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K21045 - SCP05
Fire Protection Lithium-Ion Storage Cabinet

Colofon

Titel	Maus Sweden Fire Protection Lithium-Ion Cabinet Test
Projectnummer	A0259317
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Preface

The energy transition stimulates the growing use of batteries for energy storage. The most popular batteries that are used are the lithium-based batteries in a longitudinal cell arrangement. This longitudinal cell arrangement is covered with a casing from metal or plastic.

The batteries itself are not unsafe. In the occasion of an internal failure of the isolation between the cathode and anode of the cells occurs in these batteries, it can create a severe fire difficult to control.

A test has been setup and executed to verify the function and the effectiveness of a storage- and charge system of these batteries.

The standards used in during the test are the following: updated version of Specific Certification Program SCP05 in context of TIC scheme K21045.

The innovation is ahead of rules, legislation and standards, so there are no applicable fire protection standards for this specific setup.
These standards are normally addressing fires from outside to inside. In this case is the threat an inside fire that should be controlled and to preventing spreading outside.

1.Story Insurance company
The background to the idea's development from the insrunace company was a number of fire incidents that caused significant damage — both in terms of economic loss and environmental impact. In addition, there was a challenge in getting the fire and rescue services to respond effectively for these two reasons. They tend to focus primarily on saving lives, which often means that property and environmental protection are not prioritized to the extent desired. They believe that such an approach limits other important possibilities.

Adding to this challenge are the difficulties in extinguishing incidents involving Li-ion chemistry — characterized by high heat values even when the material volume is small.

The concept of a cabinet equipped with MAUS potassium aerosol therefore emerged clearly in their minds, and the idea began to take shape.
After several meetings where insights, concepts, and combination functions were discussed, the idea was tested with fantastic results.
Developing a standard that supports this product combination is likely the final step needed to make the market, customers, and skeptics feel sufficiently confident.

2.Advice by Swedish insurance company
This is a cost-effective solution that should becomes every consumer's first choice when investing in a safe home environment. It is conceivable that mobile phones or bicycle batteries, for example, will never be charged outside of this type of cabinet in the future.

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Management Summary of the fire safety concept

In the context of increasing use of lithium-ion batteries for energy storage, fire safety is a growing concern. This report presents the results of a full-scale fire safety test of the MAUS Laden 6, a containment solution designed to mitigate the risk of thermal runaway incidents.

The test demonstrated that the MAUS Laden 6effectively contains a battery fire, prevents flame ejection, and keeps external surface temperatures below 60°C, even under worst-case conditions (100% SoC, thermal runaway triggered).

These results confirm that the MAUS Laden 6 is a proven and reliable solution for safely storing and charging lithium-ion batteries. (see technical aporval)

MAUS Laden 6
The execution of this test by MAUS Sweden and Kiwa FSS showed that the MAUS Laden 6creates a controllable situation when a lithium-ion battery starts a thermal runaway.
The door of this storage cabinet must be closed for the efficient operation is a required condition.
To ensure this, the necessary organizational and technical measures must be taken.

Thermal runaway
Lithium-ion batteries are safe under normal use. However, in the event of a short circuit, electrical overload, external heating, fire or mechanical deformation, the lithium-ion battery can become so hot that a thermal runaway occurs. This is an almost unstoppable chain of exothermic reactions that continue to spontaneously raise the temperature in a lithium-ion battery. The consequences are very high temperatures, the release of dangerous gases, a fierce conflagration and projections of electrolyte and metal parts. The lithium-ion battery entering a thermal runaway can infect adjacent cells, triggering a further chain reaction. This can have serious consequences for live, environment and property. A fire of lithium-ion batteries can cause major damage and endanger the continuation of companies.

Lithium fires are difficult to extinguish
The problem with lithium is that, when combined with water, it produces a highly explosive and harmful gas: hydrogen fluoride (HF), which poses a major health risk to people. Therefore, conventional extinguishing systems that contain water are less suitable for adequately extinguishing a lithium fire. Foam and powder are also not suitable extinguishing agents because the effect is that these agents cover the fire so that no oxygen can get to it. In a conventional fire this has the right effect, but in a lithium fire it is counterproductive because combustible gas accumulates under the blanket of the extinguishing agent, a lithium battery generates its own oxygen, and the natural cooling effect does not occur.
Note: fires on lithium-ion batteries are not the same as fires on the metal lithium itself.

