One Spark Away From a Boom

Safety, performance and reliability parameters of batteries serving telecom, data and utility applications

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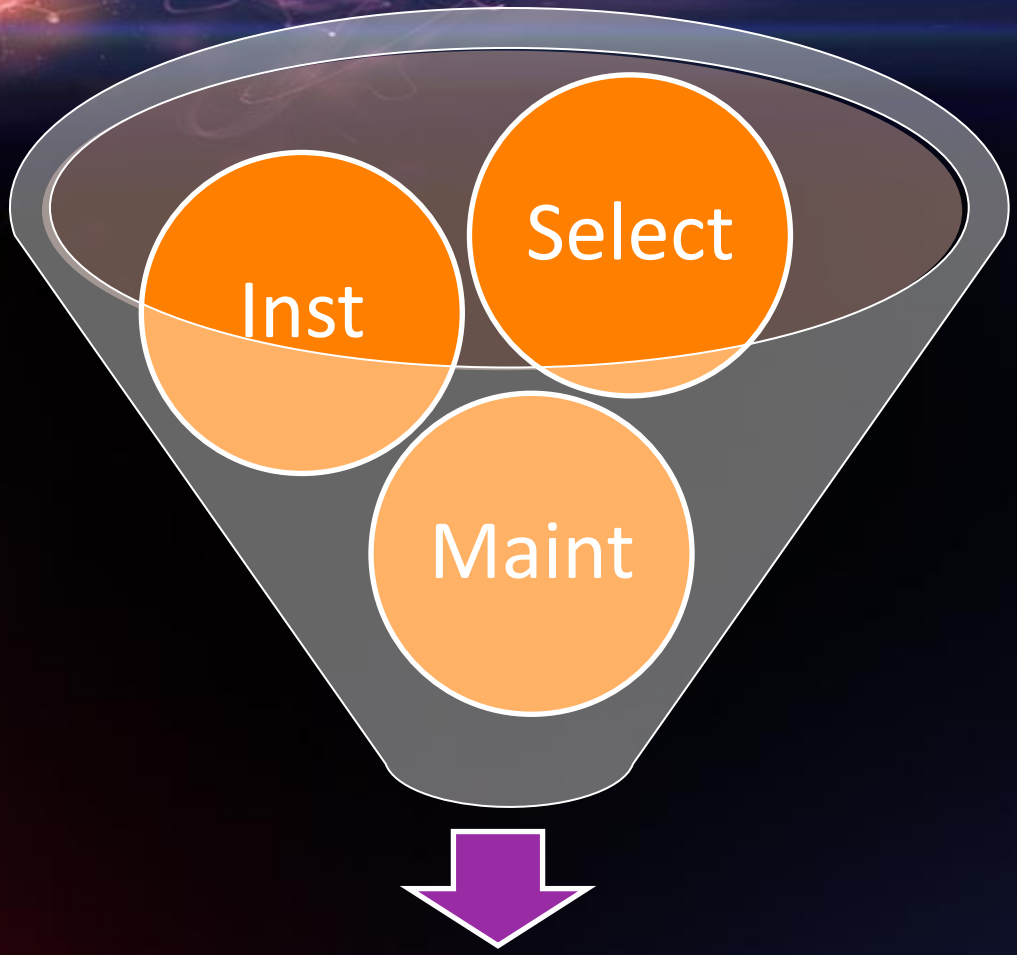
ATIS PEG March 24 – 26, 2015

One Spark Away from a Boom

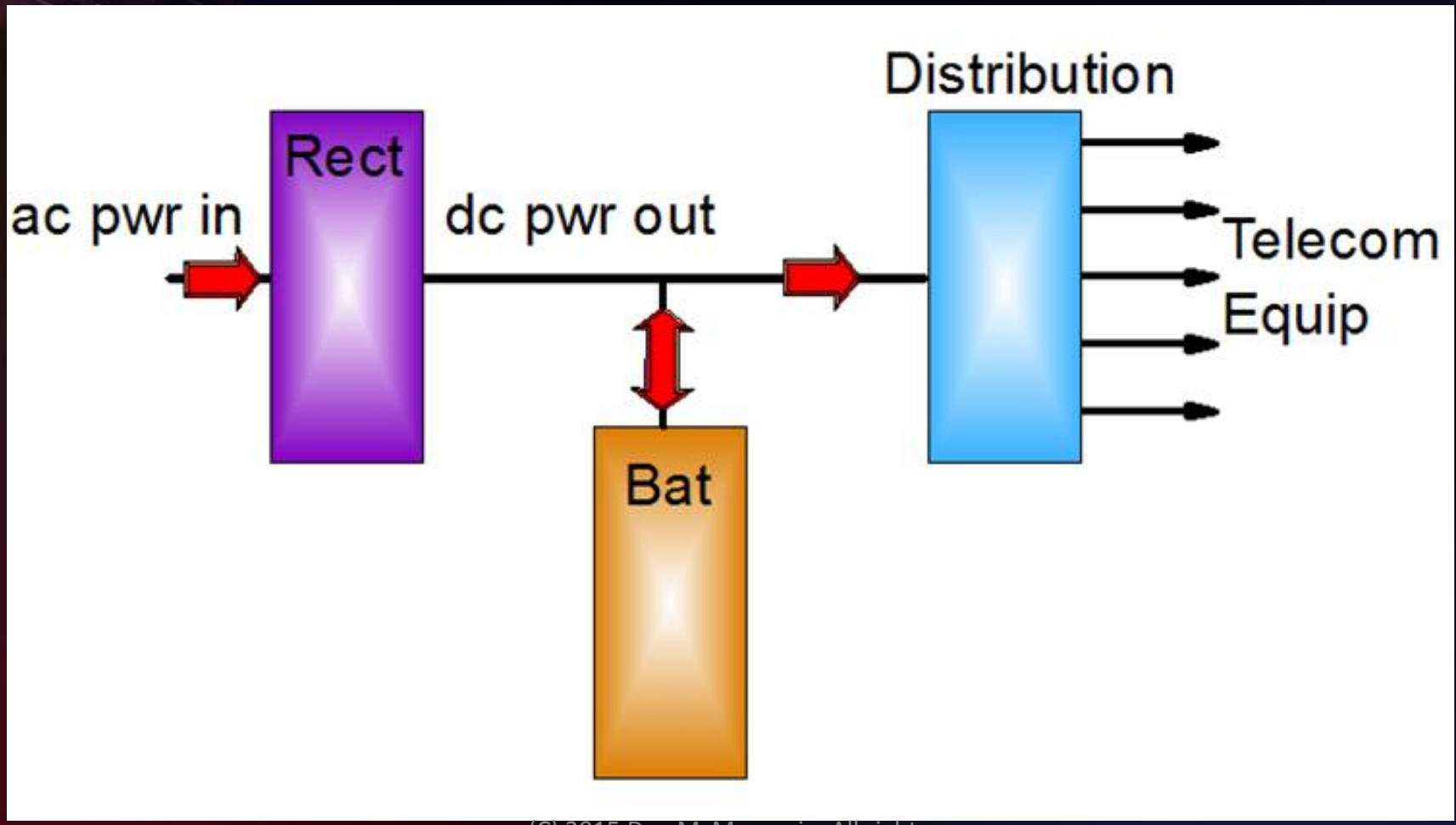
1	Lead Acid Technology
2	NiCad Technology
3	Lithium Ion
4	Molten Salt

