Total Power Solutions

member of The alpha Group™

OSP Battery Training

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Power

RELIABILITY INTELLIGENCE SUSTAINABILITY EFFICIENCY

Topics:

- Types of lead acid batteries
  - VLA vs. VRLA
  - AGM vs. Gel
  - Standby vs. Deep Cycle vs. General Purpose
- Design considerations for North America CATV applications
- Temperature impact on capacity
- AlphaCell GXL and HP overview
- Battery aging in non-temperature controlled float applications
- Internal vs. external resistance
- Battery Evaluation in the field

Types of Lead Acid Battery

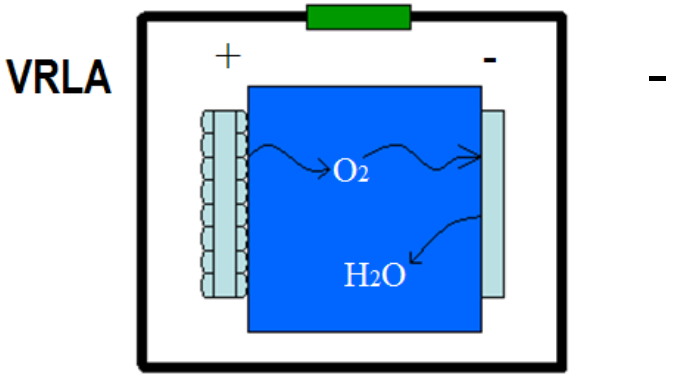
- **VLA (Vented Lead Acid) battery**
  - **Also called Flooded or Wet**
  - **Common types are Lead-Calcium, Lead-Antimony, Lead-Selenium, and Pure Lead**

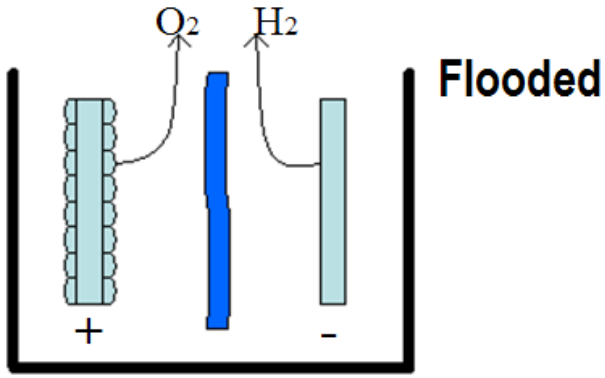
- **VRLA (Valve Regulated Lead Acid) battery**
  - **Also called Sealed or Maintenance-Free**
  - **Can be AGM (both Lead Calcium Alloy or Pure Lead)**

    Gel, or hybrid AGM-Gel

Design differences

- **Chemical reaction & Gassing**





- O_2 and H_2 generated during reaction recombines into water and stays in the cell
- Recombination rate: ~ 98-99%
- No special ventilation req'd - regular room air exchange via HVAC is sufficient

- O_2 and H_2 generated during reaction leaves the cell through open vent
- Recombination rate: ~ 20-25%
- Room ventilation must be considered - regular room air
- exchange via HVAC is NOT sufficient

