S9310-AQ-SAF-010

0910-LP-128-4800

TECHNICAL MANUAL FOR

BATTERIES, NAVY LITHIUM SAFETY PROGRAM RESPONSIBILITIES AND PROCEDURES

PUBLISHED BY DIRECTION OF COMMANDER, NAVAL SEA SYSTEMS COMMAND

20 JULY 1988

LIST OF EFFECTIVE PAGES

Total number of pages in this volume is 28 consisting of the following:

Page No.	*Change No.
Title - A	0
CERT SHEET 1	0
CERT SHEET 2	0
Flyleaf 1	0
Flyleaf 2 Blank	0
Foreword 1	0
Foreword 2 Blank	0
i	0
ii Blank	0
1-1 - 1-11	0
1-12 Blank	0
2-1 - 2-5	0
2-6 Blank	0

* Zero in this column indicates an original page.

NAVSEA TECHNICAL MANUAL
CERTIFICATION SHEET AND CHANGE FORM

NAVSEA 9086/11 (REV) SHEET 1 OF 2

NAVSEA TM Identification Number	NAVSEA TM Date
S9310-AQ-SAF-010	20 JULY 1988
TM Change Identification Number	TM Change Date

Change No. _____ Revision No. _____ Volume No. _____
Part No. _____ Book No. _____ Chapter No. _____
Other No. _____ (Explain if used)

Title
BATTERIES, NAVY LITHIUM SAFETY PROGRAM RESPONSIBILITIES AND PROCEDURES

CHANGE/REVISION DESCRIPTION (Indicate "NA" if item not applicable)

Subject of Change/Revision: NA

TMDER Numbers Incorporated: NA

ACN Numbers Incorporated: NA

TM/Change/Revision Numbers Superseded: NA

Equipment Alteration Numbers Incorporated: NA

Equipment Field Change/Engineering Change (FC/EC) Numbers Incorporated: NA

STATEMENT OF CERTIFICATION

This TM [XXX], or TM Revision [ ], or TM Change [ ] is approved and certified to be technically accurate, and to conform to the applicable Technical Manual Contract Requirement, TMCR/TMSR # NA

APPROVAL SIGNATURES

	Name	Signature	Activity	Code	Date
Preparation Approval	Mr. M. Robertson	M. P. Robertson	Naval Weapons Support Center Crane, IN	305	10/14/88
Technical Approval	Mr. E. Kratovil	E. Kratovil	Naval Sea Systems Command	SEA 666	12/8/88
Printing Release Approval	NA	NA	NA	NA	NA

NAVSEA TECHNICAL MANUAL
CERTIFICATION SHEET AND CHANGE FORM

NAVSEA 9086/11 (REV)

SYNOPSIS OF CHANGE. Generally describe each significant technical addition, deletion, and change. Use additional page(s) if necessary.

CHANGE RECORD

CHANGE NO.	DATE	TITLE OR BRIEF DESCRIPTION	ENTERED BY

FLYLEAF 1/(FLYLEAF 2 BLANK)

FOREWORD

This Technical Manual, S9310-AQ-SAF-010 of 20 July 1988, is an unclassified publication.

This manual is applicable to all Navy and Marine Corps activities. Material to which this manual applies includes lithium batteries and all equipment powered by lithium electrochemical power source(s) through all phases of the life of such systems.

The purpose of this manual is to establish safety guidelines for the acquisition, design, testing, evaluation, use, packing, storage, transporting, and disposal of lithium batteries.

All errors, omissions, discrepancies, and suggestions for improvements to NAVSEA technical manuals shall be reported to the Commanding Officer, Naval Ship Weapons Systems Engineering Station (Code 5H00), Port Hueneme, CA 93043-5700 on NAVSEA technical Manual Deficiency/Evaluation Report, NAVSEA Form 9086/10. To facilitate such reporting, three copies of NAVSEA Form 9086/10 are included at the end of this technical manual.

This publication is stocked at the Naval Publications and Form Center (NPFC) Philadelphia, PA 19120-5099. U.S. Government agencies desiring requisition copies of this publication should refer to NAVSUP Pub 2002, Navy Stock List of Publications and Forms, for stock number assignment and requisitioning publications.

TABLE OF CONTENTS

CHAPTER 1

ACQUISITION, DESIGN, USE, PACKING, STORAGE, TRANSPORTING, AND DISPOSAL OF LITHIUM BATTERIES

1-1. ACQUISITION (ACTIVE, THERMAL AND RESERVE).

a. Program Managers anticipating the use of lithium batteries shall submit a data package to the Commander, Naval Sea Systems Command (COMNAVSEASYSCOM) (SEA 666) Washington, DC 20362-5101. This data package shall contain information demonstrating the validity of the lithium battery selection and describe:

(1) Proposed Battery Design.

