
WL-TR-94-2097

# HIGH RELIABILITY, MAINTENANCE-FREE INS BATTERY DEVELOPMENT - PHASE II

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**13. ABSTRACT (Maximum 200 words)**

This report documents the findings of a study undertaken to develop a high reliability, maintenance-free battery (HRMFB) for application in the Litton LTN-72 and Delco Carousel IV Inertial Navigation Systems (INS). The current phase of this program, Phase II, comprised the procurement and qualification of preproduction INS batteries based on the specification requirements developed in Phase I.

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# Table of Contents

# Table of Contents
(Continued)



## List of Figures



## List of Tables

## Summary

This report documents the results of a program to develop a high reliability, maintenance-free battery (HRMFB) for potential application in the inertial navigation system (INS) of various military aircraft. The current phase of this program, Phase II, comprised the procurement and qualification of preproduction INS batteries based on the specification requirements developed in Phase I.

Preproduction INS batteries were competitively procured from Concorde Battery Corporation. Initial samples were submitted in April 1993 to the Naval Surface Warfare Center, Crane Division (NSWCC) for qualification testing. These initial samples were not able to meet the specified discharge performance requirements, and had to be returned to Concorde for failure analysis and corrective action. A second set of samples, incorporating several design modifications, were submitted to NSWCC in August 1993. Testing of these samples was completed in December 1993. All specification requirements were satisfied with the exception of float life. The float life sample only gave 2.17 Ah of capacity after 100 days on float at 65°C, against a requirement of 10.0 Ah. The failed sample was returned to Concorde for failure analysis and corrective action. A new sample, incorporating an improved terminal design, was submitted to NSWCC in March 1994. The test temperature was reduced from 65°C to 50°C with concurrence from NSWCC and Concorde. The capacity after 50, 75 and 100 days on float measured 12.74, 10.04 and 8.66 Ah, respectively. Based on this test data, the specification requirement was relaxed from 100 days to 50 days. A float life of 50 days corresponds to a life in the aircraft of approximately 4 years, which was considered acceptable by NSWCC.

As a result of this program, qualification of a high reliability, maintenance-free INS battery was successfully completed. The specification sheet developed in Phase I was published by NSWCC as a standard military specification, MIL-B-8565/13. The projected savings by using this battery versus previous batteries is approximately $15 million per year, assuming retrofit occurs in all aircraft models currently using the vented type batteries.

# 1.0 Background

A wide variety of Air Force and Navy weapon systems utilize either the Litton LTN-72 or Delco Carousel IV Inertial Navigation System (INS), both of which require a dedicated battery. Vented nickel-cadmium batteries are currently used for this application, but these batteries suffer from high maintenance costs. In addition, multiple versions of the INS battery exist encompassing eight different national stock numbers. Some versions contain 15-minute cells, while other versions contain 30-minute cells. However, all versions have the same basic footprint and mounting provisions. Therefore, further cost reductions are possible by replacing the multiple versions with one standard version.

The objective of this program was to develop a common, 30-minute INS battery specification utilizing High Reliability, Maintenance-Free Battery (HRMFB) technology. Past experience with HRMFBs in military aircraft applications has demonstrated significant reliability and maintainability (R&M) improvements and cost reductions compared with vented battery technology. Similar R&M improvements are anticipated for the INS battery application.

In Phase I of this program, a functional and physical analysis of the LTN-72 and Carousel IV INS was conducted to verify compatibility of candidate HRMFB technologies. A life cycle cost analysis was also performed which clearly demonstrated the economic benefits of converting to HRMFB technology. The projected savings by using this battery versus previous batteries is approximately $15 million per year, assuming retrofit occurs in all aircraft models currently using the vented type batteries. To conclude the Phase I effort, a specification (DOD-B-8565/INS) was prepared for the proposed maintenance-free INS battery. The results of Phase I were documented in an Interim Report, Document No. WL-TR-92-2082, dated 31 July 1992.

## 2.0 Phase II Contract Requirements

Phase II of this program encompassed the procurement and qualification of preproduction INS batteries, based on the specification sheet developed in Phase I. Specific tasks from the Phase II Statement of Work (SOW) are as follows:

- SOW Paragraph 3.1 - Program Scheduling
- SOW Paragraph 3.2 - Status
- SOW Paragraph 3.3 - Prototype Development
- SOW Paragraph 3.4 - Prototype Testing
- SOW Paragraph 3.5 - Technical Documentation
- SOW Paragraph 3.6 - Review Meetings

The next section summarizes the results for each of these Phase II tasks.

# 3.0 Phase II Results

## 3.1 Program Scheduling

The Phase II schedule (A001) and project planning chart (A003) were first submitted on 30 October 1992 and updated each month thereafter. The latest update of each chart is given in Appendix A. The Phase II effort experienced an 11-month schedule setback due qualification test failures (see discussion in Sections 3.3 and 3.4). The completion date was shifted from 10/28/93 to 9/30/94 to accommodate the schedule setbacks.

## 3.2 Status

The Status Report (A001) and the Performance and Cost Report (A002) were first submitted on 30 October 1992 and updated each month thereafter. A total of 22 monthly reports were submitted, with the last report being submitted on 10 August 1994.

## 3.3 Prototype Development

In October 1992, price quotations were received from two candidate battery manufacturers: Concorde Battery Corporation (West Covina, California) and Hawker Energy (Newport, U.K.). Battelle selected Concorde as its subcontractor based on lower price, and the subcontract was issued in November 1992. Concorde was given an order for five qualification samples to be delivered no later than 15 April 1993. Other deliverables under this subcontract include an Acceptance Test Procedure and a Drawing Package. Appendix B contains a copy of the INS battery specification sheet (DOD-B-8565/INS), originally developed in Phase I and updated during Phase II.

Concorde shipped the initial five samples on 10 April 1993. Four of these samples (Serial Nos. R-10318, R-10319, R-10320 and R-10321) went to Naval Surface Warfare Center for qualification testing, and one sample (R-10323) went to Battelle as a spare. These units met all acceptance test requirements, except they exceeded the maximum weight by 0.5 to 0.7 pound. A sixth sample (Serial No. R-10327), weighing one pound less than the first five samples, was shipped to Crane on 27 April 1993.

Although the initial samples form Concorde were delivered on time, they did not perform to specifications during qualification testing. As a consequence, the samples were returned to Concorde to determine the source of the problem. The failure investigation was completed in July 1993 and Concorde attributed the failure to inadequate plate compression causing rapid corrosion, and an inadequate separator barrier allowing short circuiting between plates. A copy of the failure report is included in Appendix C.

Four additional samples (Serial Nos. R-11357, R-11358, R-11359 and R-11360) with corrected plate compression and improved separator material were shipped to NSWCC on 11 August 1993. These samples were within the maximum weight allowance of 31.0 pounds. Testing of these samples commenced on 13 August 1993 and was completed in December 1993. All samples passed with the exception of the float life. The float life sample was returned to Concorde and failure was attributed to a leaking terminal (see Appendix C for failure report). A new sample (Serial No. R-13927) with an improved seal design was shipped to NSWCC on 1 March 1994, and testing was completed in July 1994. This sample maintained rated capacity after 50 days on float, but not after 100 days. A float life of 50 days at 50°C corresponds to an aircraft service life of 7.3 years, assuming 1,100 operating hours per year (550 flight hours per year times 2) and a temperature acceleration factor of 6.67 (ratio of 25°C and 50°C float life data, taken from Gates Application Manual). Since the planned replacement interval for this battery is 4 years, a 50 day float life was considered acceptable. Consequently, the float life requirement was relaxed from 100 days to 50 days, with concurrence from NSWCC.

### 3.4 Prototype Testing

Qualification testing of the INS battery was performed by Naval Surface Warfare Center, Crane (NSWCC). The test program was initiated in April 1993, and was completed in July 1994. A copy of the Test Report is provided in Appendix C.

Test results from the first samples are summarized in Table 1. Although the discharge capacity at room temperature easily met specifications (60 minutes at 10 amperes), the low temperature discharge performance fell short of the specification requirements. As described in Section 3.3, these samples were returned to Concorde and a second set of samples were submitted for testing.

**Table 1. Test Results from Samples Submitted in April 1993**

| Requirement No. | Discharge Cutoff Voltage and Temp. | Rate of Discharge | Minimum Time to Cutoff Voltage | Test Results | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Sample 1 | Sample 2 | Sample 3 | Sample 4* | Sample 5 |
| 1 | 18 V at 24°C | 1C/10A | 60 minutes | 76:45 | 77:48 | 77:45 | N/T | 68.32 |
| 2 | 18 V at 49°C | 1C/10A | 66 minutes | N/T | N/A | N/A | N/A | N/A |
| 3 | 21 V at -18°C | 425 W | 1 minute | 21.53 V @ 20:00 | 21.0 V @ 00:23 | 21.60 V @ 20:00 | N/T | 21.0 V @ 16:10 |
| | | 400 W | 19 minutes | | | | | |
| 4 | 21 V at 5°C | 425 W | 1 minute | 21.03 V @ 30:00 | N/T | 21.0 V @ 21:23 | N/T | 21.0 V @ 23:04 |
| | | 400 W | 29 minutes | | | | | |
| 5 | 21 V at -40°C | 400 W | 5 minutes | 21.12 V @ 5:00 | N/T | < 00:08 | N/T | 21.07 V @ 5:00 |

* Spare sample; not tested.

Notes:
1. Sample 1 = S/N R-10320, Sample 2 = S/N R-10318, Sample 3 = S/N R-10321, Sample 4 = S/N R-10319 (spare sample; not tested), Sample 5 = S/N R-10327.
2. Shaded boxes designate noncompliance.
3. N/A = Not applicable; N/T = Not tested.

Test results from the second samples are summarized in Table 2 and Figure 1. In contrast with the initial samples, the second samples easily complied with the discharge performance requirements. The samples also complied with the other specification requirements, with the exception of float life. The float life sample only gave 2.17 Ah after 100 days on float at 65°C, against the specification requirement of 10.0 Ah. As described in Section 3.3, this sample was returned to Concorde and a new sample was submitted for testing. The test temperature was reduced from 65°C to 50°C with concurrence from NSWCC and Concorde. The 65°C test temperature was considered unrealistically high, and could introduce artificial failure modes not reflective of actual service conditions.

Test results from the second float life test are summarized in Figures 2 and 3. The capacity after 50, 75 and 100 days on float measured 12.74, 10.04 and 8.66 Ah, respectively. As previously noted, a 50-day float life requirement was considered acceptable, and this value was used in the military specification sheet (MIL-B-8565/13). Thus, the float life test was successfully completed. As previously noted, a float life of 50 days corresponds to a service life in the aircraft of 7.3 years, which is compatible with the planned 4-year replacement interval.

Figure 3 shows the charge profile following the capacity checks during the float life test. After 75 and 100 days on float, the charge voltage peaked before reaching the 29-volt cut-off level, and charging continued at 2 amperes constant current. After 75 days on float, the charge voltage eventually reached 29 volts after 959 minutes. After 100 days on float, the charge voltage never reached 29 volts, even after 3170 minutes of charge. Significant temperature rise was also found during the charge period after 75 and 100 days on float. Thus, if the battery were left on the aircraft too long, the charger could remain in the constant current mode indefinitely, resulting in excessive overcharge and a hot battery. Although this occurrence is not expected to pose a safety hazard, it would lead to rapid dry-out and failure of the battery. Eventually, the failed battery would be detected during the load test imposed by the INS during start-up. With a 4-year battery replacement period, however, it is unlikely that the battery charge voltage would degrade to the extent found during the end of float test (e.g., after 100 days on float).

**Table 2. Test Results from Samples Submitted in August 1993**

| Requirement No. | Discharge Cutoff Voltage and Temp. | Rate of Discharge | Minimum Time to Cutoff Voltage | Test Results | | |
|---|---|---|---|---|---|---|
| | | | | Sample 1R | Sample 2R | Sample 3R |
| 1 | 18 V at 24°C | 1C/10A | 60 minutes | 79:49 | 78:30 | 79:17 |
| 2 | 18 V at 49°C | 1C/10A | 66 minutes | 82:01 | N/A | N/A |
| 3 | 21 V at -18°C | 425 W | 1 minute | 21.83 V @ 20:00 | 21.77 V @ 20:00 | 21.84 V @ 20:00 |
| | | 400 W | 19 minutes | | | |
| 4 | 21 V at 5°C | 425 W | 1 minute | 22.03 V @ 30:00 | 21.77 V @ 30:00 | 22.04 V @30:00 |
| | | 400 W | 29 minutes | | | |
| 5 | 21 V at -40°C | 400 W | 5 minutes | 21.21 V @ 5:00 | 21.15 V @ 5:00 | 21.17 V @ 5:00 |

Notes:
1. Sample 1R = S/N R-11360, Sample 2R = S/N R-11357, Sample 3R = S/N R-11358.
2. N/A = Not applicable.