Types of Lead Acid Battery

- **Standby type**
  - **Batteries are on float charge until loss of power**

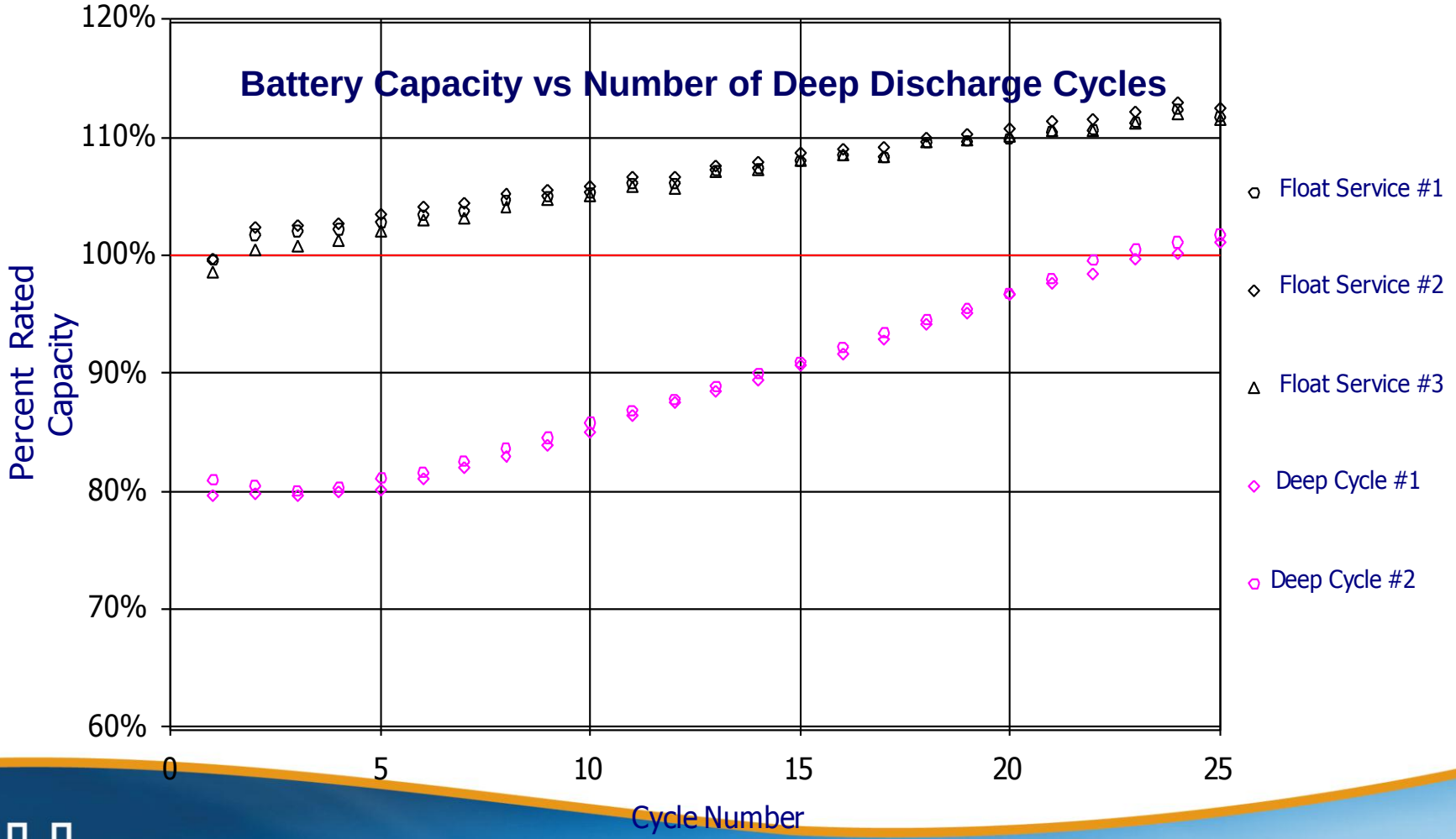
- **Cycling type**
  - **Car batteries**
  - **Fork lift batteries**
  - **Solar batteries**

Considerations for Choosing a Float Service or Deep Cycle

- Number of full cycle outages per year.
- Number of full cycle outages over the 5 to 6 year life of battery.
- Most deep cycle batteries must cycle 15-20 times before it reaches it's full rated run time.
- Power supplies with a high frequency of commercial power outages, more than two full discharges every two months, benefit from a deep cycle battery application by maximizing battery life.
- Power supplies with a normal frequency of commercial power outages, less than one every 6 months, benefit from a float service battery application by maximizing runtime.

