# Thermal runaway mitigation standardization

## Information you need to know

Flore Devleeschouwer
Senior Product Specialist -Transportation Industry EMEA

Daniel O'Shea
Principal Engineer, Emerging & Growth Markets

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# Agenda

1. UL Solutions monitoring thermal runaway events
2. UL Solutions Battery Enclosure Materials Screening (BEMS)
3. UL 2596:
   Torch and Grit (TaG) &
   Battery Enclosure Thermal Runaway (BETR)
4. UL Solutions BEMS … next generation

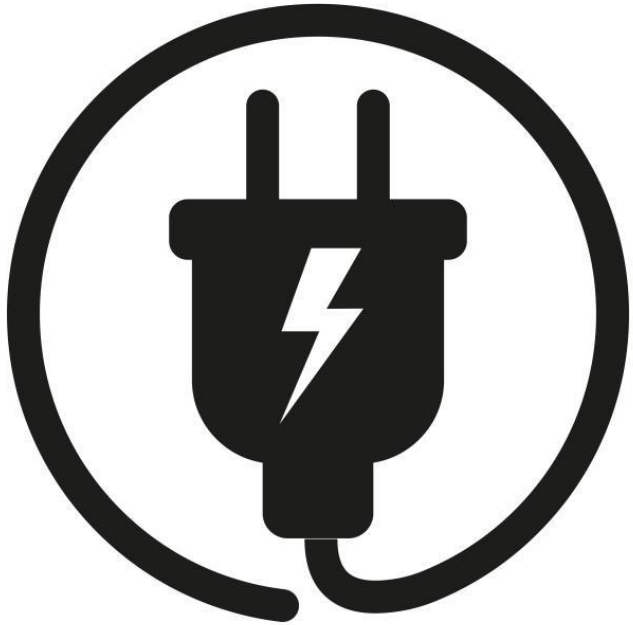
# UL Solutions monitoring thermal runaway events

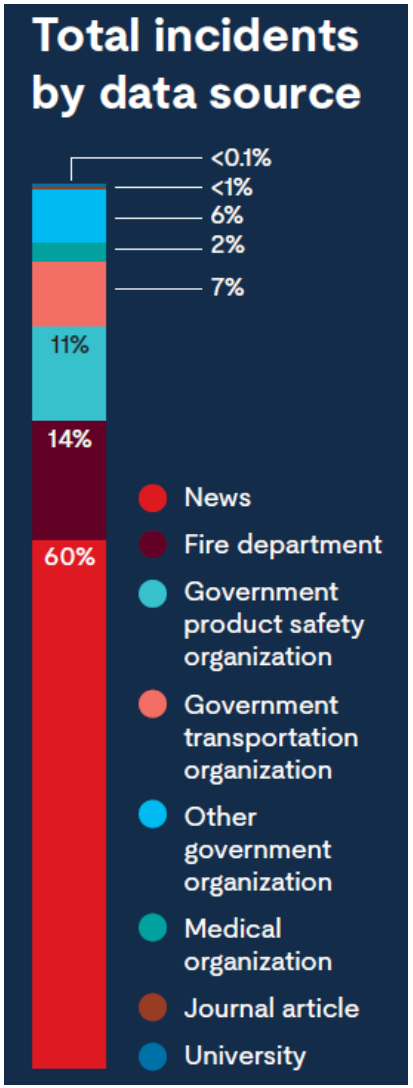
- Daniel O’Shea

UL Solutions

# Why?: Lithium-ion battery incident reporting

The proliferation of lithium-ion batteries and the products that run on them has resulted in an exponential increase in incidents resulting in injuries and fatalities.

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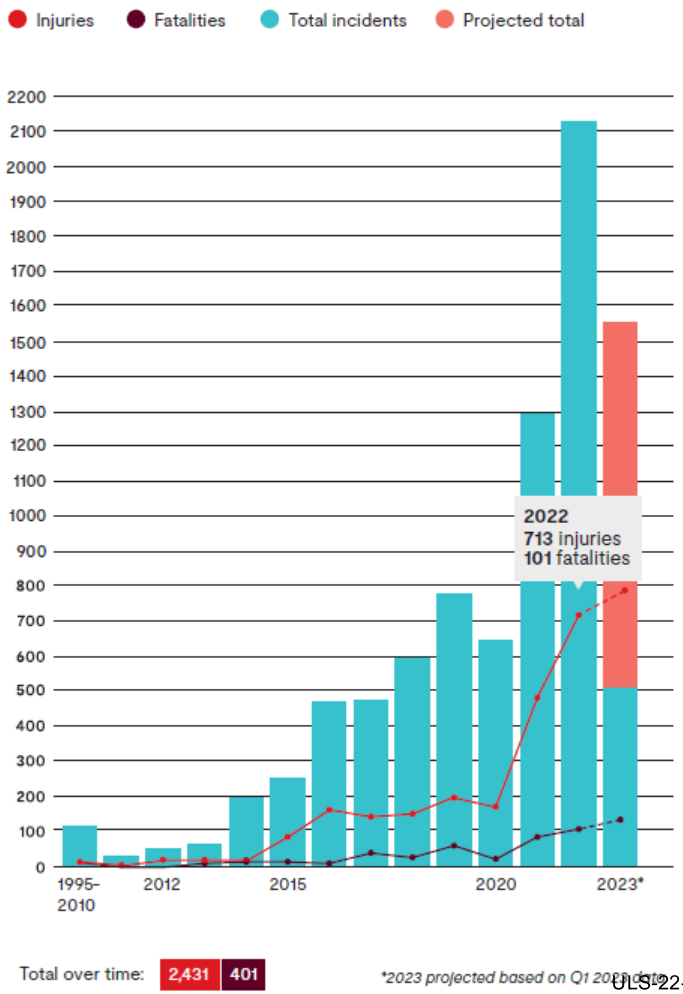
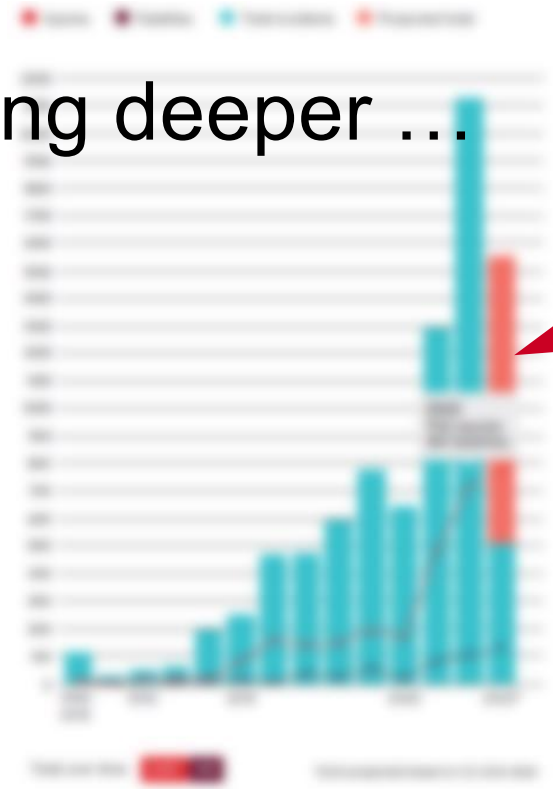
# Why?: Increase in total incidents over time

Tracking and transparent reporting of battery-related incidents — including product type, what happened and the impact — is critical to helping drive understanding of this technology and where the greatest risks exist.



