DISCOVER
ENERGY SYSTEMS



AES CABINET

NFPA 855 PRODUCT COMPLIANCE STATEMENT & PACKAGE

830-0115 REV A

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NFPA 855 PRODUCT COMPLIANCE STATEMENT & PACKAGE

1. PURPOSE AND SCOPE

This document provides a formal statement of compliance for the AES CAB outdoor lithium-iron-phosphate (LFP) energy storage cabinet, branded by Discover Energy Systems (DES) as the AES CAB Series. The scope of this statement is limited to the cabinet product as manufactured, including integrated battery systems, BMS, thermal management, fire protection, deflagration mitigation, and auxiliary systems.

Site-level NFPA 855 installation provisions (siting, distances, third-party fire alarm integration, building suppression, and utility interconnection) should be addressed by the project engineer of record using the DES documentation and other relevant resources, such as site-level Hazard Mitigation Analysis (HMA), if required.

2. APPLICABLE STANDARDS

The AES CAB battery system and integrated sub assemblies have been evaluated against the following:

- **UL 1973**, Batteries for Use in Stationary Applications (2022 Edition)
- **UL 9540A**, Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems (2019, 4th Edition)
- **UL 9540**, 2023 (3rd Edition DC Energy Storage System) Certificate - CN2508AE 001
- **NFPA 855**, Standard for the Installation of Stationary Energy Storage Systems
- **NFPA 68**, Standard on Explosion Protection by Deflagration Venting

3. COMPLIANCE SUMMARY

The AES Cabinet meets all product-level expectations of NFPA 855 for outdoor electrochemical ESS when installed per manufacturer instructions and supported by a site-level HMA as required.

3.1 UL 1973 Listing of the Battery System

The battery system (SLL03C2-D1P52S1R1 through S1R8-A01) is certified to UL 1973:2022 Batteries for use in Stationary and Motive Auxiliary Power Applications.

Testing includes:

- Overcharge, overdischarge, short circuit
- Thermal abuse, environmental cycling, dielectric
- Single cell failure tolerance
- Mechanical stress and enclosure integrity

Supporting Documentation:

- UL 1973 Report, cTUVus, Ref. CN24JVH3 001
  - UL1973 Report - **830-0105**
- Battery System Certification Pages
  - UL1973 Certificate - **830-0103**

3.2 UL 9540A Propagation Characterization

NFPA 855 requires evaluation of heat release, gas generation, and thermal runaway propagation behavior for lithium-ion ESS. The AES CAB has undergone a complete UL 9540A test program across all required levels, including an installation-level test with multiple cabinets operating in close proximity.

The following UL 9540A evaluations were completed:

- **Cell level**, Great Power 314 Ah cell (GSP71173204F)
- **Module level**, PLL03C2-D1P52S module
- **Battery system (rack) level**, SLL03C2-D1P52S1R1 through S1R8-A01
- **Unit level**, AES Cabinet
- **Installation level**, AES CAB system test (five-cabinet array), validating temperature impact and propagation behavior on adjacent enclosures

The test program characterized:

- Thermal runaway behavior and temperature escalation
- Propagation potential at cell, module, rack, and cabinet scales
- Gas volume, gas composition, and flammability characteristics

- External heat flux and fire exposure effects
- Fire spread limitations and suppression effectiveness
- Adjacent cabinet temperature rise and propagation mitigation
- Results demonstrate that thermal runaway is confined within the initiating module, with no cabinet-to-cabinet propagation, no external flaming, and hydrogen below detectable limits at the module and unit levels. Installation-level testing confirms safe performance when multiple AES CAB cabinets are deployed in close proximity.

Supporting Documentation

- **UL 9540A Cell Level**: 314Ah Cell Report – **830-0112**
- **UL 9540A Module Level: Great Power** 1P52S Module Report – **830-0113**
- **UL 9540A Rack/Battery Level:** RLL03C2 Systems Report – **830-0109**
- **UL 9540A Unit Level**: AES Cabinet Test Report – **830-0110**
- **UL 9540A Installation Level**: AES CAB Multi-Unit Test Report – **830-0114**

3.3 Deflagration Venting Analysis per NFPA 68

An engineering analysis and CFD simulation were performed to evaluate deflagration venting and internal pressure dynamics.

