Mitigate fire protection challenges related to storage of batteries (with automatic fire sprinkler protection)

Disclaimer

This publication contains potential fire protection solutions or (inspections) methods for certain areas in industrial, commercial or residential facilities and buildings which may be exposed to a fire risk. The selection and design of fire protection solutions, systems and products to mitigate these fire risks are to be executed on a case-by-case basis considering local legislation, regulation and standards and project-specific parameters and lie in the responsibility of the contracted system engineering and installation companies. So far as VdS Nederland provide technical information or (seen to be) act(ing) as a consultant, notice that this information or consulting does not belong to the scope of VdS Nederland accredited services, this is done for generally purpose, not for a project specific issue, free of charge and without any liability.

Personal introduction: Marcel Ruesink

- Managing director of VdS Nederland
  - VdS Nederland Accredited inspection body
  - Inspecting: NFPA, EN, (VdS) CEA 4001, FM, ISO, etc.

- Memberships:
  - Chairman of RUUV (CE marking via EOTA)
  - Chairman of VBE (Verenigde Brandveiligheid Experts)
  - Board member of VIVB (Vereniging van Inspectie-Instellingen voor Veiligheid en Brandveiligheid)
  - Member CFPA (Confederation of Fire Protection Associations Europe)
  - Technical expert at CEN TC191 W5, W6 & W10 (EN12845 & EN14972)

Agenda

Title:
Mitigate fire protection challenges related to storage of batteries (with automatic fire sprinkler protection)

Agenda:

Section 1: Electrification challenges
- Evolution
- Congestion: the new buzzword
- Electrification

Section 2: Fire challenge of batteries
- Footage thermal runaway
- Abuse is the genesis
- The four stages
- Battery risk in storage or production

Section 3: FM global datasheets (excl DS 5-33)
- Fire protection criteria of non-storage area's
- Fire protection criteria of storage area's
- Footage fire test

Section 4: VdS CEA 4001 TB3
- Scope and limitations
- General guidelines
- Definition (storage) rack type
- Sprinkler design of storage exceeding 2 m³
- Sprinkler design of storage exceeding 2 m³ ST4 @ 15 m
- Available at www.vds-nederland.nl

Section NFPA 855 (Stationary Energy Storage Systems)
- NFPA 855 Scope
- NFPA 855, Sprinkler protection
- Clean agent system feature selection

Section 6: Dutch CCV inspection protocol
- Dutch system of quality assurance
- VdS Nederland accreditation under 17020

