CGT Station Battery Maintenance and Testing Procedures

General

Proper and regular maintenance helps to maximize battery life. Regular testing detects weak cells before they fail, thereby improving overall direct current (dc) system reliability. Good recordkeeping is invaluable when seeking warranty recovery.

Employee Safety

Safety Equipment

The following equipment must be worn when taking specific gravity and/or electrolyte temperature readings on flooded cell batteries:

- Goggles, safety glasses with side-shields, or face shields.
- Acid-resistant gloves.
- Protective apron.

Portable or stationary eyewash equipment must be located in the battery storage area or immediate vicinity for rinsing eyes and skin following contact with electrolyte.

Precautions

Station batteries present an electric shock hazard. Observe the following precautions when working on or around the batteries:

- Smoking, open flames, and arc-producing equipment are prohibited in the immediate vicinity of the battery.
- Neutralize static buildup before working on a battery by contacting the nearest effectively grounded surface.
- Keep metallic objects, such as jewelry or non-insulated tools, away from the batteries when performing maintenance.

Electrolyte Spill Cleanup

"Small" Spill Cleanup – Non-Hazardous

Use a baking soda/water mixture (1 pound/gallon of water) to neutralize small electrolyte spills (* 1 pint or less). The baking soda/water mixture will bubble rapidly as it neutralizes the sulfuric acid electrolyte. When adding more neutralizer does not result in further bubbling, the acid can be considered neutralized. Use absorbent material to clean up the neutralized mixture (carbon dioxide gas, water, and sodium sulfate), and dispose of it as normal waste.

"Large" Spill Cleanup

For electrolyte spills larger than 1 pint, please contact your assigned environmental engineer or specialist for proper cleanup procedures.

Routine Inspections and Maintenance
This section describes inspections and procedures to be followed by district maintenance employees. For inspection and maintenance task frequency, see Table 1 on Page 3.

A. What to Check and Record (See Attachment 3, "Battery Maintenance Log Sheet.")

1. Record the overall float voltage **measured at the battery terminals**. (See Pages 4 and 5.)
2. Record cell voltages.
3. Record cell temperatures at the negative terminal using an infrared temperature detector (valve-regulated lead acid [VRLA] batteries only).
4. Record the ambient temperature in the battery storage area.
5. Record the charger/rectifier output current and voltage.
6. Record cell-to-cell interconnection resistance using an Alber Cellcorder or micro-ohmmeter.
7. Record cell/unit internal resistance using an Alber Cellcorder or micro-ohmmeter.
8. Record any **cracks** in cells or **electrolyte leakage**.
9. Record any excessive jar/cover distortion (VRLA batteries only).
10. Check the terminals, connectors, and racks for **corrosion**. Clean as per manufacturer instructions.
11. Intercell resistance measurements should be similar for similar connections. If not, or if values have increased since earlier measurements, remove and clean the connectors, and reapply corrosion inhibitor. Reassemble the connections and torque to manufacturer's specifications using an appropriate insulated torque wrench (typical torque * 100 in-lb).
12. Check the general appearance and cleanliness of the battery, rack, and surrounding area.
13. Ensure that the ventilation system is operating properly and the vents are unobstructed.
14. Check for unintentional battery grounds (if the charging equipment includes the dc ground detection feature).

B. Additional Checks for Flooded Cell Batteries

1. Measure and record specific gravity and electrolyte temperature. Electrolyte temperatures are measured by inserting a thermometer into the jar.

   Note: Take specific gravity measurements before adding water. If the electrolyte level is too low to take the reading, add water, and then **wait at least 72 hours** to take the readings. This allows adequate time for the water to mix properly with the acid.

2. Check electrolyte levels. Add distilled water to keep the level between the "Hi" and "Lo" marks on each jar.
3. Check all flame arrestors to ensure that they are not clogged.
4. Inspect the battery plates for cracks, sulfate formation, swelling, and sediment accumulation.
5. Check for excessive gassing. There should be little or no visible gassing during normal operation.

