation test as an option for large batteries at paragraph 11-3.8.

13. Appendix F was added to provide a general overview of battery disposal regulations for the users of this manual. Removed most of the specific guidance on waste classification of batteries, since assignment of hazardous waste characteristic and local disposal procedures should be managed by the servicing environmental office, beyond the scope of this manual.

0910-LP-109-9220 SECOND REVISION

# TECHNICAL MANUAL
# FOR
# NAVY LITHIUM BATTERY SAFETY PROGRAM RESPONSIBILITIES AND PROCEDURES




**PUBLISHED BY DIRECTION OF COMMANDING OFFICER**

**NAVAL ORDNANCE SAFETY AND SECURITY ACTIVITY**

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# FOR
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**DISTRIBUTION STATEMENT A: APPROVED FOR PUBLIC RELEASE**

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**PUBLISHED BY DIRECTION OF COMMANDING OFFICER**

**NAVAL ORDNANCE SAFETY AND SECURITY ACTIVITY**

**15 JULY 2010**

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The date of issue for all pages in this manual is 15 July 2010.

Date of Issue for Original and Changed Pages is:

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Revision 1 - 19 August 2004
Revision 2 - 15 July 2010

# RECORD OF CHANGES

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## NAVSEA TECHNICAL MANUAL CERTIFICATION SHEET



**CERTIFICATION APPLIES TO:** NEW MANUAL _____ REVISION 2 CHANGE ___

**APPLICABLE TMINS/PUB NO.:** NAVSEA S9310-AQ-SAF-010

**PUBLICATION DATE (MO, DA, YR):** 15 JULY 2010

**READING GRADE LEVEL (RGL):**

**TITLE:** NAVY LITHIUM BATTERY SAFETY PROGRAM: RESPONSIBILITIES AND PROCEDURES

**TMCR/TMSR/SPECIFICATION NO.:**

**CHANGES AND REVISIONS:**

**PURPOSE:** To update safety guidelines for the selection, design, testing, evaluation, use, packaging, storage, transportation and disposal of lithium batteries

**EQUIPMENT ALTERATION NUMBERS INCORPORATED:**

**TMDER/ACN NUMBERS INCORPORATED:**

*CONTINUE ON REVERSE SIDE OR ADD PAGES AS NEEDED*

### CERTIFICATION STATEMENT

THIS IS TO CERTIFY THAT RESPONSIBLE NAVSEA ACTIVITIES HAVE REVIEWED THE ABOVE IDENTIFIED DOCUMENT FOR ACQUISITION COMPLIANCE, TECHNICAL COVERAGE, AND PRINTING QUALITY. THIS FORM IS FOR INTERNAL NAVSEA MANAGEMENT USE ONLY, AND DOES NOT IMPLY CONTRACTUAL APPROVAL OR ACCEPTANCE OF THE TECHNICAL MANUAL BY THE GOVERNMENT, NOR RELIEVE THE CONTRACTOR OF ANY RESPONSIBILITY FOR DELIVERING THE TECHNICAL MANUAL IN ACCORDANCE WITH THE CONTRACT REQUIREMENT.

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# FOREWORD

1. The purpose of this manual, NAVSEA S9310-AQ-SAF-010, “Navy Lithium Battery Safety Program: Responsibilities and Procedures”, is to establish safety guidelines for the selection, design, testing, evaluation, use, packaging, storage, transportation and disposal of lithium batteries.

2. This manual applies to all Navy and Marine Corps activities and all lithium battery powered devices intended for use or transportation on Navy facilities, submarines, ships, vessels and aircraft. Material to which this manual applies includes all active batteries, both primary (non-rechargeable) and secondary (rechargeable), as well as thermal and reserve lithium batteries. This includes “lithium ion” batteries, and all equipment powered by lithium electrochemical power sources through all phases of the life of such systems.

3. This Revision Two supersedes NAVSEA S9310-AQ-SAF-010, Revision One dated 19 August 2004, which should be destroyed.

4. Requests for copies of this manual or correspondence involving its distribution on the Explosives Safety Technical Manuals (ESTM) DVD-ROM should be forwarded to Naval Surface Warfare Center (NSWC), Indian Head Division Detachment Earle. See appendix C for the complete address.

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# SAFETY SUMMARY

This publication is a safety manual which contains the instructions and regulations necessary for safe selection, design, testing, evaluation, use, packaging, storage, transportation and disposal of lithium batteries by all Navy and Marine Corps activities. While the entire content of this publication is a warning to the user, the following warnings and cautions appear in the text and are repeated here for emphasis:

**CAUTION**

Do not package other batteries with a leaking lithium battery. (Page 10-1)

**WARNING**

Safety tests can cause violent venting of batteries with deflagration and fragment hazards, and release of vapor clouds of chemically active, toxic, flammable, or corrosive materials. Appropriate safety precautions shall be observed during testing, including ventilation controls, containment of byproducts, or standoff distance to protect personnel and facilities. (Page 11-3)

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# CHAPTER 1

# INTRODUCTION

**1-1. LITHIUM CELLS AND BATTERIES.** The use of lithium cells and batteries in Navy systems and equipment offers the advantage of increased voltage and longer life, when compared to other power sources. Lithium batteries can provide increased energy density, extremely high currents, and can discharge very rapidly when short-circuited. Although these characteristics are useful in applications requiring sustained high current, a too-rapid discharge of a lithium battery can result in overheating of the battery, rupture, and even explosion. Because of these risks, lithium batteries shall be considered hazardous at all times. The Department of the Navy has adopted a Lithium Battery Safety Program to minimize hazards associated with their use.

**1-2. LITHIUM BATTERY SAFETY PROGRAM (LBSP) ELEMENTS.** The Lithium Battery Safety Program, as required by NAVSEAINST 9310.1 (series), addresses lithium batteries proposed for use in a specific system or device. Program managers are encouraged to contact the Naval Ordnance Safety and Security Activity (NOSSA) (N84) early in the program to seek assistance in the definition of test and approval requirements.

1-2.1. LITHIUM BATTERY SAFETY PROGRAM PROCESS. The LBSP test and approval process includes the following steps, which are described in detail below.

a. Safety Data Package;

b. Safety Testing;

c. Safety Review; and

d. Recommendation for Approval.

1-2.1.1. Safety Data Package (SDP). Preparation and submission of a full SDP is described in chapter 2. For exceptions, see paragraph 1-2.1.5.

1-2.1.2. Safety Testing. Conducting and reporting safety testing of lithium batteries is described in chapter 11.

1-2.1.3. Safety Review. The NOSSA Technical Agents, the Naval Surface Warfare Center Carderock Division (Code 616) and the Naval Surface Warfare Center Crane Division (GXS), review the safety aspects of lithium batteries.

a. Any system that contains a lithium battery system to be deployed, transported, or recharged on a surface ship, aircraft, or submarine, unless excepted under the criteria discussed in paragraph 1-2.1.5, must obtain platform concurrence concerning design and suitability.

(1) For Navy aircraft, the coordination office is NAVAIRSYSCOM (AIR 4.4.5.2).

(2) For Naval forces afloat, the coordination office is NAVSEASYSCOM (SEA-05Z34).

(3) For Military Sealift Command (MSC) platforms, the coordination office is Commander, Military Sealift Command (COMSC) (N7).

b. The NOSSA Technical Agents may request these concurrences as part of the safety review process.

c. Following safety review, the Technical Agents will recommend approval or other course of action to NOSSA by letter endorsement of the Program Manager request.

1-2.1.4. Safety Approval. Safety approval is based upon testing and Technical Agent review. Safety approval is specific to the battery design and system or device described in the safety data package and the safety test report. Approval is not transferrable to other applications without specific review. Further, safety approval may be limited with respect to time, place, duration, specific platforms, or in other ways, in order to reduce potential risk. NOSSA is responsible for providing written recommendation for use to the requesting program manager, with the exceptions noted in chapter 3 for certain small batteries. Ultimate approval for the use of battery systems lies with the program manager, following receipt of the NOSSA recommendation letter.

1-2.1.5. Exceptions. Some small, commercial-off-the-shelf (COTS) cells and batteries are pre-authorized for use, and do not require testing and review for certification; see chapter 3. Some small batteries may be certified by the NOSSA Technical Agents; see paragraph 3-2.

**1-3. GENERAL REQUIREMENTS.** Lithium battery applications shall comply with the instructions contained in this manual regarding design, use, packaging, storage, transportation, and disposal. Additionally, the following general requirements apply.

a. They shall be used only in systems for which they have been approved.

b. They shall not be pierced, cannibalized, mutilated, punctured, crushed, dropped, dismantled, short circuited, exposed to high temperatures, incinerated, or modified.

c. Primary (non-rechargeable) lithium cells and batteries shall not be charged or recharged.

d. In development and procurement actions, applicable system safety program requirements of MIL-STD-882 (series) shall be invoked by contract.

1-3.1. LARGE FORM LITHIUM BATTERIES. For lithium batteries or powered systems exceeding total energy content of 1 kWh per single battery pack, or a system with total battery energy exceeding 2 kWh, program managers shall implement an overarching System Safety Program (SSP) in accordance with MIL-STD-882 (series) prior to requesting full concurrence by NOSSA. The SSP shall address, at a minimum, all potential safety hazards to co-located systems, platforms, and personnel from operations and carriage, and shall identify and mitigate the risks involved. The SSP shall begin at the inception of a program or the modification of an existing system and shall remain in effect throughout the entire life cycle; e.g. storage, use and disposal, of the system. All development or contractual documents shall reflect a formal program for a systems safety evaluation and shall provide for adequate funding of the program.

**1-4. SEPARATE AND DISTINCT PROCESSES.** NOSSA safety approval, non-standard parts approval, qualification to a military specification, platform configuration control procedures, and safety review board concurrences are all separate and distinct processes. Completion of one process does not imply completion of any of the other processes.

**1-5. REPORTING REQUIREMENTS.**

1-5.1. MISHAPS AND NEAR-MISHAPS. All mishaps and near-mishaps involving lithium batteries shall be reported in accordance with OPNAVINST 5102.1 (series). Reports shall also be sent to NOSSA (N84).

1-5.2. VENTINGS, INCIDENTS, OR MALFUNCTIONS. Non-mishap ventings, malfunctions, or other incidents, either with or without visible damage to the battery, should be reported to NOSSA at Li-Batts@navy.mil, and to the designated Distribution/Screening Point as a Product Quality Deficiency Report (PQDR) in accordance with the Navy and Marine Corps Product Data Reporting and Evaluation Program (PDREP) Manual, NAVSO P-3683. The Naval Sea Logistics PDREP website at http://www.nslcptsmh.csd.disa.mil includes a web PQDR application.

**1-6. DEFINITIONS.** The definitions of terms and abbreviations commonly used in conjunction with lithium batteries, and their safe use in Navy operations, appear in appendix A. They are intended to reduce ambiguity and to provide uniformity of description and interpretation of technical information throughout this manual.

**1-7. REFERENCE DOCUMENTS.** A list of documents that contain all types of technical or administrative, mandatory or advisory, and general or specific information and data applicable to and referenced throughout this publication is presented in appendix B.

**1-8. POINTS OF CONTACT AND ADDRESSES.** Appendix C provides the points of contact and complete addresses of those parties designated in this manual as sources of further reference.

**1-9. REPORTING DEFICIENCES IN MANUAL.** Ships, training activities, supply points, depots, Naval shipyards, and supervisors of shipbuilding are requested to arrange for the maximum practical use and evaluation of NAVSEA technical manuals. All errors, omissions, discrepancies, and suggestions for improvement to NAVSEA technical manuals shall be reported to the Naval Surface Warfare Center, Port Hueneme Division (NSWC/PHD)(Code 312), on NAVSEA Technical Manual Deficiency/Evaluation Report (TMDER), NAVSEA Form 4160/1. A copy of NAVSEA TMDER Form 4160/1 is included at the end of this publication. For activities with internet access, this form may also be completed and processed using NSWC/ PHD website: https://nsdsa2.phdnswc.navy.mil. To expedite a response, also send as an email to jeri.dimaggio@navy.mil. All comments shall be thoroughly investigated and originators will be advised of TMDER resolution. If you prefer to submit a TMDER using a Word file, click here.

**1-10. DATE OF PUBLICATION.** The publication date of this manual, and its revisions and changes, as shown on the title page, is the estimated date of distribution. However, the manual, revision, or change is effective upon receipt, regardless of the date shown on the title page.

# CHAPTER 2

# PROGRAM OFFICE RESPONSIBILITIES

**2-1. PROGRAM MANAGER RESPONSIBILITIES.** Program Managers anticipating the use of lithium cells and batteries shall request a lithium battery safety review early in the program acquisition process.

**2-2. REQUEST LETTER.** Requests for safety review must be submitted by letter correspondence from the Program Manager to NOSSA via one of the NOSSA Technical Agents. The letter must:

a. Explain why a lithium cell and/or battery is needed;

b. Identify platform(s), e.g. Naval facilities, submarines, ships, vessels, and aircraft, that will carry or deploy the system;

c. Include the safety data package compiled in accordance with paragraph 2-3;

d. Be prepared on letterhead and be signed, serialized and dated. A sample request letter is provided in appendix D. Letters may be submitted electronically via electronic mail (email) or electronic media.