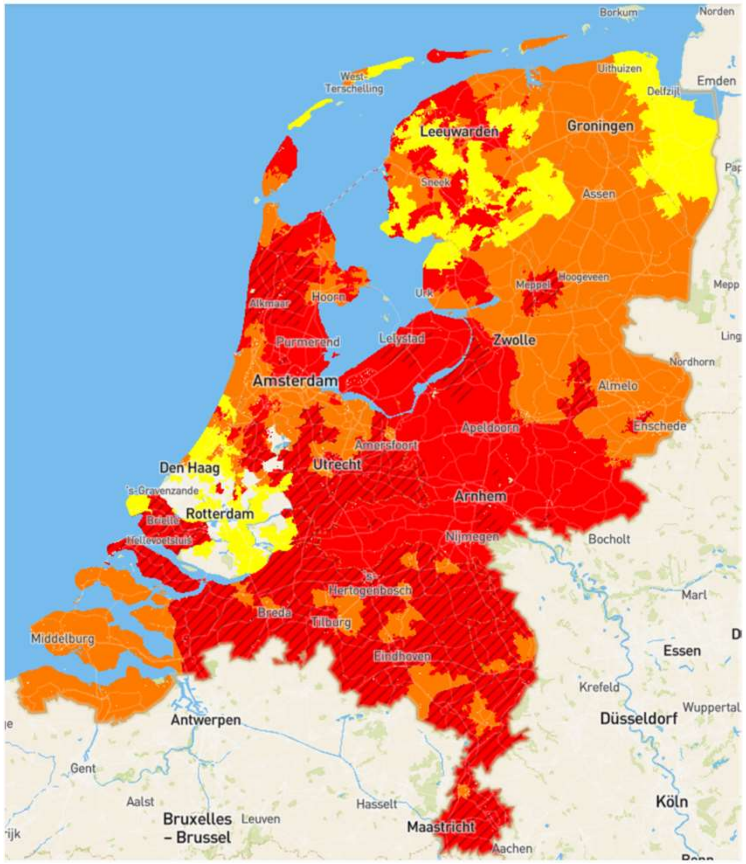
01 Electrification challenges

Evolution of engery

Congestion: the new buzzword

Capaciteitskaart afname elektriciteitsnet

Bijgewerkt: 04-04-2024 09:21