Analysis references:

- P_{max}
- P_{red}
- Effective enclosure volume
- Gas density
- Specific heat ratio
- Vent area and opening pressure

This analysis confirms that the cabinet vent system effectively controls internal pressures within the limits specified by NFPA 68.

Supporting Documentation:

- NFPA 68 CFD Analysis Report
  - NFPA68 Test Report CN2573P9 001 - **830-0111**
- Vent Component Cut Sheets
  - Deflagration Vent VIGILEX ARC-VENT VL-SS 710×710 Data Sheet - **890-0006**
- Vent Location Drawings
  - AES Cabinet Operation and Maintenance Manual, **Section 6.9 - 805-0094** Replacing the Deflagration Vent

3.4 Battery Management System (BMS) and Electrical Protection

The integrated BMS architecture (BMU, BCU, SBCU, BAU) provides:

- Real-time monitoring of cell voltages, temperatures, and current
- Insulation monitoring up to 1500 V
- Charge and discharge rate control
- Main positive, negative, and precharge contactor control
- Relay outputs for protection and suppression interaction
- CAN and RS-485 communication for EMS and PCS integration

Passive protection includes:

- Module-level fusing
- Rack-level fusing
- HV distribution protection
- Manual service disconnects

Supporting Documentation:

- BMS Overview Document
  - BMS Software User Manual - **890-0002**
- SBCU Data Sheet
  - SBCU Schematic Diagram - **890-0001**
  - UL 1973 Report (Protection Tests) - **830-0105**
- Cabinet Electrical Drawings
  - AES Cabinet Systems Wiring - **550-0279**
- Auxiliary Power Supply
  - Auxiliary Power Supply Calculation - **890-0005**

3.5 Thermal Management and Environmental Control

The cabinet integrates:

- 8 kW liquid cooling system (BTMS-80-ES)
- 50 percent ethylene glycol coolant loop
- Redundant sensors for temperature and flow
- Dehumidification system
- Environmental monitoring
- Automatic thermal derating

Supporting Documentation:

- Chiller Technical Manual
  - Great Power - Chiller Manual - **890-0003**
- Cooling System Drawings
  - Great Power - Chiller Manual - **890-0003, Page 9**
- O&M Manual (TMS) - **805-0094**
  - Section 6.2 TMS Removal and Replacement Procedure
  - Section 8.5 TMS Control Logic and Operating Parameters

3.6 Fire Detection and Suppression

Integrated fire protection includes:

- Smoke and thermal detection
- Internal suppression actuation (cell pack/cabinet)
- BMS driven shutdown logic
- Fire alarm outputs for site integration
- UPS backed auxiliary power for two hour minimum duration

Supporting Documentation:

- Fire Protection System Description - **Section 7.6, 805-0104**
  - ESS Protection - Mitigation, Detection, Suppression, Control
- Auxiliary Power Supply Calculation Report
  - UPS backed 2 hour minimum duration for auxiliary power - **890-0005**
- Detection and Suppression Drawings
  - AES Cabinet Systems Wiring - **550-0279**
  - Fire Protection System Operating Logic - **890-0009**
- Maintenance and Testing Procedures (O&M Manual) **Chapter 6, 805-0094**
  - Maintenance Operations

3.7 Enclosure Environmental Ratings

The cabinet assembly is rated:

- NEMA 3R (IP55 equivalent) for outdoor environments
- Battery sub assemblies rated IP66
- Corrosion-protected structure and hardware

Supporting Documentation:

- Product Overview Document
  - AES Cabinet Outdoor C&I Installation and Commissioning Manual - **805-0104**
- UL 1973 Test Item Particulars
  - UL1973 Test Report - **830-0105**
- Cabinet Construction Drawings
  - AES Cabinet UL9540 Test Report - **830-0102**
  - AES Cabinet C&I Installation and Operation Manual - **Section 4.2, 805-0104** Mechanical Specifications

4. INSTALLATION DEPENDENT DOCUMENTATION (PROVIDED BY INTEGRATOR OR ENGINEER OF RECORD)

NFPA 855 includes certain requirements that may or may not be invoked by the Authority Having Jurisdiction (AHJ). These provisions are typically triggered by site-specific conditions, enclosure configuration, system scale, or local fire authority interpretation. When applicable, select documentation must be developed and submitted at the installation level by the Engineer of Record, integrator, or EPC.