**2-3. SAFETY DATA PACKAGE.** A data package describing the following items for the battery and intended system in which it will be used shall be submitted as an enclosure to the request letter. Information not readily available may be so noted and omitted from the data package; omitted information deemed critical shall be obtained by the NOSSA Technical Agent during the safety review process.

2-3.1. PROPOSED CELL/BATTERY DESIGN DATA.

a. Manufacturer (name, address, phone number);

b. Model number and/or part number;

c. Electrical description (voltage, ampere-hour (Ah) capacity, and nominal load profile);

d. Electrical safety devices integral to the cell/battery;

e. Cell/battery configuration (cells/batteries in parallel or series);

f. Operating life (shelf life and functional life);

g. Physical dimensions and description (weight, size, geometry, number of cells, battery housing description);

h. Marking indicating battery chemistry;

i. Cell and/or battery yield pressure (if unvented, battery/housing room ambient yield pressure);

j. All applicable Material Safety Data Sheets (MSDSs), Product Information Sheets or equivalent document;

k. Cell failure mode (indicating whether a single cell failure can cascade into multiple cell failures);

l. Discharge rate.

2-3.1.1. For Secondary Batteries Only.

a. Rated cycle-life (versus depth of discharge) and the mean-time-between failures for the cell/battery;

b. Discharge and recharge rates including the limiting discharge/charge rates.

2-3.1.2. For Thermal Batteries Only.

a. Case temperature information, to include:

(1) Specification requirements and actual battery performance.

(2) Complete temperature profile from activation to battery cool down (this is normally beyond specification life).

b. Method of activation;

c. Battery cool down time.

2-3.1.3. For Reserve Batteries Only.

a. Method of activation;

b. Expected activated life before self-depletion.

2-3.2. LITHIUM BATTERY-POWERED SYSTEM DESCRIPTION.

a. Description of system purpose or function;

b. Manufacturer (name, address phone number);

c. Model number and/or part number and device name;

d. Diagram of the system's overall mechanical interfaces showing battery proximity to other equipment and energetic devices;

e. Battery installation (mounting, seals, electrical connectors);

f. Battery housing/container, strength, and free volume;

g. Safety features or venting mechanisms (description and estimate of operational venting pressure);

h. Current drain (load profile of the system);

i. Block diagram of system interfaces to the battery (electrical and physical);

j. Electrical schematic (showing fuses, blocking diodes, and external power interface);

k. Description of the charger and charge control mechanism, if applicable. (Are cells individually equilibrated, or is the battery charged as a series/parallel string?) Provide information for large form lithium batteries sufficient to support evaluation that features of the charging system related to charging safety have been included in the design, validated, and tested.

l. Description of other controls or mechanisms to enhance battery safety, such as a Battery Management System (BMS), software shutdown mechanism, etc.

2-3.3. LOGISTICAL AND OPERATIONAL USE DATA.

a. Packaging. How will system/battery be packaged?

b. Storage facilities. How will system/battery be stored from delivery to disposal?

c. Transportation methods.

d. Disposal information.

e. Operational use scenario, including:

(1) A complete description of how the system/batteries will be handled and used;

(2) What platform(s), e.g., Naval facilities, submarines, ships, vessels, and aircraft will carry or deploy the system;

(3) Location of recharging operations, if applicable;

(4) Recovery operations, ashore and afloat, if applicable;

(5) Number of units anticipated to be used;

(6) The sequence of events before system use/activation/deployment, etc., if applicable.

f. Description of the battery change out/replacement plan, including:

(1) Number of batteries needed to support system during deployment, and in what storage configuration.

2-3.3.1. For Thermal or Reserve Batteries Only.

a. Activation method and sequence/failure analysis;

b. Hang-fire analysis.

2-3.4. FUNCTIONAL, ENVIRONMENTAL AND SAFETY TEST DATA. Functional, environmental and safety tests representative of the actual environments to be encountered by the complete end item, including the battery, performed to date. This shall include the description of the testing performed, results, and supporting data. Data may include results from battery testing conducted by other services or agencies, manufacturers, or independent evaluators, e.g. Underwriters Laboratories (UL).

2-3.5. SAFETY TESTING PROGRAM PLAN OR COMPLETED TEST DATA. Proposed safety testing program plan or completed test results from the specific lithium battery safety abuse tests identified in chapter 11.

2-3.6. SYSTEM SAFETY PROGRAM (SSP). When available, summarized results from the System Safety Program should be submitted with the safety data package described in paragraph 2-3. Specifically, the preliminary hazard list and hazard analysis data must be supplied.

**2-4. CONFIGURATION MANAGEMENT AND CLASS I BATTERY CHANGES.** Activities procuring batteries for limited or full-scale production shall ensure that configuration management is imposed on the battery in accordance with MIL-HDBK-61 (series) or an appropriate commercial standard, such as ISO 10007. In addition to the usual definition, a Class I change shall be defined, for the purposes of this manual, as any change affecting safety characteristics of the battery, such as cell manufacturer, type, method of fabrication, insulation,

circuit load changes, battery packaging, etc. Class I battery changes must be coordinated with the NOSSA Technical Agents in order to initiate an updated safety review and approval.

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# CHAPTER 3

# EXCEPTIONS TO TESTING, REVIEW, AND/OR APPROVAL REQUIREMENTS

**3-1. TESTING.** The NOSSA Technical Agents may determine that sufficient safety test data are available from other sources for any lithium battery under review. Analyses or comparisons with similar cells/batteries in similar applications may be sufficient to eliminate the need for testing.

**3-2. CERTAIN SMALL BATTERIES.** The NOSSA Technical Agents may review and independently recommend for Program Manager approval small lithium batteries that meet the following criteria. A request letter in accordance with paragraph 2-2 must be submitted to the Technical Agent. A sample request letter is provided in appendix D.

a. Primary or secondary battery;

b. One battery with no more than two identical cells;

c. Maximum rated capacity of 3.0 Ampere-hours (Ah) per cell.

**3-3. COIN CELLS.** Non-rechargeable lithium coin cells meeting the following criteria are approved for all uses and do not require individual testing and review by NOSSA. However, they do require an initial procurement report from the purchaser in accordance with appendix E.

a. Unmodified, commercial-off-the-shelf (COTS) item;

b. Used in single-cell configuration;

c. Maximum nominal output of 3 Volts;

d. Maximum rated capacity of 1 Ah.

**3-4. CERTAIN LITHIUM ION BATTERIES.** The use of COTS electronics and equipment powered by lithium ion rechargeable (secondary) batteries meeting the following criteria is approved for all uses and does not require individual testing and review by NOSSA. However, the batteries do require an initial procurement report in accordance with appendix E.

a. Unmodified, COTS battery;

b. Underwriter's Laboratories (UL) listed;

c. Used in the device as recommended by the manufacturer. Modifications to the devices may only be made in accordance with the manufacturer's recommendations; e.g., addition of memory;

d. Recharged only by devices expressly designed for recharge of the specific battery in use;

e. No more than four cells in series (less than or equal to 18-Volt output);

f. Rated for no more than 100 Watt-hours, as listed in the manufacturer's specification or calculated by multiplying the capacity in Ah by the maximum working (nominal performance) voltage.

3-4.1. ALTERATION OF COTS SECONDARY BATTERIES. There shall be no attempt to open, modify, reform, or repair batteries in this approved category.

3-4.2. FAILED COTS SECONDARY BATTERIES. Failed batteries in this approved category shall be returned to the manufacturer or properly disposed of in accordance with chapter 9.

**3-5. PRIMARY (NON-RECHARGEABLE) LITHIUM BATTERIES.** Primary lithium batteries used in primary lithium battery-powered equipment meeting the criteria below are exempted from testing requirements. A request letter in accordance with paragraph 2-2 must be submitted. Sample request letters are provided in appendix D.

3-5.1. PRIMARY BATTERIES IN EQUIPMENT DESIGNED FOR COMMERCIAL USE. UL-approved equipment designed for commercial use and procured from commercial sources that use a single primary battery meeting the following criteria.

a. No more than two identical cells in the single battery;

b. Maximum rated capacity of 3.0 Ah per cell;

c. Equipment is unmodified, to include replacing the battery with one of a different chemistry or size;

d. A single 9-volt PP3 size, snap connector battery is included in this category.

3-5.2. PRIMARY CELLS IN EQUIPMENT DESIGNED FOR A SPECIFIC NAVY USE. This exception applies to normal repair and maintenance of the equipment, including procurement and storage of replacement batteries.

a. No more than two identical cells;

b. Maximum rated capacity of 3.0 Ah per cell;

c. No other source of electrical power to the unit exists; or

d. The battery is protected from other sources of electrical power by appropriate combinations of blocking diodes and resistors.

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# CHAPTER 4

# LITHIUM BATTERY SYSTEM DESIGN

**4-1. GENERAL REQUIREMENTS.** All lithium battery systems shall meet the best practices and specific design requirements outlined in this chapter.

4-1.1. BATTERY SELECTION. Select batteries or cells with the lowest possible total capacity to meet the mission requirement.

4-1.2. OVER-CURRENT PROTECTION. Each battery used as a power source shall contain a suitable over-current device. Devices shall either go to the open-circuit position if the battery is discharged at an excessive rate; e.g., fuse or relay; or must limit the current flow to a safe level; e.g., Positive Thermal Coefficient (PTC) Device. Batteries must be over-current protected in the ground lead of each series string. Each separate circuit shall be protected. If the battery is tapped to provide different output voltages, each tap shall be protected with an over-current device.

4-1.3. CHARGING PREVENTION. In primary (non-rechargeable) batteries consisting of series-parallel strings, each parallel string shall be protected to prevent any possibility of charging. If a primary (non-rechargeable) battery is connected to an external power source, the battery must be protected to prevent charging by the external power source.

4-1.4. VENTING. Cell or battery vents shall not be blocked. If potting is essential, ensure that venting will not be obstructed and that the potting does not adversely affect battery thermal management. A vent path for the toxic and corrosive and/or flammable vent products shall be designed to prevent case rupture or undirected venting except in applications where venting of any kind is not permitted. Housing for a battery assembly must have a functional vent mechanism to preclude rupture.

4-1.5. BATTERY COMPARTMENT. The equipment shall be designed with a special compartment for the battery. This compartment shall have no interior projections or sharp edges that could damage the electrical insulation around the battery. The battery shall be secured within the compartment to resist shock and vibration to the levels required for end item use.

4-1.6. POWER SWITCHES. Power switches in the end item shall be selected to prevent accidental battery turn-on. Switching devices shall not be used in the ground leg(s).

4-1.7. CELL UNIFORMITY. Cells of different physical characteristics, chemistries, or electrical parameters shall not be used in the same electrical circuit.

4-1.8. WARNING LABELS. The end item shall have an external label warning users of the hazards associated with lithium batteries and shall be marked in accordance with container warning requirements of 29 Code of Federal Regulations (CFR) 1910.1200.

**4-2. ACTIVE BATTERY REQUIREMENTS.** Design requirements for active batteries, both non-rechargeable and rechargeable, are described in the paragraphs below.

4-2.1. INTERNALLY-PRESSURIZED CELLS. All internally-pressurized cells shall be hermetically sealed and constructed so that the case-to-cover seal is a continuous weld, free from holes and other imperfections. The seal between the electrode and the cover shall be of the glass-or ceramic-to-metal or equivalent type and free from imperfections.

4-2.2. SAFETY-VENTING DEVICES. Each cell, battery, and battery compartment must incorporate a safety-venting device or be designed and manufactured in such a manner that will preclude a violent rupture as a result of cell venting. Nothing shall be done in the design and construction that will degrade the vent.

4-2.3. THERMAL PROTECTION DEVICES. Consideration shall be given to the use of thermal protection devices, which go to the open-circuit position at temperatures of 91 degrees C (196 degrees F) or less. Thermal protection devices must be located in close proximity to each cell string, not physically isolated from the cell or cell string being protected.

4-2.4. INTERCHANGEABLE COMMERCIAL BATTERIES. Lithium batteries of two or more cells that are unique to military equipment shall be constructed so that they are not interchangeable with commercial batteries used in consumer products, such as flashlights or radios.

4-2.5. POSITIVE PROTECTION AGAINST ACCIDENTAL SHORTING. When the battery is not installed in equipment, the leads or connector plug shall be taped, guarded, or otherwise designed or provided with positive protection against accidental shorting.

**4-3. RESERVE BATTERY REQUIREMENTS.** The following design requirements are for both thermal and liquid reserve batteries.

4-3.1. INADVERTENT ACTIVATION. Reserve batteries shall be designed to prevent inadvertent activation from the environmental conditions to which the battery or end item may be subjected during Fleet use.

4-3.2. HERMETIC SEAL. Reserve batteries shall be hermetically sealed and constructed so that the case-to-cover seal is a continuous weld, free from holes and other imperfections. The seal between the electrode connector pin and the cover shall be of the glass- or ceramic-to-metal type and free from imperfections.

