

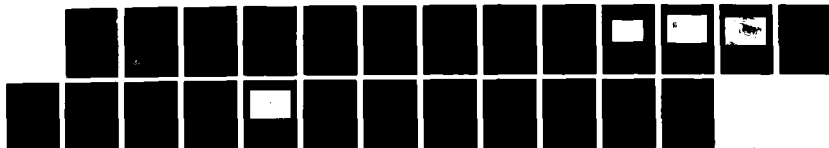
NO-A100 173

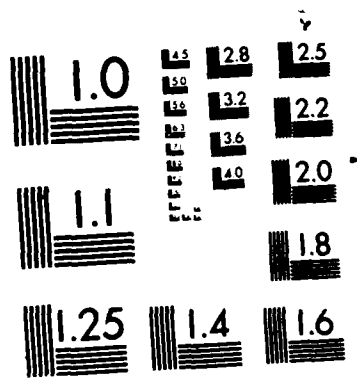
SAFETY EVALUATION OF LOCC/ROCC (NSC-6) NAVY SHF  
SATELLITE COMMUNICATIONS SET (U) NAVAL SURFACE WEAPONS  
CENTER SILVER SPRING MD S E BUCHHOLZ ET AL. 04 APR 84  
NSWC/TR-84-174

UNCLASSIFIED

F/G 10/3

NL





MICROCOPY RESOLUTION TEST CHART  
NATIONAL BUREAU OF STANDARDS-1963-A

NSWC TR 84-174

AD A180173

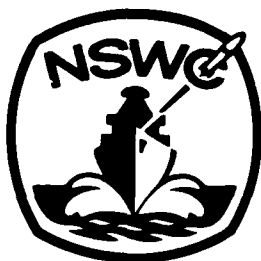
## **SAFETY EVALUATION OF LOCC/ROCC (WSC-6) NAVY SHF SATELLITE COMMUNICATIONS SET**

BY S. E. BUCHHOLZ, J. A. BARNES, R. F. BIS,  
F. C. DEBOLD, P. B. DAVIS, L. A. KOWALCHIK

RESEARCH AND TECHNOLOGY DEPARTMENT

4 APRIL 1984

Approved for public release; distribution unlimited.



**NAVAL SURFACE WEAPONS CENTER**

Dahlgren, Virginia 22448 • Silver Spring, Maryland 20910

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

| REPORT DOCUMENTATION PAGE                                                                                                                                                                                                                                                                                                            |                       | READ INSTRUCTIONS<br>BEFORE COMPLETING FORM                           |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|-----------------------------------------------------------------------|
| 1. REPORT NUMBER<br>NSWC TR 84-174                                                                                                                                                                                                                                                                                                   | 2. GOVT ACCESSION NO. | 3. RECIPIENT'S CATALOG NUMBER                                         |
| 4. TITLE (and Subtitle)<br>SAFETY EVALUATION OF LOCC/ROCC (WSC-6) NAVY SHF<br>SATELLITE COMMUNICATIONS SET                                                                                                                                                                                                                           |                       | 5. TYPE OF REPORT & PERIOD COVERED                                    |
|                                                                                                                                                                                                                                                                                                                                      |                       | 6. PERFORMING ORG. REPORT NUMBER                                      |
| 7. AUTHOR(s)<br>S. E. BUCHHOLZ, J. A. BARNES, R. F. BIS,<br>F. C. DEBOLD, P. B. DAVIS, L. A. KOWALCHIK                                                                                                                                                                                                                               |                       | 8. CONTRACT OR GRANT NUMBER(s)                                        |
| 9. PERFORMING ORGANIZATION NAME AND ADDRESS<br>Naval Surface Weapons Center (Code R33)<br>10901 New Hampshire Avenue<br>Silver Spring, MD 20903-5000                                                                                                                                                                                 |                       | 10. PROGRAM ELEMENT, PROJECT, TASK<br>AREA & WORK UNIT NUMBERS<br>OMN |
| 11. CONTROLLING OFFICE NAME AND ADDRESS                                                                                                                                                                                                                                                                                              |                       | 12. REPORT DATE<br>4 April 1984                                       |
|                                                                                                                                                                                                                                                                                                                                      |                       | 13. NUMBER OF PAGES<br>25                                             |
| 14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)                                                                                                                                                                                                                                                          |                       | 15. SECURITY CLASS. (of this report)<br>UNCLASSIFIED                  |
|                                                                                                                                                                                                                                                                                                                                      |                       | 15a. DECLASSIFICATION/DOWNGRADING<br>SCHEDULE                         |
| 16. DISTRIBUTION STATEMENT (of this Report)<br><br>Approved for public release; distribution is unlimited.                                                                                                                                                                                                                           |                       |                                                                       |
| 17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)                                                                                                                                                                                                                                           |                       |                                                                       |
| 18. SUPPLEMENTARY NOTES                                                                                                                                                                                                                                                                                                              |                       |                                                                       |
| 19. KEY WORDS (Continue on reverse side if necessary and identify by block number)<br>Navy SHF Satellite Communications Set<br>Batteries<br>LOCC/ROCC (WSC-6)                                                                                                                                                                        |                       |                                                                       |
| 20. ABSTRACT (Continue on reverse side if necessary and identify by block number)<br><br>The battery for the LOCC/ROCC (WSC-6) Navy SHF Satellite Communications Set is evaluated for use in the fleet according to NAVSEAINST 9310.1A. The following tests are performed: forced discharge, short circuit, heat tape, and charging. |                       |                                                                       |

