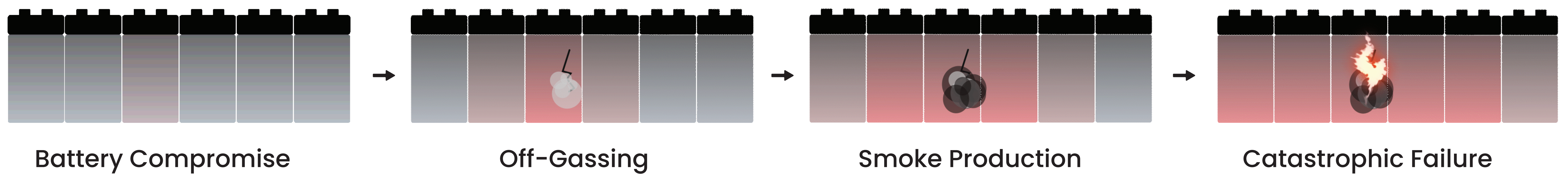


# Thermal Management, not just Fire Protection

## Background

Energy storage systems are essential in the clean energy space, enabling efficient use of solar and wind power, stabilizing the grid, enhancing energy reliability, and reducing our reliance on fossil fuels. Nonetheless, a significant safety concern with lithium-ion batteries is thermal runaway, which can trigger chain reactions of cell failures, potentially causing fires or explosions. Legacy methods used for addressing catastrophic thermal failure inadequately tackle the issue only after a fire has been detected, relying on fire suppression systems using various extinguishants. Implementing effective thermal management systems is crucial to ensure safe operation and proactively prevent fires by addressing the root issue within the cell itself.

