



Lithium-Ion Battery Safety in UPS Applications: Facts vs. Fiction

Addressing common misconceptions about the risk of overheating and fire caused by Lithium-Ion Batteries in Data Center and UPS Applications.

By: Molly Gross, Principal, Power Solutions, LLC

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- *Standards, certifications, and UPS compatibility testing*
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EXECUTIVE SUMMARY:

Review of the misconceptions about Lithium-ion battery safety, as well as regulations for lithium-ion batteries and their safety features. The different lithium-ion battery chemistries will be discussed and how they affect safety. It also covers the cell, module, and pack-level design features, the layered battery management system (BMS) and UPS protections, and the certifications and compatibility testing behind Schneider Electric's Li-ion UPS batteries, along with Schneider Electric's field safety record.

It was unfortunate timing. Right around the time battery manufacturers had engineered solutions that addressed safety concerns for lithium-ion batteries in UPS applications, the news was filled with stories of the batteries in electric vehicles and consumer electronic devices overheating. The UPS industry was in the process of launching and promoting their long-awaited 3-Phase UPS systems with Lithium-Ion Batteries (LIB) and was already facing an uphill battle to prove to data center designers and operators that LIB was a safe and effective battery option that ultimately reduces the UPS total cost of ownership.

But the viral videos of cellphones randomly catching fire on airplanes couldn't be ignored and the negative press about lithium-ion batteries complicated the UPS and battery manufacturers' ability to make the case that LIB are as safe as VRLA in UPS applications. Adding fuel to the fire, some major US cities passed laws limiting or even prohibiting the use of lithium-ion batteries in large energy storage applications and small electric vehicles such as scooters and e-bikes.

Lithium-Ion batteries for UPS applications got a bad rap from the beginning.

If thermal runaway in cellphone batteries was causing fires in handheld devices, imagine how catastrophic a fire in the data center could be. Lithium-ion car batteries are also frequently criticized for their ability to easily ignite and continue to feed a fire. If it's difficult to put out a fire in an electric vehicle, how hard will it be to extinguish a data center fire with dozens of batteries before there's a complete loss? And, what about those laws prohibiting the use of lithium-ion in large energy storage applications? If they're not safe as far as local fire departments and governments are concerned, why would data center operators feel comfortable using them in their UPS? These are questions commonly asked when discussing safety concerns for Lithium-ion batteries in UPS applications.

Prevent thermal runaway through proper installation and utilization of the type of lithium-ion battery recommended by the manufacturer.

Addressing common misconceptions about the risk of overheating and fire caused by Lithium-Ion Batteries in Data Center and UPS Applications starts with understanding the safety features of Lithium-Ion batteries for UPS and how they prevent thermal runaway or fire. To start, it's helpful to know what causes thermal

runaway in the first place. When a battery is damaged or misused, it can cause a short circuit in a battery cell. From there, a rapid chain reaction occurs producing a large amount of heat. This chain reaction may continue into neighboring cells causing them to break down and release hot flammable gases.

The primary ways to prevent thermal runaway are to ensure proper installation and protection for the battery cells to minimize the risk of damage that would cause the short-circuit. Similarly, it is important to use the lithium-ion batteries in accordance with the manufacturer's recommendations. If a short-circuit still manages to occur, it's critical to have the safety mechanisms in place to minimize the heat produced by the thermal runaway. These mechanisms include battery management systems (BMS), cell-level current interrupt devices, safety fuses, cell spacing and barriers, and other features we discuss later, to isolate the affected cell or battery module so the chain reaction doesn't spread to other cells.

The field record tells a different story.

The incidents behind most safety concerns come from consumer electronics and electric vehicles, and they are not reflected in the field record for UPS batteries. Schneider Electric has deployed more than 20 million UPS units globally over the last 40 years. It has deployed Li-ion batteries in three-phase UPS systems since 2016 and in single-phase UPS systems since 2018, when it launched what it describes as the world's first 1 and 1.5 kVA Smart-UPS with lithium-ion batteries. According to Schneider Electric, more than 500,000 Li-ion UPS units have been deployed without any reported safety incidents, a seven-year safety record with zero thermal issues.