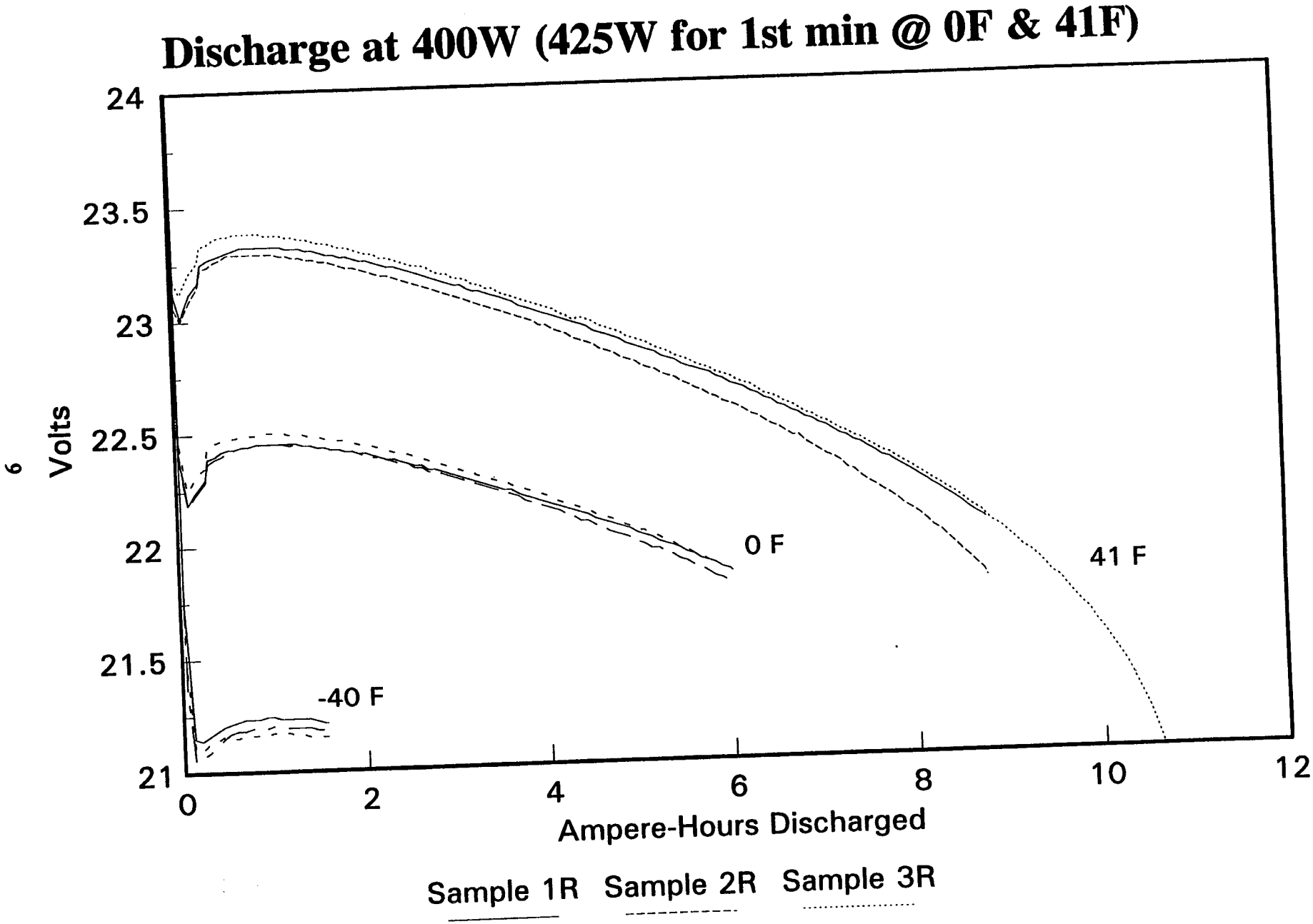



**Figure 1. Discharge Curves from Samples Submitted in August 1993**

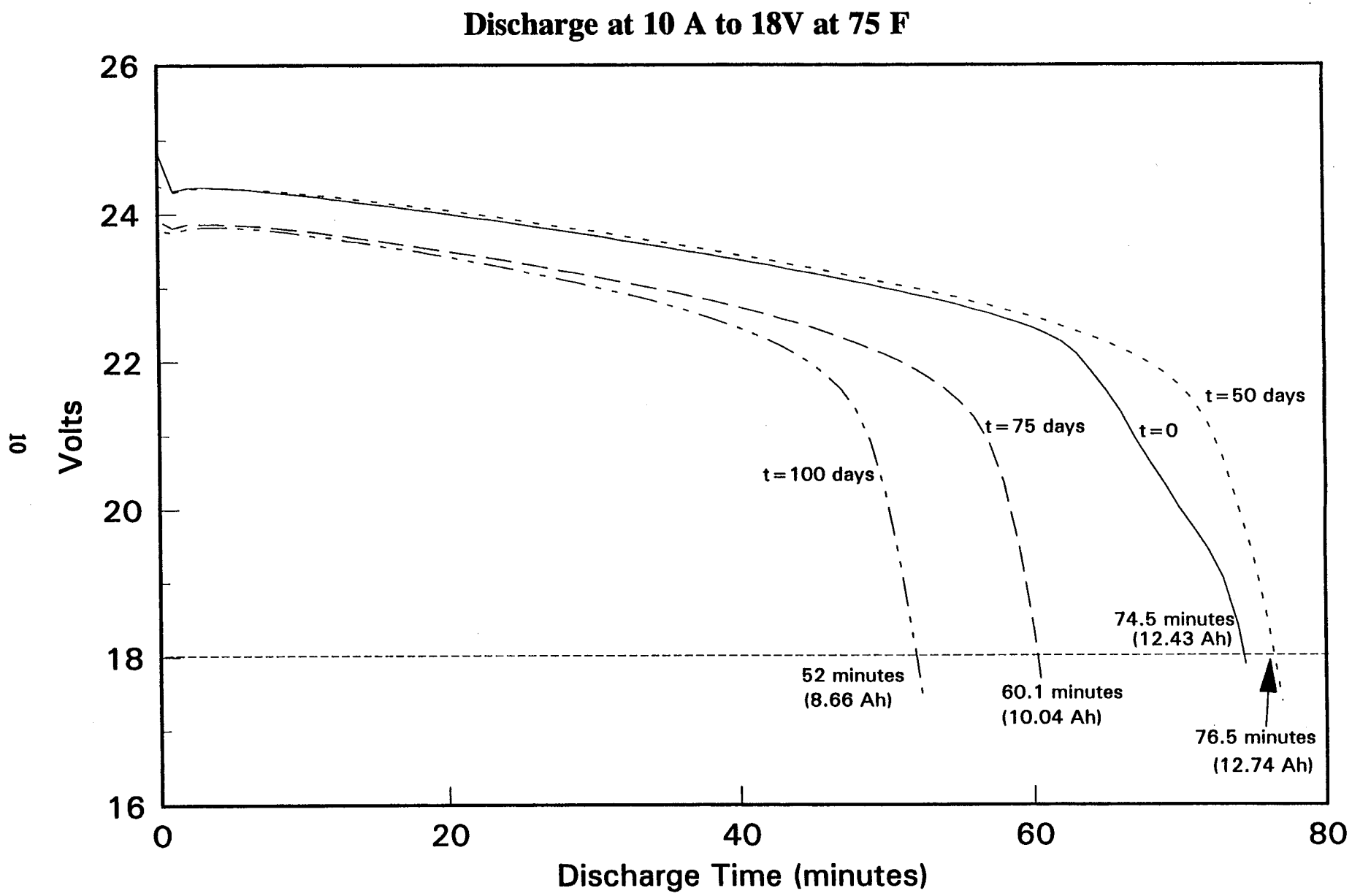



**Figure 2. Discharge Curves from Float Life Sample Submitted in March 1994**

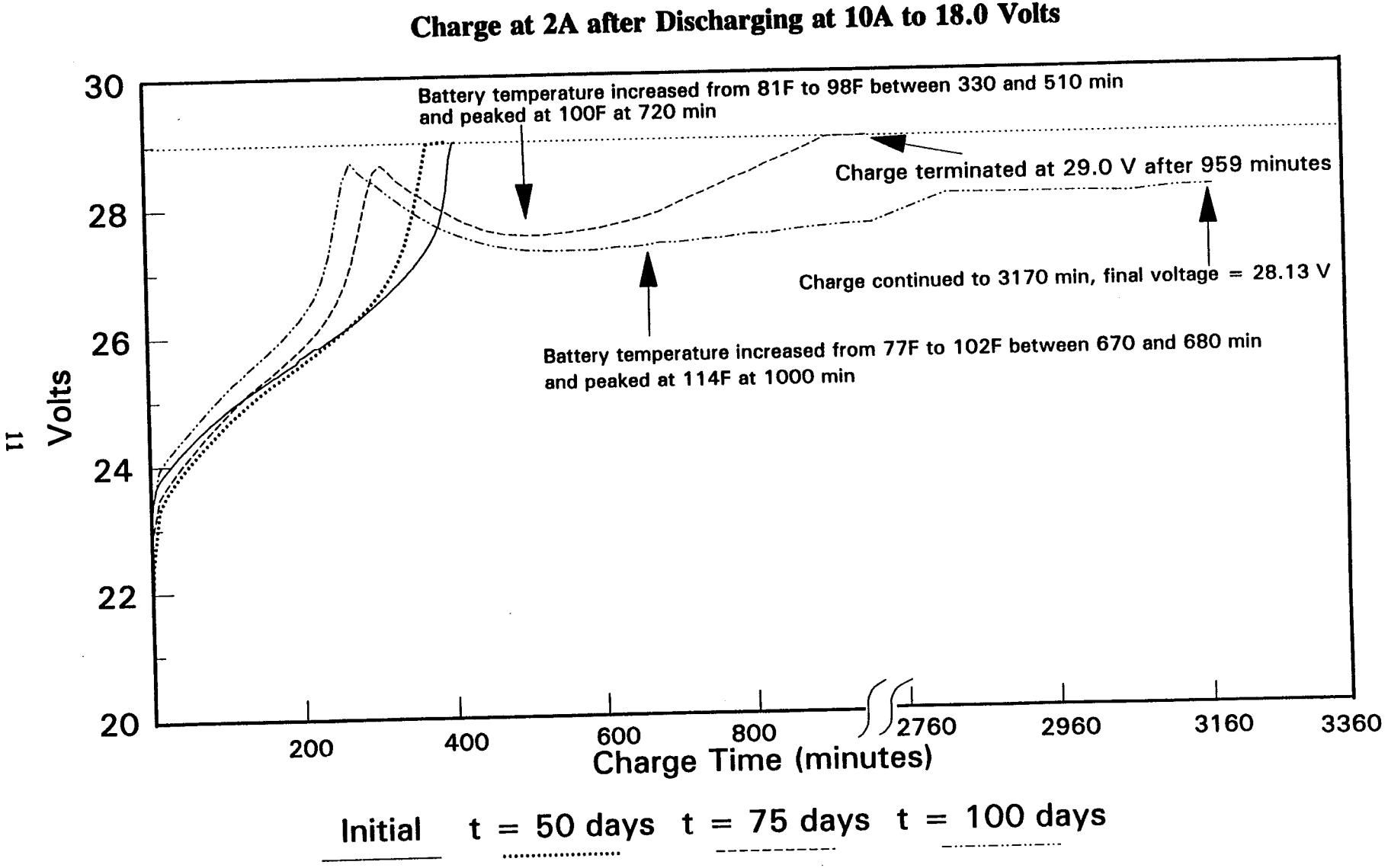



**Figure 3. Charge Curves from Float Life Sample Submitted in March 1994**

## 3.5 Technical Documentation

Engineering drawings of the INS battery are provided in Appendix D, along with the Acceptance Test Procedure (ATP). These documents were prepared by Concorde and submitted to Battelle as part of their subcontract effort. The published version of the battery specification sheet, MIL-B-8565/13, is included in Appendix E.

## 3.6 Review Meetings

The Critical Design Review (CDR) was held on 11 January 1993 at Concorde's facility in West Covina, California. A copy of the CDR meeting minutes was included in the Phase II Interim Report.

# 4.0 Conclusions and Recommendations

Qualification of a high reliability, maintenance-free INS battery, manufactured by Concorde Battery Corporation, has been successfully completed. Although an 11-month setback in the Phase II schedule was experienced due to qualification test failures, all battery design deficiencies have now been corrected. The DOD-B-8565/INS specification sheet developed in Phase I has been published by NSWCC as a standard military specification, MIL-B-8565/13. The Concorde INS battery is recommended for listing on the Qualified Products List (QPL) in accordance with the provisions of this specification.

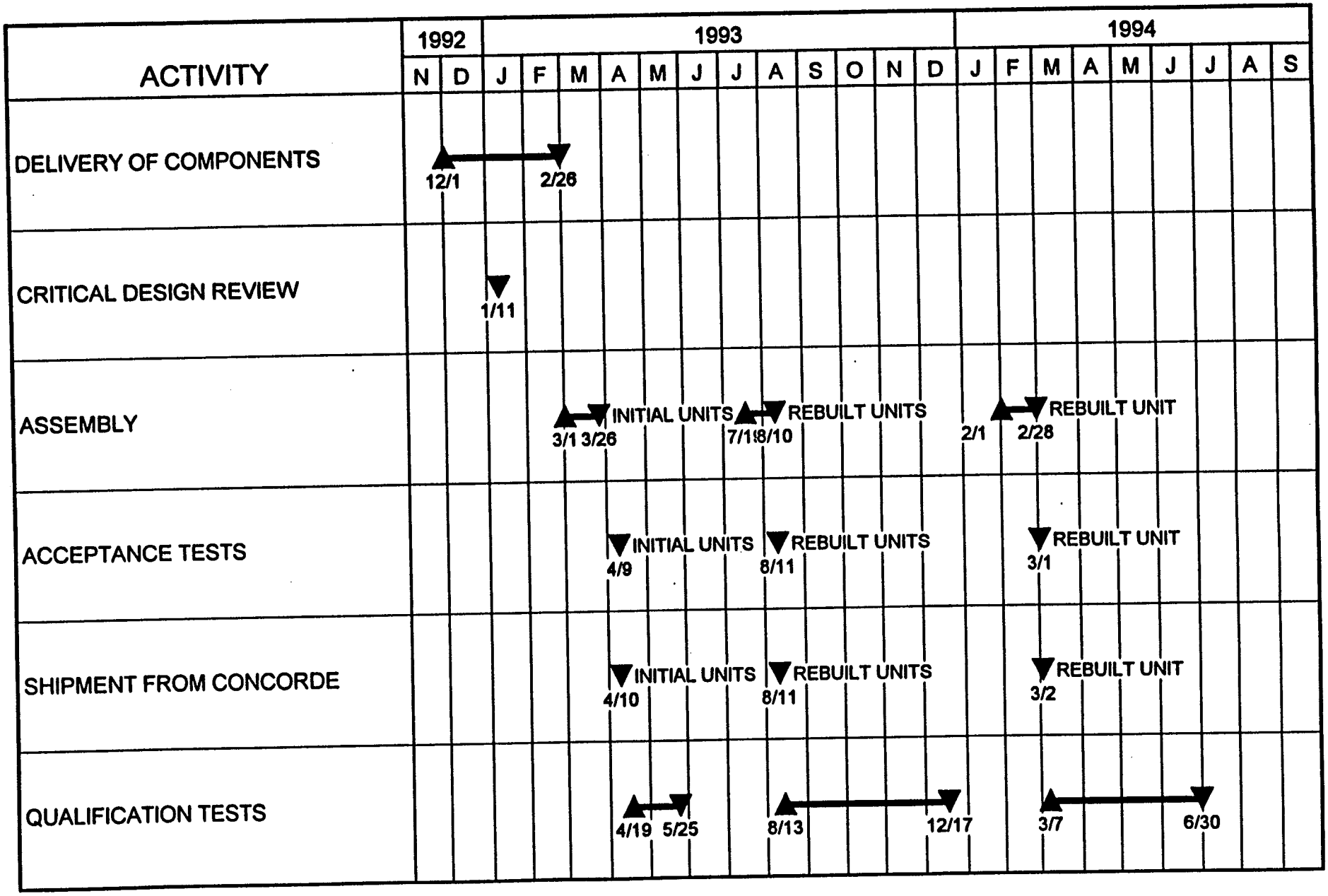
# APPENDIX A

# PROGRAM SCHEDULE
# PROJECT PLANNING CHART

# INS BATTERY DEVELOPMENT SCHEDULE - PHASE II

## (CDRL A001)

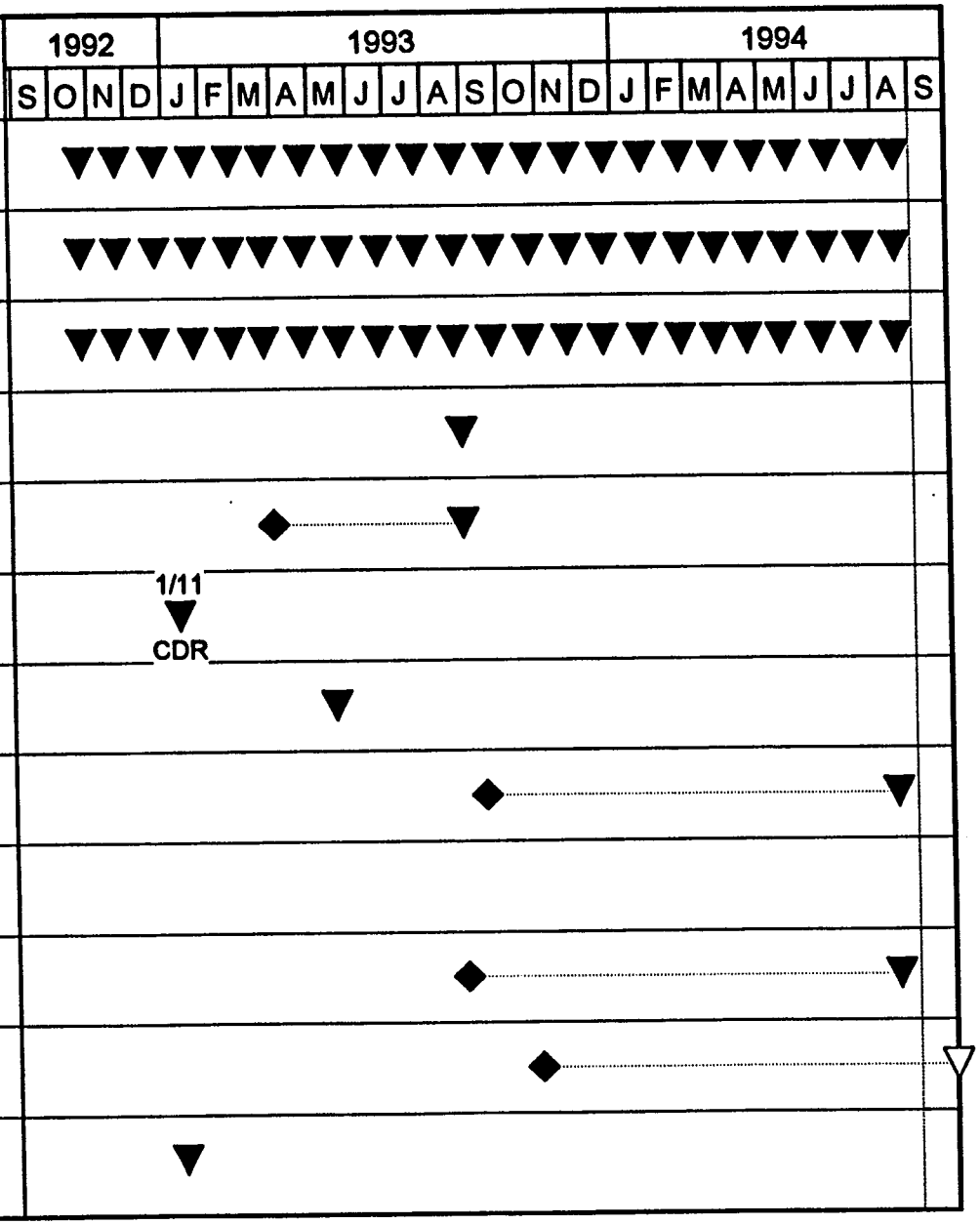
8/31/1994



# PROJECT PLANNING CHART
## (CDRL A003)

8/31/1994

| CDRL NO. | DESCRIPTION | DUE DATE |
|---|---|---|
| A001 | STATUS REPORT | MONTHLY |
| A002 | PERFORMANCE & COST RPT | MONTHLY |
| A003 | PROJECT PLANNING CHART | MONTHLY (W/ A001) |
| A004 | ENGINEERING DRAWINGS | SAME AS A010 |
| A005 | INTERIM REPORT | 7 MAC (ORIGINAL)<br>12 MAC (REVISED) |
| A006 | PRESENTATION MATERIAL | AS REQUIRED |
| A007 | TEST PLANS/PROCEDURES | 30 D BEFORE TESTS |
| A008 | TEST REPORT | 30 D AFTER TESTS |
| A009 | INFORMAL TECHNICAL INFO | AS REQ (W/A001) |
| A010 | DRAFT FINAL REPORT | 12 MAC (ORIGINAL)<br>22 MAC (REVISED) |
| A010 | REPRODUCIBLE FINAL RPT | 14 MAC (ORIGINAL)<br>24 MAC (REVISED) |
| A011 | INFORMAL TECHNICAL DATA | AS REQUIRED |



# APPENDIX B

# PROCUREMENT SPECIFICATION SHEET
# DOD-B-8565/INS

# PROCUREMENT SPECIFICATION SHEET

## BATTERY, STORAGE, AIRCRAFT, MEDIUM-RATE, TYPE 1, MAINTENANCE-FREE, 24-VOLT, 10 AMPERE-HOUR

The complete requirements for acquiring the storage battery described herein shall consist of this document and the latest issue of Specification MIL-B-8565.

Prepared by:

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APPROVED:

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D. G. Vutetakis, Battelle Program Manager

TOTAL PAGE COUNT = 7 PLUS THIS TITLE PAGE

**REQUIREMENTS:**

1. The dimensions of the battery shall be as shown on Figure 1.

2. The part number of the battery shall be D8565/INS. (Note: This part number is a temporary designation and is subject to change once the specification sheet number has been assigned.)

3. The rated capacity of the battery shall be 10 ampere-hours (10.0 AH/1 HR/21°C/18.0 V at end of life). 1C = 10.0 amperes.

4. The weight of the battery shall not exceed 14.07 kilograms (31.0 pounds).

5. The battery shall conform to military specification MIL-B-8565 for Type 1 batteries, except as modified by the following:

3.5.2.1 Type 1 battery. Add the following sentence: "The battery container shall meet the requirements of ARINC Specification 404 for a 1/2 ATR short case size, except as modified herein."

