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# Inspection and Maintenance of 252-S Switchgear Alcad (Nickel Cadmium) H34P Batteries

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Figure 1 – Cell Voltages

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1.0 PURPOSE AND SCOPE

1.1 Purpose

This procedure provides instructions for performing an inspection of the 252-S switchgear battery charger, battery condition, connecting bolt tightness, and adequacy of cell connections.

1.2 Scope

This procedure involves 252-S switchgear Alcad (Nickel Cadmium) batteries.

2.0 INFORMATION

2.1 General Information

2.1.1 During routine maintenance of batteries on float charge, topping-up is the first operation followed by boost charging.

2.1.2 Never check levels or add water during or immediately after boost charging because the gas in suspension at this stage gives false readings.

2.2 Terms and Definitions

- AHU - Air Handling Unit.
- Ripple Voltage – The small unwanted residual periodic variation of the direct current (DC) output of a power supply which has been rectified from an alternating current (AC) source. This ripple is due to incomplete suppression of the alternating waveform within the power supply.
3.0 PRECAUTIONS AND LIMITATIONS

3.1 Personnel Safety

WARNING - Batteries are capable of producing substantial short circuit currents that can cause serious heat and burns to workers due to short circuits caused by personal jewelry M&TE and tools.

WARNING - When checking the electrolyte level there is a risk of an alkali spillage, and/or chemical burns. Appropriate PPE such as alkali resistant apron, face shield, or goggles, gloves and a portable eye wash are required for this work.

WARNING - Electrolyte contained in Alcad (nickel cadmium) batteries is an alkaline (potassium hydroxide) solution. Potassium hydroxide is very harmful to skin and eyes. Appropriate alkaline resistant PPE is required for this work.

3.1.1 Follow DOE–0359, Hanford Site Electrical Safety Program for safe work practices.

Fire/Explosion Hazards

3.1.2 During equalize charging, batteries generate large amounts of hydrogen gas. To minimize off gas battery hazards, follow these precautions:

3.1.2.1 Verify Air Handling Unit (AHU) or other approved ventilation means is in normal operation before working on or equalize charging batteries.

3.1.2.2 AHU or other approved ventilation means should not be interrupted during equalize charging.

3.1.2.3 If ventilation flow from AHU or other approved ventilation means is interrupted during equalize charge, stop equalize charging until ventilation is restored.

3.1.3 Flame, spark, or electric arc generating devices are prohibited in the vicinity of the batteries during the performance of this procedure.

3.1.4 Battery maintenance is prohibited during an equalizing charge.

3.1.5 Insulated tools should be used during battery maintenance. In lieu of insulated tools, non-conductive matting can be placed over adjacent battery terminals to prevent a short circuit.
3.1 Personnel Safety (Cont.)

3.1.6 Disconnect negative lead first whenever disconnecting battery terminals.

Potassium Hydroxide (Electrolyte) Hazards

NOTE - The electrolyte is not acid, it is an alkaline solution. The electrolyte contained in Alcad (Nickel Cadmium) batteries is very dangerous when it comes in contact with skin or eyes. This solution also can damage tools, structural equipment, and clothing.

3.1.7 Check portable eyewash/shower station is located close to the area of work and is full and ready to be used.

3.1.8 Check eyewash station inspection date is current and FWS notified if otherwise.

3.1.9 If electrolyte contacts skin, wash immediately with large quantities of water. Report to First Aid.

3.1.10 If electrolyte contacts eyes, force eyelids apart and flush thoroughly with water for at least 15 minutes. Contact First Aid or call 911 or 373-0911 immediately.

3.1.11 Wear alkaline-resistant (polypropylene, polyethylene, rubber or Viton) gloves, apron, chemical goggles and a face shield when checking battery fluid level.