It's all about the chemistry.

The term 'li-ion' refers to an entire class of batteries whose electrochemistry varies widely. The actual chemistry of a lithium-ion battery is the single most determining factor in how heat-sensitive and therefore, safe, or stable, a lithium-ion battery is. Without asking you to refer to the Periodic Table of the Elements, suffice it to say that lithium-ion battery chemistries vary by application. For example, the Lithium-ion batteries in cellphones need to provide high density power for as long as possible in as little space as possible. That demands a certain kind of compound be

included in the battery – Lithium Cobalt Oxide (LCO). This chemistry offers high energy density, but sacrifices stability, particularly if the battery is damaged.

In UPS applications where there is a greater emphasis on safety, more stable compounds that include nickel (NMC), manganese (LMO), and iron phosphate (LFP) are used. These other compounds offer lower energy density, but longer life creating a more stable battery. Of these, LFP is the most thermally stable, and NMC-based chemistries are widely used for their high discharge rates. Schneider Electric uses both: its three-phase Galaxy Li-ion battery cabinets use Samsung SDI modules with a nickel-manganese-cobalt oxide (NMC/LMO) chemistry, Smart-UPS Ultra and Smart-UPS Modular Ultra batteries use NMC, and Smart-UPS Lithium-Ion (SMTL) models use LFP.

But what if there is an overheating event or fire? It depends on the chemistry. The compounds used in lithium-ion batteries for consumer electronics and electric vehicles produce oxygen when they overheat, thus increasing the chance a fire will start and, once it does, making it extraordinarily difficult to put out. Data center fire suppression systems are typically designed to extinguish fires by limiting oxygen. The compounds used for LIB in UPS and data center applications release far less oxygen when overheating, particularly LFP, which makes a fire less likely to start or sustain itself. Compliance with National Fire Protection Association (NFPA) codes is then established through the testing and listing described below.

The chemistries used for LIB in UPS and data center applications release far less oxygen when overheating than consumer-electronics chemistries, making fires less likely to start or spread.

Safety is designed in at the cell, module, and pack level.

Safety starts with a high-quality cell. Each cell in a Schneider Electric Li-ion battery has an internal current interrupt device (CID), which opens the circuit if internal pressure rises, and a safety vent to relieve pressure. A fuse outside each cell adds protection against short circuits.

At the module and pack level, safe design includes a protective enclosure, safety interlocks, barriers and shields, adequate cell-to-cell spacing, and fusing that

protects against both internal and external short circuits. Cell spacing matters because a cell experiencing high temperature can pass heat to its neighbors in three ways: conduction through the connecting tabs, conduction through the air, and radiation. Spacing and barriers slow that heat transfer so a problem in one cell does not propagate to the cells around it.

Safety is layered: cell-level interrupt devices and fuses, pack-level spacing and barriers, the BMS, and independent UPS protections.

Standards and safety features significantly reduce the risk of thermal runaway.

Many standards and testing protocols have been developed over the years by Underwriters Laboratories (UL), the National Fire Protection Association (NFPA), and the International Electrotechnical Commission (IEC). NFPA 855, the Standard for the Installation of Stationary Energy Storage Systems, addresses how to safely deploy LIB, including in data centers, and the related fire protection requirements. UL 1973 is the safety standard for batteries used in stationary applications, including UPS, and is referenced by NFPA codes. Schneider Electric's cells are certified to IEC 62133 and UN 38.3, its battery modules are certified to IEC 62619, UN 38.3, and UL 1973, and the BMS is evaluated for functional safety under IEC 60730-1 Annex H. Installation codes also set requirements for the battery cabinet and room, such as noncombustible, lockable enclosures, as well as spacing and layout to manage the energy density and capacity of the installation.

The key standards Schneider Electric's Li-ion batteries are certified to or designed to meet include:

Standard	What it covers
IEC 62133 (cells)	Safety and performance requirements and tests for lithium-ion cells and batteries.
UN 38.3 (cells and modules)	Transport safety. Cells and packs are tested for leakage, venting, rupture, or fire under altitude simulation, thermal, vibration, shock, short-circuit, impact/crush, overcharge, and forced-discharge conditions.
IEC 62619 (modules)	Safe operation of lithium cells and batteries in industrial and stationary applications, including overcharge, overheating, drop, and thermal runaway propagation tests.

