
Considerations for the Utilization of NiMH Battery Technology in Stationary Applications

Cobasys

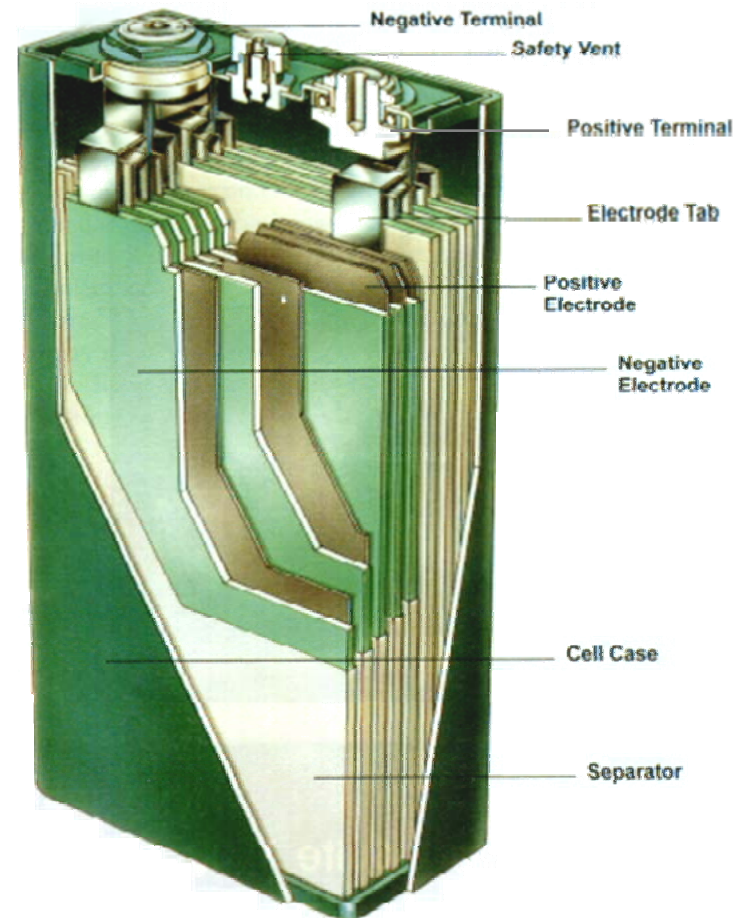
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Introduction

- NiMH battery technology is emerging into stationary battery applications
 - Requirements for technology are different from Lead Acid
 - Systems approach is required to make the transition in replacement applications
- NiMH technology
 - How does it work?
- UPS application
 - System approach
 - Configuration
- Conclusions