(a) Manufacturer
(b) Type/chemistry/part number/model number
(c) Electrical description (voltage, ampere hour capacity and load profile)
(d) Operating life (shelf life and functional life)
(e) Physical dimensions (weight, size, geometry and number of cells)
(f) Markings indicating battery chemistry
(g) Thermal battery case temperature (specification and maximum temperature/time to maximum temperature)
(h) Thermal battery cool down time
(i) Thermal or reserve battery method of activation

(2) Lithium Battery Powered Equipment Description

(a) Manufacturer
(b) Model number
(c) Diagram of the systems overall mechanical interfaces showing battery proximity to other equipment and energetic devices
(d) Battery installation (mounting, seals, electrical connectors)
(e) Battery housing/container, strength and free volume
(f) Safety features or venting mechanisms
(g) Current drain (load profile)
(h) Block diagram of system interfaces to the battery (electrical and physical)
(i) Electrical schematic (showing fuses, blocking diodes and external power interface)

(3) Logistics and Operational Use

(a) Packaging requirements
(b) Storage facilities
(c) Transportation methods
(d) Disposal requirements
(e) Operational use scenario
(f) Thermal or reserve battery activation
(g) Thermal or reserve battery hang-fire

(4) Functional and Environmental Tests Performed Including Test Parameters

(5) All Safety Testing Performed to Date

(6) Proposed Safety Testing Program Plan

Upon completion of a preliminary review, a safety assessment of the proposed battery use, including recommendations to enhance safety will be presented to the cognizant command by COMNAVSEASYSCOM.

b. Certain lithium batteries and lithium battery powered equipment of the following general design characteristics are exempted from the technical review and approval requirements. However, when equipment is designed specifically for Navy use, information shall be submitted to the NAVSEA Safety Division (SEA 666) documenting the battery manufacturer, size, chemistry and end item use.

(1) Equipment designed for commercial use and procured from commercial sources carrying approval of Underwriters Laboratory, and which utilizes a lithium battery of no more than two identical cells with a maximum rated capacity of 1.5 ampere hour per cell. This exemption does not include changing of battery, maintenance and/or modification of such equipment.

(2) Equipment designed for a specific Navy use utilizing no more than two identical cells with a maximum rated electrical capacity of 200 milliampere hours per cell and if;

(a) There is no other source of electrical power to the unit

or

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

(3) Equipment designed for a specific Navy use utilizing batteries of no more than two identical cells of either Lithium/Carbon Monofluoride $(CF_x)_n$ or Lithium/Manganese Dioxide (MnO_2) chemistries with a maximum rated electrical capacity of 1.25 ampere hours per cell and if the battery is protected from other sources of electrical power by appropriate combinations of blocking diodes and resistors.

NOTE

With the exception of (1) above, this exemption applies to normal repair and maintenance of the equipment, including procurement and storage of replacement batteries.

NOTE

Any lithium battery proposed for use on board submarines must be approved by NAVSEA PMS 393.

c. Requests for a safety review in consideration of Release to Full Production are to be submitted to NAVSEASYSCOM (SEA 666) and are to include the summarized results of the System Safety Program and the results of the tests identified in Chapter 2. A recommendation for Release to Full Production will be predicated on this information.

d. 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 CFR 1910.1200 - Hazardous Communication Standards.

e. In development and procurement actions, applicable portions of the current issue of MIL-STD-882 (System Safety Program Requirements) shall be invoked by contract.

f. Activities procuring batteries for limited or full scale production shall ensure that configuration management is imposed on the battery and its packaging in accordance with MIL-STD-480. In addition to the usual definition, a Class I change shall be defined 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 shall be coordinated with Naval Surface Warfare Center (NAVSWC) White Oak or Naval Weapons Support Center (NAVWPNSUPPCEN) Crane. Class I packaging changes shall be reviewed by the Naval Weapons Station (NAVWPNSTA) Earle, Code C11 in conjunction with the Commander, Naval Sea Systems Command (SEA 666).

g. Safety qualifications testing for a specific application shall include the tests of Chapter 2 and all environmental testing representative of the actual environments to be encountered by the complete end item, including battery, in the logistic cycle of that application.

h. Manufacturers shall be required to provide Material Safety Data Sheets (MSDS) in accordance with FED. STD. 313.

