



ZincFive

**ZincFive BC 2 UPS Battery Cabinets:
Powerful Nickel-Zinc Batteries, Smallest Battery Cabinet Footprint**

The Power of Good Chemistry™



ZincFive

- The world leader in innovation and delivery of nickel-zinc (NiZn) batteries and power solutions
- 90+ patents on NiZn architecture and manufacturing
- Trusted mission-critical solutions provider approved with large UPS OEMS
- Development partners with leading Hyperscale/Cloud and modular solutions providers
- BC and BC 2 large scale deployments globally
- Global headquarters Portland, Oregon



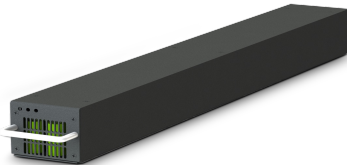
ZincFive Product Portfolio

Data Centers Portfolio

MW Class Battery Cabinets



OCP Style In-Rack
Backup



Genset Starting 8Z



Industry Leading Nickel Zinc Batteries

Monobloc for BC



Sub C for BBU



Solutions to Power a Better World

A nickel-zinc electrochemistry that provides immediate power with no harmful tradeoffs



Pressure-Tested Safety and Reliability

- No risk of fire or thermal runaway per UL testing
- No transportation restrictions
- No need to trade reliability for safety



Sustainable Power

- Lowest climate impact/carbon footprint compared to lead-acid and lithium
- Bill of materials not dominated by toxic elements
- Profitable recycling model comprising >90% of materials



Low Total Cost of Ownership

- Low TCO versus conventional lithium and lead-acid batteries





Nickel-Zinc (NiZn) Overview

New Z5 13-90 USF Battery

The Power of Good Chemistry™ works when you need it most

Nominal Voltage

Amp Hour Capacity

Discharge Current in BC Series

UL 9540A Tested

Max Continuous Discharge Power



Z5 13-80

High-Rate

13V

80Ah

800A

YES
(No Thermal Runaway at Cell Level)

8,000W



Z5 13-90

Ultra High-Rate

13V

90Ah

1200A

YES
(No Thermal Runaway at Cell Level)

12,000W

Designed with Nickel-Zinc (NiZn) Chemistry

The Ideal Battery for Backup

Nickel-Zinc Advantages	Nickel-Zinc	Lead-Acid	Lithium-Ion
Safe			
Safety in Operation	●	●	●
BMS/Fire Protection Required	●	●	●
Powerful			
Rapid Charge/Discharge Rates	●	●	●
Power Density	●	●	●
Reliable			
Operating Temperature Range	●	●	●
Long Cycle and Calendar Life	●	●	●
Green			
Raw Materials	●	●	●
Recyclability/Pollutants	●	●	●

Small Footprint and <40lbs/18kg!



80Ah
High-Rate



90Ah
Ultra-High-Rate

Monobloc Battery

Detailed information on Nickel Zinc batteries

Thomas Edison is the inventor of record for Nickel Zinc (NiZn) over a century ago.

Positive electrode: Ni (NiOOH). There are other battery chemistries that utilize a similar positive electrode, e.g. NiCd, NiMH, NiFe.

Negative electrode: Zn/ZnO

Electrolyte: Aqueous, Alkaline (KOH-based)

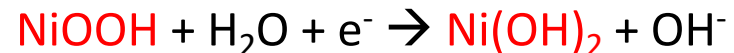
$E_0 = 1.73\text{V}$ (based on ideal thermodynamic Data)

Discharge

Anode Reaction:



Cathode Reaction:



Overall Reaction:



Charge

Anode Reaction:



Cathode Reaction:



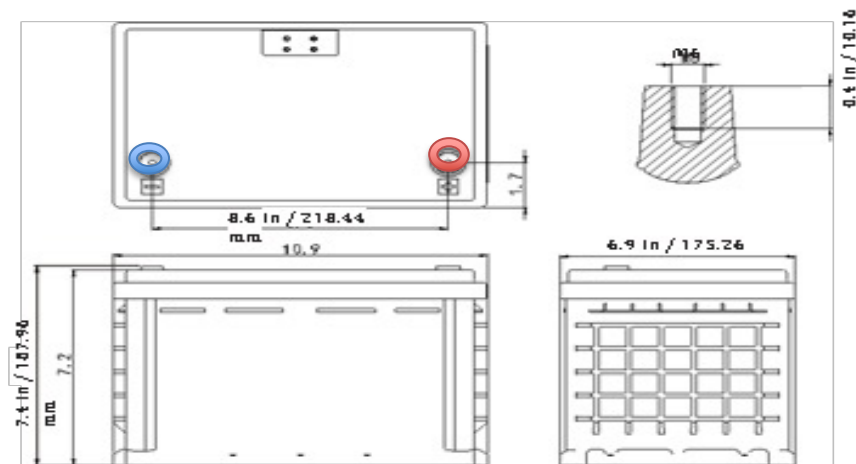
Overall Reaction:



In alkaline solution oxidation/reduction of Zn occurs via a complex zincate ion, Zn(OH)_4^{2-}

Construction/Materials Used

- The Z5 13-80 HSF and 90 USF batteries are valve-regulated, non-spillable, with a starved aqueous alkaline electrolyte.
- The relief valve is located on the center edge opposite the two terminals.
 - Under normal operation the relief valve will not open nor have any liquid discharge, but this area must never be covered.
- The case material is flame retardant V1-rated.
- The terminals have a color coated ring around base of the terminal and marked for polarity.
 - Positive terminal Red.
 - Negative terminal Blue.