Such documentation is inherently project-specific and falls outside the scope of Discover Energy Systems. These materials are intended to complement the AES Cabinet's product-level certifications, testing, and safety documentation, and do not form part of the UL listing or certification of the AES Cabinet DC ESS.

4.1 Site Level - Hazard Mitigation Analysis (HMA)

When required by the AHJ, the project HMA incorporates manufacturer UL 9540A test data at the cell, module, unit, system, and installation levels. It evaluates separation distances, fire spread limitations, explosion control strategy, detection, and suppression interfaces.

4.2 Fire Alarm and Suppression Integration

Depending on local code interpretation, the following may be required:

- Fire alarm shop drawings and calculations per NFPA 72
- Integration of cabinet alarm outputs to the building fire alarm system
- Suppression system design when external or building-level suppression is mandated
- Notification appliance locations, candela ratings, and wiring diagrams

4.3 Gas Detection and Ventilation Design (If Applicable)

For outdoor, free-standing AES CAB installations, NFPA 855 does not prescriptively require combustible gas detection or forced ventilation, as gas dispersion occurs naturally in an open atmosphere. Gas accumulation risk for these configurations is addressed through UL 9540A testing and NFPA 68 deflagration venting analysis.

For indoor or enclosed installations, or where required by the Authority Having Jurisdiction based on the site-specific Hazard Mitigation Analysis, additional gas detection or mechanical ventilation may be required. In such cases, the following documentation is provided at the installation level by the Engineer of Record or integrator:

- Gas detector locations and specifications
- Ventilation design calculations
- Controller wiring and alarm routing

4.4 Site Layout and Structural Documentation

Installation-specific engineering documents include:

- Site layout, clearances, and separation distance compliance
- Foundation and anchoring calculations
- Trenching and conduit routing
- Civil and structural drawings

4.5 PCS and Inverter Certification Documentation

For DC ESS listed systems, NFPA 855 requires that the PCS be listed to the appropriate product safety standards, generally UL 1741 or UL 62109-1. The project package should include:

- PCS cut sheets
- PCS certification listings
- Interconnection one-line diagrams

Important Note on UL 9540 for DC ESS

A full AC ESS system-level UL 9540 listing is not required when the manufacturer provides a UL 9540 3rd Edition DC ESS listing. Clause 46.14 of UL 9540 requires that DC ESS manufacturers maintain documented verification of compatible Power Conversion Equipment. Because a DC ESS is a universal DC source, it is not practical or required to list every inverter or converter within the UL 9540 certificate. Instead, the manufacturer performs interoperability validation with compliant UL 1741 or UL 62109-1 PCS devices and documents the approved PCS list in official compatibility documentation and in the installation manual. This satisfies UL 9540 3rd Edition requirements without a unified AC ESS listing.

4.6 Project-Specific Electrical Documentation

These documents complete the installation package for the AHJ review:

- Electrical one-line diagrams
- Grounding and bonding details
- Conductor schedules
- Protection and coordination studies
- Signage and labeling plans per NFPA 855 and IFC

5. COMPLIANCE STATEMENT

Based on the testing, certifications, and analyses provided, the AES CAB (Discover AES Cabinet Solution) satisfies all product-level requirements of NFPA 855 for outdoor electrochemical energy storage systems.

The cabinet incorporates UL 1973-listed battery systems, UL 9540 certification, a UL 9540A propagation-validated architecture, NFPA 68-compliant deflagration venting, integrated BMS and electrical protection, thermal management, environmental control, fire detection and suppression, and UPS-backed auxiliary power, all of which are suitable for ESS safety functions.

