KFI Certification Standard for Extinguishing Performance of Fire Extinguishers on Small Lithium-ion Battery Fires

KOREA FIRE INSTITUTE (KFI) STANDARD | NO. 630 (ENACTED ON DEC 18, 2024)

💡 Key Executive Summary

This technical standard targets special fire extinguishers capable of suppressing early-stage fires in small lithium-ion batteries commonly used in electric scooters, laptops, and smart devices. The critical core requirement dictates:

"When a fire occurs in a battery pack with a total capacity of 1,000 Wh or less, the extinguisher must immediately suppress the visible flames upon discharge, completely prevent re-ignition for 1 hour, and successfully block thermal runaway propagation to adjacent cells, maintaining a residual cell voltage of 3.7 V or higher."

1. Purpose and Background

With the exponential surge in the use of personal mobility (PM) devices, laptops, and various smart gadgets, specialized hazards regarding lithium-ion battery fires and severe thermal runaway phenomena have emerged as critical public safety concerns.

The purpose of this standard is to establish objective technical specifications, strict quality verification protocols, and standardized testing criteria for fire extinguishers engineered with early-stage mitigation capabilities to ensure enhanced field fire safety and protect human lives.

2. Definition of Key Terms

For the purpose of executing clear and uncompromised regulatory testing under this standard, the target battery components are explicitly classified based on their exact engineering capacities as follows:

Term	Definition & Technical Specifications
Single Cell	The minimum essential unit of a lithium-based battery configuration (utilizing positive electrode combinations such as Nickel-Manganese-Cobalt oxide), possessing an individual energy capacity of **100 Wh or higher**.
Small Lithium-ion Battery (Battery Pack)	A battery pack assembly consisting of exactly **5 single cells connected in a linear sequence (series or parallel)**, with the combined total capacity strictly limited to **1,000 Wh or less**.

3. Fire Performance Test Conditions (Fire Model Configuration)

To fairly and rigorously simulate the volatile characteristics of battery fires, including rapid thermal runaway and potential explosion hazards, the test apparatus must satisfy the following layout requirements:

- **Battery Arrangement & Securing:** Five single cells must be aligned linearly and rigidly fixed to an insulated test jig to prevent any structural shift during sudden thermal expansion.
- **Forced Heating Device:** A specialized film-type heater (with a thickness of 1 mm or less, and a surface area covering 50% or more of the cell's main contact surface) must be closely affixed between the 1st and 2nd cells to induce a forced thermal runaway event.
- **Emergency Safety Water Tank:** For unforeseen explosive structural failure during testing, a water tank measuring at least 1m (width) × 1m (length) × 0.5m (depth) must be prepared and filled with water to more than 60% of its capacity. The entire test battery setup must be structured to drop into this tank instantly via a remote or single-action mechanism for safety.

4. Extinguishing Test Methods & Performance Criteria

■ Test Procedure

1. Activate the film-type heating device installed between the cells to initiate forced continuous heating of the target battery pack.

2. The exact moment visible flames (fire flags) are observed emanating from the single cell adjacent to the heater, the fire extinguisher must be immediately activated to discharge its entire content capacity without interruption.

■ Performance Criteria (Both conditions must be satisfied simultaneously)

Evaluation Parameter	Pass Certification Criteria
Re-ignition Prevention	All visible flames must be extinguished completely upon completion of the agent discharge, and **no re-ignition shall occur for 1 hour (60 minutes)** post-discharge.
Fire Propagation Prevention (Cell Isolation)	After the 1-hour observation period, **at least 1 or more single cells out of the 5 total cells must remain unburnt and intact**. Furthermore, the measured open-circuit voltage (OCV) of the surviving intact single cell(s) must maintain **3.7 V or higher**.

> ※ **Technical Note (Thermal Runaway Mitigation Verification):** Maintaining a residual cell voltage of 3.7 V or higher serves as the primary technical indicator proving that the cell successfully withstood the extreme thermal stress transferred from the initial fire source without losing its functional battery capacity.

5. Environmental Conditions & Extinguisher Pre-conditioning

- **Environmental Test Conditions:** The ambient wind velocity measured at a height of 1m above the test floor must be **3 m/s or lower**, and the ambient temperature must be maintained at **5 ℃ or higher**.
- **Extinguisher Pre-conditioning:** Prior to testing, the target fire extinguisher must be stored inside an environmental chamber conditioned at its designated lower-limit operating temperature (±2 ℃) for a minimum duration of **12 hours or more**. It must be deployed into the test immediately upon removal. (This ensures operational reliability under extreme winter environments).

6. Product Marking and Labeling Requirements

Fire extinguishers certified under this standard must permanently and legibly display the following advisory statements on their product nameplate (label) to prevent consumer misinterpretation:

1. **"This product provides fire extinguishing efficacy when the entire agent capacity is discharged directly onto the cells of a lithium-ion battery."**

2. **"This product provides fire extinguishing efficacy when applied to batteries within the maximum certified lithium-ion battery capacity (000 Wh) and individual cell capacity (000 Wh) as specified."**