3.5.4 Venting. Replace entire paragraph with the following: "The battery case shall contain one or more holes for venting of gases, as depicted on Figure 1. If the hole size exceeds 6.5 millimeters, they shall be covered by a plastic or wire screen to prevent debris from entering the battery. The cells shall be equipped with a resealable venting mechanism to prevent excessive internal pressure build-up. When the battery is operating within the requirements of this specification, cell venting shall not cause entrained electrolyte to be discharged from the battery."

3.5.5 Receptacles. Add the following: "The receptacle for the battery's positive and negative connections shall be a Cannon part number DPXB-8-34P-0101-A152, or equivalent. The receptacle shall be located as shown in Figure 1 and wiring connections shall conform to Figure 2."

Add the following paragraphs:

3.5.13 Latching Handles. The battery shall be equipped with two lever latch handles, Camloc part number 61L2-1-2AA, or equivalent. The handles shall be located as shown in Figure 1.

3.5.14 Circuit breaker. The battery shall be equipped with a 20 ampere thermal overload (trip-free) circuit breaker, Type MS3320-20. The circuit breaker shall be located as shown in Figure 1 and wiring connections shall conform to Figure 2. The circuit breaker may be mounted to a suitable housing extending from the face of the battery case, provided that the total extension (housing plus circuit breaker) does not exceed 63.5 millimeters when the circuit breaker is tripped, and provided that the housing does not interfere with the operation of the latches.

3.6.3.2.1 Polarity marking. Replace with the following: "The container shall be conspicuously and durably marked with "+" and "-" in white as shown in Figure 1. The connector reference designation "P1" shall be located as shown on Figure 1, with white marking no less than 3 mm high. In addition, the schematic diagram of Figure 2 shall be placed on Label No. 3 and located as shown on Figure 1."

3.6.3.2.3 Battery caution marking (Type 1 battery only). Replace the marking for Label 2 with that shown below (0.25 inch lettering height minimum):

MAINTENANCE-FREE BATTERY

DO NOT REMOVE COVER

PROCESS THIS BATTERY IN ACCORDANCE WITH
APPROVED PROCEDURES ONLY

SEE NAVAIR 17-15BAD-1
OR T.O. _____**_____

** Leave blank, to be filled-in once this number is assigned.

3.6.7 Vent tubes. Delete.

3.6.8 Capacity and electrical performance. Replace the requirements listed in Table II with those specified below:

| Requirement No. | Discharge Cutoff Voltage and Temp. | Rate of Discharge | Minimum Time to Cutoff Voltage |
|---|---|---|---|
| (1) | 18.0 V at 24 ± 3°C | 1.0C | 60 minutes |
| (2) | 18.0 V at 49 ± 2°C | 1.0C | 66 minutes |
| (3) | 21.0 V at -18 ± 2°C | 400 watts 1/ | 20 minutes |
| (4) | 21.0 V at 5 ± 2°C | 400 watts 1/ | 30 minutes |
| (5) | 21.0 V at -40 ± 2°C | 400 watts | 5 minutes |

1/ During the first minute of discharge, the discharge rate shall be 425 watts. The minimum voltage of 21.0 volts shall apply during the entire discharge period.

3.6.9 Strength of receptacle. Delete.

3.6.10 Life. Replace with the following paragraph: "Batteries delivered under this specification shall be capable of at least 8 years of service life, demonstrated by successfully completing the cycle life test of 4.6.13.1 and the float life test of 4.6.13.4."

Add the following paragraph:

3.6.10.4 Float life. Batteries, when tested in accordance with 4.6.13.4, shall provide no less than rated capacity after 100 days of float charging at a temperature of 65°C and a charging rate of 40 milliamperes.

3.6.11 "Evaluation of Equipment" test. Replace with the following paragraph: "After all environmental tests, the battery shall be subjected to a 400-watt discharge for five (5) minutes as the test for "Evaluation of Equipment". The battery voltage shall be 21.0 volts or greater at the end of the five minutes."

3.6.13 Temperature rise and float. Replace with the following paragraph: "When tested in accordance with 4.6.21, the battery voltage shall be recorded at intervals not to exceed 5 minutes. The battery voltage, during the 8 hours of constant current charge at 2.0 amperes, shall remain above 30.0 volts once 110 percent of the capacity removed during discharge has been returned. The battery shall meet Requirement (1) of Table II following the charge period."

4.5.1.3 Constant potential charge. Delete and add the following paragraph:

4.5.1.3 Charge method. Unless otherwise specified, the battery shall be charged at a constant current rate of 2.0 ± 0.05 amperes until the battery voltage reaches 29.0 ± 0.1 volts, then the charging shall be continued for 2 hours at this same voltage.

4.6.7 Strength of vent tubes. Delete.

4.6.11 Constant voltage discharge (14.0 volts). Delete.

4.6.12 Strength of receptacle. Delete.

4.6.13.1 Cycling test (Type 1 battery). Replace with the following paragraph: "The battery shall be subjected to 85 cycles of discharge and charge. Each cycle shall consist of a 1-hour, 1.0 C-rate discharge, followed immediately by a charge per 4.5.1.3, followed by a 1-hour rest period. The battery shall meet the specified requirements of 3.6.10.1."

Add the following paragraph:

4.6.13.4 Float life. The battery shall be charged at 40 milliamperes at 65 ± 2°C for a period of 100 days. At the end of this time period, the battery shall be stabilized at room temperature and discharged per 4.6.10. The battery shall comply with the requirements of 3.6.10.4.

4.6.15 Charge and discharge test at low temperature. Replace steps (a) through (d) with the following steps:

a. Charge the battery in accordance with 4.5.1.3 at 24 ± 5°C.

b. Stabilize the battery -18°C, then discharge at 400 watts for 15 minutes.

c. Remove the battery from the chamber and charge for 2.0 hours at 27.0 ± 0.1 volts with the current source limited to 2.0 ± 0.1 amperes.

d. Immediately following charge, discharge the battery at 400 watts to 21.0 volts. The discharge time must equal or exceed 20 minutes.

4.6.16 Discharge while inverted. Replace with the following paragraph: " The battery shall be charged as specified in 4.5.1.3 and 4.5.1.1. The battery then shall be discharged at 400 watts for five (5) minutes. During the first 2.5 minutes of discharge, the battery shall be placed in the inverted position. The battery shall meet the requirements of 3.5.8 and the battery voltage shall remain above 21.0 volts during the entire discharge period."

4.6.20 Special tests. Add the following paragraph:

4.6.20.1 Battery output performance. The battery shall be discharged in accordance with Requirements (3), (4) and (5) of Table II. Prior to each discharge, the battery shall be charged in accordance with 4.5.1.3 and 4.5.1.1, then stabilized at the applicable test temperature.

4.6.21 Temperature rise and float test. Replace with the following paragraph: "The battery shall be charged in accordance with 4.5.1.3 and then placed in a temperature chamber at 49 ± 2°C for 12 hours. At this temperature, the battery shall be discharged at 400 watts for 30 minutes. Immediately following this discharge, with the battery still in the chamber at 49°C, a constant current charge of 2.0 ± 0.1 amperes shall be applied for 8 ± 0.1 hours. The battery shall than be stabilized at 24 ± 5°C and discharged per 4.6.10. The battery shall meet the requirements of 3.6.12 and 3.6.13."

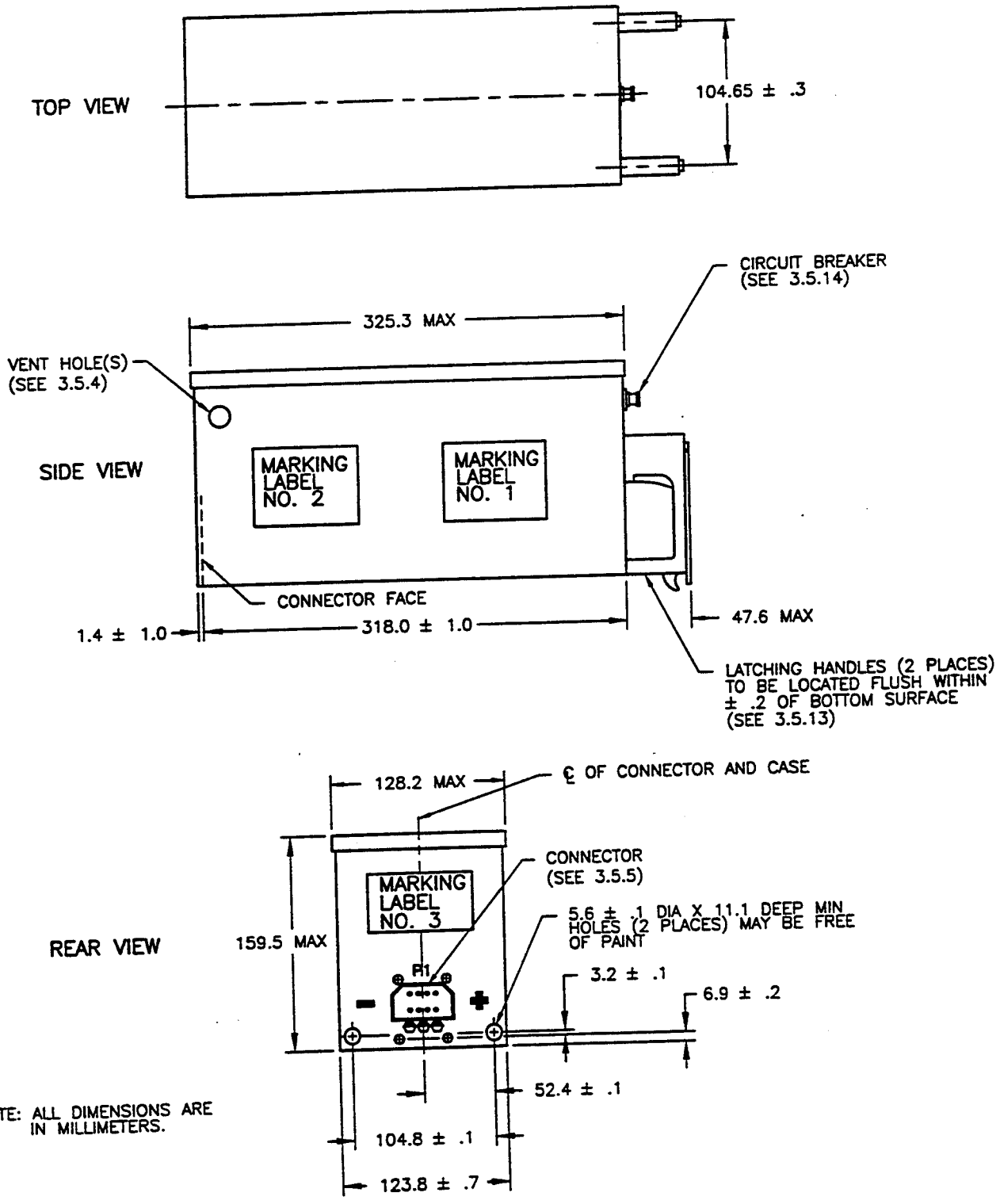


**FIGURE 1. Dimensions.**

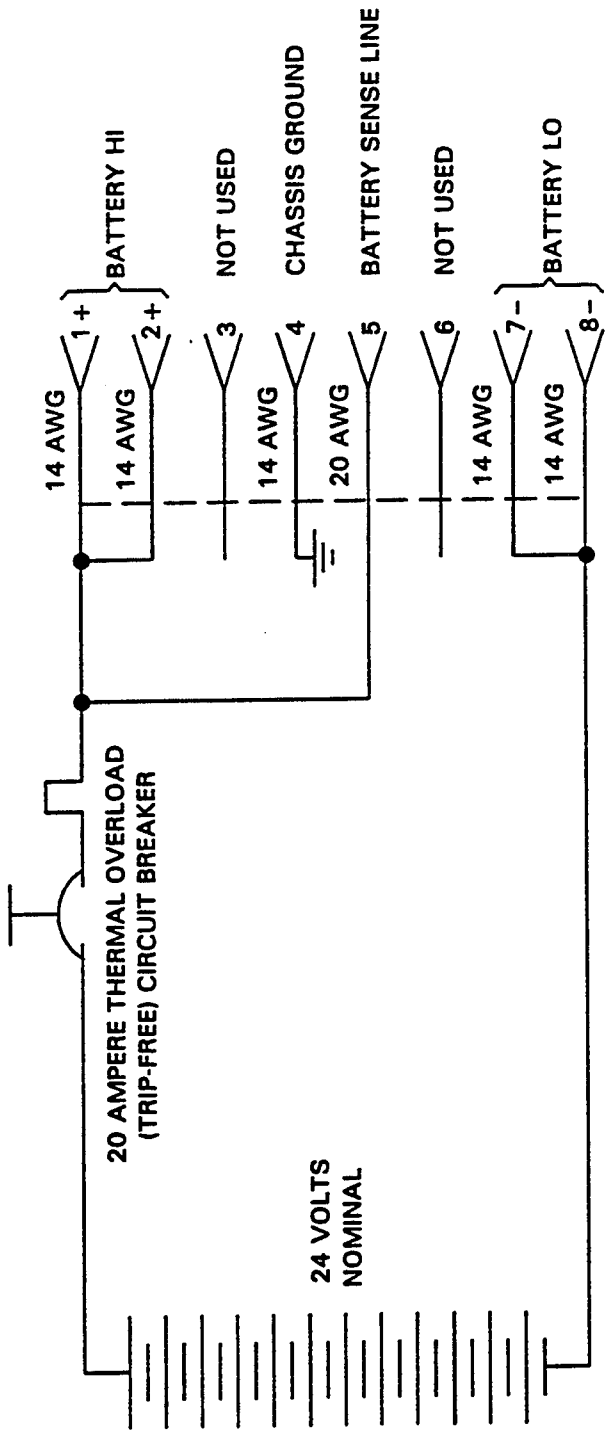


FIGURE 2. Schematic wiring diagram.
(NOTE: Wire sizes are minimum)

TABLE 1. Inspection of batteries and order of test.

| Inspection Number | Inspections | Qualification Inspection | | | Requirements Paragraph | Method of Inspection Paragraph | Quality Conformance Inspection | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Qualification Sample Number | | | | | Group A Tests | Group B Tests | |
| | | 1 | 2 | 3 | | | | 1 | 2 |
| 1 | Visual & Mechnaical Examination | X | X | X | 3.5, 3.6.22 | 4.6.3 | X | X | X |
| 2 | Dimensions & Weight | X | X | X | 3.6.5 | 4.6.4 | X | X | X |
| 3 | Dielectric Strength | X | X | X | 3.6.4 | 4.6.5 | X | X | X |
| 4 | Color and Marking | X | X | X | 3.6.3 | 4.6.8 | X | X | X |
| 5 | Conditioning Charge | X | X | X | 4.5.1.4 | 4.6.9 | | X | X |
| 6 | Capacity Discharge | X | X | X | 3.6.8 | 4.6.10 | X | X | X |
| 7 | Battery Output Performance | X | X | X | 3.6.8 | 4.6.20.1 | | X | X |
| 8 | Capacity Discharge at 49 C | X | | | 3.6.8 | 4.6.14 | | | |
| 9 | Low Temp. Discharge & Charge | X | | | 3.6.8 | 4.6.15 | | X | |
| 10 | Life Cycling | X | | | 3.6.10.1 | 4.6.13.1 | | X | |
| 11 | Float Life | | X | | 3.6.10.4 | 4.6.13.4 | | | X |
| 12 | Ground Storage | | | X | 3.6.15 | 4.6.26 | | | |
| 13 | Discharge While Inverted | | | X | 3.5.8 & 3.6.11 | 4.6.16 | | X | |
| 14 | Altitiude | | | X | 3.6.11 & 3.6.12 | 4.6.17 | | X | |
| 15 | Mechanical Shock | X | | | 3.6.11 & 3.6.12 | 4.6.18 | | | |
| 16 | Temperature Shock | X | | | 3.6.11 & 3.6.12 | 4.6.19 | | X | |
| 17 | Temperature Rise & Float | | | X | 3.6.13 | 4.6.21 | | | X |
| 18 | Battery Gas Emission Test | | | X | 3.6.14 | 4.6.22 | | | |
| 19 | Vibration | | | X | 3.6.16 | 4.6.23 | | X | |
| 20 | Humidity | X | | | 3.6.17 | 4.6.24 | | X | |
| 21 | Salt Fog | X | | | 3.6.18 | 4.6.25 | | X | |
| 22 | Physical Integrity at High Temp. | X | | | 3.6.12 | 4.6.27 | | | |
| 23 | Final Examination | X | X | X | 3.6.4 | 4.6.30 | | X | X |

# APPENDIX C

# QUALIFICATION TEST REPORT
# CONCORDE FAILURE REPORTS

Crane Division
Naval Surface Warfare Center
Crane, Indiana 47522-5001

# Evaluation Test Report on Type D8565/INS, Maintenance-Free, Lead-Acid, Aircraft Battery Manufactured by Concorde Battery Corporation Battelle Procurement Specification DOD-B-8565/INS EDD 94-035

25 July 1994


**This is Technical Data considered to be a resource under 3-200 number 4.b of DOD Regulation Number 5400.7-R and is not a "record" required to be released under the Freedom of Information Act.**

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Crane Division
Naval Surface Warfare Center
Crane, Indiana 47522-5001

Evaluation Test Report
EDD 94-035
25 July 1994

Subj: EVALUATION TEST REPORT ON TYPE D8565/INS, MAINTENANCE-FREE, LEAD-ACID, AIRCRAFT BATTERY MANUFACTURED BY CONCORDE BATTERY CORPORATION; BATTELLE PROCUREMENT SPECIFICATION DOD-B-8565/INS

Ref: (a) Battelle Project Number B-713(02-1)
(b) Battelle Purchase Order Number 53419 Change 2
(c) Military Specification MIL-B-8565J of 1 Jul 87
(d) Battelle Procurement Specification DOD-B-8565/INS of 7 Apr 93

Att: (1) Evaluation Test Summary Sheets, Life Cycling Graphs and Temperature Rise and Float Charge Graph

1. Introduction.

a. As authorized and directed by reference (a), Evaluation testing was performed on four battery type D8565/INS, maintenance-free, sealed lead-acid, aircraft storage batteries.

b. The batteries were manufactured by Concorde Battery Corporation (Concorde), 2009 San Bernardino Road, West Covina, California 91790. The batteries have a manufacturer part number of RG-INS.

c. The purpose of the testing was to evaluate conformance of the Concorde type D8565/INS battery to the requirements of references (c) and (d).

d. Testing performed and results obtained are detailed in later paragraphs of this report.

