

# **UL and Energy Safety Standards in Support of International Trade**



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International Standards  
Underwriters Laboratories Inc.  
March 2018**

# Agenda

**UL Company Overview**

**UL Standards Development**

**Energy Storage and Energy Standards**

**Safety and Trade**



# Agenda

## **UL Company Overview**

**UL Standards Development**

**Energy Storage and Energy Standards**

**Safety and Trade**



**It all started...**  
**Columbian Exposition in 1893**





GENERAL ELECTRIC CO.

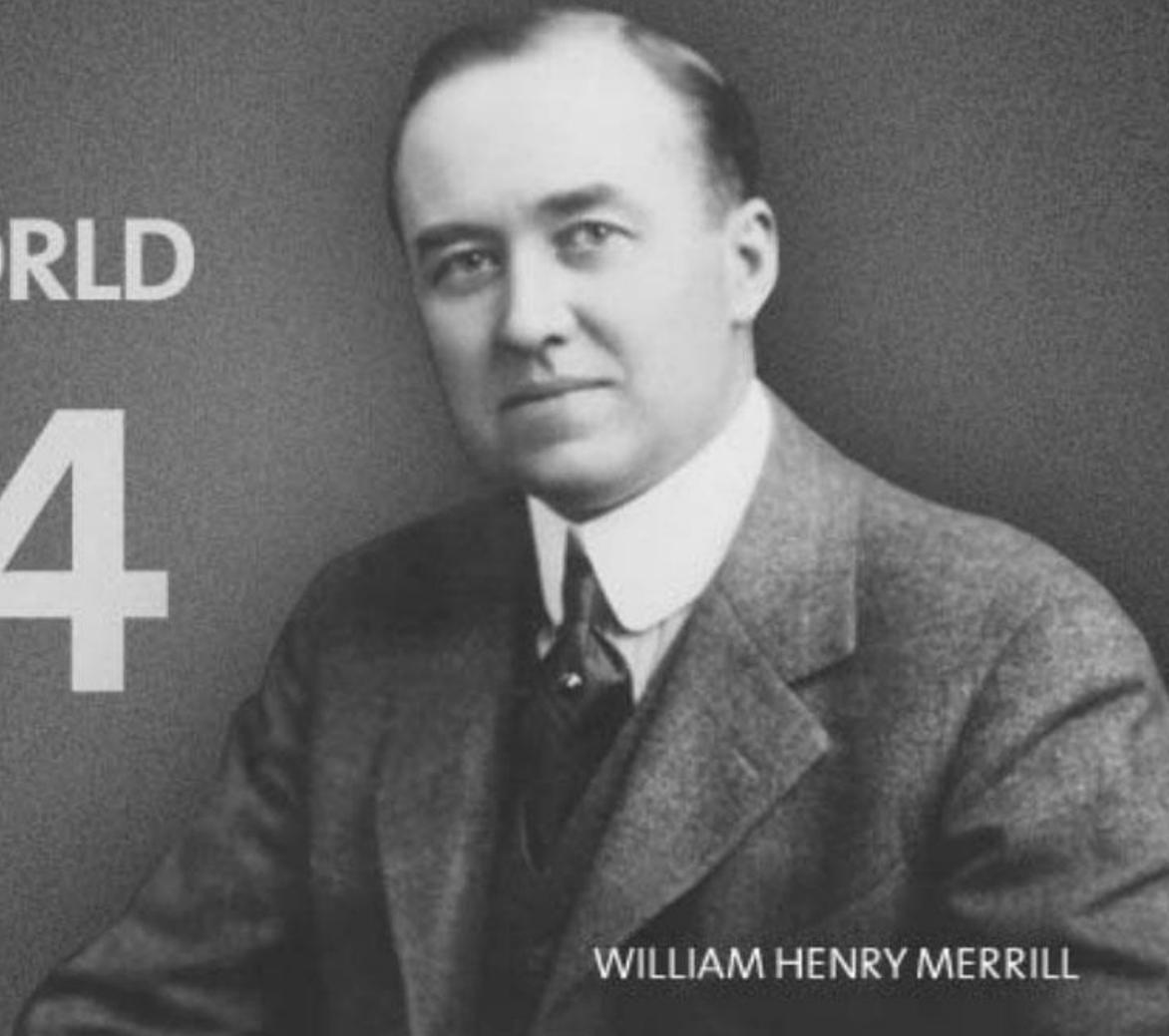
GENERAL ELECTRIC & MANUFACTURING CO.  
THE COLUMBUS 1893

GRAY'S  
TELAUTOGRAPH  
THE READY STAFF

GENERAL ELECTRIC GREAT



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



We pursue our mission through:

