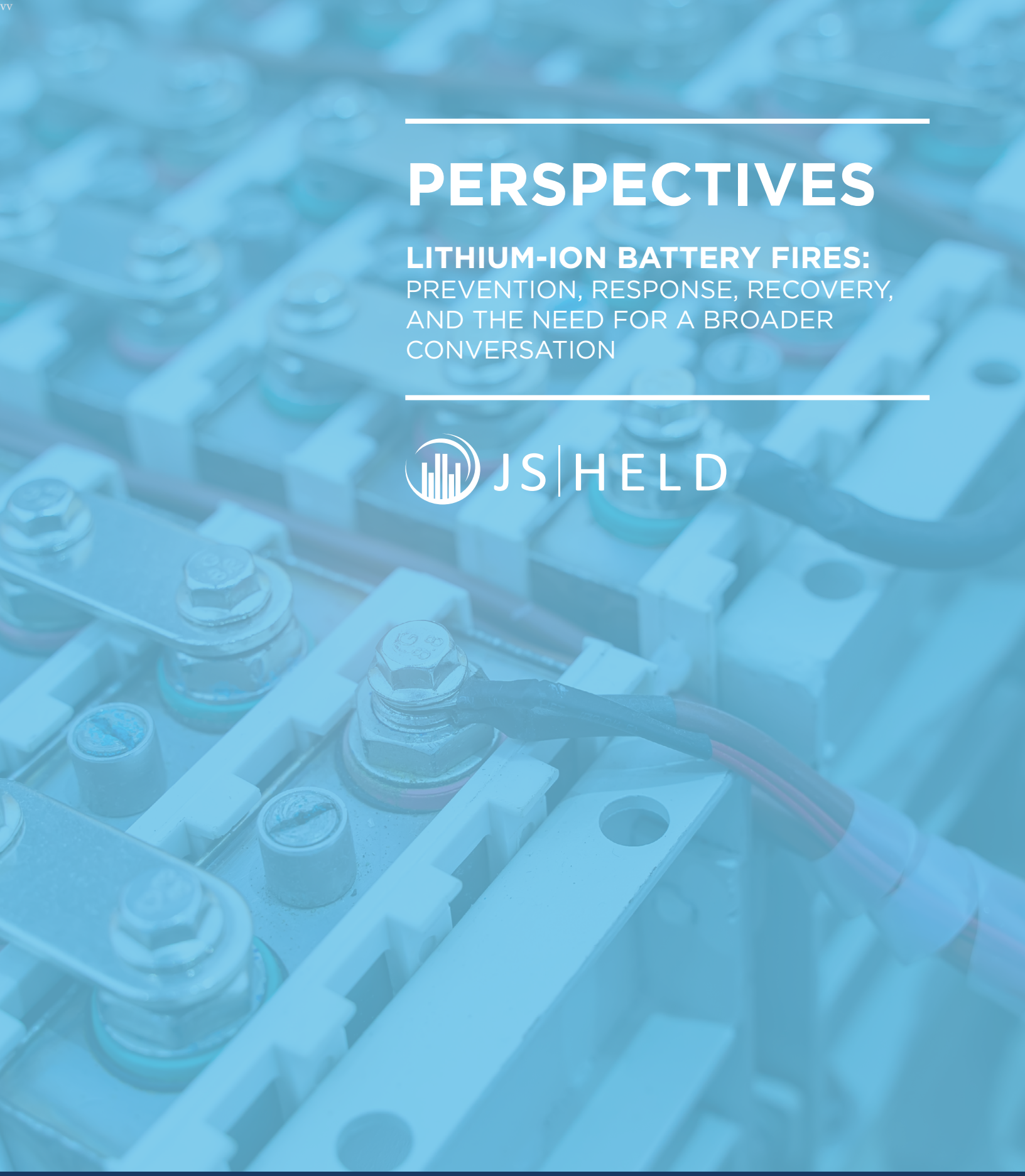


PERSPECTIVES

LITHIUM-ION BATTERY FIRES: PREVENTION, RESPONSE, RECOVERY, AND THE NEED FOR A BROADER CONVERSATION

JS|HELD

Our perspectives feature the viewpoints of our subject matter experts on current topics and emerging trends.

