Battery Storage

U.S. Codes and Standards for Battery Energy Storage Systems

This document provides an overview of current codes and standards (C+S) applicable to U.S. installations of utility-scale battery energy storage systems. This overview highlights the most impactful documents and is not intended to be exhaustive. Many of these C+S mandate compliance with other standards not listed here, so the reader is cautioned not to use this document as a guideline for product compliance.

Codes

A variety of nationally and internationally recognized model codes apply to energy storage systems. The main fire and electrical codes are developed by the International Code Council (ICC) and the National Fire Protection Association (NFPA), which work in conjunction with expert organizations to develop standards and regulations through consensus processes approved by the American National Standards Institute. For these model codes to be enforceable, they must be adopted, in whole or in part, by states or local jurisdictions. This process generally results in a lag in adoption.

Below are the most relevant codes that apply to stationary energy storage systems:

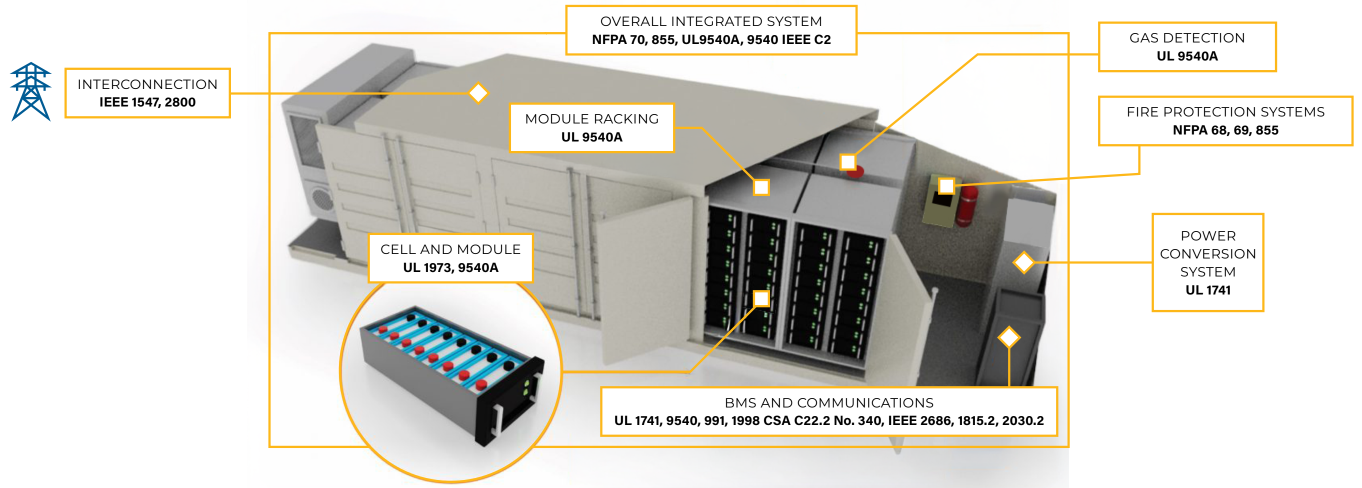
NFPA 1 *Fire Code.* Covers the hazards of fire and explosion, life safety and property protection, and safety of firefighters. Chapter 52 provides high-level requirements for energy storage, mandating compliance with NFPA 855 for detailed requirements, effectively elevating the latter to the status of a code.

International Fire Code (IFC). Similar scope to NFPA 1. In a change for 2027, ESS-specific sections of the IFC will contain high-level requirements only, mandating compliance with NFPA 855.

NFPA 70 *National Electrical Code (NEC).* Covers practical safeguarding of persons and property from hazards arising from the use of electricity. Since 2017, Article 706 has provided specific requirements for Energy Storage Systems, applying to all ESS over 1 kWh.

