UL and Energy Safety Standards in Support of International Trade

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International Standards
Underwriters Laboratories Inc.
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Agenda

UL Company Overview
UL Standards Development
Energy Storage and Energy Standards
Safety and Trade
Agenda

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Energy Storage and Energy Standards
Safety and Trade
It all started...
Columbian Exposition in 1893
WORKING FOR
A SAFER WORLD
SINCE
1894

WILLIAM HENRY MERRILL
THE PRINCIPLES AND VALUES ESTABLISHED BY OUR FOUNDER

DRIVE EVERY DECISION WE MAKE

- To promote safe living and working environments for people by the application of safety science and hazard-based safety engineering
- To support the production and use of products which are physically and environmentally safe and to apply our efforts to prevent or reduce loss of life and property
- To advance safety science through research and investigation
UL Today

- Global Safety Science Company
- 124 Years
- 143 Countries
- 1600+ Safety Standards
- UL Reaches > 1 billion consumers a year with safety messages
- UL safety marks on >22 billion products annually
- A leader in safety research
OUR PEOPLE

North America
4,000+ People

Africa, Europe, Latin America, Middle East
2,000+ People

Asia Pacific
4,000+ People

12,000+
ASSOCIATES

180+
FACILITIES
We pursue our mission through:

- Research & Development
- Standards Development
- Safety Education
- Hazard Based Safety Engineering
- Product Assessment to Standards
- Anticounterfeiting Programs
Agenda

UL Company Overview
UL Standards Development
Energy Storage and Energy Standards
Safety and Trade
UL Standards Development Process
Overview

- Balance
- No Domination
- Openness
- Balloting and Consensus
- Comment Resolution
- Appeals and Publication
What is the process for writing Standards?

- Identifying the Need
- Initiating the Project
- Forming a Working Group
- Drafting the Standard
- Balloting the Standard
- Gaining Final Approval
- Publishing the Standard
- Maintaining the Standard
Consensus Based Standards

ANSI and SCC accredited SDOs utilize standards committees that maintain a balance of members in various interest classifications so that no one group dominates.

Interest classifications include:
• Users
• Manufacturers
• Installers
• Supply Chain
• Insurance Industry
• Testing laboratories
• Government regulatory agencies.
UL and International Standards

UL contributes to ISO content. UL adopts ISO Standards.

UL is accredited to develop national standards for the US and Canada.

UL contributes to IEC content. UL adopts IEC standards.
UL and International Standards

UL standards have been adopted by national standards bodies around the world.

UL has published trinational standards for the US, Canada and Mexico.
Agenda

UL Company Overview
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Energy Storage and Energy Standards
Safety and Trade
Applications for Energy Storage and Growing Importance

Some Utility Applications

- Grid support
- Renewable energy support
- Energy reliability & operational resiliency
- Electric supply support
- Peak demand
- Ancillary

Some Commercial and Residential Applications

- Renewable energy support
- Operational resiliency
- Peak demand
- Power quality
- EV charging support
Supporting Renewables
Reliability & Resiliency
Enabling the Smart Grid
## Energy Storage System Risks

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>Electric Shock</th>
<th>Arc Flash</th>
<th>Fires</th>
<th>Explosions</th>
<th>Burns</th>
</tr>
</thead>
<tbody>
<tr>
<td>As an energy source, an electric energy storage system may represent a potential energy hazard, which could lead to:</td>
<td>Depending upon technology, etc., systems may be a potential source of exposure to harmful materials, which could result in:</td>
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<td></td>
<td>Concentrations of hazardous gases</td>
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<td>Hazardous liquid spills</td>
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<td>Exposure to hazardous solids</td>
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<td></td>
<td>Slip or other physical hazard</td>
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<td></td>
<td></td>
<td>Hazardous Moving Parts or Pinch Points</td>
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<td></td>
<td>Burns</td>
</tr>
</tbody>
</table>

There may be potential for physical hazards associated with the EESS such as:

- Burns
- Slip or other physical hazard
- Hazardous Moving Parts or Pinch Points
- Exposure to hazardous solids
- Hazardous liquid spills
- Concentrations of hazardous gases
History of Battery Safety Standards Development

UL has a long history of evaluating the safety of batteries dating back to the early 1980s, and which led UL to publish one of the first lithium battery safety standards, UL 1642, Lithium Batteries, in 1985.

