FSL:2025 Fire Safety Level Standard for EVSE

INTRODUCTION

Electric Vehicle Supply Equipment (EVSE) is rapidly becoming a core component of the global transport infrastructure. However, with increased deployment comes growing concern over fire risks, especially in enclosed or unattended locations. EVSE combines high-voltage electronics, constant exposure to the elements, and potential user tampering. Traditional standards focus on electrical and ingress protection but do not adequately define or enforce fire safety measures.

FSL:2025 MISSION

EVnoX develops advanced fire safety systems dedicated to the EVSE industry. Our mission is to reduce fire risk through engineering, standardization, and advocacy. We provide both passive and active fire mitigation technologies tailored to the specific environmental and operational needs of electric vehicle charging equipment. The FSL framework is a cornerstone of our initiative to establish clear industry-wide benchmarks.

OPEN ADOPTION AND INDUSTRY COLLABORATION

EVnoX invites industry stakeholders, safety bodies, and EVSE manufacturers to adopt the FSL:2025 standard. This system is proposed as an open benchmark that can coexist with existing IEC and UL norms. By creating a common language around fire safety in EVSE, the FSL system drives transparency, trust, and innovation.

EVnoX is committed to publishing technical criteria, supporting test methods, and helping others adopt this framework. We believe EV charging should be not only fast and smart, but fundamentally safe.

FIRE SAFETY LEVEL (FSL) CLASSIFICATION OVERVIEW

FSL rating	Description
FSL0	No integrated fire protection measures
FSL1	Inert, fireproof housing + embedded temperature cut-off system
FSL2	Passive internal fire-suppressing materials
FSL3	Automatic integrated fire extinguisher
FSL3+	FSL3 + Fail-safe safety alarm via normally closed (NC) sensor system

DETAILED DESCRIPTION OF EACH FSL LEVEL

FSL0 - No Integrated Fire Protection

FSL0 defines the baseline level in the Fire Safety Level (FSL) framework. It applies to EVSE devices that do not include any specific fire mitigation or suppression technologies beyond those required by general international legislation. Products at this level are typically either legacy models developed before modern fire safety risks were broadly recognized, or low-cost commercial offerings optimized for price rather than resilience or hazard containment.

EVSE units falling under FSL0 must still be compliant with fundamental safety directives such as:

- LVD (Low Voltage Directive) – ensuring protection from electric shock and fundamental construction safety;
- EMC (Electromagnetic Compatibility Directive) – ensuring that devices do not cause or are not affected by electrical interference.

However, FSL0 units provide no intentional or targeted fireproofing measures. This means:

- Enclosures are often made from basic plastics or composites that may be flammable or capable of dripping molten material under heat;
- No thermal sensors, internal shutdown logic, or overheating protections are incorporated beyond what is necessary for general electrical safety;

- Internal components such as relays, power electronics, and wiring may lack flame-retardant ratings or be arranged in configurations that allow fire propagation;
- No fire-resistant separation barriers exist between high-voltage sections and other components.

As a result, in the event of internal failure, such as overheating, arc faults, or component short-circuit, FSL0 devices provide no proactive mitigation to limit fire ignition or spread. External fire exposure, such as from a nearby burning object, can also easily penetrate the enclosure and ignite internal components.

FSL0 therefore does not satisfy any criteria for enhanced fire resilience and should be viewed as the minimum allowable threshold for EVSE safety. It is not recommended for use in sensitive, high-risk, or enclosed environments such as underground parking structures, near combustible storage, or in unsupervised installations.

FSL0 remains recognized within the FSL framework to provide a transparent reference point, helping authorities, users, and insurers identify EVSE products that lack proactive fire protection strategies.

FSL1 - Inert Enclosure and Thermal Cut-off

FSL1 introduces a foundational level of proactive fire safety to EVSE systems. Products in this category incorporate structural and control measures aimed at preventing the escalation of internal thermal events and limiting exposure to external heat sources.

