K21045
SCP05/01
2022-09-22

Specific Certification Program Fire Protection Systems – Components

Fire Protection of Lithium-ion batteries storage

Trust
Quality
Progress

Preface

This specific certification program has been accepted by the Kiwa Board of Experts Fire Safety, in which all relevant parties in the field of Fire Protection Systems are represented. The Board of Experts also supervises the certification activities and where necessary requires the evaluation guideline to be revised. All references to Board of Experts in this evaluation guideline pertain to the above mentioned Board of Experts.

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 - Richtlijn voor de veilige opslag van elektriciteit in Energie Opslag Systemen – Guideline for the Safe Storage of Electricity in Energy Storage Systems;
- NFPA 855 - Standard for the Installation of Stationary Energy Storage Systems;
- UL 9540A – Installation level tests with outdoor lithium -ion energy storage systems mockups.

Kiwa Nederland B.V.
Kiwa FSS
Dwarsweg 10
5301 KT Zaltbommel
The Netherlands
Tel. +31 88 998 51 00
Info.ncp@kiwa.nl
www.kiwafss.nl

Contents

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.

1.2 Field of application / scope

The performance of the fire protection system is determined for a typical lithium-ion batterie(s) fire(s). The 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 chain 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.

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 for this specific certification program

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.

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

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.

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.

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

Lithium-ion batteries: Single cells, modules, complete battery packs.

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

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

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.

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.

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.

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.

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 per typical situation in abstract

S	Situational	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.	*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.	*Specification(s)*
FPS	**Fire Protection System**	
	Configuration of the FPS This with a view on the escalation process.	*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.*
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.

5.2 Test protocol detail

The test is carried out in a sufficient air-tight compartment in respect of the fire protection system and protection of live outside the compartment.
Openings like doors shall be closed or otherwise motivated in the test protocol.
However, a limited “open” area, for example small gaps/notches between wall and ceiling may be present.
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.
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

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

Table 2.

5.3 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.

6 Factory Production Control Fire Protection Components by Kiwa

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.

14410