Battery Cleaning

3.1.12 When cleaning terminals warm water and a non-metallic brush should be used.

3.1.13 Only water is to be used to clean battery cases and covers.

3.1.14 Keep filler plugs in place when cleaning cases and covers to avoid contaminating electrolyte.

Additional Battery Precautions

3.1.15 Ensure unobstructed entry and exit routes from battery area.

3.1.16 Neutralize static buildup just before working on battery by having personnel contact nearest effectively grounded surface.

3.1.17 Nylon clothing should be avoided due to static charge buildup.
3.2 Equipment Safety

CAUTION - Filling above the correct MAX level may cause loss of electrolyte which may cause damage to the battery through external damp and leakage currents.

CAUTION - To prevent exposing the battery plates never allow the electrolyte level to fall below the “MIN” level.

CAUTION - Over torquing terminal connections causes creep (deformation) of lead (in terminals) resulting in low contact pressure, loose connections, and possible permanent damage to terminals.

3.2.1 Do not place tools on top of cells.

3.3 Radiation and Contamination Control

Work in radiological areas will be performed using a radiation work permit following review by Radiological Control per the ALARA Work Planning procedure TFC-ESHQ-RP_RWP-C-03.

3.4 Environmental Compliance

If any hazardous waste is generated during performance of this procedure, consult Facility/Plant/Area Hazardous Waste Coordinator for specific instructions to ensure compliance with all environmental standards for disposal.
4.0 PREREQUISITES

4.1 Special Tools, Equipment and Supplies

The following supplies may be needed to perform this procedure:

Tools
• Hand tools – insulated or non-conductive.
  
  The maximum non-insulated length should not exceed the minimum distance between positive and negative connections. For battery terminal work, non-conductive matting can be placed over adjacent battery terminals in lieu of insulated tools
• AC/DC Multi Meter (Root Mean Square (RMS) responding capable), calibrated
• Calibrated DC Clamp-on Amp Meter
• Calibrated Infrared or equivalent thermometer in °Fahrenheit
• Calibrated Torque Wrench, (0 to 200 inch/pounds).

Equipment
• Rubber mat
• Face shields
• Chemical goggles
• Alkali resistant apron (polypropylene, polyethylene, rubber or Viton)
• Alkali resistant (polypropylene, polyethylene, rubber or Viton) gloves
• Portable eye wash/shower station
• Vacuum cleaner with plastic attachments or low pressure air hose
• Alkali resistant plastic bottle (approximately 1 liter),
• Funnel
• Distilled or Demineralized Water.

Material
• Lint-free cleaning rags
• Stiff non-metallic brush and Scotchbrite Pad(s)
• Type E13 (potassium hydroxide) electrolyte
• No-Ox-Id A-Special grease battery terminal corrosion inhibitor
• Other tools, equipment and supplies as identified by Shift Manager/OE/FWS/User.
4.2 Performance Documents

The following documents may be needed to perform this procedure:

- GHS-SDS/MSDS #073472 for Alcad (Nickel Cadmium) battery electrolyte
- GHS-SDS/MSDS #14-320 - No-Ox-Id A-Special), grease for Battery terminal corrosion inhibitor
- Alcad Installation and Operation Manual, CVI-22684, Supplement 6
- CVI-22684, Supp. 6, 48-Volt Battery System, Alcad Standby Batteries
- H-2-824456, Electrical 252-S Substation Light and Power Plans, Elevation and Panel Board Schedules
- H-2-824458, Electrical 252-S Building Service Details.

4.3 Field Preparation

4.3.1 ENSURE portable eye-wash shower station is full of water and in-place prior to starting this procedure.

4.3.2 CHECK inspection date of eyewash station is current.

4.3.3 CHECK battery system is in normal operation, if system is operational.

4.3.4 ENSURE all personnel performing this procedure are Battery Trained.
# 5.0 PROCEDURE

**Special Instructions**

If any step/sections are not required for procedure completion, record “N/A” in the applicable space(s) on the Data Sheet and document the justification on work record or Comments Page of Data Sheet.

