PURE Pb+

Improving Energy Efficiency using Pure-Lead Battery Technology

C&D TECHNOLOGIES
Power Solutions

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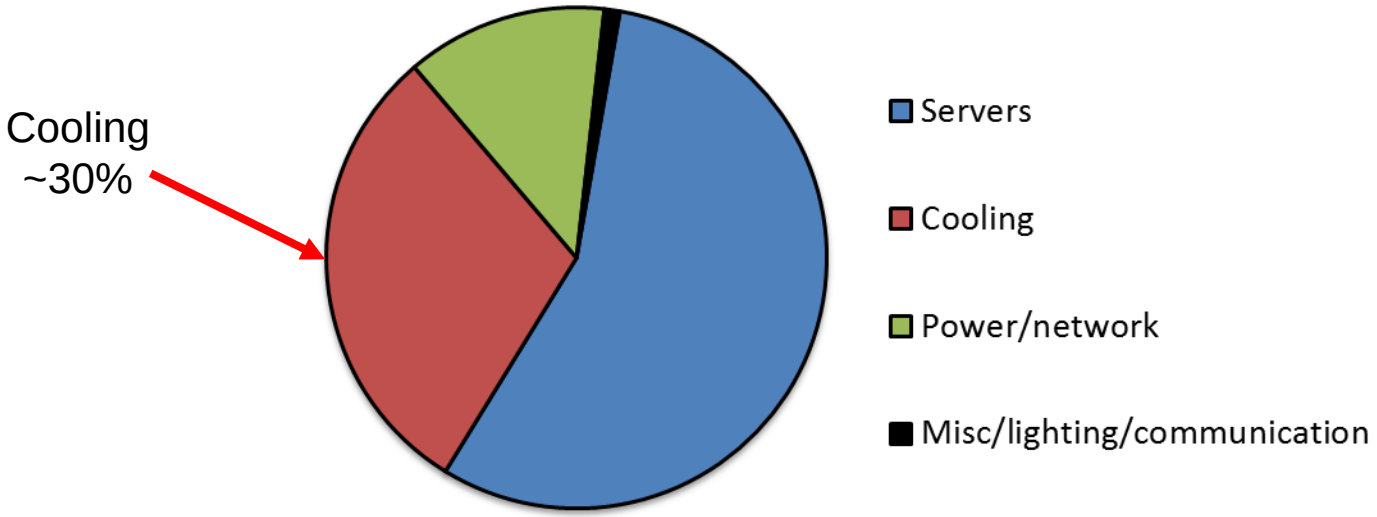
Definition of the Problem (or…What you already know)

- Data center operating costs are a significant portion of their total cost of ownership (TCO)
- Cooling/Chilling costs are major contributor to power usage
  - Cooling = 30% (varies by locale and season) *(1)*



Total Operating Costs

Limitations on Higher Temperature

- Potential cost savings
  - 1 degree = 4-5% savings in energy costs *(2)*
- Until now, conventional batteries would not tolerate ambient temperatures above 77 degrees F
- Battery life reduced ½ for every 10 degrees C
- Battery warranties reduced or voided at high temps

Example Battery Warranty Statements

Normal battery float/cycle life may be expected only when the battery is operated under the aforementioned temperature conditions. If operation of the battery is not within these parameters, the ***battery warranty shall be null*** and void.