# Why?: Increase in total incidents over time

Digging deeper …



## Total incidents reported for each category

(1995-2023 YTD)

**CONSUMER PRODUCTS**

1,159 total injuries

114 total fatalities

**MICRO-MOBILITY DEVICES (<20MPH)**

1,140 total injuries

214 total fatalities

**ELECTRIC VEHICLES (>20MPH)**

91 total injuries

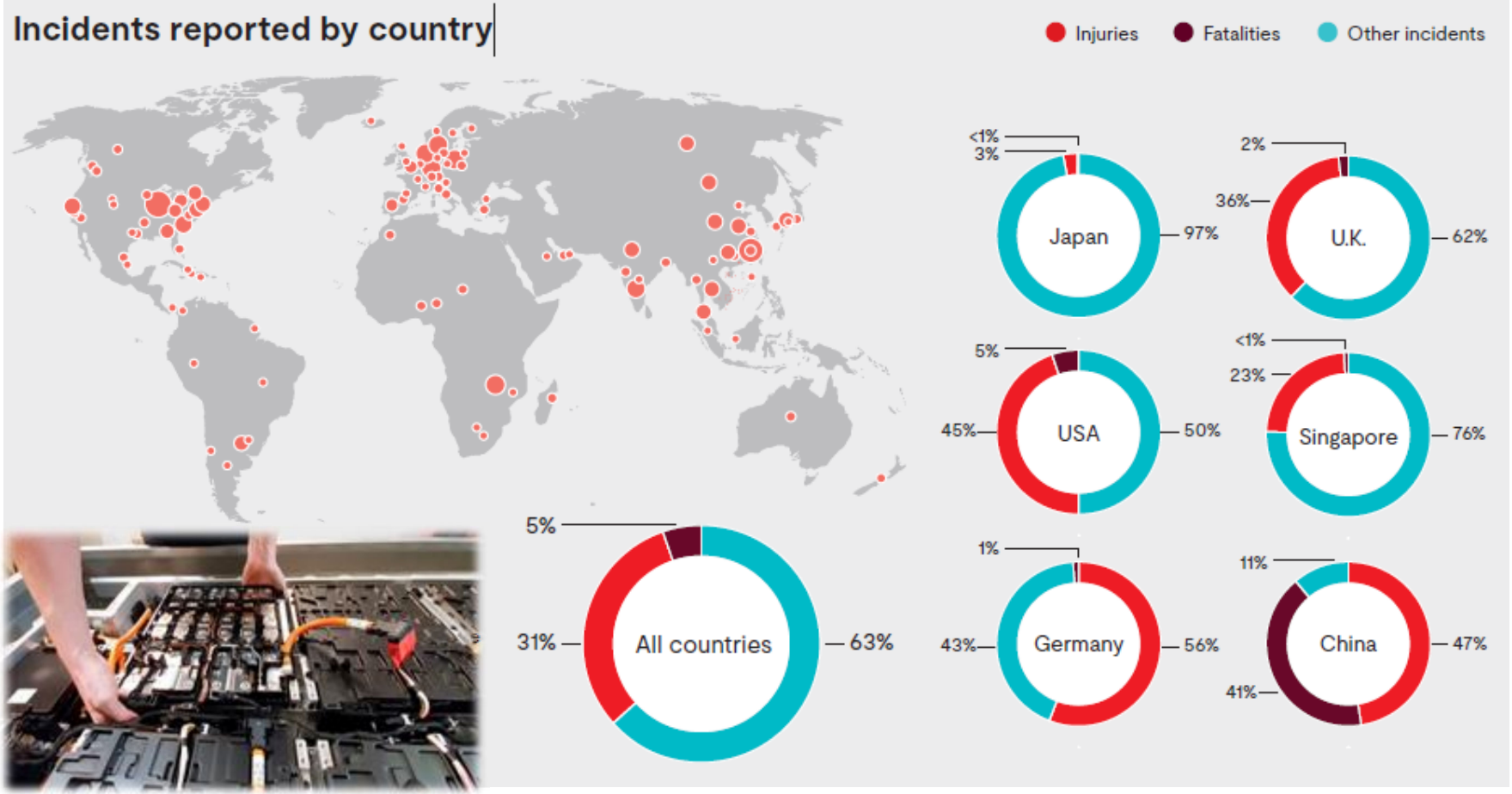
69 total fatalities

**ENERGY STORAGE SYSTEMS**

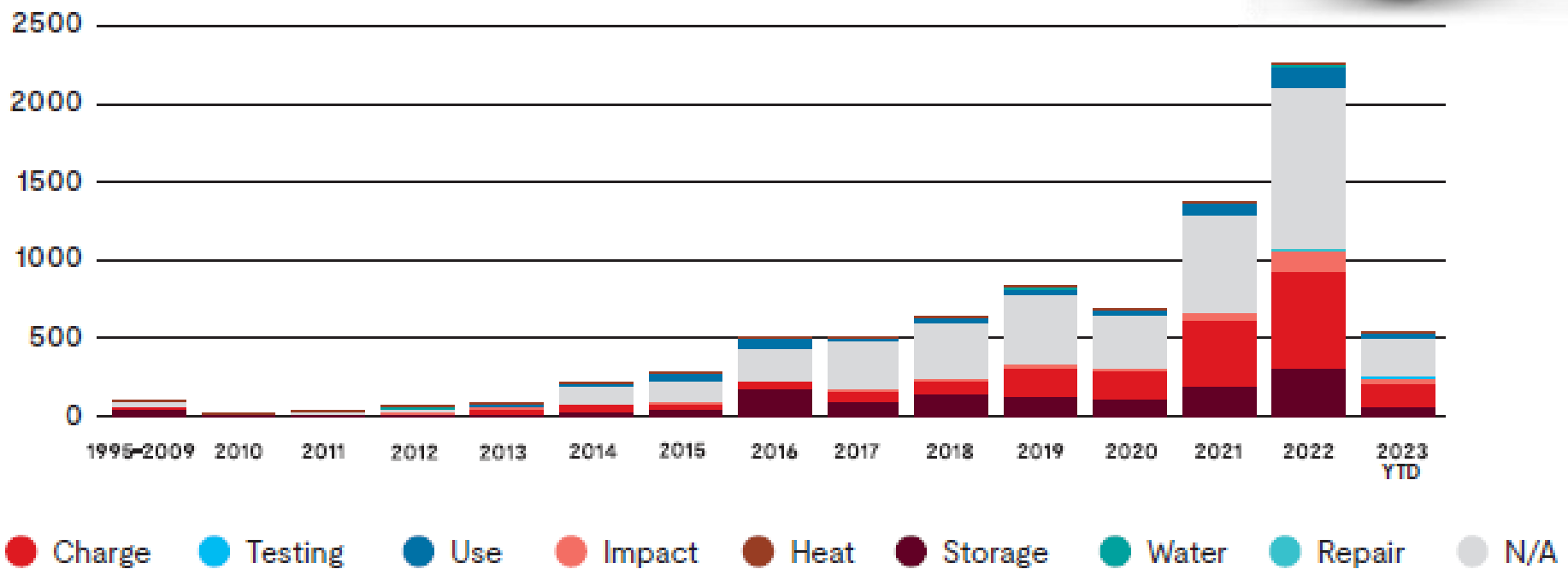
14 total injuries

4 total fatalities

# Where: Incidents reported by country

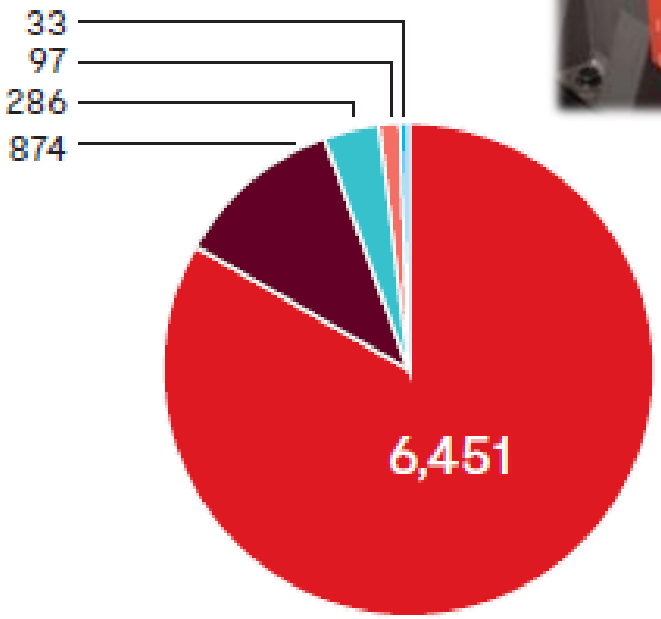


# How?: Incident over time by battery status



# How?: Reported incidents by type

- **Heat**
  Hot, no gas released
- **Swelling**
  Increased in size, may be hot, no gas released
- **Venting**
  Gas released, may be hot and/or swollen
- **Fire**
  Gas released and ignited
- **Explosion**
  Gas released, quick ignition causing loud sound and pressure increase



# UL Solutions Battery Enclosure Materials Screening (BEMS) … now available in Europe

- Flore Devleeschouwer

UL Solutions

# Electric vehicle background

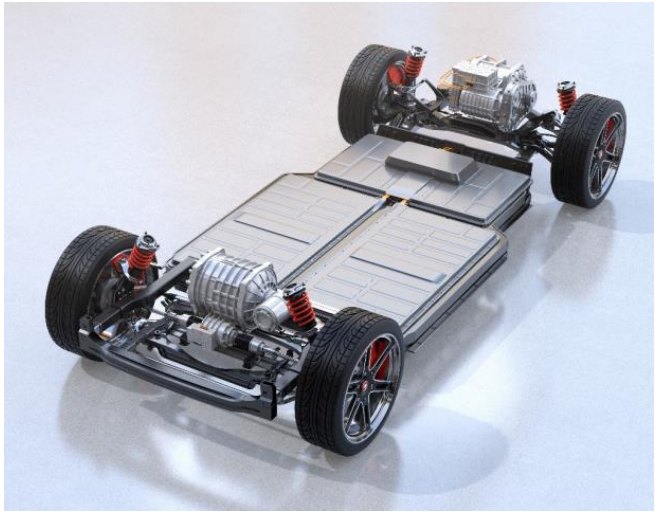
**Extending the battery range is critical to the wider adoption of EVs:**

The industry works to add capacity to EV batteries and extend the range of electric vehicles.