Minor repairs may be made as described in the text. Defective or damaged components may be replaced if spare parts are available. If spare parts are not on hand, or if major repairs are needed, findings should be noted in Comments Page of Data Sheet.

## 5.1 Quarterly Check Pilot Cells Voltages, Torque, and Temperature °F

### Check Pilot Cells

5.1.1 **ENSURE** the four (4) pilot cells has a label attached identifying each cell with Cell Voltage, and Date on Data Sheet, Step 1.

5.1.2 **RECORD** battery room temperature °F on Data Sheet Step 1a.

5.1.3 **CHECK** the voltage of the four (4) pilot cells **AND** **RECORD** the following on Step 1b of the Data Sheet:

- Pilot Cell(s) Numbers
- Cell Voltage
- Cell Temperature °F
- Date
- Initial.

5.1.4 **DOCUMENT** on the Pilot Cell Status board (next to battery bank) the updated Voltage and Date of each Pilot Cell **AND** **RECORD** Data Sheet Step 2.

5.1.5 **IDENTIFY** on the Comments Page any Pilot Cell(s) that deviate from the norm temperature by ± 5 °F per Step 2a.

### Pilot Cells Torque Value

5.1.6 **CHECK AND RECORD** the As-Found torque on the negative and positive terminals on each of the 4 pilot cells per torque table 1, Data Sheet Step 3.

5.1.7 **IF** the As-Found torques are within tolerance, **PLACE** check mark [✓] in AF=AL box at top right of Torque Table 1 on Data Sheet Step 3a **AND** **GO TO** Section 5.2.
5.1 Quarterly Check Pilot Cells Voltages, Torque, and Temperature °F (Cont.)

**Special Instructions**

If any of the Pilot Cell torque values are found out of tolerance, then the entire battery bank (40 batteries) will be re-torqued to tolerance per Data Sheet.

**CAUTION**

Over torquing terminal connections causes creep (deformation) of lead (in terminals) resulting in low contact pressure, loose connections, and possible permanent damage to terminals.

5.1.8 **IF** any of the Pilot Cells As-Found torques are out of tolerance, **CHECK/TORQUE** all battery terminals per Data Sheet **AND**

**RECORD** values on Torque Table 2, Data Sheet Step 3b.

5.1.9 **CHECK** battery post and connectors for a sufficient coating of corrosion inhibitor **AND**

**IF** warranted, **APPLY** corrosion inhibitor (No-Ox-Id-A Special grease).
5.2 Quarterly Check Electrolyte Level Verification

**WARNING**
When checking the electrolyte level there is a risk of an alkali spillage, and/or chemical burns. Appropriate PPE such as alkali resistant apron, face shield, gloves and a portable eye wash are required for this work.

NOTE - Correct level of electrolyte above the plates is approximately 1.5 inch (40 mm) for the H34P battery. On top of the electrolyte floats a layer of cell oil, approximately 1/5 inch (5mm) thick. This oil is visible through the battery case.

5.2.1 CHECK electrolyte levels on each cell.

**CAUTION**
To prevent exposing the battery plates never allow the electrolyte level to fall below the “MIN” level.

**CAUTION**
Filling above the correct "MAX" level may cause loss of electrolyte which may cause damage to the battery through external damp and leakage currents.

5.2.2 IF electrolyte level is less than midway between the MIN and MAX indication lines, USE a plastic bottle and funnel AND ADD distilled or demineralized water until level is just below the MAX line.

5.2.3 RECORD results on Step 4, Electrolyte Level Table 1.

**Special Instructions**
Battery maintenance is prohibited during the Equalizing charge.

5.2.4 AFTER electrolyte level adjustments have been completed, PLACE charger to Equalize Charge.
5.3 Semi-Annual Inspection of Batteries, Cables, and Battery Rack

Special Instructions
Conductive material such as rings, jewelry, and watches should be removed prior to working on batteries.