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Building owners and managers and design professionals should read this article to learn more about:

- Common causes of lithium-ion battery failure and how thermal runaway can spread.
- Why battery fires pose distinct suppression, toxic gas, and reignition challenges.
- How building design, ventilation, site selection, charging practices, and public education can help reduce risks.

Corporate risk managers and environmental professionals should read this article to learn more about:

- How battery residues spread through smoke, water, HVAC systems, and human activity.
- The roles of contamination assessment, HVAC restoration, and re-occupancy evaluation in post-fire recovery.
- How collaboration across fire protection, industrial hygiene, and restoration disciplines supports comprehensive recovery to protect people, property, and critical operations.

EXPERT VOICE

Derrick A. Denis



In this article, Derrick discusses lithium-ion battery fire prevention and response, industrial hygiene, indoor environmental quality, contamination assessment, and building restoration. He applies his expertise to lithium-ion battery incidents through a multidisciplinary lens, extending the conversation beyond fire suppression to post-fire contamination assessment, remediation, re-occupancy, and long-term building recovery.

Executive Summary

Derrick Denis's "Lithium-Ion Batteries, Fires and Our Industry," published in ASHRAE Journal, examined lithium-ion battery-fire risks, building and HVAC impacts, and ASHRAE's potential role in engineering guidance. This expanded standalone article broadens that foundation into a multidisciplinary approach spanning prevention, emergency response, environmental and health risks, investigation, restoration, and long-term recovery. It calls for collaboration across engineering, industrial hygiene, restoration, healthcare, insurance, utilities, and public agencies. The central imperative: managing lithium-ion battery incidents extends beyond extinguishment to understanding causes, assessing hazards, addressing contamination, restoring systems, and supporting occupants' safe return.

Introduction

Lithium-ion batteries have transformed modern society. They power mobile devices, power tools, medical equipment, electric vehicles, battery energy storage systems (BESS), and countless technologies that support daily life. Their benefits are undeniable, but like many rapidly adopted technologies, lithium-ion batteries present challenges that society is still learning to manage.

Among the most significant of those challenges is the lithium-ion battery fire.

When a lithium-ion battery fire occurs, the hazards extend well beyond those encountered in conventional fires. Responders and building occupants may face intense fire behavior, explosion potential, toxic and flammable gas generation, and contamination from battery-derived particulates. These hazards can persist long after the visible fire has been extinguished, creating complex safety, environmental, and restoration challenges.

Understanding Lithium-Ion Battery Systems

Most lithium-ion batteries are not a single large battery. Instead, they consist of multiple interconnected cells assembled into modules and battery packs.

A smartphone may contain only a few cells, while a power tool battery may contain dozens. Electric vehicles often contain thousands of cells, and utility-scale battery energy storage systems may contain millions.

This design allows significant energy storage within a relatively compact footprint. However, it also creates the potential for failure in one cell to propagate to neighboring cells, resulting in a cascading event known as thermal runaway.

Once thermal runaway begins, controlling the progression of damage can become extraordinarily difficult.

Why Lithium-Ion Batteries Fail

Most lithium-ion batteries operate safely throughout their expected service life. When failures occur, they are commonly associated with one or more of the following factors:

Manufacturing Defects

Defects introduced during manufacturing may create internal conditions that increase the likelihood of failure. The risk can be elevated when batteries are counterfeited or produced without adequate quality control measures.

Electrical Faults

Improper charging practices, incompatible chargers, overcharging events, damaged electrical connections, and short circuits can generate excessive internal heat and initiate battery failure.

Physical Damage

Dropping, crushing, puncturing, or otherwise damaging batteries can compromise internal separators and create conditions that lead to thermal runaway.

Environmental Stress

Exposure to excessive heat, extreme cold, or repeated thermal cycling can accelerate degradation and negatively affect battery performance and safety.

Water Intrusion

Flooding, firefighting operations, and environmental exposure may damage batteries and electrical systems. In some situations, batteries ignite immediately following water contact; in others, ignition may occur hours, days, or even weeks later.

Water damage and secondary issues, such as mold growth and structural deterioration, may occur following lithium-ion battery fires due to limitations in implementing traditional water mitigation and restoration practices while damaged batteries remain unstable.

Why Lithium-Ion Battery Fires Are Different

Lithium-ion battery fires involve all the hazards traditionally associated with fire, but they also introduce a unique set of additional concerns.

