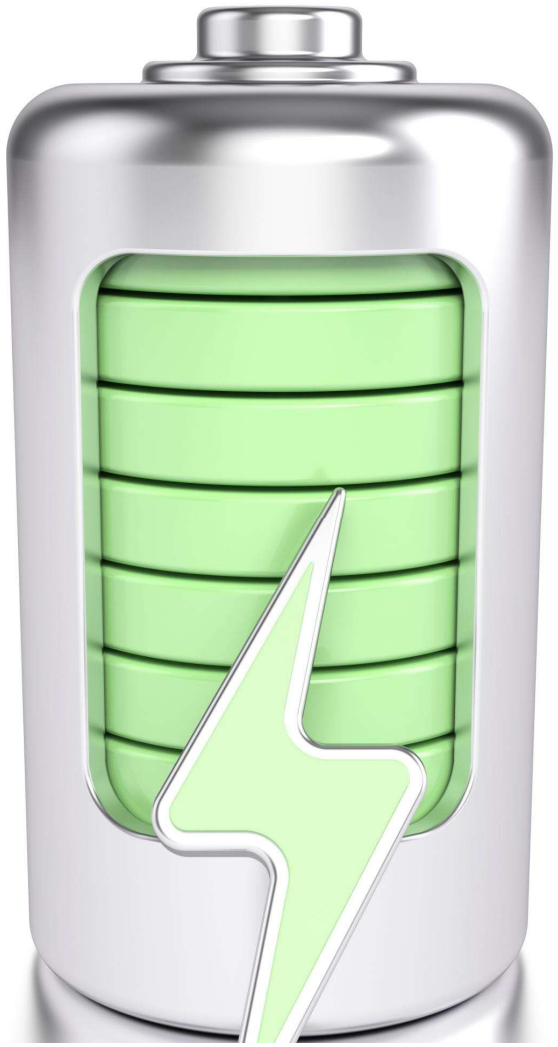

Beyond Charging: Powerbank Safety, Lithium Batteries and Fire Risk

Understanding hazards and precautions for portable energy devices

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Context and Key Messages

Homes, High-Rises and Travel

Lithium-ion Battery Risks

Lithium-ion batteries pose unique fire risks due to thermal runaway, a chemical process independent of oxygen.

High-Rise Building Challenges

High-rises amplify battery fire risks due to evacuation complexity and vertical fire spread potential.

Travel Safety Concerns

Travel introduces vibration, impact, pressure, and temperature risks to lithium batteries, especially in aviation.

Limitations of Water Suppression

Water-based suppression cools but cannot stop internal reactions and may produce toxic gases.

Critical Takeaways for Industry Professionals

Systemic Standards Gaps
Current Australian standards don't fully address lithium battery fire propagation or gas explosion risks.

Limitations of Water Cooling
Water can't stop internal thermal runaway.
Large volumes are a risk to the environment.

Challenges in Risk Assessment
Low probability but extreme consequences of battery failures make traditional risk assessments insufficient.

Compliance vs Real-world Risk
Designs meeting regulations may still leave occupants and assets vulnerable to serious hazards.

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Battery-related fires are systemic

- Battery fires occurring daily across trucks, MRFs and transfer stations
- Over 12,000 battery-related fire and heat events annually
- Workers exposed to serious safety risk
- Insurance premiums escalating; some facilities struggling to obtain cover
- Significant infrastructure damage and productivity loss
- Average increased cost over $400,000 across business

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People don't realise how many electronics contain batteries…

Flashing wristband


Electric toothbrush


Toys


Wireless earbuds


Hoverboard


Shoes and skates


Portable lamp


Scrunchies

Digital pregnancy test


Cordless vacuum


Vapes

…the risk is invisible when people throw things away

3

VID - Lithium-ion batteries are causing fires every day across Australia 7.30
https://youtu.be/jKbNIw9_szg?si=4POmwSeE8UIIADyY

Prevalence and Cost of the Problem

Ubiquity of Lithium-Ion

Wide Applications

Lithium-ion batteries power electronics, electric vehicles, and fixed installations like home storage and data centers.

Energy Capacity Range

Battery capacity ranges from 0.01 kWh in small devices to over 40 kWh in home storage systems.

Safety and Risk Challenges

High-rise buildings face energy-dense hazards not covered by legacy fire codes, posing safety risks.

Visibility and Risk Management

Lack of user knowledge about battery internals makes risk management reactive, not proactive.