Standard	What it covers
UL 1973 (modules)	Batteries for stationary applications. Evaluates the ability to withstand electrical, mechanical, EMI, and environmental abuse, including overcharge, short circuit, imbalanced charging, crush, drop, and single-cell thermal runaway.
IEC 60730-1 Annex H (BMS)	Functional safety of the BMS software and hardware, including how the electronics detect and handle internal faults.
UL 9540	Safety of energy storage systems and equipment. In the US, Galaxy UPS systems paired with Schneider Electric Galaxy Lithium-ion battery cabinets are offered as UL 9540 energy storage systems. The cabinets are listed to UL 1973 and tested to UL 9540A.

Another important distinction between batteries used in small consumer electronics where space and weight are at a high premium versus data center applications where footprint is measured in square feet rather than millimeters, is that LIB for UPS applications come with a Battery Management System (BMS) embedded in the battery modules. The BMS monitors every cell and disconnects the affected battery module or cabinet if it operates outside safe limits. In Smart-UPS Modular Ultra, which uses multiple battery modules, isolating one module allows the remaining modules to continue supporting the load. Most LIB manufacturers include additional built-in safety features such as safety fuses inside each battery module, overload, overcharge, and short-circuit protections, hardened material layers and thermal dissipation measures to minimize the chance of thermal runaway.

Battery Management Systems monitor every cell and can disconnect the affected battery module or cabinet if any cell strays outside safe operating limits.

The BMS: multiple, redundant layers of protection.

The BMS keeps every cell within its safe operating area. Its core functions are cell monitoring and balancing, battery pack monitoring, current sensing and coulomb counting, battery event logging, communication with the UPS, and battery disconnection. Schneider Electric's Galaxy Lithium-ion battery cabinets and Smart-UPS Modular Ultra batteries both provide the following protections:

- Voltage protection: cell- and pack-level over- and under-voltage protection, and protection against cell voltage imbalance. If limits are exceeded, the battery module (Smart-UPS Modular Ultra) or the cabinet's battery breaker (Galaxy) disconnects.
- Fault latching: after a major fault, the battery stays disconnected. In Smart-UPS Modular Ultra, a severe cell voltage fault takes the module offline permanently and reports it for replacement. In Galaxy cabinets, the breaker stays open until the condition clears and the BMS is reset.
- Current protection: charge and discharge over-current protection. Galaxy cabinets use multiple trip levels; Smart-UPS Modular Ultra adds a redundant hardware layer on charge current.
- Short-circuit protection: Smart-UPS Modular Ultra uses hardware short-circuit protection that opens the discharge path. Galaxy cabinets combine fusing, with fuse-failure detection, and the battery breaker.
- Temperature protection: the BMS monitors cell temperatures and disconnects the battery on over-temperature. Galaxy cabinets also trip on excessive temperature differences between cells; Smart-UPS Modular Ultra adds redundant hardware over-temperature protection on charge.
- Self-diagnostics: the BMS detects failures in its own sensing, communication, and switching components, including voltage- and current-sensing errors, lost communication, and battery breaker faults.

In Smart-UPS Modular Ultra, the BMS also measures cell resistance and remaining amp-hour capacity to estimate battery state of health. It issues a battery replacement warning before capacity becomes a problem, and it predicts runtime from individual cell voltage and capacity measurements. Galaxy systems report battery status and remaining runtime to the UPS. Schneider Electric recommends a runtime calibration test at start-up and whenever batteries are replaced to keep that estimate accurate.

The UPS adds a second, independent layer of protection.

In Smart-UPS Modular Ultra, the UPS protects the battery independently of the BMS. It uses two redundant protections, firmware and hardware, to prevent voltage above the limit from being applied to the battery. It stops discharge before the battery reaches its undervoltage level, monitors each battery's charging current to keep it below the limit, provides overload protection, and regularly self-tests on-

battery operation. Galaxy UPS systems monitor the battery breakers and battery temperature, run scheduled battery tests, and can trip the battery breakers.

