GUIDE BATTERY STORAGE · 8 MIN.

Gas Venting and Deflagration Protection: NFPA 68/69 and the Consequences for the Lining

With battery energy storage systems, the explosion is often more dangerous than the fire. What NFPA 68 and NFPA 69 require for explosion venting and ventilation — and what that means for the lining and compartmentation of the enclosure.

The Underestimated Hazard: Deflagration Rather Than Fire

During thermal runaway, battery cells release a combustible gas mixture — essentially hydrogen, carbon monoxide, carbon dioxide and hydrocarbons such as methane and ethylene. In closed containers and battery rooms this mixture can accumulate until an ignition source triggers a deflagration. Several severe incidents in recent years, some with injured firefighters, were caused not by the fire itself but by the explosion of accumulated vent gas.

Specialists distinguish two scenarios: the prompt deflagration, in which the gas ignites shortly after venting, and the delayed deflagration, in which gas accumulates over minutes or hours before igniting. The latter generates far higher pressures — and can scarcely be controlled by purely passive measures. NFPA 855 therefore requires an explosion protection solution for lithium-ion storage systems: explosion venting to NFPA 68 and/or explosion prevention to NFPA 69.

NFPA 68: Sizing Explosion Venting Correctly

NFPA 68 governs deflagration venting: rupture panels, flaps or lightweight panels open at a defined activation pressure and direct the pressure wave and flames outwards in a controlled manner. The vent areas are sized on the basis of the gas properties — maximum explosion pressure, burning velocity and flammability limits of the vent gas, as supplied by the UL 9540A cell-level report — and the pressure resistance of the enclosure (the reduced maximum pressure the containment must withstand).

- The design basis is the real gas data from the UL 9540A report, not generic assumptions
- The enclosure structure must withstand the remaining reduced explosion pressure
- Clear zones must be maintained in front of the vent openings — pressure, flames and debris are discharged there
- Passive explosion venting works reliably above all against prompt deflagrations

Note: The Limit of Passive Venting — Against a delayed deflagration with a high gas concentration throughout the entire volume, passive vent areas may be too small — the pressure peaks then exceed what can be vented

economically. In such scenarios there is no way around active concentration control to NFPA 69.

NFPA 69: Keeping the Gas Concentration Below the Ignition Threshold

NFPA 69 intervenes before ignition: gas detection and mechanical ventilation keep the concentration of combustible gases permanently below 25 per cent of the lower flammability limit (LFL). As a design benchmark for battery rooms, a ventilation rate of at least 1 cfm per square foot of floor area (around 5.1 l/s per m²) has become established, sized for the worst-case event from the test report. Since hydrogen, with an LFL of about 4 per cent by volume, is the most critical component, detection is sensibly configured with hydrogen as the reference gas.

In practice the two standards are combined: ventilation and detection to NFPA 69 prevent gas accumulation, while vent areas to NFPA 68 catch the residual risk of prompt ignition. This defence in depth protects not only the plant but above all the emergency crews who have to approach the enclosure in an incident.

What This Means for Lining and Compartmentation

For the internal lining of containers and battery rooms, explosion protection yields concrete construction rules that go beyond classic fire protection. Insulation that compartmentalises perfectly in a fire can become a problem in a deflagration — if it blocks vent areas, detaches under pressure or creates voids in which gas collects.

- Keep explosion vent areas and gas discharge paths completely free of insulation and cladding layers
- Fix linings mechanically so that they withstand the pressure surge and do not turn into flying debris
- Choose closed, non-combustible surfaces; no open voids or dead zones without through-ventilation
- Line discharge paths for hot vent gases with temperature-resistant materials — gas temperatures can reach several hundred degrees depending on cell chemistry
- Seal penetrations for ventilation, detection and cabling gas- and smoke-tight without impairing the venting function

Fire protection and explosion protection must therefore be designed together: the lining is part of both systems. Anyone who designs the thermal barrier without knowing the vent paths, activation pressures and ventilation concept risks the protection systems devaluing one another — in the worst case with a barrier that contains the fire but amplifies the explosion.

Frequently asked questions

Is an explosion relief flap to NFPA 68 sufficient as explosion protection?

Against a prompt deflagration shortly after venting, passive explosion venting can suffice. Against the more dangerous delayed deflagration with a high gas concentration throughout the whole volume, it is often inadequate on its own — then gas detection and ventilation to NFPA 69 are additionally required, keeping the concentration below 25 per cent of the LFL.

Where do the design parameters for venting and ventilation come from?

From the UL 9540A test report of the system in question: it documents gas volume, gas composition, lower and upper flammability limits, maximum explosion pressure and burning velocity of the vent gas. Generic literature values are only a stopgap, since the gas mixture varies considerably with cell chemistry and cell type.

Can the internal insulation of a battery container compromise explosion protection?

Yes, in several ways: if it blocks vent areas, detaches during the pressure surge and turns into flying debris, or creates voids in which vent gas accumulates unnoticed. Lining, vent areas and the ventilation concept must therefore be planned in an integrated way and coordinated with one another.

Let us talk about your project

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