Downtime, and Life Safety

Direct Financial Impact

Direct costs include total assets loss, structural damage, content destruction, battery system replacements after fire incidents.

Indirect Business and Reputational Costs

Indirect costs involve business interruption, resident displacement, reputational harm, and increased insurance premiums.

Life Safety and Health Risks

Incidents cause toxic gas exposure, delayed detection, and explosions that threaten occupants and first responders.

Need for Enhanced Safety Measures

Enhanced detection, compartmentation, and suppression strategies can reduce overall costs and improve safety.

Why Lithium Battery Fires Occur

Internal and External Short Circuits

Internal Short Circuits

Internal shorts occur when anode and cathode connect inside the cell due to mechanical or electrical abuse.

External Short Circuits

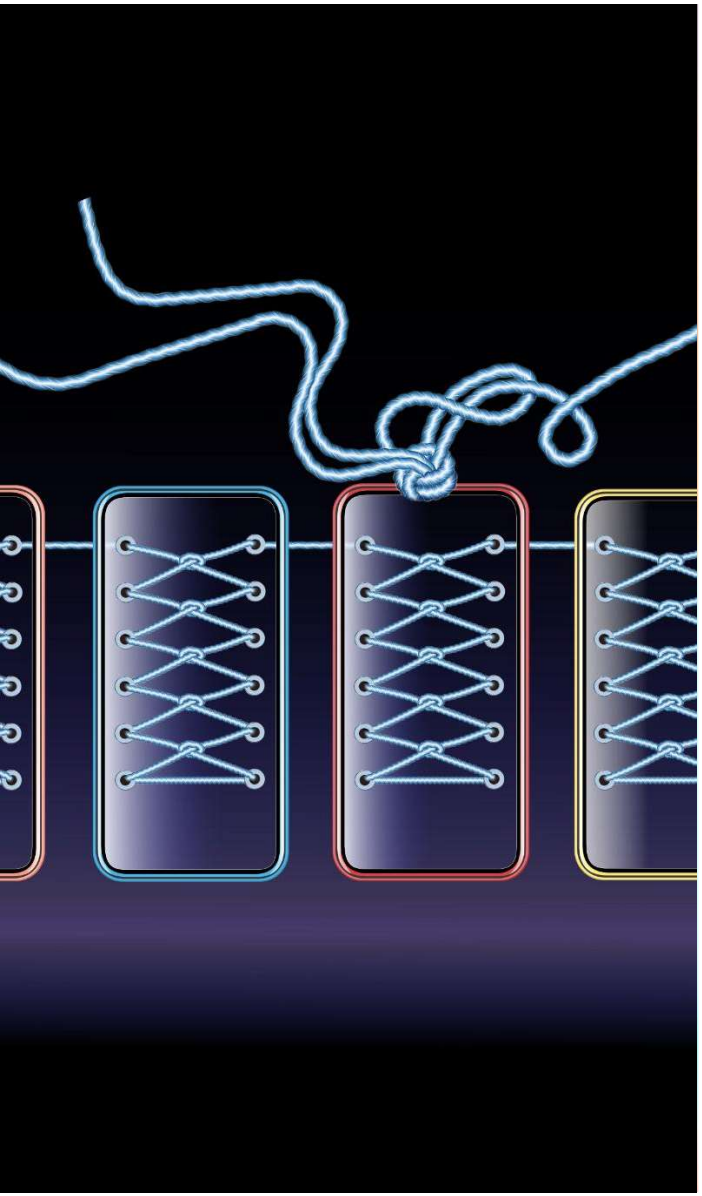
External shorts happen outside the cell from damaged wiring, conductive debris, or water ingress causing rapid energy release.

Thermal Runaway Risk

Short circuits cause localized heating that can trigger thermal runaway, increasing fire and explosion risk.

Device Vulnerabilities

Minimal protective features in consumer devices raise risks from drops, modifications, and incorrect charging.



Thermal Runaway and Gas Generation

Thermal Runaway Definition

Thermal runaway occurs when heat generated inside a lithium battery cell surpasses heat dissipation, causing uncontrollable temperature rise.

Gas Generation

High temperatures trigger release of flammable gases like hydrogen and carbon monoxide and toxic gases such as hydrogen fluoride.