Capaciteitskaart invoeding elektriciteitsnet

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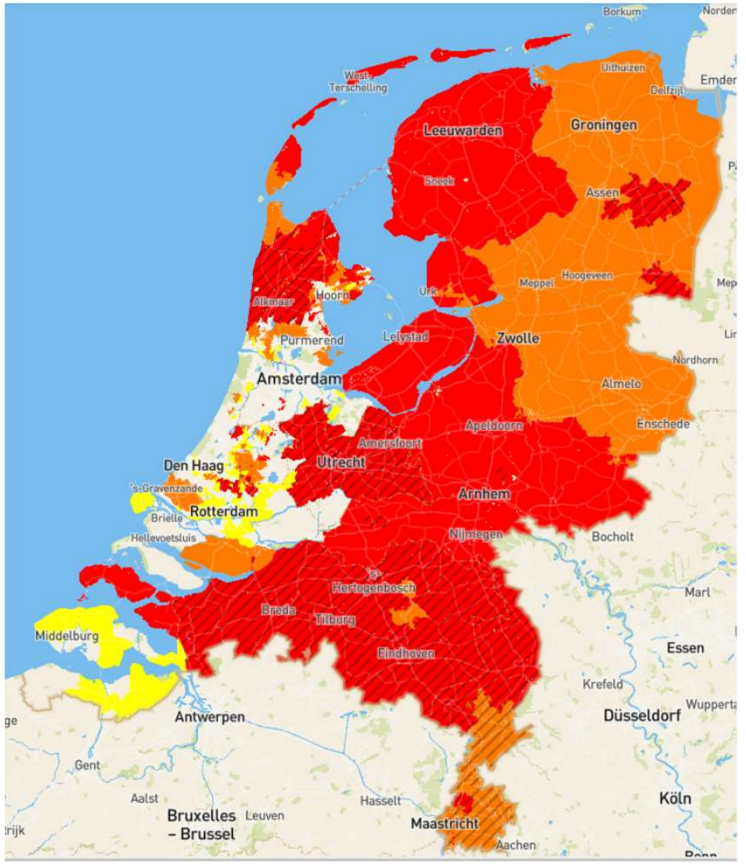
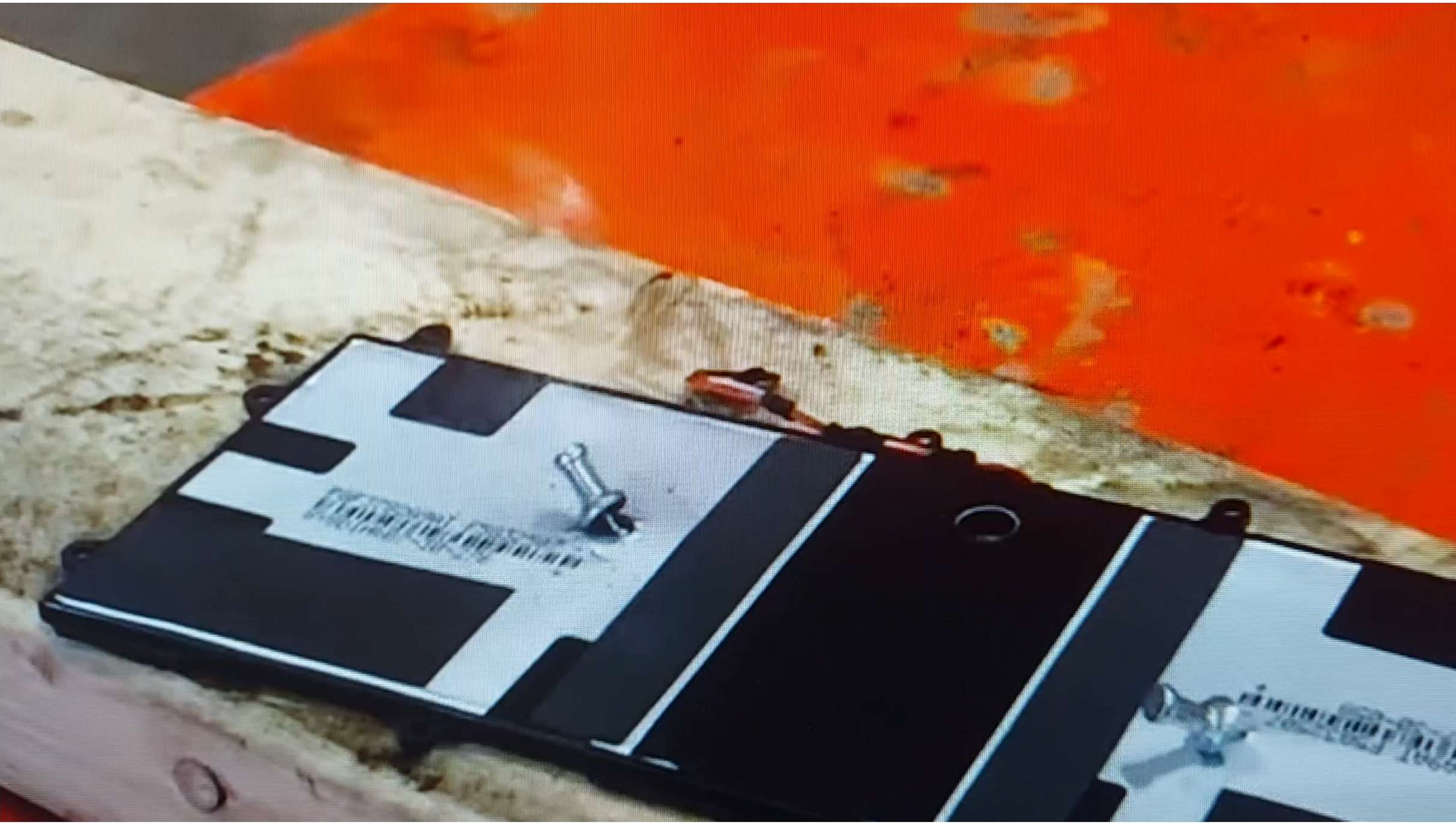
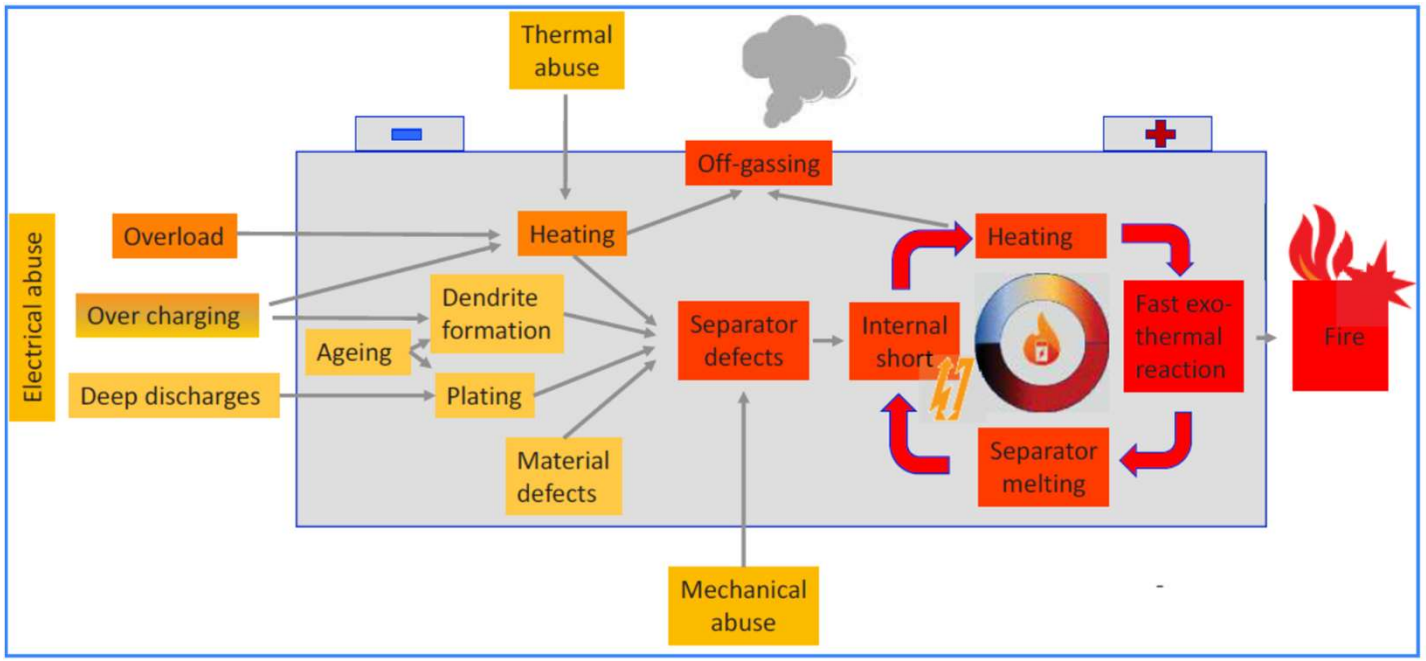