When installed according to the manufacturer's instructions and integrated into a site-level Hazard Mitigation Analysis (as required by the AHJ), the AES CAB supports full NFPA 855 compliance for permitting and AHJ review.

6. PRODUCT EVIDENCE PACKAGE (RELEASED UNDER MNDA ONLY)

Discover Energy Systems maintains a complete and controlled certification and safety evidence library for the AES Cabinet and related Magna-UTL cabinet series. This package includes UL 9540, UL 1973, UL 9540A, NFPA 68, IEC functional safety and system documentation. Because these files contain proprietary engineering and manufacturer information, they are provided only after execution of a Mutual NDA.

The evidence package supports all NFPA 855 product-level requirements and is suitable for direct inclusion in a project Hazard Mitigation Analysis (HMA).

6.1 UL 1973 Battery Subassembly Certification

Demonstrates that racks, modules, and battery units comply with ANSI/CAN/UL 1973:2022 as required by NFPA 855.

Available Documents

- All CAB UL 1973 Certificates
- All CAB UL 1973 Test Reports
- UL-listed module families: D1P52S1R*, D1P52S*, D1P104S*
- Matches the battery specifications in AES Cabinet UL 9540A and UL 9540 system listings.

6.2 UL 9540 DC ESS System Certification

NFPA 855 requires ESS to be listed to UL 9540. The AES Cabinet is evaluated as a DC ESS, which permits universal PCS interoperability per UL 9540 Clause 46.14.

Available Documents

- CAB UL 9540 Certificate (ANSI/CAN/UL 9540:2023)
- CAB UL 9540 Test Report (DC ESS evaluation, 418 kWh, liquid cooling)

Key compliance attributes

- Certified as a DC Battery Energy Storage System
- IP55 rated enclosure
- Liquid cooling system
- Compatible with N = 1-8 pack configurations (54-426 kWh)

This satisfies NFPA 855's requirement for system listing without requiring an AC-ESS listing.

6.3 UL 9540A Thermal Runaway Propagation Testing

NFPA 855 relies on UL 9540A test results to establish fire propagation characteristics, spacing, and mitigation strategies for lithium-ion ESS. The AES CAB has undergone a complete UL 9540A evaluation program encompassing cell, module, rack, unit, and installation levels.

Available Documents

- **UL 9540A Cell Level**
  314Ah Cell UL9540A Test Report – **830-0112**
  - Gas composition and flammability characterization

- **UL 9540A Module Level**
  Great Power 1P52S UL9540A Module Test Report – **830-0113**
  - No module-to-module propagation
- **UL 9540A Rack / Battery System Level**
  Rack UL9540A Test Report (RLL03C2 systems) – **830-0109**
  - Validates rack-level propagation barriers
  - Propagation limited to one adjacent cell
  - No external flaming or debris
- **UL 9540A Unit Level**
  AES Cabinet UL9540A Test Report – **830-0110**
  - No external flaming
  - Total of two cells entered thermal runaway
  - Minimal heat release and external heat flux
  - Hydrogen undetected at the unit level
- **UL 9540A Installation Level**
  AES CAB System UL9540A Test Report (five-cabinet array) – **830-0114**
  - No cabinet-to-cabinet propagation
  - Adjacent enclosure temperatures monitored and within acceptable limits

These results collectively demonstrate controlled thermal runaway behavior, effective propagation mitigation at all levels, and safe performance for multi-cabinet deployments under NFPA 855.

6.4 NFPA 68 Deflagration Venting Analysis

NFPA 855 references NFPA 68 when the UL 9540A data shows potential gas evolution.

Available Documents

- AES Cabinet NFPA 68 Venting Evaluation (CFD modeling, P_{red}/P_{max} analysis)
  - Confirms compliant deflagration vent sizing
  - Uses UL 9540A gas generation data as model input

6.5 Product Construction, Electrical Ratings, and Safety Envelope

NFPA 855 requires detailed documentation of construction, electrical limits, and environmental controls.