Cascade Failure Risk

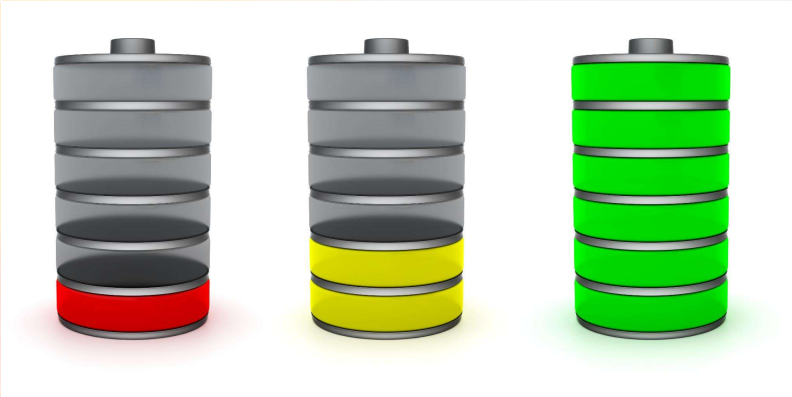
Thermal runaway spreads as neighboring cells reach critical temperatures, causing cascading failures across battery packs.

Fire Intensity Factors

Oxygen release from some cathode chemistries intensifies combustion, making fires difficult to extinguish by smothering.

Fire Risks and Assessment

Risk Factors Influencing Probability and Impact



Probability Influencing Factors

Factors like cell size, chemistry, state of charge, age, and battery management systems influence failure probability.

Environmental and Usage Risks

External heat, ventilation, mechanical abuse, and usage conditions impact risk probability and behavior.

Consequence Determinants

Cell separation, enclosure design, gas toxicity, explosion potential, and suppression systems affect impact severity.

Risk Assessment Challenges

Conventional qualitative risk matrices underestimate nonlinear dynamics and extreme credible scenarios.

Factors Influencing approvals

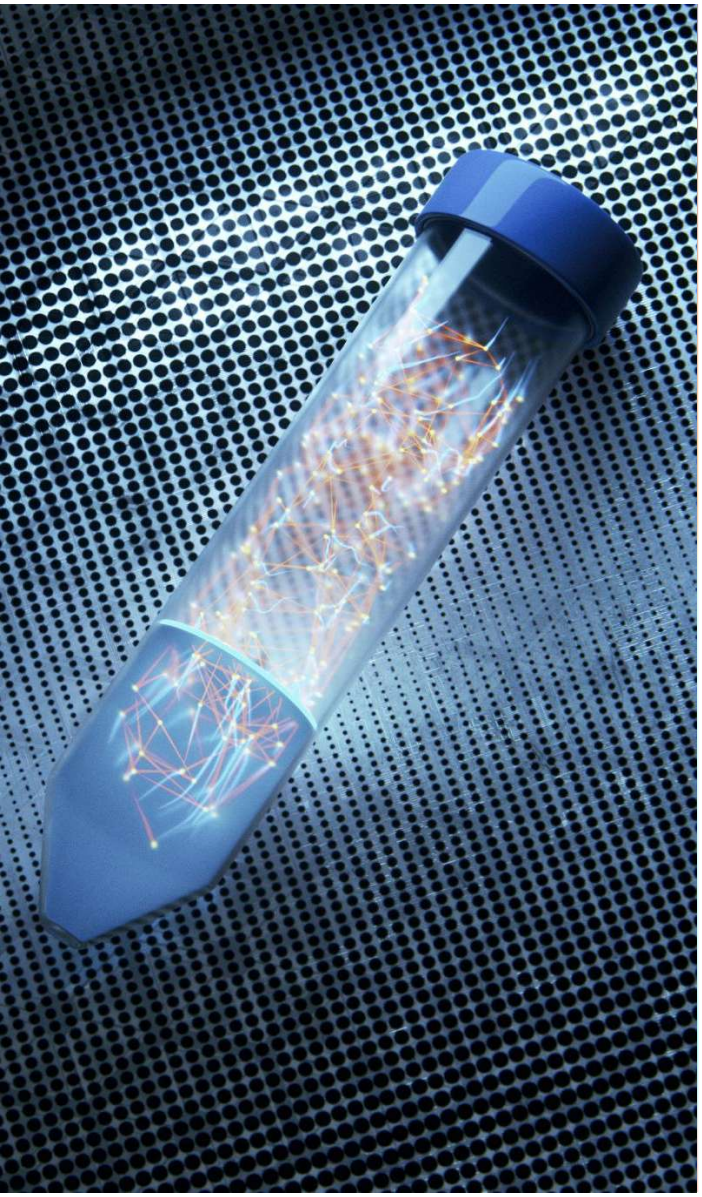
Getting approvals.
Flood of “Class L” approved products.
No clear Australian LiB test standards.
Legislation v asset retention. (FSS failure)

Environmental approvals.
Large volumes of water require larger containment.
High fines enforced by EPA. T1 is now $4m.