Deep Cycle Batteries Require Significant Cycles to Achieve 100% Rated Capacity

Cycle Test, 25A to 10.5V
Float Service vs Deep Cycle Battery



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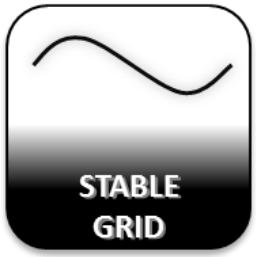

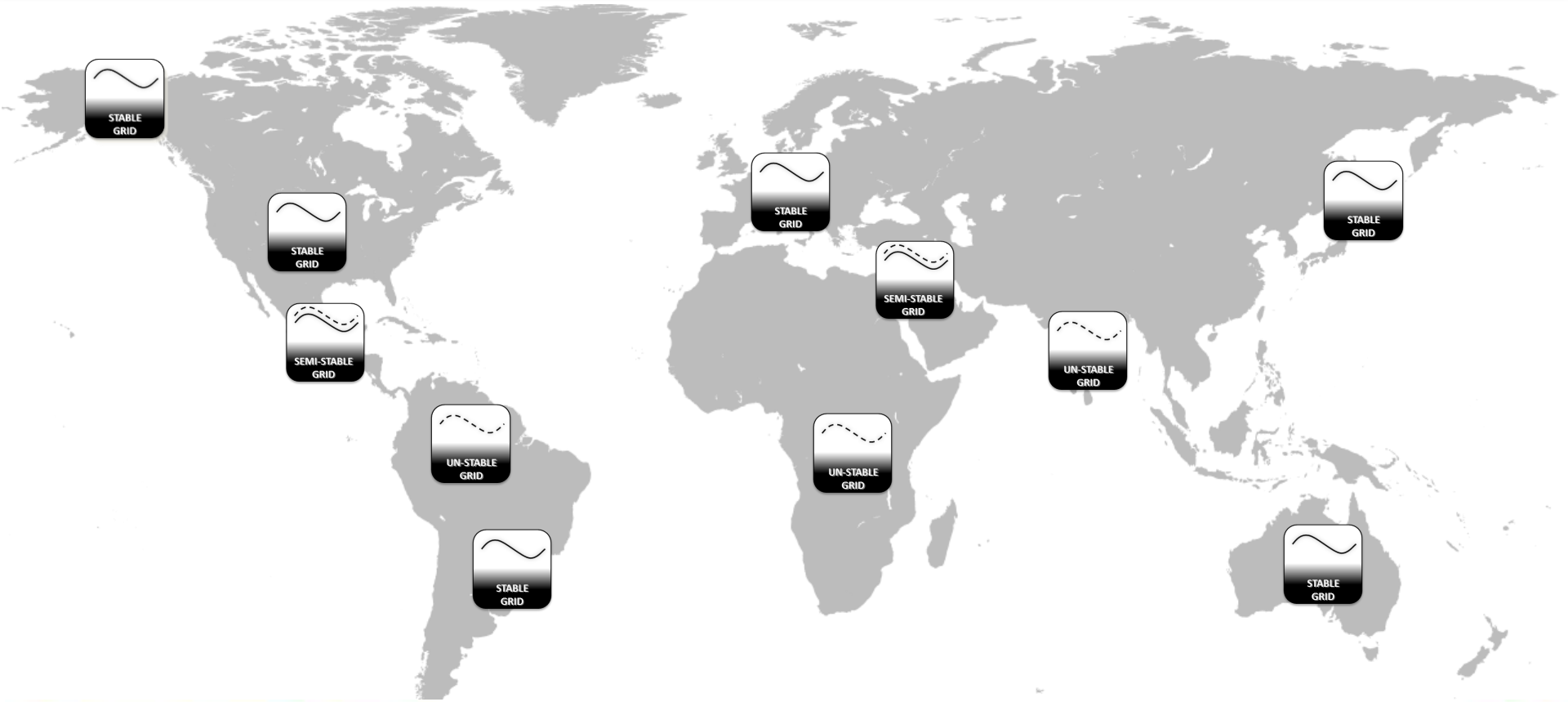

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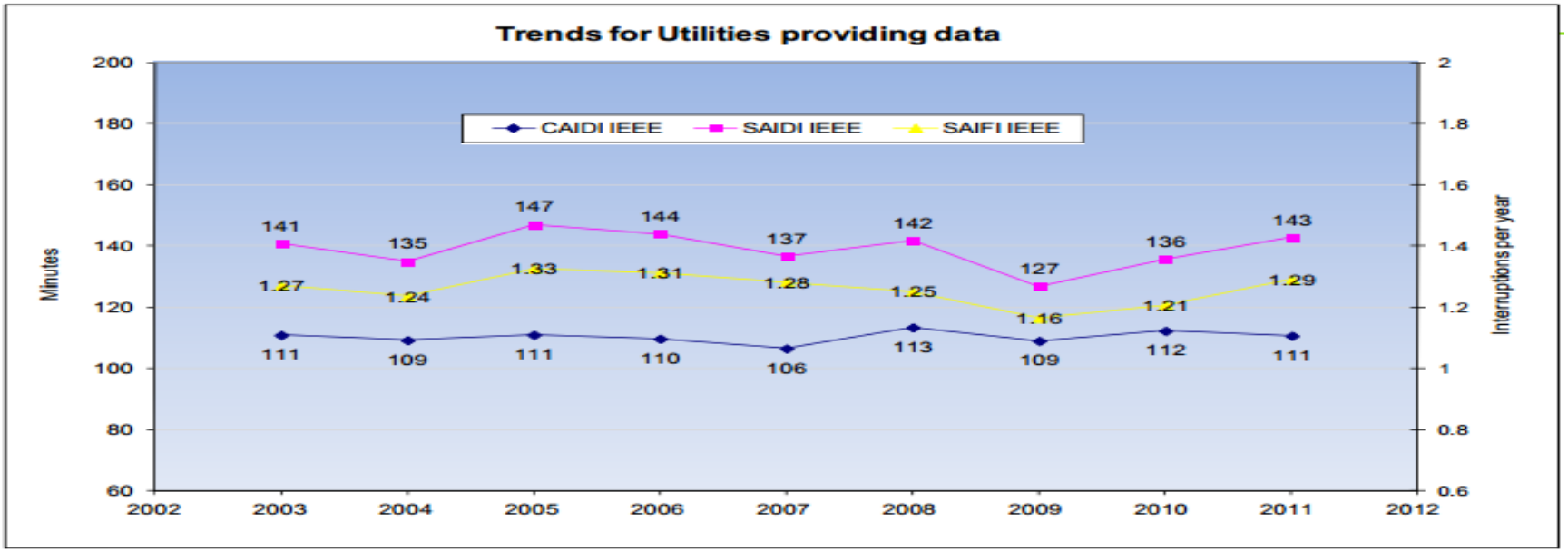
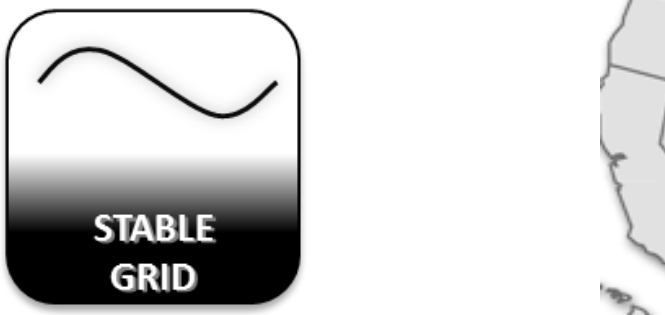
2011 IEEE Survey – Trends for Metrics