To qualify for FSL1, an EVSE must meet two mandatory criteria:

- Non-flammable or flame-resistant housing materials: The external enclosure must be constructed of inert, non-combustible materials such as (stainless) steel, powder-coated aluminum, or certified inflammable polymers.These materials must be resistant to ignition from open flames or radiant heat and capable of containing an internal thermal event without contributing to combustion or melting.
- Embedded temperature monitoring and automatic charging cut-off: The system must include internal temperature sensors or thermal switches that actively monitor for overheating. Upon reaching a predefined threshold the EVSE must automatically disable charging or reduce power levels. This

prevents thermal runaway, internal arcing, or load-induced overheating from progressing into a fire.

FSL1 does not require the use of active flame-suppressant materials or extinguishing systems. However, it represents a meaningful improvement over FSL0 by interrupting the risk chain early through thermal monitoring and use of enclosures that resist flame penetration and mechanical collapse under heat stress.

FSL1 is suited for both residential and commercial installations where active suppression may not be feasible, but where basic fire containment and overheating response are critical. This level creates a structural barrier to both internal fire propagation and external fire ingress.

FSL2 - Passive Fire Suppression Materials

FSL2 builds upon the requirements of FSL1 by introducing internal materials that passively suppress fire development. This level focuses on the integration of fire-suppressant elements into the EVSE's design to reduce and delay flame spread in the event of component failure.

To qualify for FSL2, the EVSE must:

- Incorporate self-extinguishing, suppressant or flame-inhibiting materials within the internal architecture. These may include:
    - Intumescent foams that expand and insulate when exposed to high temperatures;
    - Halogen-free materials that do not emit toxic fumes during decomposition;
    - Insulating coatings or thermal barriers applied to high-risk internal components;
    - Compartmentalization to contain internal fires and prevent spread between components.

Passive systems require no active sensor or actuator to function. Their benefit lies in being maintenance-free and always ready, particularly valuable in EVSE deployed in remote, inaccessible, or weather-exposed locations.

FSL2 aims to ensure that if a fire does begin internally, it is either self-extinguished by materials that extinguish themselves or delayed long enough to quickly starve the fire of either fuel or oxygen before the fire can burn through the

enclosure. This level is appropriate for installations in high-density parking, fleet depots, or enclosed garages where fire escalation time is a critical factor.

FSL3 - Integrated Fire Suppression System

FSL3 introduces active fire suppression into the EVSE enclosure, providing a direct response capability in the event of thermal runaway or internal combustion. EVSE systems meeting FSL3 must comply with all requirements and include:

- A built-in, self-contained active fire suppression unit, such as:
  - Thermal aerosol generator (e.g. potassium nitrate),
  - Gas discharge module (e.g. CO_2, argon, or proprietary blends),
  - Dry chemical extinguisher (e.g. ABC powder capsules).
- Automatic activation, typically via a thermal fuse, burst bulb, or bi-metallic trigger that releases the agent without requiring external power or software logic.
- Suppression coverage across all fire-prone zones inside the enclosure, including power electronics, contactors, and cable terminals.

The FSL3 approach mitigates the damage caused by internal faults that escape FSL2 protections. By detecting and extinguishing flames locally and instantly, FSL3 can prevent escalation, reduce smoke and heat release, and preserve the structural integrity of the EVSE until full power isolation or inspection occurs.

FSL3 is ideal for mission-critical or high-traffic locations, such as commercial fast-charging stations, underground car parks, or facilities where delayed fire response poses unacceptable risk.

FSL3+ – Fail-safe Alarm Trigger and Remote Monitoring

FSL3+ enhances the fire protection capabilities of FSL3 by adding a fail-safe communication mechanism that alerts external systems when a suppression event occurs, or when the system becomes electrically compromised. In addition to all FSL3 criteria, FSL3+ requires:

- A normally closed (NC) sensor circuit that opens upon:
    - Activation of the fire suppression module;
    - Temperature limit;
    - Cable disconnection;
    - Sensor or wiring failure.
- This circuit must connect to either:
    - A local alarm system;
    - A remote monitoring platform;
    - Or an on-site visible/audible alert module.