Budget constraints.
The larger and more complicated the fire safety infrastructure becomes the more expensive the solution. Pushing projects beyond the ROC tipping point.

Future proofing.
Fire Engineered Performance Solution. Higher initial cost.

Prevention and Early Intervention



Early Off-Gas Detection as a Preventive Measure

Early Detection Importance

Detecting electrolyte off-gassing early helps prevent lithium battery fires before thermal runaway begins.

Detection Technology

Metal oxide gas sensors and aspirating systems sense vapors at parts per million, enabling early warnings.

Preventive Interventions

Early warnings allow actions like cutting charging current and targeted cooling to avoid fire incidents.

Proactive Safety Shift

Off-gas detection marks a shift from reactive suppression to proactive fire prevention in battery safety.

Fire Control and Suppression

Traditional Extinguishing Methods

Limited Effectiveness on Thermal Runaway

Traditional methods fail to stop internal chemical reactions sustaining lithium battery fires causing thermal runaway.

Challenges of Water Use

Water cools and prevents fire spread but may create secondary hazards like hydrogen fluoride and hydrogen gas release.

Gaseous Agents Limitations

Carbon dioxide and nitrogen suppress flames but lack sufficient cooling for lithium battery fires.

Re-ignition Risk with Powders and AEROSOLS

Powders and aerosols may extinguish fire temporarily but risk rapid re-ignition as heat accumulates.

Market choices.

https://youtu.be/XJ1q-hLAzlQ?si=5HETZ8I5mMMiBwpq

Water
Cools cells and slows thermal runaway. Large quantities are needed. Contaminate hazards.

Gas
Suppress small developing flames. Poor cooling.

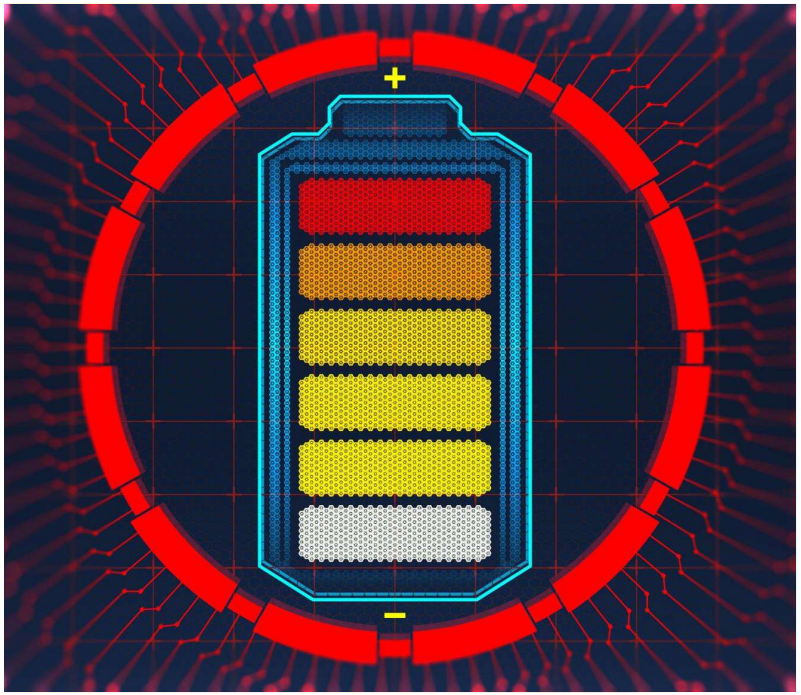
Aerosol
Effective for flame knockdown. Limited cooling.

Foam — high expansion
Reduces oxygen and heat transfer. Poor penetration and cooling.

Foam — low expansion
Blankets battery and surround. Effective cooling preventing thermal runaway/re-ignition.

Standards, Gaps, and Future Direction

Implications for Standards and



Gap in Current Standards

Existing standards mainly cover electrical safety but lack detailed guidance on fire and explosion hazards of lithium batteries.

Need for Advanced Testing

International research and full-scale tests like UL 9540A provide critical insights for improving safety guidelines and design practices.

Rethinking Fire Safety Design

Design guidance should include updated detection, compartmentation, suppression systems, and emergency response plans.

Collaborative Industry Action

Coordinated efforts by standards bodies, regulators, and professionals are essential to improve lithium battery fire safety.

Next steps?