

Battery Energy Storage System Incidents and Safety: Underwriters Laboratories Standards Overview

The world is becoming increasingly more dependent on batteries and energy storage systems, and safety standards and codes are critical to safely develop and deploy these products. Through collaboration with stakeholders, Underwriters Laboratories develops safety standards to ensure the safety of these products in the field. Industry collaboration is key for the acceptance and use of these safety standards in the global marketplace. These standards will continue to evolve as the battery and energy storage industries continue to innovate. This paper was developed by Underwriters Laboratories to provide an overview of the Standards development process and information regarding the key UL Standards for batteries and energy storage along with providing clarification on a DNV GL report dated July 18, 2020, analyzing a battery energy storage incident.

Please see the following links for more information on:

- [Executive Summary of the Underwriters Laboratories and UL Responses on Battery Energy Storage System Incidents and Safety](#)
- [Battery Energy Storage System Incidents and Safety: A Technical Analysis by UL](#)

Underwriters Laboratories Standards Development

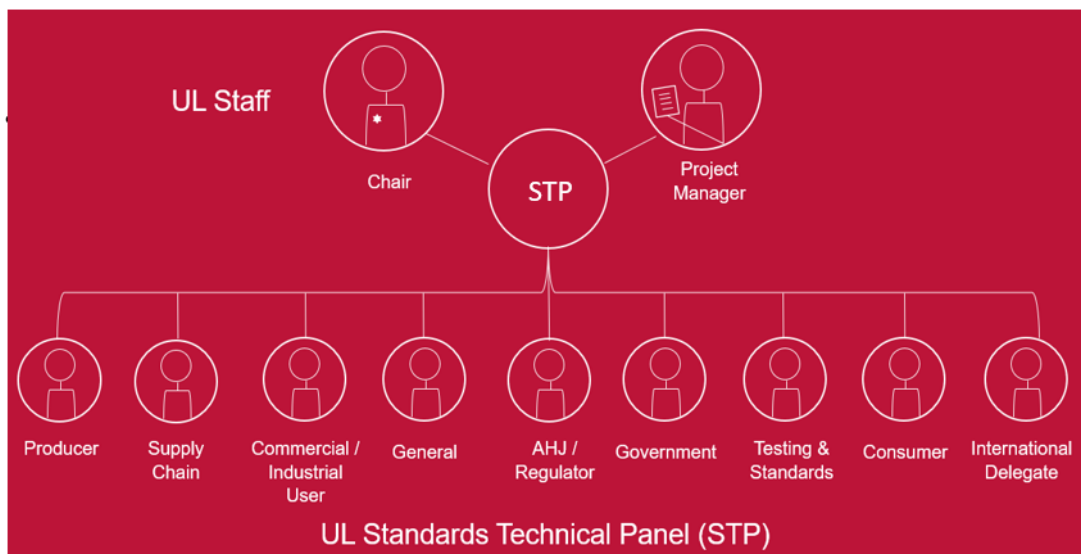
Underwriters Laboratories has nearly 120 years of experience in standards development with dedicated professionals around the world. Underwriters Laboratories has published over 1700 UL Standards and other documents with the collaboration of more than 4000 volunteer participants. UL Standards are research and science-based standards that are developed through a standards development process that is accredited by both the American National Standards Institute (ANSI) and the Standards Council of Canada (SCC).

UL Standards are consensus standards developed and maintained through Standards Technical Panels (STPs). The STPs serve as the consensus bodies for developing, reviewing and maintaining UL Standards. STPs vote on proposals for UL Standards, determining the content that will be published.

STPs are comprised of a balanced group of individuals representing any of the following nine interest categories as shown in Figure 1. Note that not every interest category is required to have representation on an STP.



Figure 1
Structure of STP and Interest Categories



Anyone interested in applying to a STP can fill out the online [STP Application](#). STPs are required to maintain a balance of these interest categories, in which the goal is to have no single interest category greater than 1/3 of the membership of the STP. A company/organization is allowed one voting member per STP. Membership may be limited due to balance considerations. Those who are not able to be accepted due to balance limitations are still encouraged and notified of other ways to participate until a time when their participation will not bring the STP membership out of the balance required by our accreditations.