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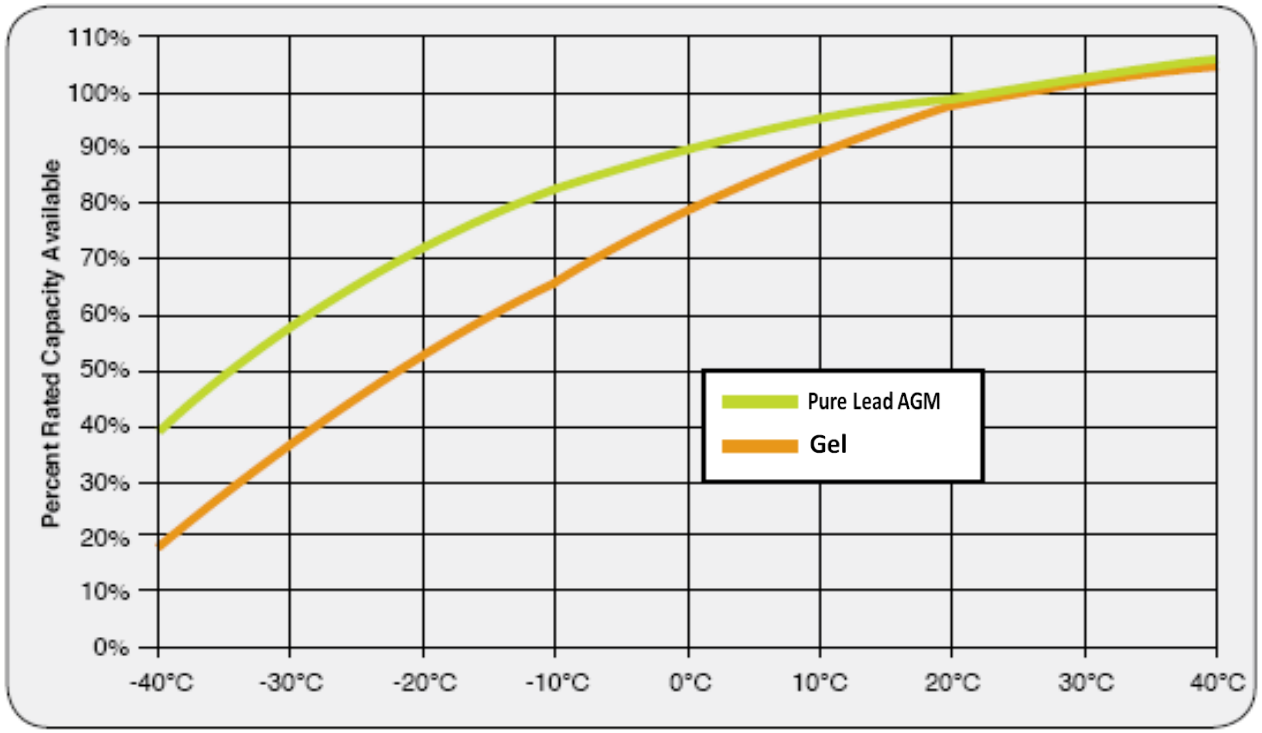
North America CATV OSP Battery Design Considerations

- Near-maintenance free (no need for watering or re-torqueing of terminal hardware-copper threaded inserts)
- Non-temperature controlled environment
- Maximum runtime at wide temp ranges (cold)
- Maximum life expectancy at wide temp ranges (hot)
- Stable Utility Grid

Cold Temperature Performance



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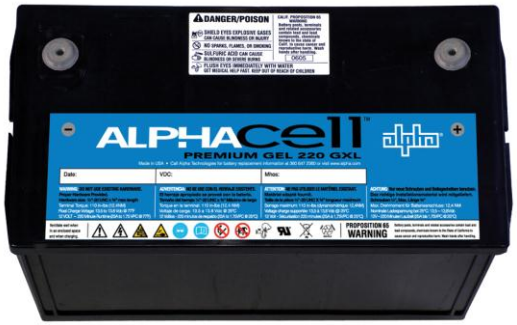
AlphaCell GXL Batteries