WARNING
Batteries are capable of producing substantial short circuit currents that can cause serious heat and burns to workers due to short circuits caused by personal jewelry M&TE and tools.

5.3.1 DON appropriate PPE, such as gloves, glasses, and face-shield.

NOTE - Steps 5.3.2 through 5.3.5 may be worked simultaneously or in any order.

5.3.2 PHYSICALLY INSPECT terminations of the following items AND CORRECT minor discrepancies:
- Connections to cables
- Connections to cells.

5.3.3 INSPECT for the following conditions on batteries AND CORRECT minor discrepancies:
- Leaks
- Spillage
- Corrosion or other damage.

5.3.4 IF cracks in battery case(s) are discovered, IMMEDIATELY NOTIFY FWS.
5.3  Semi-Annual Inspection of Batteries, Cables, and Battery Rack (Cont.)

5.3.5  **CHECK** cells flame arrestor vents are clean, battery rack is clean, cells are externally clean and have adequate battery terminal corrosion inhibitor (such as No-Ox-Id) applied to the post and connectors.

- Flame Arrestor Vent(s)
- Cell cleanliness
- Battery Post
- Battery Connectors
- Battery Rack.

5.3.6  **RECORD** inspection results from Steps 5.3.2 - 5.3.5 on Data Sheet Step 1 AND

**RECORD** any corrective actions on Data Sheet Comments Page.
5.4 Semi-Annual Check and Record All Cell Float Voltages

5.4.1 IF the charger is not on Float Charge, ADJUST the charger to Float Charge.

5.4.2 SET the DMM to VDC.

**Special Instructions**

Conductive material such as rings, jewelry, and watches should be removed prior to working on batteries.

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**WARNING**

Batteries are capable of producing substantial short circuit currents that can cause serious heat and burns to workers due to short circuits caused by personal jewelry M&TE and tools.

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5.4.3 DON appropriate PPE, such as gloves, glasses, and face-shield.

5.4.4 STARTING with Cell #1 CHECK battery voltage (observing polarity) using DMM AND RECORD the voltages on Data Sheet Step 2, “Cell Float Voltage Table 1”.

5.4.5 CHECK each of the remaining battery voltages (observing polarity) using DMM AND RECORD the remaining cell voltages on “Cell Float Voltage Table 1”.

5.4.6 IF any battery float voltages from “Cell Float Voltage Table 1” are less than 1.40 Vdc, PERFORM the following:

5.4.6.1 PLACE battery charger in Auto-Equalize Timer Mode.

**Special Instructions**

Battery maintenance is prohibited during the Equalizing charge.

5.4.6.2 AFTER equalizing charge is complete, RECORD the voltages on a clean copy of “Cell Voltage Table 1”, Data Sheet Step 2a.

5.4.6.3 IF any cell(s) voltage is ≤ 1.35 Vdc, IDENTIFY the cell(s) on “Cell Float Voltage Table” AND NOTIFY FWS for resolution.
5.4 Semi-Annual Check and Record All Cell Float Voltages (Cont.)

5.4.7 REVIEW Cell voltage readings for possible changes to the existing Pilot Cells.

5.4.8 IF Pilot Cells require changes, PERFORM the following:

5.4.8.1 REMOVE Pilot Cell label(s) that no longer apply.

5.4.8.2 IDENTIFY new Pilot Cells by attaching labels to Cells.

5.4.8.3 UP-DATE Pilot Cell Status board AND RECORD actions on Comments Page of Data Sheet.
5.5 Semi-Annual Physical Inspection of Battery Charger

**Isolate Battery Charger**

5.5.1 OPEN AC input breaker.

5.5.2 OPEN DC output circuit breaker.

5.5.3 IF not already locked out, APPLY lock and tag in accordance with DOE-0336, Hanford Site Lockout/Tagout Procedure.

**Clean Battery Charger**

NOTE - Steps 5.5.4 through 5.5.9 may be worked simultaneously or in any order.