There are several other ways in which an individual can take an active role in the Underwriters Laboratories Standards development process without being an STP member. The process is open and participation is encouraged by all who are interested. Via our online platform, the Collaborative Standards Development System (CSDS.ul.com), anyone can submit proposals to create new UL Standards or revise existing UL Standards. They can also review and comment on proposals, request to attend an STP meeting, and volunteer to participate in a task group. However, only STP members can vote on proposals. For more detailed information, visit [Ways to Participate](#).

Underwriters Laboratories strives to keep UL Standards up to date to reflect current technology and safety concerns. As standards are “living documents”, proposals to UL Standards can be submitted and entertained at any time. New STPs can be established to develop new standards to address new products or technologies.

STPs for Energy Storage and Batteries

In 2015, STP 9540 was established as the consensus body responsible for UL 9540, the Standard for Safety for Energy Storage Systems and Equipment. It was initially comprised of 28 voting members.



In 2018, UL 9540A, the Standard for Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems was added under the responsibility of STP 9540.

There has been a tremendous amount of industry support for and interest in this STP from around the world. STP 9540 is currently one of the largest STPs with a total of 97 voting members. The breakdown of the interest categories for STP 9540 as of January 2021 is provided in Table 1. The current list of the STP members is provided in the [STP 9540 Roster](#). Anyone interested in applying to STP 9540 can fill out the online [UL STP Application](#).

**Table 1
STP 9450 Membership Balance**

	AHJ	Commercial / Industrial User	Consumer	General	Government	International Delegate	Producer	Supply Chain	Testing and Standards
Number of voting members	10	7	0	22	4	1	32	13	8
% of STP	10	7	0	23	4	1	33	13	8
Total Number of Voting Members: 97									

In 2011, STP 1973 was established as the consensus body responsible for UL 1973, the Standard for Safety for Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications and UL 1989, Standard for Safety for Standby Batteries. STP 1973 was initially comprised of 10 voting members and has since grown to a total of 42 voting members. The current breakdown of the interest categories for STP 1973 as of September 2020 is provided in Table 2. The current list of the STP members is provided in the [STP 1973 Roster](#). Anyone interested in applying to STP 1973 can fill out the on-line [STP Application](#).

**Table 2
STP 1973 Membership Balance**

	AHJ	Commercial / Industrial User	Consumer	General	Government	International Delegate	Producer	Supply Chain	Testing and Standards
Number of voting members	5	5	0	8	0	0	14	3	7
% of STP	12	12	0	19	0	0	33	7	17
Total Number of Voting Members: 42									

The DNV GL report states that STP 9540 did not include LG or AES. For clarification, LG Chem LTD applied and was accepted as a voting member in February 2019. In addition to STP 9540, LG Chem LTD was added as a voting member to STP 1973 in January 2018. Underwriters Laboratories has no record of AES submitting an STP Application to either STP 9540 or STP 1973. However, AES is encouraged to participate in Underwriters Laboratories Standards development process and if interested, apply to these STPs.



Evolution of UL Safety Standards for Energy Storage and Batteries

Underwriters Laboratories is the recognized leader in the development of standards related to batteries and energy storage, having published the first battery standard for Lithium Batteries, UL 1642 in October 1985. The First Issue of the Outline of Investigation for Batteries for Use in Light Electric Rail (LER), UL 1973, was published October 6, 2010, followed by the publication of the First and Second Editions of the consensus standard UL 1973, Standard for Safety for Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications, on February 15, 2013, and February 7, 2018, respectively.

The First Issue of the Outline of Investigation for Energy Storage Systems and Equipment, UL 9540, was published June 30, 2014, followed by the publication of the First and Second Editions of the consensus standard, UL 9540, Standard for Safety for Energy Storage Systems and Equipment, on November 21, 2016, and February 27, 2020, respectively. UL 9540 references UL 1973 for the battery requirements, because UL 9540 covers multiple types of energy storage.