Reducing the vehicle's overall weight also helps to improve efficiency and extend its range. Composites help replace heavier metals in battery enclosures enabling the desired light-weighting.

Although light-weighting is important for efficiency, the battery enclosure must still safely contain the potential battery fire hazards, also known as thermal runaway events.

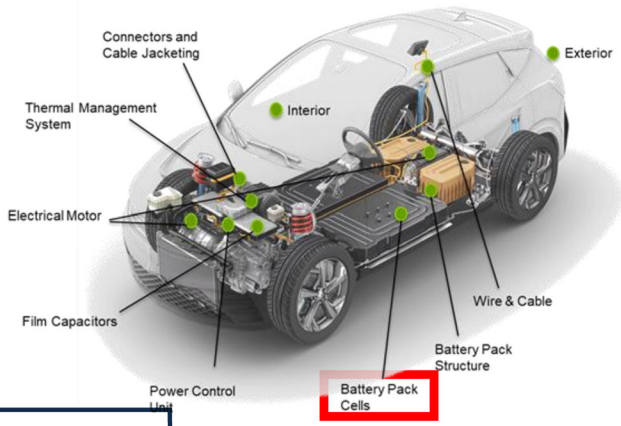
Choosing the appropriate enclosure material before building an expensive prototype is critical.



# EV Battery

Requirements :

1) Temperature resistance >100 C
2) Flame and ignition resistance
3) Impact resistance
4) Weathering resistive
5) Insulation properties

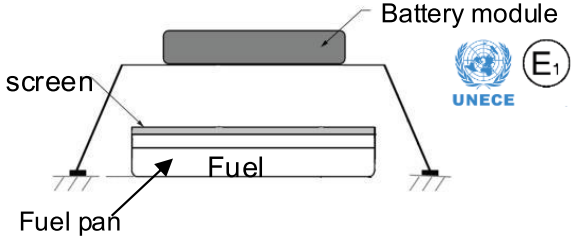



**Battery**
IEC 62660, UL 2580, UL 2054, ISO 12405,
SAE J2929, QC/T 743/UN ECE R-100, GB38031

## Polymer material requirement for EV Battery

| c UL us | EV | Light EV (e-bike) | Light electric rail and stationary |
|---|---|---|---|
| Std # | UL 2580 Ed3 | UL 2271 Ed2 | UL 1973 Ed2 |
| FR | V-1 | V-1 | 5VA |
| RTI (Impact) | 100 C | 80 C | 80 C |
| f1 (outdoor) | Required | Required | Required for outdoor |
| Enclosure | Compliant with UL 746C/50 | | |

## Safety requirements and test methods for traction battery of electric vehicle




**GB38031:** Electric Vehicle Traction Battery Safety Requirement. This standard replaces GB/T31485-2015 "Safety Requirements and Test Methods for Traction Battery of Electric Vehicle" and GB/T31467.