4-3.3. SAFETY-VENTING DEVICE. Each battery and battery compartment shall incorporate a safety venting device or be designed and manufactured in such a manner that will preclude a

violent rupture condition. Nothing shall be done in the design and construction that will degrade the vent.

4-3.4. ELECTRICAL INITIATION LEADS. When the battery is not installed in the equipment, all electrical initiation leads shall be shorted. The output leads or connector plug shall be taped, guarded, or otherwise provided with positive short circuit protection.

4-3.5. THERMAL BATTERY OVERHEATING. The battery shall be properly insulated and located to prevent overheating of the system or thermal damage to adjacent components.

4-3.6. LIQUID RESERVE BATTERY BLEEDER RESISTORS. Consideration shall be given to the incorporation of internal “bleeder resistors” so that battery depletion will automatically occur as a result of activation. An activation indicator should be considered as part of the battery design.

## 4-4. RECHARGEABLE BATTERIES.

4-4.1. CHARGING SOURCES. Rechargeable battery systems shall be designed to prevent charging by any charging source other than that specifically approved for the battery.

4-4.2. CELL-TO-CELL BALANCING MECHANISMS. During charging, differences in individual cells may lead to differing voltages in cell groups. Some cells may be undercharged, with a result of decrease in the overall battery capacity. Conversely, some cells may be overcharged, with the result of cell damage, shortening of life cycle, or the creation of safety issues. In order to achieve a uniform state of charge, consideration shall be given to including a cell-to-cell balancing mechanisms for use during battery charging systems.

4-4.3. OVERVOLTAGE PROTECTION. Rechargeable batteries shall have integrated overvoltage (over-charge) protection. These protections must disconnect the battery from the charging source. Disconnect must be automatic and not require operator action.

4-4.4. BATTERY MANAGEMENT SYSTEM (BMS). Large form rechargeable batteries must use a battery management system that provides access to information on the performance, cycle-count, age, and condition of the battery. This BMS may be integral to the battery and include the protections of paragraph 4-4.2 and 4-4.3 above, or the BMS may be an interface to the system the battery is installed in. These guidelines are also recommended for smaller batteries.

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# CHAPTER 5

# USE

## 5-1. GENERAL.

5-1.1. REMOVAL. Lithium batteries shall be removed from associated equipment upon completion of useful life, packaged in accordance with chapter 6, stored in accordance with chapter 7, and disposed of in accordance with chapter 9. All exposed terminals must be insulated to prevent short circuits.

## 5-2. ACTIVE NON-RECHARGEABLE BATTERIES.

5-2.1. PARTIALLY DISCHARGED LITHIUM BATTERIES. Never use a partially discharged lithium battery or cell in a system which uses more than one battery or cell. Parallel or series strings of used batteries containing varied amounts of remaining power can result in an imbalance of the cells and battery or cell ventings.

## 5-3. THERMAL BATTERIES.

5-3.1. ACTIVATED, NOT DEPLOYED. If the battery has been activated, but not deployed, allow cool down time and dispose of the battery in accordance with chapter 9.

5-3.2. COOL DOWN TIME. If the battery has been activated and deployed and if equipment recovery is planned, allow adequate cool down time before handling or removal for disposal in accordance with chapter 9.

## 5-4. LIQUID RESERVE BATTERIES.

5-4.1. ACTIVATED, NOT DEPLOYED. If the battery has been activated but not deployed, dispose of the battery as soon as possible in accordance with chapter 9.

5-4.2. ACTIVATED AND DEPLOYED. If the battery has been activated and deployed and if equipment recovery is planned, allow adequate time for battery depletion. Dispose of it in accordance with chapter 9.

## 5-5. RECHARGEABLE BATTERIES.

5-5.1. CHARGING SYSTEM. Rechargeable batteries shall only be charged and conditioned using the charging system described in the safety data package in accordance with paragraph 2-3.

5-5.2. CHARGING PROTOCOLS. Designated charging protocols must be followed exactly. Charging regimes or hardware designed to “fix” damaged or failed batteries or cells not described in the safety data package shall not be used.

5-5.3. CHARGING SYSTEM FAILURE. In the event of a known charging system failure, no attempts shall be made to recharge or reuse the battery. No attempt shall be made to modify the battery to allow charging by other than designated and approved charging systems.

5-5.4. HANDLING AND CHARGING SAFETY PRECAUTIONS. Facilities where large form lithium batteries are handled and charged should consider the best practices listed below.

5-5.4.1. Isolate charging areas from storage areas, including the isolation of heating, ventilation, and air conditioning system air from adjacent work areas.

5-5.4.2. Ensure that fire department has been specifically informed of the type of operations performed at the facility and the maximum credible event mishap. The base Fire Map at the fire station should include charging and storage areas for large form lithium batteries.

5-5.4.3. Establish a clear exit path from the work and charge stations.

5-5.4.4. Ensure access to an emergency hand pull alarm.

5-5.4.5. An automatic sprinkler system, actuated by smoke and/or flame, should be provided.

5-5.4.6. Ensure that the fire alarm system shuts down the chargers.

5-5.4.7. Air handling systems should be able to contain, redirect, and ventilate smoke and gases from a thermal incident.

5-5.4.8. Charging rooms should be constructed of fire proof material such as cinder block. The use of a dedicated MILVAN for charging is another alternative.

5-5.4.9. A volatile organic compounds sensor should be provided to detect flammable gases or organics released by venting under charge.

# CHAPTER 6

# PACKAGING

**6-1. GENERAL PACKAGING, MARKING AND SHIPPING REQUIREMENTS.** For new lithium batteries, the basic packaging, marking and shipping requirements imposed by the Department of Transportation are contained in 49 Code of Federal Regulations (CFR) 172.101, 172.102, and 173.185. In addition to the minimum requirements of 49 CFR 173.185, Navy activities using, storing, transferring, or collecting lithium batteries shall adhere to the following regulations.

6-1.1. BATTERY PACKAGING DESIGN DISCLOSURE. Ensure that a complete battery packaging design disclosure is obtained from the supplier of the equipment or manufacturer of the batteries before shipment.

6-1.2. PACKAGING DESIGN INCORPORATION. Ensure that the packaging design is incorporated in the appropriate acquisition specification, contract, and manuals. Descriptive language shall be supplemented by drawings or figures.

6-1.3. PACKAGING DESIGN MINIMUM REQUIREMENTS. Ensure that the packaging design meets the minimum requirements contained in MIL-STD-648 and verify that all packaging tests required by 49 CFR 173.185 have been successfully performed and approved.

6-1.4. SHIP BY “CARGO ONLY” AIRCRAFT. Ensure that batteries entered in the supply system for organizational or intermediate maintenance level replacement are packaged for shipment by “cargo only” aircraft, unless the batteries are treated as unregulated per 49 CFR 172.101, 172.102, and 173.185.

**6-2. NON-CONFORMING PACKAGING.** Packaging not conforming to the package requirements of 49 CFR 172.101, 172.102, and 173.185 must be reviewed by Naval Weapons Station Earle (PHST Center) in conjunction with NOSSA. NAVSEASYSCOM is authorized to issue a Certificate of Equivalency (COE) in accordance with procedures prescribed by DLAD 4145.41/AR 700-143/AFJI 24-210/NAVSUPINST 4030.55/MCO 4030.40 (series) when satisfied that the container design proposed will meet equal or more stringent requirements than those listed in 49 CFR 173.185. Before issuing a COE, NAVSEASYSCOM will review the following:

6-2.1. SAFETY TEST RESULTS. Results of the safety tests described in chapter 11 of this manual, and those mandated by 49 CFR 172.101, 172.102, and 173.185.

6-2.2. ENVIRONMENTAL TESTS. The environmental tests performed on the unpackaged device and the packaged device.

6-2.3. COMPLETE DESIGN DISCLOSURE. A complete design disclosure of the proposed package.

**6-3. PACKAGING FOR DISPOSAL.** Coordinate packaging of new and used lithium batteries designated for disposal with the local Defense Reutilization Marketing Office/Service, and/or the servicing Military environmental compliance branch.

# CHAPTER 7

# STORAGE

**7-1. STORAGE GUIDELINES FOR NAVAL SHORE FACILITIES, SHIPS, AND VESSELS.** All lithium batteries and lithium battery-powered equipment shall be stored in compliance with the specific requirements stipulated in appropriate equipment documents or in accordance with base or platform regulations as specified in Standard Operating Procedures (SOPs). When such documentation is not available, the general storage requirements listed below shall be followed for Naval shore facilities and ships.

7-1.1. VENTILATED SHELTER. Store batteries in a dry, cool (below 130 degrees F (54 degrees C)) ventilated shelter out of direct sunlight.

7-1.2. SEGREGATED STORAGE. Use shelter only for the storage of lithium batteries and equipment containing lithium batteries.

7-1.3. FIELD STORAGE. In the field, avoid covering containers of batteries with a black or dark-colored tarp.

7-1.4. HANDLING AND MOVING CONTAINERS. Exercise special care in handling and moving containers to prevent crushing or puncturing.

7-1.5. FIRE RESPONSE. Locations aboard ship or on shore facilities shall have a fire station in the vicinity consisting of a hose reel with a 1-inch supply and fitted with a MIL-N-24408 nozzle if possible. Sprinkler systems and smoke and flame sensors should be considered.

7-1.6. ISOLATION. Isolate the storage area from other hazardous and combustible material and use only for the storage of unused lithium batteries or equipment with lithium batteries installed.

7-1.7. MINIMUM QUANTITIES. Keep the battery quantities stored in an area to a minimum because the effect of mass storage on the hazard degree is not known.

7-1.8. INHABITED AREAS. Lithium batteries or lithium battery-powered equipment with batteries installed shall not be stored in inhabited areas, such as offices, berthing areas, etc. The one exception is batteries covered by paragraphs 3-3, 3-4, and 3-5.

7-1.9. SEGREGATION OF USED BATTERIES. Segregate battery storage area into new and unused, partially used for reuse, and disposal. If stowed in a cargo hold, isolate batteries by using equivalent barriers to those used to separate non-compatible stows of Landing Force Operational Reserve Material (LFORM) ammunition, with the exception of spares for common

office electronic devices such as laptop computers and cameras, which may be stored in inhabited areas as noted above.

7-1.10. ADDITIONAL STORAGE RECOMMENDATIONS. Bulk storage locations and locations storing large form lithium batteries should consider the applicable best practices of paragraph 5-5.4.

7-1.11. MARKING. Mark storage area or shelter appropriately, as follows:

a. “STORAGE OF NEW LITHIUM BATTERIES” or “STORAGE OF EQUIPMENT CONTAINING NEW LITHIUM BATTERIES”;

b. “STORAGE OF PARTIALLY USED LITHIUM BATTERIES FOR REUSE” or “STORAGE OF EQUIPMENT CONTAINING PARTIALLY USED LITHIUM BATTERIES”; or

c. “STORAGE OF USED LITHIUM BATTERIES AWAITING DISPOSAL”.

7-1.12. CONTAINERS AND PACKAGING. Store new and unused batteries in the original shipping container, original individual package containers, or equivalent packaging. For cells or batteries placed in drums, appropriate cushioning should be used in conjunction with packaging. This should not be Styrofoam peanuts but a vermiculite type material. This keeps shock and vibration during transit to a minimum and prevents crushing among cells/batteries as well as from the side of the container.

7-1.13. INSULATED TERMINALS. For partially used batteries intended for reuse and batteries awaiting disposal, protect battery connectors or terminals from inadvertent short circuits. Examples of protection methods include use of non-conductive tape, terminal plugs, or individual plastic bags.

7-1.14. BATTERIES AWAITING DISPOSAL. For used batteries awaiting disposal, the following additional items apply:

7-1.14.1. Establish a remote collection point and storage area for used or depleted lithium batteries awaiting disposal. Aboard ships, lithium batteries for disposal shall be stowed only on the weather decks. Separate batteries awaiting disposal from other combustible material.

7-1.14.2. Package used or depleted lithium batteries awaiting disposal or lithium-powered equipment with batteries installed and awaiting disposal in accordance with paragraph 7-1.12.

7-1.14.3. When practical, store no more than 30 lbs. of used or depleted lithium batteries awaiting disposal.

7-1.14.4. It is good practice to store used or depleted lithium batteries awaiting disposal no longer than 30 days.

7-1.14.5. Do not dispose of or transport lithium batteries with normally generated refuse.

7-1.14.6. Turn in or offload all used or depleted lithium batteries for disposal at the earliest possible time. However, in no case shall batteries be moved or offloaded during ammunition handling or fueling operations.

7-1.15. STOWAGE ABOARD SUBMARINES. Lithium battery stowage aboard submarines shall be approved by NAVSEASYSCOM (SEA-05Z34).

7-1.16. STORAGE ABOARD AIRCRAFT. Lithium battery storage aboard aircraft shall be approved by NAVAIRSYSCOM (AIR-4.4.5.2).