NFPA 855 *Standard for the Installation of Stationary Energy Storage Systems.* Provides minimum requirements for mitigating the hazards associated with energy storage systems. NFPA 855 requirements apply to the design, construction, installation, commissioning, operation, maintenance, and decommissioning of energy storage systems.

One method ACP is pursuing to bypass delays in fire-code adoption cycles is to advocate for NFPA 855 compliance as part of the permitting process, as exemplified by the ACP Model Ordinance for Utility-Scale Battery Energy Storage Systems.



This image is adapted from PNNL. While it shows a walk-in area that would result in it being treated as an indoor installation under NFPA 855, the intent is to show C+S applicability for outdoor installations only.

1 Compliance with NFPA 69 is mandatory, based on average vent gas concentration in enclosure (unless using an approved engineered explosion-control system)
2 Partial-volume deflagration evaluation to NFPA 68, based on local gas concentration
3 UL9540A to be revised later in 2025 to incorporate large-scale fire test (LSFT)
4 LSFT procedure similar to CSA/ANSI C800:25a

Qualification Standards

The relevant codes for energy storage systems require systems to comply with and be listed to **UL 9540**, *Energy Storage Systems and Equipment*, which presents a safety standard for energy storage systems and equipment intended for connection to a local utility grid or standalone application. This document applies to the complete system and in turn requires that the major components be qualified to their own standards, the most important of which are **UL 1741**, *Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources*, for the power conversion system and **UL 1973**, *Batteries for Use in Stationary and Motive Auxiliary Power Applications*, for the battery. Energy storage management systems and battery management systems (BMS) are also subject to qualification, and the main applicable standards are **UL 991**, *Standard for Tests for Safety-Related Controls Employing Solid-State Devices*, and **UL 1998**, *Software in Programmable Components*. Additional documents relating to BMS are CSA/ANSI C22.2 No. 340:23, Battery Management Systems, and IEEE Std 2686, *Recommended Practice for Battery Management Systems in Stationary Energy Storage Applications*.

Performance Standards

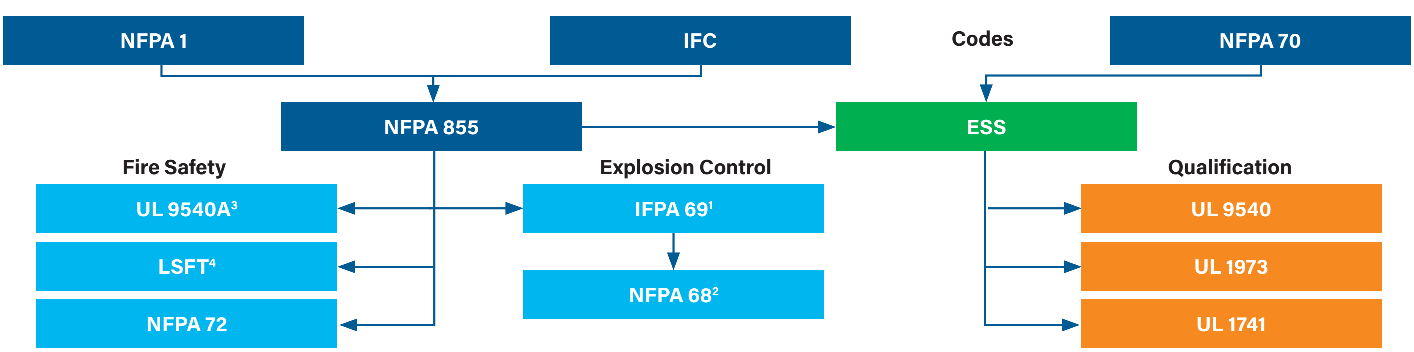
One of the most important performance standards is **UL 9540A**, *Standard for Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems*, covering fire and propagation testing. This test method (there are no pass/fail criteria) involves sequential testing at the cell, module, unit (typically, a representative battery rack), and installation levels. All lithium-ion systems are subject to cell-, module-, and unit-level tests. The installation-level test is currently being modified to conform to the requirement for large-scale fire testing in the 2026 edition of NFPA 855, with a new edition of UL 9540A to be published later in 2025. The LSFT is already included in **CSA/ANSI C800:25**, *Testing protocol for energy storage system reliability and quality assurance program*.