2. Abstract. Crane Division, Naval Surface Warfare Center (NAVSURFWARCENDIV) originally received five sample D8565/INS batteries for evaluation testing from Concorde. The samples subjected to the Battery Output Performance tests at 0°F and -40°F failed to meet the test requirements. The samples were returned to Concorde for failure analysis. Concorde submitted four new samples for testing after corrective actions were made. These samples met all of the requirements of references (c) and (d) with the exception of the Float Life test. NAVSURFWARCENDIV Crane received a fifth sample for the purpose of conducting the Float Life test at a revised temperature.

3. Summary/Conclusions.

a. Analysis of the test results obtained from the batteries tested indicates the Concorde battery type D8565/INS meets or exceeds all dimensional, mechanical, and electrical requirements of references (c) and (d) with the exception of the Float Life test. This sample failed to meet the requirements of the Float Life test at 100 days. The sample did meet the 1-hour discharge requirements after 75 days in Float Life.

4. Discussion. As previously stated, test results indicate that the Concorde battery type D8565/INS met or exceeded the electrical and mechanical test requirements of those tests conducted under references (c) and (d), with the exception of the Float Life test. The tests conducted and results obtained are contained in the following paragraphs and in attachment (1).

5. Description of Batteries.

a. The type D8565/INS is a 24.0 volt, 10.0 ampere-hour, medium-duty, maintenance-free, sealed lead-acid, aircraft storage battery.

b. The battery contains two 12.0 volt monoblocs connected in series and terminating at a Cannon part number DPXB-8-34P-0101-A152, or equivalent receptacle. Each monobloc is enclosed in a polypropylene container and contains six internally connected cells in a single-row, series configuration with two pressure release valves in each cell. Each cell contains 5 positive plates and 6 negative plates for a total of 11 plates with one layer of Absorbent Glass Material fiberglass separator material and one layer of polyethylene flat sheet separator material between each plate. The cells are constructed of 0.8% lead antimony positive grids and lead calcium negative grids. The cells are of the prismatic or flat-plate design.

c. The electrolyte is a sulfuric acid and water solution and is absorbed within the plates and separators. This battery has no free electrolyte visible in the cells and is often referred to as a "starved electrolyte" system.

d. The battery container meets the requirements of ARINC Specification 404 for 1/2 ATR short case size and is equipped with two lever latch handles, Camloc part number 61L2-1-2AA, or equivalent. The battery is equipped with a 20 ampere thermal overload (trip-free) circuit breaker, type MS3320-20.

e. The samples are acceptably close to color 21158 (Pink) of FED-STD-595a.

f. The batteries were manufactured by Concorde Battery Corporation, 2009 San Bernardino Road, West Covina, California 91790. The manufacturer part number for these batteries is RG-INS.

6. Test Results. The following subparagraphs briefly describe the tests conducted and the results obtained with summary test data in attachment (1). Unless otherwise noted, all identified tests, stated technical requirements and or cited test paragraphs are contained in references (c) and (d).

a. Visual and Mechanical Examination. Each sample was examined to verify that the basic materials, component materials and parts, design and construction, and workmanship were in accordance with all requirements of paragraphs 3.5, 3.6.3, and 3.6.22 and Table VI. The samples conformed to all requirements.

b. Dimensions and Weight.

(1) Each sample was weighed and the dimensions measured in accordance with paragraph 4.6.4.

(2) When subjected to this test, batteries shall meet the dimensional requirements of Figure 1 of reference (d) and batteries shall meet the weight requirements of 31.0 pounds (lbs.) maximum.

(3) Each battery successfully met the specified requirements. The average weight of the batteries was 30.21 lbs. Individual weights are listed in the test summary data sheet of attachment (1).

c. Dielectric Strength.

(1) Each sample was subjected to the Dielectric Strength test as described in paragraph 4.6.5. A potential of 500 ± 10 volts direct current was applied between each battery terminal and the battery container and between either battery terminal and the heater circuit.

(2) When subjected to this test, the insulation resistance between any current carrying parts of the battery and the battery container shall be above 1 megohm when tested for 1 minute.

(3) Each sample successfully met the specified requirements, exhibiting an insulation resistance of greater than 1 megohm.

d. Color and Marking. All samples were examined for conformance to paragraphs 4.6.8 and 3.6.3. Each sample met the specified requirements.

e. Initial Capacity.

(1) Upon receipt, without subsequent charge, each battery was subjected to a 1 x C-rate (10.0 amperes) discharge to a terminal voltage of 18.0 volts (V).

(2) There is no requirement stated for this discharge.

(3) Each battery performed normally during this test, delivering an average of 1 hour and 14 minutes of service. Individual performances are detailed in attachment (1).

f. Conditioning Charge.

(1) Each battery was given an initial charge at 1.0 amperes (A) for a period of 18 hours as specified in paragraph 4.5.1.4.1.

(2) There is no requirement stated for this charge.

(3) Each sample performed normally.

g. Capacity Discharge.

(1) Each battery was subjected to a 10.0 A discharge as specified in paragraph 4.6.10.

(2) When subjected to this test each battery is required to deliver a minimum of 1 hour of service to the 18.0 V cutoff.

(3) Each battery successfully met the specified requirement, delivering an average of 1 hour and 21 minutes of service. Individual performances are detailed in attachment (1).

h. Battery Output Performance.

(1) This test is performed at temperatures of -40°F, 0°F and 41°F. The fully charged batteries were placed in environmental test chambers at the applicable test temperatures for 20-24 hours. After the 20-24 hour soak the batteries were then discharged at a 400 watts (W) for a period of 5 minutes at -40°F, 20 minutes at 0°F and 30 minutes at 41°F. During the first minute of discharge at 0°F and 41°F, the discharge rate was 425 W.

(2) When subjected to this test, batteries must maintain a terminal voltage of 21.0 V or greater during the constant wattage discharge.

(3) Samples 1, 2, and 3 were subjected to this test at all three temperatures and maintained a terminal voltage of 21.0 V or greater during the constant wattage discharges at all three test temperatures. Individual performances are detailed in attachment (1).

i. Capacity Discharge at 120°F.

(1) Sample 1 was fully charged and then placed in a environmental chamber at 120°F for 20-24 hours. With the battery remaining in the environmental chamber, it was discharged at 10.0 A to a terminal voltage of 18.0 V.

(2) When subjected to this test, batteries shall exhibit a terminal voltage of 18.0 V or greater for a minimum of 1.1 hours when discharged at 10.0 A.

(3) Sample 1 successfully met the specified requirements, delivering 1.37 hours of service when discharged at 10.0 A to 18.0 V at the 120°F test temperature.

j. Charge and Discharge at Low Temperature.

(1) Sample 1 was charged per paragraph 4.5.1.3 of reference (d) at ambient and then placed in an environmental chamber set at 0°F for 20-24 hours. After the soak the battery was discharged at 400 W for 15 minutes. The sample was removed from the environmental chamber, then charged at 27.0 V for 2 hours with current limited to 2 A. Immediately following the charge, the sample was discharged at 400 W to 21.0 V.

(2) When subjected to this test, batteries shall maintain a terminal voltage of 21.0 V or greater for 20 minutes or more.

(3) Sample 1 successfully met the requirements at 0°F delivering 30.32 minutes when discharged at 400 W to 21.0 V following the 2 hour charge.

k. Life Cycling.

(1) Sample 1 was subjected to the life cycling test as specified in paragraph 4.6.13. Each cycle consisted of a 1-hour discharge at 10.0 A, followed immediately by a charge per

paragraph 4.5.1.3 of reference (d), followed by a 1-hour rest period. The charge consisted of a constant current charge of 2.0 ± 0.05 A until the battery voltage reached 29.0 ± 0.1 V, followed by a constant potential charge at 29.0 V for 2 hours.

(2) When subjected to this test, batteries shall successfully deliver 85 discharge/charge cycles. A successful cycle is the completion of a discharge during which the terminal voltage is above the 18.0 V minimum throughout the 1-hour discharge period.

(3) Sample 1 successfully met the specified requirements, delivering 85 cycles. Life cycle data for sample 1 is presented in the form of a line graph in attachment (1).

l. Float Life.

(1) Sample 2 was subjected to this test as specified in paragraph 4.6.13.4 of reference (d). The battery was placed in an environmental chamber set at 149°F and charged at 40 milliamperes for a period of 100 days. The battery was then removed from the test chamber and allowed to return to room ambient conditions. Sample 2 was discharged at 10.0 A to a cutoff voltage of 18.0 V.

(2) When subjected to this test, batteries shall successfully deliver 100 percent of the rated capacity after being charged at 40 milliamperes for 100 days at a test temperature of 149°F.

(3) Sample 2 failed to deliver the required 1 hour when discharged at 10.0 A after being subjected to this test.

(4) After consultation with Battelle's Program Manager, a revised Float Life Test was decided on and a new test sample was delivered by Concorde to NAVSURFWARCENDIV Crane for further evaluation. The test was rerun on the replacement sample at a revised test temperature of 122°F.

(5) Sample 5 was subjected to this test as specified in paragraph 4.6.13.4 of reference (d). The battery was placed in an environmental chamber set at 122°F and charged at 40 milliamperes for a period of 100 days. The battery was removed from the test chamber and allowed to return to room ambient conditions at 50 days, 75 days and 100 days. Sample 5 was discharged at 10.0 A to a cutoff voltage of 18.0 V, recharged as specified in paragraph 4.5.1.3 and returned to the environmental chamber to continue the test.

(6) When subjected to this test, batteries shall successfully deliver 100 percent of the rated capacity after being charged at 40 milliamperes for 100 days at a test temperature of 122°F.

(7) Sample 5 met the requirements of the revised test paragraph at 50 days, delivering 1 hour and 17 minutes, and at 75 days, delivering 1 hour, but failed to deliver the required 1 hour when discharged at 10.0 A after 100 days. The battery delivered 52.5 minutes of service when discharged at 10.0 A after 100 days at a test temperature of 122°F.

m. Ground Storage.

(1) Sample 3 was subjected to this test as specified in paragraph 4.6.26. The fully charged battery was placed on open-circuit in an environmental chamber at 122°F for 30 days. Following the 30-day stand, the battery was removed from the chamber and allowed to stand open-circuit for 8 hours. The battery was then discharged at 10.0 A to 18.0 V.

(2) When subjected to this test, the battery must maintain a sufficient state of charge to successfully deliver 50 percent of the rated capacity (5 ampere hours/30 minutes).

(3) The ground storage test was repeated on Sample 3 at a test temperature of -15°F.

(4) The battery successfully met the requirements after being stored for 30 days at test temperatures of 122°F and -15°F, delivering 6.08 ampere hours (36.5 minutes) after being stored at 122°F and 9.08 ampere hours (54.5 minutes) after being stored at -15°F.

n. Discharge While Inverted.

(1) Sample 3 was fully charged and then discharged at the 400 W for 5 minutes, during which the battery was inverted for the first 2.5 minutes.

(2) When subjected to this test, batteries shall meet the specified requirements of paragraph 3.5.8. When discharged at 400 W, batteries shall maintain a terminal voltage of 21.0 V or greater and shall not exhibit any electrolyte loss.

(3) Sample 3 successfully met the specified requirements, exhibiting no loss of electrolyte and having an end of discharge voltage of 22.76 V.

o. Altitude.

(1) Sample 3 was subjected to the Altitude test as specified in paragraph 4.6.17. The fully charged battery was placed in a environmental chamber and within a period of 15 minutes, was lowered in pressure to simulate the ambient conditions at 60,000 feet. The battery was inverted for 2 minutes while chamber air pressure was being reduced, returned to its upright position, and then discharged at 400 W for 5 minutes. The battery was then charged per paragraph 4.5.1.3 for 2 hours. The battery was inverted for 5 minutes during the 2-hour charge and then returned to its normal upright position. While on open circuit, the battery was inverted for 2 minutes while the chamber air pressure was being increased to ground ambient and then returned to its normal upright position. The battery was then discharged at 400 W for 5 minutes at ambient. The battery was returned to 60,000 feet and charged for 2 hours, during which the battery was inverted for 5 minutes and then returned to its normal upright position. The battery was returned to ground ambient air pressure and discharged for 5 minutes at 400 W.

(2) When subjected to this test, batteries are required to perform satisfactorily both physically and electrically. Physically, batteries must not exhibit any electrolyte loss, physical damage or distortion. Electrically, batteries must maintain a terminal voltage of 21.0 V or greater during the 5 minute discharges at 400 W.

(3) Sample 3 successfully met the specified requirements, exhibiting 22.81 V, 22.26 V and 21.83 volts when discharged at 400 W for 5 minutes.

p. Mechanical Shock.

(1) Sample 1 was subjected to the Mechanical shock test as specified in paragraph 4.6.18. The fully charged battery was subjected to 15 impacts, 3 in each direction of each orthogonal axis, except that which would place the battery upside down. The shock pulse was per Figure 516.2-1 of MIL-STD-810 using amplitude (a) and time duration (c). The battery was discharged at 5.0 amperes during the test and checked after each axis for any failure. No resilient mounting was provided. After completion of test, the battery was discharged at 400 W for 5 minutes.

(2) When subjected to this test, batteries shall not exhibit any environmental defects and shall exhibit a terminal voltage of 21.0 V or greater during the 400 W discharge for 5 minutes.

(3) Sample 1 successfully met the specified requirements, exhibiting a terminal voltage of 23.58 V after a discharge at 400 W for 5 minutes and no environmental defects were detected.

q. Temperature Shock.

(1) Sample 1 was subjected to the Temperature Shock test as specified per paragraph 4.6.19. The fully charged battery was subjected to the Thermal Shock test of Procedure I, Method 503.1 of MIL-STD-810, except the exposure time for each temperature was 4 hours. After the Thermal Shock test the sample was stabilized at room ambient and then discharged at 400 W for 5 minutes.

(2) When subjected to this test, batteries shall not exhibit any environmental defects and shall exhibit a terminal voltage of 21.0 V or greater during the 400 W discharge for 5 minutes.

(3) Sample 1 successfully met the specified requirements, exhibiting a terminal voltage of 23.40 V after a discharge at 400 W for 5 minutes and no environmental defects were detected.

r. Temperature Rise and Float.

(1) Sample 3 was subjected to the Temperature Rise and Float test per paragraph 4.6.21 of reference (d). The fully charged battery was placed in a environmental chamber and maintained at 120°F for 12 hours. While at the test temperature the battery was discharged at 400 W for 30 minutes. Immediately following the discharge, with the battery still in the chamber at 120°F, a constant current charge of 2.0 A was applied for 8 hours. The battery was then stabilized at ambient and discharged at 10.0 A to 18.0 V.

(2) When subjected to this test, batteries shall meet the specified requirements of paragraphs 3.6.12 and 3.6.13. Batteries shall not exhibit any radical current or voltage fluctuations and no physical damage during the test. During the 8 hours of charge the battery voltage must remain above 30.0 V once 110 percent recharge has been returned and batteries must deliver a minimum of 1 hour of service when discharged at 10.0 A to a terminal voltage of 18.0 V.

(3) Sample 3 exhibited no current or voltage fluctuations and no physical damage during the test. Sample 3 had a voltage of 29.35 V when 110 percent recharge was reached at 4 hours and 45 minutes into charge, 30.04 V when 117 percent recharge was reached at 5 hours and 5 minutes into charge and maintained a voltage above 30.0 V for the remainder of the 8 hours of charge. Sample 3 delivered 1 hour and 21 minutes of service. It is considered that the failure of sample 3 to reach 30.0 V at 110 percent recharge will not affect the performance of the battery in the aircraft since battery voltage continued to increase to 30.8 V at the end of 8 hours. The intent of the test was met.

s. Battery Gas Emission.

(1) Sample 2 was subjected to the Battery Gas Emission test per paragraph 4.6.22. The fully charged battery was placed in an environmental chamber having an internal volume of 15 ± 1.0 cubic feet and a 0.50 ± 0.025 inch orifice in the chamber wall. The battery was stabilized at 131°F prior to turning off the chamber heaters and coolers with the chamber fan energized. Two 1-cc air samples were randomly withdrawn from the chamber with a gas syringe. The battery was then placed on a constant potential charge of 32.0 volts for 1 hour. At the end of the 1 hour charge, two additional air samples were withdrawn. Each air sample was injected into a Perkin Elmer Sigma 3B gas chromatograph (or equivalent) to detect the percentage of hydrogen. After charge, the battery was then removed from the chamber, allowed to return to ambient conditions and discharged at 400 W for 5 minutes.

(2) When subjected to this test the percent of hydrogen concentration shall be less than 3.5 percent at all times and batteries shall maintain a terminal voltage of 21.0 V or greater during the discharge.

(3) Sample 2 successfully met the specified requirements exhibiting a hydrogen concentration of 0.7 percent and exhibiting a terminal voltage of 23.85 V.

t. Vibration.