<table>
<thead>
<tr>
<th>Standard No.</th>
<th>Title</th>
<th>Year Published</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL 1642</td>
<td>Lithium-ion Batteries</td>
<td>1985</td>
</tr>
<tr>
<td>UL 1973</td>
<td>Batteries for Light Electric Rail (LER) and Stationary Applications</td>
<td>2011/2013</td>
</tr>
<tr>
<td>UL 1989</td>
<td>Standby Batteries</td>
<td>1992</td>
</tr>
<tr>
<td>UL 1974</td>
<td>Evaluation for Repurposing Batteries</td>
<td>In Development</td>
</tr>
<tr>
<td>UL 2054</td>
<td>Commercial and Household Batteries</td>
<td>1997</td>
</tr>
<tr>
<td>UL 2271</td>
<td>Batteries for Use in Light Electric Vehicle (LEV) Applications</td>
<td>2013</td>
</tr>
<tr>
<td>UL 2272</td>
<td>Electrical Systems for Personal E-Mobility Devices</td>
<td>2016</td>
</tr>
<tr>
<td>UL 2580</td>
<td>Batteries for Use in Electric Vehicles</td>
<td>2010/2011</td>
</tr>
<tr>
<td>UL 2595</td>
<td>General Requirements for Battery-Powered Appliances</td>
<td>2013</td>
</tr>
<tr>
<td>UL 2743</td>
<td>Portable Power Packs</td>
<td>2014/2016</td>
</tr>
<tr>
<td>UL 3030</td>
<td>Unmanned Aerial Vehicles (UAVs)</td>
<td>2016-2017</td>
</tr>
</tbody>
</table>
UL 9540

Energy Storage Systems and Equipment

- Safety Standard
- Includes energy storage systems that are
  - Standalone to provide energy for local loads;
  - In parallel with an electric power system, electric utility grid; or
  - Able to perform multiple operational modes.
- For use in utility-interactive applications in compliance with IEEE 1547 and IEEE 1547.1 or
- Other applications intended to provide grid support functionality,
- May include balance of plant and other ancillary equipment of the system
Scope -
- Safety Standard
- Energy Storage Systems intended for connection to a local or utility grid or for a standby application
- Electrochemical, Chemical, Mechanical, and Thermal
- ANSI/CAN UL 9540: Bi-national (USA & Canada)

Energy Storage System (ESS)
- stores energy in some form and provides electrical energy for use when needed
UL 9540

Types of Energy Storage Technologies within Scope of UL 9540
Construction Items

- Non-Metallic Materials
- Metallic Parts Resistance to Corrosion
- Enclosures and Guarding of Hazardous Parts
- General Electrical Safety and Walk-in Systems
- Wiring and Electrical Supply Connections
- General Electrical Service Equipment
- Electrical Spacings and Separation of Circuits
- Insulation Levels and Protective Grounding
- Safety Analysis and Control Systems

Construction Items

- Communication Systems
- Remote Controls
- Heating and Cooling Systems
- Piping Systems, Pressure Vessels, Fuel and Other Fluid Supply Connections and Controls
- Containment of Moving Parts
- Hazardous Fluid Containment
- Combustible Concentrations
- Fire Detection and Suppression
- Utility Grid Interaction
- Energy Storage System Technologies
UL 9540

General Electrical Safety and Walk-in Systems

• Walk-in systems
  • Safe egress and Exit signs
  • Sufficient work space per NFPA 70
  • Use of guarding, etc. to prevent access to hazardous voltage parts
  • Ventilation per ASHRAE 62.1
  • Lighting provided within enclosed spaces and per NEC
  • Arc flash criteria per NFPA 70E

Safety Analysis and Control Systems

• Safety analysis (e.g. FMEA) of system required
  • Safety components
    • Comply with component safety standards
    • Electronic and software evaluated to functional safety standards
  • Remote controls
    • Remote controls cannot override local controls
    • System have means to disconnect from remote control
UL 9540

- The level and type of fire detection and suppression dependent upon
  - size,
  - Technology,
  - location of installation
  - local building and fire codes or utility requirements
  - Fire Risk Assessment
  - NFPA 550 & NFPA 551 guidelines

- UL 1741 including its Supplement SA, or the Standard for General Use Power Supplies, C22.2 No. 107.1 including
  - IEEE 1547, 1547.1, 1547A, 1547.1A
  - NERC PRC-024-1 as applicable

Fire Detection and Suppression

Utility Grid Interaction
UL 9540

Utility Grid Interaction

- Safety of inverters, converters, charge controllers, and interconnection system equipment (ISE) intended for use in stand-alone (not grid-connected) or utility-interactive (grid-connected) power systems.
- Used in conjunction with IEEE 1547 and IEEE 1547.1

UL 1741, Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources

- intended to validate compliance with grid interactive functions which are not covered in IEEE 1547-2003 for “grid support utility interactive inverter/converters”.