- **Major Battery testing method follow UL 2054, the Standard for Household and Commercial Batteries**

# BEMS — Its value to OEMS and materials producers

- These tests focus specifically on enclosure material performance in a thermal runaway event, replicating a real-world scenario.
- Enables testing of material plaques vs. entire battery assembly, thereby reducing cost and development time.
- Provides material producers a research and development option to screen multiple formulas and constructions, allowing them to bring only the preferred candidates to their customers (OEM or Tier 1).
- Offers OEMs the ability to compare the performance of multiple vendor materials to select the most suitable candidates.
- UL 2596 can be referenced in OEM material selection specifications.
- Third-party testing by a trusted and impartial source.

# UL 2596: Torch and Grit (TaG) & Battery Enclosure Thermal Runaway (BETR)

- Daniel O’Shea

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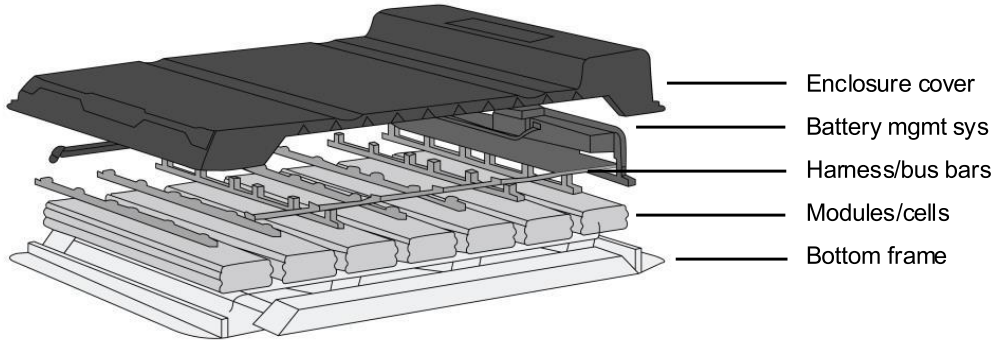
# A quick review … a hazard-based approach

**Hazard based safety engineering and a thermal runaway event that is quite dynamic.**

Thermal runaway is caused by an internal chain reaction within the battery cell and is hard to stop once it starts.

- **Temperature**
  Heat is generated, and flammable gasses that burn at very high temperatures are released, causing propagation from one cell to the others.
- **Pressure**
  Created by outgassing cells is controlled by enclosure venting design.
- **Mechanical impact**
  Abrasion from particles inside the battery propelled by outgassing.

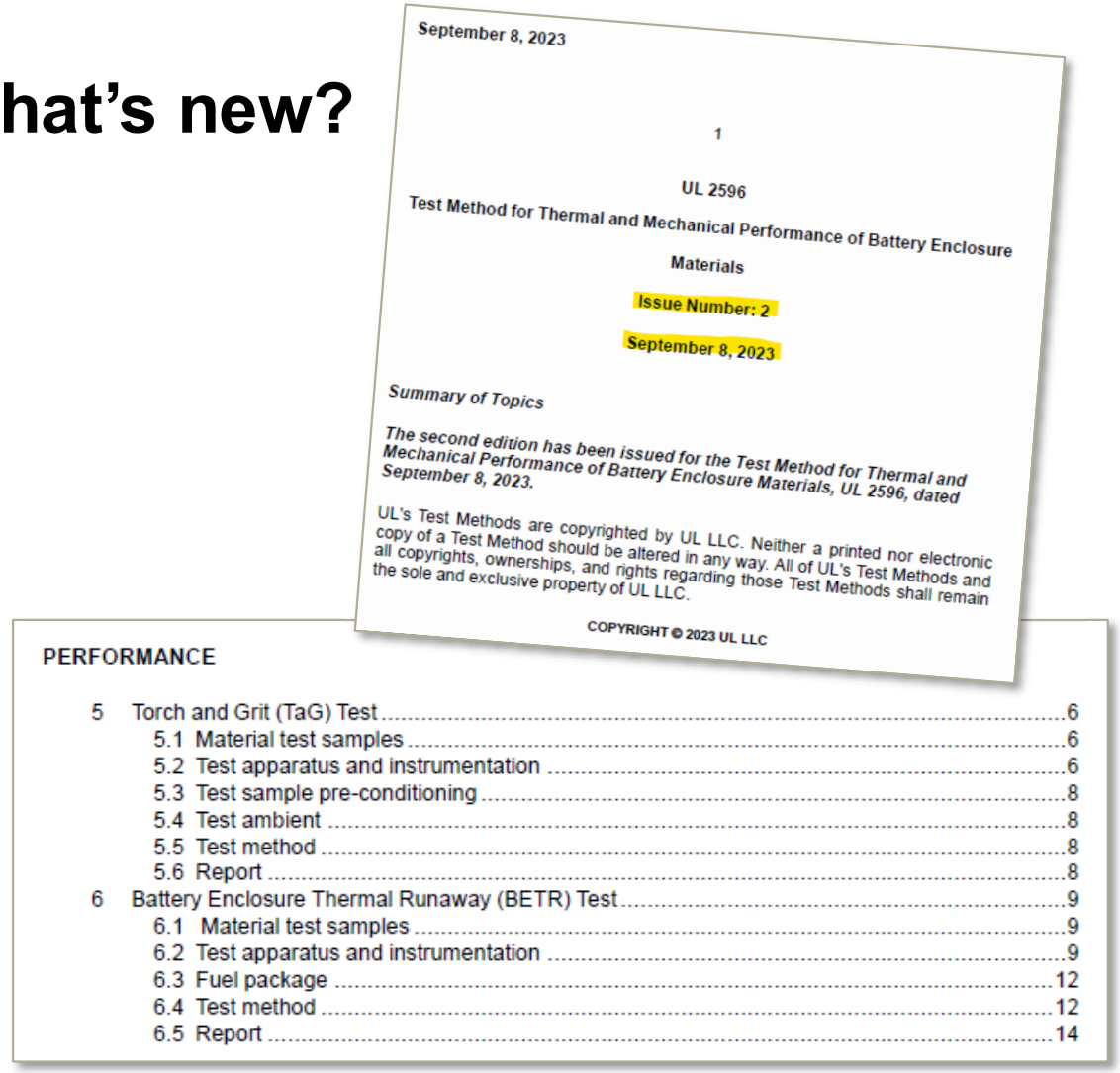


# UL 2596, 2nd Edition … what's new?

- Now includes Torch and Grit method

- BETR Clarifications
  - box dimensions
  - specimen gasket
  - 18650 cell positioning/securement
  - No longer observing cell surface temperatures

- Standardized specimen size for both tests
  200 ±10 mm by 200 ±10 mm



September 8, 2023

1

UL 2596

Test Method for Thermal and Mechanical Performance of Battery Enclosure Materials