Table 1: Maintenance Frequencies for Flooded and VRLA Batteries

Task Description	Flooded Cells				VRLA Cells			
	Initial	Monthly	Annually	Special (1)	Initial	Quarterly	Annually	Special (1)
Measurements								
Record overall float voltage of battery (measured at battery terminals)	XX		XX		XX		XX	
Record pilot cell voltage.	X	X	X	X				
Record individual cell voltage.	X		X	X	X		X	X
Record the ambient temperature in the battery storage area.	XX		XX		XX		XX	
Record pilot cell temperature.	X	X	X	X				
Record individual cell temperatures (2).	X		X	X	X		X	X
Record the charger/rectifier output current and voltage (3).	XX		XX		XX		XX	
Record cell-to-cell interconnection resistance using an Alber Cellcorder or micro-ohmmeter.	X		X	X	X		X	X
Record cell/unit internal resistance using an Alber Cellcorder.	X		X	X	X		X	X
Record pilot cell specific gravity.	X	X	X	X				
Record specific gravity of electrolyte of individual cells.	X		X	X				
Visual Inspections								
Check the general appearance and cleanliness of the battery, rack, and surrounding area.	XX		XX		XX		XX	
Check for corrosion at terminals, connectors, and/or racks. Clean per the manufacturer's instructions.	XX		XX		XX		XX	
Torque intercell connectors (4).	X			X	X			X
Ensure that the ventilation system is operating properly and vents are unobstructed.	XX		XX		XX		XX	
Check for cracks in jars and/or electrolyte leakage. Check for gassing.	XX		XX		XX		XX	
Check electrode plates for cracks, sulfate formation, and sediment formation.	X	X	X	X				
Check electrolyte levels. Add distilled water as necessary.	X	X	X	X				
Check for clogged flame arrestors.	X		X	X				
Check for excessive jar/cover distortion.					X	X	X	X
Check for unintentional battery grounds (5).	X		X		X	X	X	

Notes:

(1) Special task category is as indicated in Section C, "Special Inspections" of this attachment.

(2) Cell temperatures are checked with a thermometer (Flooded) or infrared detector (VRLA).

(3) Charger/rectifier output voltage varies with temperature (temperature-compensated equipment only). See Section G of this attachment for evaluation of readings.

(4) As indicated by intercell resistance readings (see Section A, Item 11 for more information).

(5) This can be easily checked for charging equipment having a dc ground detection feature.

C. Special Inspections

If the battery has experienced one or more of the following conditions, perform inspections and maintenance tasks as indicated in Table 1 under "Special":

- Extended power outage resulting in long discharge on the battery.
- Routine capacity testing (typically, the entire battery system is checked and documented during this testing).
- One or more battery jars is replaced.
- Extremely high (sustained) ambient temperature in the battery area.

D. Frequency of Inspection and Maintenance Tasks

See Table 1, "Maintenance Frequencies for Flooded and VRLA Batteries," on Page 3.

E. Pilot Cell Selection

When selecting a pilot cell, select one that meets the following criteria:

- Not located at either end of a rack step or tier.
- Not the first or last cell in a string.
- Not closest to or farthest from any ventilation source, such as a wall-mounted air conditioner/heater, doorway, etc.

For flooded cell batteries, it is recommended that the cell with the lowest specific gravity reading be selected as the pilot cell (also considering the other factors listed above). However, because a slight amount of electrolyte is lost each time a hydrometer reading is taken, **it is advisable to change pilot cells annually for flooded cell batteries**.

For VRLA batteries, select the cell with the **lowest float voltage**, also considering the other factors listed above.

F. Setting the Float Voltage

Improper float voltage settings are major contributors to premature battery aging, especially for VRLA batteries. Strict attention must be paid to proper adjustment. Though most charging equipment includes temperature-compensation circuitry, use the formula given in "Sample Calculations" on Page 5 to calculate the proper setting at least annually. Calculating the setting confirms that the temperature-compensation circuitry is working properly and ensures the proper adjustment to the float voltage level.

Note: Float voltage measurements must be taken at the battery terminals with a calibrated digital voltmeter. Do not rely on the charging equipment's voltmeter for this measurement.

