

Lithium-Ion Battery Manufacturing

Risk Engineering Services

Lithium-ion battery manufacturing combines clean-room production, ignitable liquids, combustible dusts, dense work-in-progress inventories, and charged cells. **The most severe losses rarely come from one hazard alone;** they emerge when process upsets, storage density, and thermal runaway exposure compound one another. The key question is not whether a site simply “has sprinklers”, but whether segregation, water supply, protection design, and emergency planning are aligned with the actual occupancy and storage arrangement.

Background and market context

Demand for lithium-ion batteries continues to drive investment in large, highly automated plants producing electrodes, cells and modules for electric vehicles, mobility applications and stationary storage. Gigafactories often combine high-bay warehousing, automated guided vehicles, compact layouts, clean rooms and hazardous liquid systems in the same property footprint.

That mix creates a loss profile in which a localized process upset can escalate into building fire, smoke contamination, and extended business interruption. A site can look modern and well-engineered, yet still carry material gaps if design assumptions, storage configurations and emergency arrangements have drifted away from current best practice.

Where major losses concentrate

Slurry preparation and coating

N-Methyl-pyrrolidone (NMP) solvent vapours, combustible powders, extraction failure, and inadequate inerting can create ignitable liquid vapour or powder dust explosion conditions.

Electrolyte filling

Ignitable liquid electrolyte systems require inerting, containment, leak detection, interlocks, and careful treatment of Hydrogen Fluoride under abnormal conditions.

Formation and aging

The first charge, long dwell times and dense tray or rack arrangements make this the critical thermal-runaway hotspot.

Rejected cells

Temporary pallet storage outside dedicated areas can turn a quality issue into a disproportionate property-loss event.

Decision focus

- Formation and aging drive the defining thermal-runaway exposure.
- Electrolyte and solvent systems can turn leaks into fire or explosion events.
- Rejected-cell handling often separates resilient risks from fragile ones.

Three insight signals

- FM Data Sheet 7-112 provides dedicated guidance for lithium-ion battery manufacturing and storage.
- Older facilities may still reflect a mix of NFPA and earlier FM criteria, so reference to a named standard alone does not confirm adequacy.
- Automatic suppression is expected to limit spread and cool surrounding assets; it cannot be assumed to stop thermal runaway once established.

Process hotspots and what strong controls look like

Process stage	Primary exposures	Risk management practices
Slurry preparation	NMP handling, combustible powders, static discharge, vapour or dust ignition.	Fire-rated liquid rooms, containment and drainage, secondary containment for transfer systems, nitrogen blanketing, dust collection, exhaust system alarms, and automatic shutdown on loss of inerting.
Coating and drying	Solvent vapour in ovens and ducts, vacuum or exhaust system failure, overheating.	Start-up and shutdown interlocks, temperature and pressure monitoring, exhaust system flow measurement, Lower Explosive Limit (LEL) alarms with staged shutdown or purge, local fire detection and suppression systems, and protected exhaust systems.
Electrolyte filling	Class IC ignitable liquid exposure, leak escalation, oxygen and hydrogen fluoride concerns.	Two-hour room construction, drainage to emergency tank, LEL and fire detection, oxygen and hydrogen fluoride (HF) monitoring, welded secondary containment for transfer systems, explosion-proof filling systems, ventilation with interlocks to limit vapour accumulation, and remote isolation logic.
Formation and aging	Charged cells, thermal-runaway events, gas release, long-duration exposure.	Two-hour chambers, gas, fire and thermal detection, emergency exhaust to a safe exterior route, and local rack, slot or chamber protection designed for the actual arrangement.
Incidental Work-in-Progress storage	Too much buffer inventory, excessive pile size or height, and high State of Charge (SOC) storage in process areas.	Clear low-pile limits, 3 metre aisles, controlled footprints, storage height limits, SOC discipline and upgraded protection when batteries move into racks.
Rejected cells	Accumulation of damaged or defective cells awaiting recycle or discharge.	Dedicated cut-off room, detached structure or managed outdoor area with separation, direct fire-service access and no exposure to critical process, utility or storage zones. Rejected cells should be discharged as soon as possible.

Practical point: the risk is usually explained by the interaction between process controls, charged inventory, storage arrangement and emergency readiness – not by any single control in isolation.

Protection implications

- Use non-combustible construction; rooftop solar panels should not aggravate a combustible roof scenario.
- Ignitable liquids, pumps and transfer systems should be separated, interlocked and contained.
- For cell finishing, formation and aging, local arrangement-specific protection is often decisive.
- Wet-pipe sprinklers remain the preferred baseline because speed, simplicity and reliability matter in fast-moving events.
- Long-duration water supply and hose allowance should be validated against the actual design basis, not assumed.

Risk signals

- Unknown basis of design or reliance on legacy standards without a gap assessment against current dedicated guidance.
- Dry-pipe systems chosen by default rather than as a clearly justified contamination or freezing trade-off.
- High-SOC buffer storage or rack storage treated as incidental when the footprint, height or arrangement no longer qualifies.
- No dedicated area for rejected cells, or slow off-site removal that allows accumulation in process spaces.
- No LEL, thermal, oxygen or hydrogen fluoride (HF) monitoring in electrolyte and cell-finishing zones.
- No pre-incident plan with the fire service and no designated external location for damaged cells.

Key message

A well-managed lithium-ion battery manufacturing facility is defined less by scale or automation and more by disciplined segregation, realistic fixed protection and strict control of charged inventory. The best risks show that management has turned a complex process into a series of bounded events.

When formation areas, electrolyte systems, WIP limits, rejected-cell handling and emergency response are all credible and aligned with the actual exposure, the risk becomes explainable. When those elements are unclear, loss potential rises sharply – even in modern facilities.

Source framework:

NFPA 13, NFPA 30, NFPA 15, NFPA 11, NFPA 855, AQ 7017 2025, GB/T 38331 2019, GB 51377-2019, FMDS 7-112, FMDS 3-26, 8-1 and 8-9,. Use alongside site-specific engineering review and applicable local requirements.

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