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



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UL Company Overview

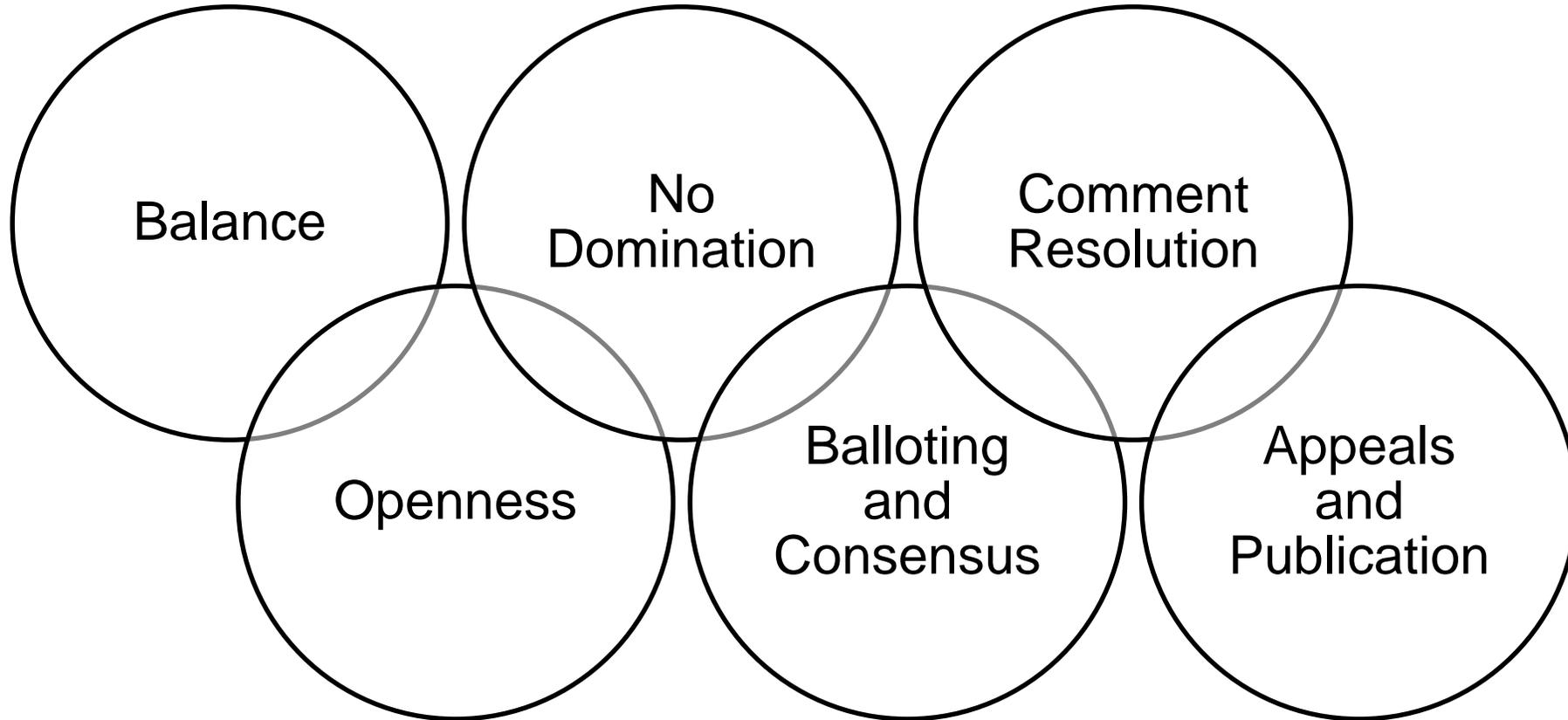
**UL Standards Development**

Energy Storage and Energy Standards

Safety and Trade



# UL Standards Development Process Overview



# What is the process for writing Standards?

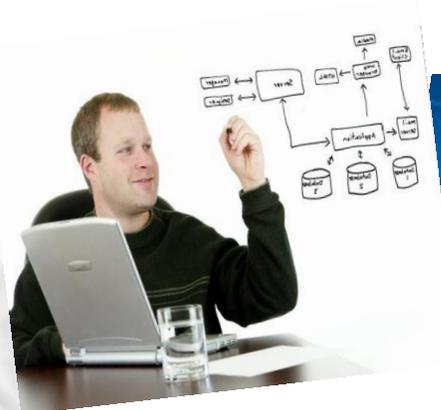


# Consensus Based Standards

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 trilateral standards for the US, Canada and Mexico.

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**Energy Storage and Energy Standards**

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# ENERGY STORAGE STANDARDS



# Applications for Energy Storage and Growing Importance

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

Some Utility Applications



- Renewable energy support
- Operational resiliency
- Peak demand
- Power quality
- EV charging support

Some Commercial and Residential Applications



# Supporting Renewables



# Reliability & Resiliency



# First Responders & Building Owners



# Enabling the Smart Grid



# Energy Storage System Risks

	As an energy source, an electric energy storage system may represent a potential energy hazard, which could lead to –		As a source of electricity, an electric energy storage system may represent a potential electrical hazard, which could lead to:		Depending upon technology, etc., systems may be a potential source of exposure to harmful materials, which could result in:	There may be potential for physical hazards associated with the EESS such as:	
