28 VOLT STATION BATTERIES 18 MONTH SERVICE TEST AND ASSOCIATED SURVEILLANCE TESTING USING BCT-2000

USE CATEGORY : II

- Biennial Review Performed: Yes ____ No ____ NA ✓
- Packages and Affected Document Numbers incorporated into this revision: None
- The following OTSCs were incorporated into this revision: None

REVISION SUMMARY

- The following changes were made to support Technical Specification Amendments 249 and 229:
  (Order 80038362, Act. 0040)
- Technical Specification reference was changed from 4.8.2.5.2.d to 4.8.2.5.2.f in section 1.0.
- Specific Gravity value in steps 5.7.3, 5.7.5, 5.16.10, 5.16.12, Attachment 4A, 4B, and Attachment 19, step 5.7.4.B was changed from 1.200 to 1.190.
- Technical Specification minimum voltage value in Attachment 19, Step 5.6.1 was changed from ≥ 28 VDC to ≥ 27 VDC.
- Deleted comparing quarterly Specific Gravity readings with previously taken readings in Steps 5.7.4, 5.7.5, Attachment 4A, 5.16.11 and 5.16.12. This is no longer a Tech. Spec. requirement.
- Deleted step 5.5.2.B.4 which required taking B-B readings. 28 VDC batteries only have A-A readings.

IMPLEMENTATION REQUIREMENTS

- Effective Date 3/15/02

APPROVED: _____ 3-15-02
Manager - Plant Maintenance **Date**

28 VOLT STATION BATTERIES 18 MONTH SERVICE TEST AND ASSOCIATED SURVEILLANCE TESTING USING BCT-2000

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ATTACHMENTS

1.0 PURPOSE

- To provide instructions for performing 28 Volt Battery 18 Month Surveillance Tests using BCT-2000.
- To fulfill requirements of Technical Specification Surveillance Requirements 4.8.2.5.2.f and 4.8.2.6.2. **[C0265]**
  - Satisfactory completion of Performance Discharge Test shall also satisfy requirements of Technical Specification Surveillance 4.8.2.5.2.f, if Performance Discharge Test is conducted during a shutdown when that test and Battery Service Test would both be required.
  - To demonstrate the capability of the 28 Volt Battery to supply all required Station Blackout and LOOP/LOCA loads.
- Applies to the following component ID#s:
  - Unit 1
    - 1A 28 Volt Battery - 1BTRY1ADE
    - 1B 28 Volt Battery - 1BTRY1BDE
  - Unit 2
    - 2A 28 Volt Battery - 2BTRY2ADE
    - 2B 28 Volt Battery - 2BTRY2BDE
- Battery Performance Test should be performed during shutdown.

2.0 PREREQUISITES

___ 2.1 The individual assigned to perform this procedure is qualified IAW NC.NA-AP.ZZ-0014(Q), Training, Qualification and Certification.

___ 2.2 If equalize charge is to exceed >30.3 VDC, VERIFY tagging is complete IAW NC.NA-AP.ZZ-0015(Q), Safety Tagging Program:

___ 2.3 VERIFY M&TE calibration due dates are NOT exceeded. **RECORD on Work Activity Sheet and Attachment 19, Section 2.0.**

___ 2.4 Prior to any battery work, VERIFY all other vital batteries of same voltage and unit are in service.

___ 2.5 VERIFY battery has NOT had an Equalizing Charge completed within 7 days prior to start of work.

___ 2.6 VERIFY Maintenance Supervisor has obtained Fire Impairment Permit for the following fire doors (as applicable) IAW NC.NA-AP.ZZ-0025(Q), Nuclear Department Operational Fire Protection Program:

___ 2.6.1 Unit 1

- 1A 28 Volt Battery - 1BTRY1ADE, Door #108-1
- 1B 28 Volt Battery - 1BTRY1BDE, Door #109-1

___ 2.6.2 Unit 2

- 2A 28 Volt Battery - 2BTRY2ADE, Door #108-2
- 2B 28 Volt Battery - 2BTRY2BDE, Door #106-2

___ 2.7 NOTIFY CR/CRS (Control Room/Control Room Supervisor) prior to performing this procedure.

___ 2.8 VERIFY Reactor Operator (RO) prior to performing this procedure.

2.9 VERIFY Load Control Unit software program is correct for the Load Bank Shunt installed as follows:

___ 2.9.1 TURN ON Load Control Unit, when "LOAD TEST PROGRAM MENU" is displayed, PRESS F4 - Hardware Diagnostics.

___ 2.9.2 From Hardware Diagnostics PRESS F1 - Calibrate.

___ 2.9.3 "HARDWARE DIAGNOSTICS" asks for a password, PRESS ENTER.

___ 2.9.4 VERIFY Load Control Unit Shunt Rate displayed matches Load Bank Shunt installed:

- 1000 amps / 100 millivolts - Load Bank Shunt 202936.
- 1200 amps / 100 millivolts - Load Bank Shunt 206826.
- 1200 amps / 100 millivolts - Load Bank Shunt 206827.

___ 2.9.5 IF Program Shunt Rate is not matched with the Load Bank Shunt THEN INFORM Job Supervisor that the Load Control Unit and Load Bank Shunt must be a matched set.

3.0 PRECAUTIONS AND LIMITATIONS

___ 3.1 ENSURE all applicable generic precautions and limitations of SH.MD-AP.ZZ-0003(Q), Maintenance Department Written Instruction Use Standard, are applied during performance of this procedure.

___ 3.2 This procedure may be completed in whole or in part. Applicable steps within a section should be completed prior to starting next section. Maintenance Supervisor should determine which sections and steps are to be performed.

___ 3.3 Performing any corrective maintenance prior to Service Test can void results. DO NOT tighten, clean or disturb any connection or perform equalizing charge/adjust battery float voltage. All connections should be monitored for excessive heating during test. Any required connection cleaning and torquing should be performed after test is complete.

___ 3.4 Only one 28 Volt Battery of same unit may be tested at a time. DO NOT perform maintenance or testing on remaining batteries of same unit during this surveillance.

___ 3.5 ENSURE battery is isolated as follows when specified in Section 5.0 IAW NC.NA-AP.ZZ-0015(Q), Safety Tagging Program:

- ♦ All loads on associated DC bus are tagged out.
- ♦ Associated battery chargers are tagged out.

___ 3.6 Gases produced by this battery are explosive. DO NOT smoke, use open flame, create an arc or spark in battery room.

___ 3.7 Periodically VERIFY associated battery room exhaust fan or temporary ventilation system is in operation to remove hydrogen gas.

___ 3.8 ENSURE at least two (2) fully charged 20 lb. CO_2 fire extinguisher are immediately available.

___ 3.9 ENSURE unobstructed exit from battery room.

___ 3.10 Unnecessary materials should NOT be taken into battery room. REMOVE items such as pens or other metallic materials from shirt pockets to prevent them from accidentally falling on battery terminals.

___ 3.11 Voltage will be present at battery cell terminals. USE caution when working to prevent contact between positive and negative terminals/bus bar or between terminals/bus bar and ground.

___ 3.12 Tools used on or in immediate vicinity of battery should be insulated so any remaining exposed metal portion of tools CANNOT short circuit battery terminals/bus bar.

___ 3.13 Two insulated wrenches should be used in counter-torque to avoid excessive stress to cell terminal posts.

___ 3.14 Battery contains diluted sulfuric acid (electrolyte) and can cause severe burns. Personnel should wear full face mask, acid-resistant gloves and apron when handling electrolyte or taking electrolyte specific gravity and temperature measurements.

___ 3.15 If electrolyte is spilled or comes in contact with skin or clothing, immediately WASH with water and NEUTRALIZE with solution of baking soda and water (1 lb/gal). If electrolyte comes in contact with eyes, FLUSH with large amounts of clean water and SECURE medical treatment immediately.

___ 3.16 Permanent eye wash station(s) or temporary unit(s) should be available and in working condition in immediate work area.

___ 3.17 Demineralized water/baking soda solution is only cleaner approved for cleaning battery jars. DO NOT use solvents for cleaning which may enter cell and cause damage by chemical reaction with element of lead acid cell, or craze thermoplastic cover or jar of cell(s).

___ 3.18 DO NOT use a wire brush, steel wool, or emery cloth to clean connectors. Lead plating damage will occur.

___ 3.19 Use and disposal of chemicals during performance of this procedure should be IAW NC.NA-AP.ZZ-0038(Q), Chemical Control Program.

___ 3.20 Electrolyte should NOT be taken from one cell and transferred to another cell. DO NOT remove or add electrolyte to change a cell's specific gravity except as directed by Supervisor.

___ 3.21 Maximum temperature of any monitored cell should NOT exceed 120°F during testing. If temperature difference between highest and lowest monitored cell is >5°F, or any cell temperature approaches 120°F, NOTIFY Supervisor. STOP TEST if temperature exceeds 120°F.

___ 3.22 Stops should be installed on thermometers prior to use to prevent dropping thermometers into cell while obtaining cell temperatures.

___ 3.23 In all cases, it is necessary for user to DEPRESS BCT-2000 Laptop Display Unit ENTER key once any menu field has been inputted/changed. Failure to depress ENTER key will cause menu field to change back to its original selection.

___ 3.24 As with any software program, it is suggested that your program be saved often in event of a power outage or glitch. At Main Menu, SELECT "F6" (Save Configuration) to save changes made in Setup Test Parameter screen. System will prompt user Configuration File Update, <Y/N>. SELECT "Y" for yes or "N" for no.

___ 3.25 PLACE a Job Information Tag on 120 VAC extension cord to inform personnel that testing is in progress. Loss of 120 VAC computer power/load bank power will void Service Test.

___ 3.26 Intertier connection will alarm when voltage drop is >0.2 VDC.

___ 3.27 Data Logging Acquisition Device (DLAD) will alarm with a two tone audible alarm when a cell or overall battery voltage (OV) indicates a warning alarm and a solid tone when a Shutdown Alarm occurs.

___ 3.28 If temperature field is changed in Setup Test Parameters screen after Step Load field, load values must be reentered so program can adjust to load amperes IAW IEEE-450 automatically.

___ 3.29 When pausing test for extended periods, battery cells will be allowed to recover and cause results to be affected/voided.

___ 3.30 During testing/while energized, Laptop Display Unit should be placed on a flat and sturdy surface.

___ 3.31 If a WARNING or SHUTDOWN voltage prompt occur during testing, READ prompt.

___ 3.32 Continuous Load Unit (CLU) cooling fans are NOT required to perform battery load testing, however personnel can be burned if they come in contact with CLU screen surfaces.

___ 3.33 ENSURE NO materials are placed on top of CLU screen areas during battery load testing. CLU will become hot during load testing.

___ 3.34 During test, BCT-2000 laptop computer screen will blackout/go blank when keys are NOT depressed for 30 minutes. DEPRESS ENTER key for test screen to appear.

___ 3.35 Cable colors, cable lengths and/or number of pins may vary depending on various upgrades of the test System. If there are discrepancies between the body of the procedure and the actual Alber System Hardware (colors, cable lengths and/or number of pins) work may continue as long as the cable connections are verified correct.

___ 3.36 The Load Control Unit and Load Bank Shunt have been calibrated as a matched set and must be used together. Use of non-matching Load Control Unit and Load Bank Shunt will result in incorrect load amperage applied to Battery, invalidating test results. The Calibration facility calibrates and maintains records for Load Control Units and Load Bank Shunts.

4.0 EQUIPMENT/MATERIAL REQUIRED

4.1 M&TE

- Two thermometers OR Electronic Infrared thermometers
- Battery Capacity Test System, BCT-2000 Series
- Torque Wrench (Capable of reading 170 in-lbs)
- Digital Low Resistance Ohmmeter (DLRO)
- Stopwatch

4.2 Additional Tools and Equipment

- Two 400 amp fast acting, current limiting DC rated fuses (to be used with battery test cables)
- Fused battery test cables, 296 MCM, (total of four) with bus bar plates (total of four)
- Ground cable for CLU chassis grounding
- 3 1/2 in. backup floppy disk (for data transfer and backup configuration)
- Clean, lint-free cloths
- Demineralized water
- Bucket (one gallon or greater capacity for demineralized water/baking soda solution)
- Baking soda
- Electrical extension cords and Hubble adapters
- Two fully charged 20 lb. CO_2 fire extinguisher
- Temporary eye wash station, if required
- Pocket calculator
- Electrical extension cords and Hubble adapters
- Insulated wrenches
- See Work Activity Sheet Section M&TE/TOOLS/EQUIPMENT/LUBE for additional requirements.

4.3 Procedures

- SC.MD-CM.28D-0004(Q), Battery Terminal Post Resistance Measurements

5.0 PROCEDURE

5.1 Prerequisites, Precautions and Limitations Review

___ 5.1.1 VERIFY all prerequisites required to start job have been met.

___ 5.1.2 VERIFY all precautions and limitations have been reviewed.

CAUTION

Performing any corrective maintenance prior to Service Test can void results. DO NOT tighten or disturb any connections. Identified connections should be monitored for excessive heating during test. Any required connection maintenance should be performed after test is complete. DO NOT add water to battery cells at this time.

5.2 Battery Room Inspection

___ 5.2.1 **RECORD ambient temperature of battery room on Attachment 19.**

___ 5.2.2 VERIFY battery room exhaust fan operating by observing air flow.

___ 5.2.3 VERIFY battery room is free of any accumulated dust, dirt and any non-essential materials. CLEAN and REMOVE, as applicable.

CAUTION

Explosive gases may be present in battery room. Prior to performing corrective maintenance on explosive proof lights, battery room exhaust fans should be operational.

___ 5.2.4 VERIFY battery room lights are lit and associated explosion proof enclosures are installed and NOT cracked.

___ A. REWORK/REPLACE as necessary.

___ B. **RECORD on Attachment 19, Section 4.0, Comments, any corrective maintenance performed.**

___ 5.2.5 **RECORD battery room condition on Attachment 19.**

5.3 Individual Battery Rack/Enclosure Inspection

NOTE

DO NOT correct any deficiencies that could affect test results unless directed by Supervisor.

___ 5.3.1 INSPECT applicable battery rack/enclosure for the following:

- ♦ Loose or missing nuts, bolts
- ♦ Grounding connection
- ♦ Damage

___ 5.3.2 If required, REWORK using approved materials. **RECORD on Attachment 19, Section 4.0 Comments.**

NOTE

Two cell support rails located beneath each row of cells are constructed of unistrut topped with gray plastic cover. Wherever joint exists in gray plastic cover, spilled electrolyte may flow under cover and erode unistrut.

___ 5.3.3 INSPECT underside of all battery cell unistrut rails in vicinity of any existing joints in their respective gray plastic covers and all side support rails for the following: Erosion, Peeling of coating OR Any other signs of deterioration.

___ 5.3.4 **RECORD battery rack/enclosure condition on Attachment 19.**

5.4 Individual Battery Cell Inspection

___ 5.4.1 INSPECT individual battery cells for the following deficiencies. **RECORD all deficient conditions with associated cell number on Attachment 19, Section 4.0, Comments.**

- ♦ Any cracked or leaking cell jars

NOTE

Procedure SC.MD-CM.28D-0004(Q), "28 Volt Battery Terminal Post Resistance Measurements", is required if connection is suspect or needs to be disassembled. DO NOT tighten, loosen or disturb cell-to-cell bus bar connections and cell bank jumper connections until instructed by Supervisor.

- ♦ Corrosion (white color on negative connections, blue-green on positive connections) or electrolyte staining (dark brown color) on cell connectors, bus bars or terminal post. CLEAN with plastic bristle brush. REGREASE as necessary (Refer to Attachment 2)
- ♦ Missing anti-corrosion coating on battery terminal posts and bus bar/cable lug and plate contact surfaces. REGREASE as necessary. (Refer to Attachment 2)
- ♦ Major post seal fractures. (NOT blistering or distortion)

NOTE

First signs of minor copper contamination appear as pinkish-red color on upper plate support strap and top of negative plates.