The release of stored energy can produce rapid fire growth, intense heat generation, and violent fire behavior. At the same time, the decomposition of battery materials can generate a mixture of toxic and flammable gases.

Depending on battery chemistry and fire conditions, these emissions may include:

- Carbon monoxide
- Hydrogen
- Hydrogen fluoride
- Hydrogen chloride
- Hydrogen cyanide

When allowed to accumulate within confined spaces, these gases may create explosion hazards. They also pose significant inhalation risks to building occupants, first responders, investigators, and recovery personnel.

The Challenge of Black Mass

Another concern is the generation of black mass, a residue consisting of fine particulate matter released during battery failure and combustion.

Black mass may contain battery constituents such as lithium, nickel, cobalt, manganese, and other metals. Because the particles are often microscopic, they can be transported considerable distances by smoke movement, HVAC systems, fire suppression water runoff, and human activity.

A practical rule of thumb is this: black mass goes where the smoke goes, where the water goes, settles near the point of origin, and is tracked wherever responders and investigators travel.

Effective incident management requires consideration of every contamination pathway.

Firefighting Continues to Evolve

Fire departments around the world continue to evaluate the most effective methods for managing lithium-ion battery fires.

Response strategies may include:

- Large-volume water application
- Specialized extinguishing agents
- Fire blankets
- Piercing nozzles or deluge systems
- Sand or other isolation techniques
- Controlled burn strategies under specific circumstances

One challenge is that batteries undergoing thermal runaway may generate oxygen internally, greatly reducing the effectiveness of certain conventional suppression approaches. This allows some lithium-ion batteries to continue reacting and generating heat even while submerged in water.

Another ongoing challenge is reignition.

Unlike many traditional fires, a lithium-ion battery incident may not be fully resolved when visible flames disappear. Damaged batteries and exposed wires can remain unstable and may reignite hours, days, or even weeks later.

Accordingly, post-fire monitoring, isolation, and risk assessment are often just as important as the initial suppression effort.

Implications for Buildings and Design Professionals

As lithium-ion batteries become increasingly common, architects, engineers, facility managers, and code officials must consider their implications during design and operation.

Key considerations include:

Ventilation and Smoke Movement

Ventilation systems can influence the movement of toxic gases, smoke, and battery-derived particulates throughout a building.

Dedicated ventilation systems for charging rooms, battery storage areas, and energy

storage installations should be evaluated. Future designs may also benefit from ventilation systems integrated with or activated by:

- Fire alarm systems
- Smoke detection systems
- Carbon monoxide monitoring
- Fire sprinkler activation signals

Outdoor Air Intakes

The location of outdoor air (OA) intakes deserves careful consideration.

An electric vehicle fire, battery storage system fire, hazardous material release, or wildland-urban interface fire occurring near a facility could introduce contaminants into occupied spaces through mechanical ventilation systems.

Remotely operated or alarm-actuated outdoor air dampers can help limit contaminant infiltration and support shelter-in-place strategies.

Thermal Management

Temperature significantly affects battery safety and longevity.

Simple measures such as shading battery installations, promoting airflow, and charging equipment during cooler periods can reduce thermal stress and potentially improve battery performance and service life.

Site Selection

Location matters.

Battery charging stations and energy storage systems should be evaluated with consideration for:

- Flood risk
- Proximity to critical infrastructure
- Emergency access
- Occupant exposure potential
- Fire department operations
- Building evacuation considerations

These concepts seem straightforward on paper, yet they are often overlooked during implementation.

The Public's Role in Battery Safety

Engineering controls, codes, standards, and emergency response capabilities are essential, but public education remains one of the most underutilized tools for reducing battery-related incidents.

Several practices should become common knowledge:

- Recycle lithium-ion batteries responsibly.
- Never dispose of lithium-ion batteries in household trash.
- Only use manufacturer-approved charging equipment.
- Monitor battery age and expected service life.
- Inspect batteries, chargers, cables, and battery management systems regularly.
- Remove damaged batteries from service immediately.
- Recognize signs of battery distress such as swelling, overheating, cracking, charging abnormalities, or water damage.
- Avoid overloading electrical circuits with multiple charging devices.
- Charge devices in attended, well-ventilated locations away from combustible materials and emergency egress routes.