Battery Size	LN3
Terminal /Torque	Ni Plated Copper Terminal with M6*10mm Bolt, Torque to 10Nm (90 in.-lb.)
Length (in/mm)	10.9 / 277
Width (in/mm)	6.9 / 175
Height (in/mm)	7.4 / 188
Weight (lbs/kg)	33 / 16

Cell Component	Description
Positive	Nickel Hydroxide, nickel metal
Negative	Zinc oxide, zinc metal, copper, tin
Separator	Polypropylene
Electrolyte	Proprietary KOH based water solution
Case	Noryl SE100X PPE+PS plastic



Safety

NFPA 855 and UL9540A

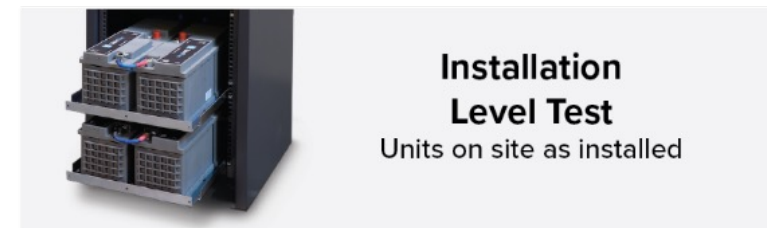
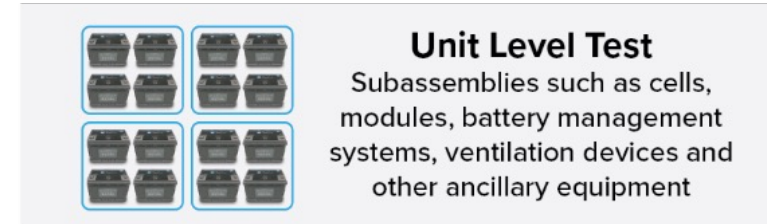


- Batteries are tested at the cell level to UL9540A
- Tests measure thermal runaway response to multiple tests
- If a test produces a flame, manufacturers are allowed to add battery management and additional safety features to prevent propagation of the flames outside of the battery module or cabinet and test at the next level
- The installation level test includes special site considerations to help suppress the fire

UL9540A Test Levels



Inherently safe,
no requirement
for active BMS!



UL9540A Test Report Summary Detail

(Excerpt from UL Report)

Test	Test Method	Venting Time (mm:ss)	Venting Temperature (°C)	Thermal Runway Time (mm:ss)	Thermal Runway Temperature (°C)
1	Overdischarge	Not Observed	N/A	Not Observed	N/A
2	Overcharge	91:30	103.7	Not Observed	N/A
3A	Heating Trial 1	22:30	216	Not Observed	N/A
3B	Heating Trial 2	46:30	180.5	Not Observed	N/A
4	Nail Penetration	00:15	84.5	Not Observed	N/A
5	Short Circuit	00:18	99.6	Not Observed	N/A
6 ³	Gas Composition (Overcharge)	66:40	97.5	Not Observed	N/A

Codes and Standards

- NFPA 855 and IFC listed favorably, due to UL9540A report, in the newest codes.
- AHJ approvals and preference growing rapidly as we expand and train personnel.
- Restrictions growing on container permitting, size, and development potential due to kWh restrictions on lithium.
- Power density requirement for customers is growing (1.5MW+) and runtimes are shrinking (5 minutes or less).

CHAPTER 12 ENERGY SYSTEMS

TABLE 1207.5
MAXIMUM ALLOWABLE QUANTITIES OF ELECTROCHEMICAL ESS

TECHNOLOGY	MAXIMUM ALLOWABLE QUANTITIES ^a
STORAGE BATTERIES	
Flow batteries ^b	600 kWh
Lead-acid, all types	Unlimited
Lithium-ion	600 kWh
Nickel-cadmium (Ni-Cd), nickel-metal hydride (Ni-MH) and nickel zinc (Ni-Zn)	Unlimited
Sodium nickel chloride	600 kWh
Zinc-manganese dioxide (Zn-MnO ₂)	Unlimited
Other battery technologies	200 kWh
CAPACITORS	
All types	20 kWh
OTHER ELECTROCHEMICAL ESS	
All types	20 kWh

