K21045 SCP05/02
6 november 2025

Specific Certification Program Fire Protection Systems for Products

Fire Protection of Lithium-ion batteries storage

kiwa

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Preface

This certification program will be used by Kiwa in conjunction with the Kiwa Regulations for Certification within the context of Certification Scheme K21045 “Fire Protection Systems”.

This specific certification program has been developed in context of:
-PGS37-1 - Lithium-containing energy carriers: Guideline for the safe storage of electricity in energy storage systems;
-PGS37-2 - Lithium-containing energy carriers: Storage;
-EN-IEC 62933-5-2 - Secondary cells and batteries containing alkaline or other non-acid electrolytes – Safety requirements for secondary lithium cells and batteries, for use in industrial applications;
-NFPA 855 - Standard for the Installation of Stationary Energy Storage Systems;
-UL 9540A – Installation level tests with outdoor lithium - ion energy storage systems mock-ups.

Kiwa Fire Safety & Security
Kiwa Nederland B.V.
Kiwa FSS Certification
Dwarsweg 10
5301 KT Zaltbommel

Tel. 088 998 51 00
NL.infocertification.fss@kiwa.com
www.kiwa.nl

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1. Introduction

1.1. General

This specific certification program includes all relevant requirements which are employed by Kiwa when dealing with applications.

This specific certification program is a first version and shall be used in context with product certification scheme K21045 “Fire Protection Systems”.

In storage are lithium-ion batteries present. In case of shortcut between the anode and cathode of one the cells in the batterie an electrochemical process starts in the batteries called “thermal runaway”. In this cases is the stored electrical energy batterie the catalyst in the electrochemical process generating heat. This heating process generates gases. The two together are creating a fire class C according to EN2. The heat and flames are also able to start a burning process with a fire class A of the solid materials of the batteries or adjacent objects such as other batteries or for example packeting materials. The reason for this shortcut can be for example failing isolation between the anode and the cathode or an electrical overload of the cells in the batteries.
The fire protection of this situations has an Achilles heel because of the stored electrical energy in the batteries that shall restart the electrochemical process if the extinguishing media has to less of a density / concentration to mitigate this process.

Kiwa has drafted this initial type testing protocol to prove the effectives of fire protection systems in the scenario of storages of lithium-ion batteries.
In this second version have the principles of several standards and guidelines been incorporated in this document.

1.2. Field of application / scope(s)

The performance of the fire protection system is determined for a typical lithium-ion batterie(s) fire(s). The repressive performance of the fire protection system depends heavily on the typical situation.

This certification program requires an test protocol per typical situation motivated on the safety methodology that consists of five phases, namely:

- Pro-action;
- Prevention;
- Preparation;
- Repression and;
- Aftercare of the process end-to-end.

The situational performance of the fire protection system shall be declared based on:

- The type of batteries with the maximum level of electrical energy and the typical containment / casing;
- How high the batteries are / can be electrically loaded;
- How the batteries are stored / moved / used.

The Type of Mitigation Performance (ToMP) of the fire protection system shall be declared based on the type of protection such as:

- Fire Control;
- Fire Prevention;
- Fire Repression;
- Fire Suppression.

The Effective Mitigation Performance Time (EMPT) of the fire protection system shall be declared based on the time of the of protection is effective.

For example are these hold time for total flooding systems or the time fire protection media is supplied by surface protection systems.

Based on the results of this test program in this specific certification program is additional listing possible in the Technical Approval of the product certificate of the fire protection system based on TIC-scheme K21045.

The Technical Approval of the product certificate shall specify the specific application.
Following options are possible:

- Storage of Lithium-containing energy carriers;
- Storage of electricity in Battery Energy Storage Systems (BESS) based on Lithium-containing energy carriers.

The applied Safety Methodology should arrange the proper application of the Fire Protection System. The Safety Methodology shall cover a minimal of technical and organizational items.

The storage of Lithium-containing energy carriers for very small applications is also possible with other technologies then with an active Fire Protection System as mentioned in scheme K21045.
A solution with fire compartmentation together with pressure relive and flame arrester is also applicable within this Specific Certification Program.

