



# Energy Storage Systems (ESS) Safety Overview

James Trudeau  
UL LLC

UL operates  
in more than  
**143**  
COUNTRIES



and across  
more than  
**20**  
INDUSTRIES

UL SERVES  
**1** OUT OF **3**  
Fortune 500 companies

WORKING FOR A  
**SAFER WORLD**  
since **1894**



UL has helped to set  
**MORE THAN**  
**1,600**

standards defining safety,  
security, quality and sustainability



**Science and  
global expertise**

UL software is used by  
**10,000+**   
**ORGANIZATIONS in  
OVER 10 INDUSTRIES**

UL MARKS APPEAR on more than  
**22 BILLION**  
products *globally*



UL has supported a  
**CENTURY OF INNOVATION**  
from electricity to nanotechnology

# Worldwide experts

**14,000**  
employees

**230+**  
locations

North America  
5,500+ employees  
70 locations

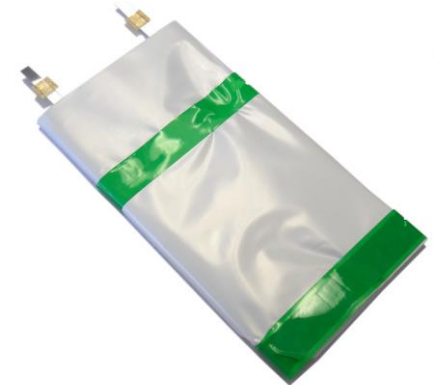
Africa, Europe,  
Latin America and  
Middle East  
3,000+ employees  
80 locations

Asia Pacific  
5,500+ employees  
80 locations



# Lithium-Ion Battery Cell Failure Modes

- Overheating and cell rupture is possible from:
  - Overcharging
  - Short circuits
  - Manufacturing defects
- Overheated cell can vent flammable gas
- Ignition source creates fire/explosion
- Lithium-ion batteries burn at 1500°C



Thermal runaway in one cell can readily spread to adjacent cells

# 28 Major ESS Fires in South Korea 2017 - 2019



# ESS System Explosion in AZ



# Thermal Runaway - 25 Lithium-Ion Cells



# Thermal Runaway - 25 Lithium-ion Cells

Let's do the math...

- A single 18650 Li-Ion cell is about 10 WH
- 25 cells is about 250 WH
- A typical ESS module has 5,000 WH
- A typical rack has 10 modules for 50,000 WH
- A typical rack has over 200 times more energy than the 25 cells in the video
- A typical 2 MW container has over 3,000 times more energy than the 25 cells in the video





# FIRE SAFETY & RISK MANAGEMENT



## Installation Codes

**NEC:** National Electric Code (NFPA 70)

**NFPA 855:** Standard for the Installation of Stationary Energy Storage Systems

**IFC 2021:** The International Fire Code



## Battery Safety Certification

**UL 1642:** Lithium Batteries

**UL 1973:** Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications

**UL 9540:** Energy Storage Systems and Equipment



## Testing for Performance

**UL 9540A:** Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems



# It Is All About Risk Management

The use of good codes and standards, coupled with independent project oversight, is critical to managing the risk profile of battery energy storage projects.

- Financial Risks
- Operational & Performance Risks
- Safety Risks
- Environmental Risks