TABLE 1207.1.3 ENERGY STORAGE SYSTEM (ESS) THRESHOLD QUANTITIES

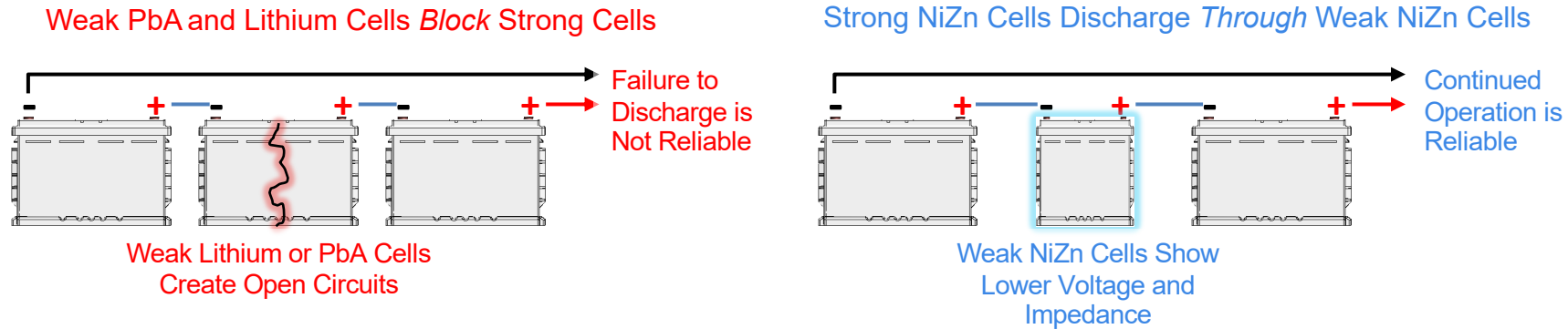
TECHNOLOGY	ENERGY CAPACITY ^a
Capacitor ESS	3 kWh
Flow batteries ^b	20 kWh
Lead-acid batteries, all types	70 kWh ^c
Lithium-ion batteries	20 kWh
Nickel-cadmium (Ni-Cd), nickel metal hydride (Ni-MH) and nickel zinc (Ni-Zn) batteries	70 kWh
Nonelectrochemical ESS ^d	70 kWh
Other battery technologies	10 kWh
Other electrochemical ESS technologies	3 kWh
Sodium nickel chloride batteries	70 kWh
Zinc manganese dioxide batteries (Zn-MnO ₂)	70 kWh



Reliability

Nickel-Zinc Reliability

NiZn String Discharge Reliability



- Unlike lead-acid and lithium-ion chemistries, a weak or depleted NiZn cell remains conductive, allowing the string to continue operating.
- Turns an emergency, unplanned maintenance situation for lithium and lead-acid into a simple string repair at the next planned maintenance cycle

NiZn reliability delivers planned maintenance with no operational impact!

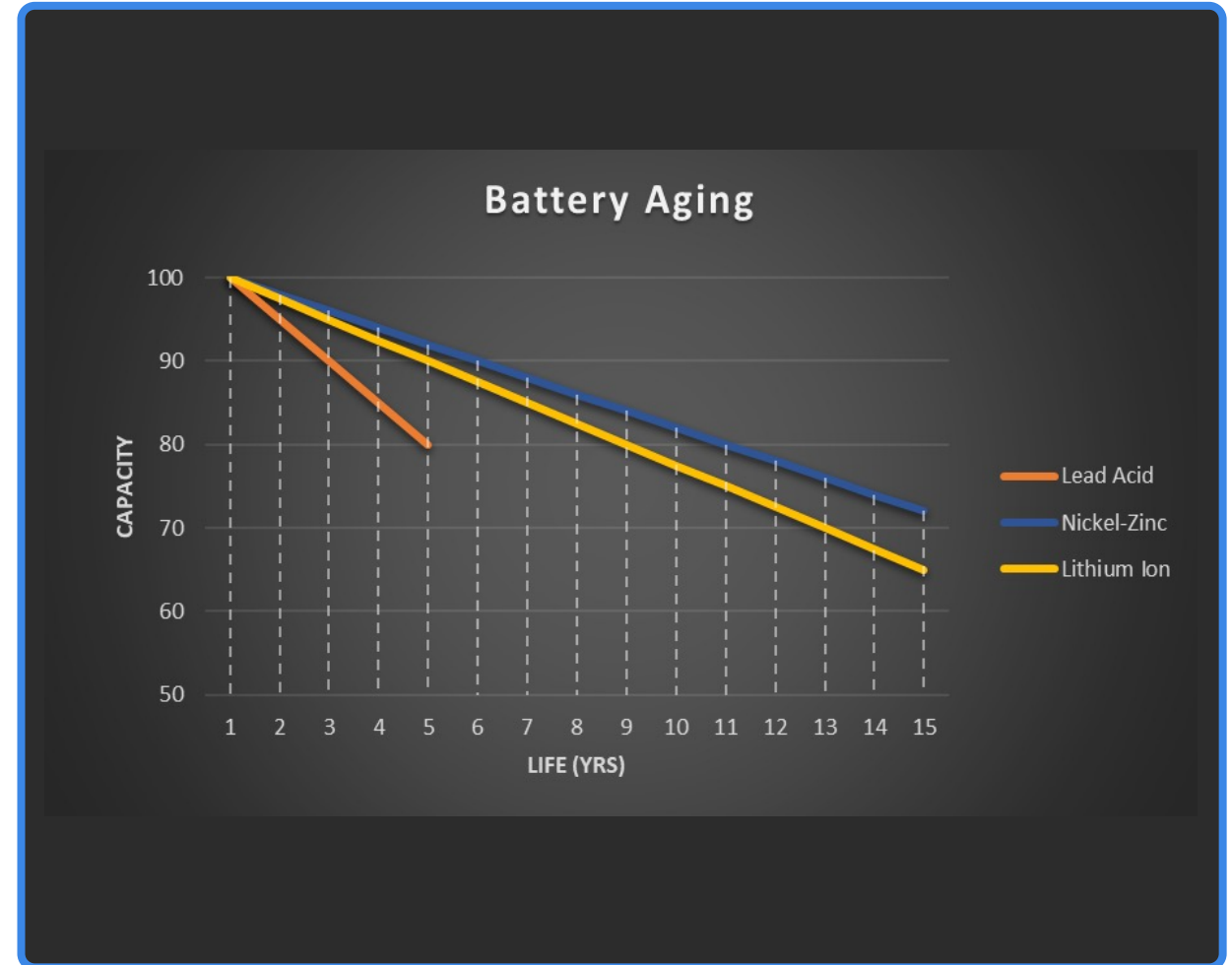
Nickel-Zinc Reliability

As batteries age Lead acid internal impedance increases and capacity fades.