Lithium Ion

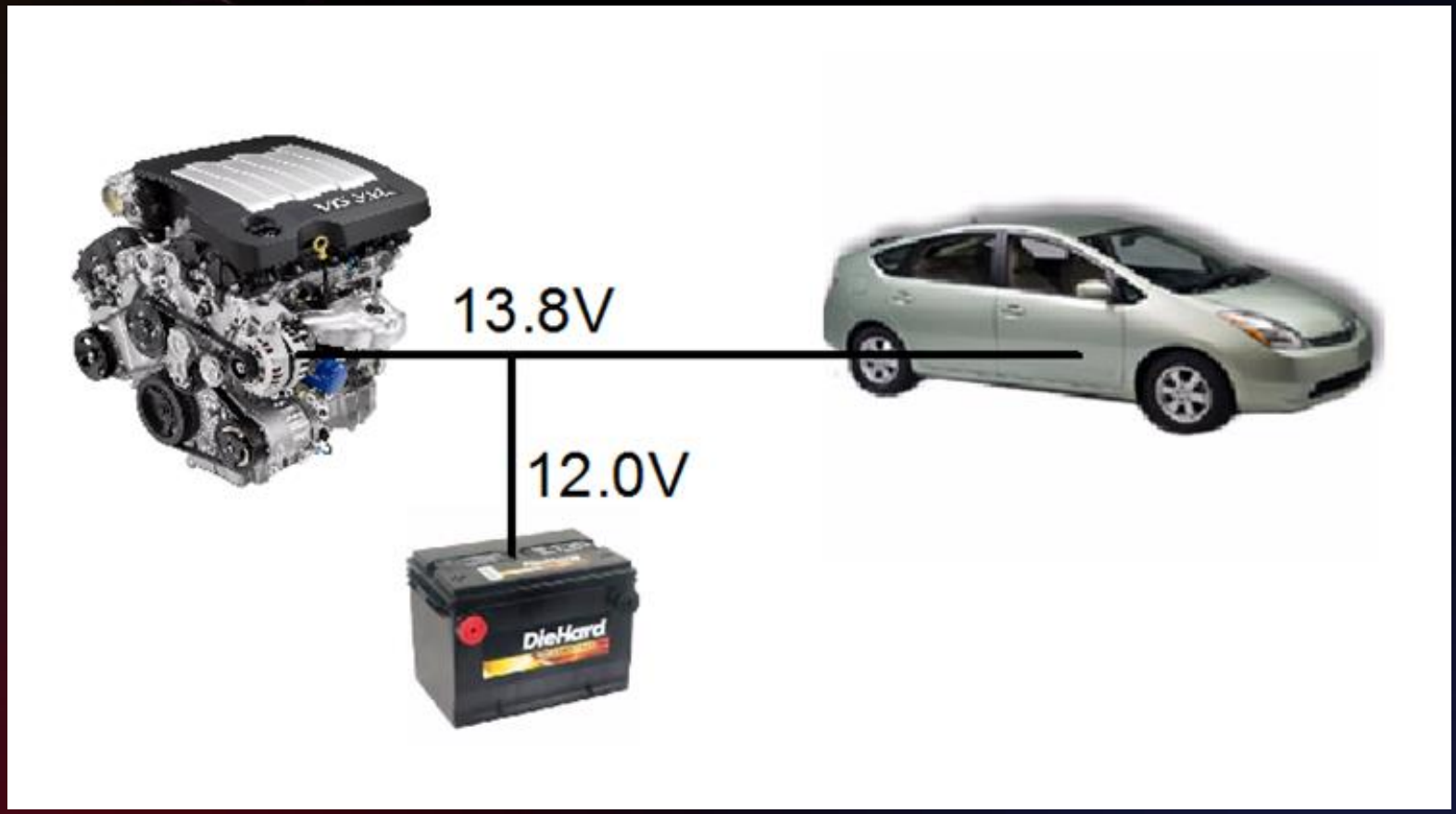


Reliability

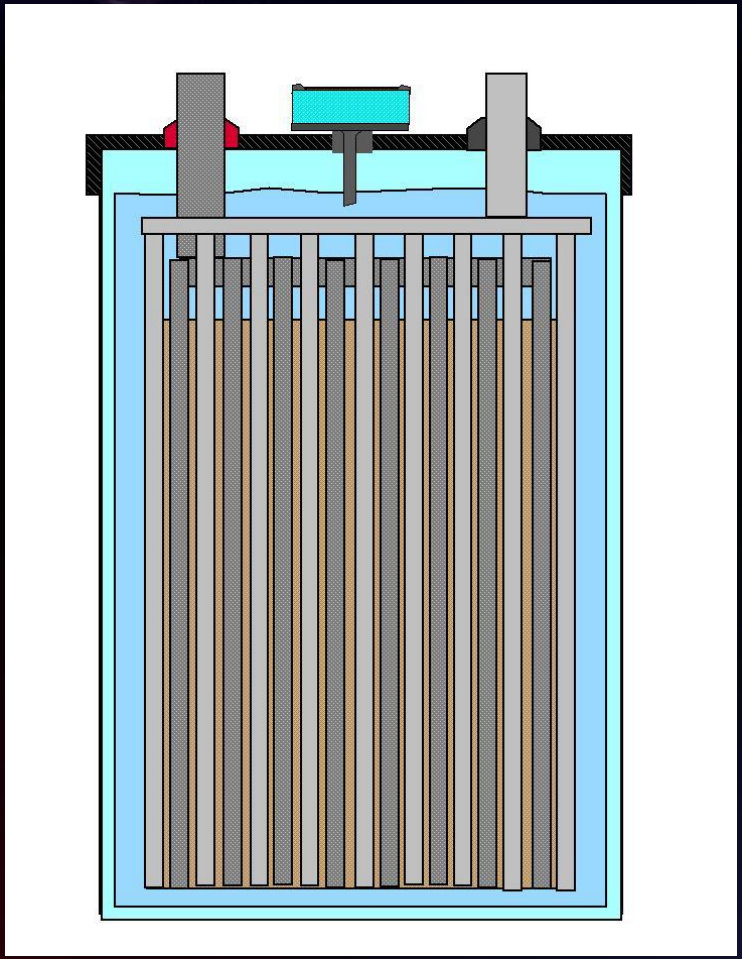
DC Plant



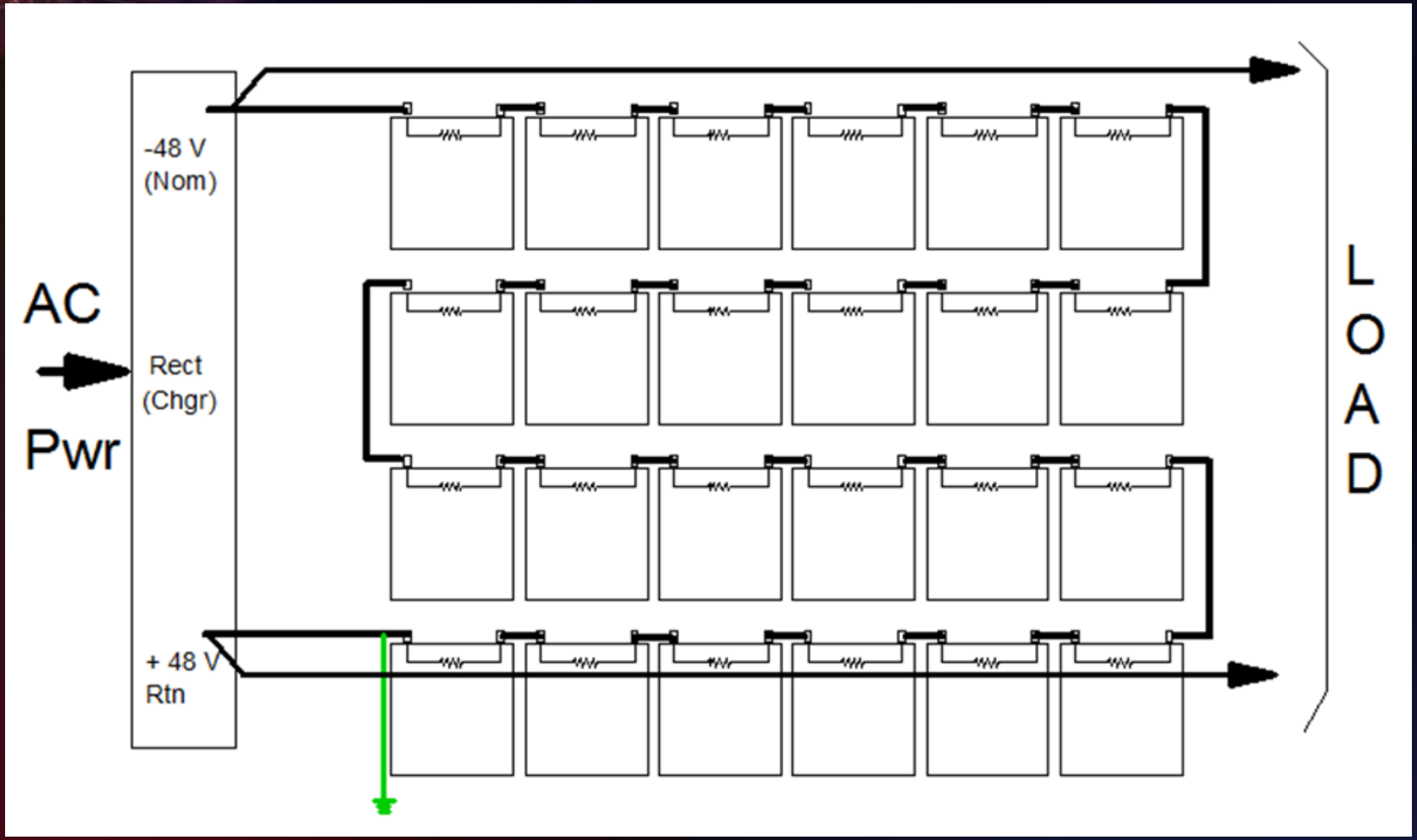
Automotive Comparison



Vented Lead Acid

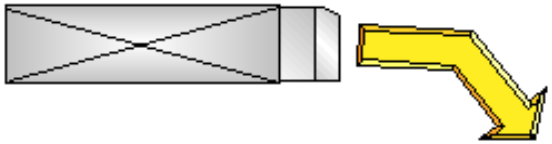


Internal Resistance

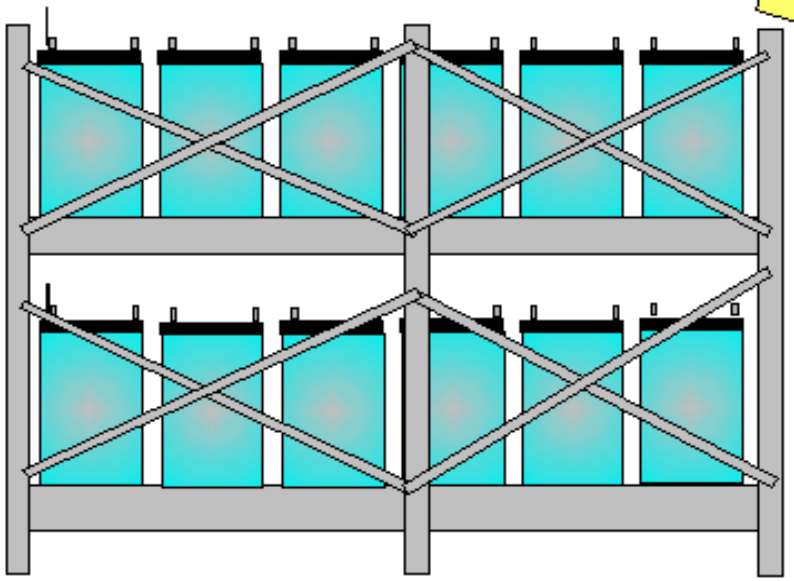


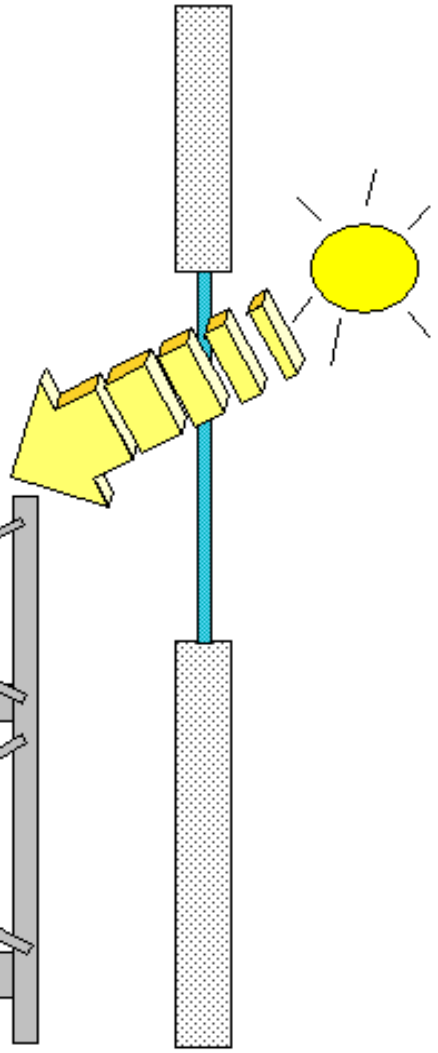
Why -48?