- **Specifically designed for Cable TV Outside Plant Applications**
- **Long Float Life Expectancy–**
  - Proven long life performance in Cable TV
- **Ultra low Calcium alloy grid chemistry**
  - Provides ultimate protection against corrosion and growth
- **100% capacity at time of installation – out of the box**
- **Longest Warranty in the Industry**



GXL Design

Attributes

- Inserted Copper Terminals
- Proprietary Grid Wire Design
- Proprietary Long Life Grid Alloy
- Extrusion Fusion Inter-cell Welds
- Patented Vent System
- Patented Silica GEL
- Low Resistance Ribbed Separators
- Ribbed Container Walls

AlphaCell HP Performance

- **Long Service Life in CATV Outdoor Plant**
  - 20% More than Traditional VRLA
- **Longer Storage time**
  - Three to Five Times Longer before recharge
- **Higher power density**
  - 10%+ More Runtime in Same Block Size
- **Superior cold temperature operation**
  - Up to 50% More Runtime – eliminate heater mats
- **Non-Hazardous / Non-Spillable**
  - No restrictions on shipping / reduced cost
- **100% Out of Box Runtime**
  - Ensures high network reliability

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Pure Lead Advantages

- Traditional AGM and Gel use calcium additives in the grids
- Pure lead plates:
  - Reduce corrosion / no intergranular corrosion – maximize battery life
  - Reduce float current – maximize float battery life
  - Lower self discharge rate – maximize shelf life

Thin Plate - Performance

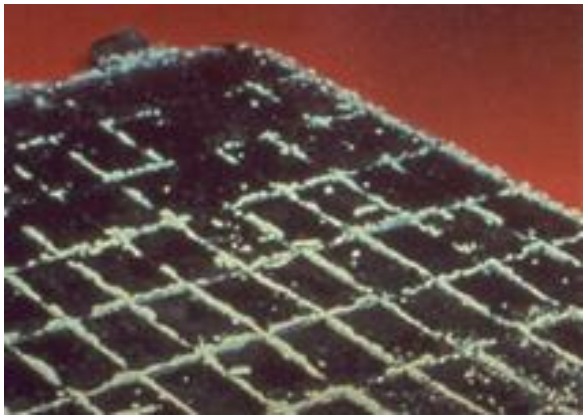
- Thin plates = more surface area = superior active material utilization
- Process and Design allows for higher cell compression
- Improved Power Density – 10%+ more run time
- Superior Active Material Utilization
  - Minimizes low temperature effects on discharge performance

Factors affecting performance and life

- Battery manufacturing
- Battery selection
- Battery sizing
- Storage
- Installation methods
- and location
- Operating temperature
- Charge voltage regulation
- AC ripple
- Temperature compensation
- Number of Cycles