- Nickel-Zinc internal impedance changes little as it ages
- Easily add/mix new and old batteries into a cabinet

Lead acid begins to degrade rapidly once it hits 80% capacity

- Nickel-Zinc battery calendar aging capacity degrades linearly reaching **~70% SOC at 15yrs**
- Increased life span decreases total cost of ownership and extends time to plan replacements





Sustainability

Sustainability Criteria



Climate Impact Score: 9.4/10



Addresses four of the United Nations' Sustainable Development Goals (SDGs)



- Safe, abundant, non-toxic materials
- Non-flammable battery chemistry
- *SDG 12*



- Advanced storage technologies for large energy users such as data centers
- Clean energy support for EV charging infrastructure
- *SDG 7*



- No solvents or VOCs used in manufacturing
- Production has lower GHG emissions (58kgCO₂e per kWh) than all conventional chemistries
- *SDG 13*



- Promoting resilient, reliable power
- Smallest footprint
- No risk of fire
- Broad operating temperature range in harsh environments
- *SDG 9*

Source: Boundless Climate Impact, 2020.

What They Said



Analysis showed that ZincFive's for CROP and GHG customers can realize [significant savings ZincFive's nickel-zinc battery.](#)

Customers purchasing ZincFive's battery [can save up to six times more GHG emissions](#) compared to lithium-ion batteries, [up to four times more](#) when compared to lead acid batteries.



In addition to the CROP and the GHG Footprint of ZincFive's battery, Boundless also analyzed the [Carbon Payback Time \(CPT\)](#)

The CPT was estimated to be [between 0.16 and 0.21 years, four times faster than lithium-ion and lead-acid](#) batteries and up to six times faster than sodium sulfur batteries.



ZincFive batteries only use [safe and abundant materials](#) that mitigate battery hazards, health risks and scarcity concerns.

Both zinc and nickel are relatively abundant materials, [four-times and five-times more abundant than lithium](#) in the earth's crust, respectively.