Organizational arrangements on site
MAUS Sweden fabricates this storage solution with the goal of controlling a fire inside the cabinet and is especially designed for Lithium-Ion Fires.
The design therefore takes into account; extreme heat and the risk of explosion.

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Test setup

Why this test

The energy transition is fully moving. New ways of energy accumulation are developed to reduce to CO load to the global environment. In this new energy supply chain are batteries having a bigger portion as energy carrier. The most popular batteries that are used are the lithium-based batteries in a longitudinal cell arrangement. This longitudinal cell arrangement is covered with a casing from metal or plastic. The growing use of these batteries makes us aware of the safety risks off these batteries.

The batteries itself are not unsafe. However, in the occasion of an internal failure of the isolation between the cathode and anode of these batteries can this create severe fires.

A test has been setup and executed to verify the function and the effectiveness of a fire protection system in a repression solution for the storage of these batteries.

The cathode and anode plates in these batteries are made of metal. This metal is a lithium or a lithium alloy.

This electrical charge is the energy source being the catalyst for a fire. At the moment of the internal failure in the battery creates the shortcut between the cathode- and the anode plates an electrical current. This electrical current creates heat melting down the insulation material of the battery. This is creating flammable gases. These flammable gases will start burning and then shall packing materials and other batteries involve in the burning process. It also can bring the metal alloy on such a high temperature that the metal alloy starts to burn.

This test has been setup and executed to verify the function and the effectiveness of the MAUS Laden 6, a solution for storage or charging of lithium batteries. The cathode and anode plates in these batteries are made of metal. This metal is a lithium alloy.

Lithium based batteries are classified as dangerous good under class 9 UN nr. 3090, 3091, 3480, 3481 or 3536. During transport the batteries are packed in UN approved packaging. The batteries are shipped with a maximum SoC of 30 %. With this SoC the lithium batteries are the most stable seen of fire propagation. Also, this is regulated in the Dangerous goods regulations of IATA/ICAO and the IMDG of the International Maritime Organization.

Definitions within this report

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.

Publication Dangerous Goods 37 (PGS 37): Publicatie gevaarlijke Stoffen 37-2: national guideline for storage and energy storage systems of lithium-based batteries.

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.

WBDBO (Weerstand tegen Brand Doorslag en Brand Overslag): Resistance to fire penetration and fire spread. With a requirement of 30 minutes WBDBO between two compartments, a fire that has started in one compartment may not spread to the other compartment for thirty minutes.

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.

MAUS Laden 6 : A specially constructed and equipped cabinet for safe storage, safe charging or quarantine, for lithium batteries.

Quarantine Space: A space outside a building with a minimum WBDO of 60/90 minutes for temporary safe storage of damaged, defected, or critical lithium-ion batteries. awaiting proper disposal for destruction or recycling.

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The goals & scenarios of this test

The goals

The goal of this test plan was to research and determine the effect of a thermal runaway with a lithium-ion battery in the MAUS Laden 6.
Creating a (temporary) safe condition and control of the fire to preventing damaging others goods.

The purpose of this test is to verify that the packaging for lithium ion batteries is capable of ensuring that the temperature on the outside of the cabinet does not rise above 100 degrees Celsius during a thermal runaway and that no flames or sparks emerge from the packaging escape.

The foreseen test scenario:

The MAUS Laden 6 is foreseen as a small fire protection cabinet with the goal of fire control in the cabinet.

This based on a scenario below, with the settings and the reasons motivated.

- The test is to be performed with 100% charged lithium-ion battery cells.
- The storage of the batteries in this solution is foreseen in the MAUS Laden 6.
- The cabinet securing the flames.
- The cabinet is foreseen with 2 Maus Stixx Pro 5 Aerosol generators (self activated with thermocord) STIXXPRO – StixxPro

MAUS Stixx Pro 5 (0,5m³)

Art no:	1360-1
Protected space:	0,5 m³ / 17,65 ft³
Dimensions:	7,6×7,6×2,2 cm / 3x3x0,9 in
Weight:	130 g / 4,6 oz
Warranty:	5 years (6 year lifespan)
Operational Temperature:	-30°C to 70°C / -22°F – 158°F
Discharge Time:	7s
Activation Temperature:	170°C+10°C / 338 °F
Certifikate:	CE 2829

- It is a conditio sine qua non that the lid of the cabinet must be closed for the efficient operation. To ensure this, the necessary organizational and technical measures must be taken.
- The type of fire can create a high temperature in a shorth instance and is not to be compared with a standard fire curve. For the storage solution to be effective a closed compartment is required. The sharp heat increase creates an over-pressure in the protected cabinet.