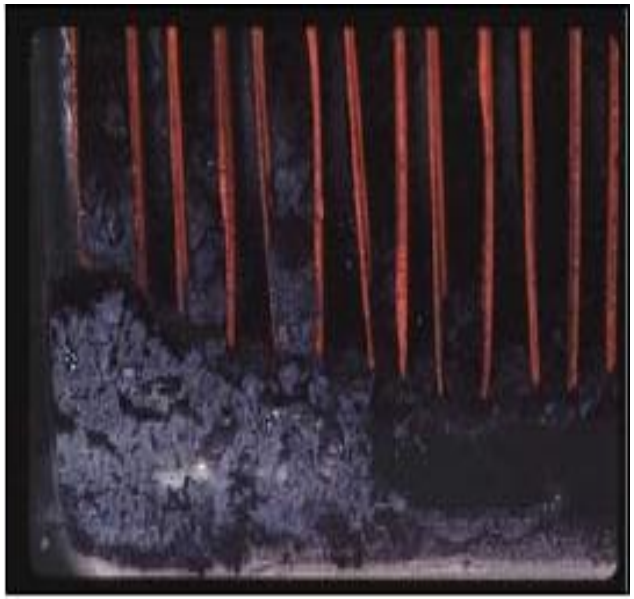
Battery aging

- **Lead-Acid Battery is a sacrificial design with unavoidable degradation over time**
  - **Highly chemically active environment**
  - **Corrosion of positive plate grid structure**
  - **Converts base material to:**
    - **Lead dioxide**
    - **Lead peroxide**
    - **Lead sulphate**
    - **Even under ideal conditions**
- **Positive Grid Corrosion is also known as "Positive Plate Growth"**
  - **Plate actually grows in size**



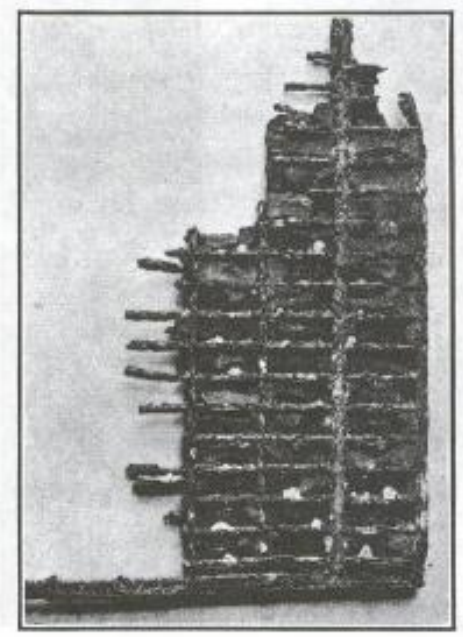
Battery aging

- **Effects of Positive Plate Grid Corrosion:**
  - **Expansion of the positive plate**
    - **Occupies more volume**
  - **Decrease in Grid cross-sectional area**
  - **Weakening of grid and straps**
    - **Lower strength**
  - **Loss of electrical contact with active material**
    - **Higher resistivity & Lower conductance**
  - **Shedding of active material**
  - **Loss of conductance**
  - **Increase of mechanical stresses**
  - **Reduced capacity**



Battery aging

- **Failure modes due to aging:**
  - **Permanent Loss of capacity**
  - **Increased internal resistance**
  - **Obstruction of active material in discharge reaction**
  - **Post seal leakage**
  - **Cracked cover**
  - **Internal short circuit**
  - **Loss of physical strength**
  - **Failure of conduction path**



Corrosion – The Oxidation of the Positive Grid

- Grid lead metal is converted to PbO2
- Grid wires are reduced in size during life of battery
- Impedes the flow of current
- Grid grow occurs - exaggerated in high calcium alloys
  - Grid expansion due to the pressure of oxidation
  - Loss of connection to the positive grid
- Grid structure no longer able to conduct current

- **Internal resistance**

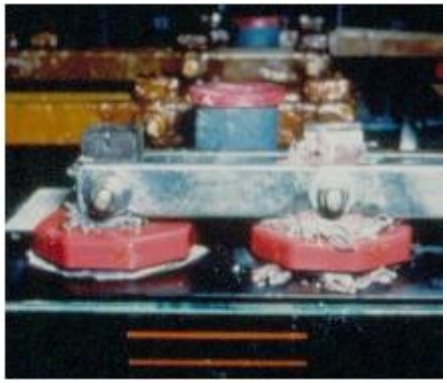
– The opposition to the electricity flow within the cell

– Sources of internal resistance
  - Electrolyte
  - Separators
  - Active material, grids, posts, & straps

– Baseline reading is useful for trending

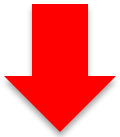
– Combine with discharge testing to predict battery health