1-2. DESIGN.

a. General

(1) Each battery used as a power source shall contain a suitable over-current device that will fail open if the battery is discharged at an excessive rate. Batteries shall 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. In batteries consisting of series-parallel strings, each parallel string shall be protected to prevent any possibility of charging. If a battery is connected to an external power source, the battery must be protected to prevent charging by the external power source.

(2) Select cells as small as possible for the mission power requirement.

(3) In development programs, assembly of batteries by user personnel should be avoided.

(4) Avoid potting of cell or battery vents. If potting is essential, assure that venting will not be obstructed and that potting does not adversely affect battery thermal management.

(5) If possible, design the equipment 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.

(6) Battery switches in the end item shall be carefully selected to prevent accidental battery turn-on and there shall be no switching in the ground leg(s).

(7) Cells of different physical characteristics, chemistries or electrical parameters shall not be used in the same electrical circuit.

b. Active.

(1) 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 type and free from imperfections. Each cell, battery and battery enclosure 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.

(2) Consideration shall be given to the use of thermal protection devices which fail open at temperatures of 91°C (194°F) or less.

(3) Lithium batteries of two or more cells shall be constructed so that they are not interchangeable with commercial batteries used in consumer products such as flashlights or radios.

(4) If the battery is not installed in equipment, the leads or connector plug shall be taped, guarded or otherwise given positive protection against accidental shorting.

c. Thermal.

(1) If a thermal battery is utilized it must be demonstrated that inadvertent activation cannot occur from the environmental conditions which the battery or end item may be subjected to during Fleet use. The environmental conditions and test program for lithium battery safety will be determined during the preliminary safety review.

(2) Thermal 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 and the cover shall be of the glass or ceramic to metal type and free from imperfections. Each battery enclosure must 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.

(3) If the battery is not installed in the equipment, all electrical initiation leads shall be shorted.

(4) The battery enclosure shall be properly insulated to prevent overheating of the system or thermal damage to adjacent components.

d. Reserve.

(1) If a reserve battery is utilized it must be demonstrated that inadvertent activation cannot occur from the environmental conditions which the battery or end item may be subjected to during Fleet use. The environmental conditions and test program for lithium battery safety will be determined during the preliminary safety review.

(2) 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 and the cover shall be of the glass or ceramic to metal type and free from imperfections. Each battery enclosure must 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.

(3) If the battery is not installed in the equipment the electrical initiation leads or connector plug shall be taped, guarded or otherwise provide positive short circuit protection and the activation leads shall be shorted.

(4) Consideration shall be given to the incorporation of internal "bleeder resistors" such that battery depletion will automatically occur as a result of activation.

1-3. USE.

a. General

(1) Lithium batteries shall be used only in their designed application.

(2) Partially or fully discharged lithium batteries shall be removed (if feasible) from associated equipment upon completion of useful life and disposed of in accordance with paragraph 1-7. All exposed terminals shall be insulated to prevent short circuits.

(3) In the event of an accident, incident or malfunction, either with or without visible damage to the battery, notify the appropriate authorities in accordance with Chapter 4 of OPNAVINST 5102.1B "Mishap Investigation and Reporting".

b. Active. (All conditions of 1-3(a) above apply).

c. Thermal.

(1) If the battery has been activated but not deployed, the battery shall be disposed of as soon as possible in accordance with paragraph 1-7.

(2) If the battery has been activated and deployed and equipment recovery is planned, allow adequate cool down time prior to handling or removal for disposal.

d. Reserve.

(1) If the battery has been activated but not deployed, the battery shall be disposed of as soon as possible, in accordance with paragraph 1-7.

(2) If the battery has been activated and deployed and equipment recovery is planned, allow adequate time for battery depletion.

1-4. PACKAGING (ACTIVE, THERMAL AND RESERVE)

a. For new lithium batteries, the basic packing, marking and shipping requirements imposed by the Department of Transportation are contained in DOT-E-7052. In addition to the minimum requirements of DOT-E-7052, Navy activities desiring to use lithium batteries shall:

(1) Ensure that a complete design disclosure is obtained on the packing of the specific battery, preferably prior to any shipment, but in any case no later than release for limited or full scale production.

(2) Ensure that the packaging design is incorporated in the appropriate acquisition specification, contract and manuals. Descriptive specification language shall be supplemented by DOD-D-1000 drawings or figures in this instruction as appropriate.

(3) Ensure that the packaging design meets the minimum requirements contained in MIL-STD-648. Other tests required by DOT-E-7052 shall also be performed.