Battery safety can no longer be viewed solely as the responsibility of manufacturers, regulators, or emergency responders. End users are an essential component of any effective fire prevention strategy.

A Broader Perspective Is Needed

The complexity of lithium-ion battery incidents highlights the need for a broader, multidisciplinary approach. Preventing, responding to, investigating, restoring, and recovering from these events requires collaboration from organizations and professionals whose expertise extends well beyond fire suppression alone.

The lithium-ion battery conversation should include fire protection professionals, industrial hygienists, environmental scientists, restoration specialists, healthcare engineers, insurers, forensic investigators, utilities, public health agencies, waste-management professionals, and consumer safety organizations.

A battery fire is not truly resolved when the flames are extinguished. Resolution occurs when:

1. The cause is understood.
2. Hazards are characterized.
3. Contamination is addressed.
4. Systems are restored.
5. Occupants can safely return.

HVAC Systems After a Lithium-Ion Battery Fire

One emerging issue that deserves greater attention is HVAC contamination following a lithium-ion battery fire.

Smoke, corrosive gases, combustion byproducts, and battery-derived particulate matter may enter air-handling systems and be distributed throughout a facility. Air handlers, filters, ductwork, coils, diffusers, and building contents can all be affected.

Unlike conventional fire residues, lithium-ion battery contaminants may include conductive, metal-containing particulates that pose additional concerns during cleanup and restoration.

If not properly evaluated and remediated, these contaminants may be reintroduced into occupied spaces during future HVAC operation.

As lithium-ion battery incidents become more common, specialized post-fire assessment, cleaning, verification, and restoration protocols will become increasingly important.

Why ASHRAE and NADCA Should Have a Seat at the Table

Historically, discussions of lithium-ion batteries have focused on manufacturers, code officials, regulators, and emergency responders. While those stakeholders remain essential, they do not represent the full range of disciplines affected by battery failures.

Many lithium-ion battery incidents generate corrosive gases, conductive residues, and fine particulates that may be transported through HVAC systems and redistributed throughout buildings.

As a result, battery safety discussions must expand beyond ignition prevention and fire suppression to include:

- Indoor environmental quality
- HVAC isolation strategies
- Post-fire contamination assessment
- HVAC cleaning and restoration
- Worker exposure protection
- Re-occupancy criteria
- Long-term building recovery

Organizations such as ASHRAE, RIA, IICRC, AIHA, IAQA, and NADCA possess expertise directly relevant to these challenges and should be active participants in developing future guidance, standards, research initiatives, best practices, and recovery frameworks for lithium-ion battery incidents.

Conclusion

Lithium-ion batteries are likely to remain a cornerstone of modern technology for decades to come. Their continued growth will bring substantial societal benefits, but it will also require a more comprehensive approach to prevention, response, recovery, and resilience.

The industry has already invested considerable effort in battery design, manufacturing standards, and emergency response. The next phase of progress must include equal attention to environmental impacts, worker protection, indoor environmental quality, building restoration, and public education.

The question is no longer whether lithium-ion battery incidents will occur. The question is whether society is prepared to address not only ignition and suppression, but also the environmental, health, infrastructure, and recovery challenges that follow. The organizations that recognize this broader reality today will be best positioned to protect people, property, and critical operations tomorrow.