- ♦ Major copper contamination on the cell's negative plates (light gray-white) and upper support strap
- ♦ Major sulfate crystals buildup (Christmas Tree Garland or mossing appearance)
- ♦ Flaking of cell positive plates and upper support strap
- ♦ Major buildup (mountain shaped) of plate materials at bottom of cell jar (it should be in close proximity to lower plate edges to be considered deficiency)
- ♦ Loose or missing caps on flame arresters or sample tubes
- ♦ Wetness at specific gravity tube gaskets. Correct condition by gasket replacement or by thorough cleaning, neutralizing and air drying
- ♦ Plate separator material floating on electrolyte surface

5.5 Battery Cell Connection Inspection

___ 5.5.1 Visually INSPECT all inter-cell, inter-rack, inter-tier and field cable connections for the following deficiencies: **DOCUMENT all deficient conditions, including associated cell number(s), on Attachment 19, Section 4.0, Comments.**

___ A. Electrolyte staining (brown color) on cell connectors, bus bars, or terminal post(s)

___ B. Dirt on cell connectors, bus bars, or terminal posts.

___ C. Little or NO anti-corrosion coating (NO-OX-ID) is on battery terminal posts, bus bar/cable lug, and plate contact surfaces.

$ D. Corrosion (white color on negative connections, blue-green on positive connections) on cell connectors, bus bars, or terminal post(s). **RECORD on Attachment 19.**

___ 5.5.2 If any connection contains visible corrosion, PERFORM As Found resistance measurements of each battery connection as follows:

NOTE

Alligator clip test leads or test probes may be used interchangeably with DLRO when taking terminal post resistance readings. Ensure letter "P" engraved on test probes face each other.

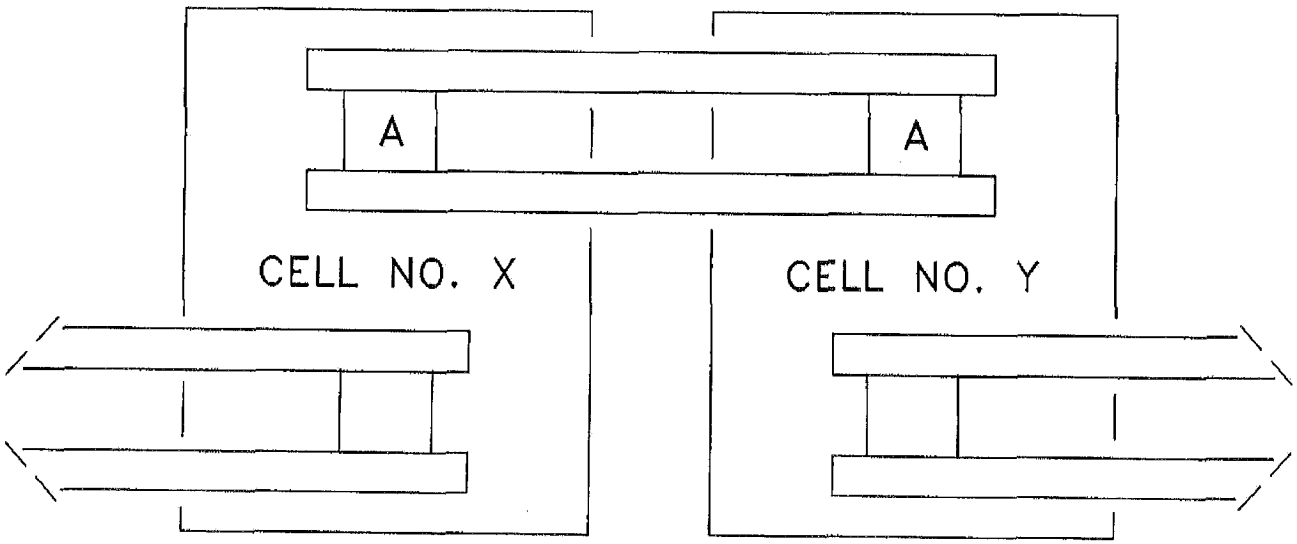
When measuring battery lead connection resistance, press test probes of DLRO between approximate top center or side of terminal post and cable lug.

When measuring post-to-post intercell resistance, press DLRO test probes between top center of post "A" on Cell No. X and top center of post "A" on Cell No. Y. (Refer to sketch below)

When measuring cell bank jumper cable resistance plus terminal post resistance, press DLRO test probes between top center or side center of cell posts A-A at either end of cell bank jumper.

DLRO displays measured resistance values in milli-ohms. Data sheets require units to be in micro-ohms. Ensure resistance readings recorded on data tables are in units of micro-ohms. To convert from milli to micro, move decimal to right 3 places.

TOP VIEW - 28V BATTERY



5.5.2 (Cont'd)

___ A. Using DLRO, MEASURE forward and reverse connection resistance for the following: **RECORD resistance values on Attachment 5, Connection Resistance Data Table.**

- ♦ Positive (+)CONN and negative (-)CONN battery lead connections
- ♦ Each "A" to "A" post-to-post connection
- ♦ Cell bank jumper connection(s)

B. CALCULATE average resistance for each connection as follows:

___ 1. For Cell No. 1, ADD forward and reverse battery lead connection resistance values.

___ 2. DIVIDE sum by 2.

___ 3. **RECORD Cell's average connection resistance on Attachment 5, Connection Resistance Data Table, in AVE CONN column.**

NOTE

Steps 5.5.3 and 5.5.4 are required if one or more cell(s) have been replaced in battery. N/A these steps when NO cell(s) have been replaced.

CAUTION

Positive/Negative battery lead connection and cell bank jumper connection resistance should NOT be used in calculating Battery Connection Average Resistance.

___ 5.5.3 PERFORM As Found Battery Connection Average Resistance Calculation as follows:

___ A. ADD each "A" to "A" post to post Cell Connection Average Resistance value.

___ B. DIVIDE sum by number of cell connections (i.e, when number of cells are jumpered). **RECORD As Found Battery Connection Average Resistance on Attachment 5.**

___ 5.5.4 For new cells, MULTIPLY As Found Battery Connection Average Resistance(s) recorded in Step 5.5.3.B by 1.1 (110%). **RECORD A to A Battery Connection 110% Average Value on Attachment 19.**

NOTE

Step 5.5.5 satisfies Technical Specification Surveillance Requirements for cell-to-cell and terminal connections to be tight and ≤0.01 ohms.

___ $ 5.5.5 EVALUATE Cell Average Connection Resistance against acceptance criteria as follows: **INITIAL in the SAT or UNSAT column, as applicable on Attachment 5, Connection Resistance Data Table.**

- For new cell(s), AVE CONN. resistance(s) is < Battery Connection 110% AVERAGE value recorded in Step 5.5.4 and have little or NO corrosion.
- For existing cells, AVE CONN. resistance(s) is <120% AVERAGE BASELINE value listed in Attachment 2, Table 4 and have little or NO corrosion.

___ 5.5.6 NOTIFY OS/CRS and Supervisor of failure to meet Technical Specification acceptance criteria.

___ $ 5.5.7 **RECORD completion of As Found connection resistance measurements on Attachment 19.**

NOTE

Data collection steps need NOT be performed in exact order as written, provided all required steps are performed and all data is obtained. For example, temperatures, specific gravities and ICVs may be obtained simultaneously.

5.6 Individual Cell Quarterly Data Collection

NOTE

With all 13 cells connected, battery float voltage span is 28.9-29.3 VDC (ICV span 2.23 to 2.25 VDC).

Minimum Technical Specification battery voltage is 27 VDC. NOTIFY Supervisor immediately if battery is found below this value.

MEASURE voltage at positive and negative battery terminals, NOT at battery charger or bus.

___ 5.6.1 MEASURE As Found battery terminal voltage at battery.
$ **RECORD As Found battery float voltage on Attachment 19.**

NOTE

Individual Cell Voltage (ICV) minimum Technical Specification Value is ≥2.13.

___ 5.6.2 MEASURE ICV's for all cells, and **RECORD ICV's on Attachment 4A Data Table, in "ICV" column.**
$

___ 5.6.3 REMOVE each cell's flame arrester cap and sample tube dust cover.

___ 5.6.4 Cell Temperature Measurements:

NOTE

Cell temperatures should be obtained using electronic temperature measurement device with acid resistant probe, if available; otherwise, non-mercury thermometer should be used.

CAUTION

If glass non-mercury thermometer is used, "Stops" should be attached to prevent dropping thermometer into cell.

___ A. INSERT acid resistant probe or non-mercury thermometer with "Stop" attached into flame arrester filler vent for Cell No. 1.

___ B. ALLOW temperature to stabilize.

___ C. **RECORD stabilized temperature on Attachment 4A Data Table, in "CELL TEMP" column (expected value 65°F-105°F).**

___ D. REPEAT Steps 5.6.4.A through 5.6.4.C for all cells listed in Attachment 4A, Data Table.

NOTE

DO NOT add water to any cells at this time.

Immediately report failure of any cell to meet Technical Specification acceptance criteria to Supervisor for evaluation and possible corrective action.

5.6.5 Electrolyte Level Determination:

___ A. MEASURE distance between bottom of high level mark and electrolyte level for all cells.

5.6.5 (Cont'd)

___ B. NOTIFY OS and Supervisor immediately if level is above high level mark or below low level mark (>8/32 in. above high level mark or ≤low level mark.

___ $ C. **RECORD number of 1/32 in. increments, electrolyte level is below high level mark on Attachment 4A Data Table, in "CELL LEVEL" column.**

- ♦ If level is >high level mark, indicate the number of 1/32 in. increments electrolyte level is above high level mark by including a positive (+) sign preceding number.

5.6.6 Specific Gravity Measurement:

___ A. INSERT hydrometer into sample tube of each cell.

___ B. WITHDRAW electrolyte sample into hydrometer.

___ C. RETURN electrolyte sample into flame arrester filler vent.

___ D. RE-INSERT hydrometer into sample tube.

___ E. WITHDRAW second electrolyte sample into hydrometer.

___ F. READ specific gravity of sample.

___ G. RETURN electrolyte into battery sample tube.

___ H. **RECORD Measured Specific Gravity on Attachment 4A Data Table, in "MEAS. S.G." column.**

___ 5.6.7 REPLACE each cell's flame arrester cap & sample tube dust cover.

5.7 Data Reduction

NOTE

Immediately report failure of any cell to meet Technical Specification acceptance criteria to Supervisor for evaluation and possible corrective action.

5.7.1 Temperature Compensation Calculation:

___ A. CALCULATE average cell temperature by adding cell temperatures recorded on Attachment 4A Data Table and dividing by total number of cell temperature measurements.

___ $ B. **RECORD cell average temperature on Attachment 19.**

___ C. CALCULATE cell specific gravity temperature compensation as follows:

- **RECORD (+) 0.001 temperature correction value for every 3°F the cell temperature is above 77°F, on Attachment 4A Data Table, in "TEMP CORR" column for each cell.**

OR

- **RECORD (-) 0.001 temperature correction value for every 3°F the cell temperature is below 77°F, on Attachment 4A Data Table, in the "TEMP CORR" column for each cell.**

___ D. CALCULATE temperature corrected S.G. by adding or subtracting TEMP CORRECTION to/from MEASURED S.G. for all cells.

___ E. **RECORD temperature corrected S.G. on Attachment 4A Data Table, in "TEMP CORR S.G." column.**

5.7.2 Level Compensation Calculation for level corrections factors. (Refer to Attachment 3)

___ A. Using recorded "CELL LEVEL", DETERMINE cell level correction factor, for each cell. (Refer to Attachment 3)

___ B. **RECORD level compensation on Attachment 4A Data Table, in "LEVEL CORR FACT" column.**

$ 5.7.3 Corrected Specific Gravity Calculation (Tech Spec minimum is ≥ 1.190).

___ A. CALCULATE corrected specific gravity for each cell by subtracting LEVEL CORRECTION FACTOR from TEMP CORRECTED S.G.

___ $ B. **RECORD corrected specific gravity on Attachment 4A Data Table, in "CSG" column.**

5.7.4 Average Corrected Specific Gravity Calculation:

___ A. CALCULATE average corrected specific gravity by adding all corrected specific gravities and dividing by total number of cells (NOT counting jumpered cells, normally 60).

___ B. **RECORD average corrected specific gravity on Attachment 19.**

$

NOTE

Immediately report failure of any cell to meet Technical Specification acceptance criteria to Supervisor for evaluation and possible corrective action.

___ 5.7.5 ENSURE the following Tech Spec Acceptance Criteria have been met for each cell listed in Attachment 4A. **INITIAL on Attachment 4A Data Table, in "TECH SPEC CRIT SAT" column of each cell when criteria listed below are met.**

- Individual cell voltage in "ICV" column is ≥ 2.13 VDC while under float charge (2.13 or more in ICV column).

5.7.5 (Cont'd)

NOTE

The next Tech Spec acceptance criteria is satisfied when any ICV is ≥ 2.13 VDC. The bases is as follows:

- All original ICV's were < 2.40 VDC.
- 2.40 VDC - 0.27 VDC = 2.13 VDC.
- However, NO cell may be allowed to be < 2.13 VDC (Tech Spec lower limit).
- Therefore, as long as ICV's are ≥ 2.13 VDC, Tech Spec for ICV's NOT decreasing by more than 0.27 VDC for original acceptance test is satisfied.

- Individual Cell Voltage in "ICV" column has NOT decreased more than 0.27 VDC from value observed during original acceptance test. This criteria is satisfied when ICV is ≥ 2.13 VDC in "ICV" column based on note above.
- Corrected specific gravity in "CORRECTED S.G." column for each cell is ≥ 1.190.
- Electrolyte level between high and low levels marks.

___ 5.7.6 ENSURE the following Non-Tech Spec Acceptance Criteria have been met for each cell listed in Attachment 4A.

___ A. NO "recorded" cell temperature is more than 5°F from cell average temperature recorded in Step 5.7.1.B. **RECORD on Attachment 19.**

NOTE

Cells with corrected specific gravity more than 0.010 below Average Corrected S.G. may require and equalizing charge. Contact Supervisor to determine if an equalizing charge is required (procedure number SC.MD-CM.ZZ-0009(Q)).

___ B. NO cell's corrected specific gravity is more than 0.010 below average corrected S.G. recorded in Step 5.7.4.B. **RECORD on Attachment 19.**

___ 5.7.7 If results are questionable, NOTIFY Maintenance Supervisor.

___ 5.7.8 If results are satisfactory, PROCEED with Service Test IAW Subsection 5.8.

5.8 BCT-2000 Series System Interconnections

___ 5.8.1 SITUATE BCT-2000 Continuous Load Unit (CLU) to minimize localized heating of nearby equipment due to its power dissipation.

NOTE

Attachment 6 should be used when performing the following BCT-2000 system interconnections.

Technician should review functions of the BCT-2000 by trial programming without CLU connected to the battery. Attachment 7 defines the BCT-2000 laptop computer screens.

___ 5.8.2 LOCATE 10 ft. gray cable with two female 37 pin molded computer connectors and CONNECT one end to BCT-128 Data Logging Acquisition Device (DLAD) labeled COMPUTER PORT. TIGHTEN thumb screws so they are secure.

CAUTION

Computer should be deenergized, when connecting/disconnecting any connectors/plugs to prevent blowing internal computer fuses.

5.8.3 CONNECT other end of 10 ft. gray cable to Laptop Display Unit (LDU) as follows:

___ A. LINE connector up with 10 ft cable connector, PUSH firmly into mating connector.

___ B. After connector is seated, TIGHTEN thumb screws.

NOTE

If LDU and DLAD are powered by same circuit, system current will trip circuit breaker.

___ C. CONNECT LDU and DLAD power cables to a separate 20 amp, 120 VAC power source.

___ 5.8.4 LOCATE and CONNECT 50 ft. gray Load Control cable with two Amphenol 37 pin connectors on each end between DLAD and CLU connector J2 (connector J29 if Hope Creek BCT-2000 is being used).