(4) Ensure that batteries entered in the supply systems for organizational or intermediate maintenance level replacement are packaged to be capable of shipment by "cargo only" aircraft, unless batteries are treated as unregulated per DOD-E-7052.

b. Packaging not conforming to the package specifications listed in DOD-E-7052 must be reviewed by the Naval Weapons Station (NAVWPNSTA) Earle, Code C11 in conjunction with the Commander, Naval Sea Systems Command (SEA 666). NAVSEASYSCOM is authorized to issue a Certificate of Equivalency (COE) pursuant to NAVMATINST 4030.11 when satisfied that the container design proposed is of equal or greater strength and efficiency than the containers specified in DOT-E-7052. In order for such a COE to be issued, NAVSEASYSCOM will review the following:

(1) Results of the safety tests prescribed in Chapter 2.

(2) Results of the tests (if conducted) required by paragraph 8e of DOT-E-7052. Note: Passing these tests is an essential prerequisite to shipment of lithium batteries, or devices containing lithium batteries, by "cargo only" aircraft, without resorting to a special overpack such as a DOT 17C or DOT 17H drum (or equivalent) equipped with a gas tight gasket. This special overpack is mandated by paragraph 8c of DOT-E-7052.

(3) The environmental tests performed on the unpackaged device and the packaged device.

(4) A complete design disclosure of the proposed package.

c. Used lithium batteries for routine disposal must be individually sealed in a plastic bag or be individually wrapped in electrical insulating material and be placed in DOT approved shipping containers in accordance with 49 CFR 173.1015.

1-5. STORAGE (ACTIVE, THERMAL AND RESERVE)

a. All lithium batteries and lithium battery powered equipment approved for use based on testing IAW this document shall be stored in compliance with the specific requirements stipulated in appropriate equipment documents. When such documentation is not available the general storage requirements listed below shall be adhered to:

(1) New and unused lithium batteries or lithium battery powered equipment with batteries installed, either ashore or afloat.

(a) Store in their original shipping containers in a cool, ventilated shelter, sprinkler-protected if possible.

(b) 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.

(c) Since the effect of mass storage on the hazard degree is not known, keep the quantity stored in an area to a reasonable minimum.

(d) Retain batteries in storage in unit packages, preferably shipping containers, to defer heat transfer between batteries.

(e) Avoid storage temperature above 130°F (54°C).

(f) Exercise special care in handling and moving containers to prevent crushing or puncturing.

(2) Used lithium batteries or lithium powered equipment with batteries installed, ashore:

(a) Package in accordance with paragraph 1-4C.

(b) Establish a remote collection point and storage area, sprinkler protected (if feasible), separate from other combustible material for batteries awaiting disposal.

(c) Effect prompt disposal (store no more than 30 lbs. or longer than 30 days).

(d) Do not dispose of or transport with normally generated refuse.

(e) Do not pierce, crush, burn, drop, cannibalize, dismantle, modify or otherwise carelessly handle nor short circuit, charge or reuse.

(3) Used lithium batteries or lithium battery powered equipment with batteries installed, afloat.

(a) Dispose of batteries consumed while underway or during ashore deployment by discharge overboard in deep water (in

excess of 100 fathoms) outside the prohibited zone (50 mile limit). Do not stow for shore disposal.

b. All lithium batteries and lithium battery powered equipment, for other services use, and approved for such, based on testing other than prescribed in this notice, shall be stowed afloat as specified below:

(1) New and unused lithium batteries may be stowed on surface ships either on the weather decks or below decks. In either stowage location the quantity stowed in an area shall be kept to the minimum consistent with requirements since the effect of mass stowage on the hazard degree is not known. Weather deck stowage is preferred and is to be used if at all possible. Specifically for:

(a) Stowage on the weather deck

(1) Stow in their original shipping containers in a drip proof, self-draining, ventilated metal locker capable of maintaining the storage temperature below 130°F (54°C).

(2) Isolate the stowage locker from other hazardous and combustible material and use only for the stowage of lithium batteries and equipment containing lithium batteries.

(b) Stowage below decks

(1) Stow in their original shipping containers in a cool, sprinkler protected, ventilated area and maintain the storage temperature below 130°F (54°C).

(2) Isolate the stowage area from other hazardous and combustible material and use only for the stowage of new and unused lithium batteries. If stowed in a cargo hold, isolate by using equivalent barriers to those used to separate noncompatible stows of LFORM ammunition.

(3) Do not stow lithium batteries or lithium powered equipment with batteries installed in berthing areas.

