

White Paper

UL 9540 Second Edition: Understanding the Impacts of Requirement Changes



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A significant effort has been made to address energy storage system safety.

Over the past several years, a significant effort has been made to address energy storage system (ESS) safety, especially those systems that use batteries as their source of energy. New technologies are now widely deployed in an already established infrastructure. While innovative, these technologies do not come with a long-standing history of use in our current infrastructure. This can cause concern from regulators, fire marshals, electrical inspectors, building owners and other industry stakeholders about the safety of these systems and how to best integrate them into facilities.

To address these concerns, development of energy storage product safety and installation standards, as well as building code updates, have been ongoing. This work culminated in the publication of UL 9540, the Standard for Safety for Energy Storage Systems and Equipment, to evaluate the safety of ESS.

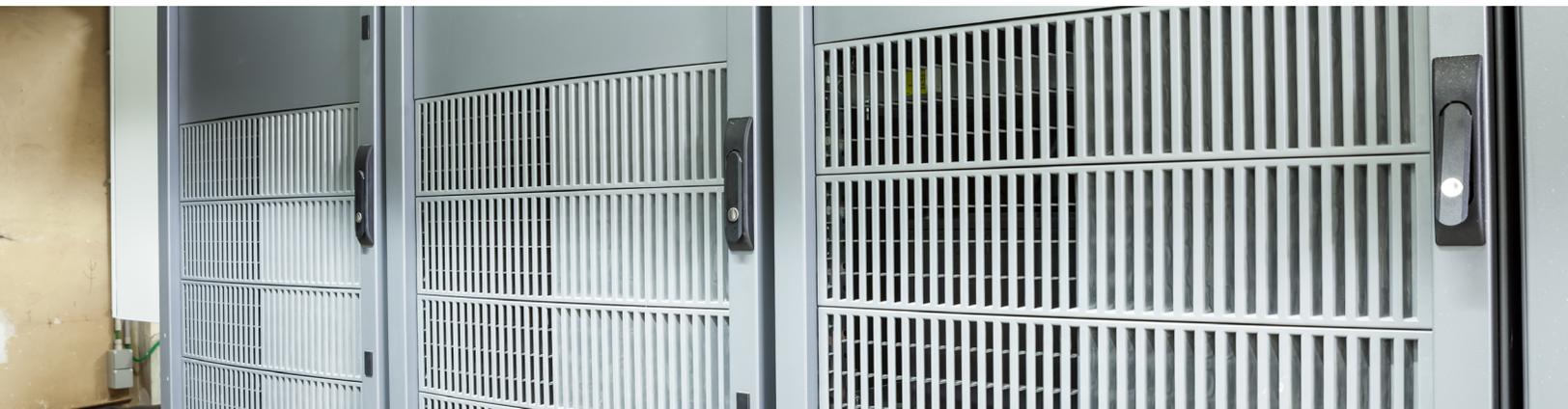
The recent publication of the National Fire Protection Association (NFPA) 855 standard for energy storage system installation; the publication of Article 706 of NFPA 70; updates to Article 480 of the NFPA 70; updates to NFPA 1 and International Code Council's International Fire Codes (ICC IFC); updates to statewide ESS installation codes and permitting documents, such as the California Fire Code; and the New York Battery Energy Storage System Guidebook all have requirements for the safety certification of ESS. UL 9540 is the Standard used to certify these energy storage systems.

On Feb. 27, 2020, the second edition of ANSI/CAN/UL 9540, was published. This newest edition reflects the latest American National Standards Institute (ANSI) and Standards Council of Canada (SCC) approval dates and incorporates the proposals dated June 28, 2019, Oct. 18, 2019, and Dec. 20, 2019.

In the rapidly growing ESS market, key stakeholders may not have sufficient time or resources to review every proposal for changes and understand how the proposed changes could impact their ESS products or their business. UL has created this document to highlight and provide clear insight to some of the major changes made to the Standard and how those changes may impact certifications going forward.

Two types of changes were made to the Standard: revised requirements and new requirements. Revised requirements, which represent a modification to an existing requirement, may happen for a number of reasons. They may provide clarification of the requirement, harmonization with another standard or a change to the requirement to match industry norms. New requirements represent requirements that have been added to the Standard and are intended to address hazards, concerns, new applications or features of ESS that were not identified in previous editions of the Standard.

The second edition of UL 9540 incorporates both revised requirements and new requirements, all of which will impact multiple stakeholders.



Manufacturers

For some manufacturers, changes to the Standard will have little to no impact on the design and performance criteria already established for the ESS they manufacture. For others, some of the requirement changes in scope and construction will have a larger impact as they seek certification to the latest requirements.