Issue Number: 2

September 8, 2023

*Summary of Topics*

*The second edition has been issued for the Test Method for Thermal and Mechanical Performance of Battery Enclosure Materials, UL 2596, dated September 8, 2023.*

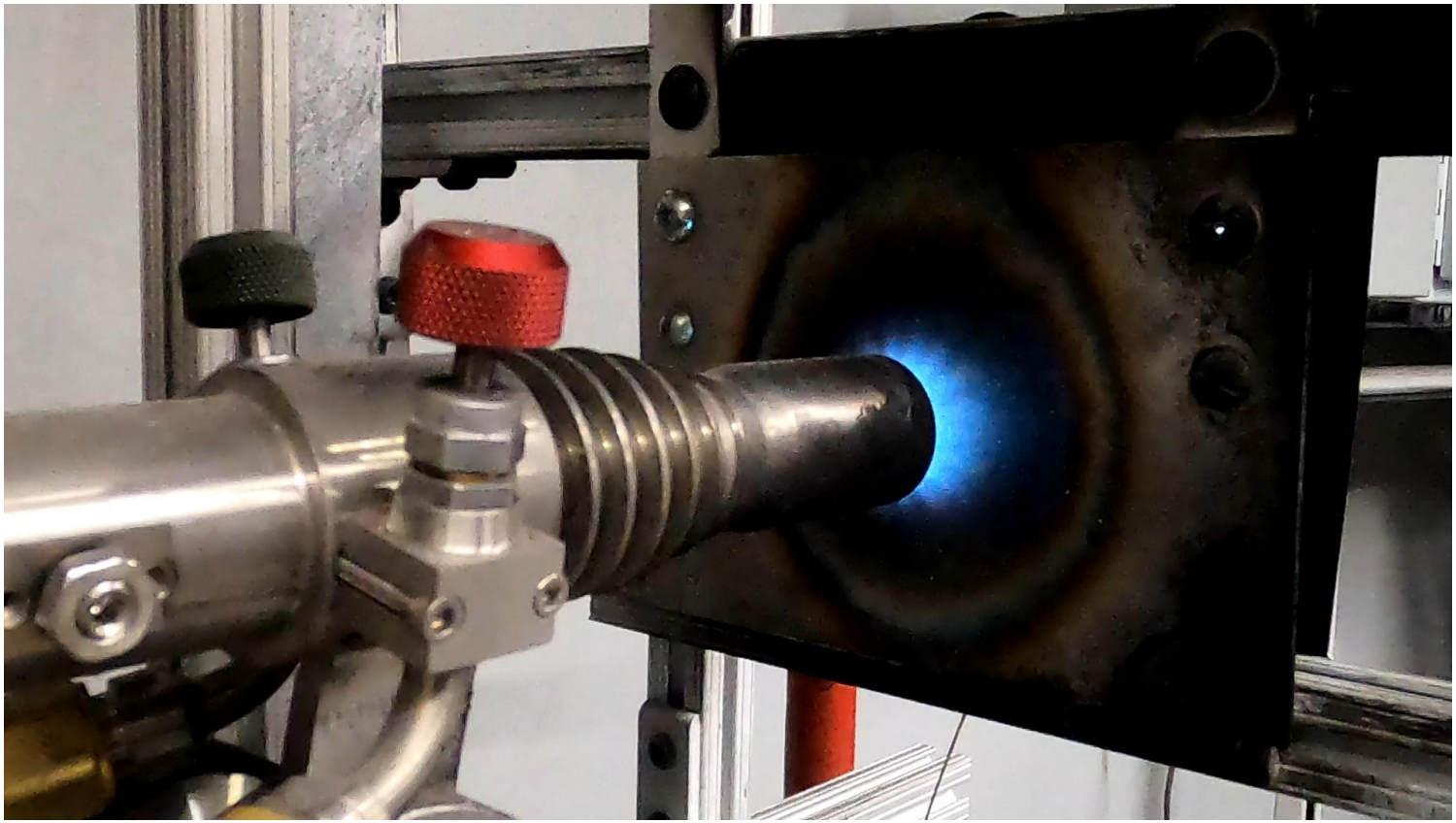


PERFORMANCE

# UL 2596 Torch and Grit (TaG) Test

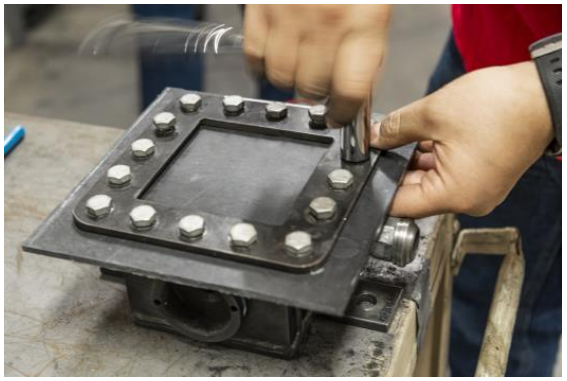
- Objective:
  - Develop a material screening test that includes the dynamic stresses found in an actual automotive battery thermal runaway event.
    - High temperature
    - Abrasion due to battery particles propelled while cells break down and outgas.
    - Supplement to UL 2596 thermal runaway test without pressure component, but quicker to run.