DD FORM 1 JAN 73 1473

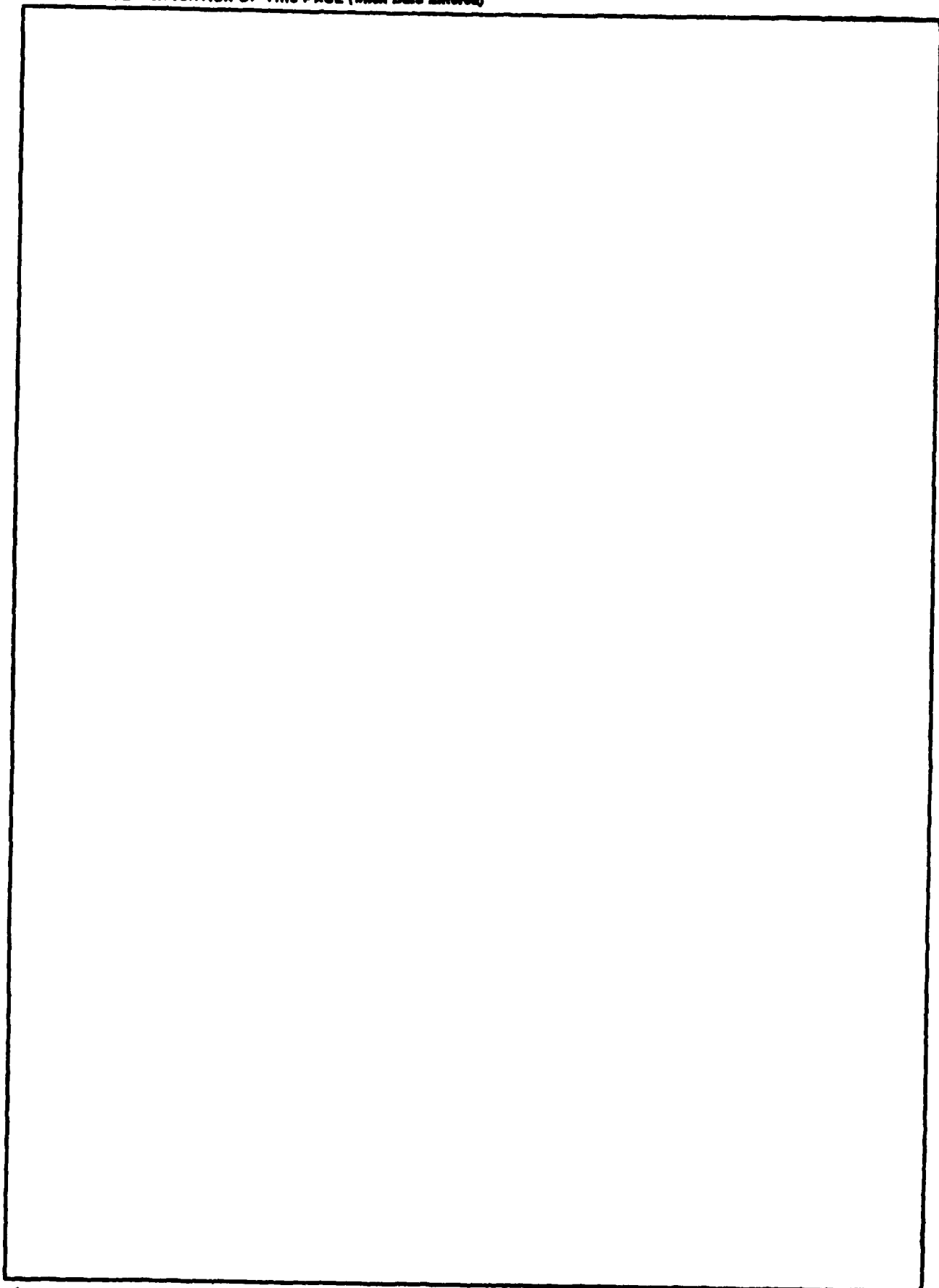
EDITION OF 1 NOV 65 IS OBSOLETE  
S/N 0102-LF-014-6601

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)



S/N 0102- LF- 014- 6601

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

FOREWORD

This work was performed for and funded by the Naval Electronic Systems Command. The safety testing was performed on the Eagle-Picher backup memory battery for a LOCC/ROCC (WSC-6) Navy SHF satellite communications set. The testing was carried out to determine if the LOCC/ROCC (WSC-6) set was safe to ship and deploy as configured. The tests presented in this report follow the guidelines set forth in NAVSEAINST 9310.1A.

Approved by:

  
JACK R. DIXON, Head  
Materials Division

CONTENTS

| <u>Chapter</u> |                        | <u>Page</u> |
|----------------|------------------------|-------------|
| 1              | INTRODUCTION . . . . . | 1           |
| 2              | EXPERIMENTAL . . . . . | 3           |
| 3              | RESULTS . . . . .      | 9           |
| 4              | CONCLUSIONS . . . . .  | 15          |

## ILLUSTRATIONS

| <u>Figure</u> |                                                                   | <u>Page</u> |
|---------------|-------------------------------------------------------------------|-------------|
| 1             | COMMUNICATIONS SET DRAWER . . . . .                               | 4           |
| 2             | BATTERY AND CIRCUIT BOARD . . . . .                               | 5           |
| 3             | MOCK-UP OF THE INSIDE OF A COMMUNICATIONS SET DRAWER . . . . .    | 6           |
| 4             | CIRCUIT DIAGRAM FOR A SHORT CIRCUIT . . . . .                     | 7           |
| 5             | CIRCUIT DIAGRAM FOR A FORCED DISCHARGE AT 125 mA . . . . .        | 7           |
| 6             | CIRCUIT DIAGRAM FOR A CHARGING CIRCUIT . . . . .                  | 7           |
| 7             | SHORT CIRCUIT . . . . .                                           | 10          |
| 8             | FORCED DISCHARGE WITH CASE IN COMMUNICATIONS SET DRAWER . . . . . | 11          |
| 9             | HEAT TAPE TEST . . . . .                                          | 12          |
| 10            | RESULTS OF HEAT TAPE TEST . . . . .                               | 13          |
| 11            | CHARGING TEST . . . . .                                           | 14          |

## CHAPTER 1

### INTRODUCTION

The Eagle-Picher 3V  $[(\text{Li}/(\text{CF})_x)]$  Keeper battery was selected for use on a printed circuit board to function as the keep alive memory for a Navy SHF Satellite Communications Set (AN/WSC-6). The system was developed under Contract N00039-82-C-0243. The work was done in accordance with the requirements laid out in NAVSEAINST 9310.1A. The minimum requirement of nine tests were completed: three short circuit, three forced discharge, and three heat tape. Also performed were two charging tests: one on a fresh cell and one on a partially discharged cell.

## CHAPTER 2

## EXPERIMENTAL

Nine tests were run, three Short Circuit, three Forced Discharge, and three Heat Tape. One of each of these tests was performed on the battery outside the drawer in which it is used. Two of each of these tests were performed with the battery in the drawer (See Figure 1). In each case, the battery was on a printed circuit board (See Figure 2). To see the relative location of the battery with respect to the other circuit boards and other equipment in the mock-up drawer, refer to Figure 3. One thermocouple was placed on each side of the battery. Temperature, voltage, and current were monitored on a Fluke datalogger and recorded on a Columbia 300C. The circuits used for the short circuit test and forced discharge are shown in Figures 4 and 5, respectively.

Also, charging tests were conducted on a fresh cell as well as a partially discharged cell. The charging circuit used is shown in Figure 6. The cells were charged at 125 mA with the voltage limited to 5V.

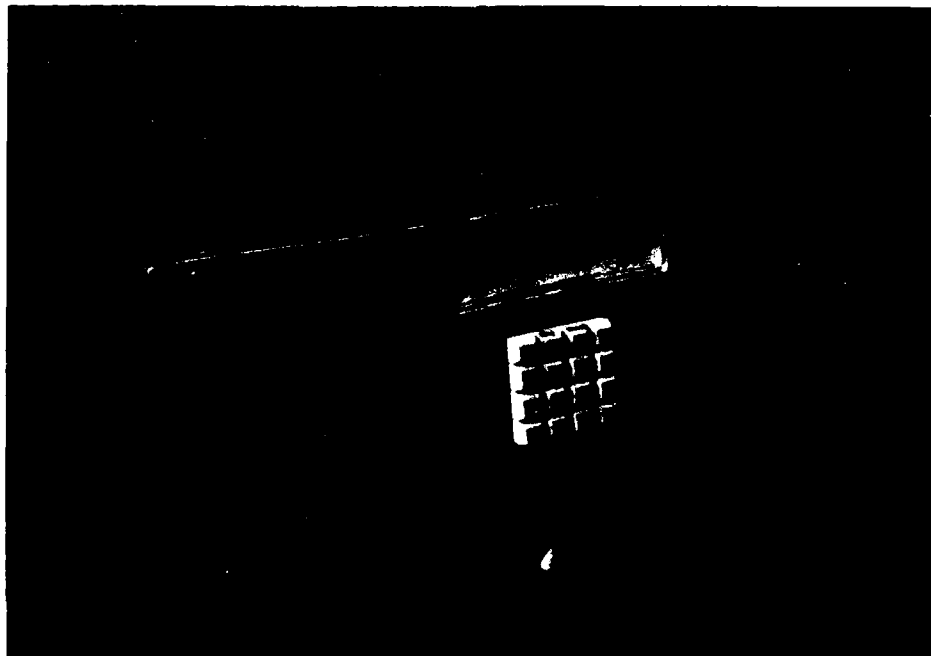


FIGURE 1. COMMUNICATIONS SET DRAWER.