___ 5.8.5 INTERCONNECT J10 to J13 on CLU IAW Attachment 6.

___ 5.8.6 INSTALL insulated boots over unused bus bars located at rear of CLU.

___ 5.8.7 Using ground lug at rear of CLU cart, GROUND CLU.

___ 5.8.8 CONNECT 120 VAC power cable to CLU (J1) and CONNECT to a separate 20 amp, 120 VAC power source.

5.9 Programming of BCT-2000 Laptop Computer

___ 5.9.1 INSTALL one thermometer in each cell specified on Attachment 13 (total of two). **RECORD on Attachment 13 (T=0).**

___ 5.9.2 CALCULATE average electrolyte cell temperature by adding all monitored cell temperatures (Step 5.9.1) and dividing by two. **RECORD on Attachment 19.**

5.9.3 In sequence, ENERGIZE the following BCT-2000 system devices:

NOTE

Laptop Display Unit will automatically execute/initialize to the Load Test Program Menu.

CAUTION

If load Test Program Menu does NOT indicate the correct time and date, notify maintenance supervisor to enter the correct time and date using DOS.

___ A. Laptop Display Unit (LDU)

___ B. Data Logging Acquisition Device (DLAD)

NOTE

A clicking sound should be heard coming from the DLAD. This is the sound of the mechanical relays scanning the monitored channels.

___ 5.9.4 DEPRESS F1, Setup Test Parameters screen.

___ 5.9.5 PROGRAM BCT-2000 for Battery Service Test of 28 Volt Battery under test IAW Attachment 8.

___ 5.9.6 DEPRESS F1 and VERIFY screen inputted data is IAW Attachment 8, as applicable.

___ 5.9.7 DEPRESS ESC key to return to Load Test Program menu.

5.9.8 BACKUP Setup Test Parameter as follows:

___ A. INSERT backup floppy disk into LDU.

___ B. DEPRESS F5, Utilities.

___ C. DEPRESS F1, Backup Configuration.

___ D. DEPRESS ENTER key to backup configuration.

___ E. On LDU screen, VERIFY file was copied.

___ F. DEPRESS ESC to return to Load Test Program Menu.

___ 5.9.9 **RECORD for completion of BCT-2000 programming on Attachment 19.**

___ 5.9.10 DEENERGIZE all BCT-2000 devices.

___ 5.9.11 REMOVE backup floppy disk from LDU.

5.10 Connecting BCT-2000 to Battery Cell Terminal Posts

NOTE

Attachment 9 contains a detailed diagram for connection of sense leads used to obtain individual cells, intertier cables and overall battery voltage for a REVERSED polarity configuration (i.e. when the field cable lead is connected to the positive terminal of Cell #13).

5.10.1 CONNECT BCT-2000 system to 28 Volt Battery as follows:

___ A. LOCATE 25 ft. Sense Lead Extender gray cables with DB37 pin on one end and an Amphenol (round/black) 37 pin connector on other end.

___ B. CONNECT cable end with DB37 to DLAD port labeled CELL 1-32.

___ C. LOCATE red individual cell wire bundle with small numbered clips on one end (0-32) and Amphenol 37 pin on other end. CONNECT black connector end into other end of Sense Lead Extender Cable.

___ D. LOCATE Sense Lead Clip #0 from first set of red Individual Cell Wire Bundle and PLACE this clip on positive (negative) post of Cell #1.

___ E. LOCATE Sense Clip #1 from set of red Individual Cell Wire Bundle and PLACE this clip on negative post of Cell #2. CONTINUE this sequence until Clips #2-#12 have been connected.

___ F. On Cell #13, PLACE Clip #13 on positive post.

___ G. LEAVE Sense Leads Clips #14-#32 disconnected.

___ H. CONNECT Individual Cell Wire Bundle leads labeled OV+, OV- and IT-1 to connector labeled SYSTEM on back of DLAD.

___ I. LOCATE Sense Lead Clip labeled OV+ and CONNECT to positive post on Cell #13. (Refer to Attachment 9)

___ J. LOCATE Sense Lead Clip labeled OV- and CONNECT to negative post on battery Cell #1. (Refer to Attachment 9)

5.11.1 (Cont'd)

K. LOCATE and CONNECT leads labeled IT-1(+) and IT-1(+) as follows:

___ 1. PLACE leads IT-1(+) on positive post and IT-1(-) on negative post of intertier jumper between Cell #7 and Cell #8.

___ 2. LEAVE leads IT-2 through IT-8 disconnected.

5.11 Connecting Continuous Load Unit to Battery

5.11.1 CONNECT fused battery test cables from CLU to 28 Volt Battery as follows: Refer to Attachment 6.

___ A. NOTIFY Maintenance Supervisor for safety tagging of associated battery bus loads and battery chargers.

___ B. ENSURE associated battery bus loads and battery chargers are isolated.

CAUTION

Fused battery test cables should be completely uncoiled and should NOT lie upon one another to preclude the possibility of overheating.

Extreme care should be used while performing the following steps. The possibility of electrical shock exists.

Insulated matting should be placed on floor under/near Continuous Load Units and battery connections to insulate Technician from ground.

Temporary insulation should be installed on fused cable lugs and battery cable lugs as specified.

To minimize connection heating effects and overheating cell terminal post, each test fuse should be mounted to a large bus bar plate so that adequate space is available to separately bolt each 296 MCM cable lug.

___ C. DISCONNECT, INSULATE, and TIE BACK positive and negative battery leads at battery. **RECORD on Attachment 1.**

5.11.1 (Cont'd)

D. CONNECT two parallel 296 MCM load test cables from CLU to 28 Volt Battery as follows:

___ 1. PLACE insulating matting on floor under/near cable connection end of battery and CLU.

___ 2. At CLU, ENSURE test cables are disconnected.

___ 3. INSULATE CLU test cable lugs from each other and ground with temporary insulation boots.

___ 4. Using bus bar plates, CONNECT 400 amp test fuses to positive and negative battery terminals.

___ 5. At battery, CONNECT negative test cable to negative battery terminal.

___ 6. At CLU, REMOVE temporary insulation boot from end of negative test cable and CONNECT to negative connection of CLU (J12).

___ 7. At battery, CONNECT positive test cable to positive fused battery terminal.

___ 8. At CLU, REMOVE temporary insulation boot from end of positive test cable and CONNECT to positive connection of CLU (J11).

5.12 Battery Service Test Using BCT-2000

___ 5.12.1 ENSURE associated battery area exhaust fan is running or temporary ventilation system is in place and running.

CAUTION

DO NOT energize the Continuous Load Unit (CLU) at this time.

5.12.2 In sequence, ENERGIZE the following BCT-2000 devices:

NOTE

Laptop Display Unit (LDU) will automatically execute/initialize to the Load Test Program Menu screen.

___ A. Laptop Display Unit (LDU)

NOTE

A clicking sound should be heard coming from the Data Logging Acquisition Device (DLAD). This is the sound of the mechanical relays scanning the monitored channels.

___ B. Data Logging Acquisition Device (DLAD)

___ 5.12.3 After BCT-2000 system has initialized to Load Test Program Menu screen, PLACE CLU power switch ON.

CAUTION

CLU can safely operate with loss of all cooling fans, however personnel should NOT come in contact with CLU screen surfaces because they will get hot.

___ 5.12.4 VERIFY CLU control panel cooling fans and resistor bank cooling fans are running.

___ 5.12.5 DEPRESS F3, Test Reports.

___ 5.12.6 DEPRESS F4, Select Log File.

___ 5.12.7 Within Select Log File window, SELECT Test File ID that was entered in Set Test Parameters screen (Attachment 8) using Up/Down arrow keys (as required) and DEPRESS F2, Accept Choice.

___ 5.12.8 DEPRESS, ESC key to return to Load Test Program menu.

___ 5.12.9 SET BCT-2000 for REVERSED polarity configuration as follows:

___ A. DEPRESS F1, Setup Test Parameters screen.

___ B. Using DOWN ARROW key, move cursor to Voltage Polarity Field.

___ C. Using (+) key, SELECT REVERSED. DEPRESS ENTER.

___ D. DEPRESS ESC key to return to Load Test Program menu.

NOTE

The Function Key menu located at the bottom left of the Load Test Program Menu screen provides the following selections before the test begins:

- ESC - Escape Back to Main Menu
- F1 - Start Test
- F5 - Toggle Setup
- F6 - View Intertier - Display Toggles Between Cells and Intertier Connections
- F7 - Print Now

While the test is running the following selections are available:

- F1 - Stop Test
- F2 - Pause/Resume Test
- F3 - Manual/Auto Control (allows for increase/decrease of load in manual using + and - keys)
- F4 - Reset Audible Alarm
- F5 - Change Setup
- F6 - View Intertier - Display Toggles Between Cells and Intertier Connections

Intertier may NOT be visible at Step 5.12.10.B, but test may continue.

The BCT-2000 system will control the Service Test, as programmed, requiring only monitoring by Technician performing the test.

The BCT-2000 will automatically terminate test after 4 hours and 10 minutes and provide final printout.

___ 5.12.10 DEPRESS F2, Run Load Test and VERIFY BCT-2000 system is connected correctly as follows:

___ A. VERIFY all 13 cell voltages are displayed on LDU screen.

___ B. DEPRESS F6, View Intertier and VERIFY all three intertier sensor voltage bars are indicating on LDU screen.

___ C. DEPRESS F6, View Cells, to return to cell voltage screen.

___ D. VERIFY battery overall voltage (OV=) is displayed at top of LDU screen.

NOTE

On the far right side of the Load Test Display screen, a column labeled ALARM is displayed. This column will display cell and/or intertier that goes out of the programmed Low Cell Voltage or High Intertier Voltage Alarm. In addition the cell (vertical voltage bar) that is failing changes color state on the screen and is listed in the ALARM column.

Refer to Attachment 8, Section B (Test Setup Block) for other test alarm conditions.

Depressing F4 key will silence alarms.

Stopwatch will be used to record discharge time in event power is lost to computer/load bank during battery discharge.

CAUTION

Any battery connections which were NOT acceptable in battery Terminal Post Resistance Test should be monitored for excessive heating during performance of Battery Service Test. Connection cleaning and torquing will be performed after Battery Service Test is complete.

If ANY of the following conditions occurs, Battery Service Test SHOULD BE STOPPED by depressing F2 (pause) to investigate problem:

- **Any cell voltage rapidly decreasing below 1.75 VDC (i.e. cell voltage may reverse).**
- **Battery overall voltage (OV) is <22.8 VDC.**
- **Any monitored cell temperature exceeds 120°F.**
- **Cell terminal/cable connection temperature is much hotter than other cell terminal/connection temperatures.**
- **Terminal post grease is melting/smoking.**
- **Any other abnormal condition.**

___ 5.12.11 To start Service Test, simultaneously DEPRESS F1 and START stopwatch. **RECORD start time on Attachment 19.**

___ 5.12.12 On LDU Program Window (Test Started), OBSERVE the following:

- Step: 001
- Time: Clock Counting Down
- Load: Indicate Programmed Load Amps for Step 001
- Total Run Time: Clock Counting Up

NOTE

Steps 5.12.13 through 5.12.15 performance will overlap each other and be performed in parallel throughout the duration of the discharge test.

If a minimum voltage value IS NOT met in Step 5.12.13, this should be brought to immediate attention of Supervisor and OS/CRS. The test may continue as long as battery minimum voltage is ≥22.8 VDC.

____
$

5.12.13 At end of each loaded programmed step, VERIFY battery terminal voltage (OV) value indicated on top of Load Test Display screen) is ≥ minimum voltage values shown on Table 1 below. **RECORD battery terminal voltage at end of each Step on Attachment 19.**

TABLE 1

Minimum Voltage Values for Programmed Steps						
Battery	**Step 001** ($)	**Step 002** ($)	**Step 003** ($)	**Step 004** ($)	**Step 005**	**Step 006**
1A	24.9	24.9	24.9	24.6	24.0	23.9
1B	24.8	24.7	24.7	24.5	24.6	24.6
2A	25.0	25.0	25.0	24.6	24.0	24.0
2B	24.8	24.7	24.6	24.4	24.5	24.5

CAUTION

Load amps displayed on LDU should NOT be less than programmed current at each step If less than programmed current, test should be terminated. If >2 amps above programmed current, load amps displayed on LDU should be recorded in Comments Section and Supervisor should be notified.

___ 5.12.14 At end of each programmed step, VERIFY BCT-2000 LDU "Test Started block" changes to next step (e.g., "001" to "002", etc.) and Load Amps indicates programmed current IAW Attachment 8, Table 3.

___ 5.12.15 MONITOR cell temperatures at 15 minute intervals IAW Attachment 13, to ensure overheating does NOT occur. If temperature exceeds 120°F, STOP test by depressing F2. **RECORD cell temperatures and times on Attachment 13.**

NOTE

When test is finished, a message in Program Window, located at bottom right of Load Test Display screen, will show TEST ENDED.

___ 5.12.16 VERIFY BCT-2000 stopped Battery Service Test after 250 minutes (240 minutes loaded and 10 minutes unloaded) by verifying LDU program window indicates Test Ended and Total Run Time is 04:10:00. **RECORD time test ends on Attachment 19.**
$

___ 5.12.17 **RECORD battery terminal voltage when test ended (OV value indicated on top of Load Test Display screen) on Attachment 19.**

___ 5.12.18 DEENERGIZE CLU by placing power switch OFF.

___ 5.12.19 DEPRESS ESC key to return to Load Test Program Menu screen.

5.12.20 COPY Report File from LDU to backup floppy disk as follows:

___ A. DEPRESS F5, Utilities, to go to Load Test Program Utilities screen.

___ B. DEPRESS F2, Transfer File, to go to Transfer File screen.

___ C. INSERT backup floppy disk into LDU.

___ D. DEPRESS ENTER key to transfer file from LDU to floppy disk.

___ E. DEPRESS enter again.

___ F. On LDU screen, VERIFY file was copied.

___ G. DEPRESS ESC key to return to Load Test Program Menu screen.

___ 5.12.21 DEENERGIZE all BCT-2000 System devices.

CAUTION

Extreme care should be used while performing the following step. The possibility of electrical shock exists.

Insulated matting should be placed on floor under/near Continuous Load Unit and battery connections to insulate Technician from ground.

Temporary insulation boots should be installed on fused test cable lugs and battery cable lugs as specified.

5.12.22 DISCONNECT Continuous Load Unit (CLU) from battery as follows:

___ A. PLACE insulating matting on floor under/near cable connection end of battery and master CLU.

___ B. At CLU, DISCONNECT positive test cable from positive connection and place temporary insulation over lug.

___ C. At battery, DISCONNECT positive test cable from positive fused battery terminal.

___ D. At CLU, DISCONNECT negative test cable from negative connection and place temporary insulation over lug.

___ E. At battery, DISCONNECT negative test cable from negative fused battery terminal.

___ F. DISCONNECT fuses from positive and negative battery terminals.

___ G. DISCONNECT cable installed in Step 5.8.4.

5.13 Battery Cell Connection Retourqe/Cleaning

NOTE

If any cell connections were unsatisfactory during battery cell connection inspection (Subsection 5.5), applicable Steps of Subsection 5.13 should be performed prior to connecting battery field leads.

Retorquing is defined as loosening connection (breaking connection) and then torquing it to value listed. Retorque values are listed in vendors manual as "Subsequent Retorque Values" (used for maintenance checks).

"Initial Torque Values" are used whenever associated connection is new or disassembled and reassembled.

___ 5.13.1 RETORQUE all terminal post connections which have resistance(s) ≥120% AVERAGE BASELINE value, < MAXIMUM ALLOWABLE value, and little or NO terminal post/connection corrosion to 130 (125-135) in-lbs. **RECORD Retorqued Connection No.'s on Attachment 19.**

NOTE

The following step is used to determine if retorque of cell(s) has been successful prior to performing As Left Intercell Resistance Measurements checks of all cells.

___ 5.13.2 Using DLRO, MEASURE contact resistance of retorqued connection(s) IAW Step 5.5.2, and COMPARE values to Acceptance Criteria listed in Attachment 5, Table 1.

5.13.3 Supervisor Notification - Corrective Action Determination

___ A. If all retorqued resistance(s) are <120% of associated AVERAGE BASELINE values and little or NO terminal post/connection corrosion exists, GO TO Subsection 5.14. **RECORD on Attachment 19.**

___ B. If resistance(s) are still ≥120% AVERAGE BASELINE value, GO TO Step 5.13.4. **RECORD on Attachment 19.**

CAUTION

Voltage will be present at battery cell terminals. Use caution when working to prevent contact between positive and negative terminal posts or between terminal posts and ground.