Battery Temperature Issues

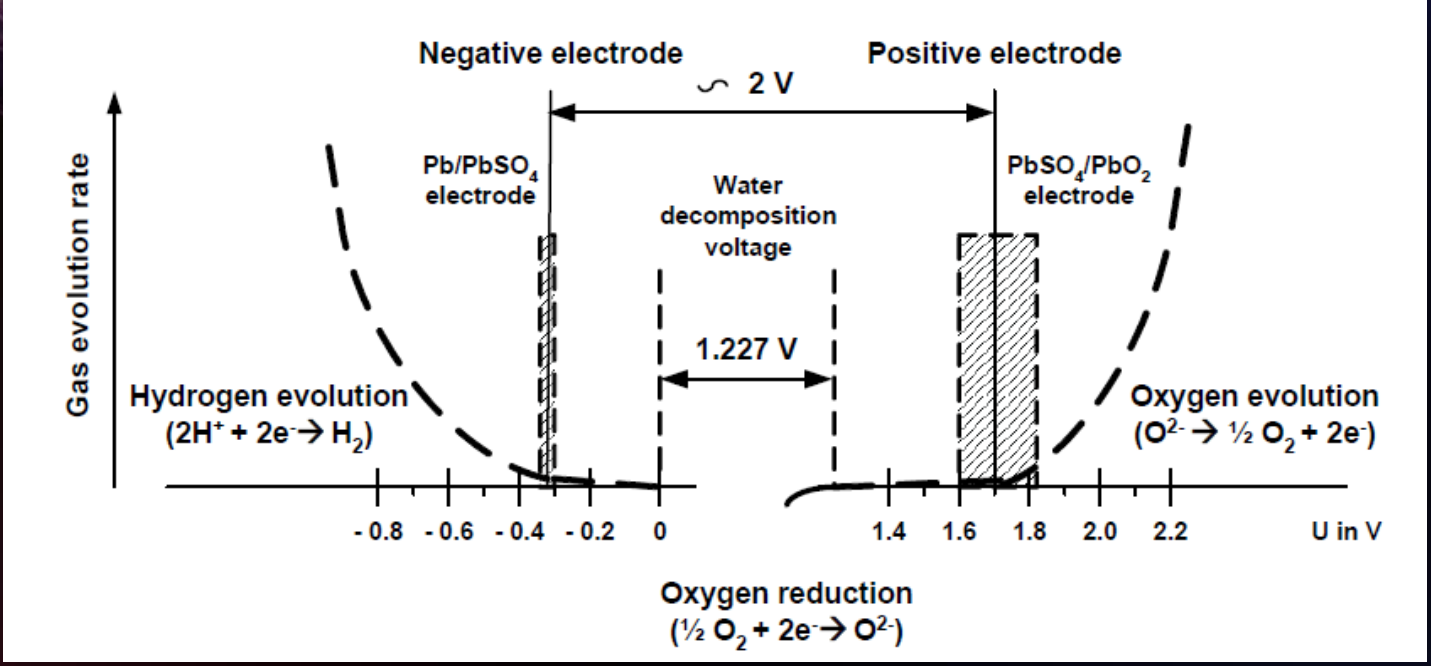


Any condition that causes series battery cells to be > 5 degrees (F) from each other will damage the colder cells through undercharge and the warmer cells through overcharge.





Hydrogen Evolution



Water decomposition increases markedly as the voltage difference between the + and - electrodes (plates) increases.