(2) Used or depleted lithium batteries or equipment with lithium batteries installed shall only be stowed on the weather decks. Specifically:

(a) Used but reusable lithium batteries shall be stowed in their original packaging containers in a drip proof, self draining ventilated metal locker, capable of maintaining the stowage temperature below 130°F (54°C).

(b) Isolate the locker from other hazardous items and combustible material and use only for the stowage of used or depleted lithium batteries or equipment with used lithium batteries installed.

(c) Stow depleted lithium batteries not to be reused in the same lockers when space permits. If locker space is not available

stow the batteries topside on the weather deck in their original packaging containers. Isolate the stowage area from other hazardous and combustible material and control (i.e., covered and posted with warning placards).

(3) Due to the increased hazard associated with use, handling and stowage of depleted or used lithium batteries, the following shall apply:

(a) Preparatory to the ashore deployment of equipment using lithium batteries, install the batteries in the equipment aboard ship in weather deck locations only. Hold shipboard equipment checks to a minimum and perform checks in weather deck locations only.

(b) Upon completion of ashore deployment stow used or depleted lithium batteries or equipment with lithium batteries installed in accordance with paragraph 1-5b(2).

(c) Offload all used or depleted lithium batteries at the earliest possible time, however, in no case shall they be offloaded during ammunition or fueling evolutions.

(d) Dispose of batteries consumed while underway or during ashore deployment by discharge overboard in deep water (in excess of 100 fathoms) outside the prohibited zone (50 mile limit). Do not stow for shore disposal.

(4) Stowage of such items ashore is the responsibility of the cognizant service.

WARNING

When entering a stowage space in which lithium batteries may have vented gas, supplied air respirators or self-contained breathing apparatus approved by the National Institute for Operation Safety and Health (NIOSH) shall be worn.

1-6. TRANSPORTATION

a. All transportation of new lithium batteries on public domain is controlled by federal law regulating shipment of hazardous materials. The general regulation is stated in 49 CFR 172.101, 173, 206(e)(1) and 175.3. The Materials Transportation Bureau, Research and Special Programs Administration, U.S. Department of Transportation, Washington, DC 20590, has issued an exemption, DOT-E-7052, which permits shipment of lithium cells and batteries by motor vehicle, rail freight, cargo vessel and cargo-only aircraft provided the detailed requirements of the exemption have been met. Potential suppliers of lithium batteries and devices containing lithium batteries not listed in the latest issue of DOT-E-7052 should become a party thereto prior to shipping batteries by any mode.

b. All transportation of used lithium batteries on public domain is controlled by federal law regulating shipment of hazardous materials. The general regulation as stated in 49 CFR 172.101 and 49 CFR 173.1015, permits shipment of waste lithium batteries to a disposal site by motor vehicle only. The transportation of hazardous waste is regulated by 40 CFR Part 263 which provides for the proper identification of the transporter and manifesting of the waste.

1-7. DISPOSAL

a. At sea, dispose of batteries consumed while underway or during ashore deployment by discharge overboard in deep water (in excess of 100 fathoms or 600 feet) outside the prohibited zone (50 Mile limit). Do not stow for shore disposal.

b. Ashore, dispose of batteries as follows:

(1) Turn into the local Defense Reutilization and Marketing Office in accordance with Chapter II of OPNAVINST 5090.1 for disposal as a hazardous waste.

(2) Under certain emergency conditions, if batteries are deemed to be too hazardous for routine disposal, Explosive Ordnance Disposal (EOD) should be utilized for immediate removal to a safe site.

CHAPTER 2

SAFETY AND PERFORMANCE TESTS FOR QUALIFICATION OF LITHIUM BATTERIES

2-1. GENERAL. This document establishes the minimum safety test requirements for lithium batteries in lithium battery powered equipment when used by the Navy or on Navy facilities. It also specifies the procedure, equipment and pass-fail criteria.

2-2. PASS-FAIL CRITERIA. It is not necessary to regard a failure of the lithium batteries or lithium powered equipment to meet the "passing" criteria as grounds for an automatic rejection of the equipment for service use. Any such items which fail to meet such criteria will be rejected only if a technical evaluation of the test results by SEA 666 establishes that rejection is the appropriate course of action. The passing criteria are as follows:

a. Unit Criteria

(1) Land	Unit has a fail safe vent system to keep pressure 50% below the yield point of the unit.
(2) Surface Ship	Same as above, except no external fire or flame.
(3) Aircraft	Same as (2) above.
(4) Submarine	Total containment; generated internal pressure shall stay under 50% of the failure pressure of the housing.

b. Relief Valve Criteria

(1) If pressure relief valves are provided in the unit, they must prevent the pressure (generated as a result of performing the tests in paragraph 2-3) from reaching a peak value of 50% of the yield pressure of the unit. If the peak pressure falls below or is equal to 50% of the yield pressure of the unit in all of the tests the unit will be considered safe. If the peak pressure in any tests exceeds 50% of the yield pressure of the unit before venting that unit will be considered unsafe.