Underwriters Laboratories also led the development of the first large scale fire test method for battery energy storage systems which resulted in the publication of UL 9540A, Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems, which was initially published November 2, 2017. UL 9540A was developed by the UL Fire Research staff with input from industry, regulators and fire experts as well as other subject matter experts. The most recent Fourth Edition of the consensus standard UL 9540A, Standard for Safety for Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems, was published on November 12, 2019.

It is important to note that UL 1973, UL 9540, and UL 9540A are all consensus-based standards. The current editions of these standards are also designated as ANSI/CAN standards, which means they are the National Standards for both the United States and Canada and were developed in accordance with the ANSI and SCC procedures.

As stated previously, the Underwriters Laboratories standards development process is open so anyone can participate. STP membership is not required to participate. Proposals to revise a UL Standard can be submitted at any time by anyone and will be sent out to the STP and all interested parties for review and comment. To date, the UL Standards division has not received any proposals to revise UL 1973, UL 9540, and/or UL 9540A from either AES, LG, or DNV GL. All interested parties are encouraged to submit proposals to revise these UL Standards if they feel there are deficiencies. Collaboration and participation play a vital role in further developing and maintaining these UL Standards through Underwriters Laboratories standards development process.



An overview of the development timeline for the key UL safety Standards is provided in Table 3.

Table 3
Overview of UL 1973, 9540, and UL 9540A - Timeline

UL Standard Number (Accreditations)	Title	Date of Publication	Edition No.
1973	Outline of Investigation for Batteries for Use in Light Electric Rail (LER) Applications and Stationary Applications	October 6, 2010	1
1973 (ANSI)	Standard for Safety for Batteries for Use in Light Electric Rail (LER) Applications and Stationary Applications	February 15, 2013 (additional revisions published June 1, 2016)	1
1973 (ANSI/CAN)	Standard for Safety for Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications	February 7, 2018	2
9540	Outline of Investigation for Energy Storage Systems and Equipment	June 30, 2014	1
9540 (ANSI/CAN)	Standard for Safety for Energy Storage Systems and Equipment	November 21, 2016	1
9540 (ANSI/CAN)	Standard for Safety for Energy Storage Systems and Equipment	February 27, 2020	2
9540A	Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems	November 2, 2017	1
9540A	Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems	January 31, 2018	2
9540A	Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems	June 15, 2018	3
9540A (ANSI/CAN)	Standard for Safety for Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems	November 12, 2019	4



Conclusion

The battery and energy storage system industries are very dynamic with many new developments underway and there have been, and continue to be, multiple revisions of the UL Standards affecting these industries. UL Standards will continue to evolve as technology advances, safety concerns are identified, and additional research, testing and data become available. Collaboration and participation in the development of these documents is critical to the effectiveness, acceptance and sustainability of UL Standards in the global marketplace.

The Underwriters Laboratories standards development process is open, and anyone interested is encouraged to participate and take an active role in standards development. Anyone can propose changes to UL Standards at any time. Any complete proposal submitted will be sent to the STP for comment, vote, and public review. Anyone can apply to become an STP member, but STP membership is not required to participate in the Underwriters Laboratories Standards development process. For more information, visit [Ways to Participate](#). Working together, we can help make a safer, more secure and sustainable world.

About Underwriters Laboratories

Underwriters Laboratories is a nonprofit organization dedicated to advancing the UL public safety mission through the discovery and application of scientific knowledge. We conduct rigorous independent research and analyze safety data, convene experts worldwide to address risks, share knowledge through safety education and public outreach initiatives, and develop standards to guide safe commercialization of evolving technologies. We foster communities of safety, from grassroots initiatives for neighborhoods to summits of world leaders. Our organization employs collaborative and scientific approaches with partners and stakeholders to drive innovation and progress toward improving safety, security, and sustainability, ultimately enhancing societal well-being. To learn more, visit [UL.org](#).