(1) Sample 4 was subjected to the Vibration test as specified in paragraph 4.6.23 in place of Sample 3 to expedite testing. The battery assembly, including connector and cable, was mounted to the vibration fixture as specified in paragraph 4.5.5. The battery was then subjected to the random vibration test procedure for equipment installed in jet aircraft, Procedure I.A, Method 514.2 of MIL-STD-810. The battery was vibrated along each orthogonal axis in accordance with the Random Vibration Test levels specified in Figure 4 of reference (d) for a period of 21 minutes per axis. The battery was discharged at 10.0 A for 10 minutes prior to the beginning of each axis of vibration and was constant potential charged at 29.0 V with the current limited to 10.0 A during vibration.

(2) When subjected to this test, batteries shall exhibit stable current and voltage during the discharge and charge. The batteries shall not exhibit any physical damage, internally or externally.

(3) Sample 4 successfully met the specified requirements exhibiting no physical damage due to the Vibration test and exhibiting a terminal voltage of 23.66 V when discharged at 400 W for 5 minutes after the completion of the vibration test.

u. Humidity.

(1) Sample 1 was subjected to the Humidity test Procedure III, Method 507.2 of MIL-STD-810. After completion of the test, the battery remained on open circuit until battery temperature returned to room ambient. The battery was then discharged at 400 W for 5 minutes.

(2) When subjected to this test, batteries are required to withstand the effects of humidity testing without any physical damage or electrical degradation. Batteries shall maintain a terminal voltage of 21.0 V or greater during the 400 W discharge for 5 minutes.

(3) Sample 1 successfully met the specified requirements, maintaining a terminal voltage of 23.23 V when discharged at 400 W for 5 minutes. Sample 1 exhibited no physical or electrical damage.

v. Salt Fog.

(1) Sample 1 was subjected to the Salt Fog test, Procedure I, Method 509.1 of MIL-STD-810. After the completion of the test, the battery remained on open circuit until battery temperature returned to room ambient. The battery was then discharged at 400 W for 5 minutes.

(2) Batteries are required to withstand the effects of this test without any physical or electrical damage. Batteries shall maintain a terminal voltage of 21.0 V or greater during the discharge at 400 W for 5 minutes.

(3) Sample 1 successfully met the specified requirements, maintaining a terminal voltage of 23.30 V when discharged at 400 W for 5 minutes.

w. Physical Integrity at High Temperature.

(1) Sample 1 was subjected to the Physical Integrity test as specified in paragraph 4.6.27. The fully charged battery was placed in a temperature chamber set at 185°F for a period of 16 hours. Following the 16-hour soak the battery was removed from the chamber and lifted by its vent tubes. The battery was allowed to stabilize at room ambient and then discharged at 400 W for 5 minutes.

(2) When subjected to this test, batteries shall exhibit no physical defects and maintain a terminal voltage of 21.0 V or greater during the 400 W discharge for 5 minutes.

(3) Sample 1 successfully met the specified requirements, exhibiting no physical defects and maintaining a terminal voltage of 23.05 V.

x. Final Examination.

(1) Each battery was examined to determine that no damage, detectable without dissection, had been done by any of the tests conducted. Additionally, each battery was subjected to the Dielectric Strength test.

(2) Each battery shall exhibit no damage due to the tests performed and must exhibit insulation resistance of 1 megohm or greater when subjected to the Dielectric Strength test.

(3) Each sample successfully met the requirements of paragraph 4.6.30, exhibiting no damage and having an insulation resistance greater than 1 megohm.

Summary Sheet for D8565/INS
Evaluation Tests

| Test | Sample | 1R | 2R | 3R | 4R |
|---|---|---|---|---|---|
| 1. Visual & Mechanical Inspection | All | OK | OK | OK | OK |
| 2. Dimensions | All | OK | OK | OK | OK |
| 3. Internal Resistance | All | 38.0 mΩ | 32.0 mΩ | 32.0 mΩ | 26.0 mΩ |
| 4. Dielectric Strength | All | OK | OK | OK | OK |
| 5. Color & Marking | All | OK | OK | OK | OK |
| 6. Weight | All | 30.14 lbs. | 30.17 lbs. | 30.11 lbs. | 30.09 lbs. |
| 7. Initial Capacity | All | 1:16:30 | 1:14:30 | 1:16:16 | 1:07:17 |
| 8. Conditioning Charge | All | OK | OK | OK | OK |
| 9. Capacity Discharge | All | 1:19:49 | 1:18:30 | 1:19:17 | 1:19:01 |
| 10. Battery Output Performance @ 0°F | All | 21.83 V | 21.77 V | 21.84 V | N/A |
| 11. Battery Output Performance @ 41°F | All | 22.03 V | 21.77 V | 22.04 V | N/A |
| 12. Battery Output Performance @ -40°F | All | 21.21 V | 21.15 V | 21.17 V | N/A |
| 13. Capacity Discharge @ 120°F | 1 | 1:22:01 | N/A | N/A | N/A |
| 14. Charge & Discharge @ Low Temperature | 1 | 0:30:19 | N/A | N/A | N/A |
| 15. Life Cycling | 1 | 85 cycles 22.65 V | N/A | N/A | N/A |
| 16. Float Life | 2 | N/A | 0:13:03 | N/A | N/A |
| 17. Ground Storage @ 122°F | 3 | N/A | N/A | 0:36:29 | N/A |
| 18. Ground Storage @ -15°F | 3 | N/A | N/A | 0:54:28 | N/A |
| 19. Discharge while Inverted | 3 | N/A | N/A | 22.76 V | N/A |
| 20. Altitude | 3 | N/A | N/A | 22.81V, 22.26V, 21.83V | N/A |
| 21. Mechanical Shock | 1 | 23.58 V | N/A | N/A | N/A |
| 22. Temperature Shock | 1 | 23.40 V | N/A | N/A | N/A |
| 23. Temperature Rise & Float | 3 | N/A | N/A | 1:20:45 *see test report | N/A |
| 24. Battery Gas Emission | 3 | N/A | N/A | 0.7% 23.85V | N/A |
| 25. Vibration | 3 | N/A | N/A | see 4R | 23.66 V |
| 26. Humidity | 1 | 23.23 V | N/A | N/A | N/A |
| 27. Salt Fog | 1 | 23.30 V | N/A | N/A | N/A |
| 28. Physical Integrity @ 185°F | 1 | 23.05 V | N/A | N/A | N/A |
| 29. Final Examination | All | OK | test not conducted | OK | OK |

Manufacturer Concorde Battery Corporation Date Received 8-13-93
Contract 36537(4404) Date Completed 12-16-93
Type D8565/INS Lot 0893-02 NSN
Sample Number CBQ-INS-1R, 2R, 3R, 4R S/N R11360, R11357, R11358, R11359 Lot Quantity 4

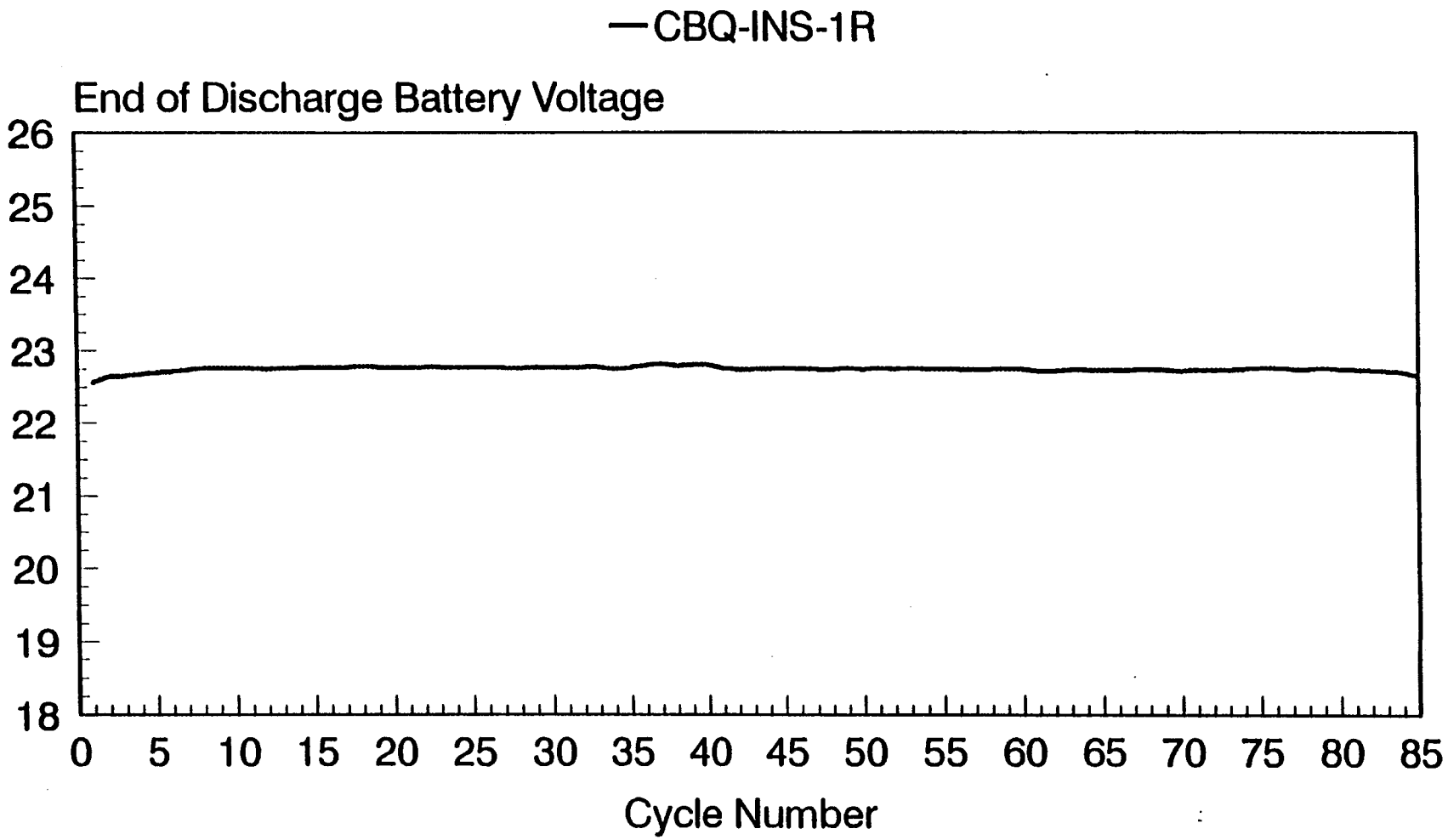
Summary Sheet for D8565/INS
Evaluation Tests

| Test | Sample | | 5R | | |
|---|---|---|---|---|---|
| 1. Visual & Mechanical Inspection | All | | OK | | |
| 2. Dimensions | All | | OK | | |
| 3. Internal Resistance | All | | 27.0 mΩ | | |
| 4. Dielectric Strength | All | | OK | | |
| 5. Color & Marking | All | | OK | | |
| 6. Weight | All | | 30.56 lbs. | | |
| 7. Initial Capacity | All | | 1:14:34 | | |
| 8. Conditioning Charge | All | | OK | | |
| 9. Capacity Discharge | All | | 1:26:01 | | |
| 10. Battery Output Performance @ 0°F | All | | N/A | | |
| 11. Battery Output Performance @ 41°F | All | | N/A | | |
| 12. Battery Output Performance @ -40°F | All | | N/A | | |
| 13. Capacity Discharge @ 120°F | 1 | | N/A | | |
| 14. Charge & Discharge @ Low Temperature | 1 | | N/A | | |
| 15. Life Cycling | 1 | | N/A | | |
| 16. Float Life (50 Days)<br>(75 Days)<br>(100 Days) | 5 | | 1:17:00<br>1:00:30<br>0:52:30 | | |
| 17. Ground Storage @ 122°F | 3 | | N/A | | |
| 18. Ground Storage @ -15°F | 3 | | N/A | | |
| 19. Discharge while Inverted | 3 | | N/A | | |
| 20. Altitude | 3 | | N/A | | |
| 21. Mechanical Shock | 1 | | N/A | | |
| 22. Temperature Shock | 1 | | N/A | | |
| 23. Temperature Rise & Float | 3 | | N/A | | |
| 24. Battery Gas Emission | 3 | | N/A | | |
| 25. Vibration | 3 | | N/A | | |
| 26. Humidity | 1 | | N/A | | |
| 27. Salt Fog | 1 | | N/A | | |
| 28. Physical Integrity @ 185°F | 1 | | N/A | | |
| 29. Final Examination | All | | OK | | |

Manufacturer Concorde Battery Corporation — Date Received 3-2-94
Contract 36537(4404) — Date Completed 6-29-94
Type D8565/INS — Lot 0394-02 — NSN
Sample Number CBQ-INS-5R — S/N R13927 — Lot Quantity 1

# Evaluation Life Cycle Record

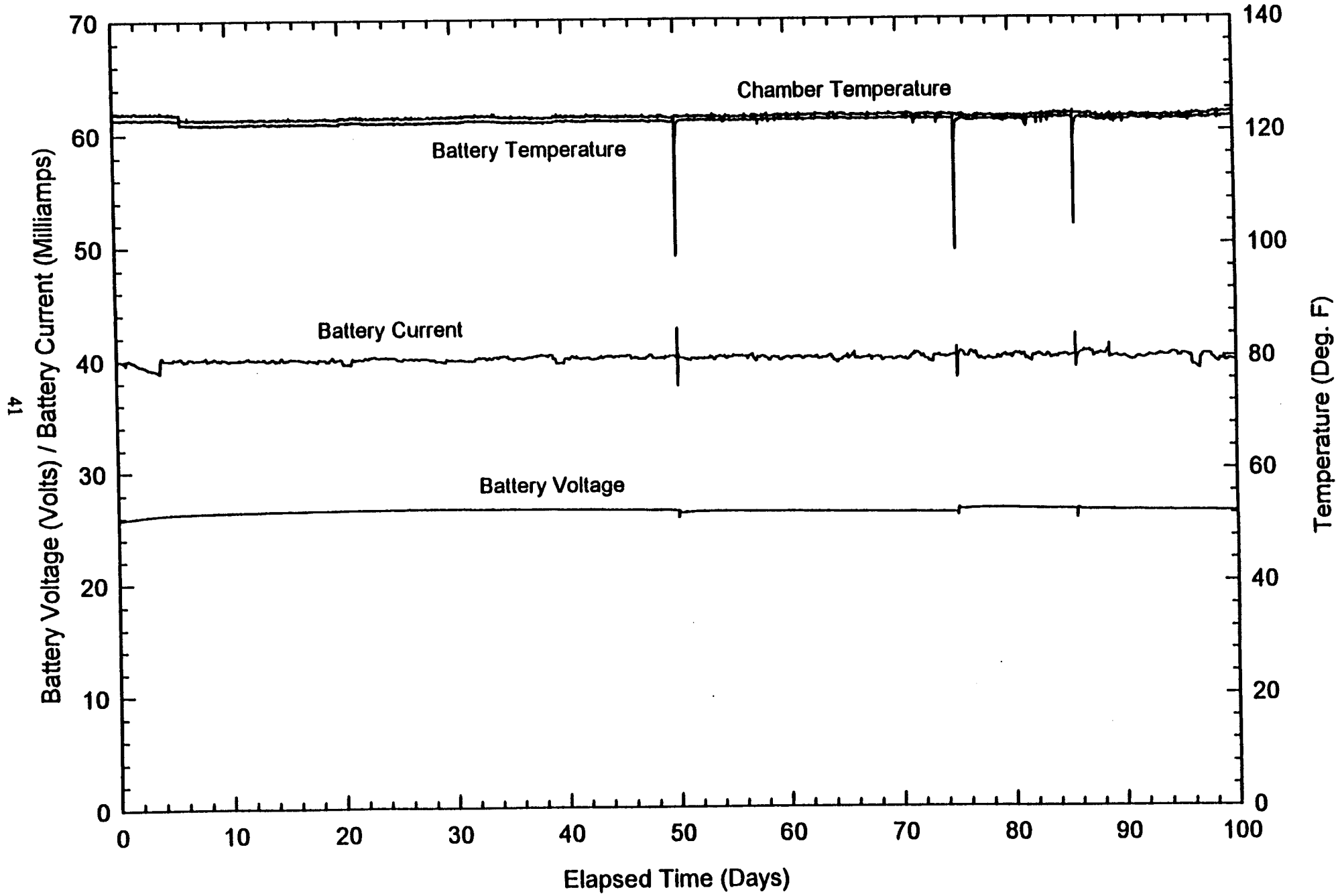
## Concorde Battery Corporation Type D8565/INS