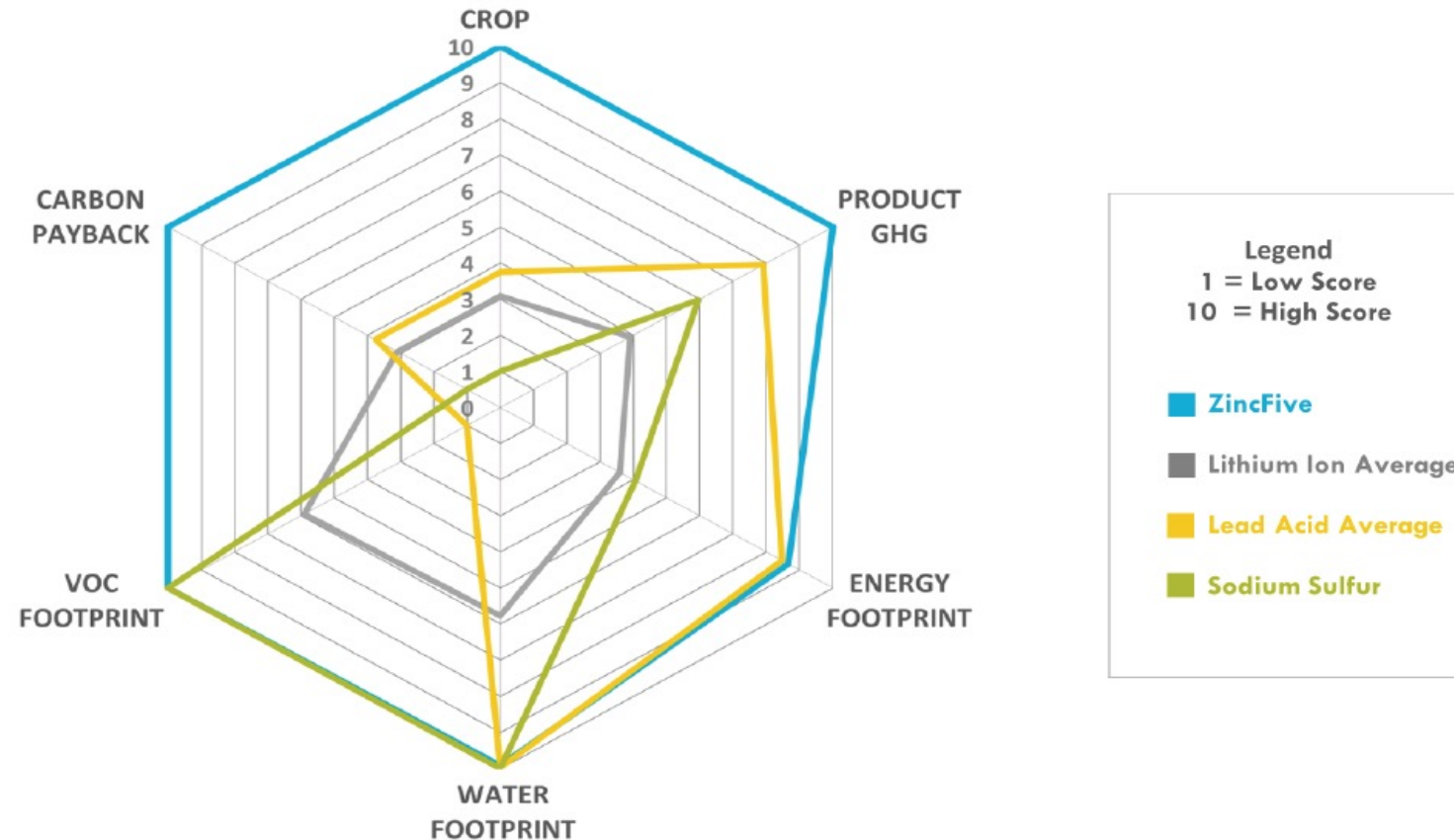


The [Energy, Water and VOC Footprint](#) of ZincFive's battery were also analyzed.

The Water Footprint of the ZincFive battery, including water requirements for raw material extraction, [was estimated to be 96% lower than the average Water Footprint of lithium-ion batteries.](#)

What This Means

For every \$1 in batteries purchased;
Lithium batteries will add 537% more CO₂e to your carbon accounting.
Lead acid batteries will add 1,700% more CO₂e produced.



Source: Boundless Climate Impact, 2020.



BC Series

ZincFive BC Series Features & Benefits

High Power Density, High Reliability Nickel-Zinc Batteries

Enables fewest cabinets per MW of competing chemistries with unrivaled string reliability.

10-year battery warranty

Ensures Lower Total Cost of Ownership.

Low maintenance nickel-zinc batteries

Simplified maintenance, lower total cost of ownership.

BC 2, 300X and 500



Drop-in replacement for lead-acid cabinets

Backward and forward compatibility with megawatt class UPS inverters.

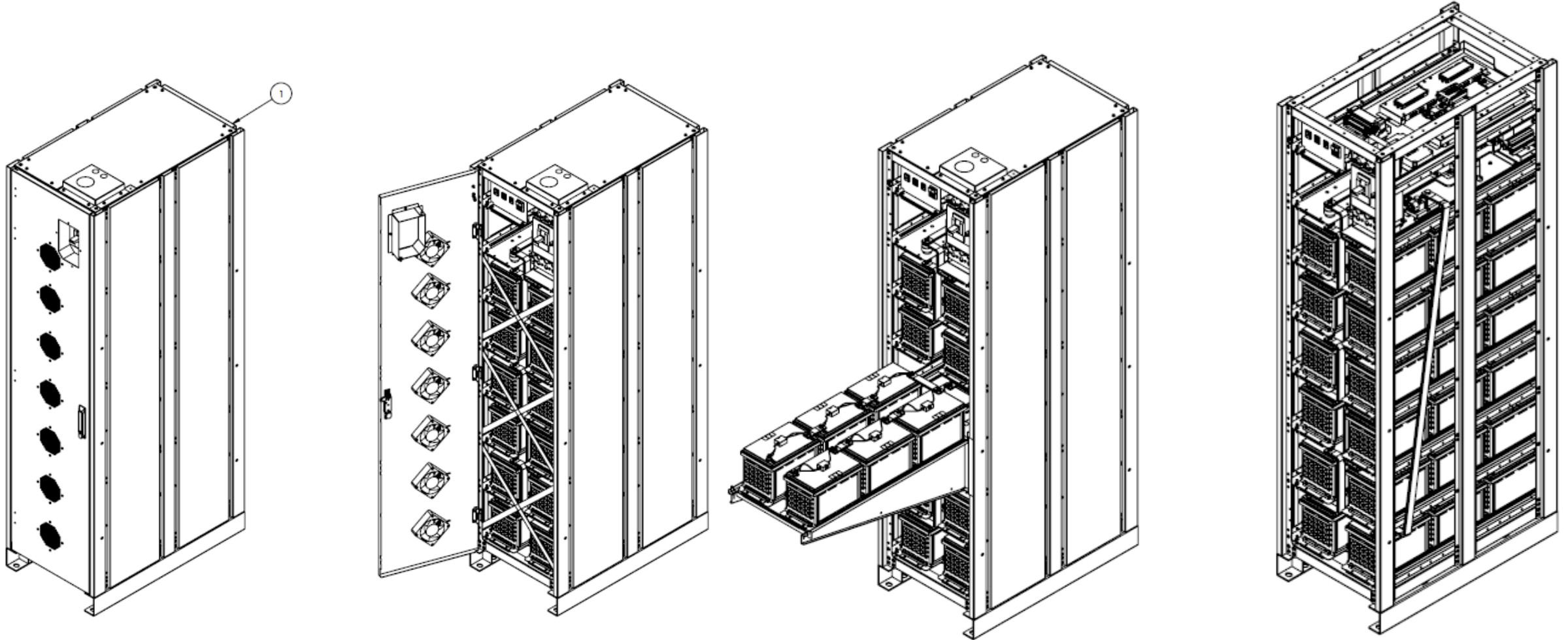
Safety in operation

Nickel-zinc batteries do not exhibit thermal runaway per UL9540A Test Method.

Nickel-Zinc battery wide operating temperature range

Less power and cooling required leading to reduced facility operating costs.