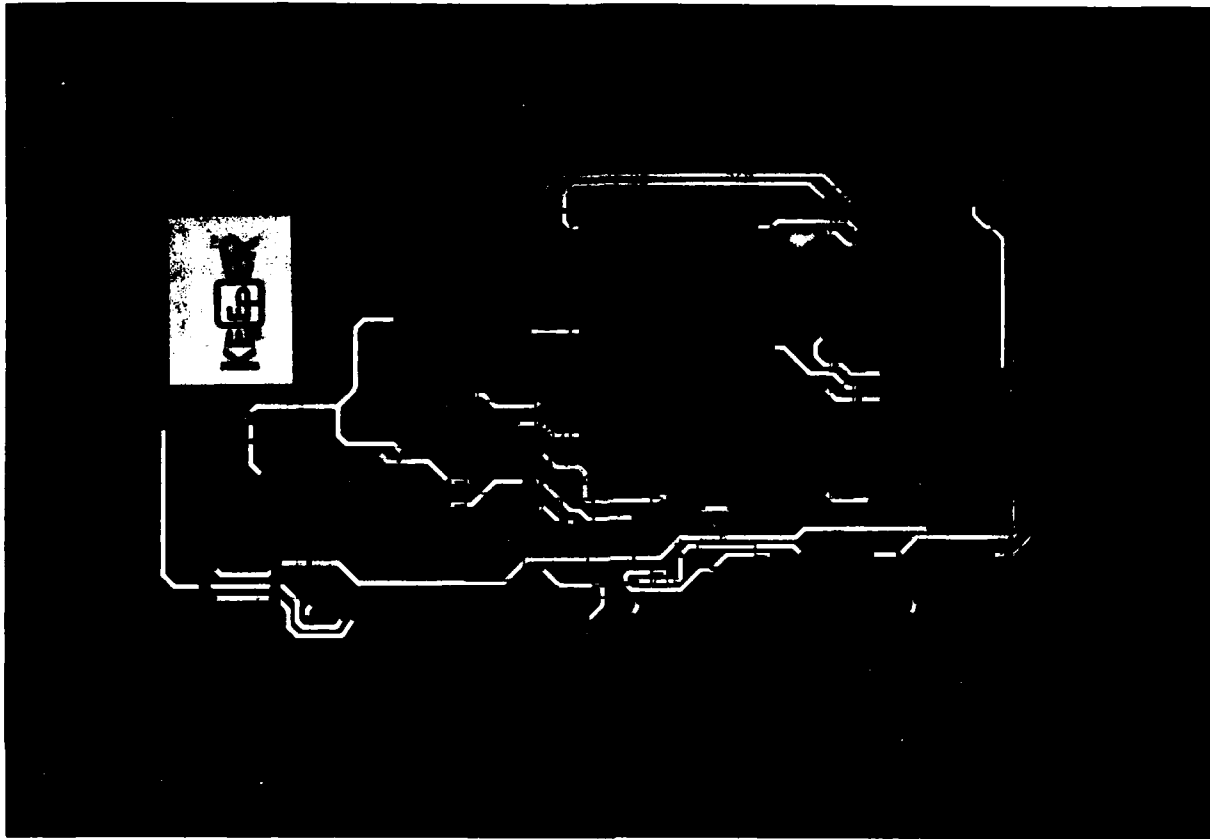


FIGURE 2. BATTERY AND CIRCUIT BOARD.