5.5.4 CLEAN out vents.

5.5.5 REMOVE dust and debris from unit.

5.5.6 INSPECT AND TIGHTEN any loose terminations on TB-1.

5.5.7 ENSURE internal wiring connections are tight and slip-on connectors are fully seated and corrosion free.

5.5.8 RECORD results of Steps 5.5.4 - 5.5.7 on Physical Inspection of Battery Charger, Data Sheet Step 3.

5.5.9 INSPECT for darkened lug insulation which is an indication of hot connections.

5.5.9.1 IF darkened lug(s) are found, NOTIFY FWS and Engineering AND RECORD in Comments Page of Data Sheet.

**Restore Battery Charger**

5.5.10 REMOVE lock and tag in accordance with DOE-0336, Hanford Site Lockout/Tagout Procedure.

5.5.11 CLOSE DC output circuit breaker.

5.5.12 CLOSE AC input breaker.
5.6 Semi-Annual Electrical Inspection of Battery Charger

Input Voltage Check

5.6.1 **ADJUST** multi meter setting to AC volts.

5.6.1.1 **MEASURE** input voltage at TB1 (L1 and L2).

5.6.1.2 **CHECK** voltage is per Data Sheet **AND**

**RECORD** the voltage on Step 4 of the Data Sheet.

5.6.1.3 **IF** AC line in voltage is out of range, **NOTIFY** FWS and Engineering for resolution **AND**

**RECORD** on Comments Page of Data Sheet.

DMM Float Voltage Reading

5.6.2 **IF** not already there, **PLACE** battery charger in Float/Manual Timer modes.

5.6.3 **ADJUST** multi meter setting to DC volts.

5.6.3.1 **MEASURE** float voltage with DMM at TB1 (+) and TB1 (-) **AND**

**RECORD** Data Sheet, Step 5a of the Data Sheet.
5.6 Semi-Annual Electrical Inspection of Battery Charger (Cont.)

Panel Meter Float Voltage Reading

5.6.3.2 CHECK value on the front panel voltmeter AND RECORD on Data Sheet, Step 5b.

5.6.3.3 IF front panel voltmeter and multi meter reading is not within ± 1.0 Vdc of each other, NOTIFY FWS and Engineering AND RECORD directions on Comments Page of Data Sheet.

DMM Equalize Voltage

5.6.3.4 ADJUST the Charger to Equalize and perform the following:

5.6.3.5 MEASURE Equalize voltage with DMM at TB1 (+) and TB1 (-) AND RECORD on Data Sheet, Step 5c of the Data Sheet.

Panel Meter Equalize Voltage Reading

5.6.3.6 CHECK value on the front panel voltmeter AND RECORD on Data Sheet, Step 5d.

5.6.3.7 IF front panel voltmeter and multi meter reading is not within ± 1.0 Vdc of each other, NOTIFY FWS and Engineering AND RECORD directions on Comments Page of Data Sheet.

5.6.3.8 RETURN battery charger to Float/Manual Timer mode.

Record Ripple Voltage

NOTE - A Root Mean Square (RMS) responding AC voltmeter (DMM set to AC) should be used for the following step. The ripple voltage on the whole rack at once is a very small AC voltage.

5.6.3.9 ADJUST multi meter setting to AC AND SET to millivolt scale.

5.6.3.10 MEASURE ripple voltage at TB1 (+) and TB1 (-) on Battery Charger output.

5.6.3.11 RECORD ripple voltage on Step 6 of the Data Sheet.
5.6 Semi-Annual Electrical Inspection of Battery Charger (Cont.)

5.6.4 IF ripple voltage is not per Data Sheet, NOTIFY FWS for resolution AND RECORD resolution on Comments Page of Data Sheet.