___ 5.13.4 LOOSEN and carefully REMOVE unsatisfactory terminal post hardware, applicable intercell bus bar(s), cable lug(s) and terminal plate(s). **RECORD on Attachment 1, Disconnect Log connections disconnected.**

CAUTION

DO NOT use solvents, cleaning compounds, oils, waxes or polishes to clean battery containers or to remove NO-OX-ID grease from cell posts/connectors. A foreign liquid/material can enter cell and cause damage. Solvents can also craze thermoplastic cover or jar.

___ 5.13.5 WIPE grease and dirt from terminal post(s), bus bar(s), and hardware.

___ 5.13.6 INSPECT cell terminal posts for exposed copper or damage.

5.13.7 PERFORM Intercell Connection Inspection/Rework as follows:

___ A. INSPECT bus bar(s) and hardware for damage and exposed copper.

___ B. REPLACE, as required, with approved parts.

___ C. **DOCUMENT all replaced parts on Attachment 19, Section 4.0 Comments.**

___ 5.13.8 Using 1 lb. of baking soda per gallon of demineralized water, PREPARE a neutralizing solution in a plastic bucket or suitable container.

CAUTION

DO NOT let solution enter battery cell.

___ 5.13.9 APPLY solution to cell terminal post(s), cell jar, terminal plates, bus bar(s), and hardware with a lint-free cloth. NEUTRALIZE until fizzing action ceases.

___ 5.13.10 Using a lint-free cloth dampened with demineralized water, REMOVE residue from area and parts. ALLOW to air dry.

___ 5.13.11 Using a plastic bristle brush, CLEAN contact surfaces of applicable cell terminal posts, bus bars(s), cable lugs and terminal plates until a clean and bright surface is obtained.

NOTE

Preferred method for applying corrosion resistant grease is by heating NO-OX-ID A to cream-like consistency. However, NO-OX-ID A SPECIAL compound (NO heat required) may be used at discretion of Maintenance Supervisor and System Manager. [PR 990423148]

CAUTION

Grease has a minimum flash point of 450°F. DO NOT use heaters with open flames. Exercise extreme care when heating grease.

5.13.12 If Using NO-OX-ID A, PREPARE corrosion resistant grease as follows:

___ A. SET temperature of electric hot plate between 160°F and 185°F.

___ B. HEAT corrosion resistant grease to a cream-like consistency (an infrared lamp may be used in lieu of a hot plate).

___ C. APPLY a light coat of melted grease to ends of bus bar(s) by dipping them into melted grease coating approximately 2 inches in from each end.

___ D. Using a paint brush, APPLY melted grease to both sides of middle holes and contact surfaces on four and six hole connectors.

___ E. REMOVE any residue grease by wiping all terminal post surfaces with a clean lint-free cloth or paper towel.

___ F. APPLY a thin film of grease to all post surfaces.

___ G. WIPE all grease from cell jar cover(s).

5.13.13 If Using NO-OX-ID A SPECIAL, PERFORM the following:

___ A. Using a brush, APPLY light coat of grease, to ends of bus bar(s).

___ B. APPLY grease, to both sides of middle holes and contact surfaces on four and six hole connectors.

___ C. REMOVE any residue grease by wiping all terminal post surfaces with a clean lint-free cloth or paper towel.

___ D. APPLY a thin film of grease to all post surfaces.

___ E. WIPE all grease from cell jar cover(s).

___ 5.13.14 REASSEMBLE intercell bus bar(s) IAW manufacturer's required configuration.

NOTE

Provide counter-torque during final nut and bolt assembly tightening by using two insulated wrenches.

___ 5.13.15 TORQUE bolt assembly to 165 (160-170) in-lbs.

NOTE

The following step is used to determine if rework of cell(s) has been successful prior to performing As Left Intercell Resistance Measurements check of all cells.

___ 5.13.16 Using a DLRO, MEASURE contact resistance of all cleaned connection(s) IAW Step 5.5.2 and COMPARE values to Acceptance Criteria listed in Attachment 5, Table 1.

5.13.17 Supervisor Notification - Corrective Action Determination

___ A. If any cleaned resistance(s) are still ≥120% AVERAGE BASELINE value and < MAXIMUM ALLOWABLE value or ≤120% AVERAGE BASELINE value, GO TO Subsection 5.14. **RECORD on Attachment 19.**

___ B. If any resistance(s) are still ≥ MAXIMUM ALLOWABLE value or new cell(s) is/are ≥120% AVERAGE BASELINE value, NOTIFY Maintenance Supervisor/System Manger for resolution. **RECORD on Attachment 19.**

5.14 Post Service Test Battery Restoration

___ IV 5.14.1 RECONNECT positive and negative output cables to battery, and TORQUE bolt assemblies to 160 to 170 in-lbs.

___ 5.14.2 Using a DLRO, MEASURE forward and reverse resistance of battery positive and negative output cable connections. DLRO probes should be placed between approximate top center or side of terminal post and cable lug. **RECORD on Attachment 19.**

NOTE

At discretion of Maintenance Supervisor, individual cell voltages may be taken using BCT-2000 or a DVOM, during battery equalize charge. If using BCT-2000, LDU cables should remain connected. If NOT using BCT-2000, cables may be disconnected.

___ 5.14.3 If BCT-2000 will NOT be used to obtain data during battery equalizing PERFORM the following:

___ A. DISCONNECT cell and intertier sensing clips and REMOVE BCT-2000 test equipment from battery area.

___ B. NOTIFY Maintenance Supervisor to release safety tags for 28 Volt battery Charger ONLY.

___ C. REQUEST Operations to energize applicable battery charger, GO TO Subsection 5.15.

___ 5.14.4 If BCT-2000 will be used to obtain data during batter equalizing charge, PERFORM the following:

CAUTION

DO NOT energize battery charger until BCT-2000 LDU and DLAD are energized/programmed first.

Minimize time the battery is in a discharged state.

___ 5.14.5 NOTIFY Maintenance Supervisor to release safety tags for 28 Volt Battery Charger ONLY.

5.14.6 In sequence, ENERGIZE the following BCT-2000 devices:

___ A. Laptop Display Unit (LDU)

___ B. Data Logging Acquisition Device (DLAD)

___ 5.14.7 DEPRESS F1, Setup Test Parameter screen.

___ 5.14.8 PROGRAM BCT-2000 for 28 volt battery equalize charge IAW Attachment 11.

5.14.9 Using PERFORM the following:

___ A. DEPRESS F2, Run Load Test.

___ B. VERIFY all 13 cell voltages and overall battery voltage is displayed on LDU screen.

___ C. DEPRESS F1 to start equalize charge cell voltage recordings.

NOTE

Charger may go into current limit state when energized. When charger current decreases to approximately 100 amps, charger should be switched to equalize voltage mode and charger voltage should be adjusted accordingly.

___ D. REQUEST Nuclear Operations to energize applicable battery charger.

5.15 Battery Equalize Charge

___ 5.15.1 VERIFY applicable battery room exhaust fan is operating and exhaust air flow is observed.

CAUTION

Battery loads can be damaged with higher voltage used during an equalized charge. Associated bus loads SHOULD BE isolated for equipment protection IAW Step 2.2.

___ 5.15.2 ENSURE battery is energized from its applicable charger.

___ 5.15.3 CONNECT DVOM to monitor battery charger output voltage.

___ 5.15.4 Using second DVOM, or BCT-2000 MEASURE the following voltages.

___ A. As Found Battery Terminal Voltage. **RECORD on Attachment 19.**

___ B. As Found Individual Cell Voltages (ICVs), Time, Date, and Initials. **RECORD on Attachment 16, Data Sheet.**

___ 5.15.5 DETERMINE equalize voltage by using one of the applicable methods outlined in Attachment 14. **RECORD Battery Equalize Voltage on Attachment 19.**

___ 5.15.6 PLACE applicable charger on equalize operation by placing selector switch or timer to EQUALIZE position, or by rotating timer to desired setting to maintain charger on equalize.

CAUTION

It is NOT expected cell temperature will rise significantly during equalize charge. However, cell temperatures should be monitored, especially in beginning when charging current is greatest, to ensure maximum temperature limits are NOT exceeded.

___ 5.15.7 MONITOR Individual Cell Temperatures by installing a temperature measuring device (with "cell stop" attached) into associated cell's flame arrester. MONITOR approximately six cells equally spaced (as indicated by # sign on Attachment 17, Data Sheet).

___ 5.15.8 VERIFY/ADJUST Battery Charger Voltage or TURN equalize potentiometer (EQ) clockwise to Equalize Voltage determined in Step 5.15.5.

___ 5.15.9 MEASURE Individual Cell Voltages. **RECORD ICVs, Time, Date and Initials on Attachment 16, Data Sheet.**

NOTE

During equalize charge, cell connections should be monitored to ensure NO hot spots exist (especially in beginning when charging current is highest).

Cell temperatures should be monitored to ensure NO cell exceeds 120°F, and the difference between any 2 cell temperatures DOES NOT exceed 5°F.

___ 5.15.10 If any of the following occur, STOP equalize charge and NOTIFY Supervisor:

- Any cell temperature exceeds 120°F.
- The difference of any 2 cell temperatures exceeds 5°F.
- Cell connections become hot to touch or smoke is observed.

NOTE

Battery terminal voltage and charging current should be monitored and recorded hourly. The most accurate indicator of return to full charge is a stabilized charging/float current.

___ 5.15.11 **RECORD hourly battery terminal voltage and charging current readings on Attachment 15, Data Sheet.**

___ 5.15.12 After battery has been on equalize charge for 8-12 hours, MEASURE ICVs. **RECORD ICV's Time, Date & Initials on Attachment 16, Data Sheet.**

___ 5.15.13 CALCULATE ICV Average by adding all ICVs and dividing by total number of cells (cells jumpered will NOT be counted toward "total number" of cells). **RECORD ICV Average Voltage on Attachment 16, at end of Data Sheet.**

NOTE

Equalize charge should NOT continue for more than 72 hours without monitoring.

___ 5.15.14 COMPARE ICV Average to recorded ICV's and PERFORM the following:

- If ANY ICV is >0.05 VDC below ICV Average, CONTINUE equalize charge IAW Step 5.15.12 for a number of 8-12 hour periods as determined by Maintenance Supervisor, then GO TO Step 5.15.15.
- If NO ICV measurement is >0.05 VDC below Average ICV, GO TO Step 5.15.17.

___ 5.15.15 For cell(s) >0.05 VDC below ICV Average, TAKE 3 consecutive ICV measurements, 1 hour apart. **RECORD each hourly ICV on Attachment 16, Data Sheet, along with Time, Date and Initials.**

___ 5.15.16 COMPARE the three consecutive ICV measurements for each cell.

- If all three ICV measurements are ≤0.05 VDC of each other, GO TO Step 5.15.17.
- If any ICV measurement(s) is >0.05 VDC of each other, CONTINUE equalize charge and GO TO Step 5.15.15.

NOTE

Battery can be considered charged when charger current is at zero or when charger current has stabilized, where stabilized is defined as 3 consecutive readings 1 hour apart within 10% of each other. At this point, loads may be reapplied to the bus, as long as bus voltage is equal to or less than maximum allowable voltage specified on Attachment 14. The remainder of procedure will be continued to ensure a "polishing charge" is applied to the battery.

___ 5.15.17 REVIEW Attachment 16 for stabilized charging current.

___ A. If the last three hourly readings are zero or stabilized (refer to NOTE above), CONTINUE the hourly readings and GO TO Step 5.15.17.C.

___ B. If charging current is NOT zero or stabilized, CONTINUE equalize charge and REPEAT Step 5.15.17.

___ C. PLACE applicable battery charger on float charge.

___ 5.15.18 After battery has been on equalize charge DEPRESS F1, Stop Test.

___ 5.15.19 DEPRESS ESC key to return to Load Test Program Menu screen.

5.15.20 COPY Report File from LDU to backup floppy disk as follows:

___ A. DEPRESS F5, Utilities, to go to Load Test Program Utilities screen.

___ B. DEPRESS F2, Transfer File, to go to Transfer File screen.

___ C. INSERT backup floppy disk into LDU.

___ D. DEPRESS ENTER key to transfer file from LDU to floppy disk.

___ E. DEPRESS enter again.

___ F. On LDU screen, VERIFY file was copied.

___ G. DEPRESS ESC key to return to Load Test Program Menu screen.

___ 5.15.21 DEENERGIZE all BCT-2000 System devices.

___ 5.15.22 DISCONNECT cell and intertier sensing clips and REMOVE BCT-2000 Test Equipment from battery area. **RECORD on Attachment 19.**

___ 5.15.23 If battery charger output and battery terminal voltage are equal to or less than maximum allowable voltage specified on Attachment 14, NOTIFY OS/CRS that any battery loads tagged out in Step 2.2 may be returned to service.

5.16 Post Service Test Operability Determination

NOTE

Battery may be declared "OPERABLE" following satisfactory completion of Subsection 5.16.

Data collection steps need NOT be performed in exact order as written, provided all required steps are performed and all data is obtained. For example, temperatures, specific gravities and ICVs may be obtained simultaneously.

___ 5.16.1 MEASURE As Found battery terminal voltage at battery.
$ **RECORD As Found battery float voltage on Attachment 19.**

NOTE

Individual Cell Voltage (ICV) minimum Technical Specification Value is ≥2.13.

___ 5.16.2 MEASURE ICV's for all cells, and **RECORD ICV's on Attachment 4B Data Table, in "ICV" column.**
$

___ 5.16.3 REMOVE each cell's flame arrester cap and sample tube dust cover.

___ 5.16.4 Cell Temperature Measurements:

NOTE

Cell temperatures should be obtained using electronic temperature measurement device with acid resistant probe, if available; otherwise, non-mercury thermometer should be used.

CAUTION

If glass non-mercury thermometer is used, "Stops" should be attached to prevent dropping thermometer into cell.

___ A. INSERT acid resistant probe or non-mercury thermometer with "Stop" attached into flame arrester filler vent for Cell No. 1.

___ B. ALLOW temperature to stabilize.

___ C. **RECORD stabilized temperature on Attachment 4B Data Table, in "CELL TEMP" column (expected value 65°F-105°F).**

___ D. REPEAT Steps 5.16.4.A through 5.16.4.C for all cells listed in Attachment 4B, Data Table.

NOTE

DO NOT add water to any cells at this time.

Immediately report failure of any cell to meet Technical Specification acceptance criteria to Supervisor for evaluation and possible corrective action.

Technical Specifications require level to be >low level mark and ≤8/32 inch above high level mark.

5.16.5 Electrolyte Level Determination:

___ A. MEASURE distance between bottom of high level mark and electrolyte level for all cells.

___ B. NOTIFY OS and Supervisor immediately if level is above high level mark or below low level mark (>8/32 in. above high level mark or ≤low level mark).

___ $ C. **RECORD number of 1/32 in. increments, electrolyte level is below high level mark on Attachment 4B Data Table, in "CELL LEVEL" column.**

___ ♦ If level is >high level mark, indicate the number of 1/32 in. increments electrolyte level is above high level mark by including a positive (+) sign preceding number.

5.16.6 Specific Gravity Measurement:

___ A. INSERT hydrometer into sample tube of each cell.

___ B. WITHDRAW electrolyte sample into hydrometer.

___ C. RETURN electrolyte sample into flame arrester filler vent.

___ D. RE-INSERT hydrometer into sample tube.

___ E. WITHDRAW second electrolyte sample into hydrometer.

___ F. READ specific gravity of sample.

___ G. RETURN electrolyte into battery sample tube.

___ H. **RECORD Measured Specific Gravity on Attachment 4B Data Table, in "MEAS. S.G." column.**

___ 5.16.7 REPLACE each cell's flame arrester cap & sample tube dust cover.

5.16.8 Temperature Compensation Calculation:

___ A. CALCULATE average cell temperature by adding cell temperatures recorded on Attachment 4B Data Table and dividing by total number of cell temperature measurements.