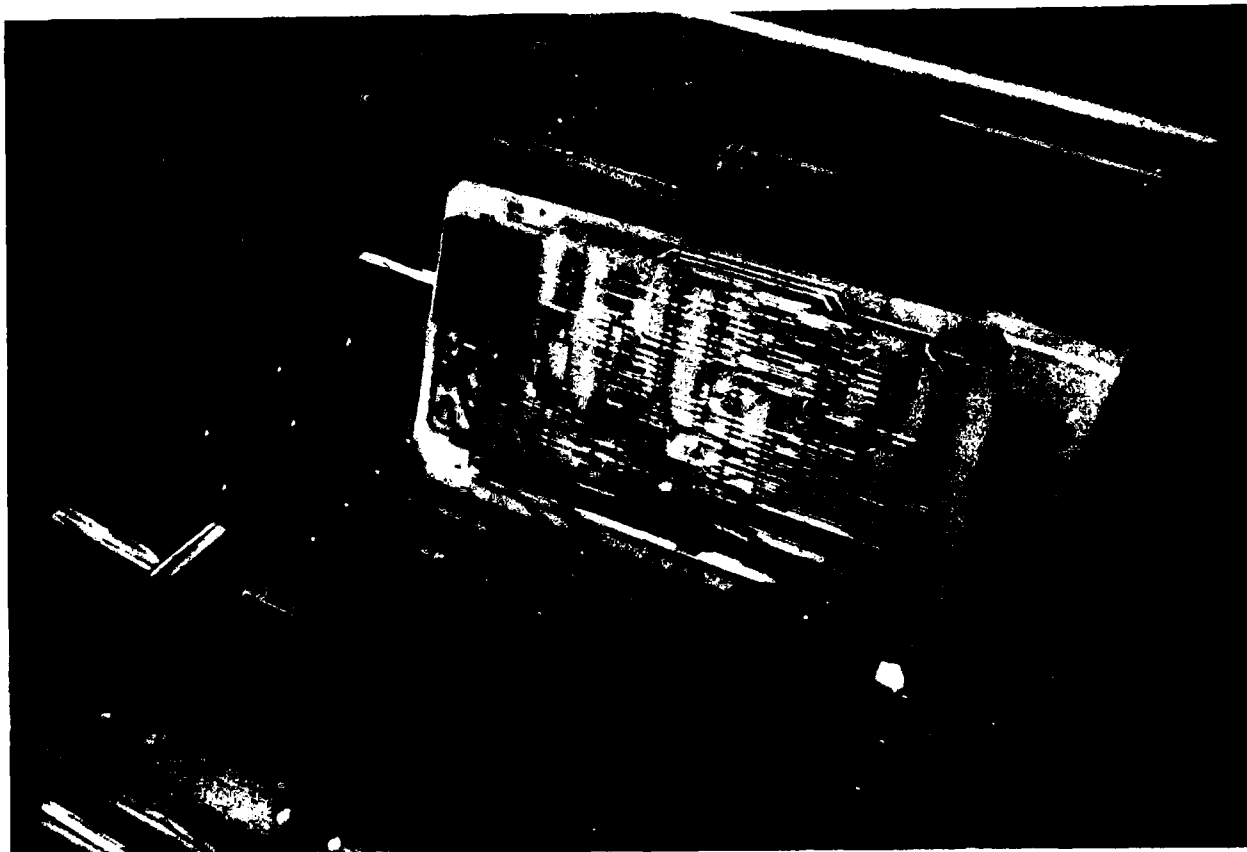


FIGURE 3. MOCK-UP OF THE INSIDE OF A COMMUNICATIONS SET DRAWER

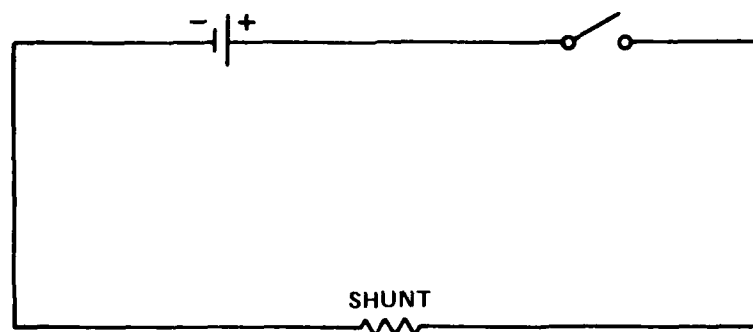


FIGURE 4. CIRCUIT DIAGRAM FOR A SHORT CIRCUIT

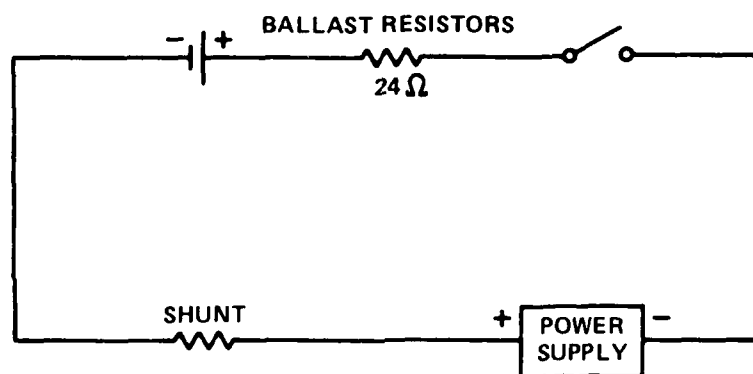


FIGURE 5. CIRCUIT DIAGRAM FOR A FORCED DISCHARGE AT 125 mA

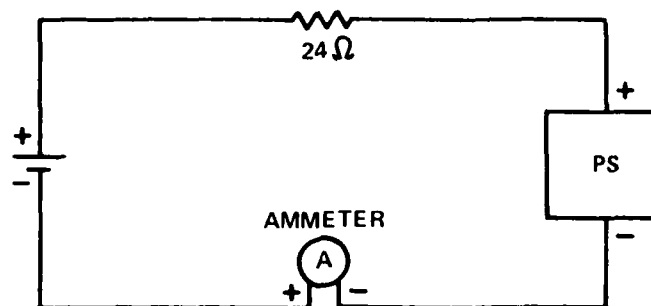


FIGURE 6. CIRCUIT DIAGRAM FOR A CHARGING CIRCUIT AT 125mA

## CHAPTER 3

## RESULTS

There was no significant difference between the tests run on the batteries inside or outside the unit.

In the short circuit test, the battery voltage dropped immediately to between 0.07 and 0.11 volt and continued to drop slowly. The battery heated slightly, reaching a peak temperature of between 34.4°C and 36°C. A representative graph is shown in Figure 7. No evidence of hazardous reaction or visible flame was apparent.

In the first forced discharge test, the battery voltage dropped immediately to 1.59 volts and continued to decrease slowly after that. The battery reached a peak temperature of 38.6°C seventeen minutes into the test. In the second forced discharge test, the voltage dropped immediately to 1.24 volts and continued to decrease slowly. The battery reached a peak temperature of 35.2°C eight minutes into the test. There was no reaction or flame generated during any of the three tests. A representative graph of the forced discharge tests is shown in Figure 8.

Lengths of heat tape were wrapped around the battery and around the section of the circuit board immediately behind the battery. The battery was heated at a rate of 6°C/min. Two of the batteries vented at 240°C approximately 38 minutes into the test. They vented again shortly after that. There was a relatively small amount of smoke. The third battery vented at 204°C approximately 26 minutes into the test with a relatively small amount of smoke. A graph of the test results is shown in Figure 9. A representative cell is shown in Figure 10. There were no differences between tests run on the batteries inside or outside the unit.

Without violent reaction, a fresh cell was discharged for 4 hours with a 24  $\Omega$  resistor. The battery was charged at 125 mA for 4 hours. Before the charging test began, the voltage had recovered to a value of 2.729 volts. During the charging tests, no hazardous reactions were observed. The cell was then discharged at 125 mA. The voltage decreased rapidly toward zero. The details of the charging experiment are shown in Figure 11.