**7-2. HAZARDOUS WASTE STORAGE.** Storage areas for hazardous waste lithium batteries must meet the requirements listed in paragraph 7-1.

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# CHAPTER 8

# TRANSPORTATION

**8-1. TRANSPORTATION BY MILITARY AIR SHIPMENT.** Transportation requirements within the DOD are covered by Air Force Interservice Manual (AFMAN) 24-204/TM 38-250/ NAVSUP PUB 505/MCO P4030.19/DLAI 4145.3. All transportation of lithium batteries on military aircraft must be conducted in accordance with the regulations therein.

**8-2. NEW LITHIUM BATTERIES ON PUBLIC DOMAIN.** All transportation of new lithium batteries on public highways is controlled by federal law regulating shipment of hazardous materials. The general regulations are stated in 49 Code of Federal Regulations (CFR) 172.101 and 173.185. Any deviations from the methods described in the CFR must be approved before shipment in the form of an exemption by the Office of Hazardous Material Safety Research and Special Programs Administration.

**8-3. USED LITHIUM BATTERIES ON PUBLIC DOMAIN.** All transportation of used lithium batteries on public highways is controlled by federal law regulating shipment of hazardous materials. The general regulation, as stated in 49 CFR 172.101 and 49 CFR 173.185 permits shipment of waste lithium batteries to a disposal site by motor vehicle only. If there is a chance for a battery to breach during transport causing electrolyte to leak, use a drum liner or lined box to contain electrolyte.

**8-4. TRANSPORTATION ABOARD US NAVY SURFACE SHIPS AND SUBMARINES.** Lithium battery transportation aboard US Navy surface ships and submarines shall be approved by NAVSEASYSCOM (SEA-05Z34).

**8-5. TRANSPORTATION ABOARD NAVY AIRCRAFT.** Lithium battery transportation aboard Navy aircraft shall be approved by NAVAIRSYSCOM (AIR-4.4.5.2).

**8-6. TRANSPORTATION ABOARD MILITARY SEALIFT COMMAND VESSELS.** Lithium battery transportation aboard Military Sealift Command platforms shall be approved by COMSC (N7).

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# CHAPTER 9

# DISPOSAL

**9-1. GENERAL.** The guidelines for disposing of lithium batteries at shore facilities are described in the paragraphs that follow. Lithium batteries, regardless of chemistry or size, are managed as universal waste under the Resource Conservation and Recovery Act. Any breached or leaking battery is managed as hazardous waste. See appendix F for additional information on managing used or excess batteries.

9-1.1. DEFENSE REUTILIZATION AND MARKETING OFFICE (DRMO). Turn into the local DRMO in accordance with chapter II of OPNAVINST 5090.1 (series) for disposal. Before initiating disposal of a lithium battery system, consult the local DRMO and servicing environmental compliance organization to coordinate battery information, packaging, quantities, labeling, shipping, and tracking requirements.

9-1.2. LOCAL ENVIRONMENTAL COMPLIANCE SUPPORT. If the local DRMO will not accept the batteries, contact the servicing environmental compliance organization at the performing activity for disposal.

9-1.3. EXPLOSIVE ORDNANCE DISPOSAL (EOD). Under certain emergency conditions, if batteries are deemed to be too hazardous for routine disposal, EOD should be contacted for immediate removal to a safe site.

**9-2. DISPOSAL AT SEA.** Routine disposal of batteries at sea is prohibited per 40 Code of Federal Regulations (CFR) 220, Subpart H.

**9-3. QUESTIONS OR PROBLEMS.** Questions or problems regarding the packaging, transportation, labeling, storage, tracking, or contract requirements of lithium batteries for disposal should be addressed to NOSSA.

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# CHAPTER 10

# EMERGENCY RESPONSE PROCEDURES

**10-1. MISHAP INVESTIGATION AND REPORTING.** As described in paragraphs 1-5.1 and 1-5.2 of this manual, all mishaps, near-mishaps, ventings, and incidents involving lithium batteries shall be reported in accordance with the current version of OPNAVINST 5102.1 (series). Reports shall also be sent to NOSSA. When possible, failed batteries in an inert state and associated equipment should be retained to support failure analysis.

**10-2. EQUIPMENT DOCUMENTS OR BASE REGULATIONS.** All lithium batteries and lithium battery-powered equipment shall have emergency response procedures stipulated in appropriate equipment documents or base regulations. When such documentation is not available, the general emergency response procedures listed below for Naval shore facilities, ships, and vessels shall be followed.

10-2.1. LEAKING BATTERIES. If a liquid is leaking from a lithium battery, use extreme caution during cleanup. The liquid may be a strong acid or other toxic or flammable substance. In such cases, take the following measures:

a. Use Personal Protective Equipment (PPE) to approach the leaking battery. Use chemically resistant gloves when handling leaking batteries. Face masks or eye protection and chemically resistant overalls/coveralls are recommended. Under extreme conditions, respirators may be required.

b. Strong acids should be neutralized with baking soda (sodium bicarbonate) or other suitable base. To perform such a neutralization, cover the spill with baking soda, then layer an absorbent over the area until the liquid is completely absorbed.

c. Sweep up the absorbent and deposit in a strong doubled plastic bag. Place the bag in an appropriate waste container.

**CAUTION**

Do not package other batteries with a leaking lithium battery.

d. Place the battery in a strong plastic bag and pack in an appropriate container. Place enough absorbent in this container to completely absorb all liquid contained in the battery. Label the outside of the container as “HAZARDOUS LEAKING LITHIUM BATTERY FOR DISPOSAL”.

e. If any lithium battery electrolyte comes in contact with skin, eyes, mouth, etc., flush with copious amounts of water for 15 minutes and report immediately to the medical department for treatment.

f. Follow the instructions provided on the appropriate Material Safety Data Sheet (MSDS).

10-2.2. LARGE CONTAINERS OF LEAKING LITHIUM BATTERIES. If there is evidence of leakage by lithium batteries in large containers, do not attempt to open or repack the original container. Take the following measures:

a. Follow the instructions provided on the appropriate MSDS for the item.

b. Contact the Military Environmental Protection Group or DRMO for further information.

c. If any lithium battery electrolyte comes in contact with skin, eyes, mouth, etc., flush with copious amounts of water for 15 minutes and report immediately to the medical department for treatment.

10-2.3. SWOLLEN OR HOT LITHIUM BATTERY. If any lithium battery feels hot or if the case of the battery shows signs of abuse or swelling, evacuate the area and contact EOD personnel. A battery in this condition may vent, catch fire, or explode without warning. Then take the following measures:

a. Follow the instructions provided on the appropriate MSDS for the item.

b. All incidents concerning equipment damage or personnel injury shall be reported to NOSSA in accordance with paragraph 10-1.

10-2.4. ACTIVELY VENTING OR BURNING LITHIUM BATTERIES. If there is evidence of a venting lithium battery, or in the event of a fire involving lithium batteries, including a fire in a location where lithium batteries are stored, immediately call the Fire Department.

a. Ensure that Fire Department responders know that lithium batteries are involved in the fire. Include the battery chemistry, size and volume.

b. Secure the area.

c. Follow the instructions provided on the appropriate MSDS for the item.

# CHAPTER 11

# SAFETY ASSESSMENT TESTING

**11-1. PURPOSE AND SCOPE.** An assessment shall be made of capability of the proposed lithium battery to perform safely in the proposed environment; i.e., its use in a specific system or device. This chapter establishes the minimum safety testing requirements for lithium batteries and lithium battery-powered equipment when used, charged, stored, or transported on Navy facilities, submarines, ships, vessels, and aircraft. The procedures, equipment, and pass/fail criteria for lithium battery safety tests are described in the following chapters.

11-1.1. ADDITIONAL TESTS. In addition to the nominal tests prescribed by NAVSEAINST 9310.1 (series), further tests or test modifications may be necessary for a variety of reasons.

11-1.1.1. Specific End Use. A given user community or a specific end user might require additional tests such as shock, vibration, atmosphere, etc.

11-1.1.2. Supplementary Data. Unusual or unique battery or system designs or use scenarios may necessitate supplementary data.

11-1.1.3. New Knowledge. New knowledge concerning lithium battery safety emerges.

11-1.1.4. Additional Test Scenarios. Completion of the System Safety Program requirements in accordance with MIL-STD-882 (series) may identify additional test scenarios that are outside the minimum required safety tests identified in this manual.

11-1.2. RATIONALE. Test methods and parameters were selected to rapidly generate sufficient data supporting a risk assessment of a given battery in its system configuration. Tests have been selected to minimize cost and schedule impacts, and still obtain enough data to effectively support making risk assessments. These test methods represent a partial compilation of over 25 years of lithium battery safety testing experience from the Department of Defense, other Government agencies, foreign governments, and industry.

11-1.2.1. Abuses and Abusive Environments. Test methods use a combination of common battery abuses and extremely abusive environments to characterize the safety behavior of the battery during its life cycle.

11-1.2.2. Quantitative Assessment. Data from safety tests support a quantitative assessment of the severity of the battery events and provide an estimate of the likelihood of such events.

11-1.2.3. Worst Case Battery Response. Tests provoke the worst-case battery response to determine if the response is acceptable based on the system and platform requirements.

11-1.2.4. Battery-Level Safety Devices Bypassed or Excluded. Characterization of worst-case battery behavior is assured by conducting some tests with battery-level safety devices bypassed or excluded.

**11-2. PASS-FAIL CRITERIA.** An inability of the lithium batteries or lithium battery-powered equipment to meet the "passing" criteria does not necessarily result in an automatic rejection of the equipment for service use. Test units that fail to meet such criteria will be rejected only if a technical evaluation of the test results by NOSSA establishes that rejection is the appropriate course of action. The passing criteria by platform are presented in table 11-1.

**Table 11-1. Passing Criteria for Test Units by Platform**

| Platform | Criteria | | |
|---|---|---|---|
| **Submarines** | Venting of gaseous/liquid/solid material and flames outside of the test unit is **prohibited**. | **and** | The peak pressure remains **equal to or below** 50 percent of the yield pressure of the unit in any test. |
| **Aircraft**(1) | Venting of gaseous/liquid material is **permitted**. Venting of solid material and flames outside of the test unit is **prohibited**. Rupture of the test unit is **prohibited**. | **and** | The peak pressure remains **equal to or below** 50 percent of the yield pressure of the unit in any test. |
| **Ships** | Venting of gaseous/liquid/solid material is **permitted**. Venting of flames outside of the test unit is **prohibited**. Rupture of the test unit is **prohibited**. | **and** | The peak pressure remains **equal to or below** 50 percent of the yield pressure of the unit in any test. |
| **Land** | Venting of gaseous/liquid/solid material and flames is **permitted**. Rupture of the test unit is **prohibited**. | **and** | The peak pressure remains **equal to or below** 50 percent of the yield pressure of the unit in any test. |
| **Unsafe** | Rupture of the test unit | **or** | The peak pressure **exceeds** 50 percent of the yield pressure of the unit in any test. |

(1) The preferred chemistry for aircraft is solid cathode chemistry. Liquid cathode chemistries are highly corrosive and toxic. The location of the cell or battery in the aircraft will be closely scrutinized, especially regarding the possibility of toxic, corrosive gasses affecting crew members, passengers, or high priority equipment or systems.

11-2.1. TEST SPECIFIC PASSING CRITERIA. System-specific pass-fail criteria shall be determined during the preliminary safety data package review. However, the following test specific criteria exist for all applicable battery programs:

11-2.1.1. Active Non-Rechargeable Batteries. Batteries must not vent in response to the Electrical Safety Device Test described in paragraph 11-3.4.5.

11-2.1.2. Thermal Batteries. Batteries must not undergo inadvertent activation in response to environmental tests conducted in accordance with paragraph 11-3.5.1.

11-2.1.3. Liquid Reserve Batteries. Batteries must not undergo inadvertent activation in response to environmental tests conducted in accordance with paragraph 11-3.6.1(a).

11-2.1.4. Rechargeable Batteries. Batteries must not vent in response to the Electrical Safety Device Test described in paragraph 11-3.7.5.

## 11-3. SAFETY TESTS.

**WARNING**

Safety tests can cause violent venting of batteries with deflagration and fragment hazards, and release of vapor clouds of chemically active, toxic, flammable, or corrosive materials. Appropriate safety precautions shall be observed during testing, including ventilation controls, containment of byproducts, or standoff distance to protect personnel and facilities.

11-3.1. NUMBER OF TEST UNITS. Fifteen (15) non-rechargeable active, 15 thermal, 21 liquid reserve, or 21 rechargeable, production-representative units shall be provided for testing. A test unit shall consist of a battery inside a complete system, or a battery inside sufficient system components to simulate the battery/system interactions. The final determination of the number of test units will be made upon review of the safety data package.

11-3.1.1. Additional Test Units. Additional test units may be required to address special battery design, equipment, or platform safety concerns.

11-3.1.2. Smaller Population. A smaller population of test units may be acceptable for safety evaluations that involve revisions to battery designs that have previously been tested in accordance with this manual, or the use of previously tested batteries in new systems or applications.