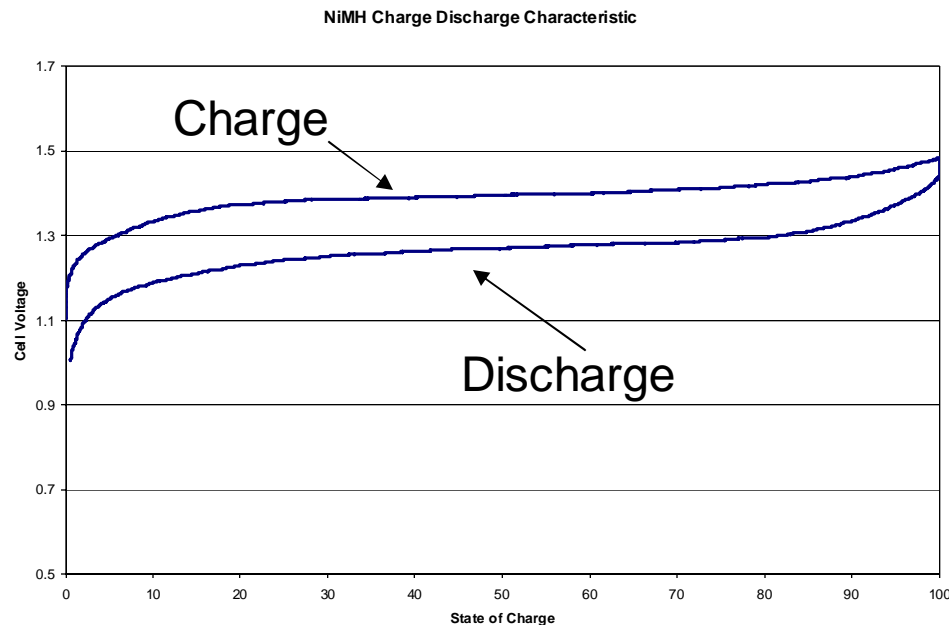
The Nickel Metal Hydride Battery

- The NiMH battery is termed an alkaline storage battery due to the use of potassium hydroxide (KOH) as the electrolyte.
- Electrically, NiMH batteries are very similar to nickel cadmium batteries.
- NiMH batteries are sealed, starved electrolyte designs.



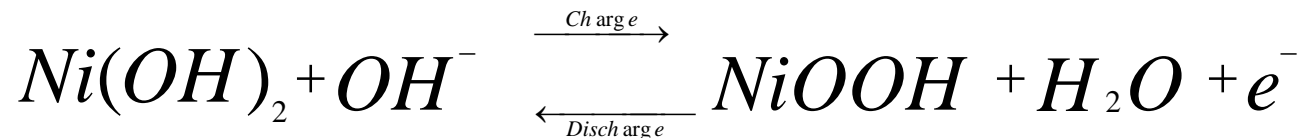
Charge and Discharge Characteristics

- Voltage profile is very flat for most of the discharge capacity.
- No appreciable memory.
- NiMH prefers constant current charging to a suitable termination criteria but can be used on float with proper charge management.



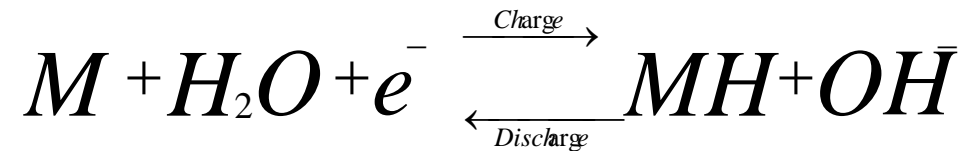
Positive Electrode

- Positive Electrode
 - The positive electrode of the NiMH battery is nickel hydroxide.
 - The electrolyte does not enter into the electrode reaction so that conductivity stays at a high level throughout the usable capacity of the battery.
 - The nickel active material is insoluble in the Potassium Hydroxide (KOH) electrolyte.
 - Only a proton is involved in the charge/discharge reaction.
 - The gravimetric and volumetric energy densities are very good for the nickel electrode.
- The simplified nickel electrode reaction in the cell is:



Negative Electrode

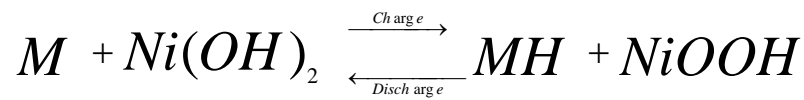
- The active material for the negative electrode in the NiMH battery is hydrogen.
 - The hydrogen ions (protons) are stored in the metal hydride structure which also serves as the electrode.
- NiMH batteries use specifically developed metal hydride alloys for the negative electrode.
 - Most NiMH batteries available today utilize the AB₅ type of metal-hydride.
- The reactions for the negative electrode can be written as:



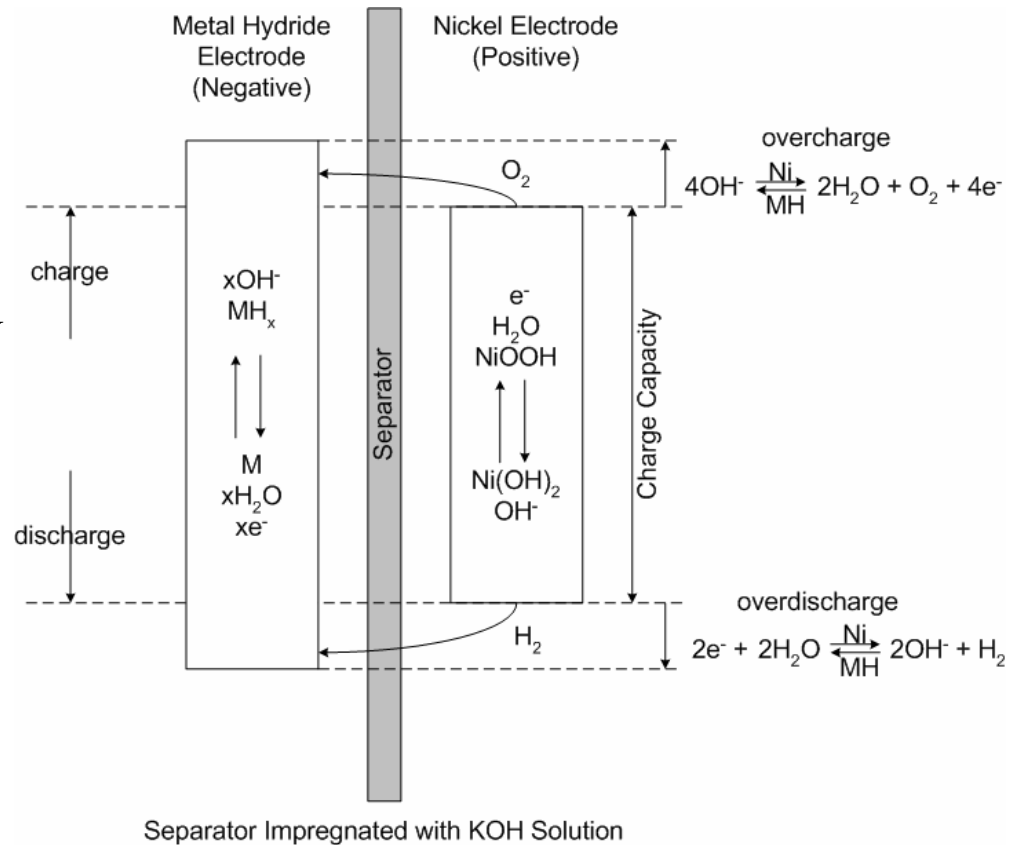
where M represents the metal hydride material.

Schematic Representation of NiMH Cell

- The combined whole cell reaction can be written as:



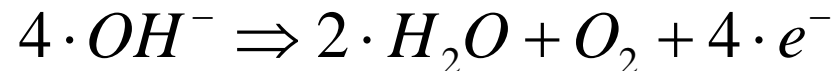
- The cell open circuit potential is about 1.3 Volts



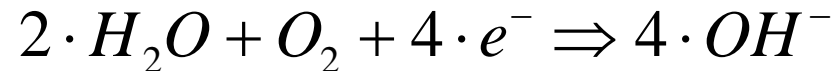
Over-Charge and Over-Discharge

- The NiMH battery has inherent electrochemical recombination processes
 - Enables abuse tolerance of Over-Charge and Over-Discharge.

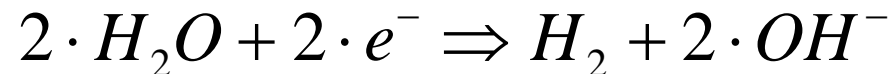
- The oxygen recombination reaction takes place as follows on overcharge:
 - For the positive electrode OH⁻ ions are oxidized generating oxygen:



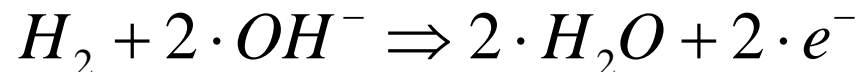
- For the negative electrode the oxygen is reduced:



- On over-discharge:
 - For the positive electrode water is reduced and hydrogen gas is formed:



- For the negative electrode the hydrogen gas is oxidized:



Failure Mechanisms

- Negative electrode corrosion
 - Slow process
 - Not catastrophic due to conductivity and stability of materials
 - Results in gradual loss of capacity
- Separator dry-out
 - Results as a byproduct of the negative corrosion or from abuse (venting)
 - Causes a gradual loss in power capability
- End of life of the battery depends on the application requirements
 - No “falling off the cliff” point to determine when to stop using battery

