

Facility UPS Uninterruptible Power Supply Battery Health Audit

1.0 Maintenance Objective & Frequency

The objective of this procedure is to perform a comprehensive health audit on the batteries within a Facility Uninterruptible Power Supply (UPS) system. This audit aims to identify degraded or failing batteries before they cause a loss of backup power during a mains failure, thereby preventing critical process downtime and equipment damage. The procedure includes visual inspection, terminal torque verification, open-circuit voltage measurement, internal resistance (impedance) testing, and thermal imaging.

Frequency: Semi-Annual (every 6 months) for flooded lead-acid batteries; Annual for VRLA (Valve-Regulated Lead-Acid) batteries. More frequent audits (quarterly) are recommended for batteries operating in high-temperature environments (>25°C) or those approaching their end-of-life (past 80% of design life).

2.0 Lockout/Tagout (LOTO) & Safety

- **Electrical Isolation:** Place the UPS in bypass mode to isolate the inverter and battery bank from the critical load. Verify bypass operation via the UPS display panel. Do not disconnect the UPS input mains, as the bypass circuit requires power. Confirm that the battery breaker is in the OFF position and apply a personal lock and tag.
- **DC Electrical Hazard:** UPS battery banks can deliver thousands of amps at nominal voltages ranging from 48VDC to 480VDC. Assume all exposed terminals are energized. Use only insulated tools rated for the system voltage.
- **Arc Flash & PPE:** Wear appropriate arc-rated clothing (minimum 8 cal/cm²), safety glasses with side shields, insulated rubber gloves (rated for the DC voltage), and a face shield. Remove all metal jewelry (rings, watches, necklaces).
- **Ventilation:** Ensure the battery room or enclosure is adequately ventilated. Hydrogen gas can accumulate during charging and is explosive. Do not create sparks or use open flames near the batteries.
- **Emergency Procedures:** Have a spill kit (for electrolyte neutralization) and a fire extinguisher rated for electrical fires (Class C) readily accessible. Review the facility's emergency response plan for electrical incidents.

3.0 Required Tools, Parts & Lubricants

- Calibrated Digital Multimeter (DMM) with 0.1% DC voltage accuracy and true RMS AC capability
- Battery Impedance Tester (e.g., Fluke BT500 Series, Megger BITE) or a DC micro-ohmmeter
- Infrared Thermal Imaging Camera (minimum 160x120 resolution, ±2°C accuracy)
- Insulated hand tools: socket set, torque wrench (0-30 Nm range), combination wrenches, screwdrivers
- Torque wrench calibrated to NIST-traceable standards, with a range suitable for battery terminal bolts (typically 8-20 Nm)
- Personal Protective Equipment (PPE): arc-rated clothing, insulated rubber gloves, safety glasses, face shield
- Lockout/Tagout kit: padlocks, hasps, tags, and a LOTO log
- Cleaning supplies: distilled water, clean lint-free rags, anti-corrosion spray (e.g., NO-OX-ID A-Special)
- Battery data log sheet or tablet with ServiceGrid mobile app for digital recording
- Spill kit for battery acid neutralization

4.0 Step-by-Step Maintenance Procedure

1. Perform LOTO: Place the UPS in bypass mode via the front panel or maintenance bypass switch. Confirm bypass operation by verifying the load is powered and the inverter is off. Open the battery breaker and apply a personal lock and tag. Verify zero voltage at the battery terminals using a calibrated DMM.
2. Conduct a visual inspection of the entire battery bank. Look for cracks, bulging, leaks, or corrosion on terminals and interconnecting cables. Check for any signs of overheating (discoloration, melting). Document all findings with photographs.
3. Measure and record the open-circuit voltage (OCV) of each individual battery cell or monobloc using the DMM. For a 12V VRLA battery, a healthy OCV is typically 12.6V to 12.8V. Flag any cell with a voltage deviation greater than $\pm 0.15\text{V}$ from the average of the string.
4. Using the battery impedance tester, measure and record the internal resistance (impedance) of each battery. Follow the tester manufacturer's instructions for proper connection (four-wire Kelvin method). Compare readings to the baseline values from the previous audit or the manufacturer's specification. Flag any cell with an impedance increase greater than 25% from baseline.
5. Using the thermal imaging camera, scan all battery terminals, interconnections, and the battery case surfaces. Look for hot spots (temperature differences $>5^{\circ}\text{C}$ compared to a reference cell under no load). Pay special attention to loose connections or high-resistance joints. Capture and save thermal images for the maintenance record.
6. Inspect and clean all battery terminals and interconnecting cables. Remove any corrosion using a wire brush or terminal cleaning tool. Apply a thin coat of anti-corrosion spray to all connections.
7. Using the torque wrench, verify and re-torque all terminal bolts to the manufacturer's specified torque value (typically 8-12 Nm for M8 bolts, 15-20 Nm for M10 bolts). Do not over-torque, as this can damage the battery posts.
8. Check the electrolyte level in flooded lead-acid batteries (if applicable). Top up with distilled water only to the maximum fill line. Do not overfill. For VRLA batteries, do not attempt to add water.
9. Inspect the UPS cabinet for dust, debris, or signs of rodent activity. Clean the cabinet interior using a vacuum with a HEPA filter and a soft brush attachment. Ensure all ventilation grilles are unobstructed.
10. Record all measured data (OCV, impedance, thermal images, visual observations) on the data log sheet or directly into ServiceGrid. Note any batteries flagged for replacement and schedule a follow-up work order for battery replacement if required.

5.0 Verification & Return to Service

1. Remove all personal locks and tags from the battery breaker. Close the battery breaker.
2. Take the UPS out of bypass mode by returning the inverter to normal operation. Verify on the UPS display that the inverter is on and the batteries are charging. Confirm that the load is now being supplied by the UPS (inverter) and not bypass.
3. Allow the batteries to charge for at least 1 hour (or until the charger indicates a float state). Monitor the charging voltage and current on the UPS display to ensure they are within normal parameters.
4. Perform a functional test of the UPS by simulating a mains failure (if safe and permitted by facility protocol). Briefly open the UPS input breaker and verify that the load remains powered without interruption. Reclose the input breaker immediately after confirming transfer.
5. Verify that all alarms and notifications on the UPS are clear. Check the event log for any anomalies during the test.
6. Complete the PM work order in ServiceGrid, attaching all data logs, thermal images, and photographs. Sign off on the procedure and note any recommendations for future action (e.g., battery replacement, follow-up testing).

Regulatory Disclaimer: This document is a generic maintenance template provided for educational and informational purposes only. It does not constitute professional engineering or reliability advice. The end-user assumes all liability for validating all step sequences, torque specs, and LOTO protocols against specific machinery OEM manuals before deployment to a live production floor.