1.3. Acceptance of test reports provided by the supplier

See TIC scheme K21045.

1.4. Quality declaration

See TIC scheme K21045.

2. Terms and definitions

See TIC scheme K21045.

2.1. Additional terms and definitions

2.1.1. Battery Energy Storage Systems (BESS)

As defined in EN-IEC 62933-5-2 is electrical energy storage system with accumulation subsystem based on batteries with secondary cells.

Note 1 to entry:
The battery energy storage system includes a flow battery energy system (IEC 62932-1:2020, 3.1.15).

Note 2 to entry:
Batteries are defined in IEC 60050-482:2004, 482-01-04, and secondary cells are defined in IEC 60050-482:2004, 482-01-03.

2.1.2. Fire Control

Limiting the size of a fire by distribution of a medium so as to decrease the heat release rate at adjacent combustibles, while controlling gas temperatures to avoid further damage.

2.1.3. Fire Compartment

Is a part of the construction of the building. It is any space within the building that is surrounded by fire barriers on all sides, including the ceiling and floor. As a type of passive fire protection, fire compartments are designed to limit the spread of fires in a building.

2.1.4. Fire Prevention

The provision of services for the purposes of preventing fires and includes planning, public awareness, enforcement of laws related to fire safety and education with respect to fires and the elimination of fire risk.
Source = https://www.lawinsider.com/dictionary/fire-prevention

2.1.5. Fire Repression

The provision of actions in the follow-up of a fire suppression process to create a fire control situation. In this steady state situation of fire control can the provision of actions be executed to secure the incident to a safe situation.

2.1.6. Fire safe

Is not part of the construction of the building. It is an accessible space within the facility that is surrounded by fire barriers on all sides as a type of passive fire protection within the facility.

2.1.7. Fire Suppression

Sharply reducing the heat release rate of a fire and preventing it's regrowth by means of direct and sufficient application of a medium throughout the protected room.

2.1.8. Intact batteries

New or tested lithium-ion batteries with a good battery management system.

2.1.9. Lithium-ion batteries

Single cells, modules, complete battery packs.

2.1.10. Non-intact batteries

Damaged or defected lithium-ion batteries (e.g. caused by drop, impact or a defective Battery Management System). These batteries should be separated and stored in a quarantine container.

2.1.11. State of Charge (SoC)

The level of charge of an electric battery relative to its capacity. The units of SoC are percentage points (0% = empty; 100% = full). For the transport and storage of lithium-based batteries SoC of 20 to 40 % is preferred.

2.1.12. Thermal Runaway

This is an almost unstoppable chain of exothermic reactions that spontaneously continue to raise the temperature in the lithium battery.

2.1.13. Untested return batteries

Are suspicious lithium-ion batteries and should be separated from the intact batteries.

3. Procedure for granting a product certificate

See TIC scheme K21045.

4. Setup of this specific certification program

4.1. General

This chapter contains the setup for the specification certification program.
For the performance of its certification work, Kiwa is bound to the requirements as included in EN-ISO/IEC 17065 “Conformity assessment - Requirements for bodies certifying products, processes and services” and certification scheme K21045.

It describes the test requirements and/or laboratories to be used for the testing, identifies the tests to be performed and provides in minimal schedules for test activities.

5. Testing the performance of the fire protection system / -solution

5.1. Test protocol detail

The test protocol shall detail at least following items based on the safety methodology:

- Type of battery / batteries and certification of the storage system;
- Traceability of all components used during testing based on product certificates of the storage system;
- The facilities used for control of environmental effects of the storage system;
- The facilities for ventilation and cooling of the storage system:
- The facilities for lighting protection of the storage system;
- The foreseen location of the storage with safety distances towards other objects;
- The fire compartmenting of the storage system;
- The fire seals in the fire compartmenting of the storage system EN1366-3 & EN1366-1;
- The combination of a hybrid storage applications;
- The physical access of the storage system;
- The automated closure of the storage system;
- The pressure relive within the containment of the storage system and applicable safety distance;
- The (remote) monitoring of the storage system based on physical features such as gas, heat, voltage, power, video or others;
- The alarming of internal external rescue parties based on EN 50136-1 & EN 50515
- The provision for switching off systems based on continuous monitoring;
- The provisions for removing affected batteries in the storage system;
- The provision for operation and maintenance of the storage system;
- The provision for training of staff;
- The provisions for the periodic inspection of the fire protection system and its safety methodology based on ISO17020.