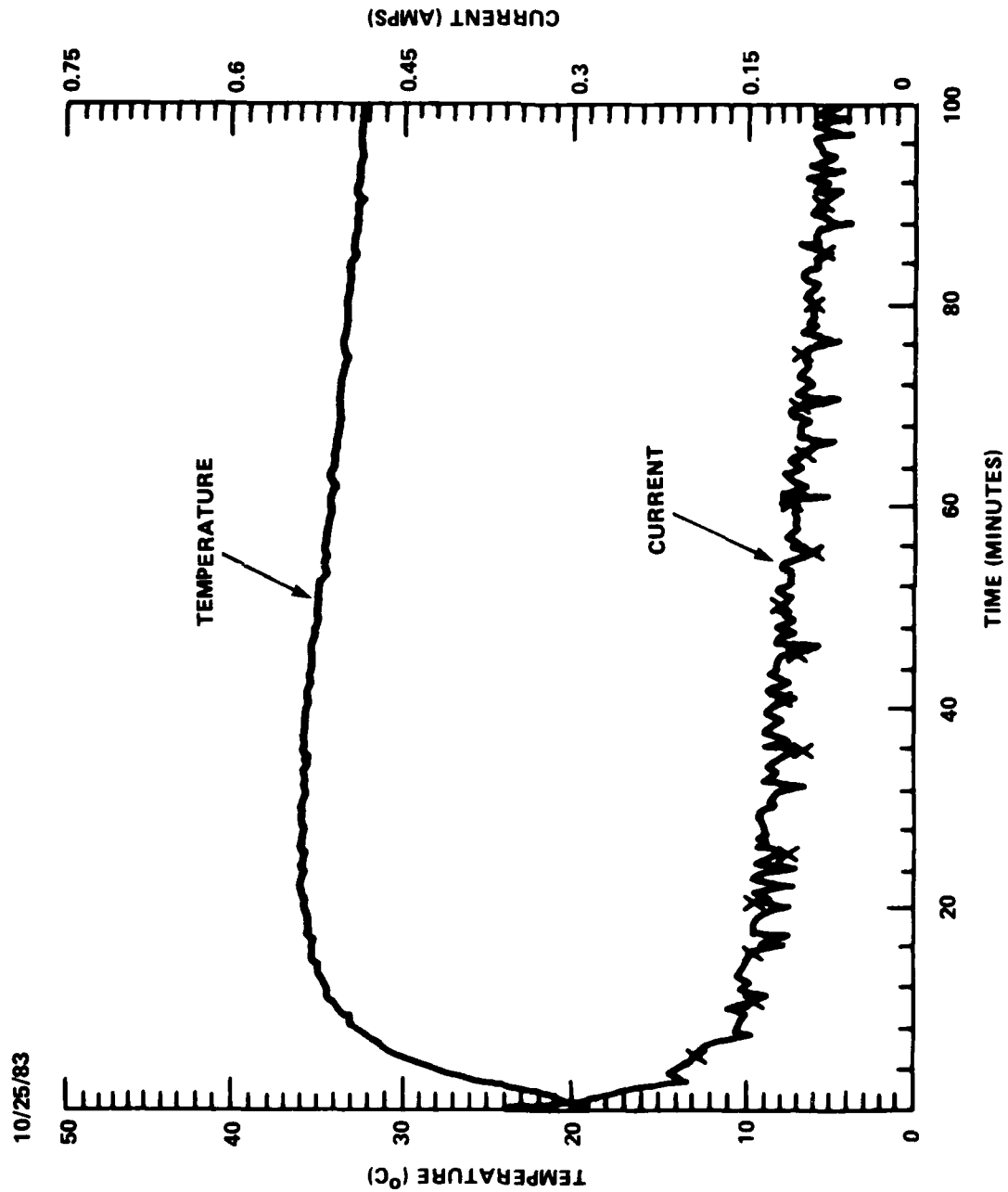


FIGURE 7. SHORT CIRCUIT

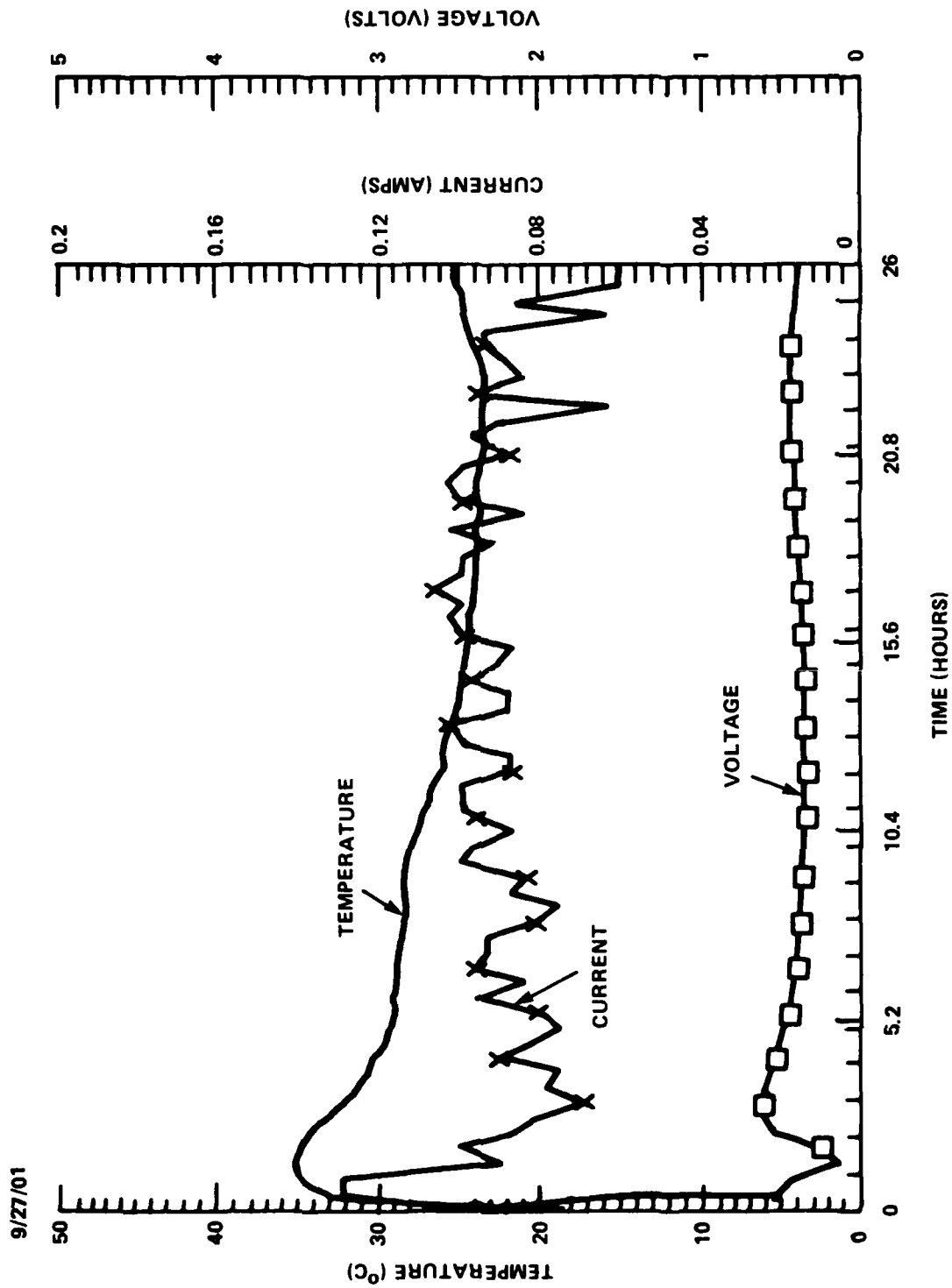


FIGURE 8. FORCED DISCHARGE WITH CASE IN COMMUNICATIONS SET DRAWER