Fires		Electric Shock		Concentrations of hazardous gases		Burns	
Explosions		Arc Flash		Hazardous liquid spills		Hazardous Moving Parts or Pinch Parts	
				Exposures to hazardous solids		Slip or other physical hazard	

# 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.

Standard No.	Title	Year Published
UL 1642	Lithium ion Batteries	1985
UL 1973	Batteries for Light Electric Rail (LER) and Stationary Applications	2011/2013
UL 1989	Standby Batteries	1992
UL 1974	Evaluation for Repurposing Batteries	In Development
UL 2054	Commercial and Household Batteries	1997
UL 2271	Batteries for Use in Light Electric Vehicle (LEV) Applications	2013
<b>UL 2272</b>	<b>Electrical Systems for Personal E-Mobility Devices</b>	<b>2016</b>
UL 2580	Batteries for Use in Electric Vehicles	2010/2011
UL 2595	General Requirements for Battery-Powered Appliances	2013
UL 2743	Portable Power Packs	2014/2016
UL 3030	Unmanned Aerial Vehicles (UAVs)	2016 - 2017
<b>UL 9540</b>	<b>Energy Storage Systems and Equipment</b>	<b>2015/2016</b>



## 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



# UL 9540

## 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)

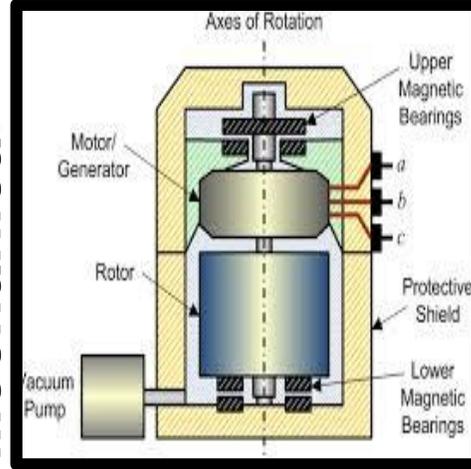
- stores energy in some form and provides electrical energy for use when needed