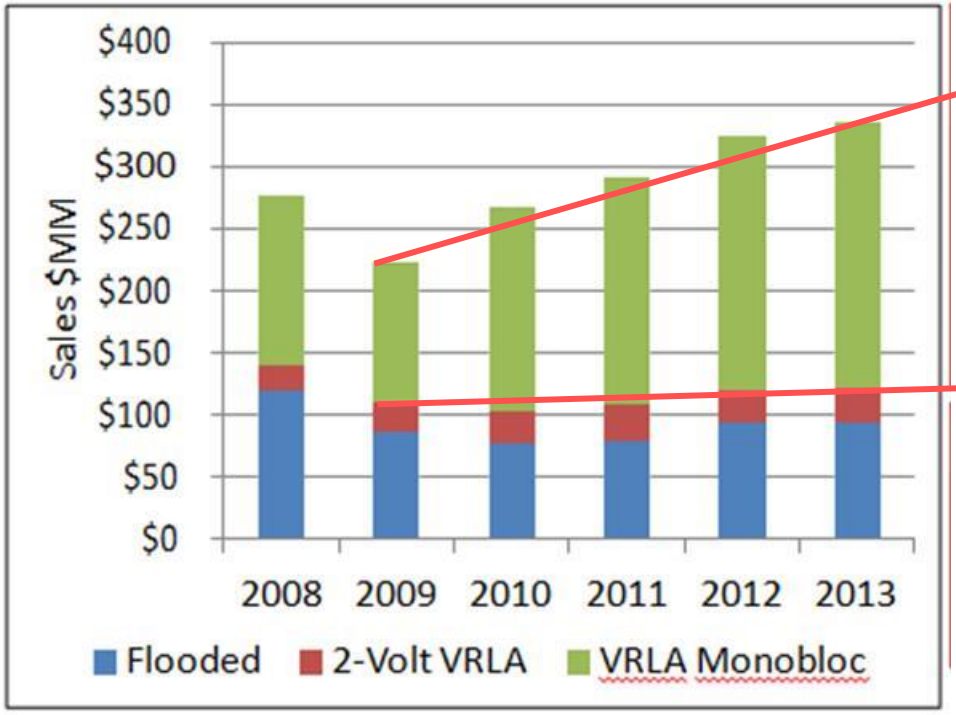
The ***Warranty Period will be reduced 50%*** for every 8 degrees Centigrade increase in operating temperature above 25°C (base temperature).

BATTERY OPERATING TEMPERATURES

Annual average battery temperature	***Cell temperature not to exceed*** for more than 30 days per year
77°F(25°C)	89°F(32°C)

UPS Market Growth

North American UPS Battery Sales – Pure-Lead is part of growth of UPS VRLA market



Source: Battery Council International (BCI)

Valve-Regulated Lead-Acid (VRLA)

1.Largest segment (>$200M)

2.Fastest growing UPS segment

How does 'Pure-Lead' affect data center operations

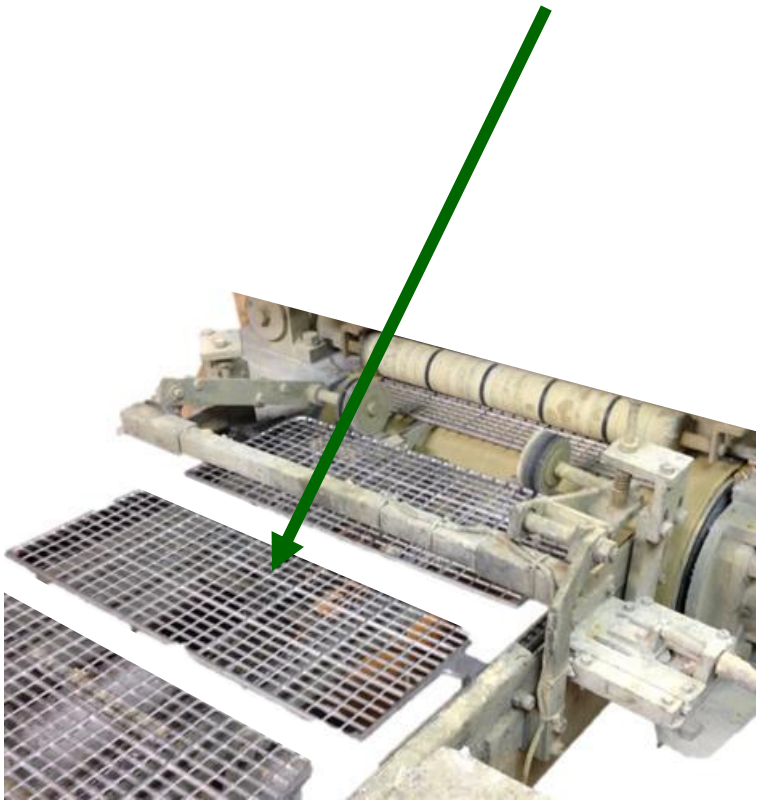
- **Battery replacement costs**
- **Energy savings**