Donnell & Schiemann BATTCON paper used with permission

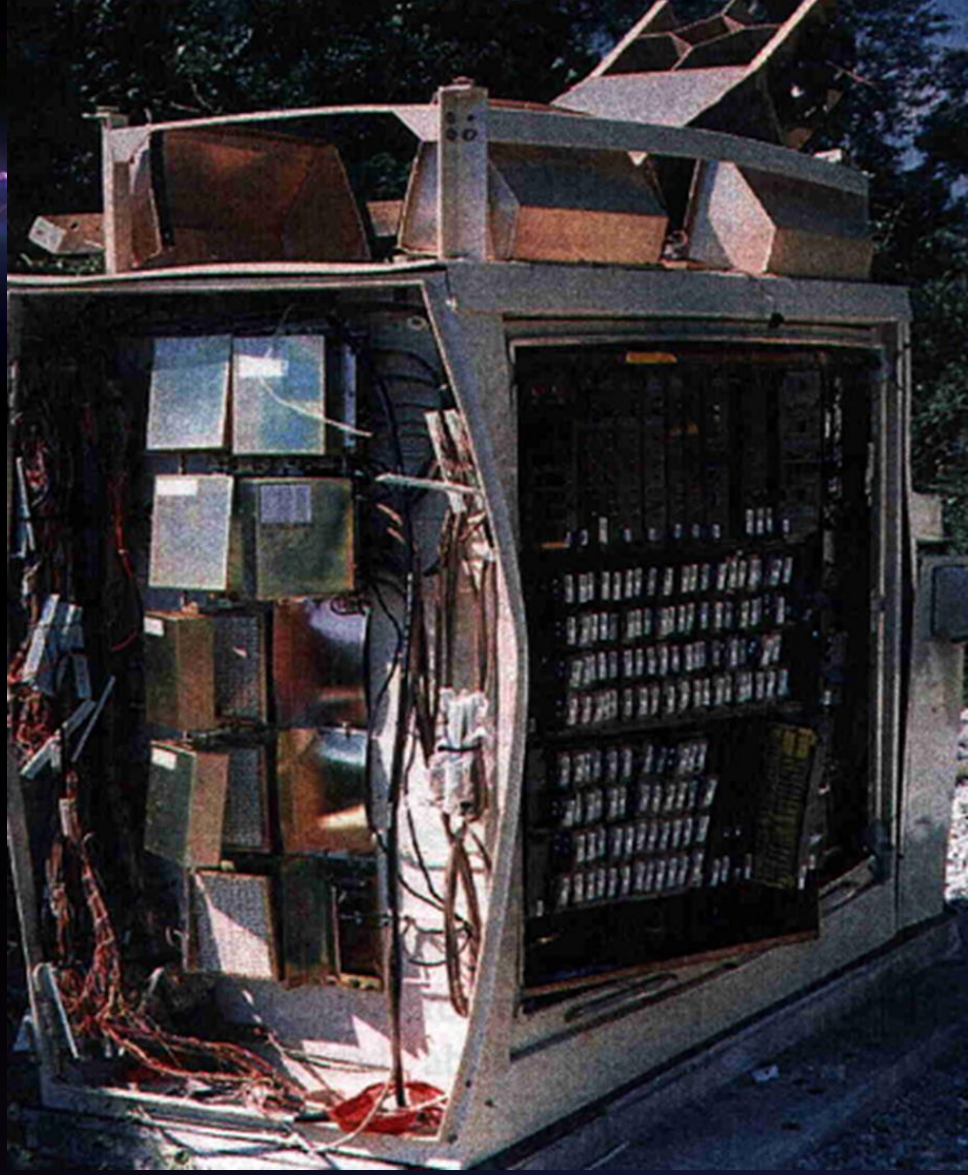
Vented VS: VRLA

- Under normal conditions, flooded cells outgas much more hydrogen than do Valve Regulated cells.
- This condition is because VRLA cells are maintained under a higher than atmospheric pressure condition within the battery jar where hydrogen and oxygen recombine back into water that is absorbed into the electrolyte

Thermal Runaway (Walkaway)

- Long-term overcharge
  - High Float current
  - Temperature excess
  - Increased outgassing
  - Possible fire

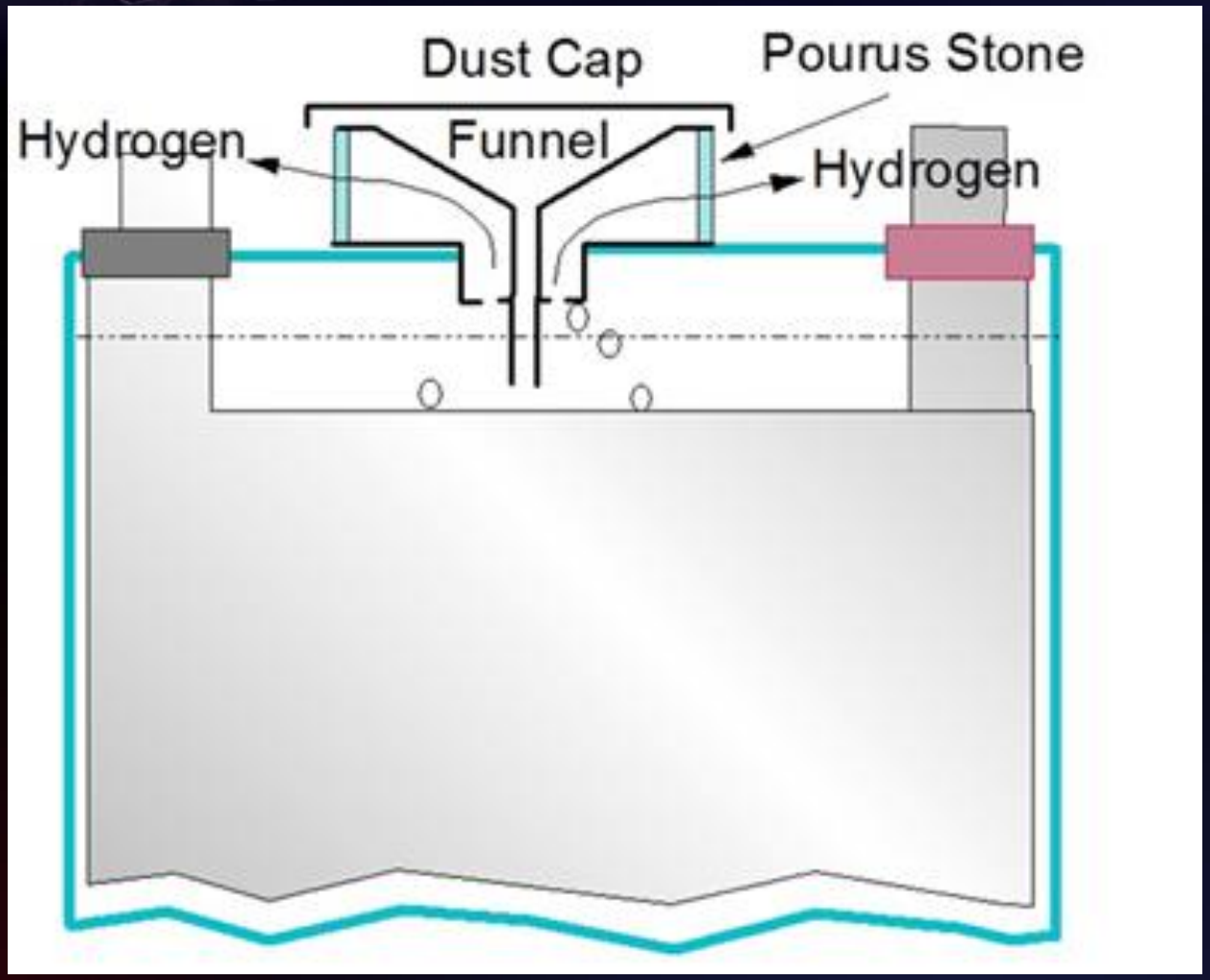
HVAC Failure



Whatever you do don't screw this up:

- Be responsive to high temperature conditions
  - Either something bad has happened
  - Or, something bad is underway
- Use adequate ventilation when dealing with large electrolyte spills

Explosion-Resistant Vents



May 31, 1949. J. RITTENHOUSE ET AL 2,471,585

EXPLOSION-PROOF BATTERY VENT AND FILLER PLUG

Filed March 9, 1946

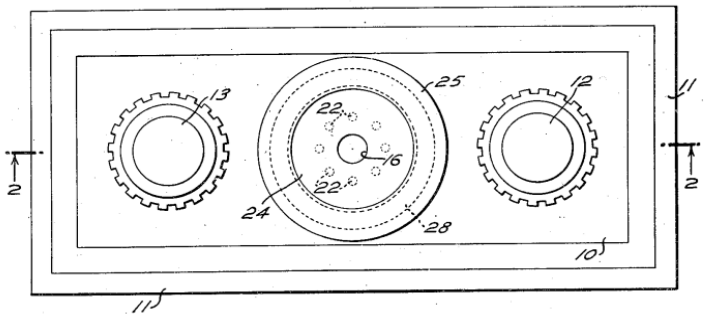
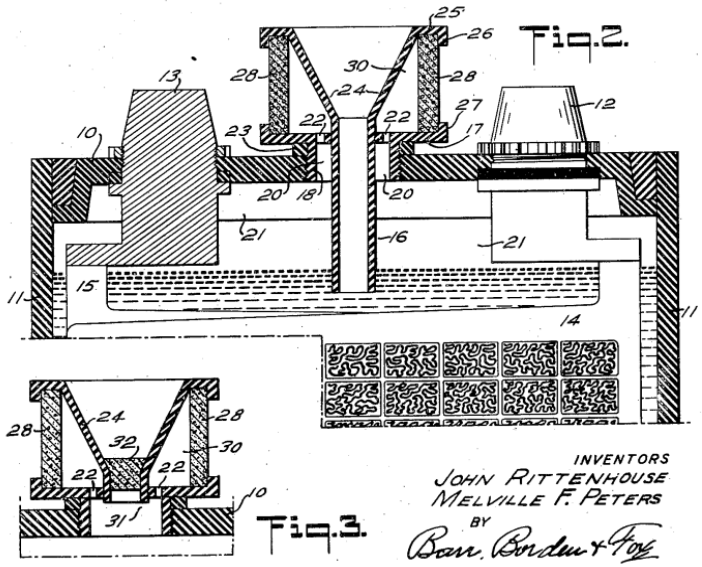
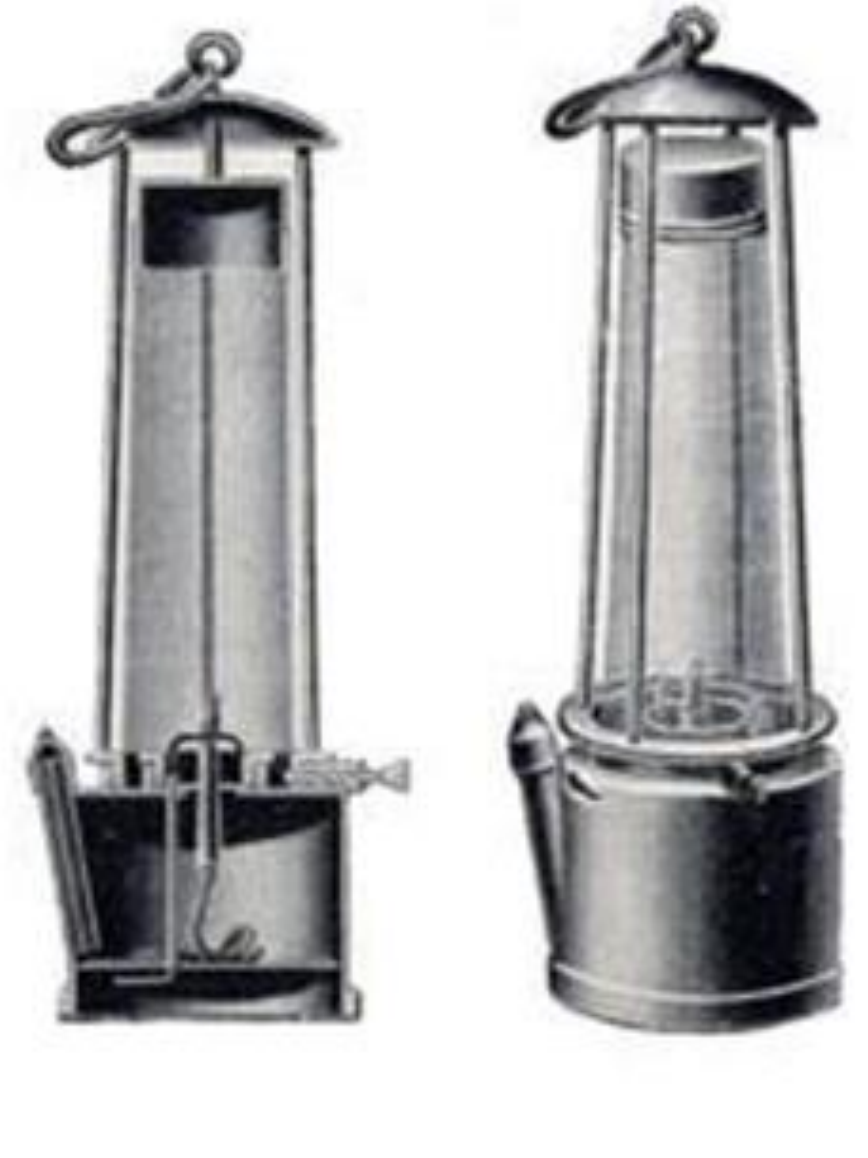