(2) If pressure relief valves are not provided the recorded peak pressure in any test must not exceed 50% of the failure pressure of the unit for the unit to be considered safe.

2-3. TEST. The following tests are conducted to evaluate the safety and performance of the lithium batteries and the lithium powered equipment:

WARNING

The following tests will most likely cause violent venting of batteries; therefore all possible safety precautions shall be observed.

a. Test Items. A minimum of fifteen (15) active, fifteen (15) thermal and eighteen (18) reserve units shall be provided.

b. Test Instrumentation. All tests shall be instrumented as described in this paragraph. The instrumentation for the tests shall include six (6) thermocouples capable of measuring and withstanding temperatures up to 800°C, two (2) voltage monitoring leads; one set of power leads and a pressure transducer capable of measuring pressure up to the failure pressure of the unit. Four (4) thermocouples shall be placed inside the unit in the following manner: one secured on each end of the battery pack, one secured at the center of the battery pack and one in the air space surrounding the battery pack. The remaining two (2) thermocouples shall be located and secured on the outside of the unit 180° apart near the battery pack. The pressure transducer shall continually monitor the pressure inside the battery pack housing.

c. Active Battery Tests

(1) Constant Current Discharge & 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) 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 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 time equivalent to 1.5 times the nominal rated ampere-hour capacity of the battery pack. This test shall be completed on three units; voltage, current, pressure and temperatures shall be continuously monitored and recorded.

(2) Short Circuit Test. This test shall consist of orting the battery (after all internal electrical safety devices ve been bypassed) through a load of 0.02 ohm or less and leaving the oad attached for not less than 24 hours. This test shall be ompleted on three units; voltage, current, pressure and temperature hall be continuously monitored and recorded.

(3) High Temperature Test. This test shall consist of heating the battery pack inside the unit at a rate of approximately 20°C rise per minute up to a temperature of 500°C. This test shall be completed on three units; voltage, pressure and temperature shall be continuously monitored and recorded.

(4) Charging Test. This test shall be performed if a battery consists of series-parallel strings or is to be connected to an outside D.C. power source. This test shall consist of charging using D.C. power supply after all internal electrical safety devices have been bypassed. The battery shall be discharged to remove at least 50% of its capacity at a current equal to the fuse value. The battery shall then be allowed to stand for at least 72 hours and then be charged at a current equal to the fuse value to 100% of capacity. The voltage of the D.C. power supply shall be limited to the battery pack open circuit voltage or to the voltage of the outside source whichever is larger. This test shall be completed on three units; voltage, current, pressure and temperature shall be continuously monitored and recorded.

(5) Electrical Safety Device Test. This test shall consist of constant current discharge using D.C. power supply. All electric safety devices shall be in place and operational. The discharge shall be performed at a current equal to 80% to 90% of the battery pack fuse value. The voltage of the D.C. power supply shall be limited to 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 time equal to 1.5 times the advertised ampere-hour capacity of the battery pack. This test shall be completed on three units; voltage, current, pressure and temperature shall be continuously monitored and recorded. The pass-fail criteria for this test shall be no venting of any kind.

d. Thermal Battery Tests. System specific test requirements and pass-fail criteria will be determined during the preliminary safety data package review.

(1) Unactivated. Environmental tests shall be performed (Shock, Vibration, EMI, ESD, HERO and Temperature-altitude) to demonstrate no inadvertent activation or unsafe conditions may exist under any unactivated use scenarios. Tests performed to satisfy requirements of other program qualification series evaluations may be substituted for these tests, subject to approval of NAVSEASYSCOM (SEA 666). Activation of the battery when subjected to these tests shall constitute a failure.

(2) High Rate Discharge Tests. This test shall consist of conditioning the 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 will be instrumented separately.

All battery sections will be discharged simultaneously. This test shall be completed on three units; voltage, current and battery skin temperature shall be continuously monitored and recorded.

(3) Heating Tests. This test shall consist of placing the battery in a furnace that has been pre-heated to 600°C. Continuously monitor and record the open-circuit voltages of all battery sections and the outer case temperature. Continue the test until the battery voltage rises (indicating battery activation) and then falls again below twenty percent (20%) of the maximum observed voltage. This test shall be completed on three batteries.