The test is carried out in a sufficient air-tight compartment if applicable in respect of the fire protection system and protection outside the compartment.
Closing and openings of doors or other openings shall be motivated in the test protocol.
Specifications on a limited “open” area, for example small gaps/notches between wall and ceiling shall be detailed and motivated.
Any forced ventilation system or apparatus/system that will affect the density in the room, shall be shut down or otherwise motivated in the test protocol.
The test shall be based on the exact arithmetical calculation of density / concentration per volume and used elements to achieve the value stated in the supplier specifications.
Physical obstructions in the compartment shall be in the protocol motivated based on the actual use of the fire protection system.

5.2. Test protocol per typical situation in abstract

The listing below is an example of a test protocol. The listing shall be drafted based on the design of the fire protection system in context with the safety methodology of the total design of the system.

S	Situational- Demand	Information
1	Type of batterie(s)	*Specification(s)*
2	Maximum level of electrical energy of the batteries	*AH*
3	Casing material of the batteries	*Specification such as metal, plastic or other.*
4	Containment of the batteries in a compartment.	-

4a	The maximum compartment volume and height.	*m3* *m*
4b	The physical characteristic of the compartment such as for example 10 cm concrete of 6 mm steel with a view on the escalation process. Pressure relieve valve: Flame arrester:	*Description*
4c	Resistance to fire penetration and/or fire spread compartment. This with a view on the escalation process. EN13501-2 classifications.	*Minutes*
4d	The packages of the batteries for examples in pallet arrangements with for example with carton or plastic.	*Description*
4e	The storage arrangements of the batteries in maximum height and distance. This with a view on the escalation process.	*Description* *m* *m*
4f	The batteries are stored / loaded / repaired in the compartment.	*Description*
ToMP	**Type of Mitigation Performance**	
	a. Fire Control b. Fire Prevention c. Fire Repression d. Fire Suppression This with a view on the escalation process.	*Fire*
EMPT	**Effective Mitigation Performance Time**	
	a. Hold time total flooding systems required based of the fire protection media or; b. Supply time fire protection media for surface protection. This with a view on the escalation process.	*Minutes* *first activation and minuets for additional activations.*
FPM	**Fire Protection Media**	
	Speciation, classification and initial approval and certification of the FPM. Product certificate like K21045	*Specification(s)*
FPS	**Fire Protection System**	
	Configuration of the FPS This with a view on the escalation process. Components according to: EN12094-1 EN-54-X	*Configuration used during the test whit motivation for the engineering choices.*
FDS	**Fire Detection System**	
	Configuration of the FDS based on 2 depend detector independence with a minimal of 2 fire phenomena. This with a view on the escalation process.	*Configuration used during the test whit motivation for the engineering choices.*

	Very small cabinets (box) < 0,1m3 non Small cabinets < 1.0m3 min 1 criteria Larger room > 1.0 m3 min 2 criteria	
IM	**Initiation Method** of a cell in the batteries	
	a. Electrical overload creating shortcut between cathode and anode of the cell in the batteries. b. External heating (element) damaging the isolation creating shortcut between cathode and anode of the cell in the batteries. c. Blunt external mechanical force (axe) damaging the isolation creating shortcut between cathode and anode of the cell in the batteries. d. Other method applicable for the typical situation.	*Initiation method used during the test whit motivation for the engineering choices.*
C	**Closing of the compartment after activation**	
	Procedure of closing the compartment. Focal points in this procedure are: a. having sufficient oxygen in the compartment when the batteries are activated; b. the function and performance of the fire protection system (for example self-closing); c. the follow mitigation process.	*Registration*
FMP	**Follow-up Mitigation Process**	
	The method used after the test used to finally mitigate the risk of fire of the batterie(s).	*Description*

Table 1

5.3. Test plan & preparation for reporting

In advance of the test shall a test plan be developed to set the minimal settings during the test.
Each test shall be executed 2 times to show the effectiveness of the solution.
The safety methodology shall be part of the test plan.
The test of the fire extinguishing effect shall be made under the following conditions.