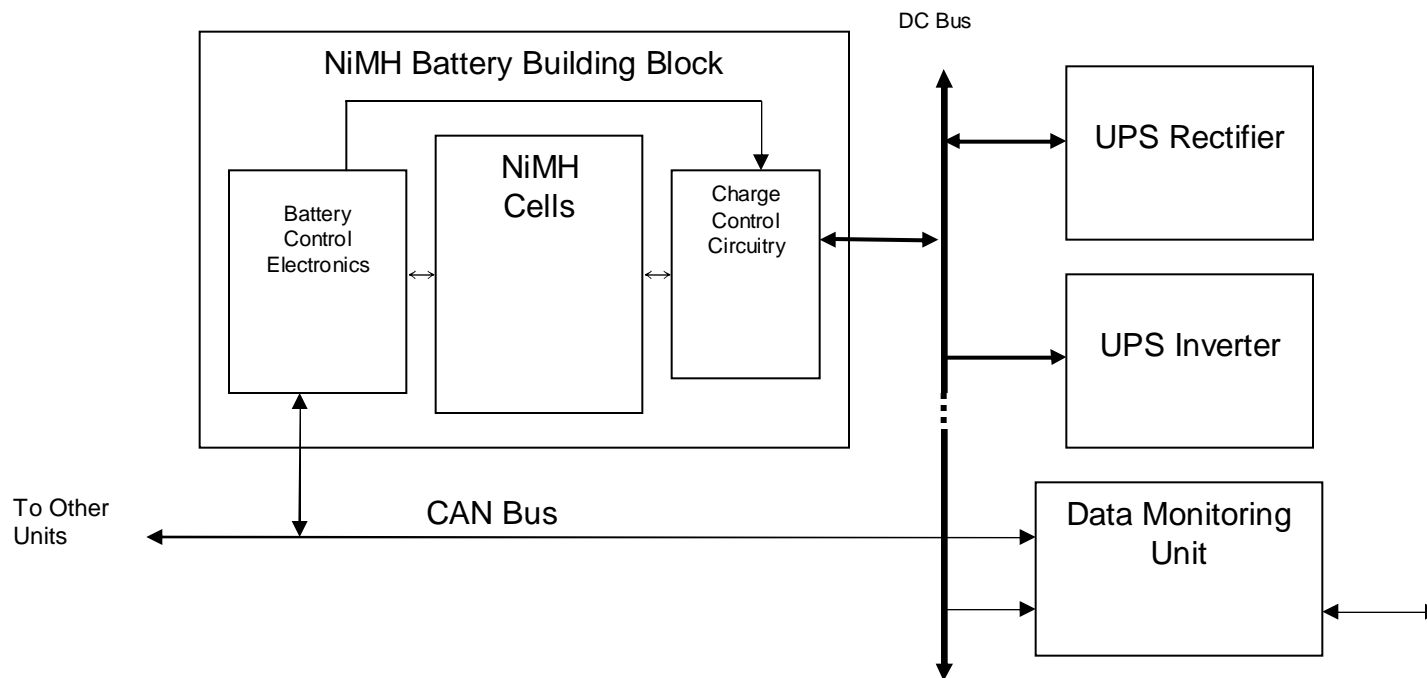


UPS System Application

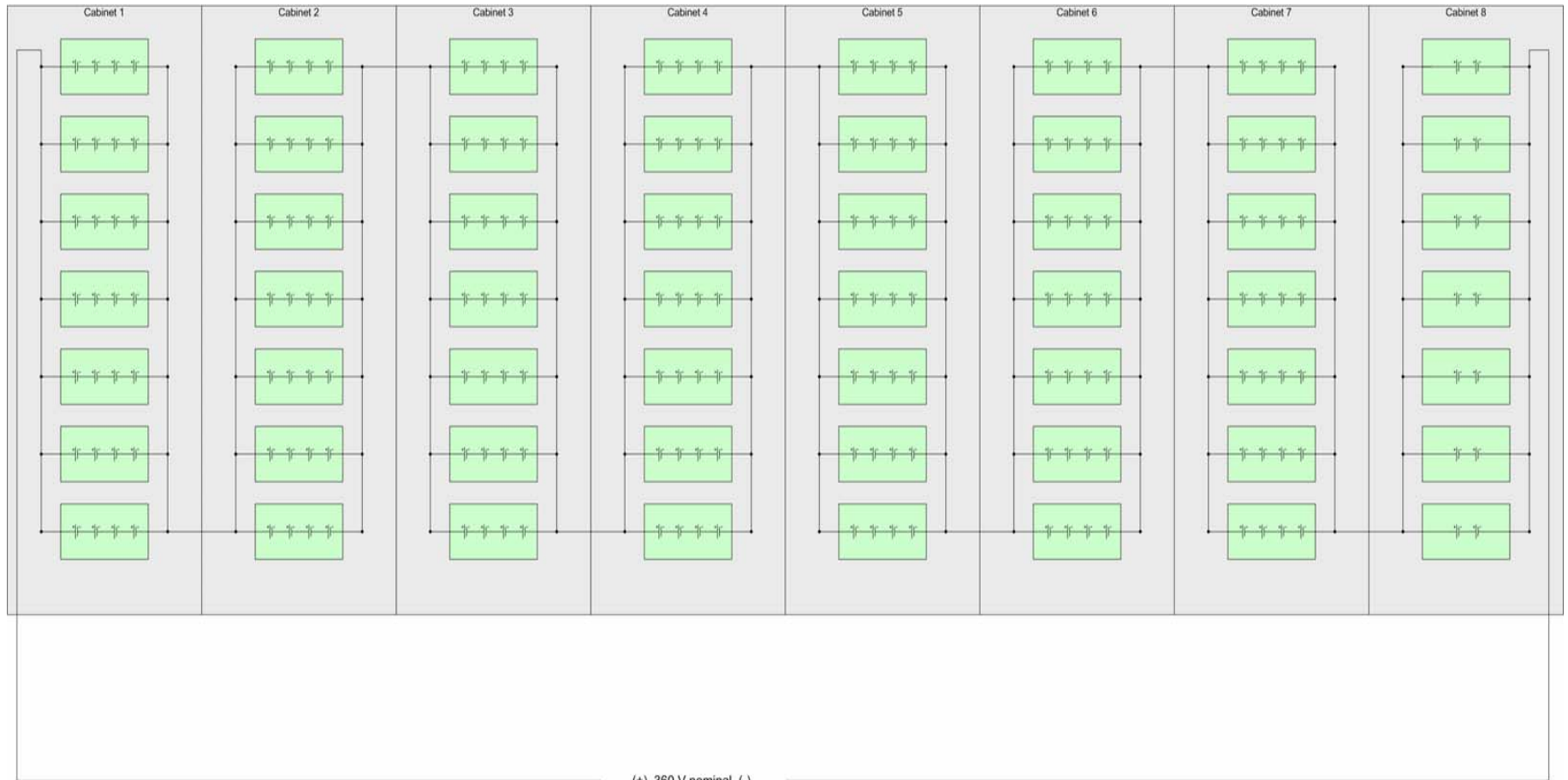
- Design for UPS
 - 15 min run time at 560 kW
 - Redundant design desired
 - 420 V float, 300 V end of discharge
 - Compact system to save space from pre-existing battery
- NiMH Solution
 - Utilize discrete building block approach
 - Equivalent of 300 cells in series required to match voltage range
 - Implemented as 49 building blocks at 48 V and 7 building blocks at 24V
 - Connection of blocks in parallel – series arrangement
 - 19” rack form factor