11-3.1.3. Alternative Test Units. In some tests, individual cells, subsections, and/or partially populated batteries may be substituted as test units for large batteries. The use of alternative test units and configurations must be justified by the program manager in consultation with the designated NOSSA Technical Agent.

11-3.1.4. Multiple Use of Test Units. Test units that have been subjected to environmental compliance tests such as shock, vibration, and humidity exposure, that did not result in discharge of the battery (or when the battery can be recharged to its full capacity), may be used for safety testing. Alternate allocations of test units are possible. For example, a short-circuit

test article with an expended non-removable safety device may be re-used for high temperature test evaluation, with justification.

11-3.2. TEST INSTRUMENTATION. All tests shall be instrumented as described in this paragraph. The minimum test instrumentation for the testing shall include thermocouples capable of measuring and withstanding temperatures up to 800 degrees C, voltage monitoring leads, power leads, current sensing equipment, pressure sensing equipment, and a data acquisition system. All test iterations must be documented using videotape with audio recording. These recordings will be retained for review and must be made available upon request.

11-3.3. FINAL REPORT. A full narrative description of each test will be included in the final report. The final report shall as a minimum include:

a. Test conditions and test equipment;

b. Test sequences and asset usage;

c. Test anomalies;

d. Test unit response to test conditions;

e. Details on test unit responses and test events with tabular, graphical data;

f. Discussion on the impact of test responses on personnel or system safety (maximum credible event);

g. Photographic, schematic, or diagrammatic documentation and evidence of the test units, test unit conditions before and after the tests, test events of note and special aspects of the test protocol used.

11-3.4. ACTIVE NON-RECHARGEABLE BATTERY TESTS. The following safety tests shall be completed on three test units; voltage, current, pressure, and temperatures shall be continuously monitored and recorded, when applicable, as determined by the test engineer. The testing shall be video recorded.

11-3.4.1. Constant Current Discharge and Reversal Test. This test shall consist of a constant current discharge using a direct current (D.C.) power supply. All internal electrical safety devices shall be bypassed (shorted) and the discharge shall be performed at a current equal to the value of the battery pack fuse. The voltage of the D.C. power supply shall be limited to 1.1 times the battery open circuit voltage (OCV). After the battery voltage reaches zero volts, the discharge shall be continued into voltage reversal at the same current for a capacity equivalent to 1.5 times the nominal rated ampere-hour capacity of the battery pack. The total test duration is defined as the capacity of the battery/cell to zero volts plus 1.5 times the maximum published capacity after reaching zero volts.

11-3.4.2. Short Circuit Test. This test shall consist of shorting the battery, after all internal electrical safety devices have been bypassed, through an appropriate load to stress the battery (typically 0.02 ohm or less) and leaving the load attached for not less than 24 hours.

11-3.4.3. High Temperature Test. This test shall consist of heating the battery pack at a rate of 10 degrees C to 20 degrees C rise per minute up to a temperature of 500 degrees C, and maintained until the battery vents or reactions stop. The temperature ramp rate may be revised depending on the battery pack size to ensure uniform thermal distribution. Test units may be tested with or without internal battery electrical safety devices.

11-3.4.4. Charging Test. This test shall be performed if a battery contains parallel strings, or the system containing the battery is to be connected to an outside D.C power source. This test shall consist of charging the battery using a D.C. power supply. All internal battery electrical safety devices shall be bypassed. The battery shall be discharged to remove at least 50% of the maximum published capacity at a current equal to the fuse value. The battery shall then be charged at a current equal to the fuse value to 1.5 times circuit voltage or to the voltage of the outside source, whichever is greater.

11-3.4.5. Electrical Safety Device Test. This test shall consist of constant current discharge using a D.C. power supply. All electric safety devices shall be in place and operational. The discharge shall be performed at a current equal to 85 – 90% of the battery pack fuse value. The voltage of the D.C. power supply shall be limited to 1.1 times the open circuit voltage of the battery pack. After the battery voltage reaches zero volts, the discharge shall be continued into voltage reversal at the same current for a capacity equal to 1.5 times the maximum published capacity of the battery pack. The total test duration is defined as the capacity of the battery or cell to zero volts plus 1.5 times the rated capacity after reaching zero volts.

11-3.4.6. Short Circuit Electrical Safety Device Test. All electric safety devices shall be in place and operational. This test shall consist of shorting the battery through an appropriate load to stress the battery (typically 0.02 ohm or less) and leaving the load attached for not less than 24 hours.

11-3.5. THERMAL BATTERY TESTS.

11-3.5.1. Unactivated Enviromental Tests. Environmental tests (shock, vibration, Electromagnetic Interference (EMI), Electrostatic Discharge (ESD), Hazards of Electromagnetic Radiation to Ordnance (HERO), and temperature-altitude) shall be performed to demonstrate that no inadvertent activation or unsafe conditions exist under any unactivated use scenarios. Tests performed to satisfy other program requirements may be substituted for these tests, subject to NOSSA approval.

11-3.5.2. High Rate Discharge Test. This test shall consist of conditioning the test unit to the maximum non-operating temperature required by the end item specification, followed by activation into a load equivalent to approximately 80 % of the current-carrying capability of the battery sections or of the fuse value. This test shall continue until the discharge voltage drops below 1% of the peak output voltage. Each battery section shall be instrumented separately.

All battery sections shall be discharged simultaneously. This test shall be completed on three test units; voltage, current, pressure and battery skin temperature shall be continuously monitored and recorded, when applicable, as determined by the test engineer. The testing shall be video recorded.

11-3.5.3. High Temperature Test. This test shall consist of preconditioning the battery to a temperature of 150 degrees C ± 15 degrees C (or no less than 75 degrees C above the maximum non-operational storage or operational temperature condition, whichever is higher, but not to exceed 175 degrees C) until fully equilibrated. The battery shall be activated within 10 minutes after removing the battery from the conditioning chamber. Battery voltage outputs and surface temperature shall be monitored until values have fallen to less than 10% of the peak values recorded during the test. Thermocouples shall be placed on a minimum of four locations on the battery: header, base, and on opposite sidewalls. This testing shall be completed on a minimum of three batteries. The testing shall be video recorded.

11-3.5.4. Open Circuit Test. This test shall consist of conditioning the test unit to the maximum non-operating temperature required by the end item specification, activating the battery without a discharge load, and allowing the battery to stand in this condition until the voltage falls below 10% of the maximum observed voltage. This test shall be completed on three test units; voltage, pressure, and battery skin temperature shall be continuously monitored and recorded. The testing shall be video recorded.

11-3.5.5. Charging Test. This test shall be performed if a battery consists of parallel-connected sections or can be connected to an external power source. This test shall consist of battery activation, after all safety devices have been bypassed, followed by discharge to 50% of the available rated capacity, at a rate equal to the average mission load current. The battery shall then be charged using a D.C. power supply, until the battery no longer accepts the charge. The charge current will be limited to a rate equal to the maximum battery operational current. The charge voltage shall be limited to the battery open circuit voltage or the external power source voltage, whichever is greater. This test shall be completed on three test units; voltage, current, pressure, and battery skin temperature shall be continuously monitored and recorded, when applicable, as determined by the test engineer. The testing shall be video recorded.

11-3.6. LIQUID RESERVE BATTERY TESTS.

11-3.6.1. Unactivated. The following two tests shall be performed on unactivated liquid reserve batteries.

a. Environmental Test. Environmental tests (shock, vibration, EMI, ESD, HERO, and temperature-altitude) shall be performed to demonstrate that no inadvertent activation or unsafe conditions exist under any unactivated use scenarios. Tests performed to satisfy other program requirements may be substituted for these tests, subject to NOSSA approval.

b. High Temperature Test. This test shall consist of heating the battery inside the unit at a rate of 10 degrees C to 20 degrees C rise per minute up to a temperature of 500 degrees C. The temperature ramp rate may be revised depending on the battery pack size to ensure

uniform thermal distribution. Test units may be tested with or without internal battery electrical safety devices. This test shall be completed on three units; voltage, pressure and temperature shall be continuously monitored and recorded. The testing shall be video recorded.

11-3.6.2. Activated. The following six tests shall be performed on activated liquid reserve batteries. All tests shall be completed on three test units; voltage, current, pressure and temperature shall be continuously monitored and recorded, when applicable, as determined by the test engineer. The testing shall be video recorded.

a. Constant Current Discharge and Reversal Test. This test shall consist of a constant current discharge using a D. C. power supply. All internal electrical safety devices shall be bypassed (shorted), the battery shall be activated, and the discharge shall be performed at a current equal to the value of the battery pack fuse. The voltage of the D.C. power supply shall be limited to 1.1 times the open circuit voltage of the battery pack. After the battery voltage reaches zero volts, the discharge shall be continued into voltage reversal at the same current, for a capacity equivalent to 1.5 times the maximum published ampere-hour capacity of the battery pack. Total test duration is defined as the capacity of the battery/cell to zero volts plus 1.5 times the maximum published capacity after reaching zero volts.

b. Short Circuit Test. This test shall consist of bypassing all internal electrical safety devices, activating the battery, shorting the battery through an appropriate load to stress the battery (typically 0.02 ohm or less), and leaving the load attached for not less than 24 hours.

c. Open Circuit Test. This test shall consist of activating the battery into a no load and allowing the battery to stand in this condition for a period of time to be determined during the preliminary safety data package review.

d. Electrical Safety Device (ESD) Test with High Temperature Preconditioning. This test shall consist of heating the battery to the maximum unactivated temperature required by the end item specification with the ESDs in place. The battery shall then be activated and discharged at a current rate equal to 80% of the fuse value or at the mission load current profile. After the battery voltage reaches zero volts, the discharge shall be continued into voltage reversal at the same current, for a capacity equivalent to 1.5 times the maximum published ampere-hour capacity of the battery pack. The total test duration is defined as the capacity of the battery/cell to zero volts plus 1.5 times the maximum published capacity after reaching zero volts.

e. Charging Test. This test shall be performed if a battery consists of parallel-connected sections or is connected to an external power source. The test shall consist of battery activation, after all internal electrical safety devices have been bypassed, followed by discharge to 50% of maximum published capacity at the rate equal to 1.5 times the average mission load current. The battery shall then be charged using a D.C. power supply, to 1.5 times the maximum published capacity. The charge current will be limited to a rate equal to the maximum battery operational current. The charge voltage shall be limited to 1.1 times the battery open circuit voltage or the external power source voltage, whichever is greater.

f. High Temperature Test. This test shall consist of heating the battery inside the unit at a rate of 10 degrees C to 20 degrees C rise per minute up to a temperature of 500 degrees C. The temperature ramp rate may be revised depending on the battery pack size to ensure uniform thermal distribution. Test units may be tested with or without internal battery electrical safety devices. This test shall be completed on three units; voltage, pressure, and current (where applicable) shall be continuously monitored and recorded. The testing shall be video recorded.

11-3.7. RECHARGEABLE BATTERY TESTS. A standard, non-abusive charge/discharge cycle shall be defined for each battery under test based on the manufacturer's recommended guidelines, or the actual use scenario. Cycle counts shall begin with the first discharge. This profile shall be used in the tests described below. All tests shall be conducted on three test units; voltage, temperature, pressure and current (where applicable) shall be continuously monitored and recorded. The testing shall be video recorded.

11-3.7.1. Short Circuit Test. All safety devices located inside the battery but external to the cells, such as fuses, Positive Thermal Coefficient (PTC) Devices, diodes, charge control chips, Battery Management Systems (BMSs), shall be disabled or bypassed. All embedded, cell-level safety devices shall be left intact. This test shall consist of shorting the fully charged battery through an appropriate load to stress the battery (typically 0.02 ohm or less) and leaving the load attached for not less than 24 hours.

11-3.7.2. Overcharge/Discharge Test. All safety devices located inside the battery but external to the cells such as fuses, PTCs, diodes, charge control chips, or BMSs shall be disabled or bypassed. All embedded, cell-level safety devices shall be left intact. This test shall consist of charging the test unit with a constant current at the maximum output rate of the designated charging source to 1.25 times the maximum charge voltage limit and discharging the unit using the standard non-abusive discharge regime. A minimum of 20 cycles shall be conducted, unless the test unit vents, fails to accept charge, or delivers less than 25% of the manufacturer's published value on discharge.

11-3.7.3. Overdischarge/Charge Test. All safety devices located inside the battery but external to the cells such as fuses, PTCs, diodes, charge control chips, or BMSs, shall be disabled or bypassed. All embedded, cell-level safety devices shall be left intact. This test shall consist of charging the test unit using the standard non-abusive charge regime and discharging with a constant current at the maximum sustainable output rate for 1.25 times the maximum published capacity of the battery. A minimum of 20 cycles shall be conducted, unless the test unit vents, fails to accept charge, or delivers less than 25% of the manufacturer's published value on discharge.

11-3.7.4. High Temperature Test. This test shall consist of heating the fully charged battery pack at a rate of 10 degrees C to 20 degrees C rise per minute up to a temperature of 500 degrees C, maintained for one hour, or until the battery vents. The temperature ramp rate may be revised depending on the battery pack size to ensure uniform thermal distribution. Test units may be tested with or without internal battery electrical safety devices.