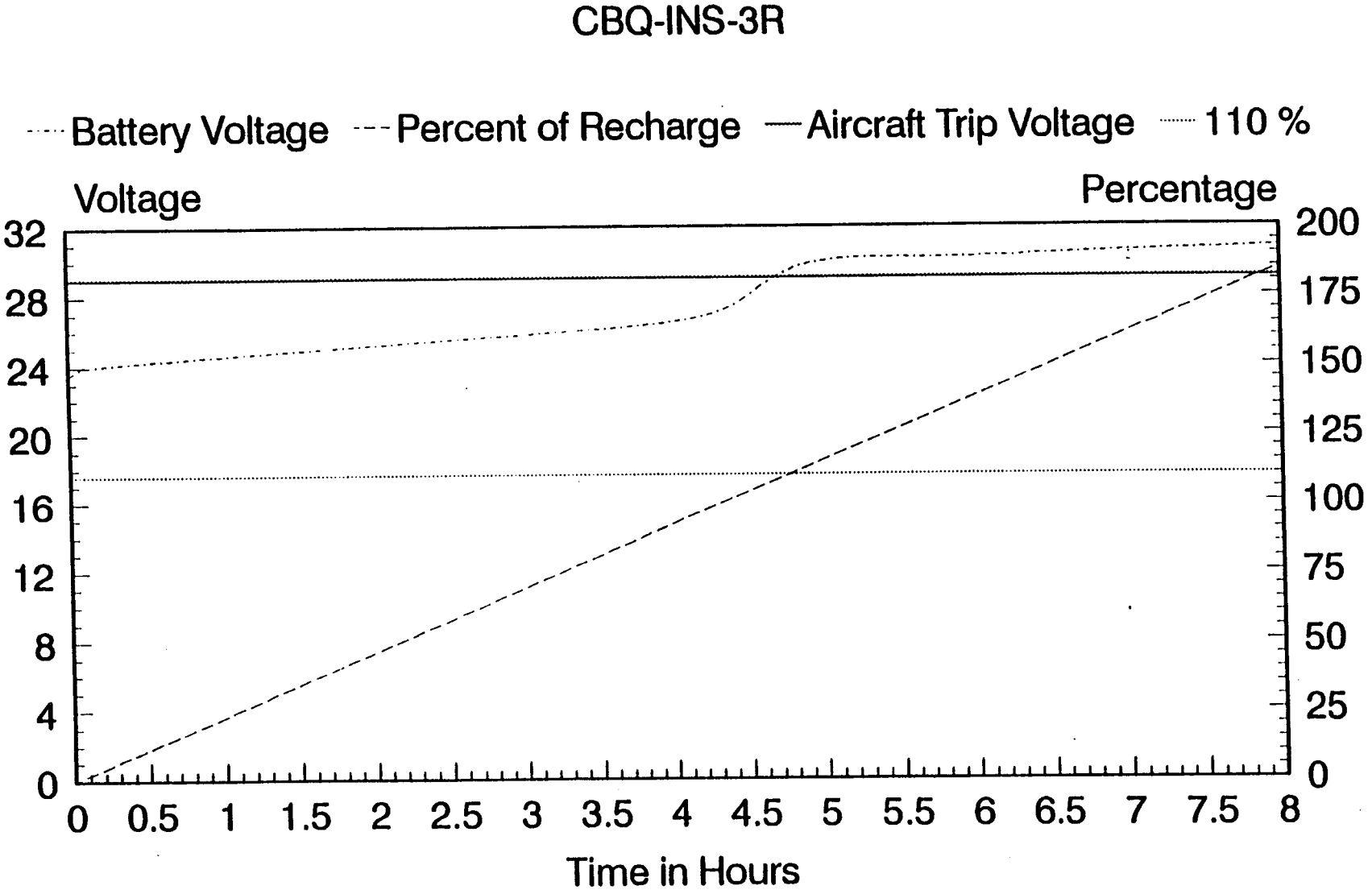
# INS Battery Float Test at 122 Deg. F

Test Started: 10 March 1994

100 Days Completed on 26 June 1994



# Temperature Rise & Float Charge



CONCORDE BATTERY CORPORATION

August 10, 1993

Dr. David Vutetakis
505 King Avenue
Battelle Memorial Institute
Columbus Division
Columbus, Ohio 43201-2693

Re: Failure Analysis Report, INS Batteries, Serial Numbers R-10318, R-10319, R-10321, R-10327.

Of the four batteries received, two were torn down, namely R-10318 and R-10327. R-10318 was representative of the first batch which were overweight and R-10327 was representative of an in-spec weight battery.

R-10318

Battery was recharged at 28.5V to 0.2A and discharged at ambient of 75°F to 18V. Time to 18V was 68 minutes.

The cover was removed and each cell was tapped for measuring voltage. The monoblocs were then discharged at 10A. Individual cell voltages were measured during discharge. Cell #9 dropped faster than the rest of the cells. However, there were another three cells that were lower than anticipated. The discharge was discontinued after about 25 minutes and cell #9 torn down.

Upon teardown, it was determined that the cell had failed due to two distinct causes: 1) Inadequate compression and 2) shorted out.

R-10327

The battery was recharged at 28.5V to 0.2A and cycled an additional 5 times to determine if the battery needed additional cycling. The results of cycling to 18 V are noted below:

| Cycle # | Minutes to 18V |
|---|---|
| 1 | 64 |
| 2 | 65 |
| 3 | 64 |
| 4 | 64 |
| 5 | 66 |

These times are much lower than anticipated.

Each cell was tapped and the monoblocs discharged at 10A. Upon monitoring the individual cell voltages, cell # 8 indicated a much lower voltage than the rest of the cells.

This cell was torndown in the presence of Mr. Alan Goodman of the NSWC on July 8, 1993. It was determined that the cell had shorted out. Additionally, cell #7 was also removed to see the appearance of the plates. The plates were in excellent condition.

Corrective Action

Compression for each cell will be increased to the appropriate value.

Each AGM separator will be encapsulated in polyethylene sheets to eliminate shorts.

If you have any questions please call.

Sincerely,

JMRajpara

Janak M. Rajpara

cc: D. Godber

January 26, 1994

Dr. David G. Vutetakis
Battelle Memorial Institute
Columbus Division
505 King Avenue
Columbus, OH 43201-2693

Re: Failure Analysis of D8565/INS, Serial Number R-11357

Analysis

Open circuit voltage, as received: 24.6V

Battery weight, as received: 29.8 lb.

The battery was charged at a constant potential of 28.25V. However, the charge rate did not drop below 0.7A. Coupled with a weight drop and the fact that the rate of charge did not drop down to the normal 0.2A or less, suggests that the battery could have dried out.

The aluminum cover was removed to reveal the monoblocs. Inspection of the wiring revealed severe corrosion of the stranded wire at the positive terminal, with slightly less corrosion at the other terminals. Additionally, the hot melt used to attach the wiring to the monoblocs appeared charred and the channels around the monoblocs contained residue of acid. Since the hot melt is not reactive with sulfuric acid, the only other explanation of the charring could be the presence of electrical discharge around the wiring.

The wire at the positive terminal was clipped and soldered back to make a good connection and the battery was discharged at 10A to 18V, yielding 42 minutes. Subsequently, the battery was flooded with 1.285 S.G. acid and the discharge repeated. The second discharge yielded 54 minutes. The recharge current finally dropped to 0.2A. The test was repeated, yielding 66 minutes.

One monobloc was removed and a teardown analysis performed. The positive plates had expanded and some had cracked, but the positive active material was firm. The negative plates were in good condition.

Corrective Action

We have developed an alternative design for the posts. However, in order for the test to be successful, the recommendations must be followed.

Conclusion

The test temperature of 150°F is detrimental to the integrity of the battery since the epoxy and the polypropylene become soft. This prolonged high temperature soaking could have lead to acid seepage around the posts and premature drying of the battery. We are not certain that this method of testing correctly evaluates the specified overall life of the battery.

Based on the results of the analysis, the failure of the battery was due to drying out of the cells.

Recommendations

Our recommendations for the float life test are as follows:

i) The test temperature must be reduced to 125°F since the higher temperature adversely affects the integrity of the construction materials and causes the battery to dry out prematurely.

Realistically, the choice of this acceleration factor does not seem appropriate, since:

a) The aircraft does not see such high temperatures.

b) In order to conduct a reasonable analysis of life in a short period, acceleration conditions should be such that they do not introduce abnormal variations within the test envelope.

ii) Based on a meeting we had with the Navy about two years ago, the general consensus was that, in order to have reasonable savings, batteries replacing Ni-Cd's should last four years. In line with this proposal, we believe that the battery should be tested for no more than 50 days at the proposed temperature.

Sincerely,

JMRajpara

Janak M. Rajpara

cc: D. Godber
G. Hollett

September 22, 1994

Dr. David Vutetakis
Battelle Memorial Institute
Columbus Division
505 King Avenue
Columbus, Ohio 43201-2693

Re: Teardown Analysis on one INS battery, serial number R-13927

As received, the battery did not appear damaged.

The battery was charged at a constant potential of 28.3V. It was noted that, during charging, the current did not drop below 1A and the battery was quite warm. Upon an initial discharge at 10A, the battery yielded 9.3 Ah. The battery was subsequently recharged at a CP of 28.3V and each cell was tapped.

The battery was again discharged at 10A to 18V. During the discharge, each cell voltage was monitored. No weak cells were found. The battery yielded 9.4 Ah. At this point, the monoblocs were removed from the external container and one monobloc was cut open. One group was examined. The plates and AGM were dry. No other sign of defect was found. One additional cell was examined in your presence on September 14, 1994, with similar findings.

Since the battery became uniformly warm on charge and in addition to the fact that the current did not drop below 1A during charging, it appeared that the battery was dry. The other monobloc was filled with 1.270 s.g. electrolyte, recharged at CP of 14.1V, rested for about two hours and discharged at 10A. This monobloc yielded 17 Ah. Additionally, the charge rate dropped normally to 0.2A at the end of charge.

The teardown indicates that the monoblocs had dried out during the elevated temperature float test.

Sincerely,

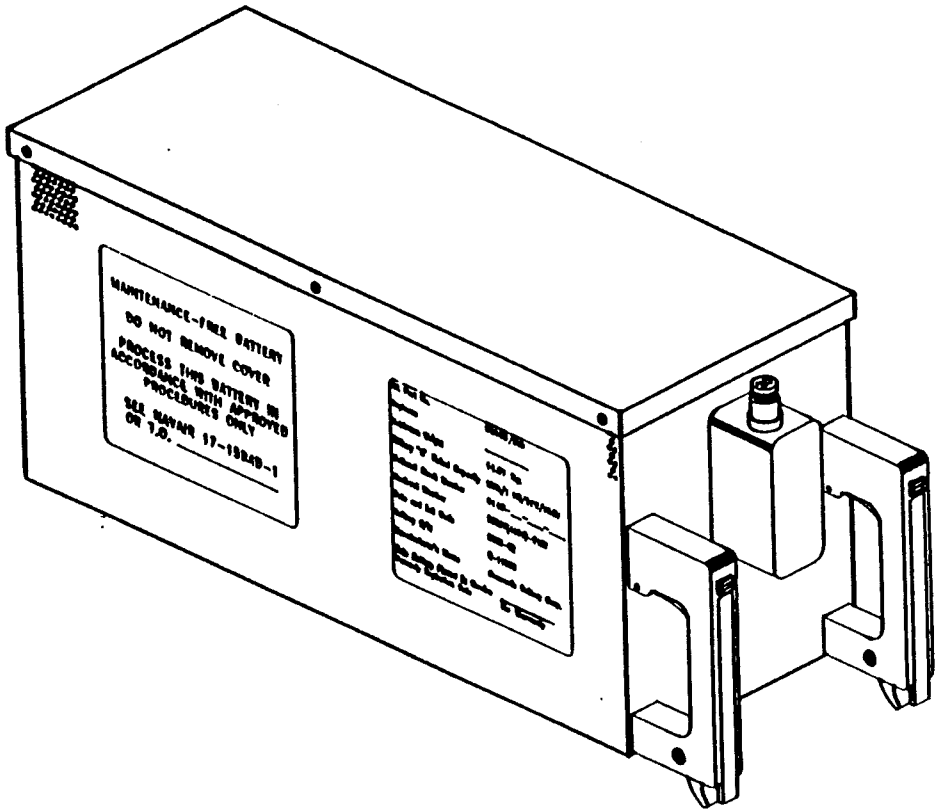
JMRajpara

Janak M. Rajpara

# APPENDIX D

## 3-D DRAWING
## ASSEMBLY DRAWING
## ENVELOPE DRAWING
## ACCEPTANCE TEST PROCEDURE

| REVISIONS | | | |
|---|---|---|---|
| REV | DESCRIPTION | DATE | APPROVED |




| QTY REQD | FSCM NO. | PART OR IDENTIFYING NO. | NOMENCLATURE OR DESCRIPTION | MATERIAL SPECIFICATION | ITEM NO. |
|---|---|---|---|---|---|

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS DECIMALS ANGLES
.XX ±
.XXX ±

TREATMENT

FINISH

SIMILAR TO | ACT WT | CALC WT

CONTRACT NO.

| APPROVALS | DATE |
|---|---|
| DRAWN TORRES J. | 9/3/93 |
| CHECKED JR | 9/3/93 |
| APPROVED | |
| ISSUED | |

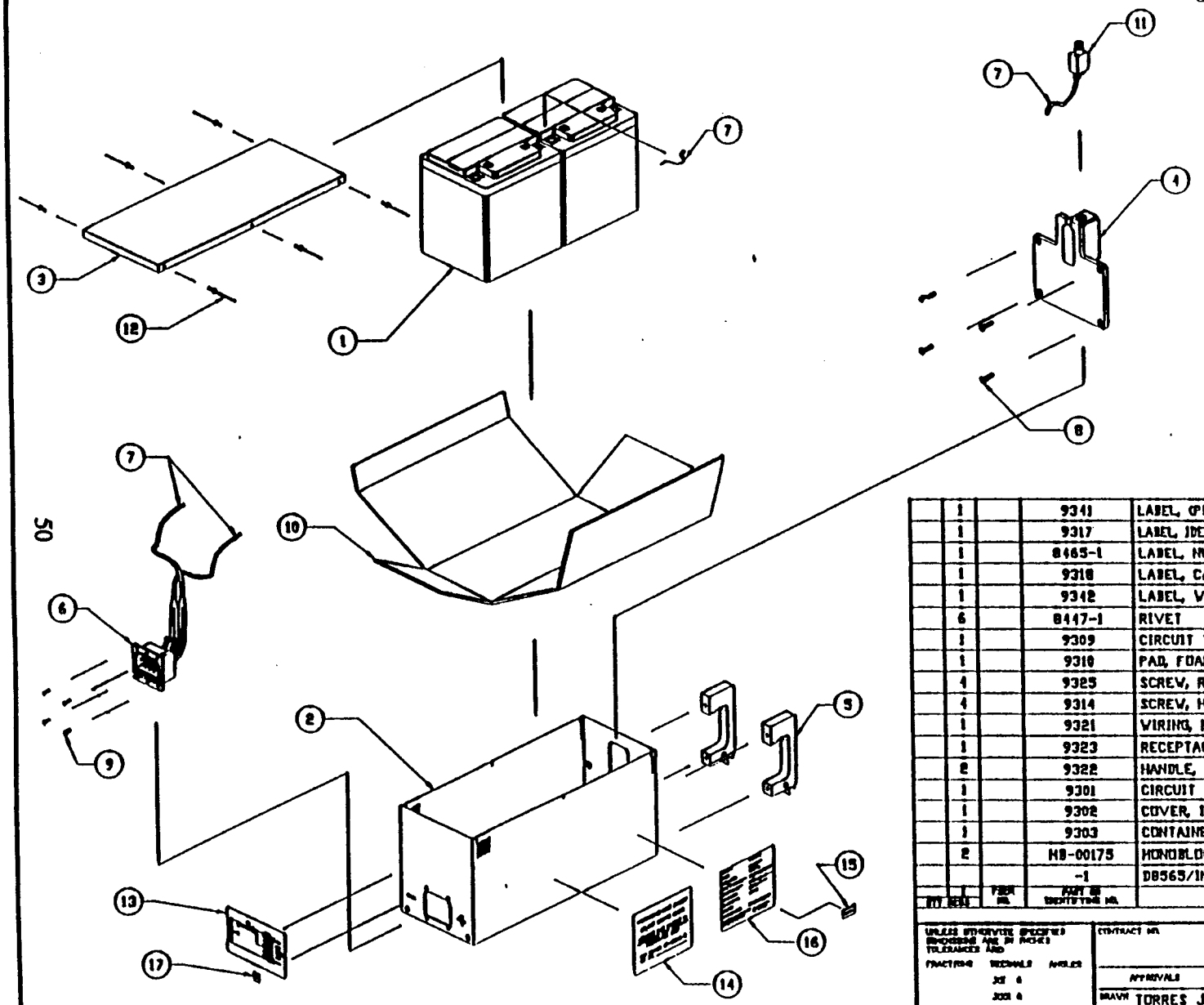
CONCORDE BATTERY CORPORATION
2009 SAN BERNARDINO RD, W. COVINA, CA 91790

TITLE
D8565/INS, BATTERY

| SIZE | FSCM NO. | DWG NO. | REV |
|---|---|---|---|
| A | 63017 | | |

SCALE NONE SHEET 1 OF 1

| REVISIONS | | | |
|---|---|---|---|
| REV | DESCRIPTION | DATE | APPROVED |
| A | PRODUCTION RELEASE | 9/3/93 | |




| | | | | | | |
|---|---|---|---|---|---|---|
| | 1 | | 9341 | LABEL, (PI), CONNECTOR REF. DESIGNATION | | 17 |
| | 1 | | 9317 | LABEL, IDENTIFICATION/VARRANTY (LABEL 81) | | 16 |
| | 1 | | 8465-1 | LABEL, NUMERICAL SEQUENCE, R SERIES | | 15 |
| | 1 | | 9318 | LABEL, CAUTION MARKING (LABEL 82) | | 14 |
| | 1 | | 9342 | LABEL, WIRING SCHEMATIC (LABEL 83) | | 13 |
| | 6 | | 8447-1 | RIVET | | 12 |
| | 1 | | 9309 | CIRCUIT BREAKER | | 11 |
| | 1 | | 9310 | PAD, FOAM | | 10 |
| | 4 | | 9325 | SCREW, RECEPTACLE | | 9 |
| | 4 | | 9314 | SCREW, HANDLES. | | 8 |
| | 1 | | 9321 | WIRING, HARNESS (INS) | | 7 |
| | 1 | | 9323 | RECEPTACLE | | 6 |
| | 2 | | 9322 | HANDLE, LEVER LATCH | | 5 |
| | 1 | | 9301 | CIRCUIT BREAKER HOUSING | | 4 |
| | 1 | | 9302 | COVER, INS, EXTERNAL | | 3 |
| | 1 | | 9303 | CONTAINER, INS, EXTERNAL | | 2 |
| | 2 | | MB-00175 | MONOBLOC ASSEMBLY, RG-12 | | 1 |
| | | | -1 | D8565/INS, BATTERY ASSEMBLY | | |
| QTY REQ | | FIGR NO. | PART OR IDENTIFYING NO. | NOMENCLATURE OR DESCRIPTION | MATERIAL SPECIFICATION | ITEM NO. |