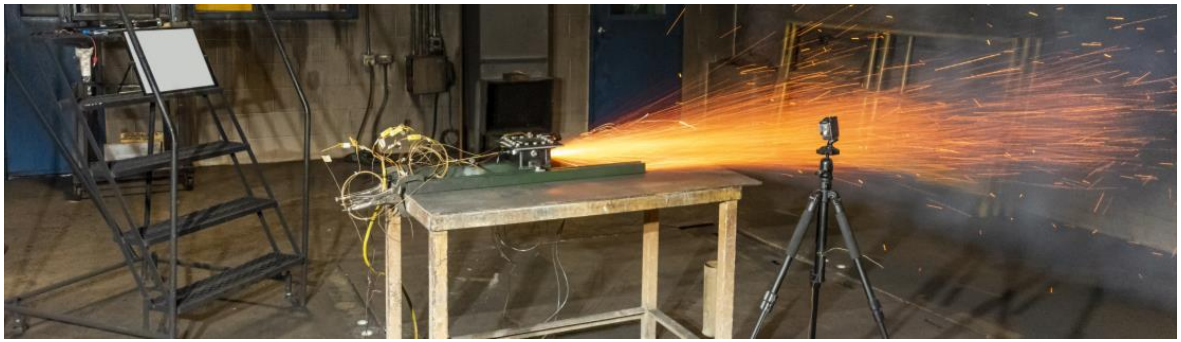
# UL 2596 Torch and grit (TaG) test



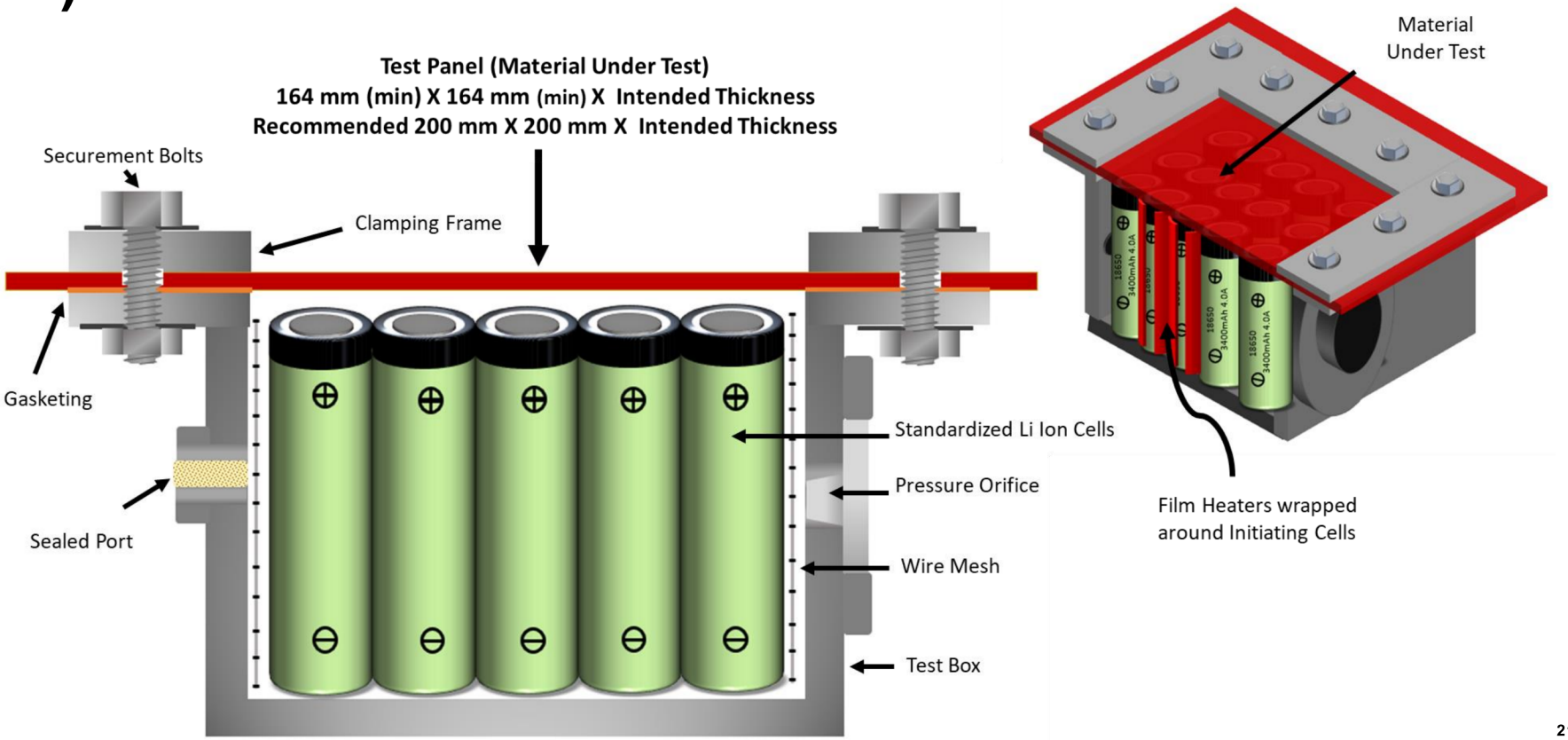
# UL 2596 Battery Enclosure Thermal Runaway (BETR)

- Our first test in **UL 2596 — Test Method for Thermal and Mechanical Performance of Battery Enclosure Materials**
- A rigorous test to evaluate material performance in a simulated thermal runaway event.