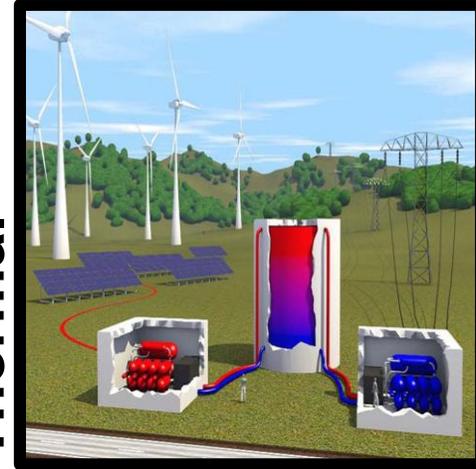
# UL 9540

Types of Energy Storage Technologies within Scope of UL 9540

Mechanical



Thermal



Electrochemical



Chemical

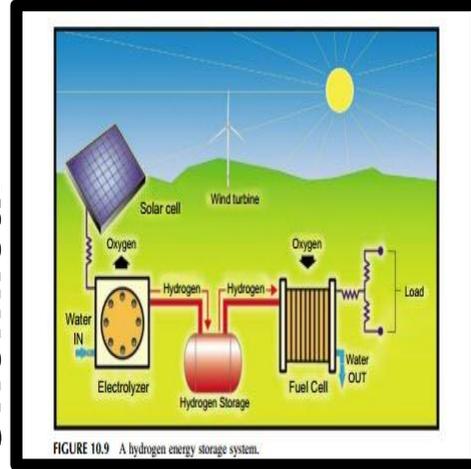


FIGURE 10.9 A hydrogen energy storage system.



# 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

- 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

## General Electrical Safety and Walk-in 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

## Safety Analysis and Control Systems

		Detectability		
		High	Medium	Low
Risk (P, S)	High	Yellow	Red	Red
	Medium	Green	Yellow	Red
	Low	Green	Green	Yellow

Legend: ■ Low risk ■ Medium risk ■ High risk



# 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

## Fire Detection and Suppression



- 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

## Utility Grid Interaction

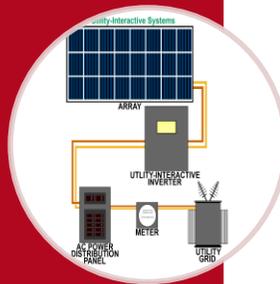


# UL 9540

## Utility Grid Interaction

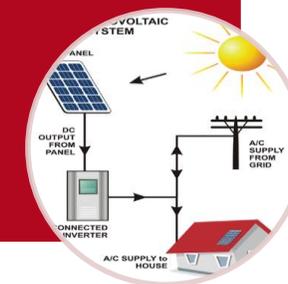
- Safety of inverters, converters, charge controllers, and interconnection system equipment (ISE) intended for use in stand-alone (not grid-connected) or utility-interactive (grid-connected) power systems.
- Used in conjunction with IEEE 1547 and IEEE 1547.1

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
    - UL 1973, Standard for Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications, 2<sup>nd</sup> Ed.
  - 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



# UL 9540



## Nameplate:

- 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, ect.; 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