G. Sample Calculations

Battery Type: GNB Absolyte IIP (VRLA), 60 Cells

Ambient Temperature[1]: 65°F

Nominal Voltage @ 77°F: 2.23 - 2.27 volts per cell (VPC)

$V_{corrected} = V_{77F} - [(T_{actual} - 77°F) \times (0.003\ V/°F)]$

Using the data and formula given above[2]:

$V_{corrected} = 2.25 - [(65 - 77) \times 0.003] = 2.286$ VPC

$V_{float} = (2.286) \times 60 = 137.16$ V

Compare this with the nominal value at 2.25 VPC = 135 V, a 2.16 V difference.

H. Equalizing Charge

Note: Equalize charging is not normally recommended for most VRLA-type batteries. Allowable variations among cell voltages in VRLA batteries can be much greater than for flooded-cell batteries. Consult the manufacturer's literature for specific instructions for the battery type being used.

Perform an "equalize charge" on a flooded cell battery when any of the following conditions are noted during routine maintenance and inspection:

1. Cell voltage readings vary from the average value by more than ±0.04 V for lead-calcium cells, or ±0.02 V for lead-antimony cells.
2. The specific gravity of any individual cell falls below the manufacturer's lower limit.
3. An individual cell voltage reading falls below the minimum recommended voltage set by the manufacturer (typically 2.13 V for 1.215 specific gravity cells).
4. Following battery capacity testing.

[1] Ambient temperature for this calculation is the average temperature in the battery area.
[2] Formula taken from "Absolyte IIP, Installation and Operating Instructions," Section 8-20, Page. 20. Consult the appropriate manufacturer's literature for correction formulae for batteries other than the GNB Absolyte.

Required Testing and Replacement

Testing will be done by a minimum of one Gas Construction Maintenance and Construction (GC M&C) technician and one district technician. GC M&C has the primary responsibility for overall test schedule coordination.

A. VRLA Batteries

Capacity testing is required for these batteries at the time of installation and **annually** thereafter.

B. Flooded Cell Batteries

Capacity testing is required for these batteries at the time of installation, **2 years thereafter**, and at subsequent intervals of **5 years**.

Testing **every 2 years** is required when the battery has reached 85% of its service life (typically 17 years for a 20-year battery).

Annual testing is required when any or all of the following conditions exist:

- The battery has reached 85% of its service life **and** has a tested capacity below 100% of the nameplate value.
- The battery capacity falls 10% or more from the prior tested capacity.
- The battery capacity is below 90%.

C. Testing Procedures

Testing procedures are documented in Attachment 2, "CGT Battery Capacity Testing Procedure." The following documents are also included as attachments to this guideline:

- Attachment 4, "List of Station Batteries and Testing Intervals"
- Attachment 5, "Battery Discharge Test Parameters"

Battery testing software and hardware should be used to properly document test results.

The advantages of using this equipment over other "manual" methods are as follows:

1. Discharge test parameters are entered into the capacity testing program and allow for precise and automatic control of the discharge current through the load bank throughout the test.
2. Voltage readings for each cell are taken continuously, displayed, and recorded to a data file for later analysis. This saves time and allows closer evaluation of each individual cell's performance throughout the test.
3. Very robust reporting and analysis tools are available following testing that give a precise picture of the battery's condition.
4. Test reports using the AlberCorp software have proven very useful in obtaining warranty support on failed batteries.
5. The ability to compensate for temperature variations from nominal (77°F) is built into the program. No correction factor tables are needed.
6. In most cases, the discharge tests can be completed more quickly using the computer-controlled equipment rather than using manual methods.

D. Test Results

Copies of annual load test results shall be mailed (or emailed) to:

[redacted]
GSM&TS Station Engineering
375 N. Wiget Lane, Suite 130
Walnut Creek, CA 94598

The test results will be used to write a final test report for each location at which testing was performed. This report will include observations and recommendations to the district, along with a detailed printout of the test results for each battery tested.

E. Replacement Criteria

It has been demonstrated that battery capacity deteriorates rapidly after falling to the 80% level. Therefore, batteries testing below 80% of rated nameplate capacity should be replaced within 12 months.

Recordkeeping Requirements

Maintenance employees must use Form F14293-3, "Battery Maintenance Log Sheet" (Attachment 3) to record maintenance on each battery bank. Log sheets must be kept in a binder at each facility along with copies of past Capacity Test Reports and manufacturers' literature. These log sheets and reports must be kept on file until a battery is removed or replaced.