Scope

One of the most significant revisions to UL 9540 Second Edition is that the Standard now identifies applications for which an ESS may be used and has aligned the listings and approvals to the correlating changes and updates to installation codes. The scope of the Standard now restricts the maximum allowable energy capacity for some types of ESS based upon their intended use. The addition to the scope mirrors the provisions found in the 2020 version of NFPA 855, the 2018 International Fire Code and the 2018 International Residential Codes:

The maximum energy capacity of individual electrochemical ESS shall not exceed the following values:

- a) Outdoor wall mounted electrochemical ESS shall not exceed 20 kWh (72 MJ);
- b) Residential use electrochemical ESS shall not exceed 20 kWh (72 MJ); and
- c) Non-residential use electrochemical ESS shall not exceed 50 kWh (180 MJ), except as allowed in based on specific evaluation criteria as noted in the Standard.

Systems in excess of these values are allowed to be Listed and approved if the electrochemical ESS meets the required performance criteria in accordance with UL 9540A, the Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems.

Listed or approved electrochemical ESS will be required to identify the UL 9540A report if the anticipated installation exceeds the capacity limits. The instructions for the ESS shall include the UL 9540A report identification, the testing organization and date.

ESS using lead-acid or nickel-cadmium batteries that fall within the scope of UL 1778, the Standard for Uninterruptible Power Supply Equipment, and only serve as an uninterruptible power system (UPS) are outside the scope of UL 9540. However, the use of other electrochemical sources such as lithium-ion or capacitors in a UPS application may fall under the scope of UL 9540 as UL 9540 has been revised to consider applications that go beyond the scope of UL 1778.

ESS have traditionally been considered stationary or fixed applications. Section 4.5 of NFPA 855, Standard for the Installation of Stationary Energy Storage Systems, has been revised to now address mobile energy storage systems (MESS) that can be temporarily sited, used, and then taken away similarly to the way gas or electric powered generators are used now. UL 9540 Second Edition has been revised to certify and approve those ESS that are not portable but have a means to be moved. An example of this application is an ESS that is mounted on a wheeled trailer or skid and then taken to different sites for providing power on a temporary basis.

The changes to the scope of UL 9540 Second Edition closely align with the numerous applications of ESS and the codes that are being revised to address them.

Construction

To align with the certain provisions of the International Fire Codes in addition to some state and local codes, UL 9540 Second Edition has revised requirements for enclosures of electrochemical ESS.

Polymeric materials employed for enclosures, or parts of enclosures for ESS shall comply with other sections noted in the Standard and the enclosure requirements outlined in UL 746C, Path III of the Enclosure Requirements, or CAN/CSA-C22.2 No. 0.17.

Exception No. 1: Energy storage systems intended for outdoor installation shall employ an enclosure of non-combustible materials.

Exception No. 2: Electrochemical ESS shall employ an enclosure of non-combustible materials.

The exceptions indicate that enclosures for electrochemical energy storage systems shall be made of noncombustible materials. ESS, regardless of type, installed outdoors shall also be made of non-combustible materials. These exceptions essentially require these systems to use metallic enclosures.

Safety analysis and control systems

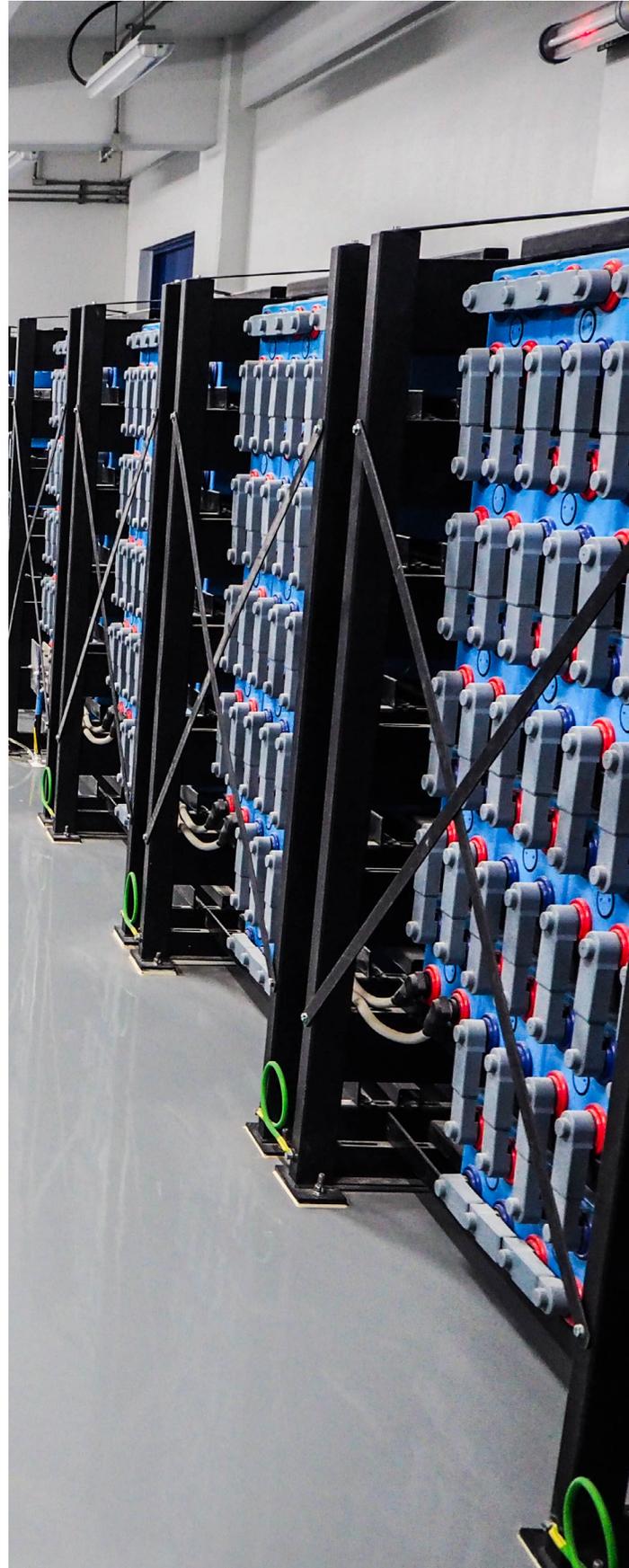
In some cases, the catastrophic failure of ESS can be directly tied to the inability of electronics and/or safety control system software to properly protect the ESS. The second edition has been revised to ensure manufacturers use minimum performance levels when determining the appropriate safety levels for the ESS. UL 9540 Second Edition revised the requirements to specify minimum levels as follows.