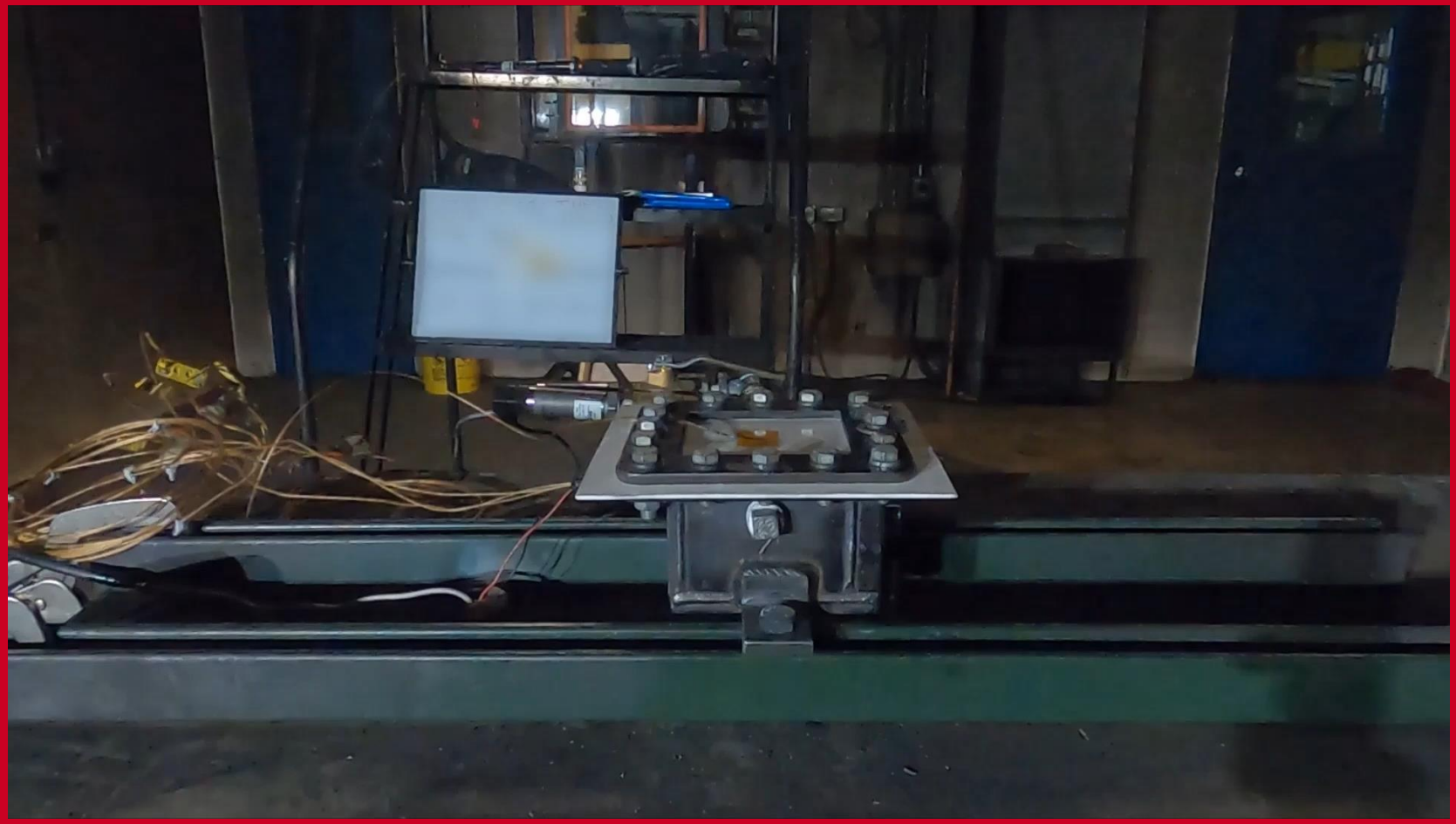




# UL 2596 Test Method for Thermal and Mechanical Performance of Battery Enclosure in Thermal Runaway (BETR)



# UL 2596 BETR Test



# UL Solutions BEMS … next generation

- Flore Devleeschouwer

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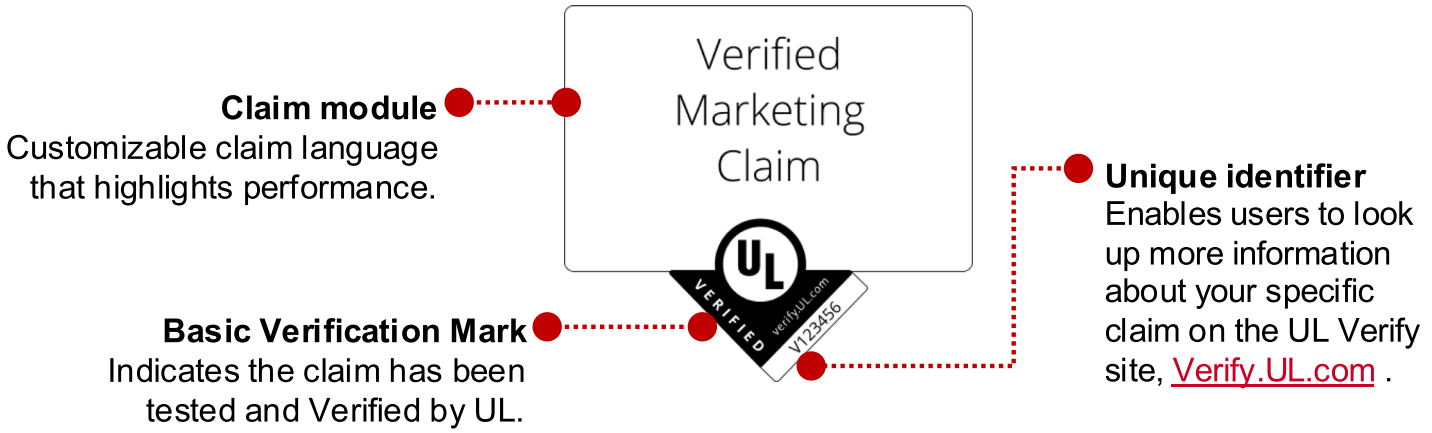
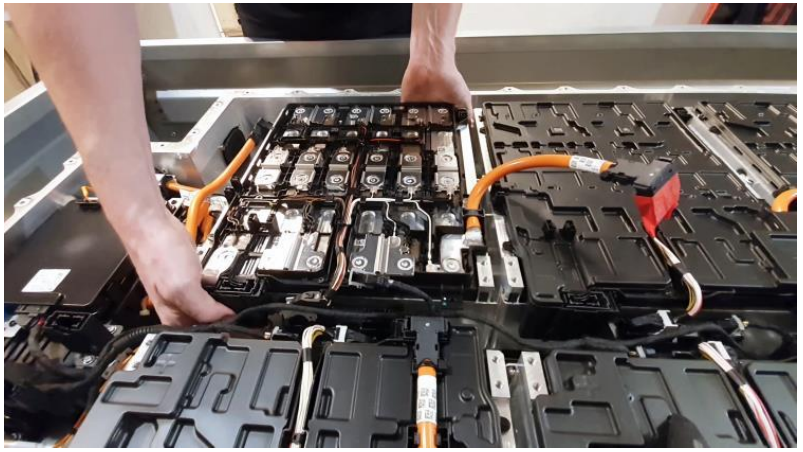
# UL 2596 : Marketing Claim Verification Service

- UL Verification is an **objective, science-based assessment** that evaluates the **accuracy of service.**
- UL's independent assessment process uses **scientifically sound, repeatable methodologies** to determine the validity of specific promotional statements.
- Successful verification of a marketing claim through testing, auditing and/or inspection results in the issuance of a **UL Verification Mark**.



# UL 2596 extension

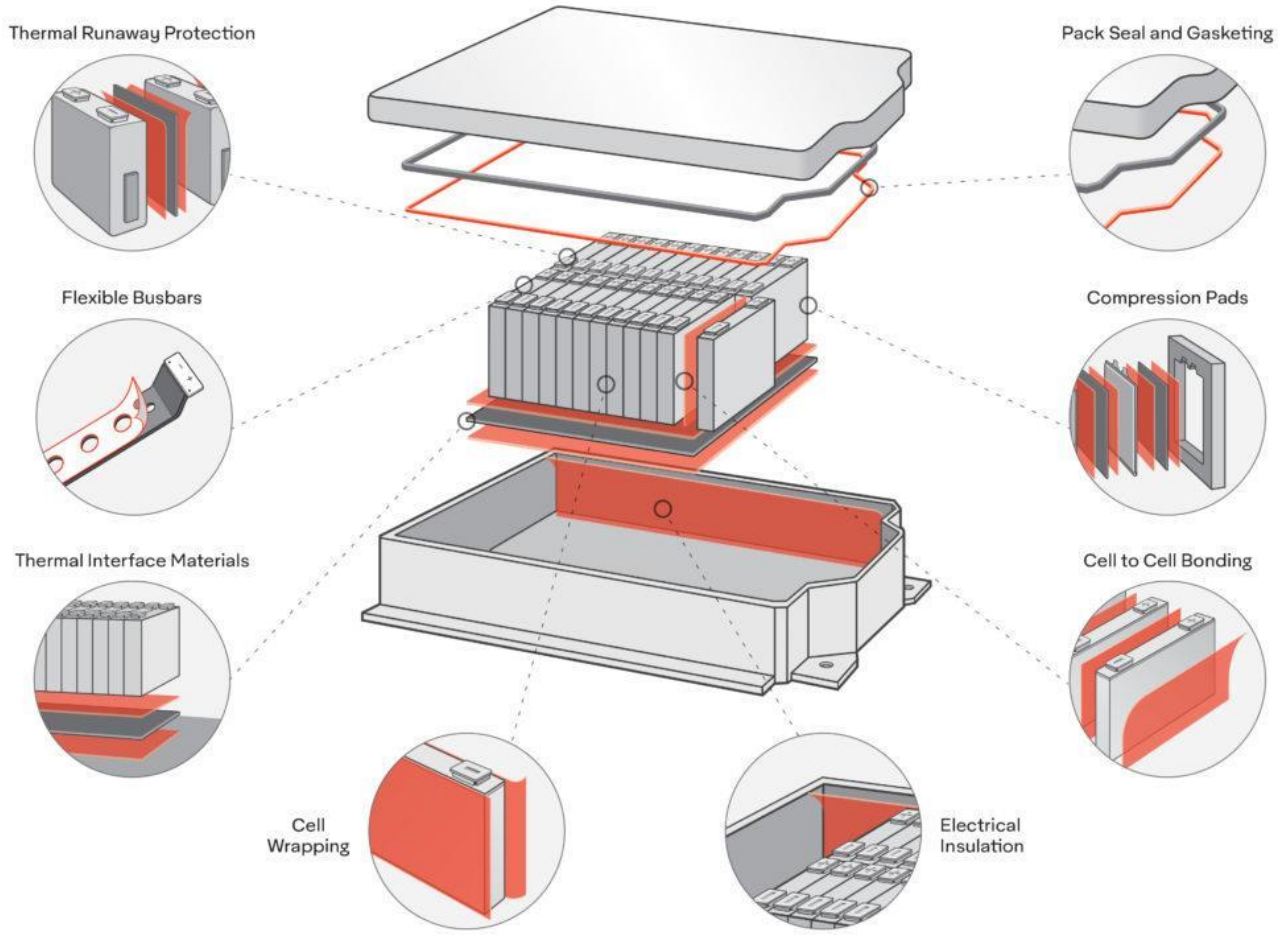
- Comparison of TaG and BETR to standardized material
- Correlation of TaG → BETR → array scale → pack level
- Thermal runaway mitigation by cell isolation
  – No longer a hazard contingency perspective
- Hot/cold side testing of rectilinear specimens



