# Thermal Runaway Initiation Methodology (TRIM): a leading-edge technology solution to improve the safety of battery systems

National Research Council Canada. Automotive and Surface Transportation

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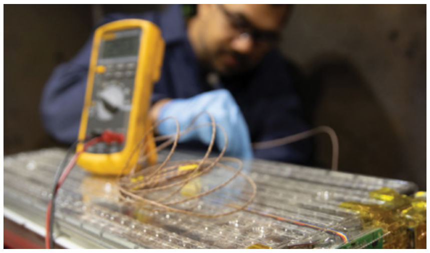
# Thermal Runaway Initiation Methodology (TRIM)

●●● A leading-edge technology solution to improve the safety of battery systems

In an environment where regulators are raising safety requirements and asking for reliable tests for evaluating compliance of energy storage technologies, the National Research Council of Canada (NRC) has taken a leading role in developing a tool and methodology to validate the safety of battery systems against potential abusive thermal events. The NRC's Thermal Runaway Initiation Methodology (TRIM) has been adopted by various businesses and R&D environments based in North America, Europe and Asia. This unique technology is a part of the testing toolbox for global battery safety testing standards.[1]

With dozens of licenses issued, the TRIM technology is available for various commercial or R&D purposes:

- Further develop the technology through research collaboration
- License for manufacturing purposes
- License for distribution purposes



Our staff is highly trained to conduct TRIM-initiated thermal runaway propagation tests.

## About the TRIM technology

The NRC's patented[2] TRIM device and testing methodology can be used to study how a single cell thermal runaway failure can propagate through battery modules and packs. The TRIM method consists of locally heating the external surface of one lithium-ion cell with a pulse of heat, which rapidly (in a few seconds) increases the cell's active material above some critical temperature to initiate thermal runaway without preheating neighboring cells. It represents significant progress towards a reliable compliance validation test for LiB pack thermal runaway. TRIM operates based on the localized rapid external heating method described in ISO6469-1:2019/Amd1:2022 and is currently being considered in other standards and regulations.

## Benefits

TRIM has several advantages over conventional battery testing methodology for thermal runaway activation:

- **Realistic**: It applies heat locally and rapidly in the same manner as a single-cell internal short circuit.
- **Minimally invasive**: TRIM has been successfully deployed on fully operational battery systems, including vehicles, and was invisible to the thermal and battery management system.
- **Reliable**: An embedded temperature feedback sensor prevents premature element failures or unwanted cell sidewall ruptures.
- **Repeatable**: A high-speed temperature controller ensures the desired temperature profile is maintained.
- **Adaptable** to a wide variety of cell types, sizes and geometries; at the cell, component or system scales. Its small size and minimum thickness allow placement almost anywhere.

## Potential applications

- **Understanding thermal failure modes of batteries to improve detection and mitigation strategies**. Investigating and validating how packaging materials, cell spacing and thermal management strategies can mitigate the propagation of single cell thermal failures.
- **Suitable for applications that utilize lithium-ion batteries** including: automotive, military, aeronautical, marine, energy storage, medical and more.
- **Adaptable to safety performance testing at any technology readiness level**, from initial prototype to end-use compliance.

## Potential output

- Evaluation of the thermal response of your battery design in realistic conditions
- Explore how your battery reacts in hazardous situations and failure scenarios
- Identify improvement opportunities for your chosen battery design
- Establish safeguards within your chosen battery cell choices and pack designs

## Technical Specifications

| | Heating Element V4B | Heating Element V5 |
|---|---|---|
| Specification | Value | Value |
| Target Applications | Cylindrical and pouch cells | Prismatic and pouch cells |
| Active Surface Area ($cm^2$) | 3.2 | 17.6 |
| Thickness (mm) | 0.7 | 0.7 |
| Peak Applied Power (W) | 1000 | 2000 |
| Typ. Heat Flux ($W/m^2$) | $>1 \times 10^6$ | $>1 \times 10^6$ |
| Maximum Temperature (°C) | 1000 | 1000 |
| Typ. Ratio of applied electrical energy divided by target cell's rated discharge capacity | < 10% | < 10% |

Controller Unit

| Specification | Value |
|---|---|
| Input Voltage | 180 to 260 VAC @50/60Hz |
| AC Current | 15.5A/180VAC |
| TRIM Output Voltage | 24VDC |

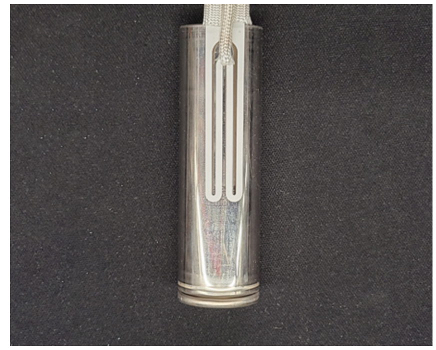
Features:

- Programmable operational modes such as multiple ramp and soak
- High frequency response – 100ms
- Temperature feedback ensures heating power is stopped once self-sustaining exothermic reactions begin
- Thermostatic control prevents unwanted elements burnout or sidewall ruptures
- Optional software control

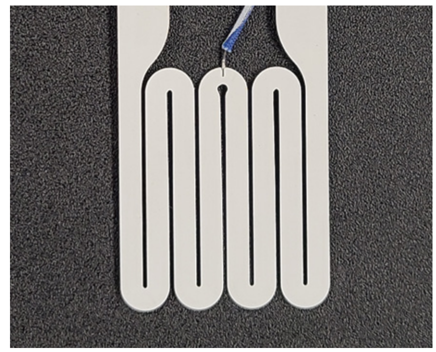
Since batteries of various chemistries, formats and energy densities will continue to appear in the market for some time to come, the NRC is also interested in opportunities to collaborate in areas that will contribute to further developments of battery safety and related technologies.

If you are interested by any of these opportunities, please contact us.


Controller unit.



Heating element V4B positioned on a 21700 cell.



Heating element V5.

## Contact

**Steven Recoskie, PhD,**
**Research Officer and**
**Lead developer of TRIM**
Battery Testing and Optimization Team, Automotive and Surface Transportation Research Centre
+1.613.853.6840
steven.recoskie@nrc-cnrc.gc.ca

**Peter M. Banks,**
**Business Development Officer**
Automotive and Surface Transportation Research Centre
+1.519-851-3873
peter.banks@nrc-cnrc.gc.ca

**canada.ca/nrc-automotive-surface-transportation**



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[1] With the financial partnering support of Transport Canada

[2] "Apparatus and Method for initiating Thermal Runaway in a Battery" with application date of January 18, 2018 numbered PCT/CA2018/050055.