Electrical and electronic controls of the ESS that are determined to be critical for safety shall comply with an appropriate safety standard for the control and used within their ratings.

Electronics and software controls determined to be critical for safety are to be tested to verify electromagnetic immunity in accordance with other sections of the Standard if this testing is not part of the functional safety standard requirements, and shall be evaluated for functional safety to one of the following sets of standards and safety ratings as applicable to the system:

- a. UL 991 and UL 1998;
- b. CSA C22.2 No. 0.8 (Software Class B requirements for software controls);
- c. The Annex for Requirements for Electronic Controls, Annex H of UL 60730-1 or CAN/CSA-E60730-1 (Software Class B requirements for software controls);
- d. IEC 61508 (all parts) (minimum of Safety Integrity Level (SIL) "2" requirements for active protective devices with software controls);
- e. ISO 13849-1 and ISO 13849-2 (minimum of Performance Level (PL) "c" requirements for active protective devices with software controls); or
- f. ISO 26262 (all parts) (minimum Automotive Safety Integrity Level (ASIL) "C" requirements for active protective devices with software controls).

UL 9540 Second Edition has been revised to require a minimum performance or equivalent level for programmable controls and has additional standards that may be used.



Production, markings and instructions

Minor changes to the markings, instructions and requirements for production testing have been made to UL 9540 Second Edition to support each of the construction and performance requirement updates in the Standard.

Code authorities and manufacturers

UL 9540 Second Edition has been updated to support fire code and building code changes particularly as it pertains to large-scale fire testing. The listings and approvals of ESS are not only addressing fire, shock and mechanical hazards associated with ESS, but they are now also specifically addressing installation concerns like energy limitations, fire suppression and spacing.

Large-scale fire testing

Both fire codes and building codes have placed strict limitations on the size and quantity of ESS as well as separation distances between systems and between systems and structures that can be installed in mixed-use occupancies. The limitations on size are based on energy limits and are technology and chemistry dependent. Large-scale fire testing can be used to reduce separation distances, increase size (energy) of systems and show effectiveness of fire suppression systems. UL 9540 Second Edition has been revised to include large-scale fire testing requirements to meet criteria within the codes.

Electrochemical type ESS, including but not limited to capacitor and battery ESS, shall be subjected to the large scale fire testing in accordance with UL 9540A as follows in (a) – (g). See Appendix E for guidance on code limits related to separation distances and energy capacity.

- a. Systems with increased energy capacities as required in codes and standards;
- b. Indoor systems with decreased separation distances to adjacent ESS units, doors and windows, or to combustibles, non-combustibles, or limited combustibles. This includes building construction components (e.g., wall and ceilings) or any materials in the vicinity of the ESS.
- c. Outdoor systems with decreased separation distances to adjacent units and to exposures;
- d. Outdoor wall mounted systems with reduced separation distances;
- e. Indoor wall mounted systems;
- f. Systems for installation in residential dwellings (where permitted); and
- g. When an explosion analysis is required to confirm the installations location is safe

The new edition of UL 9540 aligns with the language, technologies and applications being added to code requirements that manufacturers, code authorities and other key stakeholders should be made aware of.

Code authorities and manufacturers alike should expect a supporting UL 9540A large-scale fire test report summary to accompany each listed or approved ESS that has been required to conduct large scale fire testing, along with the installation and commissioning instructions

Changes made to the sections regarding production testing, markings and instructions are prescriptive and should be adhered to as applicable. The need to supplement the instruction manual with a large-scale fire testing report summary will be the most impactful change to UL 9540 Second Edition.



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