BC 2 Drawing Package



ZincFive BC 2 – 300X and 500 Comparison



Powered by
Nickel-Zinc (NiZn)
BC 2 - 300X

BC 2 – 300X

Higher Energy Density Compared to BC 2

Greater than 5-minute runtimes

- Smallest footprint for longer runtimes
- $\leq 325\text{kWb}$ – 850A current target
- Increased Ah and energy density
- All LVCO's possible



Powered by
Nickel-Zinc (NiZn)
BC 2 - 500

BC 2 – 500

Highest Power Density of BC Series

Less than 5-minute runtimes

- Smallest footprint in industry
- $> 325\text{kWb}$ applications - 1200A High-current capable power path design
- Increased power output, same battery footprint
- Highest powers require $< 390\text{V}$ or Lower

Same 10-year warranty, wide operating temperature range, and low TCO!



BC 2 Series 1.5MW 3 min EOL @ 10 yr. Comparison



BC 2 – 500 vs Lithium

60%

Less aisle Width per MW

Note: BC 2 – 300X
would provide 5
min EOL

Depth
600 mm (23.6 in)

Depth
914 mm (36 in)

Total Width: 84” or 2,132mm

ZincFive BC 2 - 500	ZincFive BC 2 - 500	ZincFive BC 2 - 500	ZincFive BC 2 - 500
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Total Width: 105” or 2,665mm

ZincFive NiZn BC 2 and 300X	ZincFive NiZn BC 2 and 300X	ZincFive NiZn BC 2 and 300X	ZincFive NiZn BC 2 and 300X	ZincFive NiZn BC 2 and 300X
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Total Width: 205” or 5,218mm

Lithium Cabinet	Lithium Cabinet	Lithium Cabinet	Lithium Cabinet	Lithium Cabinet	Lithium Cabinet	Lithium Cabinet	Lithium Cabinet
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BC 2 Series 1MW 7 min @ 10 yr. Comparison



BC 2 – 300 vs Lithium

32%

Less aisle Width per MW

Depth
914 mm (36 in)

Total Width: 2665 mm (8.75 ft)

ZincFive BC 2 – 300X	ZincFive BC 2 – 300X	ZincFive BC 2 – 300X	ZincFive BC 2 – 300X	ZincFive BC 2 – 300X
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Depth
914 mm (36 in)

Total Width: 3198 mm (10.5 ft)

ZincFive BC 2	ZincFive BC 2	ZincFive BC 2	ZincFive BC 2	ZincFive BC 2	ZincFive BC 2
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Depth
600 mm (23.6 in)

Total Width: 3913mm (12.8)

Lithium Cabinet	Lithium Cabinet	Lithium Cabinet	Lithium Cabinet	Lithium Cabinet	Lithium Cabinet
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Modular Container Benefits – 1,500kW @ Year 10 Solution

Reduced cooling load:

- 35C Operating temp
- 50C Flexibility
- No capacity loss or warranty changes!

Reduced battery cabinet count:

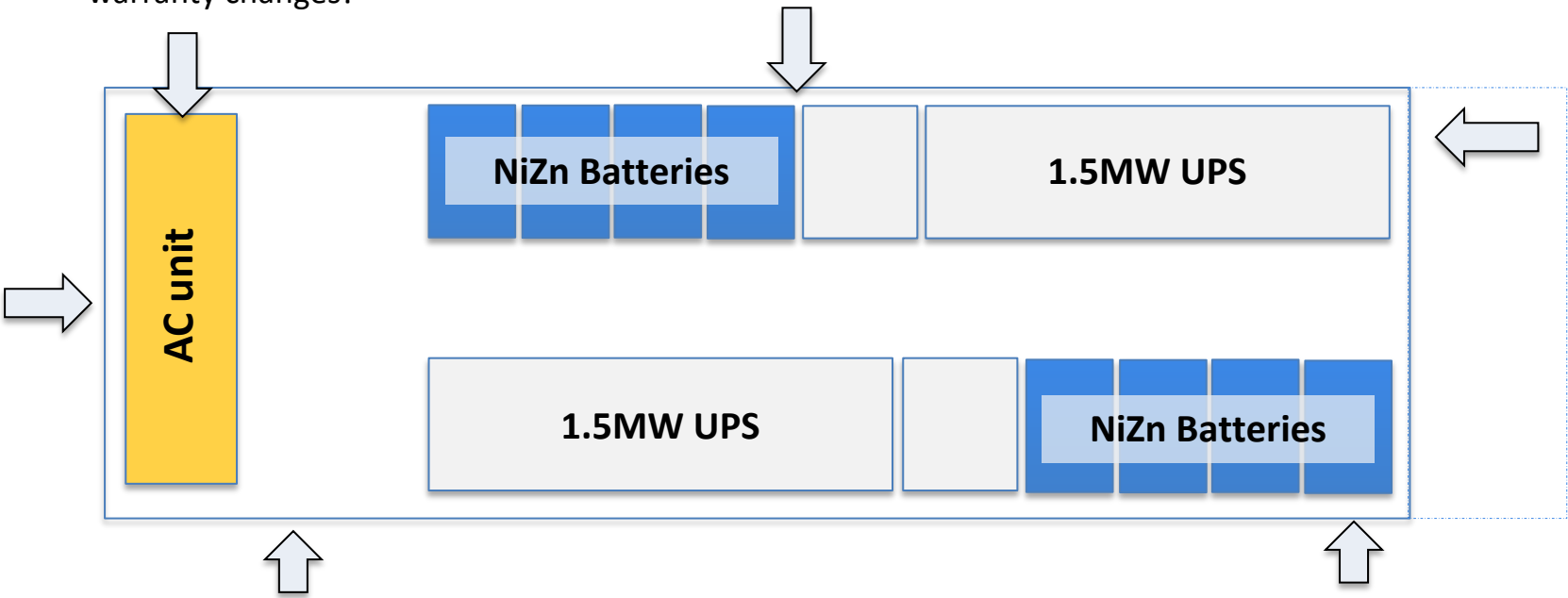
- Less cable and conduit
- Less cabinets
- Less footprint

Simplified code requirements compared to other chemistries:

- IFC, NFPA 855, UL9540A benefits

Container size reduction over lithium:

- \$10,000 saved per ft!