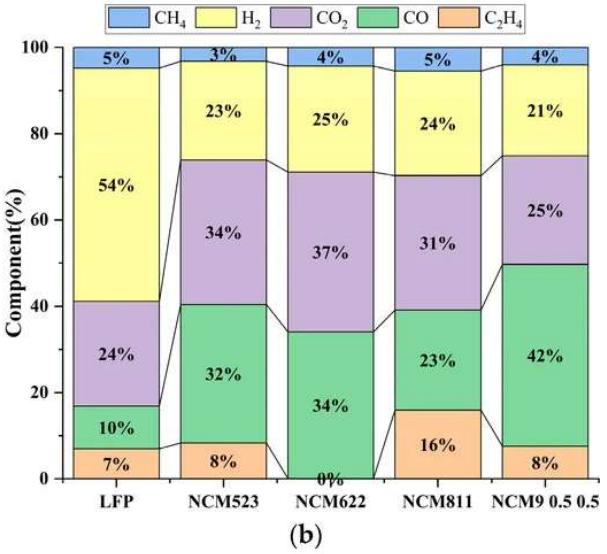
Electrification

02 | Fire challenge of batteries



Abuse is the genesis

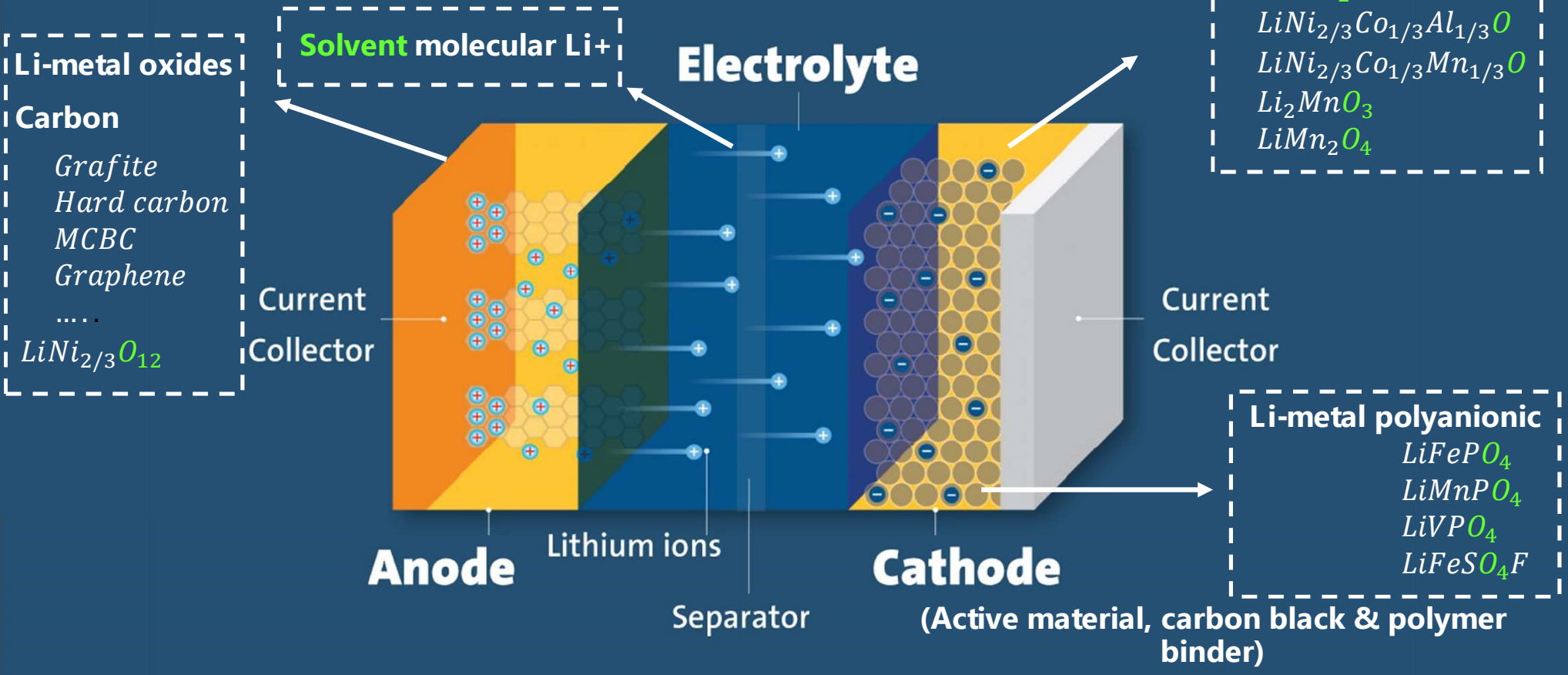




https://www.mdpi.com/2079-9292/12/7/1603

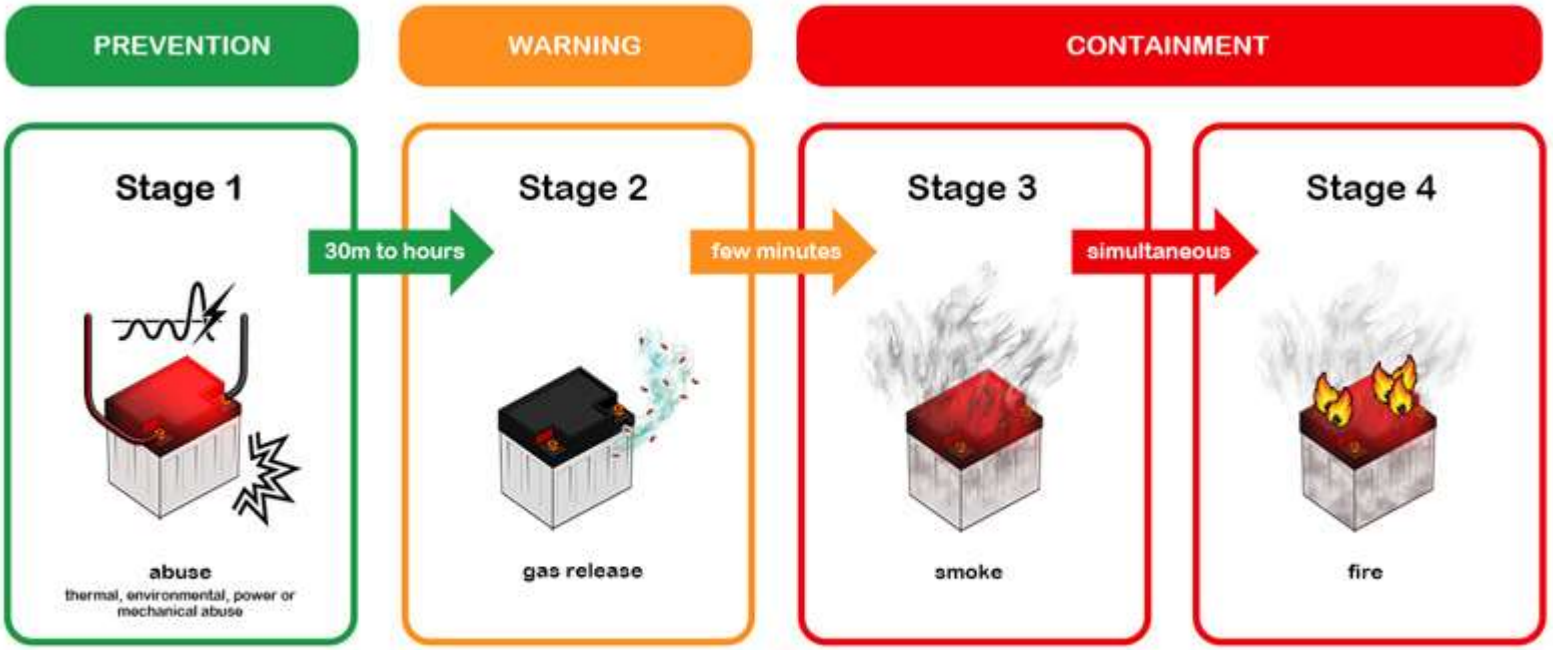
LFP battery technology is a type of lithium-ion battery using lithium iron phosphate (LiFePO 4) as the cathode material

Fire behaviour: the components

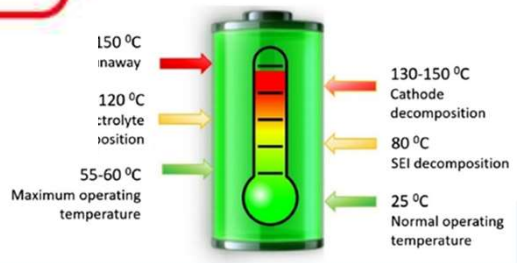


Source: Gao, Jian, Si-Qi Shi, and Hong Li. "Brief overview of electrochemical potential in lithium-ion batteries." *Chinese Physics B* 25.1 (2015): 018210.