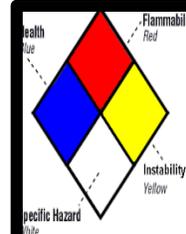
Arc Flash Warnings



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

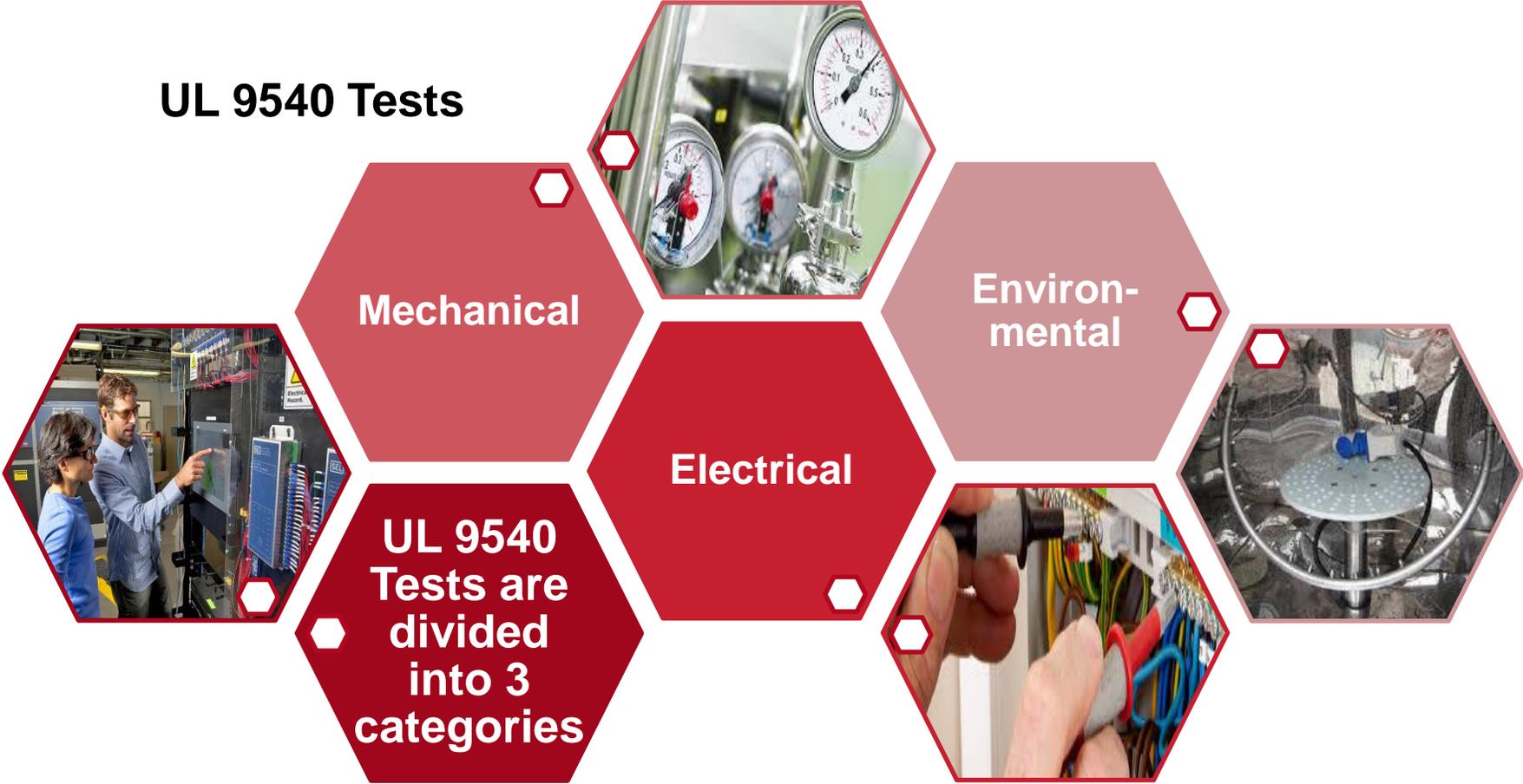
Maintenance Instructions

Operating Instructions

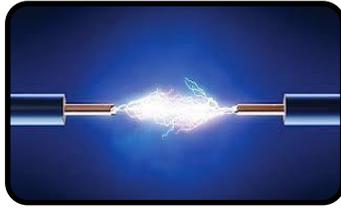


# UL 9540

## UL 9540 Tests



# 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 28, 2015

Since 1989, we've known that this would be the year of the **hoverboard**. After all, if Robert Zemeckis says something future, we all ...

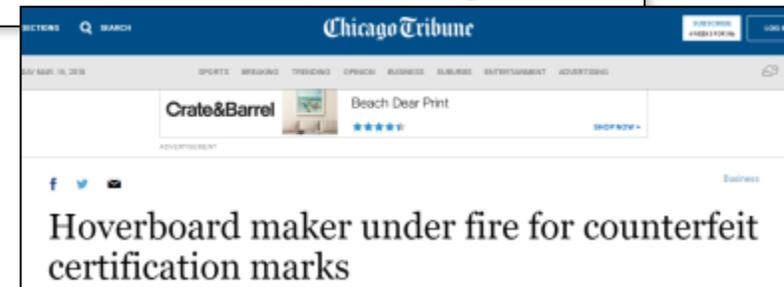


## Why Are 'Death Trap' Hoverboards Exploding?

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 ...