___ B. **RECORD cell average temperature on Attachment 19.**

$

___ C. CALCULATE cell specific gravity temperature compensation as follows:

- **RECORD (+) 0.001 temperature correction value for every 3°F the cell temperature is above 77°F, on Attachment 4B Data Table, in "TEMP CORR" column for each cell.**

OR

- **RECORD (-) 0.001 temperature correction value for every 3°F the cell temperature is below 77°F, on Attachment 4B Data Table, in the "TEMP CORR" column for each cell.**

___ D. CALCULATE temperature corrected S.G. by adding or subtracting TEMP CORRECTION to/from MEASURED S.G. for all cells.

___ E. **RECORD temperature corrected S.G. on Attachment 4B Data Table, in "TEMP CORR S.G." column.**

NOTE

Level compensation is NOT required if:

- recorded level is ≥ high level mark, or
- battery charging current is < 2 amps while on float charge.

5.16.9 Level Compensation Calculation for level corrections factors. (Refer to Attachment 3)

___ A. Using recorded "CELL LEVEL", DETERMINE cell level correction factor, for each cell. (Refer to Attachment 3)

___ B. **RECORD level compensation on Attachment 4B Data Table, in "LEVEL CORR FACT" column.**

5.16.10 Corrected Specific Gravity Calculation (Tech Spec minimum is ≥ 1.190).

___ A. CALCULATE corrected specific gravity for each cell by subtracting LEVEL CORRECTION FACTOR from TEMP CORRECTED S.G.

NOTE

Individual battery cell corrected specific gravity nominal range should be 1.200-1.220 for fully charged cell. If any cell's corrected specific gravity is < 1.200 OR any cell's corrected specific gravity is > 1.230, NOTIFY Supervisor and System Manager.

___ $ B. **RECORD corrected specific gravity on Attachment 4B Data Table, in "CSG" column.**

5.16.11 Average Corrected Specific Gravity Calculation:

___ A. CALCULATE average corrected specific gravity by adding all corrected specific gravities and dividing by total number of cells (NOT counting jumpered cells, normally 60).

___ $ B. **RECORD average corrected specific gravity on Attachment 19.**

NOTE

Immediately report failure of any cell to meet Technical Specification acceptance criteria to Supervisor for evaluation and possible corrective action.

___ 5.16.12 ENSURE the following Tech Spec Acceptance Criteria have been met for each cell listed in Attachment 4B. **INITIAL on Attachment 4B Data Table, in "TECH SPEC CRIT SAT" column of each cell when criteria listed below are met.**

- Individual cell voltage in "ICV" column is ≥ 2.13 VDC while under float charge (2.13 or more in ICV column).

NOTE

The next Tech Spec acceptance criteria is satisfied when any ICV is ≥ 2.13 VDC. The bases is as follows:

- All original ICV's were < 2.40 VDC.
- 2.40 VDC - 0.27 VDC = 2.13 VDC.
- However, NO cell may be allowed to be < 2.13 VDC (Tech Spec lower limit).
- Therefore, as long as ICV's are ≥ 2.13 VDC, Tech Spec for ICV's NOT decreasing by more than 0.27 VDC for original acceptance test is satisfied.

- Individual Cell Voltage in "ICV" column has NOT decreased more than 0.27 VDC from value observed during original acceptance test. This criteria is satisfied when ICV is ≥ 2.13 VDC in "ICV" column based on note above.
- Corrected specific gravity in "CORRECTED S.G." column for each cell is ≥ 1.190.
- Electrolyte level between high and low levels marks.

___ 5.16.13 ENSURE the following Non-Tech Spec Acceptance Criteria have been met for each cell listed in Attachment 4B.

___ A. NO "recorded" cell temperature is >5°F from cell average temperature recorded in Step 5.16.9.B. **RECORD on Attachment 19.**

NOTE

Cells with corrected specific gravity >0.010 below average corrected S.G. should corrected by polishing charge (Subsection 5.17).

___ B. NO cell's corrected specific gravity is >0.010 below average corrected S.G. recorded in Step 5.16.11.B. **RECORD on Attachment 19.**

___ 5.16.14 REVIEW Attachment 4B for individual cells that have level >16/32 in. below high level mark.

___ 5.16.15 ADD demineralized water to all cells whose electrolyte level is >16/32 in. below high level mark AND "TEMP CORRECTED S.G." listed in Step 5.16.8.E of Data Table 4B is 1.218 or greater. FILL cell between 10/32 & 12/32 in. below high level mark.

NOTE

Electrolyte in all cells should be at approximately same level, and all cells should require watering at same time. Cell with levels considerably lower than majority of cells, may be indicative of leaks or internal problems, and should be investigated.

If, in judgement of Supervisor, electrolyte level will decrease to >16/32 in. below high level mark prior to next quarterly inspection, demineralized water may be added to those cells with an electrolyte level between 13/32 and 16/32 in. below high level mark provided those cell's "TEMPERATURE CORRECTED" S.G. is 1.218 or greater.

___ 5.16.16 At Supervisor's discretion, ADD demineralized water to those cells whose electrolyte level is between 13/32 and 16/32 in. below high level mark AND "TEMP CORR S.G." listed in column Step 5.16.8.E of Data Table 4B is 1.218 or greater. FILL cell between 10/32 & 12/32 in. below high level mark.

___ 5.16.17 **RECORD yes (Y) or no (N) on Attachment 4B Data Table, in "WTR ADD" column for individual cells.**

___ 5.16.18 **RECORD on Attachment 19 individual cell numbers for all cells from Steps 5.16.15 and 5.16.16 that were NOT filled due to "TEMPERATURE CORRECTED" S.G. being <1.218 AND level ≥16/32 in. below high level mark.**

___ 5.16.19 CONTACT Supervisor for resolution of cells recorded in Step 5.16.18.

___ 5.16.20 If all Tech Spec acceptance criteria of Step 5.16.12 was satisfactory, NOTIFY Operations that battery may be declared operable.

5.17 Post Service Test Polishing Charge

NOTE

Equalize charge may be terminated any time during performance of Step 5.17.2 at the discretion of Supervisor/System Manager.

___ 5.17.1 PLACE applicable battery charger on equalize.

5.17.2 OBTAIN daily temperature corrected specific gravity measurement for each cell as follows:

___ A. REMOVE each cell's flame arrester and sample tube dust cover.

NOTE

Cell temperatures should be obtained using electronic temperature measurement device with acid resistant probe, if available; otherwise, a non-mercury thermometer may be used.

CAUTION

If a glass non-mercury thermometer is used, "Stops" must be attached to prevent dropping thermometer into cell.

___ B. OBTAIN cell temperature measurements as follows:

___ 1. INSERT acid resistant probe or non-mercury thermometer with a "stop" attached into applicable cell's (as indicated on Attachment 17) flame arrester filler vent.

5.17.2 (Cont'd)

NOTE

The expected stabilized cell temperature is 65°F to 120°F.

2. ALLOW temperature to stabilize. **RECORD stabilized temperatures on Attachment 17, in CELL TEMP column.**

C. OBTAIN specific gravity measurements as follows:

1. INSERT hydrometer into sample tube of cell.

2. WITHDRAW electrolyte sample into hydrometer.

3. RETURN electrolyte sample into flame arrester filler vent.

4. REINSERT hydrometer into sample tube.

5. WITHDRAW a second electrolyte sample into hydrometer.

6. READ specific gravity of sample.

7. RETURN electrolyte sample into flame arrester filler vent. **RECORD measured specific gravity on Attachment 17, in MEASURED SG column.**

D. REPLACE each cell's flame arrester and sample tube dust cover.

E. PERFORM specific gravity temperature compensation/correction calculation as follows:

1. ADD all cell temperatures recorded on Attachment 17.

2. DIVIDE sum of cell temperatures by total number of cells measured. **RECORD cell temperature average on Attachment 19.**

5.17.2.F (Cont'd)

___ 3. CALCULATE cell specific gravity temperature compensation as follows:

- **RECORD a (+) 0.001 temperature correction value for every 3°F, average cell temperature is above 77°F, on Attachment 17, in TEMP CORR FACTOR column for each cell.**

OR

- **RECORD a (-) 0.001 temperature correction value for every 3°F, average cell temperature is below 77°F, on Attachment 17, in TEMP CORR FACTOR column for each cell.**

___ 4. CALCULATE temperature corrected specific gravity by adding **OR** subtracting temperature correction to/from measured specific gravity for all cells. **RECORD temperature corrected specific gravity on Attachment 17, TEMP CORR SG column.**

___ F. REPEAT Steps 5.17.2.A through 5.17.2.E.4 daily (as determined by supervisor) until temperature corrected specific gravity for each cell is ≥1.215 or as determined by Supervisor/System Manager.

___ G. VERIFY temperature corrected specific gravity for each cell is ≥1.215 or as determined by Supervisor or System Manager. **RECORD on Attachment 19.**

5.17.3 TERMINATE equalize charge by performing the following:

___ A. **RECORD on Attachment 19 battery Nominal Float Voltage.** [28.9-29.3]

___ B. PLACE charger selector switch or timer to FLOAT position, or by turning timer to zero (0) position.

5.17.3 (Cont'd)

NOTE

Float voltage span is the number of cells connected, multiplied by minimum and maximum Individual Cell Voltage ICV).

When one or more cells are jumpered, reduce battery float voltage to maintain maximum "volt/cell" value while maintaining minimum required battery voltage is 28 VDC.

CAUTION

DO NOT set float voltage greater than 29.3 VDC.

___ C. ADJUST Battery Charger Output Float Voltage Pot so Battery Terminal Voltage is within Nominal Float Voltage Range recorded in Step 5.17.3.A. **RECORD on Attachment 19.**

___ 5.17.4 TAKE 3 consecutive ICV measurements of all cells, 1 hour apart. **RECORD each hourly ICV on Attachment 18, Data Sheet, along with Time, Date and Initials.**

___ 5.17.5 COMPARE the three consecutive ICV measurements for each cell.

- If all three ICV measurements (of an individual cell) are ≤0.05 VDC of each other, GO TO Step 5.17.6.
- If any ICV measurement(s) (of an individual cell) is >0.05 VDC of each other, CONTINUE Float Charge and REPEAT Step 7.5.8.

___ 5.17.6 MEASURE As Left Battery Terminal Float Voltage. **RECORD on Attachment 19.**

___ 5.17.7 VERIFY electrolyte level is between high and low level mark on each cell. **RECORD on Attachment 19.**

___ 5.17.8 NOTIFY OS/CRS equalize charge is complete, and if loads were NOT returned to service in Step 5.15.17.C, they may be return to service at this time.

___ 5.17.9 PERFORM SC.MD-ST.28D-0003(Q), Quarterly Inspection and Preventive Maintenance, in its entirety 72 hours after battery has been restored to float charge.

5.18 Completion Summary

___ 5.18.1 NOTIFY OS/CRS testing is complete.

___ 5.18.2 NOTIFY RO testing is complete.

___ 5.18.3 Independently VERIFY all calculations are correct. **RECORD signature of verifier on Attachment 19, Section 4.0. [C0284]**

___ 5.18.4 FORWARD backup floppy disk to System Manager.

END OF PROCEDURE SECTION

6.0 RECORDS

6.1 Retain the entire procedure.

7.0 REFERENCES

7.1 UFSAR Sections

7.1.1 8.3.2, DC Power

7.2 Technical Specifications - Units 1 & 2

7.2.1 4.8.2.3.2.f, Surveillance Requirement

7.2.2 4.8.2.4.2, Surveillance Requirement

7.2.3 Technical Specification Amendments 249 and 229

7.3 Commitments

7.3.1 C0265 NSO#LER 311/89-015-00

7.3.2 C0284 NSO#LER 272/90-014-00

7.4 PSBPs

7.4.1 121834, C&D Installation and Operation Instructions for Stationary Batteries

7.4.2 316844, Alber Corp. - BCT-2000 Series Operations Manual

7.4.3 301960, C&D Stationary Battery Operating Instructions (LC-33)

7.5 Others

7.5.1 IEEE-450-1987, Recommended Practice for Maintenance, Testing and Replacement of Large Lead Storage Batteries for Generating Stations and Substations

7.5.2 C&D Battery-Installation and Operating Instructions 12-800 Copyright 1986 and 1988

7.5.3 C&D Calculated Short Circuit Current Values, September 1983

7.5.4 C&D Battery Discharge Characteristics Curves - KCR(D842 Rev. 1), LCR(D-841 Rev. 1) and C&D Data Sheets KCR(12-316) and LCR(12-334)

7.5.5 Field Directive S-C-E200-EFD-0318, Rev. 0

7.5.6 C&D Batteries Letter dated October 3, 1989 from Graham Walker, Manager Applications Engineering to L. Miceli/R. Chranowski; Subject: Correcting Electrolyte Specific Gravity for Level

7.5.7 Design Calculation ES-4.003(Q), Rev. 1

7.5.8 Design Calculation ES-4.004(Q), Rev. 2

7.5.9 UFSAR Change Notice #94-04

7.5.10 UFSAR Change Notice 96-53

7.5.11 Engineering Memo, NE-96-0647, Subject; 125 & 28 VDC Envelope (LOOP/LOCA and SBO) Battery Load Profile

7.5.12 Salem ECG Section 7.2, Loss of DC Power Capabilities

7.5.13 PR 960504082

7.5.14 PR 970829096

7.5.15 PR#971201342 - TSSIP project enhancements

7.5.16 PR#971126143 - TSSIP project enhancements

7.6 Cross-References

7.6.1 SC.MD-CM.ZZ-0009(Q), Battery Equalizing Charge Procedure

7.6.2 NC.NA-AP.ZZ-0011(Q), Document Management Program

7.6.3 NC.NA-AP.ZZ-0014(Q), Training, Qualification and Certification

7.6.4 NC.NA-AP.ZZ-0015(Q), Safety Tagging Program

7.6.5 NC.NA-AP.ZZ-0038(Q), Chemical Control Program

- Baking soda (bicarbonate sodium) CICP# 900-0047

7.6.6 SH.MD-AP.ZZ-0003(Q), Maintenance Department Written Instruction Use Standard

ATTACHMENT 1

DISCONNECT LOG				
TERMINAL CONNECTION	DISCONNECTED		CONNECTED	
	DISCONNECTED BY	CONCURRENT DUAL VERIFICATION BY	CONNECTED BY	INDEPENDENT VERIFICATION BY
(+) BATTERY LEADS				
(-) BATTERY LEADS				
1A-2A				
2A-3A				
3A-4A				
4A-5A				
5A-6A				
6A-7A				
# 7-8				
8A-9A				
9A-10A				
10A-11A				
11A-12A				
12A-13A				

ATTACHMENT 1 (Cont'd)

JUMPER LOG

JUMPER NO.	TERMINAL LOCATION				INSTALLED		REMOVED	
	FROM		TO					
	TERM. BLOCK	TERM. NO.	TERM. BLOCK.	TERM. NO.	INSTALLED BY	CONCURRENT DUAL VERIFICATION BY	REMOVED BY	INDEPENDENT VERIFICATION BY

ATTACHMENT 2

PREPARATION OF CONTACT SURFACES FOR ANTI-CORROSION COATING

NOTE

All electrical surfaces should have clean, bright finish before NO-OX-ID Grease is applied.

A. NO-OX-ID GREASE (C&D Part No. RG-26)

1. INSPECT surfaces and REMOVE all grease, oil and discoloration with clean cloth and plastic bristle brush.

CAUTION

If hot plate DOES NOT have thermostatic control, exercise extreme care to avoid overheating grease and causing a fire. DO NOT use heaters with open flames. NO-OX-ID grease has minimum flash point of 450°F (232°C)

2. HEAT NO-OX-ID grease to cream like consistency, using infrared lamp or thermostatically controlled hot plate.

3. SET temperature somewhere between 160°F (71°C) to 185°F (85°C) to maintain this consistency.

4. Use 1 in. paint brush to apply NO-OX-ID grease. APPLY light coat of NO-OX-ID grease to each surface of intercell connectors that has been cleaned.