Safety Costs:

- No fire suppression
- No burn rated walls
- No explosion proofing

Labor and Installation Savings:

- Battery cabinets ship complete
- Container can ship complete
- BMS for maintenance

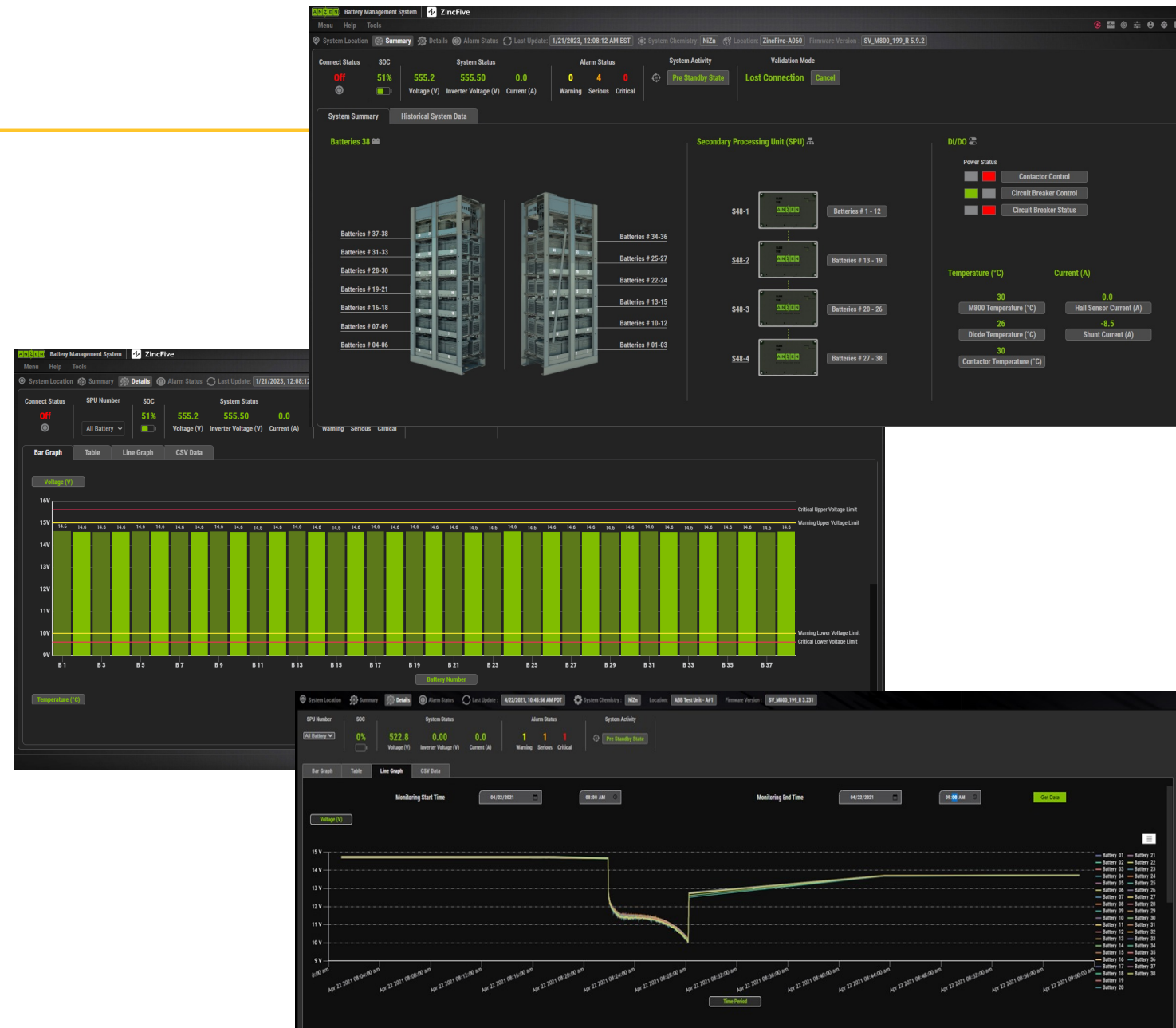
System Interfaces

Data Available

- All Errors/Faults
- State Transition into or out of Discharge or Charge
- Battery Module Voltage
- Battery String Voltage
- Breaker Voltage
- Battery Temperature
- Inverter Voltage
- Current
- Discharge/Charge log frequency
- Time stamp on each log event
- Log firmware uploads.
- Logging interval changes.