Science Times





**The New York Times**  
**Laws Struggle to Keep Up as  
Hoverboards' Popularity Soars**

**BBC NEWS**  
**Authorities warn of exploding  
hoverboard imitations**

**abc NEWS**  
**Government issues 'urgent' hoverboard warning  
after fatal fire**

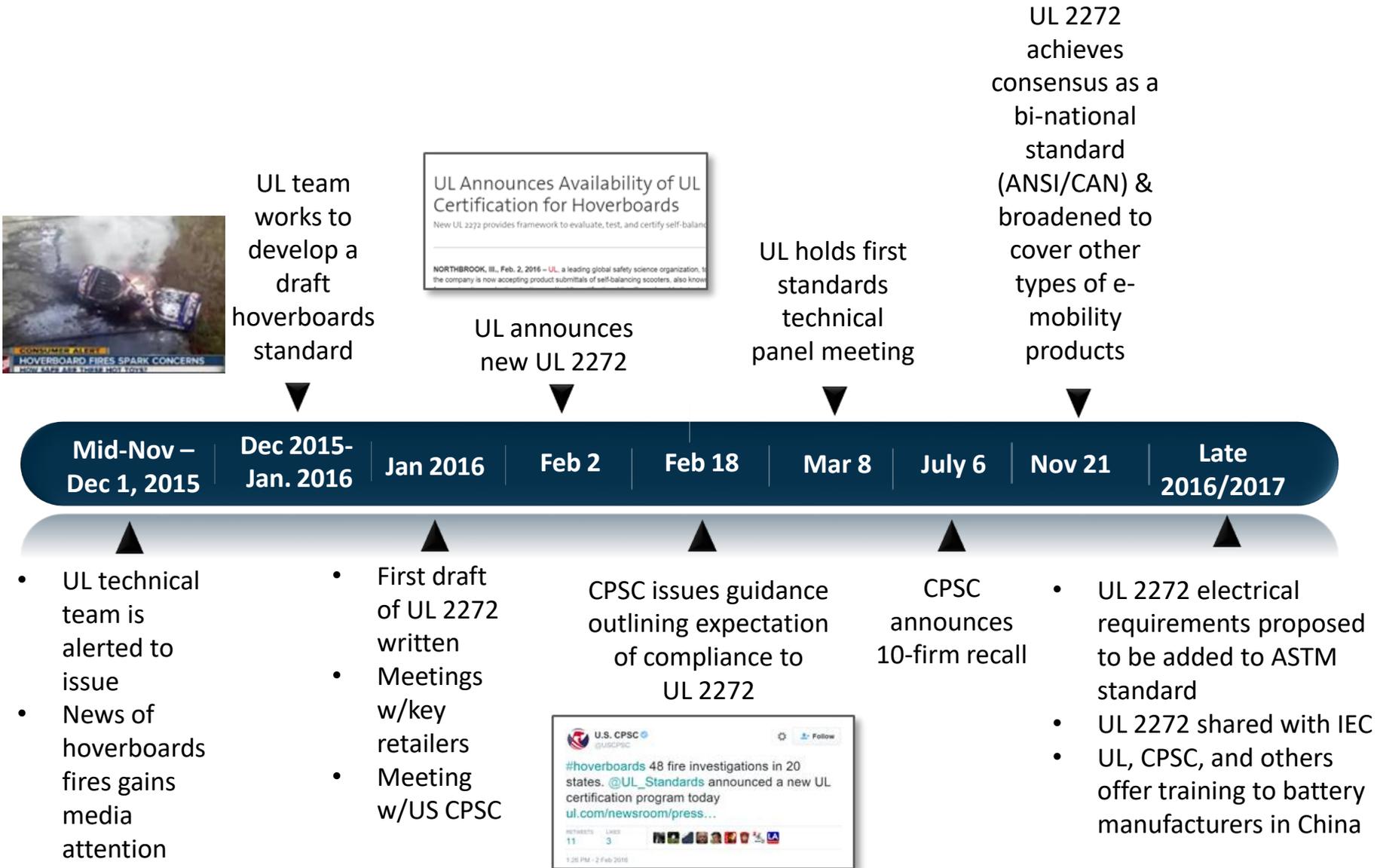


# HOVERBOARD – Risk of Fire

- 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...



# 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

# Agenda

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**Safety and Trade**



# Innovation, Commercialization, Global Trade

- 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



PRODUCTS



MARKETS

Photo Source: NOAA. Gov and UL



**THANK YOU**

Dan Ryan  
International Standards Manager  
Underwriters Laboratories Inc.