With regard to	Requirement/ Function	Unit	Tolerance
Fire class Assessment method to EN2 and applicable standard	Fire Class	N/A	N/A
Thermal energy/power	Test protocol per typical situation and objective	N/A	N/A
Burning time due to catalyst	Test protocol per typical situation and objective	Minutes	± 15 sec
Catalyst	Test protocol per typical situation and objective	N/A	N/A
Relative humidity in the room, before the fire, measured with a hygrometer	60	%	± 20%
Ambient temperature before	Test protocol per typical situation and objective	°C	According test protocol

With regard to	Requirement/ Function	Unit	Tolerance
Temperature in the test room	20 or ambient Note: According test procedure. Otherwise determined using at least 2 thermocouples on the ceiling with ΔT 10 sec recording using a data logger	°C	5, N/A for ambient
Thermocouples	The use of K type thermocouples (Ni-CrNi), diameter 1 mm, is recommended.	n/a	
Dimensions of the test room	Test protocol per typical situation and objective	m and m^3	- 0 / + XX
Ventilation during the pre-burning time and free burning time, using constant measurement	See fire protection test and objective	n/a	According test protocol
"Open" area or leakage area and position during extinguishing	The % max. of the volume of the room, distributed evenly across the room *	% in m^2	-0.1 / +0
Air flow through the room	Non-forced (Natural), <1	m/s	-1 / +0
Oxygen level in the room	Test protocol per typical situation and objective	% O2	According test protocol
Closing of the test room after igniting the fire	Test protocol per typical situation and objective	s	According test protocol
Required amount of fire extinguishing agent	Supplier's design formula	gram/m^3	Supplier's design formula
Extinguishing time	Test protocol per typical situation and objective	s	According test protocol
Monitoring time	Test protocol per typical situation and objective	s	According test protocol
Agent discharge	Test protocol per typical situation and objective	s	According test protocol
Activation	Supplier's system	n/a	According test protocol
Instrumentation			
Weighing scale	If applicable	According test protocol	According test protocol
Oxygen meter	If applicable	According test protocol	According test protocol
Multi meter	If applicable	According test protocol	According test protocol
Volume meter	If applicable	According test protocol	According test protocol

* "Open" area or leakage area during extinguishing = 0.1% (e.g.: 1000 m^3 = 1 m^2 and 100 m^3 = 0.1 m^2).

"Open" areas are generally allowed as, for example, small gaps/notches between wall and ceiling but not as, for example, open ventilation piping or a hole/opening in a wall or ceiling.

- Open ventilation piping or a hole/opening in a wall or ceiling are to be considered as a an defect regarding the architectural and/or technical design of the room.

With regard to	Requirement/ Function	Unit	Tolerance
• Small gaps/notches between wall and ceiling are to be considered as a an defect regarding the architectural finishing of the room.			

Table 2

5.4. Mandatory registrations during the test

Mandatory registrations during the test in seconds are:

- Time of activation of the cells / batteries
- Pre burning time (if applicable)
- Free burning time (if applicable)
- Time of initial activation of the fire protection system
- Time of the end of the function of the fire protection system and the connected temperature readings
- Time of the reignition of the batteries based on the temperature readings (if applicable)
- Time of secondary activation of the fire protection system (if applicable)
- Time at which the flames are extinguished (if possible)
- Time of the opening of the doors and results

There shall be adequate ventilation during the pre-burning and free burning time and the oxygen concentration in the test room shall be maintained. If this cannot be guaranteed then during the activation the oxygen percentage at the level of the source of fuel shall not deviate more than 0.5 vol% from the normal percentage under ambient conditions and the oxygen percentage shall be measured with a calibrated oxygen gauge using a sensor at the same level as the source of fuel.