PGS 37-2

PGS 37-2: regarding fire compartment, fire safe, fire cabinet:

- PGS 37-2 can provide a set of rules and good housekeeping for the storage, charging and working with lithium-ion batteries. This is subject to the final text of PGS 37-2 and its further elaboration.

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The test setup

The test is performed according to specific test program on the test object.
This test object is specified in figure 1.

Figure 1 – test object with specifications.

The test is monitored with thermocouples to follow the heat buildup and degrees in and on the surface of the outside of the cabinet.

T1- Inside the cabinet 10 cm for batterypack	(not calibrated)
T2- Door (outside) of the cabinet	(not calibrated)
T3- Thermal pointer gun	(not calibrated)
T4- Thermal pointer gun	(not calibrated)

Figure 2 – Configuration of the thermocouples during the test.

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The cabinet has specific design features enabling a safe function. The are detailed below.

Test object	Speciale design features
	The cabinet is fabricated with: • 1,0 mm stainless steel outside The lid of the cabinet is fabricated extra with: • Espagnolette lock • Aerosol Generators 2 x MAUS Stixx PRO 5 • Spring loaded/self-closing hinges • Distance spacers on the back of the cabinet • -Perforated shelves

Figure 3 - specific design features test object.

The manufacturer specifies following safety features. In the table below is detailed what features have been tested.

Nr.	Safety features	Tested
1	Fire-resistant – prevents flame spread in case of battery fires	Yes
2	Explosion-proof – pressure relief through integrated ventilation openings	Yes
3	Controlled heat dissipation – ventilation openings minimize the risk of overheating	Yes
4	Activation Aerosol Generators within 5 seconds	Yes
6	Online detection equipment with mobile phone alert – warning in case of temperature exceedance	No
7	Audible alarm – sound signal in case of overheating or battery issues	No

Figure 4 – tested safety features

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Enabling a functional test and validating the test have equipment and material(s) been checked on their specifications. The outcome of this is found in the table below.

No	Item	Specification
1	MAUS Cabinet	See figure 1 & 3. MAUS-LADEN-PROD UKTBLAD-ORGINAL-E
2	Activator for the batterie	Penetration of the battery with a steel pin forced by a hammer.
3	Data logger & Thermocouple's:	Environment meter Velleman DVM401 S/N 11020350 (internal logger) Measuring cabinet temperature at +/-15 cm form battery Bosch Temp meter (laser pointer) 231004959 (Surface temperature) Multipoint Temp (laser pointer) 210927240 (Surface temperature) Hydometer MEEC Tools SW 572 (humid and temp) 3 BBQ non calibrated temperature devices, no logging (visual control)
4	Multi meter	UNI-T NCV UT 123T This meter is brand new.
5	Fireproof material in the box	N/A
6	Fire suppressions	2 x MAUS Stixx PRO 5 Automatic aerosol extinguisher

Figure 5 - Equipment and material(s)

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Details on the used batteries can be find in the table below.

Setup lithium-ion batteries and packaging
The test was performed with 95-100% charged cells in the batteries. (fully charged on charger) This was established before the test.
Primary batteries that was activated. Lithium-ion batteries : Lithium-ion Rechargeable Battery 100% State of Charge Voltage: 18 Volt Charged loading: 100% Details: 90 Wh 5.0 Ah Manufacturer: Makita Plastic casing. PDF Data Sheet Makita Battery.pdf 
   

Figure 6 – used batteries for the test

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The test

General

The test was performed on September 23th , 2025, MAUS Sweden AB, Sockerbruksgatan 20, 531 40, Lidkoping.