11-3.7.5. Electrical Safety Device Test. This test shall consist of charging the test unit at the maximum output rate of the designated charging source to 1.25 times the maximum charge voltage limit until the current has decreased by 95%; then discharging the test unit at the maximum sustainable output rate for 1.25 times the maximum published capacity of the battery. All safety devices shall be in place and operational. In the event that a battery safety device trips prior to completing the test, resume testing as soon as the device resets. If the test unit completes the 10 cycles , repeat the test with the charging source voltage at 1.50 times the maximum charge voltage limit, then 1.75 times and 2.00 times, unless the test unit vents, fails to accept charge, or delivers less than 25% of the manufacturer's published value on discharge during any test iteration.

11-3.7.6. Short Circuit Electrical Safety Device Test. All electric safety devices shall be in place and operational. This test shall consist of shorting the battery through an appropriate load to stress the battery (typically 0.02 ohm or less) and leaving the load attached for not less than 24 hours.

11-3.7.7. Aging Safety Test. This test shall consist of cycling the test unit at the manufacturer's maximum recommended charge and discharge rates and voltages. All electric safety devices shall be in place and operational. Cycling should be continuous, unless precluded by battery electronics, until the battery capacity per discharge cycle drops below 75% of the original capacity or until 0.5 times the rated cycle life has been achieved, whichever comes first. Upon completion of the aging portion of the test, batteries shall be subjected to either the High Temperature Test in accordance with paragraph 11-3.7.4 or the Short Circuit Test in accordance with paragraph 11-3.7.1.

11-3.8. PROPAGATION TEST (APPLICABLE TO RECHARGEABLE OR NON-RECHARGEABLE BATTERIES). Propagation tests are conducted to determine the effects of a critical failure of one cell to neighboring cells. When applicable as determined by the test engineer, the test shall be conducted in a fashion that simulates the real system's physical constraints (i.e., cell spacing and orientation, free volume, packing material, wiring, etc.). Multiple methods can be used to initiate the donor cell, including but not limited to: internal short (as built in by the original equipment manufacturer's process), localized thermal abuse (to minimize the heating of neighboring cells prior to donor cell failure), overcharge, or external short/puncture. The Preliminary Hazards Analysis and concept of Operation should be evaluated to determine the best triggering event. Less than full-up battery tests or system tests may be conducted to understand the potential hazards from thermal, electrical, and mechanical effects of a propagation event prior to testing in all-up platform and enclosures.

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# APPENDIX A

# DEFINITIONS AND ABBREVIATIONS

**A-1. INTRODUCTION.** This appendix contains definitions of terms and abbreviations related to lithium batteries and the Navy Lithium Battery Safety Program. Not all definitions listed are used in this document, but may prove useful in understanding the subject matter.

Activation – The process of making an electrochemical cell or battery functional. For example, the process of introducing the electrolyte into a reserve cell; the firing of pyrotechnics to make a thermal battery active; or the first charge cycle on a lithium ion cell.

Active Battery – A battery which is designed to deliver electrical power any time a load is applied. Ordinary flashlight batteries are examples of active batteries, as are lead-acid starting-lighting-ignition (SLI) batteries.

Anode – The electrode in an electrochemical cell where oxidation takes place. During discharge, the anode is the negative electrode in a cell. Typical anodes are reactive metals, alloys, and supporting matrices containing lithium.

Battery – An assembly of electrochemical cells connected in an appropriate series or parallel arrangement to provide the required operating voltage and current levels, which has been packaged for use, including, if any, ancillary components (fuses, diodes), case, terminals, and markings.

Battery Management System (BMS) – An electronic system designed for a secondary (rechargeable) battery that monitors the charging cycle to protect the individual cells of a battery from overcharging. A BMS may also be used to control/monitor discharge of individual cells in either a primary (non-rechargeable) or secondary (rechargeable) battery. Also known as Battery Monitoring Systems.

Bleeder Resistor – A resistor installed in a reserve battery that will discharge the battery at an appropriate rate should the battery be inadvertently activated.

Cathode – The electrode in an electrochemical cell where reduction takes place. During discharge, the cathode is the positive electrode in a cell. Cathodes can be solids such as manganese dioxide and carbon monofluoride, liquids such as thionyl chloride, or gases such as sulfur dioxide. Cathodes may be pure materials or mixtures of reactive compounds and additives. In cells with non-solid cathodes, the term “cathode” is often applied to a solid, non-reactive current collector.

Catholyte – The portion of an electrolyte in the galvanic cell adjacent to a cathode; if a diaphragm is present, the electrolyte on the cathode side of the diaphragm. In terms of composition, the chatholyte is a mixture of cathodically reducible material with supporting ionic conductive salts of co-solvents.

Cell – An individual unit of a battery consisting of a container, anode, cathode, separator, and electrolyte.

Charge/Discharge Methods – The method used to charge or discharge a battery. The most common methods are constant current, constant voltage, constant power, and pulse current.

Depleted Battery – A battery that has been discharged to the recommended minimum voltage and/or capacity.

Diode – A semi-conductor device, which prevents significant flow of current in one direction. Diodes are used to prevent application of charging voltages to batteries that are not designed to be charged; i.e., primary (non-rechargeable) cells and batteries. A shunting diode may be used to prevent a battery or cell from being driven into voltage reversal by preferentially conducting current around that battery or cell.

Discharge (Drain) Rate – The current flow during discharge of a cell or battery. It can be expressed in amperes, but is sometimes normalized to rated capacity.

Electrolyte – The conductive material within a battery, which allows charged species to move between anode and cathode so that the cell reaction may proceed and ionic current will flow. Most electrolytes are liquid and are solutions of an ionic material; for example, salts or acids, such as potassium hydroxide or sulfuric acid, in a poor/non-conductive solvent such as water. Non-liquid examples are polyethylene oxides (PEO) plastics, which have been doped with lithium salts, or various ceramics or glasses doped with sodium or lithium oxides and hydroxides. Liquid, non-aqueous electrolytes are limited to molten, ionic salt mixtures, which require no additives to improve conductivity (usually operated at high temperatures), or mixtures of covalent organic or inorganic solvents, which require the addition of ionic salt additives.

Electrical Fuse – A protective device containing a piece of metal that melts under heat produced by an excess current in a circuit, thereby breaking or opening the circuit.

Energy Density – The quantity of energy stored by a battery per unit weight or unit volume. Typical units include watt-hours per pound or watt-hours per cubic inch. To be most useful, energy densities must be measured at a specific discharge rate and temperature.

Fully Equilibrated – A battery system is considered to be fully equilibrated when both temperature and voltage are stable for at least four continuous hours.

Hermetic Seal – An airtight seal, usually rated at cc/sec leakage of air or air equivalent helium.

Housing, Battery – A fully enclosed case and support for the internal components of a battery.

Intercalation – A process where lithium ions are reversibly removed or inserted into a host material without causing significant structural change to that host. This process is the basis for the operation of the lithium ion batteries, and distinguishes those batteries from lithium rechargeable batteries with metallic anodes.

Large Form Lithium Battery – Primary or rechargeable lithium battery packs over 1 kWh total energy content, or battery powered systems with total battery energy over 2 kWh.

Liquid Reserve Battery – A battery that is inactive until the automatic addition of a liquid electrolyte or catholyte that was stored separately from the electrode assembly.

Lithium Battery – For the purpose of this document, lithium batteries include all cells or batteries in which lithium metal, any lithium alloy, or any form of lithium in a supporting matrix serves as the active anodic component, as in the lithium ion battery.

Lithium Ion Battery – Lithium ion batteries are comprised of cells that use lithium intercalation compounds as the positive and negative electrodes. As the battery is cycled, lithium ions (Li+) exchange between the positive and negative electrodes.

Load Profile – An illustration of the power needed from a battery to support a given system. This is usually expressed by graphing required current versus time.

Nominal Rated Capacity – The manufacturer's advertised capacity at a given current under ambient conditions.

Positive Thermal Coefficient (PTC) Device – A polymeric or ceramic element which has a very low resistance and conducts electricity with very little loss until a critical temperature or current range is reached. Upon reaching a predefined critical range, the internal resistance of the PTC increases exponentially, preventing the continued flow of current by the driving voltage applied. Resistance increase is typically five to six orders of magnitude over a temperature range of 25 degrees C. Upon cooling below the critical temperature range, resistance of the PTC device recovers to nearly the same resistance as originally found.

Potting – (*Noun)* A supportive material in a battery used to immobilize cells and connections and protect them under shock and/or vibration. (*Verb)* The process of surrounding the individual cells in a battery with a material designed to immobilize and support the battery contents.

Primary Battery – A battery which is designed to be discharged only once; i.e., it is NOT designed to be recharged. Also called a non-rechargeable battery.

Reserve Battery – A battery, stored in an inactive state such that some activation process must occur before use. Activation may be a manual process such as pouring electrolyte into a dry battery, or it may be automated as when the electrolyte is forced into the cell stack from an

external reservoir. Due to the added expense of manufacture and reduced energy density, generally reserve systems are specially developed for the application in which they will be used. The two main categories of lithium reserve batteries are liquid reserve and thermal batteries.

Room Ambient Conditions – Temperature = 25±5 degrees C, pressure = 29±2 inches Hg, humidity (RH) = 30-90 percent.

Safety Data Package – A collection of information about a battery and the system it will be used in. The required elements of a safety data package are listed in paragraph 2-3 of this document.

Secondary Battery – A battery in which the electrochemical reaction is thermodynamically reversible and is designed to be recharged after use. Common secondary batteries include the lead-acid, nickel-cadium and lithium ion batteries common to many consumer products. May also be referred to as a rechargeable battery.

System – For the purpose of this document, “the system” refers to the entire unit that is powered by the battery in question. For example, a missile, sonobuoy, or mine with its battery installed would be a system. By extension, a missile interconnected to its launch platform is also a system.

Test Unit – For the purpose of this document, a test unit shall consist of a battery inside a complete system, or a battery inside sufficient system components to simulate the battery/ system interactions.

Thermal Battery – A reserve battery in which all of the components are solids at room temperature. The battery is activated by heating to a temperature at which the anode and cathode become reactive and the electrolyte becomes conductive. The heat source is often a pyrotechnic material which is built into the battery and which can be remotely ignited.

Thermal Fuse – A fusible link electrical element that conducts current while it is below a critical threshold temperature. Once this threshold temperature is exceeded, the current-carrying capacity of the thermal fuse is irreversibly terminated, typically by melting a circuit breaker element allowing a spring to disconnect the circuit.

Unactivated – The state of a reserve cell prior to introducing an electrolyte into the cell; **or**, the state of a thermal battery prior to firing the pyrotechnics that melt the electrolyte.

Used Battery – A battery that is not fresh, i.e., it has been partially discharged. A used battery may be re-used or it might be set aside for disposal, depending on the system requirements and operating procedures.

Vent – (*Noun)* Most cells and batteries contain a vent mechanism, which is designed to release internal pressure in a benign manner in order to prevent any violent rupture of the battery case. In batteries which are known to release a gas during normal use, such as many aqueous electrolyte systems, the vent is often an open hole or spring-loaded valve. In batteries which

are designed to remain hermetically sealed, the vent is often an intentionally weakened part of the cell case, which will pop open before the case ruptures violently. (*Verb)* The venting of a battery is considered to be a relatively mild event. In some cases, it is normal; in all cases, it represents the mildest form of release of material from the battery. If the material released is explosive, noxious, or toxic, even a mild venting can be unpleasant or dangerous. An unofficial hierarchy often goes from mild venting to venting to vigorous venting to violent venting with flame to explosion to detonation. In a venting, the battery case remains intact.

## A-2. ABBREVIATIONS.

Ah – Ampere-hour

BMS – Battery Management System

CFR – Code of Federal Regulations

COE – Certificate of Equivalency

COMSC - Commander, Military Sealift Command

COTS – Commercial-off-the-Shelf

D.C. – Direct Current

DRMO – Defense Reutilization and Marketing Office

EMI – Electromagnetic Interference

EOD – Explosive Ordnance Disposal

EPA - Environmental Protection Agency

ESD – Electrical Safety Device or Electrostatic Discharge

HERO – Hazards of Electromagnetic Radiation to Ordnance

LFORM- Landing Force Operational Reserve Materiel

LQHUW - Large Quantity Handler of Universal Waste

MSC - Military Sealift Command

MSDS – Material Safety Data Sheet

NAVAIRSYSCOM – Naval Air Systems Command

NAVSEASYSCOM – Naval Sea Systems Command

NOSSA – Naval Ordnance Safety and Security Activity

OCV – Open Circuit Voltage

OECD - Organization for Economic Co-operation and Development

PPE – Personal Protective Equipment

PTC – Positive Thermal Coefficient

SOP – Standard Operating Procedure

SQHUW - Small Quantity Handler of Universal Waste

SSP – System Safety Program

UL – Underwriters Laboratories

# APPENDIX B

# REFERENCE DOCUMENTS

**B-1. INTRODUCTION.** This appendix contains a list of documents containing all types of information referenced in this manual. These documents, together with ship (station) instructions and notices, technical publications, and standard operating procedures (SOPs), shall be maintained in appropriate libraries as a collection of current information pertaining to lithium battery safety.