5.6.5 PRESS “Lamp Test” key on front panel.

5.6.6 CHECK all lamps illuminate.

5.6.6.1 IF all lamps do not illuminate, NOTIFY FWS AND RECORD directions on Comments Page of Data Sheet.

5.6.7 REFER to Figure 1 for cell operating voltages.

5.6.8 EXERCISE front panel controls by performing the following:

5.6.8.1 ON "float", CYCLE through meter modes AND RECORD the following on Step 7 of Data Sheet:
- Volts (≥ 56 volts)
- Amps (≥0.1 amps)
- Hours (≥8 hours).

**Voltages Using Edit Key**

5.6.8.2 SET equalize method to on (Auto EQLZ Time).

5.6.8.3 CHECK voltages using Edit key on front panel to scroll through the following AND RECORD the voltages on Step 8 of Data Sheet:
- Float voltage (≥ 56 volts)
- Equalize voltage (≥ 58 volts).
5.6 Semi-Annual Electrical Inspection of Battery Charger (Cont.)

5.6.8.4 **CHECK** the “Current Limit Alarm” setting by performing the following:

a. **PRESS** the “Up” arrow and “Edit” keys simultaneously.

b. **RECORD** the “Current Limit Alarm” setting on Step 9 of the Data Sheet.

c. **IF** the “Current Limit Alarm” is not per Data Sheet. **NOTIFY** FWS for direction AND **RECORD** directions on Data Sheet comments page.

**NOTE** - When charger is de-energized, then later re-energized and returned to service, the charger restarts using last parameters set.

5.6.9 **RESTORE** charger to normal operation by pressing the EDIT key.

5.6.10 **ENSURE** Float and Manual Timer lights are lit.

5.6.11 **CLOSE** latch on front panel.

5.6.12 **PERFORM** an "Equalize" charge of the unit.
5.7 Restoration

5.7.1 IF not already removed, REMOVE all tools and test equipment.

5.7.2 RECORD Test Equipment information and calibration status on Data Sheet.

5.7.3 CHECK equipment restoration by observing indications are consistent with expected conditions.

5.7.4 CLEAN work area.

5.7.5 NOTIFY Shift Manager when complete.

5.7.6 IF performed, RECORD Radiological Survey Report (RSR) number(s) on Comments Page of Data Sheet or Work Record.
5.8 Acceptance Criteria

Successful completion of the testing detailed under these instructions will establish acceptance of equipment for return to service.

5.9 Review

5.9.1 **INFORM** FWS procedure is complete.

5.9.2 **FWS REVIEW AND ENSURE** the following:

- Completed Data Sheets meet acceptance criteria
- Comments page is filled out appropriately.

5.9.2.1 **IF** deficiencies cannot be immediately repaired, FWS or Engineering initiate a Work Request **AND**

**RECORD** Work Request Number(s) in the comments/remarks section of the Data Sheet.

5.9.2.2 **NOTIFY** Engineering of deficiencies.

5.10 Records

The following records are generated during the performance of this procedure.

5.10.1 **SUBMIT** the completed records to the shift office for record retention.

- This procedure in its entirety

The record custodian identified in the Company Level Record Inventory and Disposition Schedule (RIDS) is responsible for record retention in accordance with TFC-BSM-IRM_DC-C-02.
Figure 1 – Cell Voltages
Figure 2 – Charger Model Number Showing Parameters
Figure 3 – Charger Faceplate Layout

- 1% digital meter shows voltage, amperage and hours. Also displays self-diagnostics error codes.
- LED lamps indicate abnormal conditions.
- Press to switch to EDIT mode and to ENTER voltage settings and timer hours.
- Press to choose digital display of Volts/Amps/Equalize hours remaining.
- Press to select float or equalize mode.
- Choose from three equalize methods: continuous, timed, or automatically times after AC interrupt.
- Press to adjust voltage settings or timer hours when in EDIT mode. Press to test LED lamps when in normal mode.
- Choose from three equalize methods: continuous, timed, or automatically times after AC interrupt.