- **External resistance**
  - The opposition to the electricity flow outside the cell
  - Connection integrity is very important
    - Loose connection
    - Corrosion build-up
    - Cleanliness – remove corrosion/byproducts
    - Tightness – torque to recommended value
    - Hardware – Replace worn or damaged hardware
    - Preparation – Follow contact surface preparation and NO-OX-ID application to prevent corrosion
    - A loose connection can cause arcing and overheating - in worst case, it can result in fire



Battery Preventative Maintenance Procedure

Description:	As part of a comprehensive Preventative Maintenance Program, batteries must be verified to be in a reliable operating condition. Understanding Stand-By Power Supply Batteries: • When performing service and maintenance on batteries always follow recommended safety practices and wear recommended personal protective equipment. See AlphaCell Battery User's Manual for reference. • Batteries last longer in cooler climates and degrade faster in hotter climates • Charger settings and temperature compensation are critical to maximize battery life. • Batteries left off charge will sulfate. If left off charge for prolong periods of time this can permanently reduce the capacity and life of the battery. • Proper charger operation should be routinely validated either by regular onsite preventive maintenance visits or remotely via status monitoring.



Evaluation Procedure:

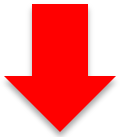
1. Physical Check

   Any battery showing physical sign of compromise should be immediately removed from service by switching the battery breaker off and physically removing from the system. Physical conditions include but are not limited to swelling, cracking, seeping, and discoloration. DO NOT PERFORM SELF TEST ON BATTERIES SHOWING PHYSICAL SIGN OF DAMAGE OR COMPROMISE.

2. Power Supply Battery "Self" Test
   a. Initiate a 10 minute self- test via the front panel display of the power supply. Monitor the individual battery voltages during the test. If any battery measurement varies more than .5 VDC off of the string average, replacement is recommended.
   b. If a PS self-test fails due to a weak battery string, replace the entire battery string. Refer to section 3.5 (Battery Refurbishment Plan) of AlphaCell User's Manual to determine if any batteries are healthy enough to redeploy.
3. Float Voltage Test

   After validating system under test is in "Float" charge mode, measure the voltage of each battery. Use the following chart to determine battery status at various temperature ranges.

Temperature	Battery OK	Battery Suspect	Replace Battery
30 F / 0 C	>14 VDC	≤14 VDC	<13.4 VDC
77 F / 25 C	>13.2 VDC	≤13.2 VDC	<12.6 VDC
100 F / 38 C	>12.8 VDC	≤12.8 VDC	<12.2 VDC



Evaluation Procedure:

4. Use an Alpha/Midtronics CTE-1200AT conductance meter to measure the voltage and Siemens count of each battery.

   Reference table below. Replace any battery which falls below suspect level.

Midtronics Conductance Models 3200/micro CELLTRON	170XLT	85 GXL-HP	135 GXL	160 AGM	165 GXL	195 GXL	195 GXL-FT	220 GXL	195 GOLD-HP	220 GOLD-HP
Approximate Conductance Values (mhos) Healthy Battery @ 77°F (25°C)	1040-1560	480-720	900-1350	1040-1560	800-1200	880-1320	800-1200	960-1400	880-1320	960-1400
Suspect Battery @ 77°F (25°C) in mhos	<520	<240	<450	<520	<400	<440	<400	<480	<440	<480

** Siemens values are affected by temperature. As a general rule of thumb for every 2°F drop in temperature below 77°F the Siemens reading should be adjusted up by .7%

5. 24 Hour Open Circuit Test (Battery Refurbishment Plan)
   Measure the open circuit voltage of the suspected battery exactly24 hours after the battery has come off of the float charge. A battery below 12.6 VDC should be replaced. This test requires the suspect battery to be removed from service. Typically done at the warehouse or battery return facility.

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Thank you for your time!

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