**B-2. DEPARTMENT OF DEFENSE (DOD).**

NAVSEA Instruction

9310.1 – Naval Lithium Battery Safety Progam

NAVSO P-3683 – Navy and Marine Corps Product Data Reporting and Evaluation Program Manual

OPNAV Instruction

5090.1 – Environmental Readiness Program Manual

5102.1 – Navy and Marine Corps Mishap and Safety Investigation, Reporting and Record Keeping Manual

SECNAV Manual 5216.5 – Department of the Navy Correspondence Manual

**B-3. STANDARDIZATION DOCUMENTS.**

MIL-HDBK-61 – Configuration Management Guidance

MIL-N-24408 – Nozzles, Fire Hose, Combination Aqueous Film Forming Foam, Water Spray, Adjustable Pattern (Shipboard Use)

MIL-STD-648 – Specialized Shipping Containers

MIL-STD-882 – Standard Practice for System Safety

ISO 10007 – Guidelines for Configuration Management

## B-4. FEDERAL REGISTER.

Code of Federal Regulations

Title 29 – Labor

Title 40 – Protection of Environment

Title 49 - Transportation

## B-5. JOINT SERVICE DOCUMENTS.

DLAD 4145.41/AR 700-143/AFJI 24-210/NAVSUPINST 4030.55/MCO 4030.40 – Packaging of Hazardous Material

AFMAN 24-204/TM 38-250/NAVSUP Pub 505/MCO P4030.19/DLAI 4145.3 - Preparing Hazardous Materials for Military Air Shipments

# APPENDIX C

# POINTS OF CONTACT AND ADDRESSES

**C-1. TECHNICAL WARRANT AUTHORITY.** The Department of the Navy Technical Warrant Authority for Explosives Safety includes Lithium Battery Safety. The Lithium Battery Safety Program point of contact (POC) is:

Commanding Officer
Naval Ordnance Safety and Security Activity
Attn: Code N841
Farragut Hall
3817 Strauss Avenue
Indian Head, MD 20640-5151
POC: Mr. John Dow, dsn 354-5640, commercial (301) 744-5640, or email: john.dow@navy.mil

**C-2. TECHNICAL AGENTS.** The Lithium Battery Safety Program Technical Agents are:

Commander
Naval Surface Warfare Center, Crane Division
Attn: GXS
Bldg. 3235
300 Highway 361
Crane, IN 47522-5000
POC: Mr. Mark Tisher, dsn 482-5912, commercial (812) 854-5912, or email:
mark.tisher@navy.mil

Commander
Naval Surface Warfare Center, Carderock Division
Attn: Code 616
Bldg. 12
9500 MacArthur Boulevard
West Bethesda, MD 20817-5700
POC: Ms. Julie Banner, dsn 287-1853, commercial (301) 227-1853, or email:
julie.banner@navy.mil

## C-3. PLATFORM CONCURRENCE COORDINATION.

C-3.1. The designated authority for lithium battery design and suitability for Naval Forces Afloat (ship and submarine platform concurrence) is:

Commander
Naval Sea Systems Command
Attn: SEA-05Z34
614 Sicard Street SE
Washington Navy Yard
DC 20376
POC: Mr. David Cherry, dsn 326-1304, commercial (202) 781-1304, or email: david.f.cherry@navy.mil.

C-3.2. The designated authority for lithium battery design suitability for Naval Aircraft (aviation platform concurrence) is:

Commander
Naval Air Systems Command
Attn: AIR 4.4.5.2
48298 Shaw Road, Building 1461
Patuxent River, MD 20670
POC: Mr. Mark Hurley, commercial (301) 995-4559, or email: mark.a.hurley@navy.mil.

C-3.3. The designated authority for lithium battery design suitability for Military Sealift Command (ship platform concurrence) is:

Commander
Military Sealift Command
Attn: N7
914 Charles Morris Ct. SE
Washington Navy Yard, DC 20398-5540
POC: Mr. John Berman, commercial (202) 685-5765, or email: jonathan.berman@navy.mil.

## C-4. OTHER REFERENCED POINTS OF CONTACT.

### Approved Packaging

Director
Naval Surface Warfare Center Indian Head Division Detachment Earle
Attn: Code E43
Naval PHST Center
201 Highway 34
Colts Neck, NJ 07722-5023
POC: Mr. Robert Dress, dsn 449-2821, commercial (732) 866-2821, or email: robert.dress@navy.mil.

### Transportation of Lithium Batteries

U.S. Department of Transportation
Pipeline and Hazardous Materials Safety Administration
East Bldg, 2nd Floor
1200 New Jersey Avenue SE
Washington, DC 20590
http://www.phmsa.dot.gov

### TMDERs

Commander
Naval Surface Warfare Center
Port Hueneme Division
Attn: Code 312
4363 Missile Way,
Port Hueneme, CA 93043-4307
https://nsdsa2.phdnswc.navy.mil

### TMDERs, Requests for Copies, Distribution Changes

Director
Naval Surface Warfare Center Indian Head Division Detachment Earle
Attn: Code E43
Naval PHST Center
201 Highway 34
Colts Neck, NJ 07722-5023
POC: Ms. Jeri DiMaggio, dsn 449-2976, commercial (732) 866-2976, or email:
jeri.dimaggio@navy.mil

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# APPENDIX D

# SAMPLE REQUEST LETTERS

**D-1. INTRODUCTION.** This appendix provides, as figures-D-1 and D-2, examples of letters requesting lithium battery safety review. Such request letters must be submitted early in the program acquisition process by the Program Manager of systems or equipment using lithium cells and batteries.

**D-2. REQUEST FOR SAFETY REVIEW.** Requests for safety review must be submitted by the Program Manager to one of the NOSSA Technical Agents for Lithium Batteries. The letter must address the elements of paragraph 2-3.

13280
26 Feb 09

From: Program Manager for System
To: Commanding Officer, Naval Ordnance Safety and Security Activity (N841)
Via: Commander, Carderock Division, Naval Surface Warfare Center (616)
***or***
Commander, Crane Division, Naval Surface Warfare Center (GXS)

Subj: SAFETY REVIEW OF LITHIUM BATTERY CONTAINED IN THE NAVY XYZ SYSTEM

Ref: (a) NAVSEA S9310-AQ-SAF-010
(b) NAVSEAINST 9310.1B

Encl: (1) Battery Safety Data Package for ...

1. (Your office) requests that the Naval Ordnance Safety and Security Activity (NOSSA) provide concurrence for use of the (model or part number) battery as used in the NAME system in accordance with reference (a) as required by reference (b). A safety data package describing the battery and the system it is used in is included as enclosure (1) for review by the technical agent.

2. BRIEFLY DESCRIBE THE BATTERY AND THE SYSTEM, WHO WILL BE USING IT, WHERE IT WILL BE USED…(i.e., the XYZ Battery used in the NAME system is a lithium/thionyl chloride battery manufactured by Acme Battery Manufacturers, Inc. The battery is a single cell, hermetically sealed lithium/thionyl chloride system with a mechanical activation mechanism. The system is currently in development by the Army and is proposed for use by Navy SEALs on surface ships and submarines. Total theoretical capacity is 0.314 amp-hours (approximately one-sixth the capacity of a bobbin construction “AA” LI/$SOC1_2$ cell). The manufacturer’s rated capacity is 0.280 amp-hours under 0.5 a load at room temperature. Limited safety testing has been conducted on the XYZ battery in support of the PDQ Program. These results are included in the enclosed data package.

3. (Your office) requests that this package be reviewed, and that a response be returned by (date you need this). Any questions concerning this letter should be addressed to (POC, number, fax number…).

SIGNATURE

**FIGURE D-1. Sample Letter Requesting Safety Review of Lithium Battery**

13280
Ser PMS123/NNN
26 Feb 09

From: Program Manager for System
To: Commander, Carderock Division, Naval Surface Warfare Center (616)
***or***
Commander, Crane Division, Naval Surface Warfare Center (GXS)

Subj: SAFETY REVIEW OF LITHIUM BATTERY CONTAINED IN THE NAVY XYZ SYSTEM

Ref: (a) NAVSEA S9310-AQ-SAF-010
(b) NAVSEAINST 9310.1B

Encl: (1) Battery Safety Data Package for ...

1. (Your office) requests that the Naval Ordnance Safety and Security Activity (NOSSA) provide concurrence for use of the (model or part number) battery as used in the NAME system in accordance with reference (a) as required by reference (b). A safety data package describing the battery and the system it is used in is included as enclosure (1) for review by the technical agent.

2. BRIEFLY DESCRIBE THE BATTERY AND THE SYSTEM, WHO WILL BE USING IT, WHERE IT WILL BE USED…(i.e., the XYZ Battery used in the NAME system is a lithium/thionyl chloride battery manufactured by Acme Battery Manufacturers, Inc. The battery is a single cell, hermetically sealed lithium/thionyl chloride system with a mechanical activation mechanism. The system is currently in development by the Army and is proposed for use by Navy SEALs on surface ships and submarines. Total theoretical capacity is 0.314 amp-hours (approximately one-sixth the capacity of a bobbin construction "AA" LI/$SOC1_2$ cell). The manufacturer's rated capacity is 0.280 amp-hours under 0.5 a load at room temperature. Limited safety testing has been conducted on the XYZ battery in support of the PDQ Program. These results are included in the enclosed data package.

3. (Your office) requests that this package be reviewed, and that a response be returned by (date you need this). Any questions concerning this letter should be addressed to (POC, number, fax number…).

SIGNATURE

**FIGURE D-2. Sample Letter Requesting Safety Review of Small Lithium Battery Under the Exception of Paragraph 3-2 of this Manual**

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# APPENDIX E

# INITIAL PROCUREMENT REPORT REQUIREMENTS

**E-1. GENERAL.** Lithium batteries meeting the criteria of paragraphs 3-3 and 3-4 are approved for all uses and do not require individual testing and review by NOSSA. However, these batteries do require an initial procurement report, which shall be submitted via email to Li-Batts@navy.mil. The following information shall be included in the initial procurement report.

a. Subject: Initial Procurement Report;

b. Manufacturer/brand name;

c. Model identification (name and number);

d. Use scenario/environment (e.g., office computer or test set, submarine);

e. Point of contact (name, organization, email and phone number).

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# APPENDIX F

# ENVIRONMENTAL REQUIREMENTS FOR MANAGEMENT OF USED/EXCESS BATTERIES

**F-1. INTRODUCTION.** Environmental compliance in the management of battery disposal should be accomplished by the servicing environmental compliance organization at the performing activity. The following information is provided for information only.

F-1.1. TYPES OF HAZARDOUS WASTE COVERED BY UNIVERSAL WASTE RULE. The U.S. Environmental Protection Agency (EPA) established requirements for the management of used lithium batteries under the Universal Waste Rule. The rule establishes an alternative set of management standards applicable to a set of widely generated hazardous wastes. These standards can be used in lieu of the management requirements already in place for all other hazardous wastes. The requirements under the rule are easier for a waste generator to comply with than the requirements under the general hazardous waste laws. Four types of wastes are covered under the universal waste regulations: hazardous waste batteries, hazardous waste pesticides that are either recalled or collected in waste pesticide collection programs, mercury-containing equipment designated as waste, and hazardous waste lamps. These four types of hazardous wastes share several characteristics related to their proper management:

a. They are frequently generated in a wide variety of settings other than the industrial settings usually associated with hazardous wastes;

b. They are generated by a vast community, the size of which imposes implementation difficulties for both those who are regulated and the regulatory agencies charged with implementing the hazardous waste program, and;

c. They may be present in significant volumes in non-hazardous waste management systems.

F-1.2. DETERMINATION OF APPLICABILITY OF RULE TO LITHIUM BATTERIES. The requirements for the management of lithium batteries [to include all primary (non-rechargeable) and secondary (rechargeable), active, thermal, and reserve lithium batteries, including “lithium ion” batteries], as hazardous waste under the universal waste rule are set forth in 40 Code of Federal Regulations (CFR) 273. Not all lithium batteries that are “used” or no longer wanted are hazardous waste. However, the EPA determined that there was insufficient data available to make a broad generalization about whether various battery types are always or never hazardous; nor did they have the resources to perform sufficient testing. Therefore, it is up to the generator of the waste batteries to determine if the batteries are hazardous (i.e., are a listed hazardous waste or exhibit one or more characteristics of hazardous waste in accordance with

40 CFR 261) and subject to the hazardous waste regulations. The universal waste regulations are relatively simple for a generator to comply with and it may be easier and more efficient to manage all lithium batteries under the universal waste rule rather than trying to determine if a specific battery is a hazardous waste.

## F-2. UNIVERSAL WASTE RULE APPLICABILITY.

F-2.1. GENERATION OF WASTE BATTERIES. A used battery becomes a waste on the date it is discarded (e.g., when sent for reclamation.) An unused battery becomes a waste on the date the handler decides to discard it.