FSL3+ creates a layer of external accountability and emergency response linkage, allowing site operators, building systems, or even fire departments to be notified in real time without user input. This is critical in unattended installations, large multi-unit charging bays, or smart cities integrating EVSE into wider safety infrastructure.

The fail-safe configuration ensures that any failure in the sensor loop triggers an alert, rather than disabling the system. This design is essential for systems operating in heat, vibration, or corrosive environments where connector integrity may degrade over time.

FSL3+ sets the highest benchmark for integrated EVSE fire protection, combining physical suppression with event awareness; creating both a protective and responsive system.

VERIFICATION AND DOCUMENTATION OF FSL CLASSIFICATION

FSL classifications under the FSL:2025 framework are intended to be open and self-declarable. Verification by a notified body or third-party certification authority is not required. Manufacturers, developers, and integrators may determine the applicable FSL level of their EVSE product through internal assessment, provided that clear and structured documentation is maintained to justify the assigned level. To ensure consistency, transparency, and accountability, the following documentation must be prepared and retained by the declaring party for each product claiming an FSL rating:

- Fire rating of all relevant materials: This includes the glow wire flammability index (GWFI), glow wire ignition temperature (GWIT), UL94 flammability classification, or equivalent national or international standards applicable to enclosures, cable insulation, internal plastic components, printed circuit boards, and foams. Ratings must be sourced from material datasheets or test reports from the manufacturer or (re)seller.
- Description of safety features and fire mitigation measures: A narrative overview must be provided describing the fire protection features implemented for the claimed FSL level. This includes the type of housing, location of sensors, logic for thermal cut-off, type and positioning of passive suppression materials, and configuration of extinguishing modules or alarm circuits (where applicable).
- Technical documentation of implementation: This must include schematics, mechanical drawings, internal layout diagrams, bills of materials (BOM), wiring diagrams, or software routines related to the applied fire safety features. The goal is to clearly demonstrate how the protection mechanisms have been physically and functionally implemented in the product.
- Test reports (if available): While testing is not mandatory, any internal or external fire tests, heat chamber data, thermal sensor response trials, or extinguisher activation tests should be included. These reports help validate the reliability of the protection features and add credibility to the self-declared FSL level.

The documentation must be made available on request to relevant stakeholders, including regulatory authorities, insurance assessors, installers, or end-users who rely on the FSL classification.

False or unsupported claims of compliance with a given FSL level may result in public disassociation, withdrawal of label usage rights, or legal notice in case of intentional misrepresentation. Maintaining accurate, detailed, and truthful records is therefore essential to preserve the value and trust of the FSL:2025 standard

FSL:2025 LABEL AND USAGE

The FSL label is a standardized visual identifier that denotes the Fire Safety Level classification (FSL0 to FSL3+) of an EVSE product according to the FSL:2025 framework. The label must be displayed with a minimum height of 30 mm to ensure legibility and visibility. While it is not mandatory to physically affix the label to the product, it is strongly recommended to place the label in a clearly accessible location, such as near the charging connector, user interface, or data plate, so that users, installers, and safety personnel can easily verify the fire safety level of the equipment.

Use of the FSL label is free and unrestricted, including in commercial, industrial, and consumer-facing applications, provided the product fully meets the technical criteria of the corresponding FSL level. However, the label may not be modified, altered, resized disproportionately, recolored, or used in a misleading context. Only the official version provided in the FSL:2025 may be used.

The FSL label design and associated classification system are protected by copyright and trademark. The FSL name and logo may not be registered or claimed as a separate trademark, brand, or certification by third parties under any jurisdiction. Use of the label constitutes acceptance of these conditions.