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE FRACTIONS DECIMALS ANGLES .XX ± .XXX ±

CONTRACT NO.

| APPROVALS | DATE |
|---|---|
| DRAWN TORRES J | 9/3/93 |
| CHECKED | |
| APPROVED | |
| ISSUED | |

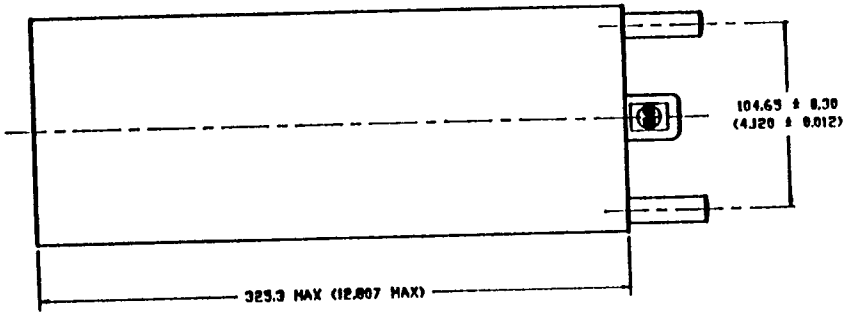
CONCORDE BATTERY CORPORATION
2009 SAN BERNARDINO RD. W. COVINA, CA 91790

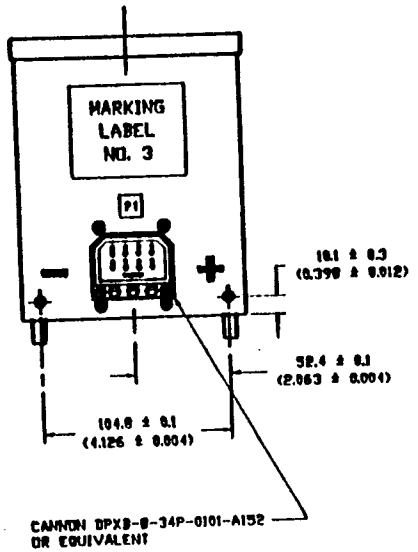
TITLE
D8565/INS, BATTERY ASSEMBLY

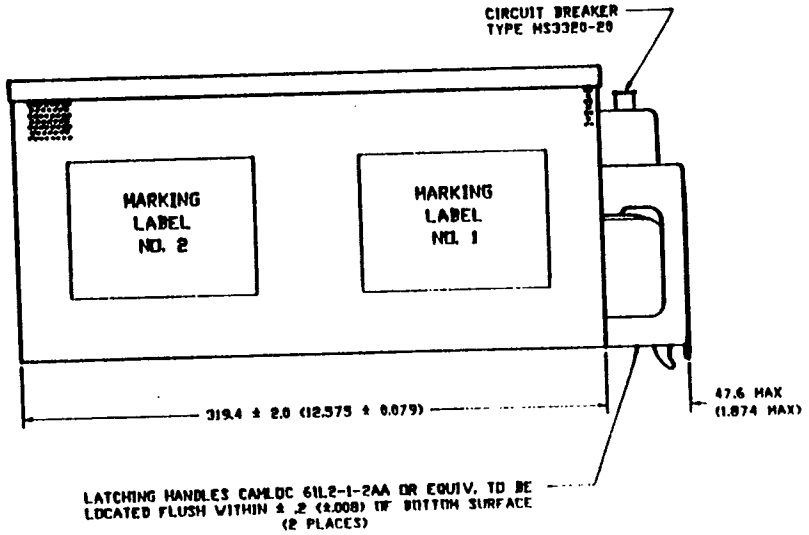
| SIZE | FSCM NO. | TYPE NO. | REV |
|---|---|---|---|
| A | 63017 | CB-00213 | A |

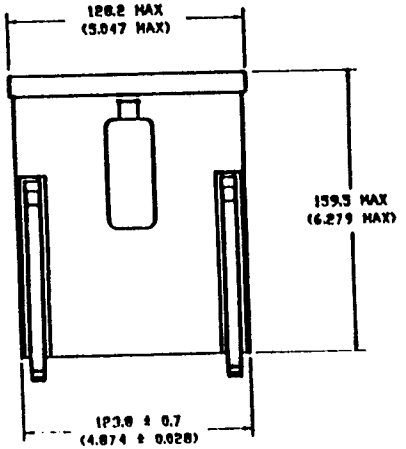
SCALE NONE SHEET 1 OF 1

| REV | DESCRIPTION | DATE | APPROVED |
|---|---|---|---|
| A | PRODUCTION RELEASE | 9/8/93 | |




# ENVELOPE DRAWING

| ITT ITEM | PREV NO. | PART ID IDENTIFYING NO. | NOMENCLATURE OR DESCRIPTION | MATERIAL SPECIFICATION | FINISH NO. |
|---|---|---|---|---|---|
| | | | PARTS LIST | | |

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN ACCORDANCE WITH ANSI Y14.5M-1982
FRACTIONS DECIMALS ANGLES
TREATMENT
FINISH
MATERIAL NO. | ALT MT | ALT MT

CONTRACT NO.

| | APPROVALS | DATE |
|---|---|---|
| DRAWN | TORRES J | 9/10/93 |
| DESIGNED | JR | 9/10/93 |
| APPROVED | | |
| ISSUED | | |

CONCORDE BATTERY CORPORATION
2009 SAN BERNARDINO RD, W. COVINA, CA 91790

TITLE
BATTERY, LEAD ACID 24V

SIZE A | PARTS NO. 63017 | DWG NO. D8565/INS | REV A
SCALE NONE | SHEET 1 OF 1

# GROUP A INSPECTION PROCEDURE FOR D8565/INS BATTERIES

## 1.0 SCOPE

1.1 This specification describes the procedures for inspecting D8565/INS batteries to conform to Group A requirements of MIL-B-8565J and DOD-B-8565/INS.

## 2.0 APPLICABLE DOCUMENTS

2.1
1) DOD-B-8565/INS dated April 7, 1993
2) MIL-B-8565J dated 1 July 1987.
3) Form Q.C. 12A dated July 1993.
4) Form Q.C. 10B dated February 1993

## 3.0 TEST REQUIREMENTS

3.1 The batteries are to meet Group A requirements specified in Table 1 of DOD-B-8565/INS.

3.2 Inspection of individual components and assembled cells will require the following tools or equipment:
1) Verniar calipers.
2) Simpson analog multimeter.
3) Digital weigh scale.
4) Digatron/Bitrode battery testers.
5) Pacer Power Megohmmeter model PM2000
6) VWR Digital Timer
The equipment will be well maintained and in current calibration status.

3.3 The tests will be performed at ambient conditions.

3.4 Group "A" Inspection Procedure
Inspection shall consist of the following types:
1) Visual and Mechanical Examination.
2) Color and Marking.
3) Dimensions and Weight.
4) Dielectric Strength.
5) Capacity discharge

1) Visual and Mechanical Examination
a) Defects will be identified as indicated in Table VI of MIL-B-8565J.
b) Inspection of intermediate components and assembly is done in various stages as the battery nears completion. These stages, including final inspection, will be documented in Form Q.C 12A.

Burned Group - Stage I:
a) Examine each group for plate attachment
b) Inspect straps for cracks or other visual imperfections like misfills/voids, etc.
c) Inspect separators for tears, coverage, etc.

Hot Melt Inspection - Stage II:
a) Inspect hot melt application for fill and group integrity (group must not be damaged during application of hot melt).

Inner cell inspection - Stage III:
a) Inspect each group for polarity
b) Visually verify burn thickness with the intercell post. The burn should be at least as thick as the intercell post.
c) Each group shall be checked for shorts using the Simpson multimeter.
d) Inspect for lead rundowns (excessive lead stringers attached to the bottom of the strap).
e) Visually verify that each group is firmly inserted in each cell. There must be no loose fitting groups.

Finished cell inspection - Stage IV:
a) Inspect hot melt adhesion of group to cell wall.
b) Inspect the intercell burn connection.
c) Make final visual observation of all groups, checking for all items noted above.

Assembled monobloc inspection - Stage V:
a) After cover is epoxied in place, keep batteries in inverted position for 8 - 10 hours, then inspect for air leakage at 2 psig for 30 sec. for each cell.

Filling and conditioning - Stage VI:
a) Measure fill acid gravity and determine use of sodium sulfate as per requirements noted in the assembly specification. Monitor filling, conditioning and siphoning. Note results in Form QC 10B.

Monobloc testing - Stage VII:
Each monobloc will be tested for shorts by subjecting it to a high rate, 300A, of discharge for 30 seconds. Batteries failing to stay above 9V shall be considered as defective. All results shall be recorded on Form Q.C. 12A.

Circuit Breaker Testing - Stage VIII:
Each circuit breaker shall be tested at 24A for 2 minutes. Tripping at 24A will constitute a circuit breaker failure. The results will be recorded on Form Q.C. 12A.

Final Battery Assembly - Stage IX:
a) Inspect insertion of monoblocs in outer metal container. Make sure foam pad is properly placed around the monoblocs.
b) Inspect insertion of vent caps. Care must be taken to ensure that the caps are not ripped during insertion.
c) Make sure that the protective sheath is correctly placed on top of the monoblocs. This sheath will protect the caps from being obstructed.
d) Inspect wiring harness per schematic wiring diagram shown in D8656/INS.
e) Inspect connections for proper contact on positive and negative terminals, connector, and circuit breaker.
f) Inspect attachment of container lid. The lid will be riveted in place.

2) Color and Marking
a) Verify color conformance to 3.6.3.1
b) Verify all markings, including polarity, labels and serial number, conform to 3.6.3.2.1, 3.6.3.2.2, 3.6.3.2.3 and 3.6.3.2.5.

3) Dimensions and Weight
a) Measure and record dimensions specified on Form QC12A.
b) Each finished battery will be weighed and the weight recorded on Form Q.C. 12A.

4) Dielectric Strength
a) Determine the dielectric strength of the insulation between the battery and the outer metal container using the Pacer Power Megohmmeter. The duration of the test shall be 1 minute and is conducted at 500 +/- 10VDC. One end of the leads will be attached to pin 1, which is the positive and the other can be attached to the connector, which is grounded, at the locator pin holes. The results shall be recorded on Form Q.C. 12A.

5) Capacity Discharge
Each battery shall be subject to a 10A discharge to 18V end of discharge voltage. The capacity, in amp.hrs., shall be recorded on Form Q.C. 12A. Following discharge, charge battery at 28.5V for 4 hours.

3.5 Final Inspection and Certification
QC will certify the results on Forms Q.C. 12A and 10B by affixing their accept/reject stamp on both forms.

# CONCORDE BATTERY CORPORATION

## GROUP "A" INSPECTION

Part # _____ Lot # _____ Serial # _____ QC_____

| Description of Defect | | | |
|---|---|---|---|
| 1 | Electrical contact surfaces obstructed by insulation. | 9 | Insulators or insulation missing or damaged. |
| 2 | Pitting/blow holes on the external cell container. | 10 | Welds containing blow holes, cracks, slag incl. |
| 3 | Electrolyte leakage. | 11 | Burrs on container, cover, hardware. |
| 4 | Loc. and polarity of terminals not as specified. | 12 | Improper color on outside of container. |
| 5 | Term. and identification markings not as specified. | 13 | Hot melt not filled correctly. |
| 6 | Terminal or cover, seal missing or damaged. | 14 | Deformed or damaged parts. |
| 7 | Corrosion. | 15 | Improper flame treat. |
| 8 | Particles of foreign material. | 16 | Improper assembly. |

## INSPECTION LOG

| Date | Stage | Inspection Performed | Acc | Rej | Type Rej |
|---|---|---|---|---|---|
| | I | Burned Group Inspection | | | |
| | II | Hot Melt Inspection | | | |
| | III | Inner Cell inspection | | | |
| | IV | Finished Cell Inspection | | | |
| | V | Assembled Monobloc Inspection | | | |
| | VI | Filling and conditioning | | | |
| | VII | Monobloc Testing | | | |
| | VIII | Circuit Breaker Testing | | | |
| | IX | Final Battery Assembly | | | |

## FINAL INSPECTION

Date: _____ Eqpt. Cal: _____ Contract # _____

| INSPECTION | REQUIREMENT | RESULT |
|---|---|---|
| Visual and Mechanical | 3.5, 3.6.22 | |
| Color and Markings | 3.6.3 | |
| Dielectric Strength | 1.0 megohm minimum | |
| Dimensions | SEE SHEET 2 | |
| Weight | 31.0 lb. maximum | |
| Capacity Discharge | 11.5 A.Hr. to 18V. * | |

*Note: This requirement serves only as a guideline for releasing the battery, as established by Concorde Battery Corporation. It does not supersede the D8565/INS specification requirement of 10 A.Hr. at end of life (85 cycles).

# CONCORDE BATTERY CORPORATION

## GROUP "A" INSPECTION

Part # _____ Lot # _____ Serial # _____ QC _____

| DIMENSIONS (IN) | MAX (IN) | MIN (IN) | ACTUAL (IN) |
|---|---|---|---|
| Length, at base | | | |
| Length with cover | | | |
| Handle, extension from face | | | |
| Width (Bottom) | | | |
| Width (Top) | | | |
| Height | | | |
| Locator pin spacing | | | |
| Handle hole location | | | |
| Connector hole center line, base | | | |
| Distance between connector holes at c/l - horizontal | | | |
| Distance between connector holes at c/l - vertical | | | |

# APPENDIX E

## MILITARY SPECIFICATION SHEET
## MIL-B-8565/13

METRIC

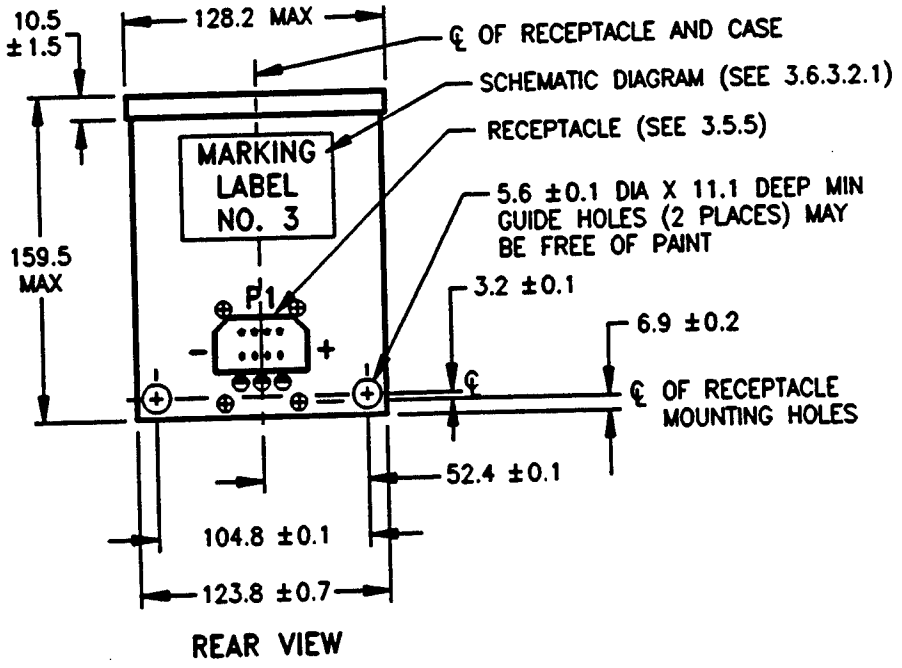
MIL-B-8565/13
21 April 1994

MILITARY SPECIFICATION SHEET

BATTERY, STORAGE, AIRCRAFT, MEDIUM-RATE, TYPE 1,
MAINTENANCE-FREE, 24-VOLT, 10-AMPERE-HOUR

This specification is approved for use by all Departments and Agencies of the Department of Defense.