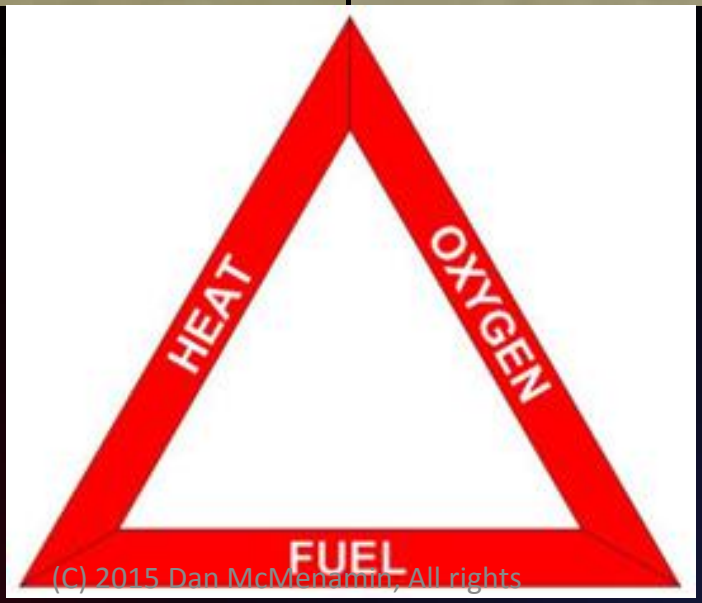
Fig.1.



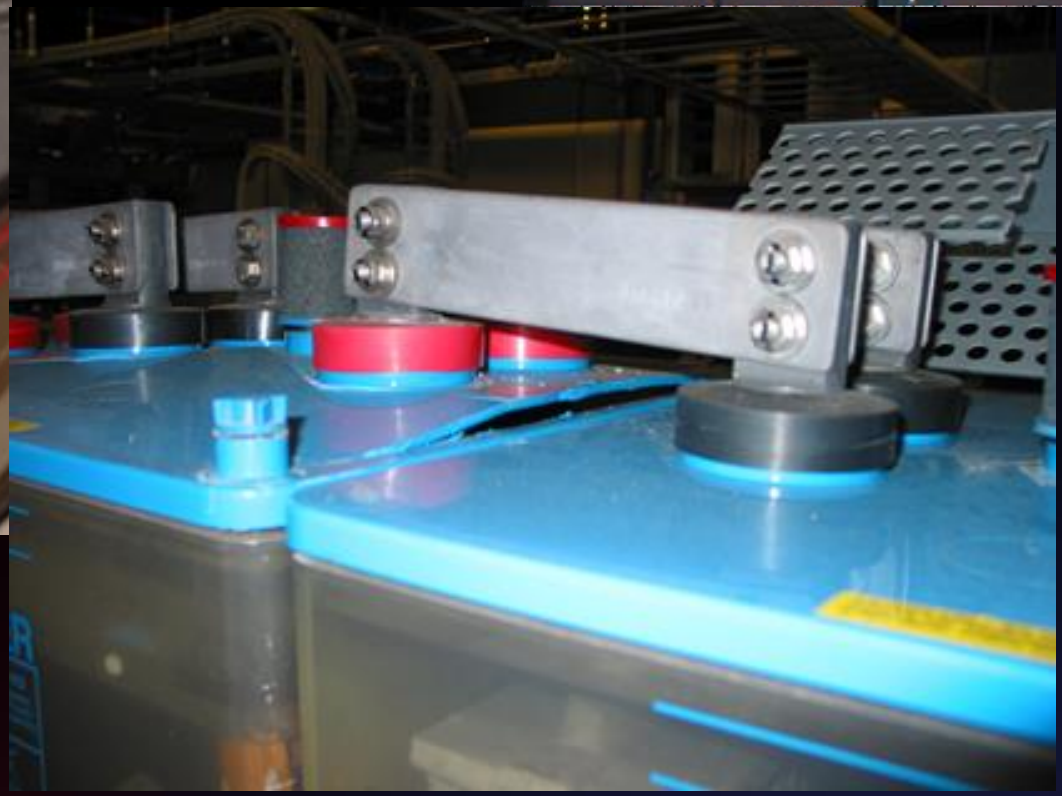
INVENTORS
JOHN RITTENHOUSE
MELVILLE F. PETERS
BY
Barr, Borden & Fox
ATTORNEYS



Davy Lamp: Sir Humphry Davy 1815



Jar Damage



Whatever you do don’t screw this up:

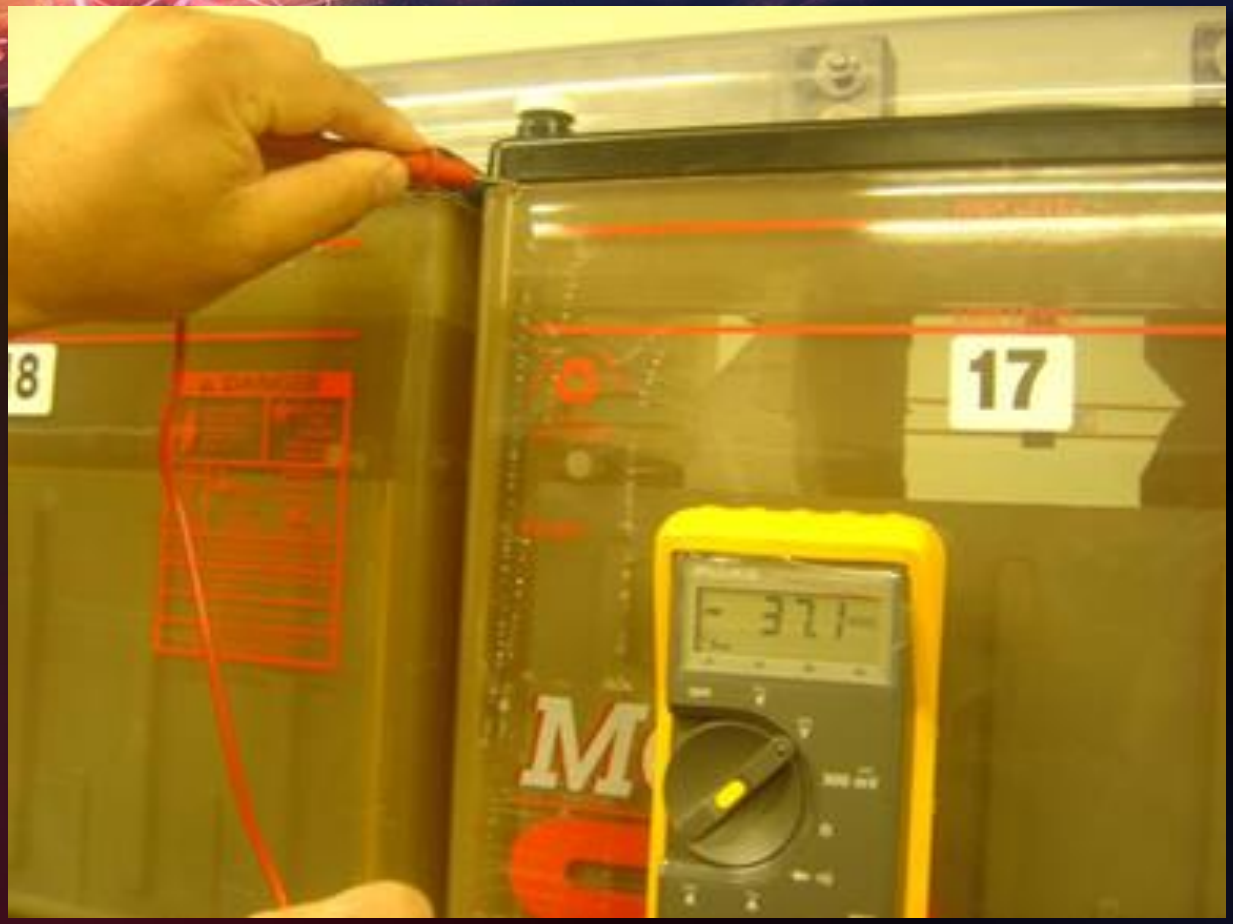
- It is important to perform a very observant visual inspection of battery cells, being mindful of the potential for cracks in the jar or the explosion-resistant vent.