Acknowledgments

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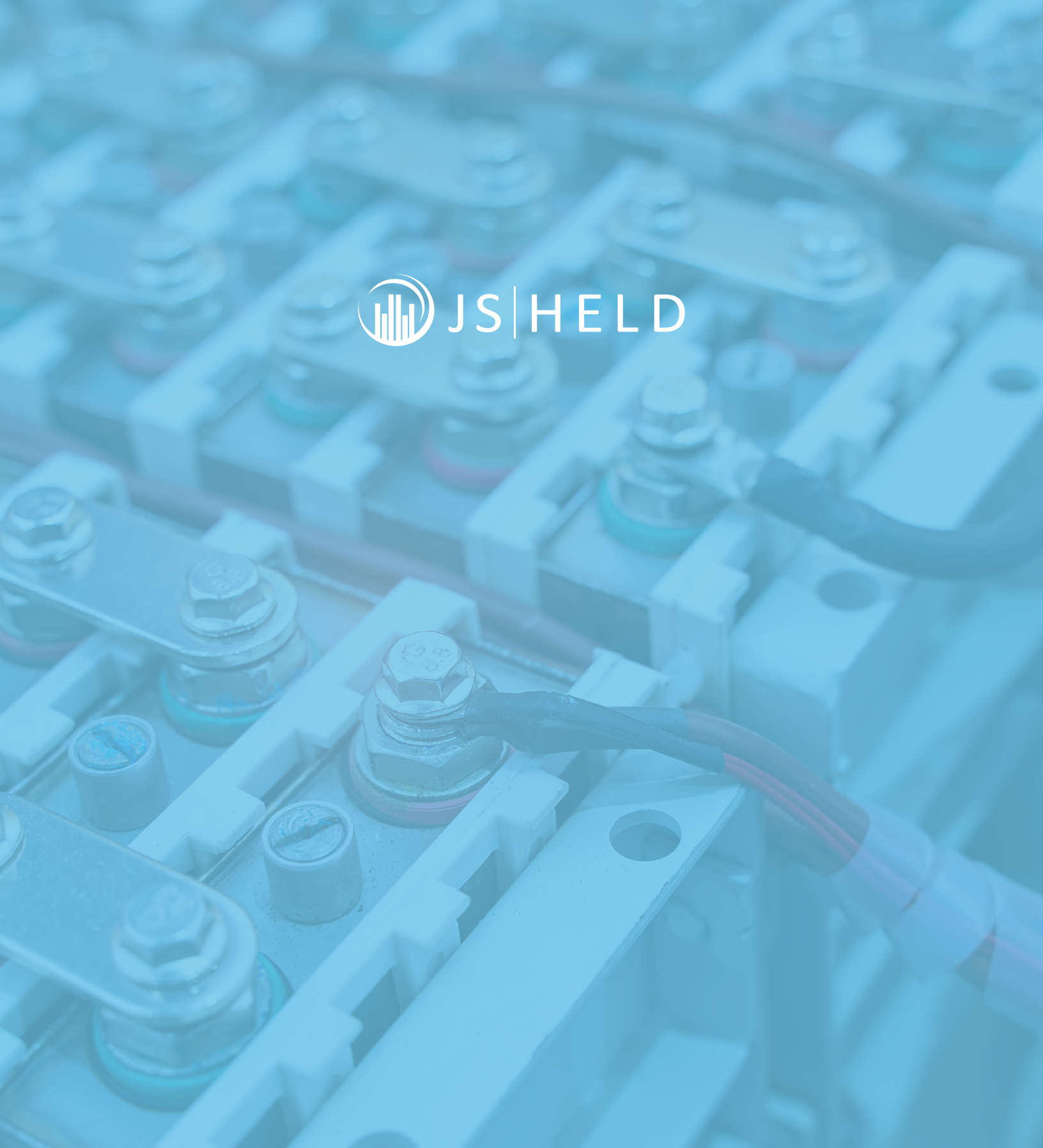
More About J.S. Held's Contributor

Derrick A. Denis joined J.S. Held in May of 2026 as part of J.S. Held's acquisition of Clark Seif Clark, Inc. Derrick is an internationally recognized industrial hygienist, inventor, educator, author, and subject matter expert in lithium-ion battery fire prevention, emergency response, contamination assessment, building restoration, and recovery. Since the early 1990s, he has provided professional industrial hygiene (IH), environmental health and safety (EHS), infection control (IC), and indoor environmental quality (IEQ) services domestically and abroad. As a sought-after presenter, he has delivered hundreds of educational sessions for associations and private groups worldwide.

Derrick leverages a B.S. in Environmental Science, multiple certifications and licenses, and extensive experience to serve as a respected, impartial expert witness. He has supported more than 100 state and federal cases on behalf of both plaintiffs and defendants, from depositions through trial testimony. Actively engaged in the industry, Derrick has held board positions with organizations including the Indoor Air Quality Association (IAQA), Environmental Information Association–Arizona Chapter (EIA AZ), and the American Council for Accredited Certifications (ACAC). He is also an inventor and patent holder, including a disposable N95 fit test hood for healthcare use and Sewer Gas Solutions®, a patented product designed to prevent sewer gas and pest infiltration through plumbing traps.

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