ATTACHMENT 3

CELL LEVEL CORRECTION FACTORS

NO. OF 1/32" INCREMENTS	CORRECTION FACTOR	NO. OF 1/32" INCREMENTS	CORRECTION FACTOR
1	0.001	17	0.011
2	0.001	18	0.012
3	0.002	19	0.012
4	0.003	20	0.013
5	0.003	21	0.014
6	0.004	22	0.014
7	0.005	23	0.015
8	0.005	24	0.016
9	0.006	25	0.016
10	0.007	26	0.017
11	0.007	27	0.018
12	0.008	28	0.018
13	0.009	29	0.019
14	0.009	30	0.020
15	0.010	31	0.020
16	0.010	32	0.021

ATTACHMENT 4A

PRE SERVICE TEST BATTERY DATA TABLE

STEP	5.6.2	5.6.4.C	5.6.5.C	5.6.6.H	5.7.1.C	5.7.1.E	5.7.2.B	5.7.3.B	5.7.5	N/A
CELL NO.	ICV (VDC) $	CELL TEMP (°F)	CELL LEVEL NO. OF 1/32'S $	CORRECTED SPECIFIC GRAVITY CALCULATION SG (*) TC = TCSG (-) LC = CSG					ACCEP CRIT. SAT INIT.	WTR. ADD Y/N
				MEAS. S.G.	TEMP CORR.	TEMP CORR. S.G.	LEVEL CORR. FACT.	CORR. S.G. $		
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										

* Enter plus or minus sign in parenthesis from temperature compensation calculation performed in Step 5.7.1.C.

$ TECH SPEC ACCEPTANCE CRITERIA:

1. ICV's ≥ 2.13 VDC
2. Present ICV's NOT < 0.27 VDC from original acceptance test (satisfied if present ICV is ≥ 2.13 VDC).
3. Electrolyte level between high & low marks.
4. Corrected specific gravity ≥ 1.190

ATTACHMENT 4B

POST EQUALIZE BATTERY DATA TABLE

STEP	5.16.2	5.16.4.C	5.16.5.C	5.16.6.H	5.16.8.C	5.16.8.E	5.16.9.B	5.16.10.B	5.16.12	5.16.17
CELL NO.	ICV (VDC) $	CELL TEMP (°F)	CELL LEVEL NO. OF 1/32'S $	CORRECTED SPECIFIC GRAVITY CALCULATION SG (*) TC = TCSG (-) LC = CSG					ACCEP CRIT. SAT INIT.	WTR. ADD Y/N
				MEAS. S.G.	TEMP CORR.	TEMP CORR. S.G.	LEVEL CORR. FACT.	CORR. S.G. $		
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										

* Enter plus or minus sign in parenthesis from temperature compensation calculation performed in Step 5.16.8.C.

$ TECH SPEC ACCEPTANCE CRITERIA:

1. ICV's ≥ 2.13 VDC
2. Present ICV's NOT < 0.27 VDC from original acceptance test (satisfied if present ICV is ≥ 2.13 VDC).
3. Electrolyte level between high & low marks.
4. Corrected specific gravity ≥ 1.190.

ATTACHMENT 5

CELL Resistance Data Table

UNIT NO. _____ BATTERY NO. _____ DATE _____

BETWEEN CONN.	Step 5.5.2.A RESISTANCE (MICRO-OHMS) FWD	REV	Step 5.5.2.B.3 A-A AVE CONN.	$ Step 5.5.5 ACCEPTANCE CRITERIA SAT	NOT SAT	INITIAL
* (-)CONN						
1A-2A						
2A-3A						
3A-4A						
4A-5A						
5A-6A						
6A-7A						
# 7-8						
8A-9A						
9A-10A						
10A-11A						
11A-12A						
12A-13A						
* (+)CONN						
STEP 5.5.3.B	BATTERY CONNECTION AVERAGE RESISTANCE		_____ μOhms			

NOTE

* Enter connection resistance of terminal post and positive or negative field cable. These resistance NOT to be used in BATTERY CONNECTION AVERAGE RESISTANCE calculation.

\# Enter measurement of cell bank jumper plus connection resistance. These resistance NOT to be used in BATTERY CONNECTION AVERAGE RESISTANCE calculation.

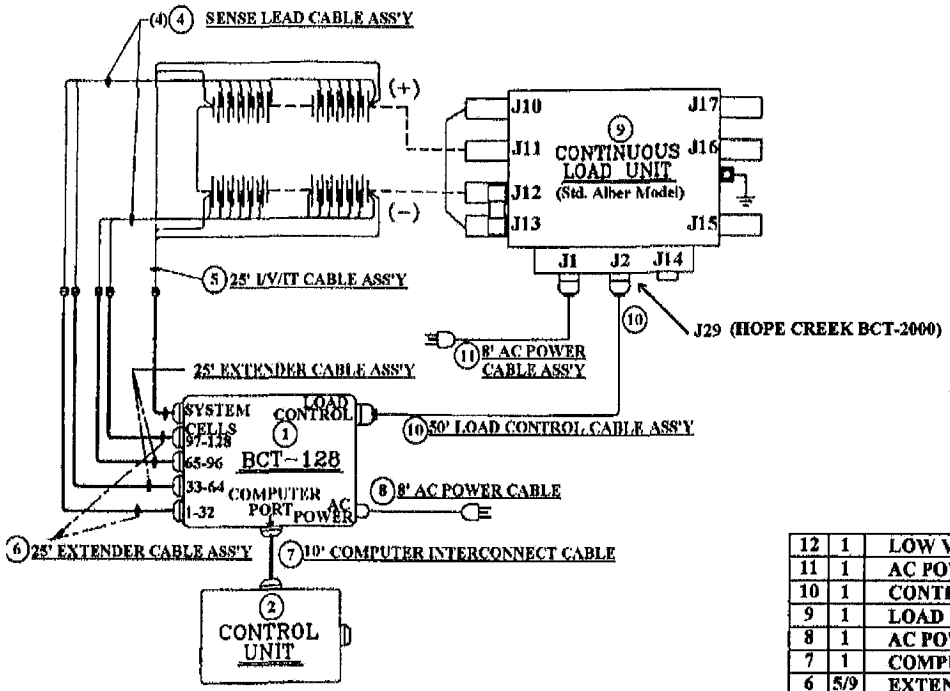
ATTACHMENT 5 (Continued)

Table 1 - Cell Resistance Acceptance Criteria

28V BATTERIES		
CONNECTION TYPE	**120% AVE BASELINE**	**MAXIMUM ALLOWABLE**
Square Four Post: (A-A)	≤31 μohms	≤50 μohms
Field Cable: (+)CONN, (-)CONN	≤8 μohms	≤20 μohms
Jumper Cable + Connections: NO. 7-8	≤135 μohms	≤150 μohms

ATTACHMENT 6

BCT-2000 SERIES INTERCONNECTION DIAGRAM



12	1	LOW VOLTAGE JUMPER CABLE
11	1	AC POWER CABLE (CLU)
10	1	CONTROL CABLE (ECU/CLU)
9	1	LOAD UNIT (CLU)
8	1	AC POWER CABLE (ECU)
7	1	COMPUTER INTERCONN. CABLE
6	5/9	EXTENDER CABLE
5	1	I/V/IT CABLE
4	4/8	SENSE LEADS
3	1	PRINTER (OPTIONAL) - NOT SHOWN
2	1	CONTROL UNIT
1	1	BCT-128

<u>ONLY</u> CABLE EXTENDER PORT 1-32 WILL BE USED FOR 13 CELL BATTERY SENSE LEAD CABLE CONNECTIONS

ATTACHMENT 7

DEFINING BCT-2000 SERIES SCREENS

Load Test Program Menu - The Main Menu

Load Test Program Menu, also known as Main Menu is where user begins all operations. This is point where user makes selection to use subsequent Menu Screens. Whenever a user finishes with a screen they will revert back to Load Test Program Menu (Main Menu). If user wants to exit to BCT-2000 program, hit F6 (Function Key) to exit to DOS and DOS SHELL program. To return from DOS to program, turn computer off, and then turn back on or select Exit from DOS SHELL and then depress ENTER. If you exited DOS SHELL to C:>, type in CD\ALBER, depress ENTER, then type BCT-2000 and depress ENTER.

Set-Up Test Parameters Screen F1

Each time a test is performed or system is used for data-logging, it is necessary to go through this screen. Set-Up Test Parameter screen allows user to input information on battery being tested for report purposes. In addition, this screen is where user will set all parameters such as Cell Alarms, Voltage Alarms, Number of Cells Tested, Intertier Connections and Test Program. THIS SCREEN GIVES SYSTEM ALL ITS INSTRUCTIONS ON HOW TO OPERATE TEST.

Run Load Test Display Screen F2

User will spend majority of test time in this screen. This screen provides all relative information pertaining to battery during testing in a real time mode. All individual cells are in a bar graph format enabling user to visually scan all individual cell voltages (ICVs) without having to interpolate columns of numbers. In addition to ICVs, Overall Volts, Current, KW and Capacity, Test Parameters, Cell Faults (alarms), Step Number(s) and Total Run Time are also displayed. This screen also allows user to toggle between ICVs screen and Intertier Voltage screen.

Load Test Report Screen F3

This screen is used when a report is required from a previously completed test. This screen gives option of listing Test Files, how report will be outputted and type of report wanted. This screen is the ONLY screen that will provide user with a final report or option of transferring test data file to a floppy disk for analysis using another commercial software package or for report printout using BCT-2000 software on a PC. Printout of completed test file will be performed by System Engineer or Maintenance Supervisor.

ATTACHMENT 7 (Cont'd)

Hardware Diagnostics Screen F4

Hardware Diagnostic Screen basically moves user to a second Sub-Menu labeled Hardware Diagnostic menu. This menu allows user to calibrate system (password protected), perform diagnostic on BCT-2000, I70 Control Board or to perform diagnostics on Load Control Board for use with Alber Optional Load Banks. This screen is primarily used when calibration of system is required or if a problem is encountered with unit. Diagnostic function is a tool to help user perform self checks on system. Use of this screen will void BCT-2000 calibration and test results. DO NOT USE THIS FUNCTION.

Utilities F5

This allows user to go to a sub-menu where configuration can be Backed-up to Transfer Files. Follow procedure steps when asked to save files to a floppy disk.

Save Configuration F6

This allows for SAVING of all changed parameters, before exiting program. Failure to SAVE CONFIGURATION will result in loss of set-up screen parameters.

Exit to DOS F7

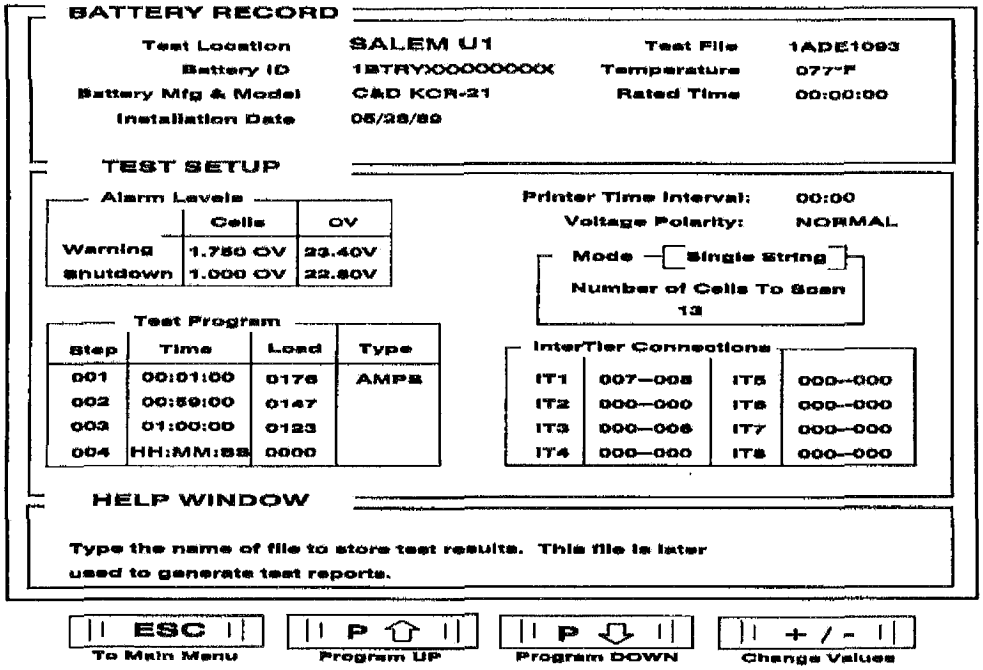
Load test program terminates with F6 keystroke, causing all parameters to be lost unless otherwise saved before exiting. This then allows user to use Laptop Display unit for other programs. DO NOT USE THIS FUNCTION.

Entering Correct Time and Date

At Load Test Program Menu screen, DEPRESS ESC to exit to DOS (when "EXIT PROGRAM ?" appears select "Y"). At MS-DOS shell, tab to Main Command Prompt and DEPRESS ENTER.
At C:\> TYPE "TIME" and DEPRESS ENTER. ENTER new time if applicable and DEPRESS ENTER.
At C:\> TYPE "DATE" and DEPRESS ENTER. ENTER new date if applicable and DEPRESS ENTER.
At C:\> TYPE "CD\ALBER" and DEPRESS ENTER.
At C:\ALBER TYPE "BCT-2000" and DEPRESS ENTER to return to Load Test Program Menu.
DEPRESS F1 to Setup Test Parameters.

ATTACHMENT 8

BCT-2000 PROGRAMMING SERVICE TEST
(TYPICAL)



NOTE

Setup Test Parameter screen is split into three main blocks as follows:

- Center Block - Test Setup - This block is used to give BCT-2000 its complete instructions on in regards to service test.
- Top Block - Battery Record - This block is used for information applicable to battery ID/test location. Much of this information is used for header of test report. Use as much detail, as required.
- Bottom Block - Help Window - During all programming, bottom block acts as an on screen HELP WINDOW. This will provide instructions as to what system is requiring at that cursor location.

There are a few different ways to move around Setup Test Parameter screen. When moving to a specific block, TAB key can be used. When inside a block, UP and DOWN ARROW keys located on numeric keypad allow user to move to desired location inside that block.

ATTACHMENT 8 (Cont'd)

CAUTION

In all cases it is necessary for user to hit ENTER key once any data has been inputted. Failure to execute ENTER key will cause reading to change back to its original value.

A. BATTERY RECORD BLOCK

___ 1. Test Location - TYPE [SALEM STATION U1] **OR** [SALEM STATION U2], as applicable for test location (maximum of 18 characters). DEPRESS ENTER key.

___ 2. Battery ID - TYPE [applicable battery ID and work order number from Table 1] for 28 Volt Battery being tested (maximum of 18 characters). DEPRESS ENTER key.

TABLE 1

	BATTERY IDs		BATTERY IDs
1A-28V	1BTRY1ADEXXXXXXXXX	2A-28V	2BTRY2ADEXXXXXXXXX
1B-28V	1BTRY1BDEXXXXXXXXX	2B-28V	2BTRY2BDEXXXXXXXXX

___ 3. Battery MFG. & Model - TYPE [C&D KCR-21] for Battery MFG. & Model (maximum of 18 characters). DEPRESS ENTER key.

___ 4. Installation Date - TYPE [applicable installation date from Table 2] date battery was installed (MM/DD/YY). DEPRESS ENTER key.

TABLE 2

UNIT 1		UNIT 2	
Battery ID	Installation Date	Battery ID	Installation Date
1BTRY1ADE	09/28/99	2BTRY2ADE	04/27/99
1BTRY1BDE	10/04/99	2BTRY2BDE	04/29/99

ATTACHMENT 8 (Cont'd)

___ 5. Test File - TYPE name of data file (maximum 8 characters, particular battery ID followed by present month and date test is run, e.g. 1ADE1093). Space and punctuation marks are NOT allowed in this field. DEPRESS ENTER key.

___ 6. Temperature - TYPE [77] for average electrolyte fahrenheit temperature. Temperature correction is NOT required for a Profile/Multi-Step Service Test. DEPRESS ENTER key.