Lead Acid Battery Basics

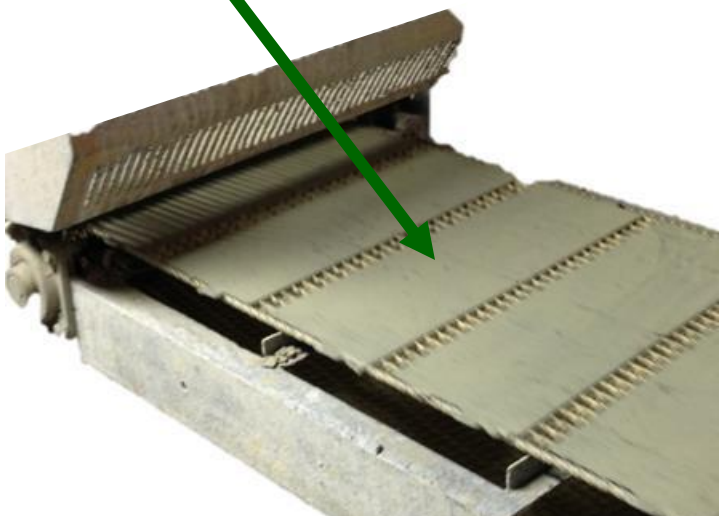
There are many variations of lead acid batteries

Lead Acid Plates

- **Almost all have a solid metallic grid to carry the current …**



...filled with a lead oxide paste to create the current



Significance of Pure Lead Raw Materials

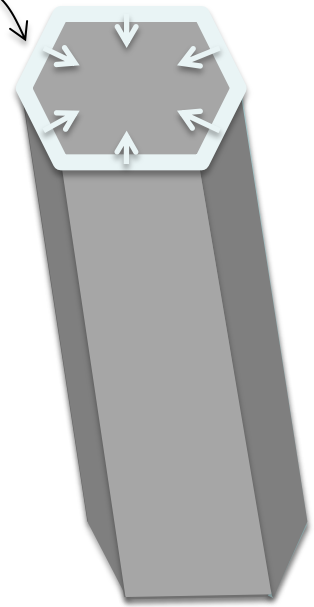
- **‘Pure-Lead’ means using virgin, or freshly mined lead as the raw material for internal components**
- **Both positive and negative plates are essentially all lead**
  - **Grids**
  - **Active material plate paste**
- **Making the plates out of pure lead changes how they age**