Furthermore shall document what components have been used during testing with the applicable product certificates for monitoring, detection, control of the fire protection systems based of the used items in the safety methodology.

5.5. Additional context for BESS

EN-IEC 62933-5-2 has requirements for the implementation of protection from fire hazards.
The following chapters in this document shall be incorporated in the test protocol when testing a BESS.
See annex A of this document.

6. Factory Production Control Fire Protection Components

See TIC- scheme K21045.

7. Inspection of Fire Protection Systems by Kiwa

See TIC- scheme K21045.

8. Marking

8.1. General

See TIC scheme K21045.

8.2. Certification mark

See TIC scheme K21045.

9. Requirements in respect of the quality system

See TIC scheme K21045.

10. Summary of tests and inspections

See TIC scheme K21045.

11. Agreements on the implementation of certification

See TIC scheme K21045.

12. Titles of standards

12.1. Public law rules

See TIC scheme K21045.

12.2. Standards / normative documents

See TIC scheme K21045.

13. Annex A - Requirements EN-IEC 62933-5-2

EN-IEC 62933-5-2 has requirements for the implementation of protection from fire hazards.
The following chapters in this document shall be incorporated in the test protocol when testing a BESS.

7.10.5 Protection from fire hazards
Only non-combustible materials shall be used in the construction of the BESS enclosure or supporting structures and assemblies.
NOTE. The non-combustibility test is described in ISO 1182.

Integration of electrochemical accumulation subsystems and their surroundings shall be designed to prevent chains of thermochemical reactions or fire propagation (e.g. separating into a battery section, charging equipment section and a section which includes a DC conductor, circuit breaker and discharge circuit). Where applicable, both fire and thermal risks that are adjacent to the BESS shall also be considered.

Compliance shall be reviewed by conducting safety design checks in accordance with the result of system level risk assessments (see Clause 6). Fire-load calculations on the BESS, or the experimental fire characteristics recommended in 8.2.5 with details in Annex C are applicable for the process of system risk assessment.

The inside of the BESS shall be separated into a battery section, charging equipment section and a section which includes a circuit breaker and discharge circuit, using fire-proof partitions (e.g. metal plates, non-flammable boards, etc.).

Testing shall be conducted, and compliance shall be assessed, in accordance with 8.2.5.

7.11.3.4 Protection from fire hazards
A risk of fire can result from excessive temperatures either under normal operating conditions or due to overload, component failure, insulation breakdown or loose connections. Fires originating within the equipment should not spread beyond the immediate vicinity of the source of the fire, nor cause damage to the surroundings or the equipment.

Category "S-O" BESS shall have a fire detection system, fire alarms deploying both audible alerts and visual signals, and fire extinguishers within the BESS location.
For category "S-O" BESS, if the electrochemical accumulation subsystems of the BESS have doors, the doors shall be fire-protecting doors.

Category "S-U" BESS shall have a fire detection system, fire alarms deploying both audible alerts and visual signals, and fire extinguishers within a safe and easily accessible location.

A signal of fire detection sent from the fire detection system shall be transmitted to the fire alarms with location data via a communication network and fire suppression system, or via secure relays and receivers where applicable.

If a fire incident is detected, the fire suppression system, if any, shall automatically operate and the fire alarms shall be automatically started.

Testing shall be conducted, and compliance shall be assessed, in accordance with 8.2.5.

8.2.5 Fire hazards (propagation)
Category "C-A" electrochemical accumulation subsystems shall be tested and validated in accordance with the requirements of IEC 62619: 2017, 7.3.3.