ESD

Whatever you do don't screw this up:

- People who will touch battery cells should discharge ESD from their body before touching any part of the cell.
- Cells should be allowed to vent off-charge for at least 24 hours before moving them.

Jar to Cover Leaks



Evidence of streaking

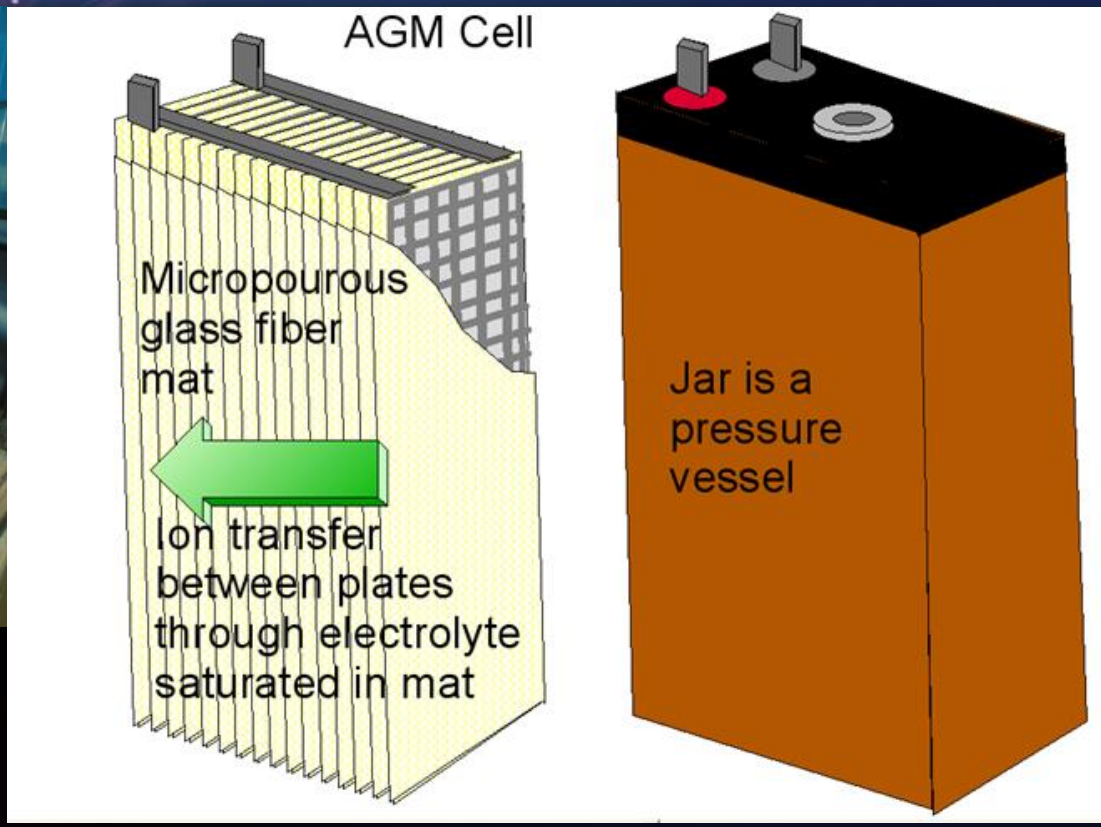
Voltage present at junction

Fire caused by Jar Leakage

Whatever you do don’t screw this up:

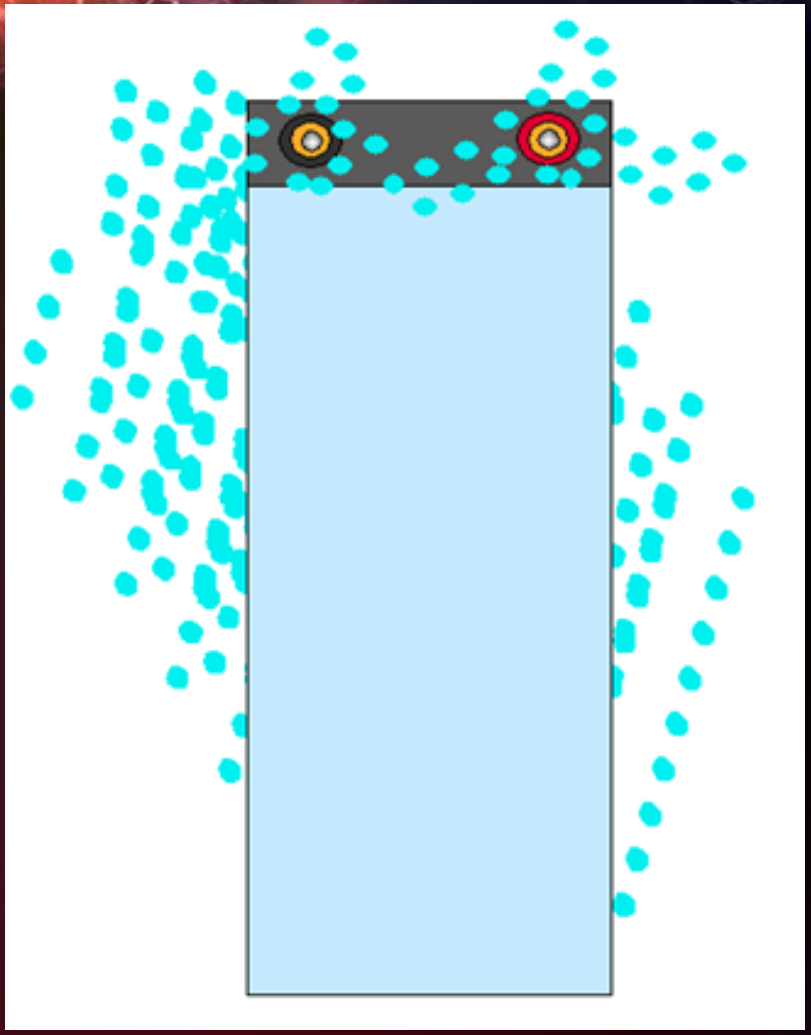
- Be alert to any signs of electrolyte leakage.