The battery and the UPS are tested together.

To confirm that a Li-ion battery pack is fully compatible with its UPS, Schneider Electric's R&D and test teams run system-level tests including battery discharge runtime, deep discharge, recharge, float charging, the battery test function, battery protection, EPO function, dry contacts, operation on battery at no load, and transfer to battery at full load with the battery charged. This validation is one reason substituting batteries from unapproved manufacturers creates risk: that pairing has not been through it.

What about those laws prohibiting li-ion batteries in some cities?

It's a common misunderstanding that lithium-ion batteries for data center and UPS applications are prohibited in some large cities such as San Diego and New York City. Neither city prohibits them. Both regulate lithium-ion energy storage, including UPS batteries, through their fire and building codes, and both require listed, tested equipment.

In New York City, every stationary lithium-ion energy storage system needs a product-specific FDNY approval, and indoor systems need an FDNY permit, supported by UL 9540 listing and UL 9540A test data. Department of Buildings rules effective October 26, 2025, formally permit indoor energy storage systems under a NYC-modified version of NFPA 855, with capacity thresholds as low as 1 kWh for lithium-ion.

In San Diego, as throughout California, the California Fire Code (Section 1207) applies to lithium-ion energy storage systems above 20 kWh, a threshold a single Galaxy Lithium-ion battery cabinet exceeds. The code requires a permit, a listed system, and large-scale fire test data such as UL 9540A, and its UPS-specific exemptions apply only to lead-acid batteries. Facilities in the San Diego County Fire Protection District with more than 600 kWh of lithium-ion storage face additional guidelines.

Much of the public attention, and much of the legislation, has focused on e-bikes and e-scooters. New York City, for example, prohibits selling, leasing, or renting e-bikes unless their electrical systems are certified to UL 2849.

It's worth pointing out that the batteries behind most e-vehicle incidents, particularly aftermarket and used packs, often use different chemistries and lack the listed BMS, enclosure, and testing of a UPS battery system. So, it really is about the chemistry, and about the complete system around it.

Conclusion

The special chemistries and robust safety features unique to LIB were engineered and developed specifically to address the safety concerns for Lithium-ion batteries in UPS applications. For this reason, it is important that the Lithium-Ion Battery be approved by the UPS manufacturer for use in stationary storage battery systems. The safety features of the UPS and LIB must be compatible to ensure safe operation, which is why Schneider Electric tests each battery and UPS pairing together. Substituting or replacing Lithium-ion batteries from unapproved manufacturers can put your facility at risk. Similarly, we recommend factory assembly and start-up services for LIB systems for UPS and regular factory preventive maintenance services. When the time comes to replace aging Lithium-ion batteries for UPS, it is important to use brand new factory parts and service.

The development of chemistries specific to LIB in data center and UPS applications coupled with the advanced safety features embedded in each battery cell, module, and string allows the UPS OEMs to offer a lower total cost of ownership for lithium-ion batteries versus VRLA in UPS applications. With more power in less space and at a fraction of the weight, LIBs are emerging as a safe, best-in-class choice for standby emergency power for critical applications, backed by more than 500,000 Schneider Electric Li-ion UPS units deployed with no reported safety incidents. With the UL 1973 listing and compliance with NFPA fire codes, many existing data centers can be retrofitted to a LIB solution without requiring major changes to the fire suppression and HVAC systems, subject to review by the local authority having jurisdiction (AHJ).

For more information about lithium-ion batteries for UPS applications, and a side-by-side comparison of the total cost of ownership of Lithium-ion

batteries versus VRLA, please see our article, [‘The Higher Upfront Cost of Li-Ion UPS Batteries Pays for Itself — Here’s the Proof’](#). If you would like to review a sampling of single-phase and 3-Phase UPS Systems that come with Lithium-Ion batteries, please visit our [website](#). For more details including configuration assistance and pricing, email sales@power-solutions.com, or call 800-876-9373.

Power Solutions | PO Box 100 | Barrington | RI | 02806