The four stages



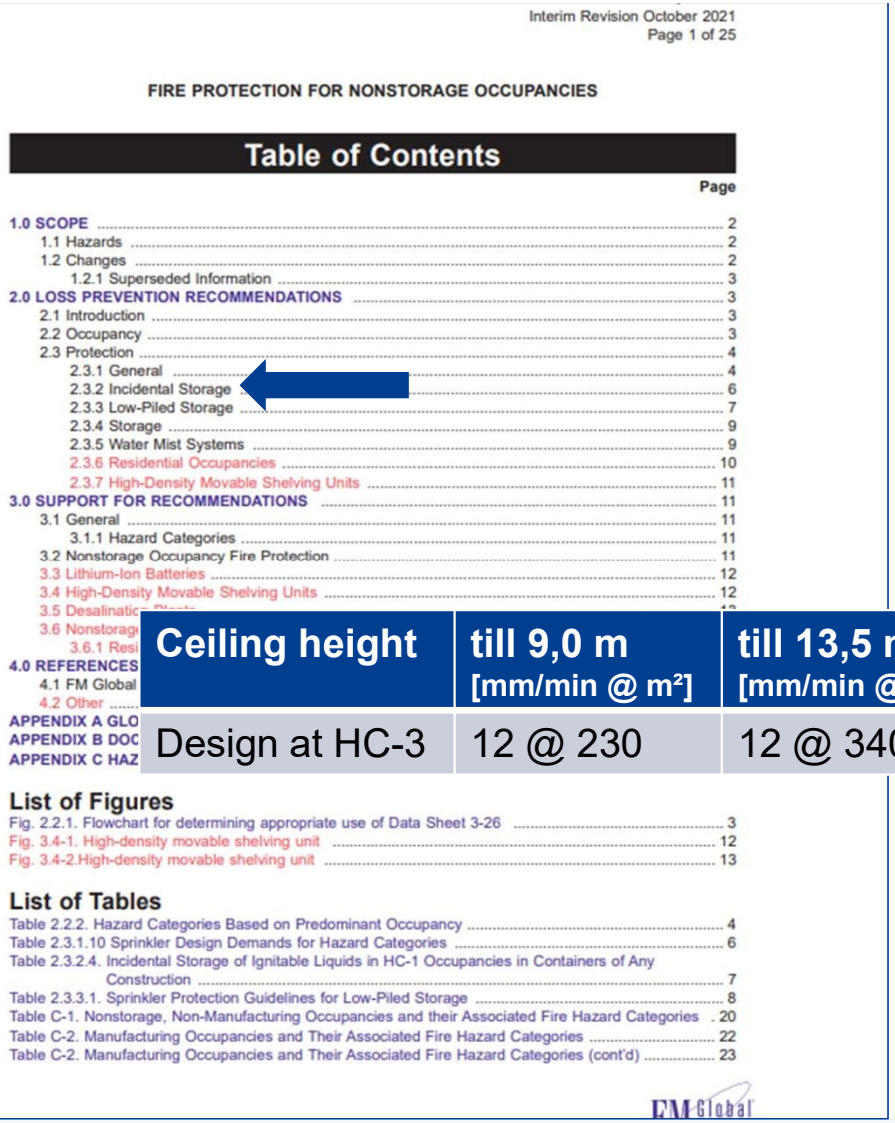
Infrasensing.com



Battery risk in storage or production

03 FM Global data sheets

Excluding FM DS 5-33



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FIRE PROTECTION FOR NONSTORAGE OCCUPANCIES

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FM Global

Fire protection Non-storage

FM DS 3-26 (October 2001) @ 2.3.2.5

- Limit storage area to no more than 20 m^2
- Separate multiple storage areas by aisles not less than 3 m
- Maximum storage height at 1,8 m
- State Of Charge (SOC) 60% at max

Ceiling height	till 9,0 m [mm/min @ m²]	till 13,5 m [mm/min @ m²]	till 18 m [mm/min @ m²]	till 30 m [mm/min @ m²]
Design at HC-3	12 @ 230	12 @ 340	20 @ 280	24 @ 110

Fire protection of storage

FM DS 8-1

- Any finished products if:
- Maximum ceiling height 12 m
  - SOC max. 60%
  - New batteries up to 60% SOC (Table 2.4.2.1)
  - Used/refurbished batteries and SOC > 60% with in rack protection

Li-ion Cell/ Module State of Charge	*Ceiling Height*	*Storage Height*	*Storage Arrangement*	*Packaging*	*Ceiling Protection (QR sprinklers only)*	*In-Rack Protection*
≤ 60%	≤ 40 ft (12 m)	Maximum 3 levels of storage up to a total height of 15 ft (4.5 m)	Open-frame rack, solid-pile or palletized	Wood crate, metal encased or corrugated carton with cellulosic and/or unexpanded plastic internal packaging only	K22.4 or K25.2 (K320 or K360) 12 @ 35 psi (2.4 bar)	NA
				Corrugated carton with expanded plastic internal packaging	CEP per 8-9*	NA
				Plastic external packaging	UUP per 8-9*	NA
		NA	Open-frame rack	Uncartoned	Per surrounding occupancy.	See Section 2.4.2.2
	(12 m)			Cartoned or uncartoned	Per surrounding occupancy.	See Section 2.4.2.2
> 60%	NA					

Tab. 2.4.2.1
Protection of Lithium-Ion Cells and Modules

2.4.2.4 Develop a pre-incident plan […]. The plan should include manual fire protection methods to be employed and a designated location outside of the facility to which damaged and impacted cells can be moved.

2.4.2.5 Develop a post-incident recovery plan that addresses the potential for reignition of li-ion batteries, as well as the removal and disposal of any damaged or impacted cells, modules or products.


1.5
1
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Convective HRR (MW)
01:19

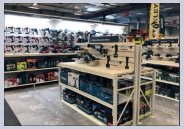
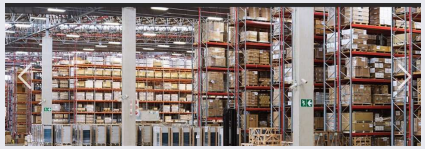
04 | VdS CEA 4001 TB3

Scope and limitations

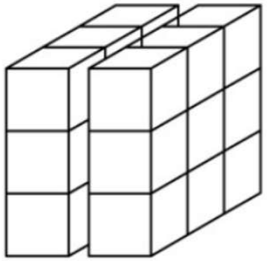
- Testing and research is ongoing. The following design criteria for sprinkler protection reflects the current (2022) state of research and design
- Design is based on tests on Li-Ion batteries
- Pending further testing and research, the guidelines below can also be used for Li-Polymer and Li-Fe-Phosphate