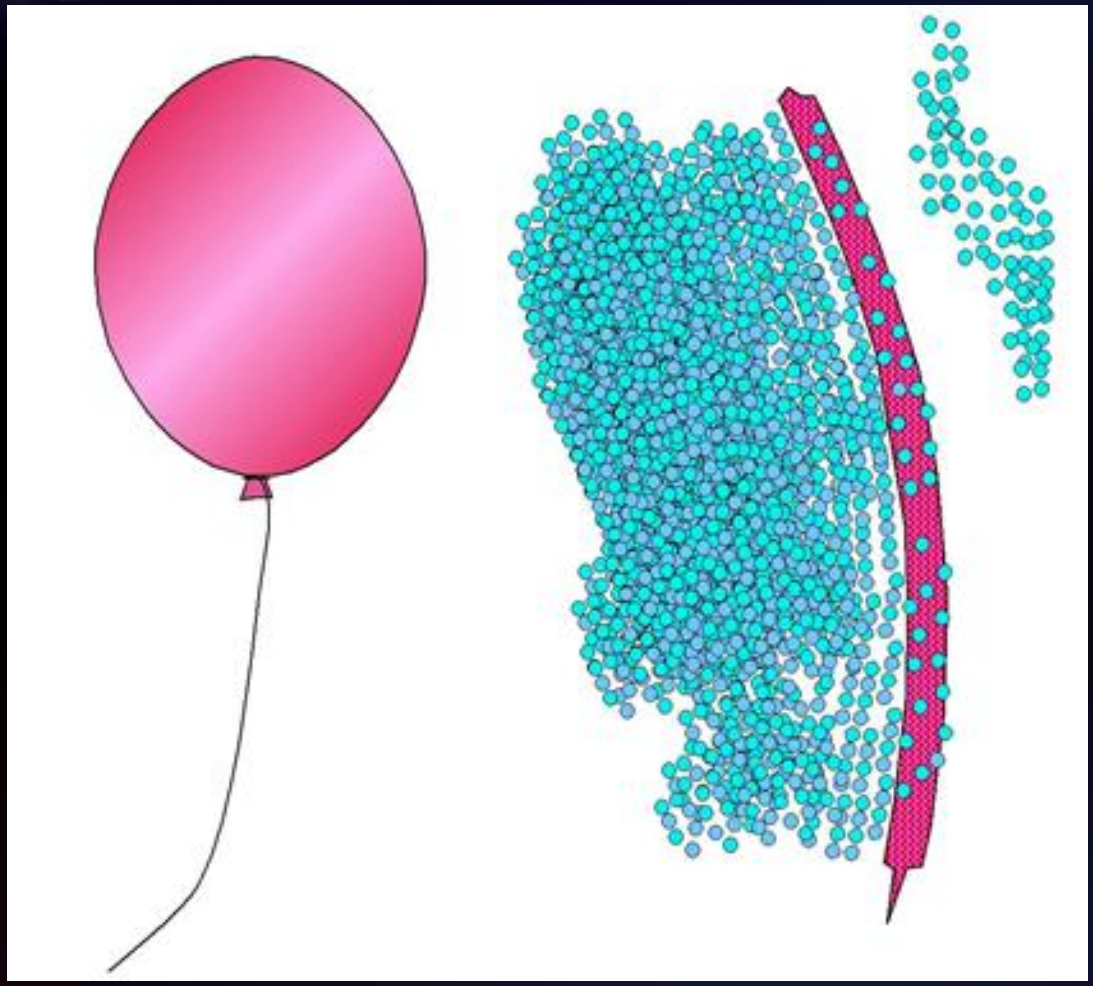
VRLA Issues



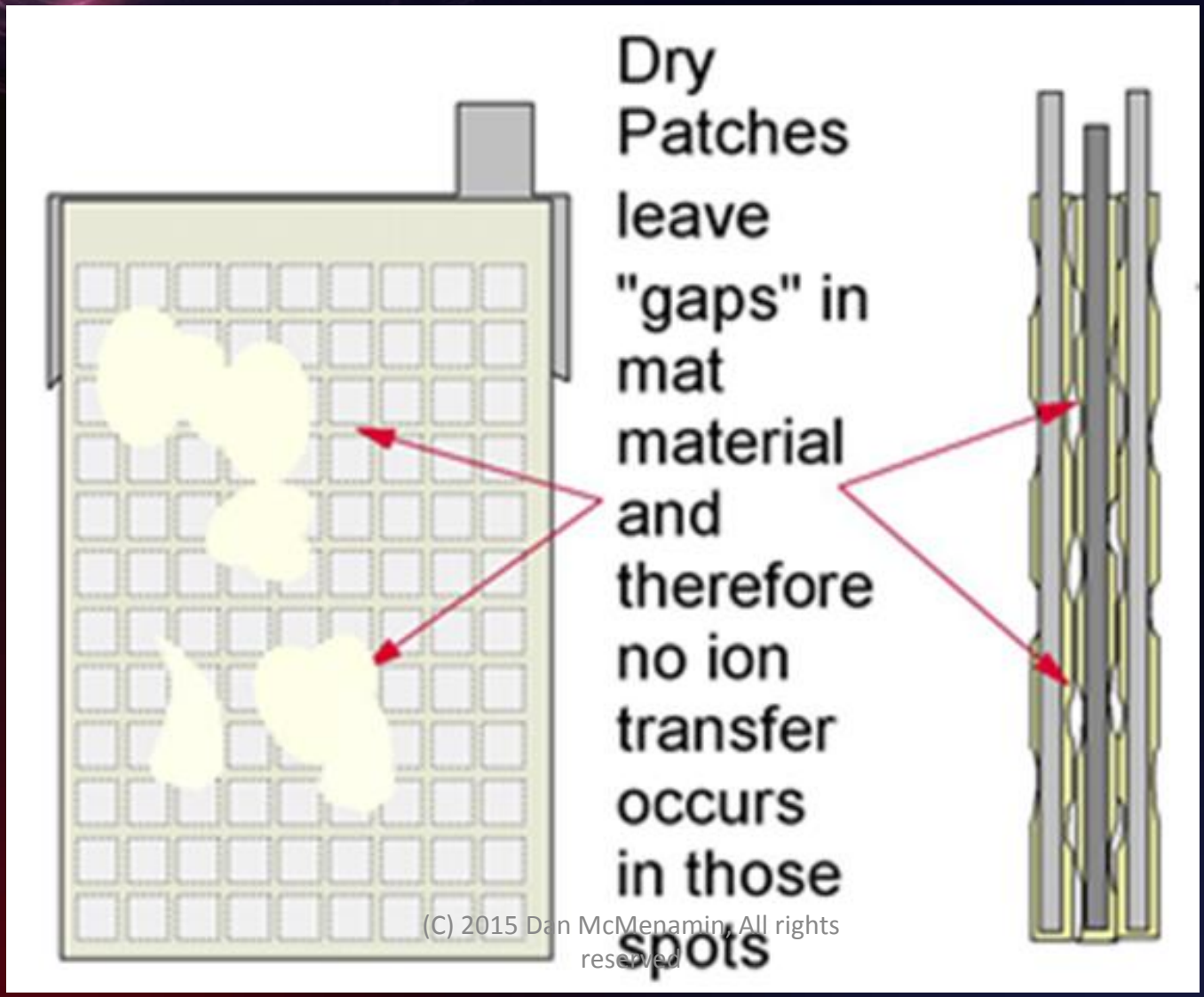
Monoblocks

Cell Dryout





Dryout



Reversing Dryout

Special Recovery Process, IEEE practice 1188a-2014IOVR, IOVR+

Ventilation Codes

- Limit hydrogen so as to keep concentration well under 4%
- International Mechanical Code § 502.4
- Internal Fire Code § 608
  - The ventilation system design must limit the maximum amount of hydrogen accumulation to something less than 1% of total room volume
  - •Continuous ventilation at a rate of at least 1 cubic foot per minute per square foot (cfm/ft2) [0.00508 m3/(s • m2)] of floor area within the room