___ 7. Fahrenheit or Celsius - Average electrolyte temperature should be indicated in fahrenheit. USE numerical keyboard's [+/-] key to change from celsius to fahrenheit, as required. DEPRESS ENTER key.

___ 8. Rated Time - Rated Time field (HH:MM:SS) asks for theoretical length of time test is being performed. This is important for On-Line Capacity calculation (visible in Load Test Display Window) that will be required during a single step capacity test (five year discharge test). It is NOT required for a profile/multi-step/Service Test. DEPRESS ENTER key.

B. TEST SETUP BLOCK

NOTE

Test Setup Block - Test Setup block includes sub-blocks that allow user to program Alarm Levels (Warning - Cells, Shutdown - Cells, Overall Volts (OV) - Warning and Overall Volts (OV) - Shutdown), Test Program, Intertier Connections, Number of Cells, Voltage Polarity and Printer Time Interval.

Warning-Cells Field - If any cell voltage falls below 1.750 volts, during an actual test, a Warning-Cell alarm will signal user. Failing cell will be listed in ALARM column on Load Display Screen and bar graph on Load Display Screen will shade to a different contrast/ or from green to yellow. Run Load Test Display Screen F2 may be referred to as required.

Shutdown-Cells Field - If any cell voltage falls below 1.000 volts, during an actual test, BCT-2000 will automatically SHUTDOWN test.

OV-Warning Field - If battery overall voltage falls below 23.4 volts, during an actual test, a OV-WARNING alarm will signal user that battery system will be approaching shutdown shortly and OV field will be boxed.

OV-Shutdown Field - If battery overall voltage falls below 22.8 volts, during an actual test, BCT-2000 will automatically SHUTDOWN test.

ATTACHMENT 8 (Cont'd)

___ 1. Alarm Levels - Alarm Level block is broken into four separate fields. TYPE alarm level data as follows:

a. Warning - Cells - TYPE [1.750] in this field. DEPRESS ENTER key.

b. Shut-Down Cells - TYPE [1.000] in this field. DEPRESS ENTER key.

c. OV - Warning - TYPE [23.4] in this field. DEPRESS ENTER key.

d. OV - Shutdown - TYPE [22.8] in this field. DEPRESS ENTER key.

NOTE

Table 3 indicates test discharge rates (Step currents and times) to be inputted in "Test Program" block for applicable 28 VDC battery.

___ 2. Test Program - Test Program block is area user programs system for type of discharge to perform, length of discharge and load to be applied. Each Step is programmed individually with a maximum number of 99 Steps. PGUP/PGDN keys may be used to move step blocks. If cursor is NOT on Step 001, time field, USE PGUP/PGDN Arrow key to move to this field and PERFORM the following:

a. Step 001, Time Field - TYPE [00:01:00]. DEPRESS ENTER key.

TABLE 3

Battery ID	LOAD FIELD AMPS						
	Step 001	Step 002	Step 003	Step 004	Step 005	Step 006	Step 007
1BTRY1ADE	151	137	134	128	105	107	0
1BTRY1BDE	166	173	156	121	83	82	0
2BTRY2ADE	161	130	127	125	106	106	0
2BTRY2BDE	169	176	167	126	83	84	0

ATTACHMENT 8 (Cont'd)

NOTE

Load Field is location where amount of current is to be inputted for a test step.

b. Step 001, Load Field - TYPE [applicable step current from Table 3] DEPRESS ENTER key.

NOTE

After Step 001 is completed, TYPE FIELD (KW/AMPS) is only field that CANNOT be changed.

c. Type Field - SELECT AMPS using (-) key to toggle field. DEPRESS ENTER key.

d. Step 002, Time Field - TYPE [00:29:00]. DEPRESS ENTER key.

e. Step 002, Load Field - TYPE [applicable step current from Table 3]. DEPRESS ENTER key.

f. Step 003, Time Field - TYPE [00:30:00]. DEPRESS ENTER key.

g. Step 003, Load Field - TYPE [applicable step current from Table 3]. DEPRESS ENTER key.

h. Step 004, Time Field - TYPE [01:00:00]. DEPRESS ENTER key.

i. Step 004, Load Field - TYPE [applicable step current from Table 3]. DEPRESS ENTER key.

j. Step 005, Time Field - TYPE [01:59:00]. DEPRESS ENTER key.

k. Step 005, Load Field - TYPE [applicable step current from Table 3]. DEPRESS ENTER key.

l. Step 006, Time Field - TYPE [00:01:00]. DEPRESS ENTER key.

m. Step 006, Load Field - TYPE [applicable step current from Table 3]. DEPRESS ENTER key.

n. Step 007, Time Field - TYPE [00:10:00]. DEPRESS ENTER key.

o. Step 007, Load Field - TYPE [applicable step current from Table 3]. DEPRESS ENTER key.

ATTACHMENT 8 (Cont'd)

___ 3. Printer Time Interval - This field allows user to input print interval (MM:SS) for connected on-line printer during test. Since BCT-2000 printer will NOT be used in field, TYPE [00:00]. DEPRESS ENTER key.

___ 4. Voltage Polarity - This field allows user to switch between NORMAL and REVERSED. NORMAL is used when field cable is connected to positive terminal of Cell #1. REVERSE is used when field cable is connected to positive terminal of Cell #13. Using (+) key, TOGGLE to REVERSED. DEPRESS ENTER key.

___ 5. Mode - SELECT Single String using numerical keyboard's (-) key. DEPRESS ENTER key.

___ 6. Number of Cells to Scan - TYPE [13]. DEPRESS ENTER key.

___ 7. Intertier Connections - This field allows user to input cells to which intertier cable jumpers are connected to. At IT-1 field, USE numerical keyboard's +/- keys to change to select cells 007 - 008. DEPRESS ENTER key.

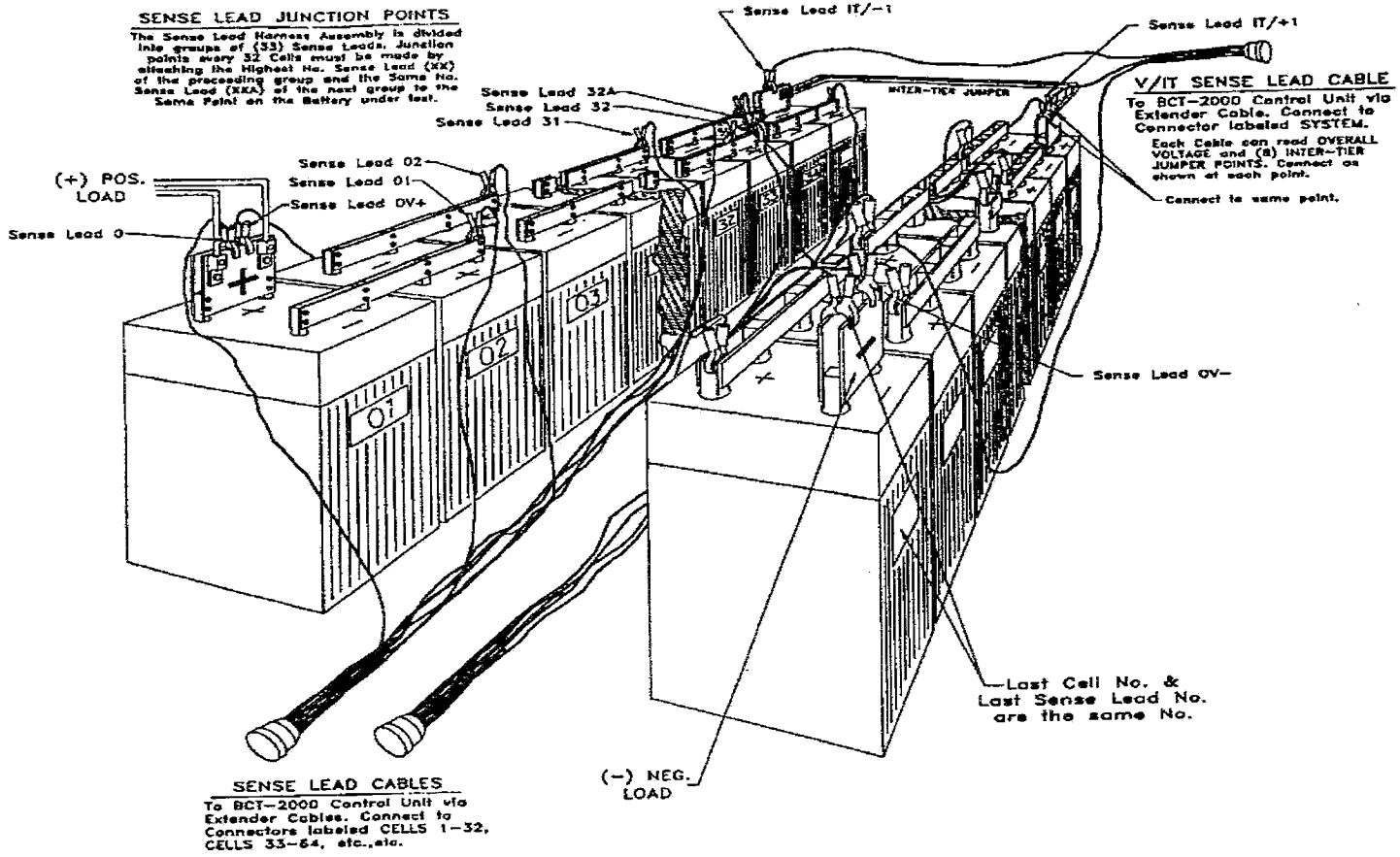
___ 8. DEPRESS ESC key to return to Load Test Program Menu.

___ 9. DEPRESS F6 and Y (yes) key to save configuration.

___ 10. RETURN to Step 5.9.6.

ATTACHMENT 9

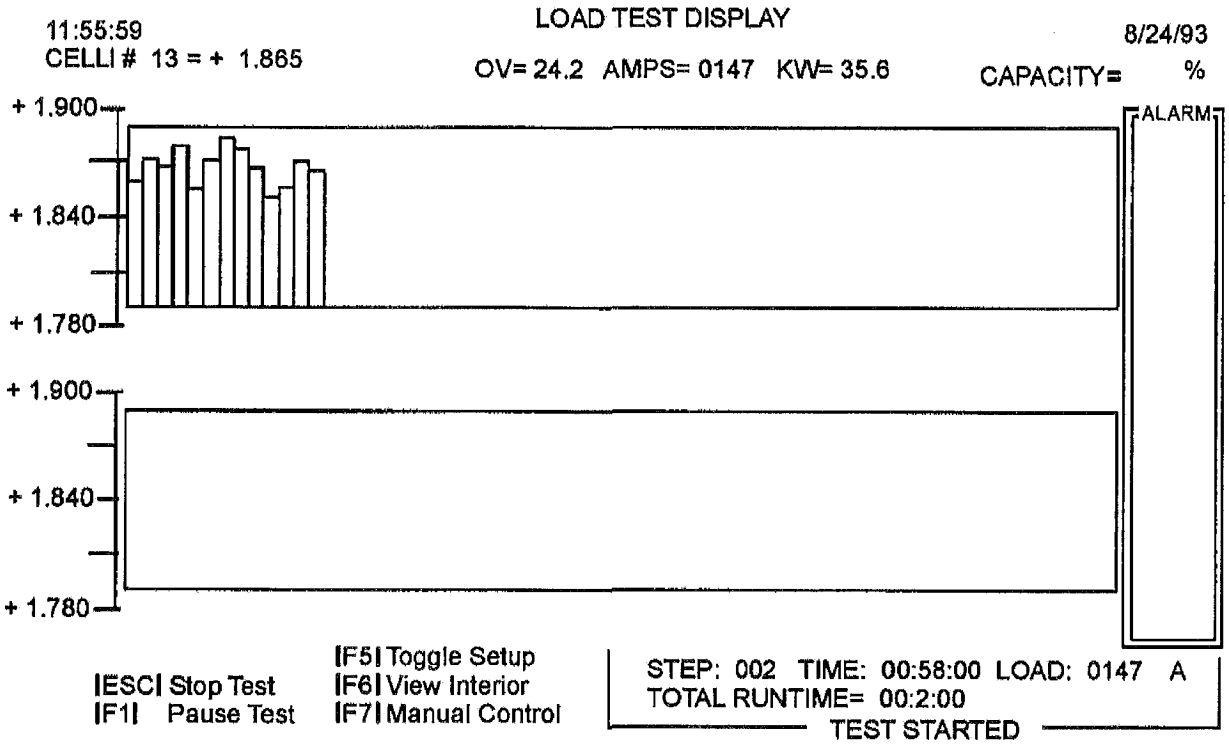
BCT-2000 SENSE LEAD CONNECTION DIAGRAM



<u>ONLY</u> EXTENDER CABLE PORTS 1-32 WILL BE USED FOR 13 CELL BATTERY SENSE LEAD CABLE CONNECTIONS

ATTACHMENT 10

TYPICAL LOAD TEST DISPLAY



FOR 28 VOLT BATTERY SERVICE TEST <u>ONLY</u> 13 BARS (CELLS) WILL BE SHOWN ON RUN LOAD TEST SCREEN

Attachment 11

BCT-2000 PROGRAMMING EQUALIZE CHARGE

NOTE

Setup Test Parameter screen, illustrated in Attachment 3, is split into three main blocks as follows:

- Top Block (Battery Record) - This block is used for information applicable to battery ID/test location. Much of this information is used for header of test report. Use as much detail, as required.
- **Center Block (Test Setup) - This block is used to give BCT-2000 its complete instructions in regards to Performance Discharge Test.**
- Bottom Block (Help Window) - During all programming, bottom block acts as an on screen HELP WINDOW. This will provide instructions as to what system is requiring at that cursor location.

There are a few different ways to move around Setup Test Parameter screen. When moving to a specific block, the TAB key can be used. When inside a block, UP and DOWN ARROW keys, located on the numeric keypad, allow user to move to desired location inside that block.

CAUTION

In all cases it is necessary for user to hit ENTER key once any data has been inputted. Failure to execute ENTER key will cause reading to change back to its original value.

A. BATTERY RECORD BLOCK

___ 1. Test Location - TYPE [SALEM STATION U1] **OR** [SALEM STATION U2], as applicable for test location (maximum of 18 characters). DEPRESS ENTER key.

___ 2. Battery ID - TYPE [applicable battery ID and work order number from Table 1] for 28 Volt Battery being tested (maximum of 18 characters). DEPRESS ENTER key.

Attachment 11 (Cont'd)

TABLE 1

	BATTERY IDs		BATTERY IDs
1A-28V	1BTRY1ADEXXXXXXXXX	2A-28V	2BTRY2ADEXXXXXXXXX
1B-28V	1BTRY1BDEXXXXXXXXX	2B-28V	2BTRY2BDEXXXXXXXXX

___ 3. Battery MFG. & Model - TYPE [C&D KCR-21] for Battery MFG. & Model (maximum of 18 characters). DEPRESS ENTER key.

___ 4. Installation Date - TYPE [applicable installation date from Table 2] date battery was installed (MM/DD/YY). DEPRESS ENTER key.

TABLE 2

UNIT 1		UNIT 2	
Battery ID	Installation Date	Battery ID	Installation Date
1BTRY1ADE	09/28/99	2BTRY2ADE	04/27/99
1BTRY1BDE	10/04/99	2BTRY2BDE	04/29/99

___ 5. Test File - TYPE name of data file (maximum 8 characters, particular battery ID followed by "EQUL" for equalize charge (e.g. 1ADEEQUL). Space and punctuation marks are NOT allowed in this field. DEPRESS ENTER key.

___ 6. Temperature - TYPE [77] for average electrolyte fahrenheit temperature. Temperature correction is NOT required for a Profile/Multi-Step Service Test. DEPRESS ENTER key.

___ 7. Fahrenheit or Celsius - Average electrolyte temperature should be indicated in fahrenheit. USE numerical keyboard's [+/-] key to change from celsius to fahrenheit, as required. DEPRESS ENTER key.

___ 8. Rated Time - Time battery will be on equalize charged and LDU will record/display ICVs. TYPE [00:00:00] in this field. Field will default to HH:MM:SS when ENTER key is depressed. DEPRESS ENTER key.