### Stages of a thermal event

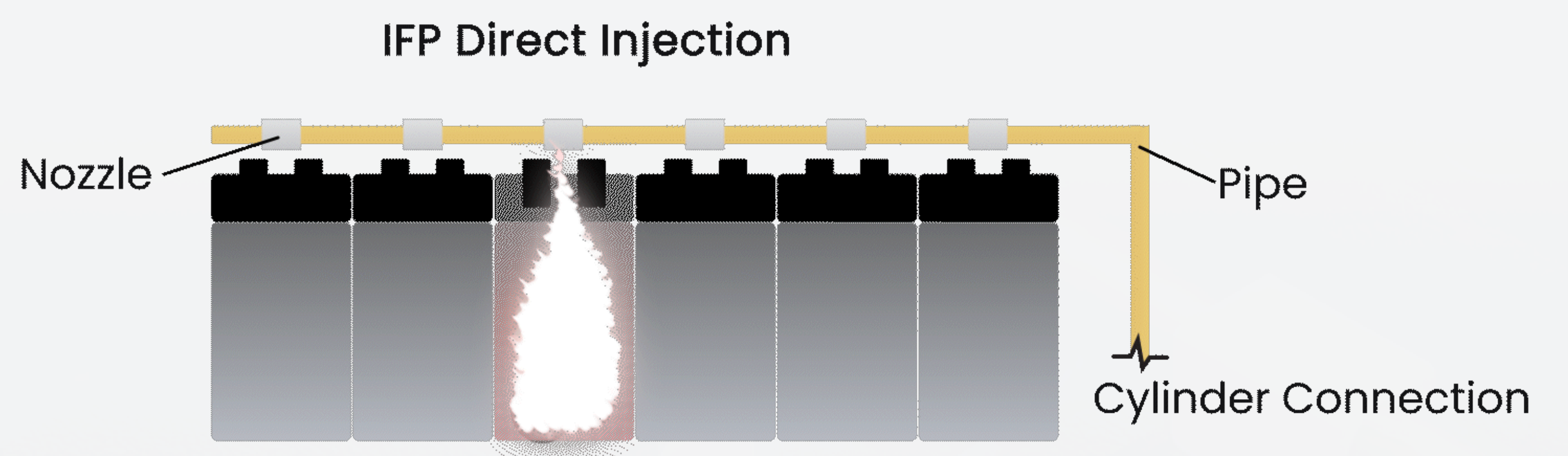


### Lets talk data..

#### Proof of concept - Fluid Immersion/Direct Injection

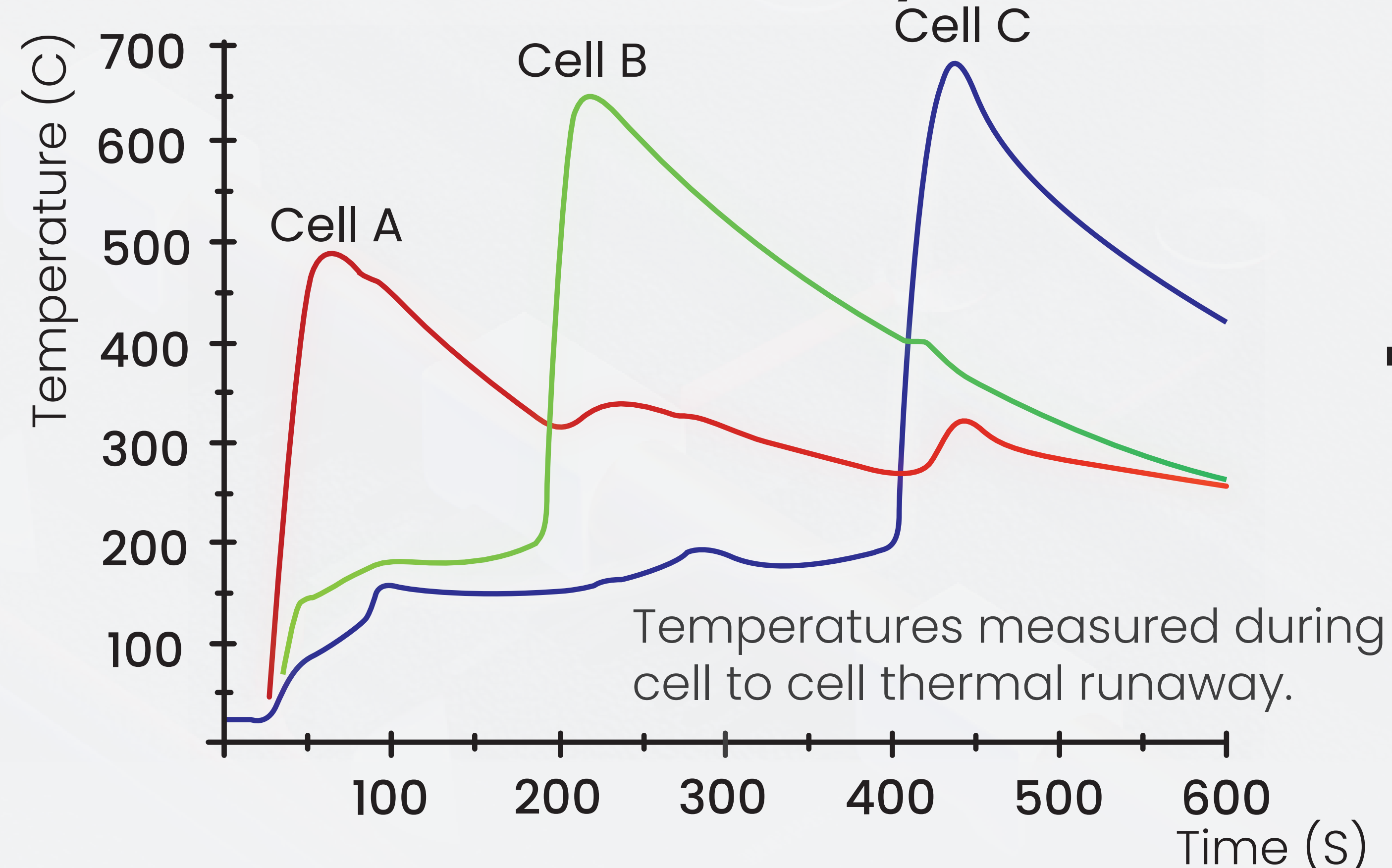
LFP Batteries tested using fluorinated fluid for prevention of cell to cell cascading thermal runaway with direct injection immersion technology.

- Cell A fails reaching temperature of 500C°
- Cell B fails reaches temperature of 650C°
- Cell C reaches temperature of 665C°
- Battery in thermal runaway.