# Future product testing/certification

### Thermal Runaway Protection

Electric vehicle battery suppliers must adhere to strict industry standards and regulations concerning thermal runaway protection. To protect against thermal runaway, flame-retardant adhesives and single- or double-coated filmic tapes bond materials such as ceramic fiber and mica to EV battery cells.




- EV Battery Tapes, Adhesives, and Encapsulant Materials |TPC Converting

# UL Standard Technical Panel (Technical Committee) for automotive application

- The Standards Technical Committee is the consensus body for the development and revision of UL standards
- Participate in UL standard development and revision through CSDS http://csds.ul.com/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# What makes UL Solutions rise above

- Scientific leadership
- Collaborative partnership
- Deep industry and technical problem-solving expertise
- Comprehensive risk management approach
- Extensive global footprint
- Broad marketplace trust



"In the course of our work, we meet extraordinary people whose companies are having an extraordinary impact on the world and creating the future."

**Jennifer Scanlon**
CEO and President, UL Solutions



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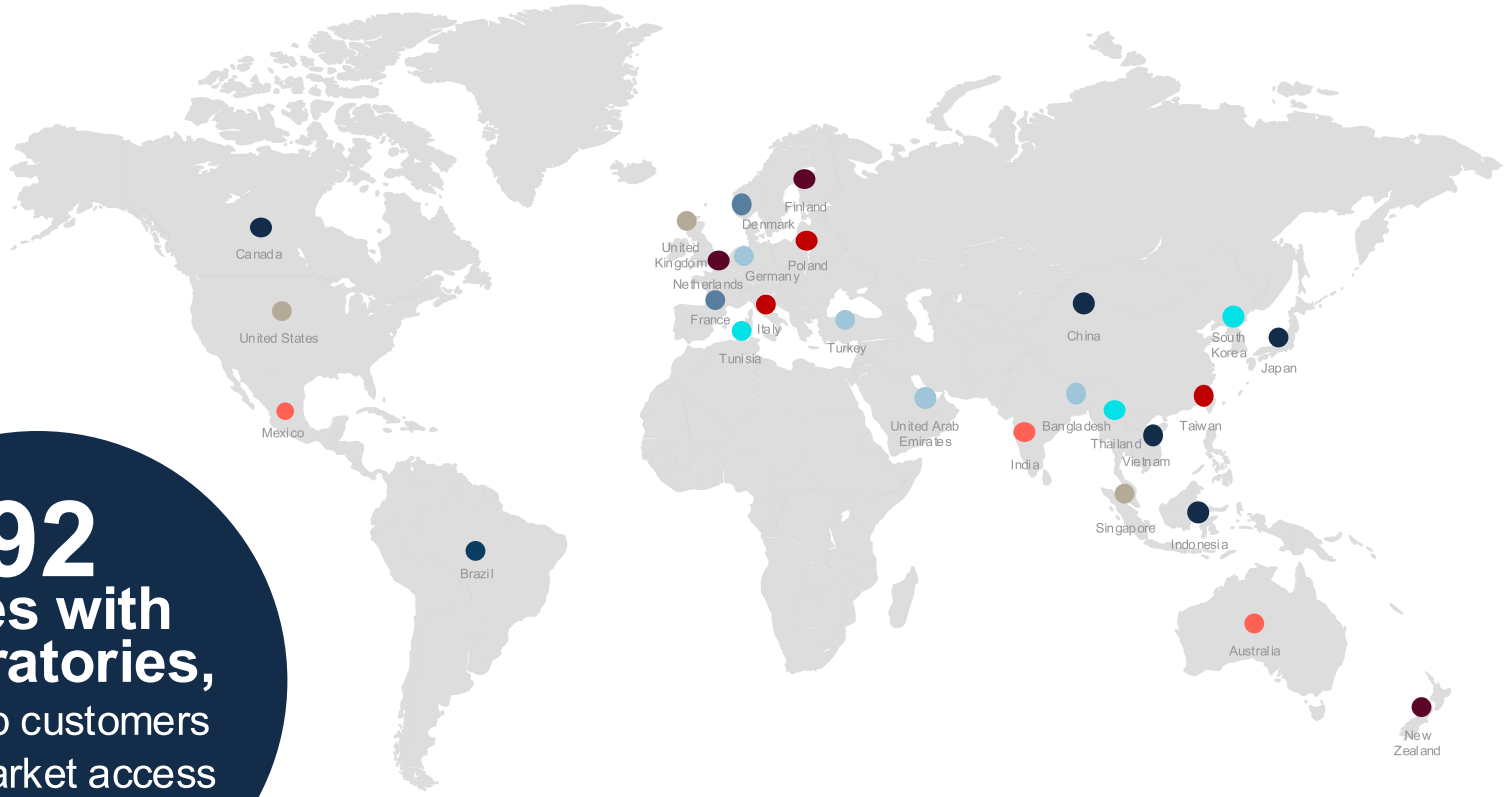
# Laboratories

Through our **technical expertise, market knowledge** and

**92 sites with laboratories,** we help customers gain market access quickly




Site and laboratory information is as of June 2022.


# QUESTIONS?


# Thank you

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