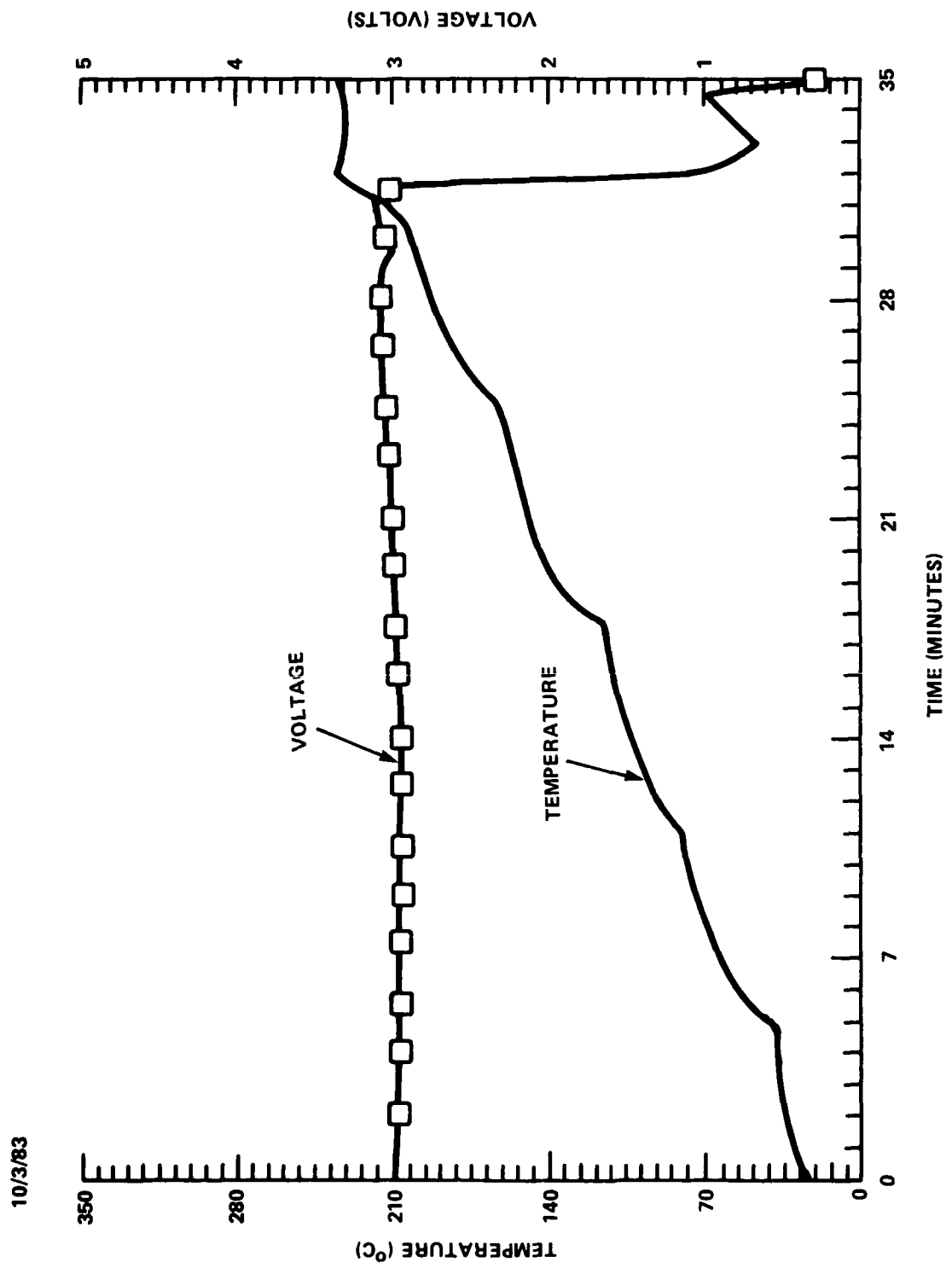


FIGURE 9. HEAT TAPE TEST

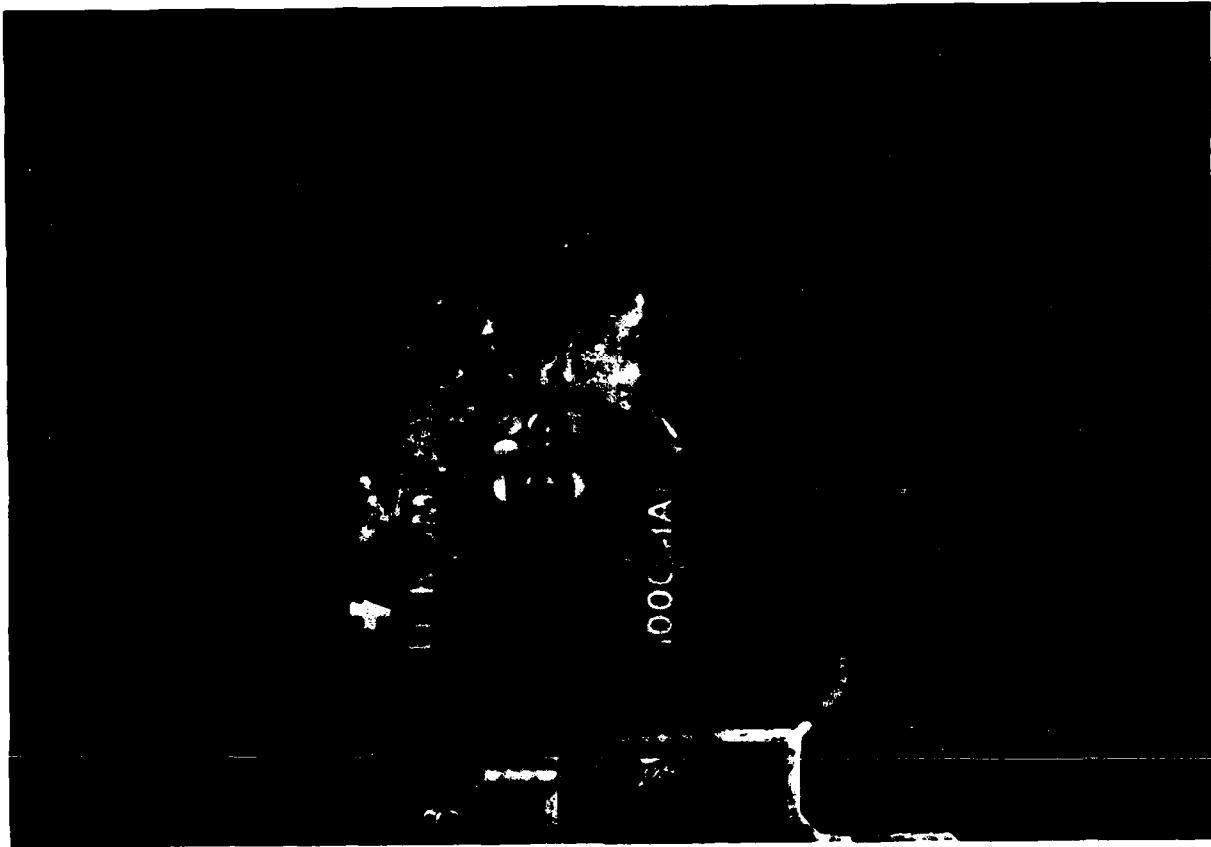


FIGURE 10. RESULTS OF HEAT TAPE TEST.