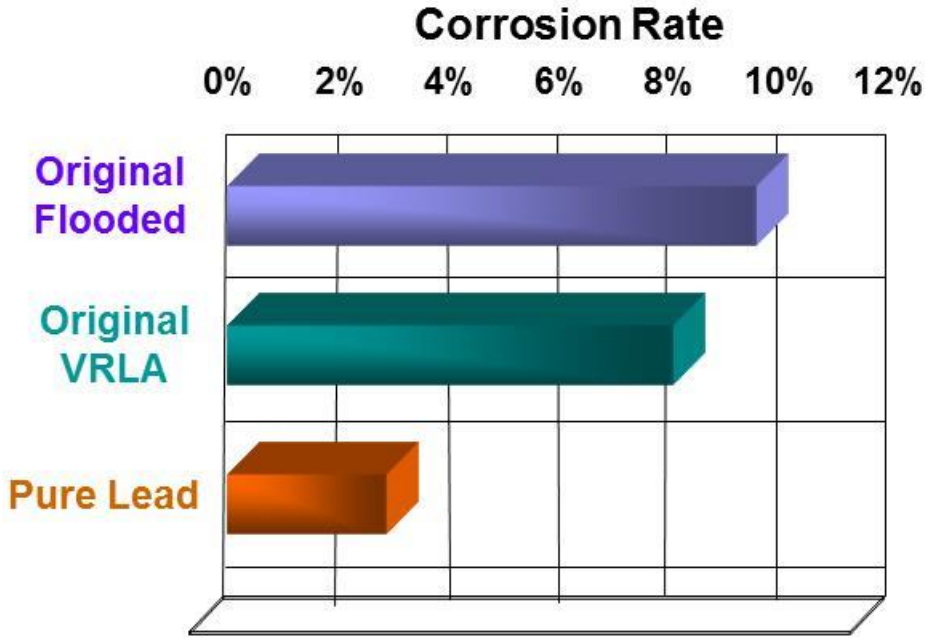
How Lead Acid Batteries Fail

- Positive Grid Corrosion = major mode of failure
- Grid corrosion is well understood, easy to control and predictable
- Is mainly a function of:
  - Grid alloy
  - Specific gravity of electrolyte
  - Temperature
  - Float voltage

Pure Lead Grid Advantages

- **Pure lead reduces grid corrosion**
  - **Grain boundaries**
  - **Corrosion rate**





Active Material Paste

BUT… This Grid Corrosion is only ½ the Story:

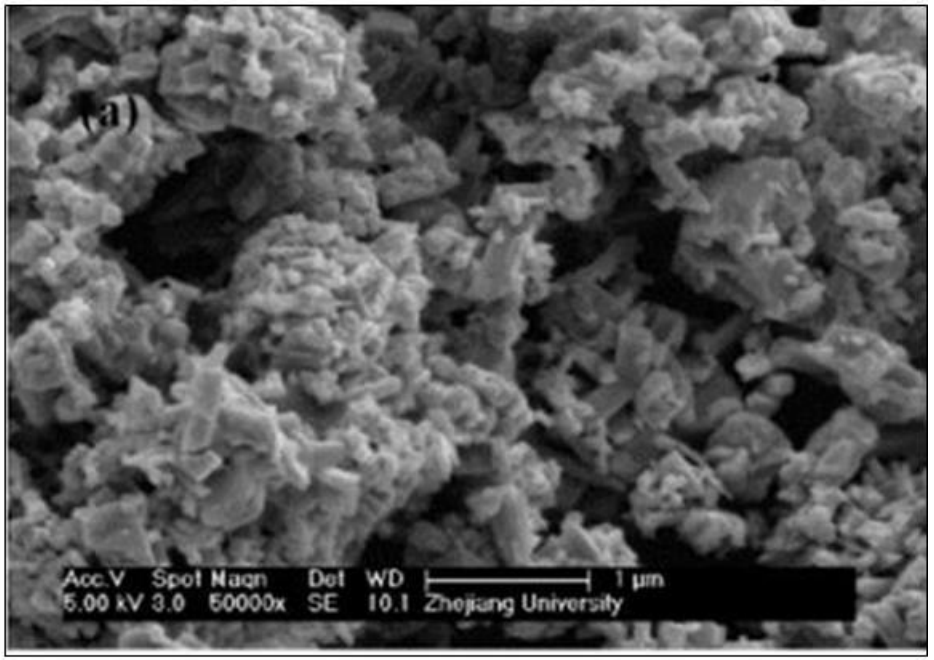
Improvement in the grid will not improve how the active material paste ages

- **For full benefits, the entire plate must be made from pure lead**
  - **The oxide used in the paste must be made from pure (virgin) lead**
  - **The oxide manufacturing step must be tightly controlled**
    - **Particle size distribution is critical**
    - **Oxide density is key metric**

Active Material Paste

- **Factory paste processing methods must be optimized for pure lead raw materials**
  - **Paste mixing time and temperatures**
  - **Plate pasting method**
  - **Plate curing**
    - **Forms the basic crystal structure – defines cycle life and aging characteristics**
  - **Formation process – defines how the batteries perform on a discharge**