The requirements for acquiring the product described herein shall consist of this specification sheet and the issue of the following specification listed in that issue of the Department of Defense Index of Specifications and Standards (DODISS) specified in the solicitation:
MIL-B-8565

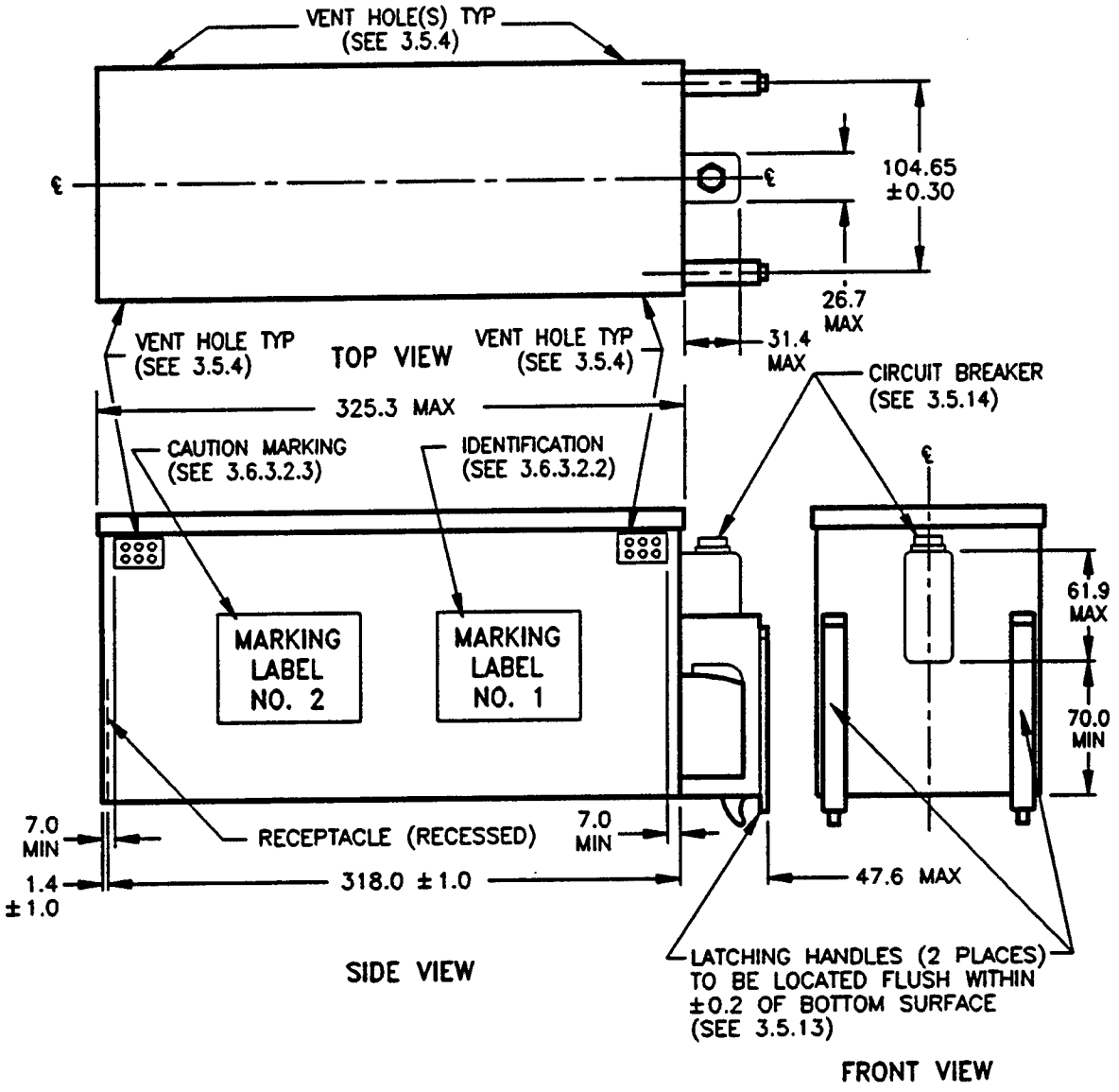



NOTES:
1. All dimensions are in millimeters.
2. Abbreviations used in this figure are diameter (DIA), maximum (MAX), minimum (MIN), and part number (PN).

FIGURE 1. PN D8565/13-1 dimensions.

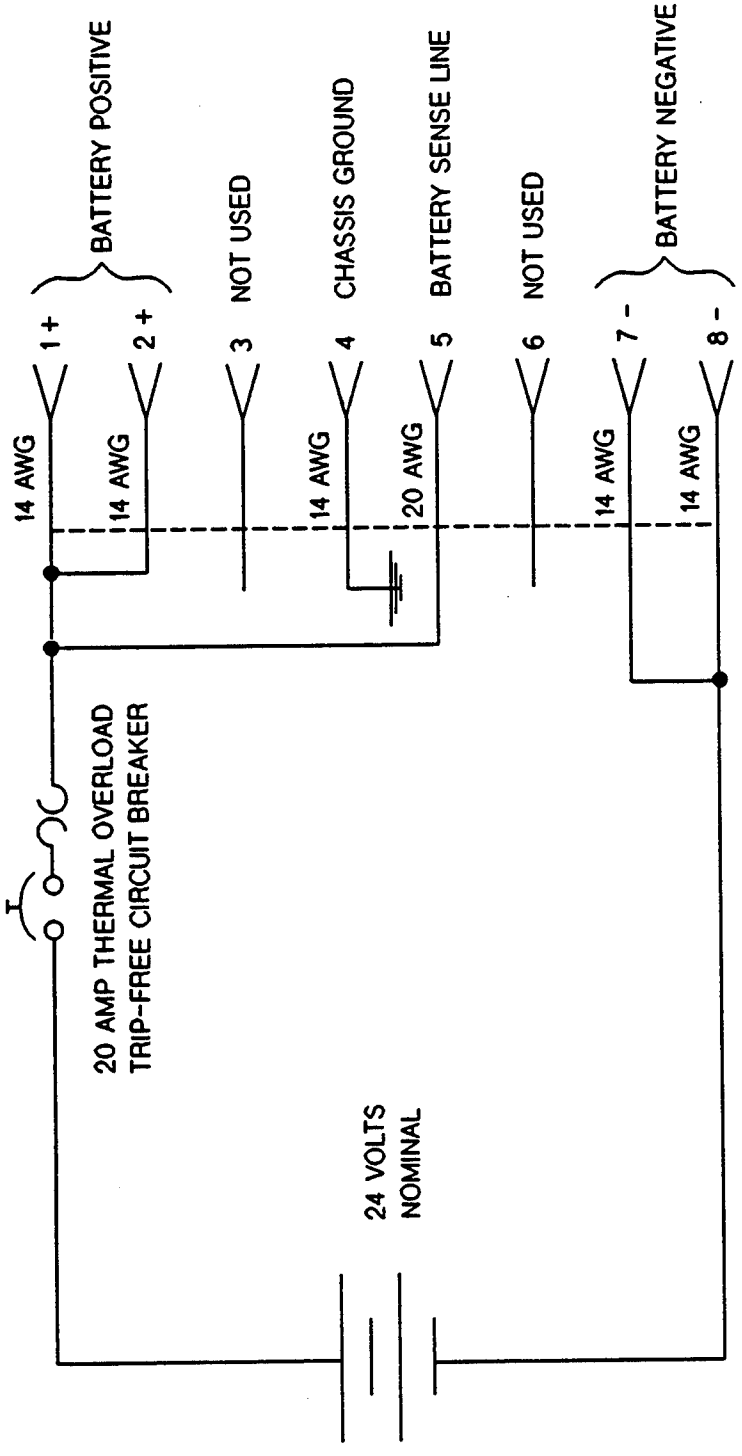
FSC 6140

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




NOTES:
1. All dimensions are in millimeters.
2. Abbreviations used in this figure are maximum (MAX), minimum (MIN), part number (PN) and typical (TYP).

FIGURE 1. PN D8565/13-1 dimensions-Continued.




NOTES:

1. Abbreviations used in this figure are American wire gauge (AWG) and ampere (AMP).
2. Wire sizes are minimum.

FIGURE 2. Wiring diagram.

REQUIREMENTS:

1. The dimensions of the battery shall be as shown on Figure 1.

2. The part number of the battery shall be D8565/13-1.

3. The rated capacity of the battery shall be 10 ampere-hours, based on its ability to conform to the life cycle final discharge (10.0 Ah/1 Hr/24°C/18.0 V).

4. The weight of the battery shall be not greater than 14.03 kilograms (31.0 pounds).

5. Battery service life in the aircraft shall be 4 years.

6. Table I lists the quality assurance tests.

7. Delete all requirements for threaded-post connected batteries.

8. The battery shall conform to MIL-B-8565 for type 1, medium rate, except as modified by the following.

2.2 Other publication. Add the following: "ARINC Specification 404".

3.5.2.1 Type 1 battery. Add the following: "The battery container shall meet the requirements of ARINC Specification 404 for a 1/2 ATR short case size, except as modified herein."

3.5.4 Venting. Delete and substitute the following: "The battery case shall contain one or more holes for venting of gases, as depicted on Figure 1. Vents shall be located such that the container cover, battery monoblocs, or cell assemblies do not block the venting holes. If the hole(s) size exceeds 6.5 millimeters, the hole(s) shall be covered by a plastic or wire screen to prevent debris from entering the battery. The cells shall be equipped with a resealable venting mechanism to prevent excessive internal pressure build-up. When the battery is operating within the requirements of this specification, cell venting shall not cause the battery to discharge entrained electrolyte."

3.5.5 Receptacles. Add the following: "The receptacle for the battery's positive and negative connections shall be a Cannon part number DPXB-8-34P-0101-A152 or equivalent. The receptacle shall be located as shown on Figure 1, and wiring connections shall conform to Figure 2."

Add as new requirement:

"3.5.13 Latching handles. The battery shall be equipped with two lever latch handles, Camloc part number 61L2-1-2AA or equivalent. The handles shall be located as shown on figure 1.

"3.5.14 Circuit breaker. The battery shall be equipped with a 20-ampere thermal overload (trip-free) circuit breaker, type MS3320-20. The circuit breaker shall be located as shown on Figure 1, and wiring connections shall conform to Figure 2. The circuit breaker shall be

mounted in a suitable housing extending from the face of the battery case, provided that the total extension (housing plus circuit breaker) does not protrude above the top surfaces of the battery when the circuit breaker is tripped and provided that the housing does not interfere with the operation of the latches."

3.6.3.2.1 Polarity marking. Delete and substitute the following: "The container shall be conspicuously and durably marked with "+" and "-" in white as shown on Figure 1. The receptacle reference designation "P1" shall be located as shown on Figure 1, with white marking not less than 3 millimeters high. In addition, the schematic diagram of Figure 2 shall be placed on label no. 3 and located as shown on Figure 1."

3.6.3.2.3 Battery caution marking (type 1 battery only). Delete and substitute the following: "Marking for Label 2 shown on Figure 1 shall show the following with lettering height 0.25 inch minimum.

MAINTENANCE-FREE BATTERY

DO NOT REMOVE COVER

PROCESS THIS BATTERY IN ACCORDANCE WITH
APPROVED PROCEDURES ONLY

SEE NAVAIR 17-15BAD-1
OR APPLICABLE SERVICE T.O."

3.6.7 Vent tubes. Delete.

3.6.8 Capacity and electrical performance. Delete TABLE II and substitute the following:

"TABLE II. Capacity performance requirements (type 1 battery).

| Requirement no. | Discharge cutoff voltage and temperature | Rate of discharge factor | Minimum time to cutoff voltage |
|---|---|---|---|
| (1) | 18.0 V at 24 ± 3°C | 1.0C | 60 minutes |
| (2) | 18.0 V at 49 ± 2°C | 1.0C | 66 minutes |
| (3) | 21.0 V at -18 ± 2°C | 400 watts 1/ | 20 minutes |
| (4) | 21.0 V at 5 ± 2°C | 400 watts 1/ | 30 minutes |
| (5) | 21.0 V at -40 ± 2°C | 400 watts | 5 minutes |

1/ During the first minute of discharge, the discharge rate shall be 425 watts. The minimum voltage of 21.0 volts shall apply during the entire discharge period."

3.6.9 Strength of receptacle. Delete.

3.6.10 Life. Delete and substitute: "Batteries delivered under this specification shall be capable of at least 4 years of service life, demonstrated by successfully completing the cycling test of 4.6.13.1 and the float life test of 4.6.13.4."

Add as a new requirement:

"3.6.10.4 Float life. When tested in accordance with 4.6.13.4, batteries shall provide not less than rated capacity after 50 days of float charging at a temperature of 50°C and a charging rate of 40 milliamperes."

3.6.11 "Evaluation of Equipment" test. Delete and substitute the following: "After all environmental tests, the battery shall be subjected to a 400-watt discharge for 5 minutes. The battery voltage shall be 21.0 volts or greater at the end of the 5 minutes."

3.6.13 Temperature rise and float. Delete and substitute the following: "When tested in accordance with 4.6.21, the battery voltage shall be recorded at intervals not to exceed 5 minutes. The battery voltage, during the 8 hours of constant current charge at 2.0 amperes, shall remain above 29.0 volts once 110 percent of the capacity removed during discharge has been returned. The battery shall meet requirement (1) of table II following the charge period."

4.5.1.3 Constant-potential charging. Delete and substitute the following: "Unless otherwise specified, the battery shall be charged at a constant current rate of 2.00 $\pm$ 0.05 amperes until the battery voltage reaches 29.0 $\pm$ 0.1 volts. The charging shall then be continued for 2 hours at 29.0 $\pm$ 0.1 volts."

4.6.7 Strength of vent tubes. Delete.

4.6.11 Constant voltage discharge (14.0 volts). Delete.

4.6.12 Strength of receptacle. Delete.

4.6.13.1 Cycling test (type 1 battery). Delete "2-hour charge per 4.5.1.3" and substitute "charge in accordance with 4.5.1.3".

Add as new requirement:

"4.6.13.4 Float life. The battery shall be charged at 40 milliamperes at 50 $\pm$ 2°C for a period of 50 days. At the end of this time period, the battery shall be stabilized at room temperature and discharged in accordance with 4.6.10. The battery shall comply with the requirements of 3.6.10.4."

4.6.15 Charge and discharge test at low temperature. Delete steps (a) through (d) and substitute the following:

"a. Charge the battery in accordance with 4.5.1.3.

"b. Place the battery in a test chamber in accordance with 4.5.1.2 at -18°C, then discharge at 400 watts for 15 minutes.

"c. Remove the battery from the chamber and charge for 2.0 hours at 27.0 ± 0.1 volts with the current source limited to 2.0 ± 0.1 amperes.

"d. Immediately following charge, discharge the battery at 400 watts to 21.0 volts. Battery shall meet the requirement (3) of table II."

4.6.16 Discharge while inverted. Delete and substitute the following: "The battery shall be charged as specified in 4.5.1.3. The battery then shall be discharged at 400 watts for 5 minutes. During the first 2.5 minutes of discharge, the battery shall be placed in the inverted position. The battery shall meet the requirements of 3.5.8, and the battery voltage shall remain above 21.0 volts during the entire discharge period."

4.6.20 Special tests. Add the following:

"4.6.20.1 Battery output performance. Battery samples 1, 2 and 3 shall be tested as follows to verify conformance to paragraph 3.6.8.

"a. Charge each battery in accordance with paragraphs 4.5.1.3.

"b. Stabilize the three samples in accordance with 4.5.1.2 at the applicable test temperatures as specified in requirements (3), (4) and (5) of table II.

"c. Discharge sample 1 in accordance with requirement (3) of table II. Discharge sample 2 in accordance with requirement (4) of table II. Discharge sample 3 in accordance with requirement (5) of table II.

"d. Each sample shall meet the minimum cutoff voltage of the applicable requirements of table II."

4.6.21 Temperature rise and float test. Delete and substitute the following: "The battery shall be charged in accordance with 4.5.1.3 and then placed in a temperature chamber at 49 ± 2°C for 12 hours. At this temperature, the battery shall be discharged at 400 watts for 30 minutes. Immediately following this discharge, with the battery still in the chamber at 49 ± 2°C, a constant current charge of 2.0 ± 0.1 amperes shall be applied for 8.0 ± 0.1 hours. The battery shall then be stabilized at 24 ± 5°C and discharged in accordance with 4.6.10. The battery shall meet the requirements of 3.6.12 and 3.6.13."

TABLE I. Inspection of batteries and order of test.

| Order of test | Description of inspection | Requirements paragraph | Inspection method paragraph | Qualification inspection | | | | Quality conformance inspection | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Qualification sample number | | | | Group A tests | Group B tests | |
| | | | | 1 | 2 | 3 | 4 | | 1 | 2 |
| 1 | Visual & mechanical examination | 3.5, 3.6.1, 3.6.3 & 3.6.22 | 4.6.3 | X | X | X | X | X | X | X |
| 2 | Dimensions & weight | 3.6.5 | 4.6.4 | X | X | X | | X | X | X |
| 3 | Dielectric strength | 3.6.4 | 4.6.5 | X | X | X | X | X | X | X |
| 4 | Color & marking | 3.6.3 | 4.6.8 | X | X | X | | X | X | X |
| 5 | Conditioning charge | 4.5.1.4 | 4.6.9 | X | X | X | X | | X | X |
| 6 | Capacity discharge | 3.6.8 | 4.6.10 | X | X | X | X | X | X | X |
| 7 | Battery output performance | 3.6.8 | 4.6.20.1 | X | X | X | | | X | X |
| 8 | Charge & discharge test at low temperature | 3.6.8 | 4.6.15 | | | X | | | X | |
| 9 | Life cycling | 3.6.10.1 | 4.6.13.1 | X | | | | | X | |
| 10 | Float life | 3.6.10.4 | 4.6.13.4 | | X | | | | | |
| 11 | Capacity discharge at 49°C | 3.6.8 | 4.6.14 | | X | | | | | X |
| 12 | Discharge while inverted | 3.6.8 & 3.6.11 | 4.6.16 | | | X | | | X | |
| 13 | Altitude | 3.6.11 & 3.6.12 | 4.6.17 | | | X | | | | X |
| 14 | Mechanical shock | 3.6.11 & 3.6.12 | 4.6.18 | X | | | | | | |
| 15 | Temperature shock | 3.6.11 & 3.6.12 | 4.6.19 | X | | | | | X | |
| 16 | Temperature rise & float | 3.6.11, 3.6.12 & 3.6.13 | 4.6.21 | | | X | | | | X |
| 17 | Battery gas emission test | 3.6.14 | 4.6.22 | | | X | | | | |
| 18 | Vibration | 3.6.11, 3.6.12 & 3.6.16 | 4.6.23 | | | | X | | | |
| 19 | Humidity | 3.6.11, 3.6.12 & 3.6.17 | 4.6.24 | | X | | | | | X |
| 20 | Salt fog | 3.6.11, 3.6.12 & 3.6.18 | 4.6.25 | X | | | | | X | |
| 21 | Ground storage | 3.6.15 | 4.6.26 | | | | X | | | |
| 22 | Physical integrity at high temperature | 3.6.12 | 4.6.27 | | X | | | | | |
| 23 | Final examination | 3.6.4 | 4.6.30 | X | X | X | X | | X | X |

Custodians:
Navy - AS

Review Activity:
Air Force - 99

Preparing activity:
Navy - AS

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