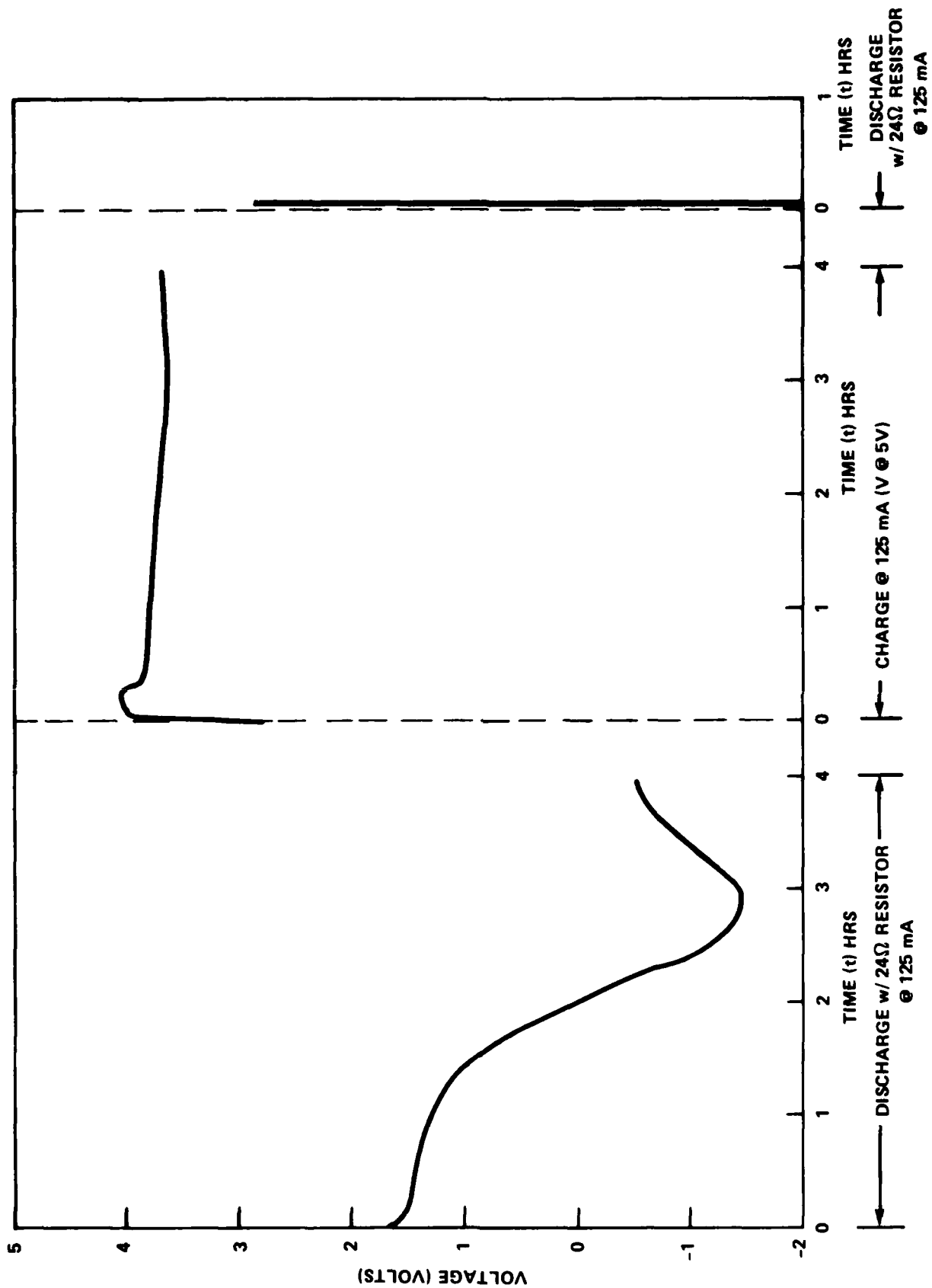


FIGURE 11. CHARGING TEST.

## CHAPTER 4

### CONCLUSIONS

Based on the test data discussed in this report, a recommendation for service use has been made to NAVSEA 06H. The results indicate that the Eagle-Picher 3V [(Li/(CF)<sub>x</sub>)] Keeper battery is abuse-resistant under the tests conditions described here.

## DISTRIBUTION

|                                   | <u>Copies</u> |                                      | <u>Copies</u> |
|-----------------------------------|---------------|--------------------------------------|---------------|
| Commander                         |               | Commander                            |               |
| Naval Sea Systems Command         |               | Naval Weapons Center                 |               |
| Attn: Sea 63R3                    | 1             | Attn: Code 38 (E. Royce)             | 1             |
| Sea 63X12 (J. Lascody)            | 1             | Code 3852                            | 1             |
| Sea 9823                          | 1             | Code 3626 (W. Haight)                | 1             |
| Sea 65321 (H. Holter)             | 2             | China Lake, CA 93555                 |               |
| Sea 09G32                         | 2             |                                      |               |
| Sea 921AN                         | 1             | Office of Naval Research             |               |
| Sea 543                           | 1             | Attn: ONR 472 (G. Neece)             | 2             |
| Washington, DC 20362              |               | 800 N. Quincy Street                 |               |
|                                   |               | Arlington, VA 22217                  |               |
| Commander                         |               | Commander                            |               |
| Naval Ocean Systems Center        |               | Naval Intelligence Support Center    |               |
| Attn: Code 19 (CAPT M Dorman)     | 1             | Attn: Code 362 (H. Ruskie)           | 1             |
| Code 922                          | 1             | Washington, DC 20390                 |               |
| Code 712 (J. McCartney)           | 1             |                                      |               |
| San Diego, CA 92152               |               | Office of Navy Technology            |               |
| Commander                         |               | Associate Director                   |               |
| Naval Weapons Support Center      |               | Attn: Support Technology (072)       | 1             |
| Electrical Power Sources Division |               | 800 N. Quincy Street                 |               |
| Attn: Code 3054 (S. Shuler)       | 1             | Arlington, VA 22217                  |               |
| Crane, IN 47522                   |               | Chief of Naval Operations            |               |
| Commander                         |               | Operating Evaluation Group           | 1             |
| Space and Naval Warfare Systems   |               | Washington, DC 20350                 |               |
| Command                           |               | Commander                            |               |
| Attn: Code PME124-31 (A. Sobel)   | 1             | Naval Air Development Center         |               |
| Code PME 106-13B (W. McCabe)      | 1             | Attn: Library                        | 1             |
| SPAWAR 01K (A. Sliwa)             | 1             | Warminster, PA 18974                 |               |
| 40736 (W. Weingartner)            | 1             |                                      |               |
| Washington, DC 20363-5100         |               | Defense Technical Information Center |               |
| Commander                         |               | Cameron Station                      | 12            |
| Naval Underwater Systems Center   |               | Alexandria, VA 22314                 |               |
| Attn: Code 3642 (R. Lazar)        | 2             |                                      |               |
| (J. Moden)                        | 1             |                                      |               |
| Newport, RI 02840                 |               |                                      |               |

## DISTRIBUTION (Cont.)

|                                      | <u>Copies</u> |                                  | <u>Copies</u> |
|--------------------------------------|---------------|----------------------------------|---------------|
| Jet Propulsion Laboratory            |               | EIC Corporation                  |               |
| Attn: MS 277-102 (G. Halpert)        | 2             | Attn: K. M. Abraham              | 1             |
| 4800 Oak Grove Drive                 |               | 111 Downey Street                |               |
| Pasadena, CA 911909                  |               | Norwood, MA 02062                |               |
| Saft America Inc.                    |               | Mare Island Naval Ship Yard      |               |
| Advanced Battery Systems             |               | Attn: Code 280.08 Stop 060       |               |
| Attn: Franklin C. Regan              | 1             | (R. Houlder)                     | 1             |
| 107 Beaver Court                     |               | Vallejo, CA 94592                |               |
| Cockeysville, MD 21030               |               |                                  |               |
| U. S. Army Laboratory Command        |               | David W. Taylor Naval Ship and   |               |
| Attn: Code SLET-PB (T. Reiss)        | 1             | Development Center               |               |
| Code SLCET-PR (S. Gilman)            | 1             | Annapolis Laboratory             |               |
| Fort Monmouth, NJ 07703              |               | Attn: Code 2724 (H. R. Urbach)   | 1             |
|                                      |               | Code 2724 (R. Bloomquist)        | 1             |
|                                      |               | Annapolis, MD 21401              |               |
| Air Force Aero Propulsion Laboratory |               |                                  |               |
| Attn: AFWAL/POOC-1 (W. S. Bishop)    | 1             | NOAA Data Buoy Center            |               |
| AFAPL/OPE-1 (D. Marsh)               | 1             | Attn: D. Scully                  | 1             |
| Wright Patterson AFB, OH 45433       |               | NSTL Station, MS 39529           |               |
|                                      |               |                                  |               |
| NASA Johnson Space Center            |               | U. S. Army HQDA-DAEN-ASR-SL      |               |
| Attn: Code EP5 (B. J. Bragg)         | 1             | Washington, DC 20314             | 1             |
| NASA Road 1                          |               |                                  |               |
| Houston, TX 77058                    |               | Norton Air Force Base            |               |
|                                      |               | Attn: Code BMO/ENBE              | 1             |
| National Bureau of Standards         |               | Code AFISC/SES                   | 1             |
| Attn: William Dorko                  | 1             | Norton AFB, CA 92409             |               |
| B 364 (CHEM)                         |               |                                  |               |
| Washington, DC 20234                 |               | NASA Goddard Space Flight Center |               |
|                                      |               | Attn: Code 711                   | 1             |
| Panasonic Industrial Company         |               | Greenbelt, MD 20771              |               |
| Attn: R. Morioka                     | 1             |                                  |               |
| P. O. Box 1511                       |               | NASA Langley                     |               |
| Secaucus, NJ 07094                   |               | Attn: MS 433 (J. Gowdey)         | 1             |
|                                      |               | Hampton, VA 23665                |               |
| Wilson Greatbatch Ltd.               |               |                                  |               |
| Attn: P. Krall                       | 1             | Central Intelligence Agency      |               |
| 10000 Wehrle Drive                   |               | Attn: OTS (C. Schuilla)          | 1             |
| Clarence, NY 14031                   |               | Washington, DC 20505             |               |