Available Documents

- Complete UL construction data forms (embedded in UL 9540 and UL 1973 reports)
- Battery pack construction and separation materials
- Temperature, charge, and discharge operational limits

- Cooling system specifications (liquid cooling)
- Enclosure dimensions and mechanical drawings

Examples include:

- Technical data from UL 1973 certificate showing nominal 166.4*N Vdc, 314 Ah rating, and temperature envelope
- Technical data from UL 9540 system certificate showing auxiliary supply (220/277 V), cooling type, IP55 rating, and environmental limits

6.6 Gas Release, Heat Release, Smoke Release, and Propagation Data

NFPA 855 requires validated safety characteristics for the HMA.

UL 9540A reports include:

- Cell gas composition and LFL values
- Module propagation limits
- Unit-level external heat flux and gas data
- Smoke release rate and total smoke mass
- Absence of external flaming
- CFD-ready gas generation datasets

For example:

- AES Cabinet unit-level gas composition showing hydrogen below detectable limit and low hydrocarbon release

6.7 Listed Variants and Model Families

The UL 1973 and UL 9540 certifications explicitly cover all cabinet energy sizes:

- X = 54, 106, 160, 210, 266, 318, 372, 426
- N = 1-8 packs

This ensures NFPA 855 compliance for all cabinet configurations without separate testing.

6.8 Documentation Provided Under MNDA

The following documents will be released as part of a complete Evidence Package:

1. **(Root folder) UL 9540 certificate and full test report**
   - 830-0102-aescab-ul9540-certificate
   - 830-0104 CN2508AE 001 signed_extsigned
2. **(Folder 3.1) UL 1973 certificates and full test reports**
   - 830-0103-aescab-ul1973-certificate
   - 830-0105-aescab-ul1973-report-CN25PFEM 001 All__Signed_extsigned
3. **(Folder 3.2) UL 9540A test reports (cell, module, unit, system)**

Supporting documentation:

- • UL 9540A Cell Level: 314Ah Cell Report – **830-0112**
- • UL 9540A Module Level: Great Power 1P52S Module Report – **830-0113**
- • UL 9540A Rack / Battery System Level: RACK Test Report – **830-0109**
- • UL 9540A Unit Level: AES Cabinet est Report – **830-0110**
- • UL 9540A Installation Level: AES Cabinet System Test Report (five-cabinet array) – **830-0114**

4. **(Folder 3.3) NFPA 68 venting report**
   - 830-0111 CAB-426-NFPA68 Test Report
   - 890-0006 Deflagration Vent VIGILEX ARC-VENT VL-SS Data Sheet
5. **(Folder 3.4) BMS functional safety test reports**
   - 830-0105-aescab-ul1973-report-CN25PFEM 001 All__Signed_extsigned
   - 890-0002 Great Power - BMS Software User Manual
6. **System drawings and schematics**

(Folder 3.4)

- 550-0279 - AES Cabinet schematics
- 890-0001 Great Power - SBCU Schematic diagram
- 890-0005 Auxiliary Power Supply Calculation Report

(Folder 3.6)

- 890-0008 AES Cab Wiring Diagrams
- 890-0009 Fire Protection System Operating Logic

7. **MSDS and environmental compliance documentation**

(Root folder)

- 805-0104-aes-cabinet-energy-storage
- 830-0102-aescab-ul9540-certificate

(Folder 3.1)

- 830-0105-aescab-ul1973-report-CN25PFEM 001 All__Signed_extsigned

8. **(Root folder) O&M, installation manuals, and emergency procedures**
   - **(Folder 3.3)** 805-0094-aes-cab-operation-maintenance
   - **(Folder 3.6)** 805-0104-aes-cabinet-energy-storage
9. **Performance and degradation datasets**
   - **(Root folder)** 890-0010 Great Power - UltraMagna418 - Degradation and RTE
10. **Additional resources**
    - **(Folder 3.3)** 805-0094-aes-cab-operation-maintenance
    - **(Folder 3.5)** 890-0003 Great Power - Chiller Manual

This package satisfies all NFPA 855 product-level documentation requirements and provides all necessary inputs for the Engineer of Record to develop the project HMA.