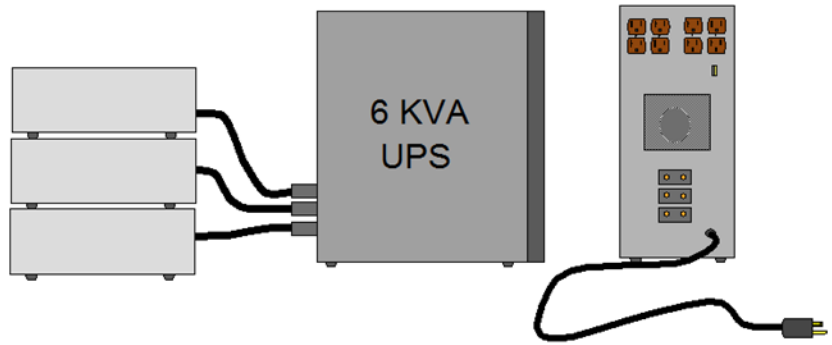
Hydrogen Sensors

IEE P-1635 § 7.6.2 Sensors

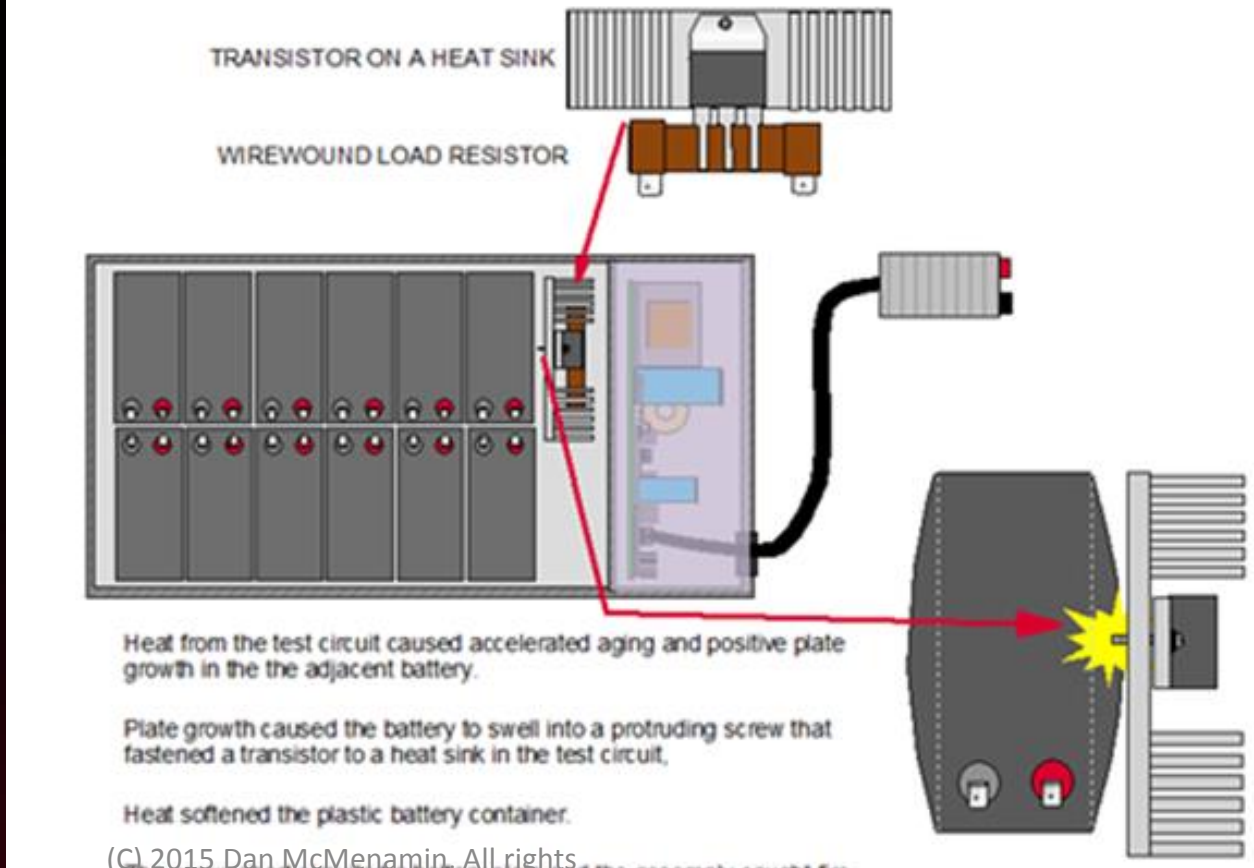
"Hydrogen and other gas sensors are not required to maximize operational safety of battery installations designed with natural or forced ventilation systems meeting the design basis dilution and reliability criteria (see 7.4 Ventilation)."

"Hydrogen sensors may be used as a supplemental monitor but are not a substitute for dilution ventilation. If a decision is made to use gas sensors, the user is encouraged to consult with experts in their selection and placement and to enforce disciplined maintenance practices. Sensors require frequent maintenance and calibration, typically on less than a 1 year interval and periodic replacement. If regular maintenance and replacement, in accordance with the manufacturer's recommendations cannot be assured, hydrogen sensors should not be used. "

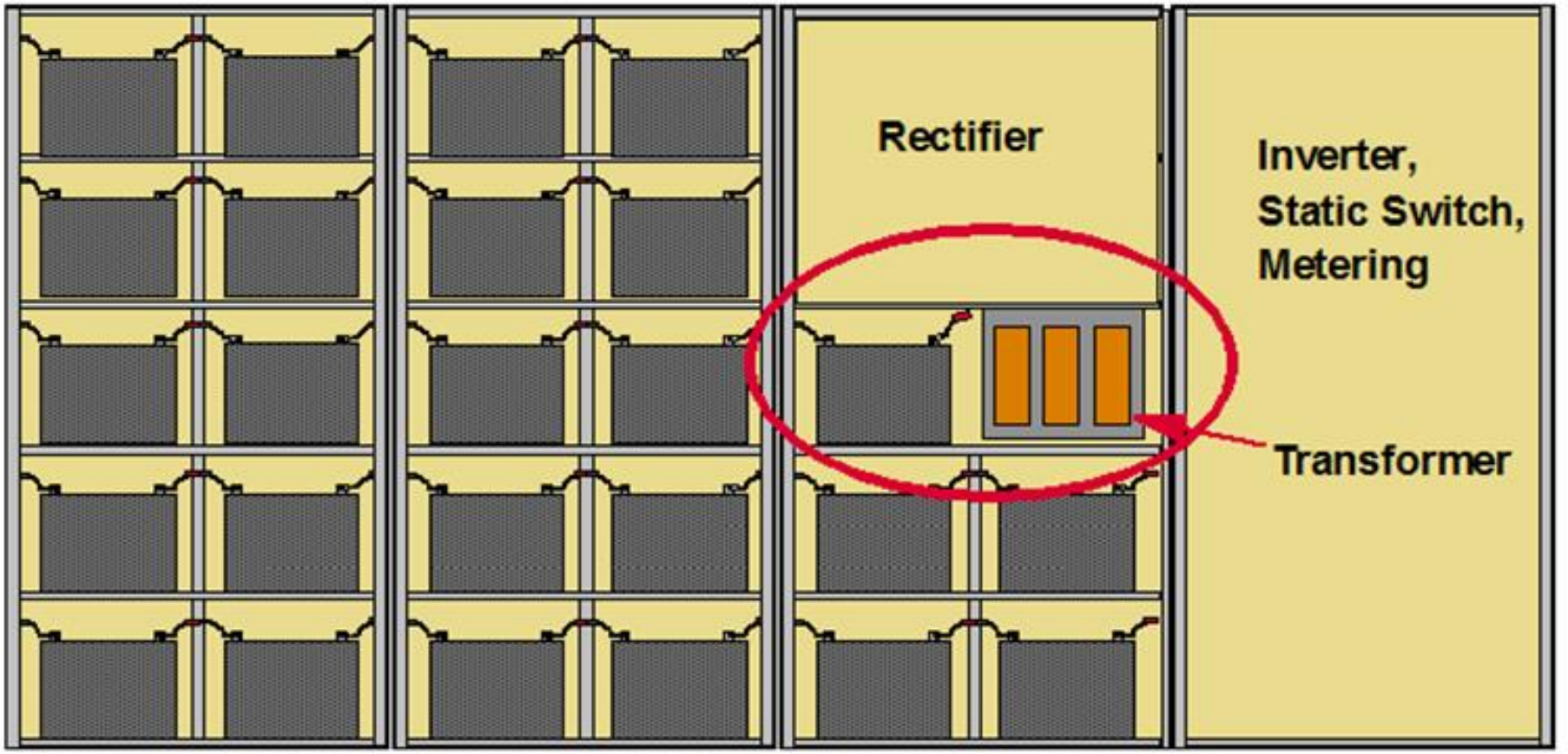
UPS OOPS



Oops



They never learn…



Heat from the transformer windings and core, accelerated the aging, plate growth and electrolyte dryout of the adjacent battery unit.

Whatever you do don’t screw this up:

- Be careful to understand the details of a UPS design and the placement of batteries with respect to heat sources.
- (See if the sales guy’s lips are moving)

Ni-Cad

Lithium

LMP

Whatever you do don't screw this up:

- Be sure to thoroughly vet any lithium product you consider to IEEE Standard 1679, Guide for the Characterization and Evaluation of Emerging Energy Storage Technologies in Stationary Applications
- Perform a controlled introduction deployment.

Molten Sodium

- Developed in WW-II for ordinance applications
- Rechargeable developed in the 1980's for EV
- SONick invented by Zeolite Battery Research Africa project (nicknamed ZEBRA)
- G.E. and Fiamm make them
- Cells maintain 100% SOC
- Small parasitic power drain to maintain heaters the salt is molten between 270 °C (518 °F) to 350 °C (662 °F).

BCM

- The BCM prevents:
  - Over or undercharge
  - Maintains the appropriate internal temperature
  - Protects from over-discharge
  - Reports improper operating conditions via alarm leads.

Whatever you do don't screw this up:

- Be sure to thoroughly vet any molten salt product you consider to IEEE Standard 1679, Guide for the Characterization and Evaluation of Emerging Energy Storage Technologies in Stationary Applications
- Perform a controlled introduction deployment

Conclusions

- Those responsible for battery product applications and deployments should abide with the standards and battery selection, installation and maintenance guidelines and industry best practices for that industry.
- It is critical that installers, maintenance technicians and all who will be a part of that battery operation be trained and qualified to perform their assigned tasks. (See IEEE 1657)

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- Cells should be allowed to vent off-charge for at least 24 hours before moving them.

Do you have any questions?