Attachment 11 (Cont'd)

B. TEST SETUP BLOCK

NOTE

Test Setup Block - Test Setup block includes sub-blocks that allow user to program Alarm Levels (Warning - Cells, Shutdown - Cells, Overall Volts (OV) - Warning and Overall Volts (OV) - Shutdown), Test Program, Intertier Connections, Number of Cells, Voltage Polarity and Printer Time Interval.

Warning-Cells Field - If any cell voltage falls below 1.750 volts, during an actual test, a Warning-Cell alarm will signal user. Failing cell will be listed in ALARM column on Load Display Screen and bar graph on Load Display Screen will shade to a different contrast/ or from green to yellow. Run Load Test Display Screen F2 may be referred to as required.

Shutdown-Cells Field - If any cell voltage falls below 1.000 volts, during an actual test, BCT-2000 will automatically SHUTDOWN test.

OV-Warning Field - If battery overall voltage falls below 23.4 VDC during an actual test, a OV-WARNING alarm will signal user that battery system will be approaching shutdown shortly and OV field will be boxed.

OV-Shutdown Field - If battery overall voltage falls below 22.8 volts, during an actual test, BCT-2000 will automatically SHUTDOWN test.

___ 1. Alarm Levels - Alarm Level block is broken into four separate fields. TYPE alarm level data as follows:

a. Warning - Cells - TYPE [1.750] in this field. DEPRESS ENTER key.

b. Shut-Down Cells - TYPE [1.000] in this field. DEPRESS ENTER key.

c. OV - Warning - TYPE [23.4] in this field. DEPRESS ENTER key.

d. OV - Shutdown - TYPE [22.8] in this field. DEPRESS ENTER key.

Attachment 11 (Cont'd)

NOTE

The following indicates EQUALIZE CHARGE step currents and times to be inputted in "Test Program" block for 28 VDC battery.

___ 2. Test Program - Test Program block is area user programs system for type of equalization to perform (length of equalize charging). Each Step is programmed individually with a maximum number of 99 Steps. PGUP/PGDN keys may be used to move step blocks. If cursor is NOT on Step 001, time field, USE PGUP/PGDN Arrow key to move to this field and PERFORM the following:

a. Step 001, Time Field - TYPE [23:00:00]. DEPRESS ENTER key.

NOTE

Load Field is location where amount of current is to be inputted for a test step.

b. Step 001, Load Field - TYPE [0000] DEPRESS ENTER key.

c. Type Field - SELECT AMPS using (-) key to toggle field. DEPRESS ENTER key.

NOTE

After Step 001 is completed, TYPE FIELD (KW/AMPS) is only field that CANNOT be changed.

d. Step 002, Time Field - TYPE [23:00:00]. DEPRESS ENTER key.

e. Step 002, Load Field - TYPE [0000]. DEPRESS ENTER key.

f. Step 003, Time Field - TYPE [23:00:00]. DEPRESS ENTER key.

g. Step 003, Load Field - TYPE [0000]. DEPRESS ENTER key.

h. DEPRESS ENTER key twice.

ATTACHMENT 11 (Cont'd)

___ 3. Printer Time Interval - This field allows user to input print interval (MM:SS) for connected on-line printer during test. Since BCT-2000 printer will NOT be used in field, TYPE [00:00]. DEPRESS ENTER key.

___ 4. Voltage Polarity - This field allows user to switch between NORMAL and REVERSED. NORMAL is used when field cable is connected to positive terminal of Cell #1. REVERSE is used when field cable is connected to positive terminal of Cell #13. Using (+) key, TOGGLE to REVERSED. DEPRESS ENTER key.

___ 5. Mode - SELECT Single String using numerical keyboard's (-) key. DEPRESS ENTER key.

___ 6. Number of Cells to Scan - TYPE [13]. DEPRESS ENTER key.

___ 7. Intertier Connections - This field allows user to input cells to which intertier cable jumpers are connected to. At IT-1 field, USE numerical keyboard's +/- keys to change to select cells 007 - 008. DEPRESS ENTER key.

___ 8. DEPRESS ESC key to return to Load Test Program Menu.

___ 9. DEPRESS F6 and Y (yes) key to save configuration.

___ 7. RETURN to Step 5.8.4.

ATTACHMENT 12

BATTERY CONNECTION TORQUE REQUIREMENTS

BOLT ASSEMBLY SIZE	INITIAL TORQUE in-lbs	SUBSEQUENT TORQUE in-lbs
1/4-20 stud w/cast lead brass inserted lead nut	67 to 70	57 to 60
5/16-18 brass stud w/inserted lead nuts	105 to 110	95 to 100
5/16-18 stainless steel bolt, washers, nuts	152 to 160	119 to 125

ATTACHMENT 13

ELECTROLYTE TEMPERATURE (°F) DATA SHEET

NOTE

The following table list cells which require temperature data to be taken during Service Test (thermometers to be installed prior to test).

CAUTION

Monitor cells for excessive temperatures (≥120°F) during Service Test.

TABLE 1

INDIVIDUAL CELL TEMPERATURE DATA SHEET (STEPS 5.9.1 AND 5.12.15)		
CELL NO	2	8
T=0		
T+15		
T+30		
T+45		
T+60		
T+75		
T+90		
T+105		
T+120		
T+135		
T+150		
T+165		
T+180		
T+195		
T+210		
T+225		
T+240		

ATTACHMENT 14

EQUALIZE VOLTAGE DETERMINATION

I. Method 1 - NO Cells bypassed and ALL battery loads cleared and tagged. USE equalize voltage as close as possible to top of span (e.g., 30.9 VDC).

TABLE 1

BATTERY (VDC)	NUMBER OF CELLS	BATTERY EQUALIZE VOLTAGE (VDC)	NOMINAL EQUALIZE VOLTAGE PER CELL (VDC)	MAXIMUM EQUALIZE VOLTAGE PER CELL (VDC)
28 Unit 1(2)	13	30.3 to 30.9	2.33 to 2.38	2.60

II. Method 2 - NO cells bypassed and battery loads NOT cleared and tagged.

TABLE 2

BATTERY (VDC)	NUMBER OF CELLS	MAXIMUM BATTERY EQUALIZE VOLTAGE (VDC)	NOMINAL EQUALIZE VOLTAGE PER CELL (VDC)	MAXIMUM EQUALIZE VOLTAGE PER CELL (VDC)
28	13	30.3	2.33 to 2.38	2.60

III. Method 3 - With one or more cells bypassed, LOWER battery equalize voltage to 2.33 to 2.38 VDC per cell.

ATTACHMENT 15

BATTERY VOLTAGE AND CURRENT DATA SHEET

DATE/ TIME (*)	VOLTAGE (VDC)	CURRENT (AMPS)	INITIALS	DATE/ TIME (*)	VOLTAGE (VDC)	CURRENT (AMPS)	INITIALS

*** - Battery terminal voltage and charging current should be logged every hour during charge.**

ATTACHMENT 16

CHARGE ICV DATA SHEET

28V BATTERY

INDIVIDUAL CELL VOLTAGE (VDC)								
STEP	**5.15.4.B**	**5.15.9**	**5.15.12**	**5.15.12***	**5.15.12***	**5.15.15**	**5.15.15**	**5.15.15**
CELL NO.	**TIME/ DATE**	**TIME/ DATE**	**TIME/ DATE**	**TIME/ DATE**	**TIME/ DATE**	**TIME/ DATE**	**TIME/ DATE**	**TIME/ DATE**
1								
2								
3								
4								
5								
6								
#7								
8								
9								
10								
11								
12								
13								
INT.								

ICV AVERAGE			
STEP NO.	**5.15.13**	**5.15.13***	**5.15.13***
INITIALS			

NOTES

* Use these columns if more than one 8 to 12 hour equalize period is used. Copy additional data sheets as required.

\# Install Thermometers with "Cell Stop" in this cell.

ATTACHMENT 17

SPECIFIC GRAVITY DATA SHEET

Shaded blocks in CELL TEMP column DO NOT require a temperature reading

STEP	5.17.2.B.2	5.17.2.C.7	5.17.2.E.3	5.17.2.E.4
CELL NO.	CELL TEMP (°F)	MEASURED SG	TEMP CORR FACTOR	TEMP CORR SG
28V BATTERY				
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				

ATTACHMENT 18

FLOAT ICV DATA SHEET

INDIVIDUAL CELL VOLTAGE (VDC) (Step 5.17.4)								
CELL NO.	TIME / DATE _____	TIME / DATE _____	TIME / DATE _____	TIME / DATE _____	TIME / DATE _____	TIME / DATE _____	TIME / DATE _____	TIME / DATE _____
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
INT.								

ATTACHMENT 19

DATA SHEET

1.0 **JOB DATA:**

Work Order No._____ Activity No._____

Station Battery No._____

2.0 **TEST EQUIPMENT DATA**

DEVICE NAME	M&TE No.	DUE DATE
DVOM	_____	_____
DVOM	_____	_____
BCT-2000 Series System	_____	_____
DLRO	_____	_____
Torque wrench	_____	_____
Electronic Temperature Device	_____	_____
Thermometer	_____	_____
Thermometer	_____	_____
Thermometer	_____	_____
Thermometer	_____	_____
Hydrometer	_____	_____
_____	_____	_____
_____	_____	_____

3.0 **TEST DATA:**

STEP	DESCRIPTION	DATA	ACCEPTANCE CRITERIA	COMPLETED BY/ DATE
5.2.1	Battery room ambient temperature	_____ °F	None	_____/_____
5.2.5	Battery room condition	Sat___ Unsat___	Exhaust fan operable, room clean, lighting operable	_____/_____

ATTACHMENT 19 (Cont'd)

	DESCRIPTION	DATA	ACCEPTANCE CRITERIA	COMPLETED BY/ DATE
5.3.4	Battery rack enclosure	Sat___Unsat___	All bolts tight, no unistrut damage, of no signs of deterioration	_____/_____
5.5.1.D $ STEP	Battery cell connections	Sat___Unsat___	No corrosion on terminal posts, bus bars, cable lugs and plate contact surfaces	_____/_____
5.5.4	As Found new cell 110% resistance value	_____μohms	None	_____/____
5.5.7 $	As Found connection resistance measurements	Sat___Unsat___	IAW acceptance criteria specified in Step 5.5.5 and Attachment 5	_____/_____
5.6.1 $	Battery As Found float voltage	_____VDC	Nominal Value 28.9-29.3 VDC Tech Spec min. ≥ 27 VDC	_____/_____
5.7.1.B $	Record cell average temperature	_____°F	Tech Spec Min. > 65°F	_____/_____
5.7.4.B $	Record average corrected S.G.	_____	≥ 1.190	_____/_____
5.7.6.A	Verify Recorded cell temperatures within limit	Sat___Unsat___	All recorded cell temps ≤ 5°F average cell temp	_____/____
5.7.6.B	Verify corrected S.G. is within limits	Sat___Unsat___	No cell's corrected S.G. is more than 0.010 below average corrected S.G.	_____/____
5.9.2	Calculate avg. electrolyte temperature	Average _____°F	AVG - > 65°F	_____/____

ATTACHMENT 19 (Cont'd)

STEP	DESCRIPTION	DATA	ACCEPTANCE CRITERIA	COMPLETED BY/ DATE
5.9.9	BCT-2000 programming complete	Sat___Unsat___	Programmed screen is IAW Attachment 8	_____/____
5.12.11	Service Test start time	Time_____	None	_____/____
5.12.13	Minimum battery terminal voltage for each Loaded Step	Loaded Steps 001 _____ VDC 002 _____ VDC 003 _____ VDC 004 _____ VDC 005 _____ VDC 006 _____ VDC	Per Design Calc. (Reference 7.5.7 and 7.5.8) ≥ voltage values shown on Table 1	_____/____
5.12.16	Service test end time	Time_____	Programmed BCT-2000 runs 4 hours loaded and 10 minutes unloaded	_____/____
5.12.17	Test Ended battery terminal voltage	Battery #_____ _____ VDC Sat___Unsat___	1A ≥23.9 VDC 1B ≥24.6 VDC 2A ≥24.0 VDC 2B ≥24.5 VDC	_____/____

ATTACHMENT 19 (Cont'd)

STEP	DESCRIPTION	DATA	ACCEPTANCE CRITERIA	COMPLETED BY/ DATE
5.13.1	Cell No. of all retorqued connections	CELL# / CELL# ___ / ___ ___ / ___ ___ / ___ ___ / ___ ___ / ___ ___ / ___	None	_____/___
5.13.3.A	Retorqued resistance <120% AVE BASELINE	Yes___No___	If YES, connections are acceptable. RECORD As Left values per Subsection 5.14	_____/___ SN _____/___
5.13.3.B	As Left resistance ≥120% AVE BASELINE	Yes___No___	If YES, connections should be cleaned per Step 5.13.4	_____/___ SN _____/___
5.13.17.A	Cleaned connection resistance ≥120% AVE BASELINE and < MAX ALLOWABLE	Yes___No___	If YES, GO TO Subsection 5.14	_____/___ SN _____/___
5.13.17.B	Cleaned connection resistance ≥ MAX ALLOWABLE	Yes___No___	If YES, connections NOTIFY Supervisor\ System Manager for resolution	_____/___ SN _____/___

ATTACHMENT 19 (Cont'd)

STEP	DESCRIPTION	DATA	ACCEPTANCE CRITERIA	COMPLETED BY/ DATE
5.14.2	Measure forward and reverse resistance of battery + and - output cable connections	Positive F_____μohms R_____μohms Negative F_____μohms R_____μohms	≤20 μohms	_____/___
5.15.4.A	As Found battery terminal voltage	_____VDC	As Found	_____/___
5.15.5	Battery equalize voltage	_____VDC	IAW Attachment 1	_____/___
5.15.22	Disconnect cell, intertier sensing clips and remove BCT-2000	Sat___Unsat___	Disconnected cell and intertier sensing clips and removed BCT-2000	_____/___
5.16.1 $	Battery As Found float voltage	_____VDC	Nominal Value 28.9-29.3 VDC Tech Spec min. ≥28 VDC	_____/_____
5.16.8.B $	Record cell average temperature	_____°F	Tech Spec Min. >65°F	_____/___
5.16.11.B	Verify temperature corrected specific gravity	Sat___Unsat___	≥1.215 or as determined by Supervisor/ System Manager	_____/___
5.16.13.A	Verify recorded cell temperatures within limits	Sat___Unsat___	All recorded cell temps ≤°F of average cell temp	_____/___
5.16.13.B	Verify corrected S.G. is within limits	Sat___Unsat___	No cell's corrected S.G.is >0.010 below average corrected S.G.	_____/___

ATTACHMENT 19 (Cont'd)

STEP	DESCRIPTION	DATA	ACCEPTANCE CRITERIA	COMPLETED BY/ DATE
5.16.18	Individual cells requiring System Manager's evaluation	Cell # Cell # _____ _____ _____ _____ _____ _____ _____	Level ≥16/32 in. below high mark and temperature corrected S.G. <1.218	_____/____
5.17.2.E.2	Cell temperature average	_____°F	65°F to 120°F	_____/____
5.17.2.G	Verify temperature corrected specific gravity	Sat___Unsat___	≥1.215 or as determined by Supervisor/ System Manager	_____/____
5.17.3.A	Record nominal float voltage range	_____VDC	28.9-29.3 VDC	_____/____
5.17.3.C	As Left battery terminal voltage	_____VDC	28.9-29.3 VDC	_____/____
5.17.6	As Left battery terminal float voltage	_____VDC	28.9-29.3 VDC	_____/____
5.17.7	Verify electrolyte level	Sat___Unsat___	Between high and low mark	_____/____

ATTACHMENT 19 (Cont'd)

4.0 **COMPLETION SUMMARY:**

Calculations Independently Verified by (Step 5.18.3): **[C0284]**

Signature _____ Date _____

Comments: _____

ATTACHMENT 19 (Cont'd)

Individuals Performing Work:

Print Name	Signature	Date

This procedure has been reviewed for completion in accordance with SH.MD-AP.ZZ-0003(Q).

Maintenance Supervisor / Date