(4) Open Circuit Tests. This test shall consist of conditioning the unit to the maximum non-operating temperature required by the end item specification and activating the battery into an open circuit (no load) and allowing the battery to stand in an open circuit condition until the open circuit voltage falls below 10% of the maximum observed voltage. This test shall be completed on three units; voltage and battery skin temperature shall be continuously monitored and recorded.

(5) Charging Tests. This test shall be performed if a battery consists of parallel connected sections or is 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 charging shall continue (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 units; voltage, current and battery skin temperature shall be continuously monitored and recorded.

e. Reserve Battery Tests

(1) Unactivated

(a) Environmental. Environmental tests shall be performed (Shock, Vibration, EMI, ESD, HERO and Temperature-altitude) to demonstrate no inadvertent activation or unsafe conditions exist under any unactivated use scenarios. Specific test parameters will be determined during the preliminary safety data package review. Tests may be performed to satisfy requirements of other qualification series evaluations subject to approval of NAVSEASYSCOM (SEA 666). Activation of the battery when subjected to these tests shall constitute a failure.

(b) High Temperature Tests. This test shall consist of heating the battery inside the unit at a rate of approximately 20°C rise per minute up to a temperature of 500°C. This test shall be completed on three units; voltage, pressure and temperature shall be continuously monitored and recorded.

(2) Activated

(a) Short Circuit Test. This test shall consist of activating the battery (after all internal electrical safety devices have been bypassed) into a load of 0.02 ohm or less and leaving the load attached until the current drops to less than 1% of the maximum measured current level or 500ma whichever is less. Each battery output section shall be shorted separately. All battery sections shall be shorted simultaneously. This test shall be completed on three units; voltage, current and battery skin temperature shall be continuously monitored and recorded.

(b) Open Circuit Tests. This test shall consist of activating the battery into an open circuit (no load) and allowing the battery to stand in an open circuit condition for a period of time to be determined during the preliminary safety data package review. This test shall be completed on three units; voltage and skin temperature shall be continuously monitored and recorded.

(c) High Temperature Activation. This test shall consist of heating the battery to the maximum unactivated temperature required by the end item specification. 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. This test shall be completed on three units; voltage, current and battery skin temperature shall be continuously monitored and recorded.

(d) Charging Tests. 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 nominal rated capacity at a rate equal to 1.5 times the average mission load current. The battery shall then be charged (using a D.C. power supply) to 100% capacity. 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 units; voltage, current and battery skin temperature shall be continuously monitored and recorded.

(Insert Classif. of TMDER Here and At Bottom of Page) CLASSIFICATION:

NAVSEA (USER) TECHNICAL MANUAL DEFICIENCY/EVALUATION REPORT (TMDER)
(NAVSEA S0005-AA-GYD-030/TMMP & NAVSEAINST 4160.3)

INSTRUCTIONS: Insert classification at top and bottom of page. Read the following before completing his form. Continue on 8½" × 11" paper if additional space is needed.

1. USE THIS REPORT TO INDICATE DEFICIENCIES, USER REMARKS, AND RECOMMENDATIONS RELATING TO PUBLICATION
2. BLOCKS MARKED WITH "★" ARE TO BE FILLED IN BY THE CONTRACTOR BEFORE PRINTING
3. FOR UNCLASSIFIED TMDER'S, FILL IN YOUR RETURN ADDRESS IN SPACE PROVIDED ON THE BACK, FOLD AND TAPE WHERE INDICATED AND MAIL. (SEE OPNAVINST 5510.1E FOR MAILING CLASSIFIED TMDERS')
4. FOR ADDITIONAL INFORMATION, CALL AUTOVON 360-4805/5084 OR COMMERCIAL 805 982-4805/5084

1. NAVSEA NO. ★	2. VOL. PART ★	3. TITLE ★
S9310-AQ-SAF-010		BATTERIES, NAVY LITHIUM SAFETY PROGRAM RESPONSIBILITIES AND PROCEDURES