- https://vds-nederland.nl/normen-richtlijnen/technisch-informatieblad-voor-opslag-van-lithium-ion-batterijen/
- Research test by FMglobal

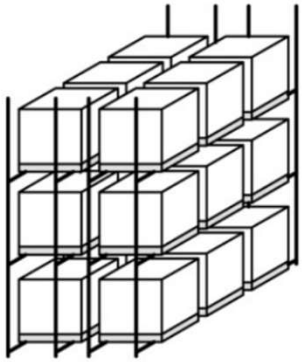
General guidelines

Configuration	Example / typical situation	Requirement
Small batteries (<100Wh)	Laptop in offices, electric tools in a workshop, Display of electrical equipment in retail….  	No additional requirements: The sprinkler design provides sufficient protection for this risk.
Storage of goods containing Li-ion batteries (limited to 1kWh per item)	Consumer goods such as electro-technical, computers, drilling machines  	The classification of goods containing Li-ion batteries is HHS3 or the corresponding classification by plastic content, whichever predominates.
Storage of used or damaged Li-ion batteries	More than 0.5 m³	• Dedicated container (no other goods in the container) • Specially designed container for batteries • Stored separately in boxes with a high level of fire rating • Limited to 1 level on ground (no piled storage) • Ceiling protection with design no less than 12.5 mm/min over 260 m² • Note: If less than 0,5 m³ per design area no specific requirement shall be taken into account.
Limited storage of Li-Ion batteries, e.g. in production areas	No more than 2 m³ (Including packaging) within an area of operation. Batteries must be contained in cardboard boxes and 60% SOC. This could be in one single block or separated in several smaller units.	• Protect as per HHS3. Where ceiling protection only is provided, the design shall be no less than 12.5 mm/min over 260 m² or ESFR or CMSA protection. • Where in-rack protection is provided, the design shall be as per HHS3 with no additional requirement.

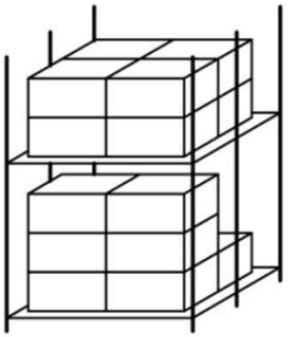
Definition (storage) rack type



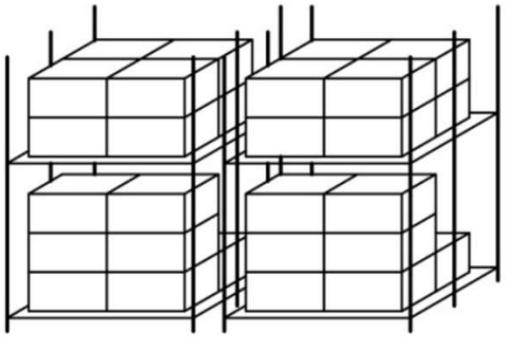
Freistehende Lager (ST 1)



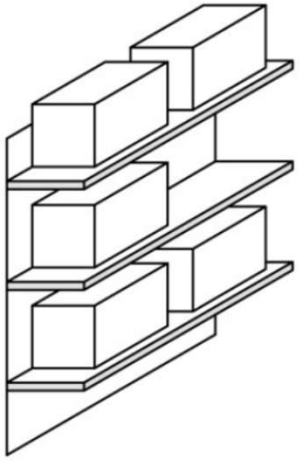
Paletten-Regallager (ST 4)



Einreihige Ständerlager (ST 2)



Mehrreihige Ständerlager (ST 3)



Geschlossene oder
gelattete Zwischenböden (ST 5/6)

Sprinkler design of storage exceeding 2 m³

Storage configu -ration	Max ceiling height (m)	Max storage height (m)	Sprinkler design			Comments
			Type of sprinkler	Density (mm/min)	Area of operation (m^2)	
ST1	9	1 level on floor not exceeding 1,5m height	Spray sprinkler minimum K115, 68°C	12,5	260 (wet) 325 (dry)	
ST1	12,2	1 level on floor not exceeding 1,5m	Spray sprinkler minimum K160, 68°C	17,5	260 (wet)	Wet system only
ST1/ST 2/ST3/S T4	12,2	4,6 (measured from floor to top of storage)	ESFR K 360 68°C or 74°C		12 spk @2,4 bar	Ceiling protection only. If mixed commodities, the maximum storage height remains 4,6m. Further more: * SOC of 60% * 50 kWh max / battery * Limited area per 5.02 VdS CEA 4001
ST4	15	Ceiling height minus 1m (clearance)	Ceiling :Spray sprinkler minimum K115, 68°C In-rack : Spray sprinkler minimum K115, quick response , 68°C	12,5	260 (wet) (Ceiling sprinkler water demand and the IRAS demand shall be balanced at the point of connection)	Wet system only In-rack protection according to figure F 3a for cartoned batteries. In-rack protection according to figure F 3b for uncartoned batteries.