F-2.2. UNIVERSAL WASTE PARTICIPANTS. There are four types of participants in the universal waste system.

a. Small quantity handler of universal waste (SQHUW);

b. Large quantity handler of universal waste (LQHUW);

c. Transporter of universal waste;

d. Destination facilities (recyclers or treatment/disposal).

F-2.3. Navy installations will generally be either an SQHUW or an LQHUW. Non-Navy entities will normally perform the transportation and final disposition (destination facility) of lithium batteries; therefore this chapter does not address the requirements for these tasks. Information for requirements related to transporters is in 40 CFR 273.50. Information for requirements related to destination facilities is in 40 CFR 273.60.

F-2.3.1. An SQHUW does not accumulate 5,000 kilogram (11,000 pounds) or more total (all universal waste categories combined) of universal waste at their location at any time.

F-2.3.2. An LQHUW accumulates 5,000 kilograms or more total (all universal waste categories combined) of universal waste at any time. This designation as a large quantity handler of universal waste is retained through the end of the calendar year in which 5,000 kilograms or more total of universal waste is accumulated, at any one time.

F-2.4. The designation of SQHUW or LQHUW is based on the total quantity of universal waste generated or handled at an installation. This total includes the quantity of lithium batteries subject to the universal waste rule and the quantity of other hazardous wastes managed under the universal waste rule (other batteries, pesticides, mercury-containing equipment, and lamps). Shops generating waste lithium batteries must notify the installation's Environmental Office to inform them of their activities so that the universal waste handler status can be appropriately established.

F-2.5. There are two further classifications of handlers of universal waste, regardless of whether they are an SQHUW or an LQHUW.

a. The first type of handler is a person who generates, or creates, universal waste. This is a person who uses batteries and who eventually decides that they are no longer usuable, and thus are waste.

b. The second type of handler is a person who receives universal waste from generators or other handlers, consolidates the waste, and then sends it on to other handlers, recyclers, or treatment/disposal facilities.

F-2.6. Universal waste handlers accumulate universal waste, but do not treat, recycle, or dispose of the waste. Each Navy activity/installation that generates or collects used/excess lithium batteries is considered a handler of universal waste and a single location.

## F-3. REQUIREMENTS.

F-3.1. The requirements for the following topic areas are the same for an SQHUW and an LQHUW.

a. Prohibitions;

b. Waste Management;

c. Labeling/Marking;

d. Accumulation Time Limits;

e. Response to Releases;

f. Off-Site Shipments;

g. Exports.

F-3.2. The requirements for the following topic areas are dependent on whether the generator is an SQHUW or an LQHUW.

a. Notification;

b. Employee Training;

c. Tracking Universal Waste Shipments.

F-3.3. PROHIBITIONS. An SQHUW and LQHUW are prohibited from disposing (final disposition performed by a destination facility) of universal waste. The hazardous waste lithium batteries must be sent to another universal waste handler or to a destination facility. They are also prohibited from diluting or treating universal waste, except by responding to releases as provided in paragraph 3-3.7, or by managing specific wastes as provided in paragraph 3-3.4.

F-3.4. WASTE MANAGEMENT. An SQHUW and LQHUW must manage universal waste batteries in a way that prevents releases of any universal waste or component of a universal waste to the environment, as follows:

a. Any universal waste battery that shows evidence of leakage, spillage, or damage that could cause leakage under reasonably foreseeable conditions must be stored in a container. The container must be closed, structurally sound, compatible with the contents of the battery, and must lack evidence of leakage, spillage, or damage that could cause leakage under reasonably foreseeable conditions.

b. As long as the casing of each individual battery cell is not breached and remains intact and closed (except that cells may be opened to remove electrolyte but must be immediately closed after removal), the following activities may be conducted.

a. Sorting batteries by type;

(1) Mixing battery types in one container;

(2) Discharging batteries so as to remove the electric charge;

(3) Regenerating used batteries;

(4) Disassembling batteries or battery packs into individual batteries or cells;

(5) Removing batteries from consumer products; or

(6) Removing electrolyte from batteries.

a. A small quantity handler and a large quantity handler of universal waste who removes electrolyte from batteries, or who generates other solid waste (e.g., battery pack materials, discarded consumer products) as a result of the activities listed above, must determine whether the electrolyte and/or other solid waste exhibit a characteristic of hazardous waste identified in 40 CFR 261 Subpart C.

(1) If the electrolyte and/or other solid waste exhibit a characteristic of hazardous waste, it is subject to all applicable requirements of 40 CFR 260 through 272. The handler is considered the generator of the hazardous electrolyte and/or other waste and is subject to 40 CFR 262.

(2) If the electrolyte or other solid waste is not hazardous, the handler may manage the waste in any way that is in compliance with applicable federal, state, or local solid waste regulations.

F-3.5. LABELING/MARKING. An SQHUW and LQHUW must label or mark the universal waste batteries in the following manner: Each individual universal waste battery, or a receptacle in which a number of batteries are contained, must be labeled or marked clearly with

nay one of the following phrases: “Universal Waste – Battery(ies)”, or “Waste Battery(ies),” or “Used Battery(ies).”

F-3.6. ACCUMULATION TIME LIMITS.

F-3.6.1. An SQHUW or LQHUW may accumulate universal waste for no longer than one year from the date the universal waste is generated, or received from another handler, unless the requirements of paragraph 3-3.6.2 are met.

F-3.6.2. An SQHUW or LQHUW may accumulate universal waste for longer than one year from the date the universal waste is generated, or received from another handler, if such activity is solely for the purpose of accumulation of such quantities of universal waste as necessary to facilitate proper recovery, treatment, or disposal. However, the handler bears the burden of proving that such activity is solely for the purpose of accumulation of such quantities of universal waste as necessary to facilitate proper recovery, treatment, or disposal.

F-3.6.3. An SQHUW or LQHUW who accumulates universal waste must be able to demonstrate the length of time that the universal waste has been accumulated from the date it becomes a waste or is received. The handler may make this demonstration by:

a. Placing the universal waste in a container and marking or labeling the container with the earliest date that any universal waste in the container became a waste or was received;

b. Marking or labeling each individual item of universal waste (e.g., each battery or thermostat) with the date it became a waste or was received;

c. Maintaining an inventory system on-site that identifies the date each universal waste became a waste or was received;

d. Maintaining an inventory system on-site that identifies the earliest date that any universal waste in a group of universal waste items or a group of containers of universal waste became a waste or was received;

e. Placing the universal waste in a specific accumulation area and identifying the earliest date that any universal waste in the area became a waste or was received; or

f. Any other method which clearly demonstrates the length of time that the universal waste has been accumulated from the date it becomes a waste or is received.

F-3.7. RESPONSE TO RELEASES.

F-3.7.1. An SQHUW or LQHUW must immediately contain all releases of universal wastes and other residues from universal wastes.

F-3.7.2. An SQHUW or LQHUW must determine whether any material resulting from the release is hazardous waste, and if so, must manage the hazardous waste in compliance with all

applicable requirements of 40 CFR 260 through 272. The handler is considered the generator of the material resulting from the release, and must manage it in compliance with 40 CFR 262.

F-3.8. OFF-SITE SHIPMENTS.

F-3.8.1. An SQHUW or LQHUW is prohibited from sending or taking universal waste to a place other than another universal waste handler, a destination facility, or a foreign destination.

F-3.8.2. If an SQHUW or LQHUW self-transports universal waste off-site, the handler becomes a universal waste transporter for those self-transportation activities and must comply with the requirements for universal waste transporters while transporting the universal waste.

F-3.8.3. If a universal waste being offered for off-site transportation meets the definition of hazardous materials under 49 CFR 171 through 180, an SQHUW or LQHUW must package, label, mark, and placard the shipment, and prepare the proper shipping papers in accordance with the applicable Department of Transportation regulations under 49 CFR 172 through 180.

**NOTE**

A Hazardous Waste Manifest, normally required by the EPA for hazardous waste shipments, is not required for the shipment of universal waste.

**NOTE**

There have been incidents in which fires have occurred during transport of used lithium batteries. When preparing batteries for shipment, extra attention should be given to ensuring the battery cannot be short-circuited and that the packaging is robust and correctly labeled. It is recommended that the minimum requirements for packaging be exceeded to preclude incidents during transportation.

F-3.8.4. Prior to sending a shipment of universal waste to another universal waste handler, the originating handler must ensure that the receiving handler agrees to receive the shipment.

F-3.8.5. If an SQHUW or LQHUW sends a shipment of universal waste to another handler or to a destination facility and the shipment is rejected by the receiving handler or destination facility, the originating handler must either:

a. Receive the waste back when notified that the shipment has been rejected, or

b. Agree with the receiving handler on a destination facility to which the shipment will be sent.

F-3.9. EXPORTS. An SQHUW or LQHUW who sends universal waste to a foreign destination other than to those Organization for Economic Co-operation and Development (OECD)

countries specified in 40 CFR 262.58(a)(1) (in which case the handler is subject to the requirements of 40 CFR 262 Subpart H) must:

a. Comply with the requirements applicable to a primary exporter in 40 CFR 262.53, 262.56(a)(1) through (4), (6), and (b), and 262.57;

b. Export such universal waste only upon consent of the receiving country and in conformance with the EPA Acknowledgement of Consent as defined in 40 CFR 262 Subpart E;

c. Provide a copy of the EPA Acknowledgement of Consent for the Shipment to the transporter for export of the shipment.

F-3.10. REQUIREMENTS SPECIFIC TO AN SQHUW.

F-3.10.1. Notification. An SQHUW is not required to notify EPA of universal waste handling activities.

F-3.10.2. Employee Training. An SQHUW must inform all employees who handle or have responsibility for managing universal waste. The information must describe proper handling and emergency procedures appropriate to the type(s) of universal waste handled at the facility.

F-3.10.3. Tracking Universal Waste Shipments. An SQHUW is not required to keep records of shipments of universal waste.

F-3.11. REQUIREMENTS SPECIFIC TO AN LQHUW.

F-3.11.1. Notification. Except as provide in this paragraph, an LQHUW must have sent written notification of universal waste management to the Regional Administrator, and received an EPA Identification Number, before meeting or exceeding the 5,000 kilogram storage limit. An LQHUW who has already notified EPA of his hazardous waste management activities and has received an EPA Identification Number is not required to re-notify under the requirements of this paragraph. Notification must include:

a. The universal waste handler's name and mailing address;

b. The name and business telephone number of the person at the universal waste handler's site who should be contacted regarding universal waste management activities;

c. The address or physical location of the universal waste management activities;

d. A list of all of the types of universal waste managed by the handler (e.g., batteries, pesticides, thermostats);

e. A statement indicating that the handler is accumulating more than 5,000 kilograms of universal waste at one time and the types of universal waste (e.g., batteries, pesticides, thermostats) the handler is accumulating above this quantity.

F-3.11.2. Employee Training. An LQHUW must ensure that all employees are thoroughly familiar with proper waste handling and emergency procedures, relative to their responsibilities during normal facility operations and emergencies.

F-3.11.3. Tracking Universal Waste Shipments.

a. Receipt of Shipments. An LQHUW must keep a record of each shipment of universal waste received at the facility. The record may take the form of a log, invoice, manifest, bill of lading, or other shipping document. The record for each shipment of universal waste received must include the following information:

(1) the name and address of the originating universal waste handler or foreign shipper from whom the universal waste was sent;

(2) the quantity of each type of universal waste received (e.g., batteries, pesticides, thermostats);

(3) the date of receipt of the shipment of universal waste.

b. Shipments Off-Site. An LQHUW must keep a record of each shipment of universal waste sent from the handler to other facilities. The record may take the form of a log, invoice, manifest, bill of lading, or other shipping document. The record for each shipment of universal waste sent must include the following information:

(1) the name and address of the universal waste handler, destination facility, or foreign destination to whom the universal waste was sent;

(2) the quantity of each type of universal waste sent (e.g., batteries, pesticides, thermostats);

(3) the date the shipment of universal waste left the facility.

c. Record Retention. An LQHUW must retain those records described in paragraph F-3.11.3a for at least three years from the date of receipt of a shipment of universal waste, and those records described in paragraph F-3.11.3b for at least three years from the date a shipment of universal waste left the facility.

## NAVSEA/SPAWAR TECHNICAL MANUAL DEFICIENCY/EVALUATION REPORT (TMDER)

INSTRUCTION: Continue on 8 1/2" x 11" paper if additional space is needed.

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|---|---|---|---|
| **NAVSEA S9310-AQ-SAF-010** | | **Rev 2/15 July 2010** | |

| 5. TITLE | 6. REPORT CONTROL NUMBER |
|---|---|
| **BATTERIES, NAVY LITHIUM SAFETY PROGRAM RESPONSIBILITIES AND PROCEDURES** | |

7. RECOMMENDED CHANGES TO PUBLICATION

| PAGE NO. A | PARA-GRAPH B | C. RECOMMENDED CHANGES AND REASONS |
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