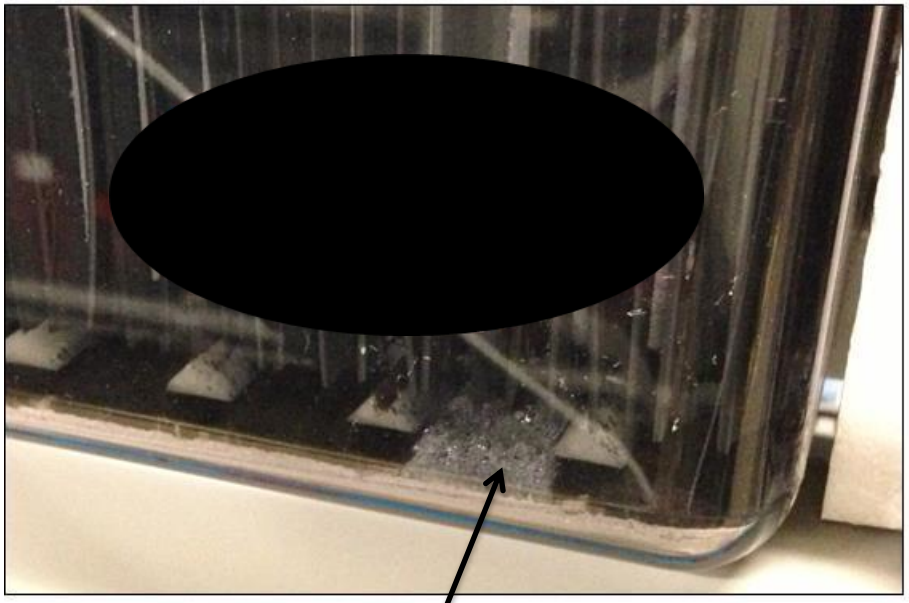
Effect of Pure Lead on paste

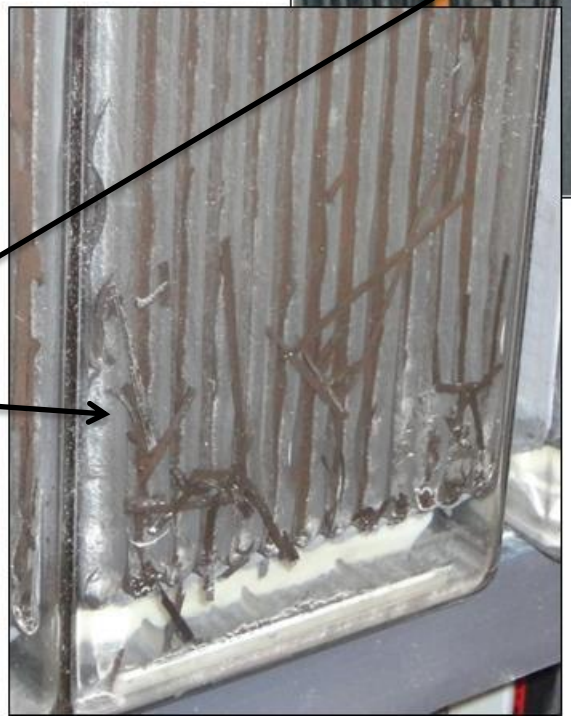


Paste is 40-60% porous – the underlying crystal structure determines the life of the battery