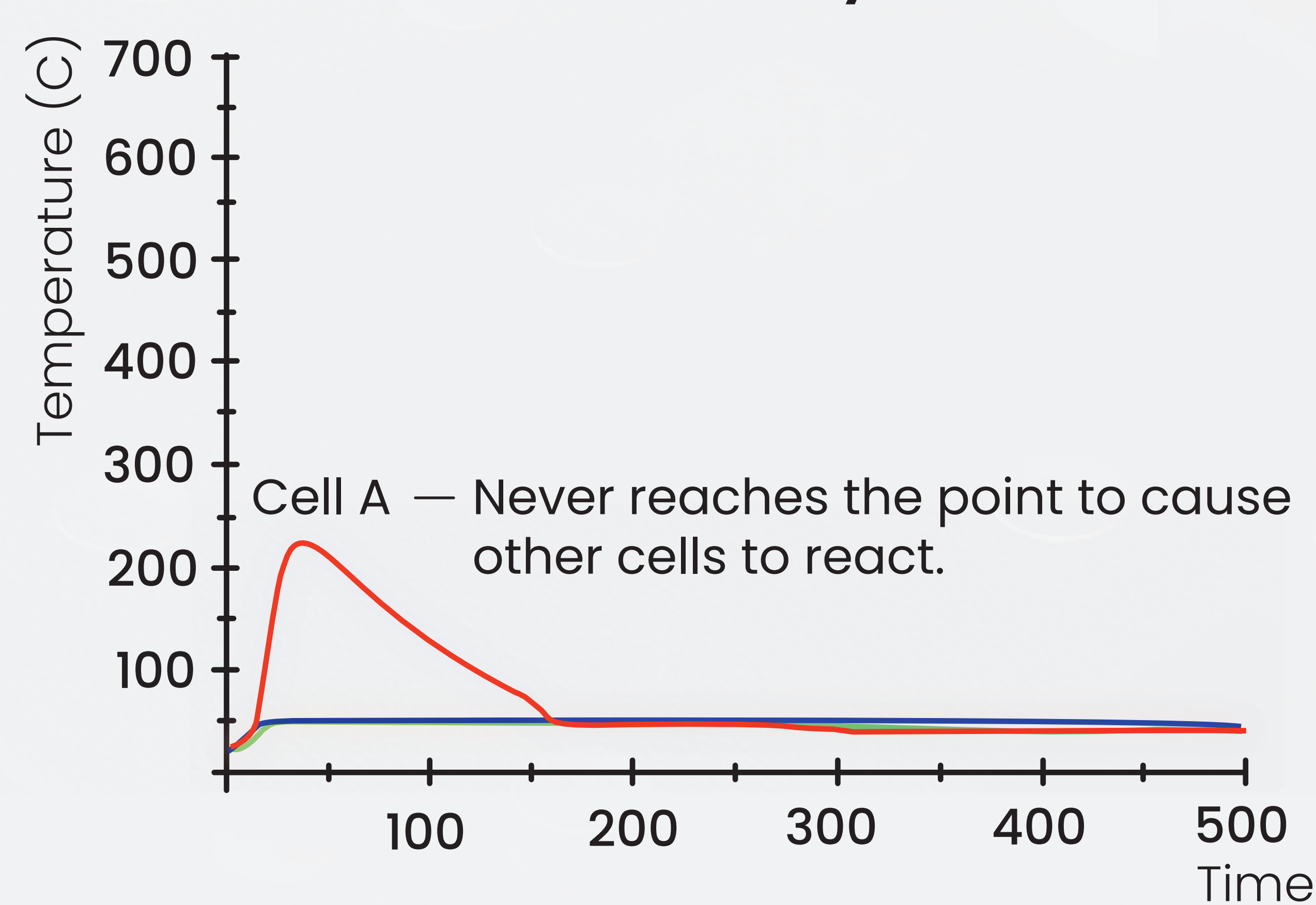


By bathing the damaged cell in fluorinated fluid, the thermal event is isolated as heat transfer to adjacent cells is contained.

#### Cell to Cell Thermal Runaway - No Protection



#### Cell to Cell Thermal Runaway - Immersion Protection



Meyring, Lu, Johnson, 3M Company, Application of Fluid Immersion for Increased Safety and Efficiency of Lithium-Ion Battery and Electronic Devices, SFPE International North America Conference and Expo, April 2014

The most important step for the industry is to get educated on the root causes of safety issues in these containers. When we embrace the understanding of the root problems and seek solutions, it will boost the confidence of authorities and the public in Energy Storage Systems (ESS) and in energy transition as a whole.



#### What can the industry do?

- Early Detection
- Advanced battery designs
- Implementation of sophisticated Battery Management Systems (BMS)
- Incorporation of effective cooling and thermal management technologies.