NiMH Battery Building Block

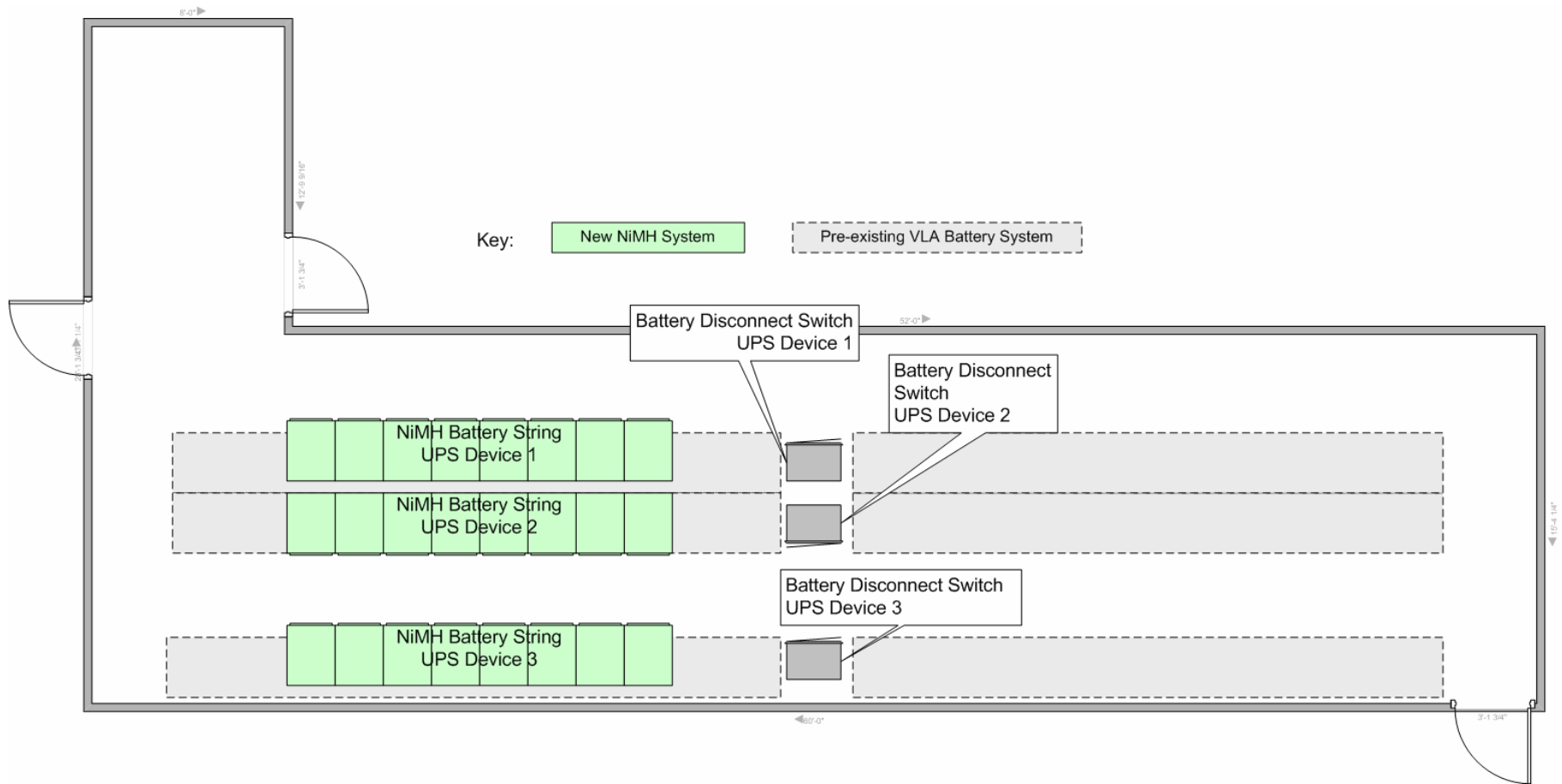


Building Block Connection



COBASYS

Battery Room Diagram



Battery Room

Before



After



It works great too!

Wrap Up

- NiMH is a familiar technology for consumer applications and Hybrid Electric Vehicles.
 - Proven its durability and ability to deliver long term performance
- NiMH is a new technology for stationary applications.
 - Successful implementations depend on proper attention to the details during the design process.
 - UPS
 - Telecommunications
 - Energy Storage Applications
- Proper management of any advanced technology battery is required for successful application in the field.
 - UPS is one such successful application for NiMH technology
- NiMH coming soon to an application near you!