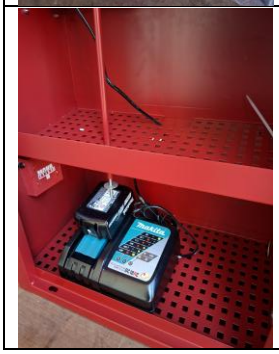
The weather during test was sunny with clouds and dry. The temperature was about 15 degrees Celsius, the test was performed outdoors.

During the test was staff present of:

Organisation	Name	Function
Maus Sweden AB	Andreas Norlin	Founder
Maus Sweden AB	Jonas Sundquist	Engineer and CSO
KIWA Fire Safety & Security	Wouter van Beers	Assessor / Test engineer

Figure 7

In the table below is the test setup documented with photos.

	General setup
	The battery. The primary battery has the thermocouple on top and the pin to penetrate it.

	Detail of the penetrating pin.

Figure 8 – test setup.

Test results

In the table below the activation of the cells in the batteries is measured based on the readings of the thermocouples en the pointer guns.
The data below shows the activations and the degrees of the temperature in the cabinet and outside the cabinet.

No data logger was used during the test
Figure 8 – temperature readings during the test

During the test have following peak temperatures been observed. These are presented in the table below.

Location	**Temperature in °Celsius at peak**	**Time in hours**
T1- Inside the cabinet 10 cm for battery pack	Max temperature <250	0-60 minutes
T2- Door (outside) of the cabinet	Max temperature <60	0-60 minutes
T3- Thermal pointer gun	Max temperature <60	0-60 minutes
T4- Thermal pointer gun	Max temperature <60	0-60 minutes

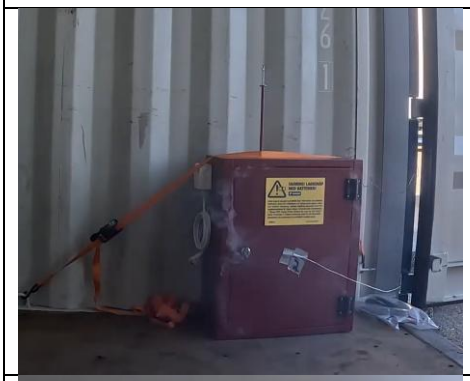
The temperature measurement between the cabinet spacers and the "wall" never exceeded 19 degrees Celsius

Figure 9 – peak temperatures

Visual observation during the test

- Smoke development along the door of the cabinet when the cells exploded.
- No flames or sparks were observed outside the cabinet.
- The cabinet retained its structural integrity.
- The door of the cabinet stayed closed when the cells exploded and created severe overpressure.

In the table below is the test process documented with photos.

	When the battery went into thermal runaway, some smoke gases came through the cracks in the door.
	When the aerosol generators were activated, a lot of aerosol came through the cracks in the door.
	After about two minutes was the cascade of fire propagation between the cells in the batterie realized and was a thermal runaway of the cells in the batterie happening .

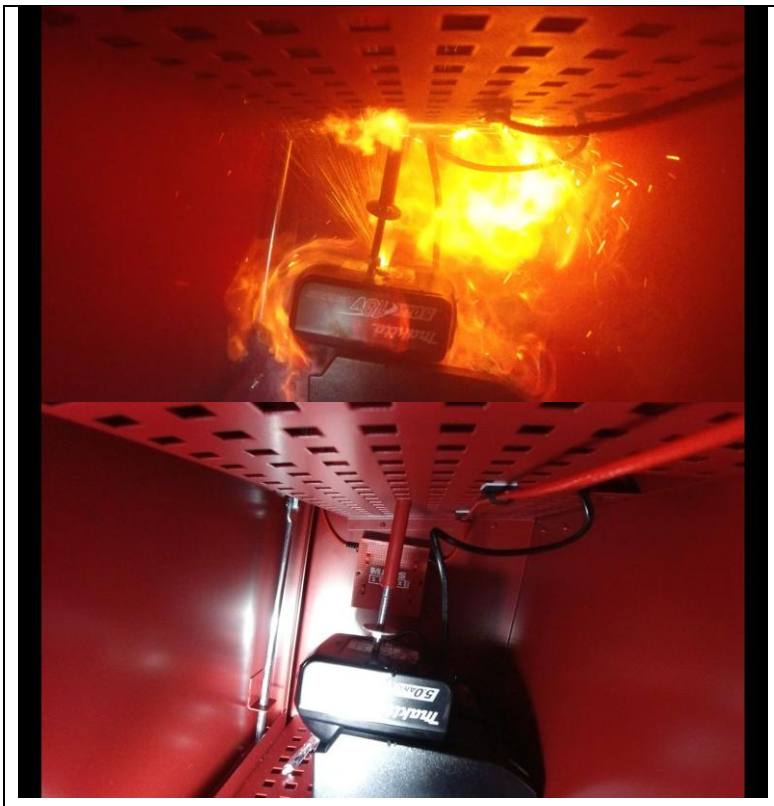
	In the first 10 minutes all cells have participated in the burning process