UL 1741, SA – Supplement for Grid Support Utility Interactive Inverters and Converters
UL 9540

• Technology specific criteria of UL 9540:
  • Electrochemical
  • Chemical
    • ANSI CSA FC1
    • UL 2200, CSA C22.2 No. 100
    • Parts suitable for chemical service (e.g. hydrogen), strength and leakage tests
  • Mechanical
    • Containment of moving parts tests
    • Strength and leakage tests
  • Thermal
    • Strength and leakage tests

Energy Storage System Technologies
• Output and input current (maximum) in Amps;
• Output and input voltage (maximum) in Volts;
• Output and input power (maximum) in Volts;
• Energy output in Wh (maximum);
• Auxiliary output and input voltage (V), current (A) and frequency (Hz) (if applicable);
• Number of phases (for input and output);
• Frequency in Hz;
• Duty cycle (if applicable);
• Maximum short circuit current in Amps;
• Ambient temperature range in °C or °F;
• Special environmental ratings and limitations as applicable (e.g. seismic, indoor/outdoor only, etc.);
• Weight (maximum) in lbs or kg, etc.; and
• Maximum dimensions for height, width, and length (installation instructions)
• Date of manufacture (does not need to be on nameplate)
UL 9540

Markings and Signage

WARNING: Hazardous Voltage Circuits

WARNING: To Reduce the Risk of Injury, read all instructions

Arc Flash Warnings

Restricted Access Markings

Enclosure Ratings (Seismic, IP or NEMA enclosure ratings, installation limitations, etc.)

Code Markings
- NFPA 70 (NEC)
- ICC IFC, NFPA 1
- NFPA 855 (TBD)
UL 9540

Installation Instructions

Maintenance Instructions

Operating Instructions
UL 9540

UL 9540 Tests

 Mechanical

 Electrical

 Environmental

UL 9540 Tests are divided into 3 categories
**UL 9540**

**Electrical**
- Normal Operations Test
- Dielectric Voltage Withstand Test
- Impulse Test
- Equipment Grounding and Bonding Test

**Mechanical**
- Containment of Moving Parts
- Over Speed Qualification Test
- Faulted Securement Qualification Test
- Leakage & Strength Tests

**Environmental**
- Outdoors installations subject to moisture exposure
- Outdoor installation near marine environments
- Installation in seismic environments

**Production Tests**
- Dielectric Voltage Withstand
- Grounding and Bonding System Check
- Maximum Abnormal Operating Speed
Case Study – A Mini-Energy System – HOVERBOARDS
December, 2015: Hoverboard Fires Gain Media Attention

Hoverboard fires, injuries soar amid safety probe
CBS News - Dec 14, 2015
The number of injuries and fires associated with hoverboards has spiked 25 percent in recent days as U.S. safety officials try to determine what is causing one of...

Girl’s hoverboard Christmas gift catches fire at Brentwood home; No ...
abc7news.com - Dec 15, 2015
The Real Reason Hoverboards Are Bursting Into Flames
In-Depth - Daily Beast - Dec 16, 2015
Hoverboard explodes, bursts into flames at East Bay home
In-Depth - San Jose Mercury News - Dec 15, 2015

Hoverboards still catching fire, despite warnings
SlashGear - Dec 29, 2015
Since 1969, we’ve known that this would be the year of the hoverboard. After all, if Robert Zemeckis says something future, we all...

Why Are ‘Death Trap’ Hoverboards Exploding?
Sky News - Dec 16, 2015
Some models have been catching fire and blowing up, which is believed ... Sky News spoke to Joann Ensell, who bought a hoverboard for her ...

Hoverboard maker under fire for counterfeit certification marks
Laws Struggle to Keep Up as Hoverboards’ Popularity Soars

Authorities warn of exploding hoverboard imitations

Government issues 'urgent' hoverboard warning after fatal fire
HOVERBOARD – Risk of Fire

- 48 fires in 20 U.S. states per CPSC
- 17,000 Hoverboards examined in UK, 15,000, or 88 percent, were confiscated for safety reasons.
A CRISIS & RESPONSE UNFOLD...

- UL team is alerted to issue
- News of hoverboards gains media attention

UL team works to develop a draft hoverboards standard

UL announces new UL 2272

UL holds first standards technical panel meeting

UL 2272 achieves consensus as a bi-national standard (ANSI/CAN) broadened to cover other types of e-mobility products

- First draft of UL 2272 written
- Meetings with key retailers
- Meeting with US CPSC

CPSC issues guidance outlining expectation of compliance to UL 2272

CPSC announces 10-firm recall

- UL 2272 electrical requirements proposed to be added to ASTM standard
- UL 2272 shared with IEC
- UL, CPSC, and others offer training to battery manufacturers in China
NAVIGATING THE CRISIS

The best/most effective standards and technical regulations are:

• driven by sound science
• dynamic and updated as necessary to address known or emerging safety hazards

• often the result of public-private partnership
• able to apply previous experience and expertise to solve current crisis or prevent future crises
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UL’s work is at the nexus of supporting regulators’ confidence needs, manufacturers’ and retailers’ market access needs, and UL’s public safety mission.

UL is committed to sharing standards and safety information with partners around the world to promote increased safety and to facilitate global trade.

- Safety science research
- Standards development
- Full complement of conformity assessment
- Consumer education and training
THANK YOU

Dan Ryan
International Standards Manager
Underwriters Laboratories Inc.