## DISTRIBUTION (Cont.)

|                               | <u>Copies</u> |                                 | <u>Copies</u> |
|-------------------------------|---------------|---------------------------------|---------------|
| Headquarters                  |               |                                 |               |
| Department of Transportation  |               | Martin Marietta Aerospace       |               |
| U. S. Coast Guard             |               | Attn: John Wear                 | 1             |
| Ocean Engineering Division    |               | P. O. Box 179                   |               |
| Attn: GEOE-3/61 (R. Potter)   | 1             | Denver, CO 80201                |               |
| Washington, DC 20590          |               |                                 |               |
| Magnavox                      |               | Teledyne Electronics            |               |
| Department 529                |               | Attn: G. Lamb                   | 1             |
| Attn: Carl Keuneke            | 1             | 649 Lawrence Drive              |               |
| 1313 Production Road          |               | Newbury Park, CA 91320          |               |
| Fort Wayne, IN 46808          |               |                                 |               |
| McDonnell Douglas Corporation |               | Duracell U. S. A.               |               |
| 1150 17th Street NW           |               | Attn: Glenn Cruze               | 1             |
| Suite 500                     |               | Technical Sales Marketing Group |               |
| Washington, DC 20036          | 1             | Berkshire Industrial Park       |               |
|                               |               | Bethel, CT 06801                |               |
| Gould Incorporated            |               | Power Conversion Incorporated   |               |
| Gould Laboratories            |               | 495 Boulevard                   |               |
| 40 Gould Center               |               | Elmwood Park, NJ 07407          | 1             |
| Rolling Meadows, IL 60000     | 1             |                                 |               |
| The Aerospace Corporation     |               | Lockheed Palo Alto Research     |               |
| Attn: H. F. Bittner           | 1             | Laboratory                      |               |
| MS/275                        |               | Lockheed Missiles and Space     |               |
| P. O. Box 92957               |               | Company Incorporated            |               |
| Los Angeles, CA 90009         |               | Attn: Library                   | 1             |
|                               |               | 3251 Hanover Street             |               |
|                               |               | Palo Alto, CA 94304             |               |
| Honeywell Incorporated        |               | General Electric Company        |               |
| Power Sources Center          |               | Attn: R. W. Race                | 1             |
| Attn: Library                 | 1             | Manager Advance Programs        |               |
| 104 Rock Road                 |               | Marketing                       |               |
| Horsham, PA 19044             |               | Room 2544A-OP#2                 |               |
|                               |               | 100 Plastics Avenue             |               |
| The Boeing Company            |               | Pittsfield, MA 01201            |               |
| Attn: A. C. Johnson           | 1             |                                 |               |
| P. O. Box 3707                |               | Acoustic Systems Incorporated   |               |
| Seattle, WA 98124             |               | Attn: J. Fish                   | 1             |
|                               |               | 600 Norman Firestone Road       |               |
| GTE Laboratories Incorporated |               | Goleta, CA 93177                |               |
| Attn: Library                 | 1             |                                 |               |
| 40 Sylvan Road                |               |                                 |               |
| Waltham, MA 02154             |               |                                 |               |

## DISTRIBUTION (Cont.)

|                                 | <u>Copies</u> |                                   | <u>Copies</u> |
|---------------------------------|---------------|-----------------------------------|---------------|
| Honeywell Power Sources Center  |               | Navy Environmental Health Center  |               |
| Attn: D. Chua                   | 1             | Attn: J. R. Crawl, Head Hazardous |               |
| 104 Rock Road                   |               | Material Evaluation Branch        | 1             |
| Horsham, PA 19044               |               | Naval Station                     |               |
|                                 |               | Norfolk, VA 23511                 |               |
| Battery Engineering             |               | Sparton Electronics               |               |
| Attn: N. Marincic               | 1             | Attn: C. H. Bush                  | 1             |
| 80 Oak Street                   |               | 2400 East Ganson Street           |               |
| Newton, MA 02164                |               | Jackson, MI 49202                 |               |
| GTE Sylvania                    |               | Sanders Associates                |               |
| Attn: R. McDonald               | 1             | Attn: G. Disco                    | 1             |
| 189 B Street                    |               | 95 Canal Street                   |               |
| Needham Heights, MA 02194       |               | Nashua, NH 03061                  |               |
| Altus Corporation               |               | Sonatech Incorporated             |               |
| 1610 Crane Court                |               | Attn: R. Cyr                      | 1             |
| San Jose, CA 95112              | 1             | 700 Francis Botello Road          |               |
| Yardney Electric Corporation    |               | Goleta, CA 93017                  |               |
| Attn: Library                   | 1             | Internal Distribution:            |               |
| 82 Mechanic Street              |               | R30                               | 1             |
| Pawcatuck, CT 02891             |               | R33 (Files)                       | 1             |
| Duracell U. S. A.               |               | R33 (Staff)                       | 20            |
| Laboratory for Physical Science |               | R33 (Bis)                         | 70            |
| Attn: Library                   | 1             | E35                               | 1             |
| Burlington, MA 01803            |               | E231                              | 9             |
|                                 |               | E232                              | 3             |
| Eagle-Picher Industries         |               |                                   |               |
| Couples Department              |               |                                   |               |
| Attn: Library                   | 1             |                                   |               |
| Joplin, MO 64801                |               |                                   |               |
| Advance Battery Group           |               |                                   |               |
| ATTN: R. Murphy                 | 1             |                                   |               |
| 269 Westwood Street             |               |                                   |               |
| Lancaster, NY 14086             |               |                                   |               |
| Ray-O-Vac                       |               |                                   |               |
| Attn: R. F. Udell               | 1             |                                   |               |
| B. C. Bergum                    | 1             |                                   |               |
| 101 East Washington Street      |               |                                   |               |
| Madison, WI 53703               |               |                                   |               |

END

7-87

DTIC