Cell Failures from Poor Plate Processing

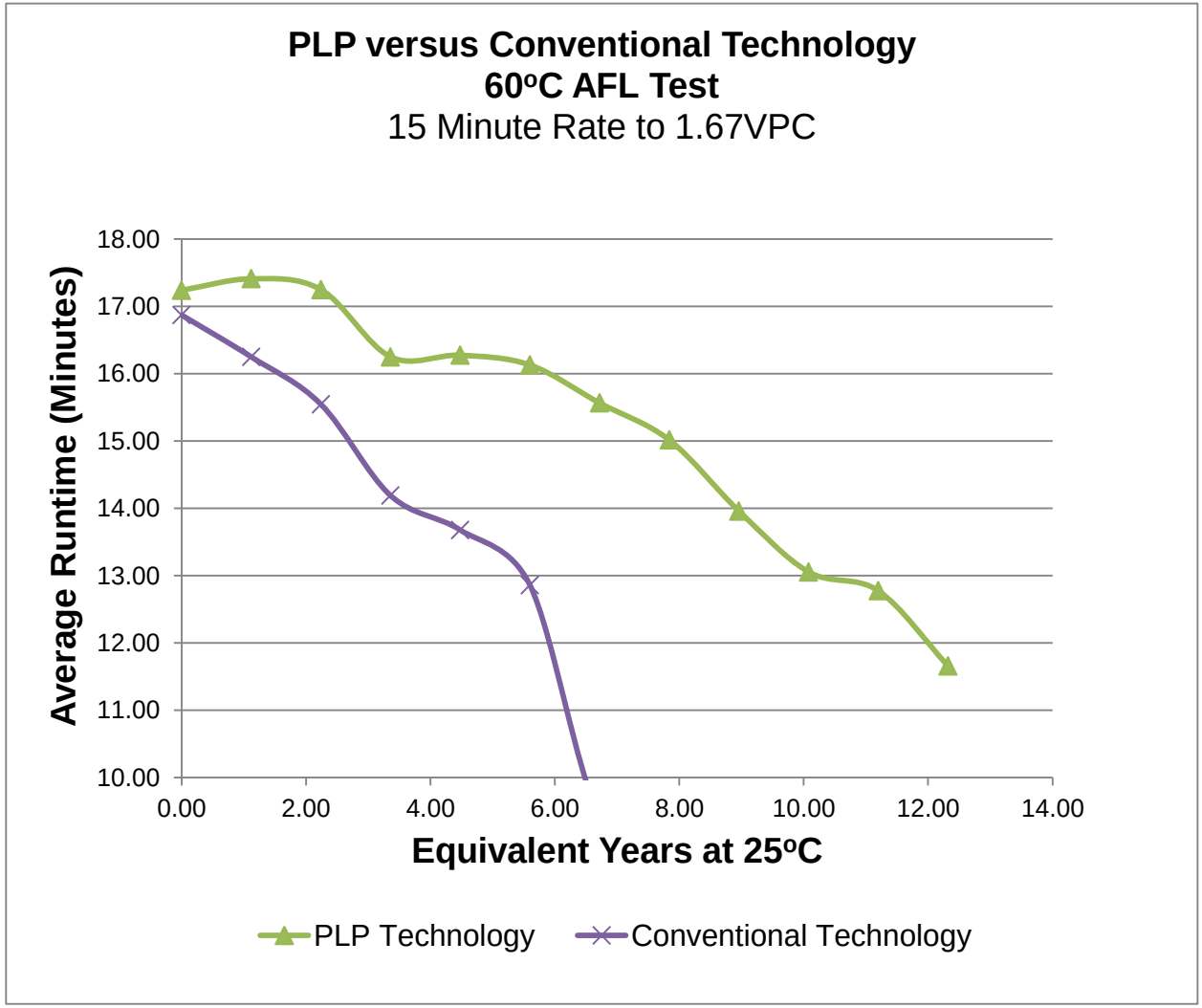
Poor paste processing can cause early failures





Sediment and plate deconstruction to cause early cell failure

Dramatic Pure Lead Improvements



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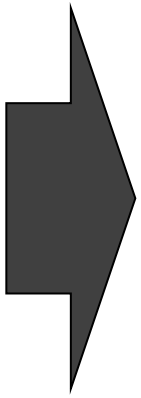
Summary of Pure Lead benefits

Desired Benefits

- Reduced grid corrosion
- Reduced side reactions
- Reduced internal heat
- Slower aging mechanisms
- Higher tolerance to heat



- Lasts 2X longer in normal operation
- Lasts longer in high temperature
- 2X longer shelf life

What this means to Data Centers

- **Batteries last longer**
  - **Full 5 year warranty at 77 F (12 volt batteries)**
- **Battery rooms can be operated at higher temperatures**
  - **Full 3 years at 90 F**

- **Cost savings using 'Pure'Lead' lead-acid**
  - **One battery replacement in 10 yr datacenter lifecycle**
  - **Significant cooling savings for battery room**

'Pure-Lead' lead-acid can provide significant energy and/or battery cost savings to data centers

Questions?

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