Sprinkler design of storage exceeding 2 m³
ST4 @ 15 m ceiling height

Vertical: 3.5 m

Horizontally 1.5 m/3.0m

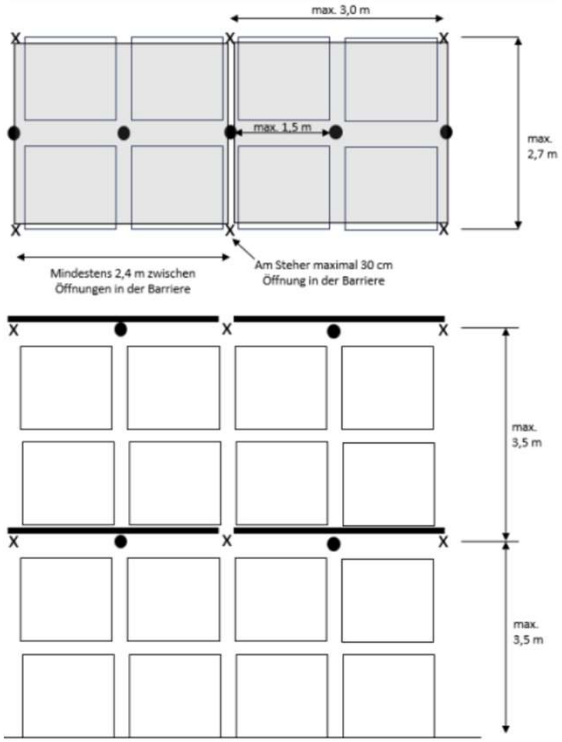
0.7 mm/10 mm horizontal barrier

K115/K160 @ 216 l/min

4 spk @ 2 lines

Protection above the top storage level

Restriction to lower levels possible



In-rack protection for cartoned batteries

Vertical: 1.8 m

Horizontally 1.5 m/3.0 m

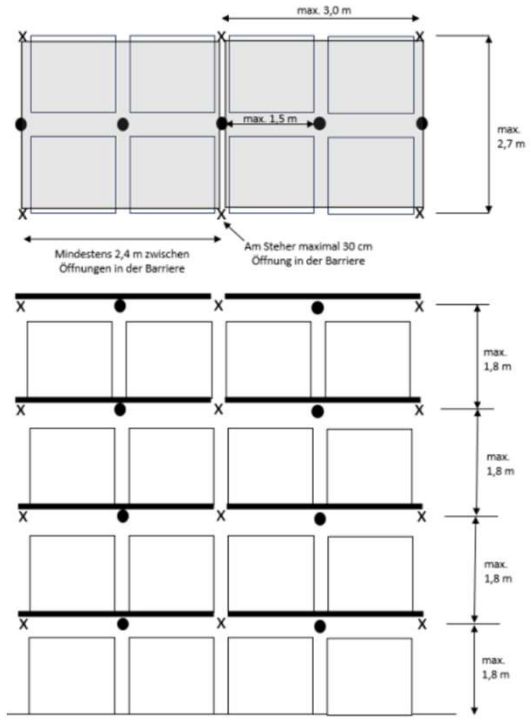
0.7 mm/10 mm horizontal barrier

K115/K160 @ 216 l/min

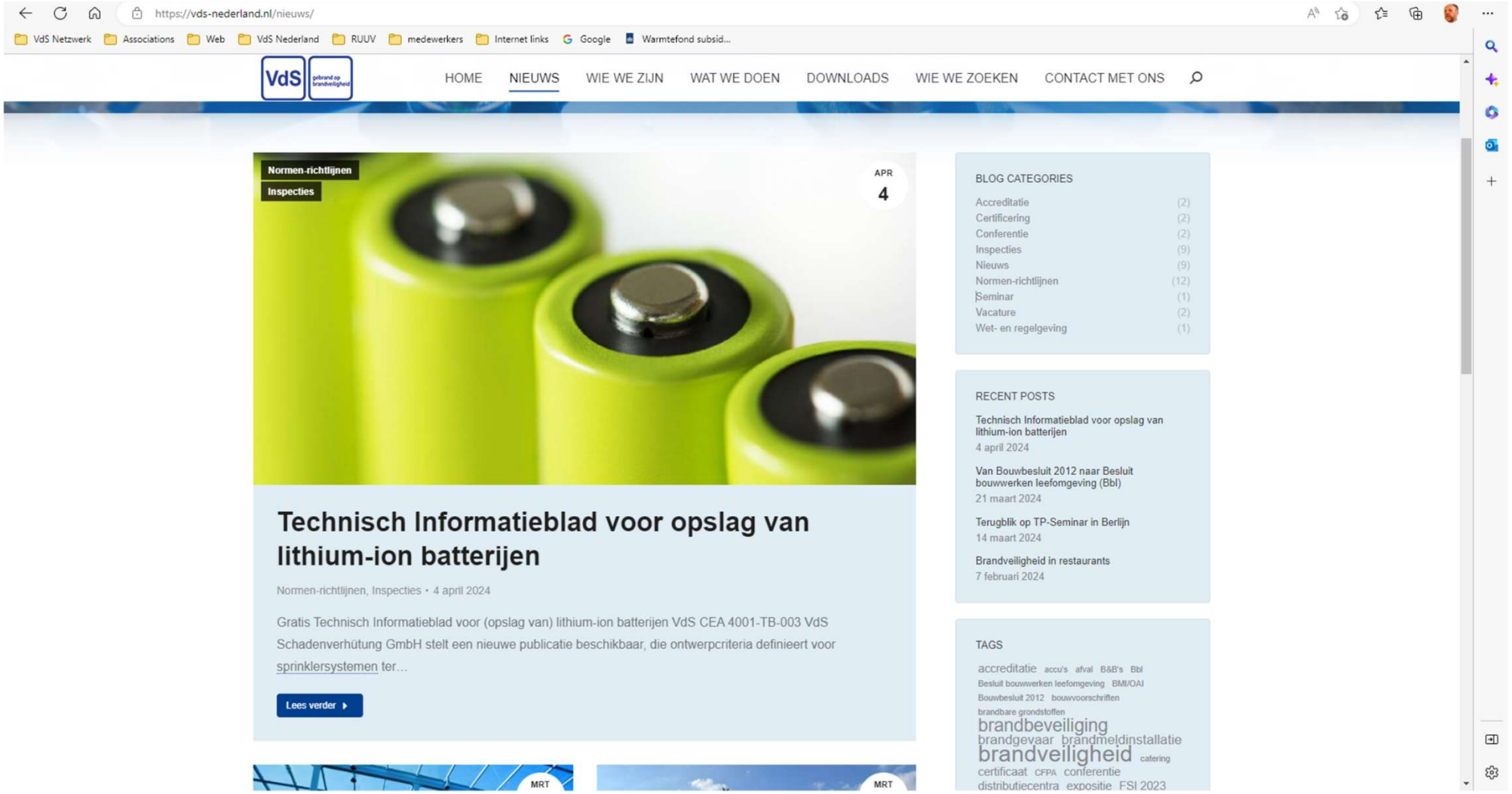
4 spk @ 2 lines

Protection above the top storage level

Restriction to lower levels possible



In-rack protection for uncartoned batteries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brandbeveiliging
brandgevaar brandmeldinstallatie
brandveiligheid catering
certificaat CFPA conferentie
distributiecentra expositie FSI 2023