UL 9540A testing, including the LSFT, is required if group (unit) energy exceeds 50 kWh or separation between groups is less than 3 ft (0.9 m), as called out in NFPA 855. These deviations from the standard are subject to approval by the authority having jurisdiction (AHJ).

The 2026 edition of NFPA 855 requires that ESS have an explosion control and prevention system meeting **NFPA 69**, *Standard on Explosion Prevention Systems*. NFPA 69 compliance requires that the concentration of flammable gas be maintained below 25% of the lower flammable limit (LFL), which is typically achieved using a combustible concentration reduction system (emergency ventilation). There is an exception allowed for approved engineered explosion-control systems that meet certain requirements. NFPA 69 compliance is based on the average concentration of gas within an enclosure; NFPA 855 also requires a deflagration study to be performed according to **NFPA 68**, *Standard on Explosion Protection by Deflagration Venting*, based on local gas concentration at the point of cell venting. Previous editions of NFPA 855 gave manufacturers the option of complying with either NFPA 68 or NFPA 69, but it is now clear that an NFPA 68-only approach can create a hazard for first responders if vent gas accumulates above the upper flammable limit.

Interconnection performance standards have been published by IEEE, with **IEEE Std 2800**, *Standard for Interconnection and Interoperability of Inverter-Based Resources (IBRs) Interconnecting with Associated Transmission Electric Power Systems*, applying to ESS connected at transmission and sub-transmission levels, and **IEEE Std 1547**, *Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces*, for distribution-connected resources. IEEE has also published an ESS-specific guide, **IEEE Std 1547.9**, *Guide for Using IEEE Std 1547 for Interconnection of Energy Storage Distributed Energy Resources with Electric Power Systems*.

The graphic below provides a flow chart on how these relevant codes and standards feed into the greater ESS ecosystem.



Other Notable Documents

In April 2025, FM Global published an interim revision to its **Data Sheet 5-33**, *Lithium-Ion Battery Energy Storage Systems*. The revision addresses the earlier prescriptive minimum spacing and separation distances for ESS enclosures and brings them into line with the 2026 edition of NFPA 855 and the LSFT.

The SunSpec Alliance has established information models to assist in the integration of energy storage and other DER. The **SunSpec DER model** standardizes DER communication with utility SCADA (Supervisory Control and Data Acquisition) protocol and is to be published as **IEEE Std 1815.2**, *Standard Profile for Communications with Distributed Energy Resources (DERs) using IEEE Std 1815 [Distributed Network Protocol (DNP3)]*. Closely related is **IEEE Std 2030.5**, *Standard for Smart Energy Profile Application Protocol*. The **SunSpec Energy Storage models** are based on Modbus protocol and are important for ease of ESS integration. Models for lithium-ion systems are complete, while those for other technologies are still under development. Another group working with SunSpec is the Modular Energy System Architecture (MESA) Standards Alliance.

For companies interested in second-life EV batteries in ESS applications, **UL 1974** [B17] covers the *process* of sorting and grading battery packs for repurposing, but not their *qualification*. The document does not cover the process for remanufacturing/refurbishing/rebuilding batteries, where repair or replacement of parts may be needed. NFPA 855 mandates that repurposing be carried out by a UL 1974-compliant company and also requires that reused equipment, such as second-life batteries, be 'reconditioned, tested, and placed in good and proper working condition and approved.' Approval would involve listing systems to UL 9540, which necessarily includes qualification of the battery to UL 1973. Since each integrator of such systems would most likely replace the vehicle BMS with one more suitable for ESS and would probably have to perform UL 9540A testing and the LSFT, achieving the necessary codes and standards compliance could represent a significant financial burden.

Photo credit: Recurrent Energy