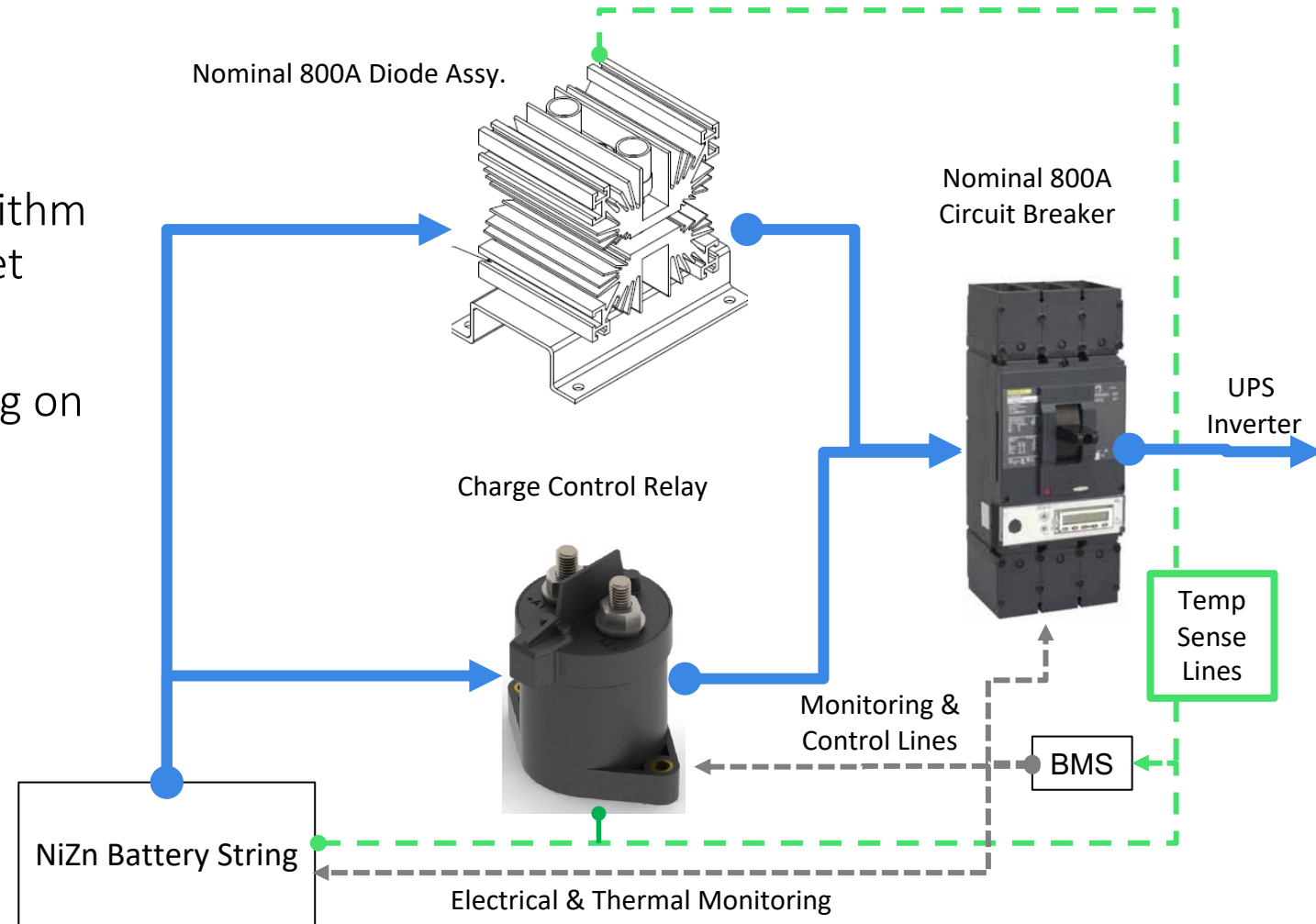
Communication, Real-Time, and Trending

- Ethernet
- USB
- WiFi
- CSV
- Modbus



Intelligent Charging/Monitoring System

- Enables NiZn battery string to act as **drop-in replacement** for lead-acid strings
- Adapts existing UPS lead Acid charging algorithm to NiZn charging profile and performs cabinet monitoring
- Total Recharge time – 2 to 5 hours depending on variables
 - Temperature is at or below 40°C.
 - Charge current: 20 A min/160 A max.

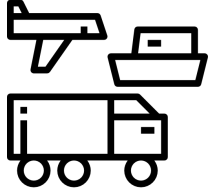


Nickel-Zinc Overview

No Compromises



>90% Recyclable using existing equipment and processes, using less energy than VRLA, no toxic chemicals, and a larger credit!



No transportation restrictions. Can easily ship fully populated and assembled cabinets by highway, overseas, or by air!



Manufactured using four and five times more abundant materials than lithium, while using less water and energy for extraction!



BC 2

BC 2 - 300X

BC 2 - 500

Summary

- ✓ Drop-In Replacement for Lead-Acid Cabinets
- ✓ Small footprint, high power
- ✓ SAFE – No Thermal Runaway
- ✓ Sustainable, Powerful, Recyclable, and Reliable!
- ✓ Higher Operating Temperature
- ✓ Low Maintenance
- ✓ 10 Year Warranty/ 15 Year Design Life
- ✓ Low Total Cost of Ownership!

Brandon Smith – Sr. Product Manager
bsmith@zincfive.com



BC 2
High-Rate

NEW



BC 2 - 300X
High-Rate Extended
Runtime

NEW



BC 2 - 500
Ultra-High-Rate

BC 2 – 21" x 36" x 82.5"
(w/o top box, 83.5" with)



80Ah
High-Rate

NEW



90Ah
Ultra-High-Rate



ZincFive

www.zincfive.com