4. REV. DATE OR TM CH. DATE	5. SYSTEM/EQUIPMENT	6. IDENTIFICATION/NOMENCLATURE (MK/MOD/AN)

7 USER'S EVALUATION OF MANUAL (*Check appropriate block(s)*)

	A. EXCELLENT		B GOOD		C FAIR		D POOR		E COMPLETE		F INCOMPLETE

8. GENERAL COMMENTS

9. RECOMMENDED CHANGES TO PUBLICATION

PAGE NO. A.	PARAGRAPH B.	LINE NO. C.	FIG. NO. D.	TABLE E.	F. RECOMMENDED CHANGES AND REASONS

10 ORIGINATOR AND WORK CENTER (PRINT)	11. ORIGINATOR'S RANK, RATE OR GRADE, AND TITLE	12. DATE SIGNED

13 SIGNATURE OF WORK CENTER HEAD	14. SIGNATURE OF DEPARTMENT OFFICER	15 AUTOVON/COMM. NO.

16. SHIP HULL NO. AND/OR STATION ADDRESS (DO NOT ABBREVIATE)

17. THIS SPACE ONLY FOR NSDSA

A CONTROL NO	B. COG SEA	C DATE			D PRIORITY	E TRANSMITTED TO
		RECEIVED	FORWARDED	DUE		

NAVSEA 9086/10 (REV. 6-85) S/N 0116-LF-090-8651 CLASSIFICATION:
(REPLACES 4-84 EDITION & NAVSEA 4160/1 - DESTROY STOCK)

(Insert Classif. of TMDER Here and At Bottom of Page) CLASSIFICATION:

NAVSEA (USER) TECHNICAL MANUAL DEFICIENCY/EVALUATION REPORT (TMDER)
(NAVSEA S0005-AA-GYD-030/TMMP & NAVSEAINST 4160.3)

INSTRUCTIONS: Insert classification at top and bottom of page. Read the following before completing this form. Continue on 8½" × 11" paper if additional space is needed.

1. USE THIS REPORT TO INDICATE DEFICIENCIES, USER REMARKS, AND RECOMMENDATIONS RELATING TO PUBLICATION
2. BLOCKS MARKED WITH "★" ARE TO BE FILLED IN BY THE CONTRACTOR BEFORE PRINTING.
3. FOR UNCLASSIFIED TMDER'S, FILL IN YOUR RETURN ADDRESS IN SPACE PROVIDED ON THE BACK, FOLD AND TAPE WHERE INDICATED, AND MAIL. (SEE OPNAVINST 5510.1E FOR MAILING CLASSIFIED TMDERS.)
4. FOR ADDITIONAL INFORMATION, CALL AUTOVON 360-4805/5084 OR COMMERCIAL 805 982-4805/5084

1. NAVSEA NO. ★	2 VOL. PART ★	3. TITLE ★
S9310-AQ-SAF-010		BATTERIES, NAVY LITHIUM SAFETY PROGRAM RESPONSIBILITIES AND PROCEDURES

4. REV. DATE OR TM CH. DATE	5. SYSTEM/EQUIPMENT	6. IDENTIFICATION/NOMENCLATURE (MK/MOD/AN)

7. USER'S EVALUATION OF MANUAL *(Check Appropnate blocks)*

	A. EXCELLENT		B. GOOD		C. FAIR		D. POOR		E. COMPLETE		F. INCOMPLETE

8. GENERAL COMMENTS

9. RECOMMENDED CHANGES TO PUBLICATION

PAGE NO. A.	PARAGRAPH B.	LINE NO. C.	FIG. NO. D.	TABLE E.	F. RECOMMENDED CHANGES AND REASONS

10. ORIGINATOR AND WORK CENTER (PRINT)	11. ORIGINATOR'S RANK RATE OR GRADE, AND TITLE	12. DATE SIGNED

13. SIGNATURE OF WORK CENTER HEAD	14. SIGNATURE OF DEPARTMENT OFFICER	15. AUTOVON/COMM. NO.

16. SHIP HULL NO. AND/OR STATION ADDRESS (DO NOT ABBREVIATE)

17. THIS SPACE ONLY FOR NSDSA

A. CONTROL NO	B. COG ISEA	C. DATE			D. PRIORITY	E. TRANSMITTED TO
		RECEIVED	FORWARDED	DUE		

NAVSEA 9086/10 (REV. 6-85) S/N 0116-LF-090-8651 CLASSIFICATION:
(REPLACES 4-84 EDITION & NAVSEA 4160/1 - DESTROY STOCK)

REPRODUCED AT GOVERNMENT EXPENSE

PLEASE CLOSE WITH TAPE – DO NOT STAPLE – THANK YOU

Fold Here

DEPARTMENT OF THE NAVY

Official Business
Penalty for Private Use $300

COMMANDING OFFICER
NAVAL SHIP WEAPON SYSTEMS ENGINEERING STATION
NAVAL SEA DATA SUPPORT ACTIVITY (Code 5H00)
PORT HUENEME, CA 93043-5007

Fold Here

NAVSEA 9086/10 (Rev. 6-85) (BACK)