The fire characteristics of a BESS which has the potential to exhibit thermal runaway according to Annex B should be determined through a large-scale fire test of the BESS that evaluates fire propagation and heat generation for an anticipated BESS installation with and without the fire suppression system. Test data generated as a result of large-scale fire testing can validate a BESS installation with the intended fire suppression system. See Annex C for details regarding large-scale fire testing.

Upon installation, measures below shall be checked:
– for category "S-O" BESS, that fire alarms and fire suppression subsystems are installed and commissioned at the BESS location.
– for category "S-U" BESS, that any fire alarms and fire suppression subsystems are provided within the vicinity.
– in the case of both, if a fire alarm detects a fire hazard, that fire suppression subsystems automatically operate.

In the case that the result of the system level risk assessment shows that a fire suppression system is not needed, it would not be necessary to install a fire suppression system. The effectiveness of the communication function shall be confirmed by inputting suitable simulated signals. The signals shall be transmitted to the communication networks, relays, receivers and fire suppression subsystem securely as designed.

Upon installation, any functions of fire detection systems, audible alerts and visual signals for reporting an incident of fire, and fire extinguishers, shall be tested in accordance with appropriate standards, manufacturer instructions and local regulations to confirm that their functions automatically operate when the fire incident occurs. Their functions shall operate as designed. The type test for individual components of detection systems, audible alerts and visual signals shall be done. The FAT or SAT for the whole of the BESS installation with a combination of detection systems, audible alerts and visual signals, and fire extinguishers should also be done.

Annex C - Large-scale fire testing on BESS
A large-scale fire test of a BESS is intended to evaluate the fire characteristics of a BESS system that undergoes thermal runaway. The data generated can be used to determine the fire and explosion protection required for installation of a BESS. An example of this type of test method can be found in UL 9540A.

The test method is initiated through the establishment of a thermal runaway condition that leads to combustion within the BESS. The test method outlined in UL 9540A consists of several steps:

cell level testing, module level testing, unit level testing and installation level testing. The cell and module level testing steps are information gathering steps to inform the unit and installation level testing. The following outlines the information that is gathered as part of this testing:

a) Cell level – An individual cell fails in a manner that leads to thermal runaway and fire through a suitable method such as external heating. Data such as off-gassing contents, temperatures at venting and temperatures at thermal runaway are recorded.

b) Module level – One or more cells within a BESS module fail in the manner determined during the cell level testing. Data such as fire propagation in the module, temperatures on the failed cells and surrounding cells, off-gassing contents and heat release data are gathered.

c) Unit level – A complete BESS is installed surrounded by target (e.g. dummy) BESS and walls separated at a distance as intended in its installation. The module level test is repeated on a module located in the BESS in the most unfavourable location. Data such as temperature within the BESS, on surrounding walls and target BESS; incident heat flux on walls and target BESS; observation of fire propagation from BESS to target units and walls as well as observance of explosions or evidence of re-ignition within the BESS; and heat release and off-gassing contents are gathered.

d) Installation level – This test is a repeat of the unit level test with the test conducted within a test room and with the intended fire suppression system installed as well as any overhead cables (that can lead to fire propagation) installed. This test is intended to validate the fire suppression system for the BESS installation. Data such as temperature within the BESS, on surrounding walls and target BESS; incident heat flux on walls and target BESS; fire

propagation from the BESS to target units, walls or overhead cables and any observable explosion incidents or re-ignition within the BESS; and off-gassing contents (if needed) and heat release are gathered.

The data and other information gathered as a result of the testing steps noted above can be used to determine the suitability of the protection measures utilized in the BESS installation.

These include the following:
1) Control of the size, separation distances and maximum quantity of BESS for an installation based upon data gathered during testing.
2) Suitability of installation construction based upon temperatures measured and observable fire propagation.
3) Suitability of the fire suppression means for a BESS installation based upon temperatures and observable fire propagation.
4) Design of ventilation, exhaust and deflagration protection needed within an installation according to local codes and regulations based upon off-gassing information.
5) Location and type of gas detection within a BESS installation based upon off-gassing information.
6) The fire-protecting door of BESS should be selected to allow firefighters to react.