Figure 10 – test in process

Observations tests and results

- During the start of the test the door of the cabinet is closed. The door stayed closed during the test.
- When the batteries started the “thermal runaway” it created flammable and explosive gasses. Some gases and smoked were released through the cracks/openings in the door. No flames or sparks observed outside the packaging
- The whole activated battery pack was complete destroyed by the burning and the explosions cells of the batterie.
- The packaging has retained its structural integrity to safely contain the battery.
- The temperature on the outside of the packaging did not exceeded the limit of 100 °Celsius.
- After 60 minutes, the cabinet was opened and the test result was assessed.

In the table below is the test result documented with photos.

	The battery is destroyed by the fire and explosions.
 	The casing of the batterie was completely destroyed.
	The cabinet is not damaged on the outside

Figure 11 – result of the test.

The conclusion of this test is that the Maus Laden 6 met its performance objectives.

Concept of the Fire Protection System

Containing the fire, controlling the fire by using an Aerosol fire suppression system.

Organizational arrangements storage

- For an effective controllable situation the door of the Maus Laden 6 must be closed.

Organizational support

N/A

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Certification according to scheme

- This concerns an initial type test report for product certification.
- This report is to be used for the start of product certification based on the updated version of Specific Certification Program SCP05 - Specific Certification Program Fire Protection Systems – Fire Protection of Lithium-ion batteries storage - in context of TIC scheme K21045 – Fire Protetion Systems.
- Although product certification is not yet finalized, this report demonstrates compliance with the performance requirements.
- This product has no product certificate yet and may not be expressed so.

Techical Approval;

S	Situational- Demand	Information
1	Type of batterie(s)	*Makita BL1850B Rechargeable Lithium Ion Battery IEC 61960*
2	Maximum level of electrical energy of the batteries	*5.0 AH* *18 V 90 Wh*
3	Casing material of the batteries	*Plastic Casing*
4	Containment of the batteries in a compartment.	**MAUS Laden 6 -** Medium Cabinet Dimensions: 48B x 58H x 25D 6 charging points 2 shelves 2 x MAUS Stixx PRO 5
4a	The maximum compartment volume and height.	**MAUS Laden 6 -** Medium Cabinet Dimensions: 48B x 58H x 25D 6 charging points 2 shelves 2 x MAUS Stixx PRO 5
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.	*N/A*
4c	Resistance to fire penetration and/or fire spread compartment. This with a view on the escalation process. EN13501-2 classifications.	*N/A*
4d	The packages of the batteries for examples in pallet arrangements with for example with carton or plastic.	*Plastic casing*
4e	The storage arrangements of the batteries in maximum height and distance. This with a view on the escalation process.	*See pictures of start setup*

4f	The batteries are stored / loaded / repaired in the compartment.	*Stored / Charged*
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.	a. Fire Control d. Fire Suppression
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.	*a. n/a* *b. n/a*
FPM	**Fire Protection Media**	
	Speciation, classification and initial approval and certification of the FPM.	*Specification(s)* Material certificate, 22969422, 20250608
FPS	**Fire Protection System**	
	Configuration of the FPS This with a view on the escalation process. Components according to: EN12094-1 EN-54-X	*N/A* *Stand alone solution*
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. Very small cabinets (box) < 0,1m3 non Small cabinets < 1.0m3 min 1 criteria Larger room > 1.0 m3 min 2 criteria	*N/A*
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.	c. Activation pin
C	**Closing of the compartment after activation**	
	Procedure of closing the compartment. Focal points in this procedure are:	*N/A*

	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.	
FMP	**Follow-up Mitigation Process**	
	The method used after the test used to finally mitigate the risk of fire of the batterie(s).	*N/A*