05

NFPA 855

Standard for the Installation of Stationary Energy Storage Systems

NFPA 855 Scope (see also FM DS 5-33)

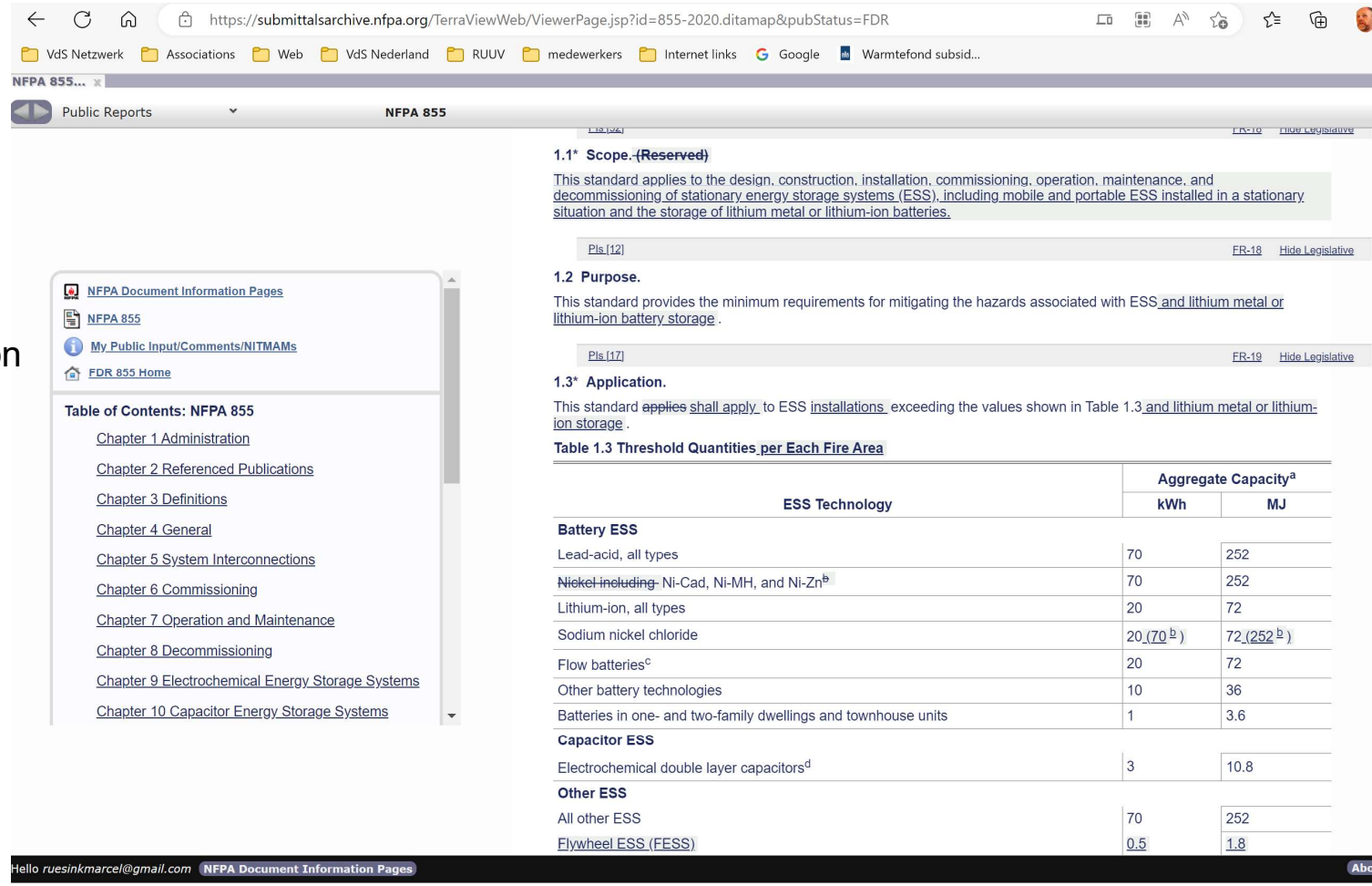
Scope NFPA 855:

Free accessible on the internet

Click here

Applies to stationary ESS situation and storage of lithium metal or lithium-ion batteries:

- Design
- Construction
- Installation
- Commissioning
- Operating
- Decommissioning



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NFPA 855...

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Table of Contents: NFPA 855

Chapter 1 Administration
Chapter 2 Referenced Publications
Chapter 3 Definitions
Chapter 4 General
Chapter 5 System Interconnections
Chapter 6 Commissioning
Chapter 7 Operation and Maintenance
Chapter 8 Decommissioning
Chapter 9 Electrochemical Energy Storage Systems
Chapter 10 Capacitor Energy Storage Systems

1.1* Scope. ~~**(Reserved)**~~

This standard applies to the design, construction, installation, commissioning, operation, maintenance, and decommissioning of stationary energy storage systems (ESS), including mobile and portable ESS installed in a stationary situation and the storage of lithium metal or lithium-ion batteries.

Pls [12] FR-18 Hide Legislative

1.2 Purpose.

This standard provides the minimum requirements for mitigating the hazards associated with ESS and lithium metal or lithium-ion battery storage .

Pls [17] FR-19 Hide Legislative

1.3* Application.

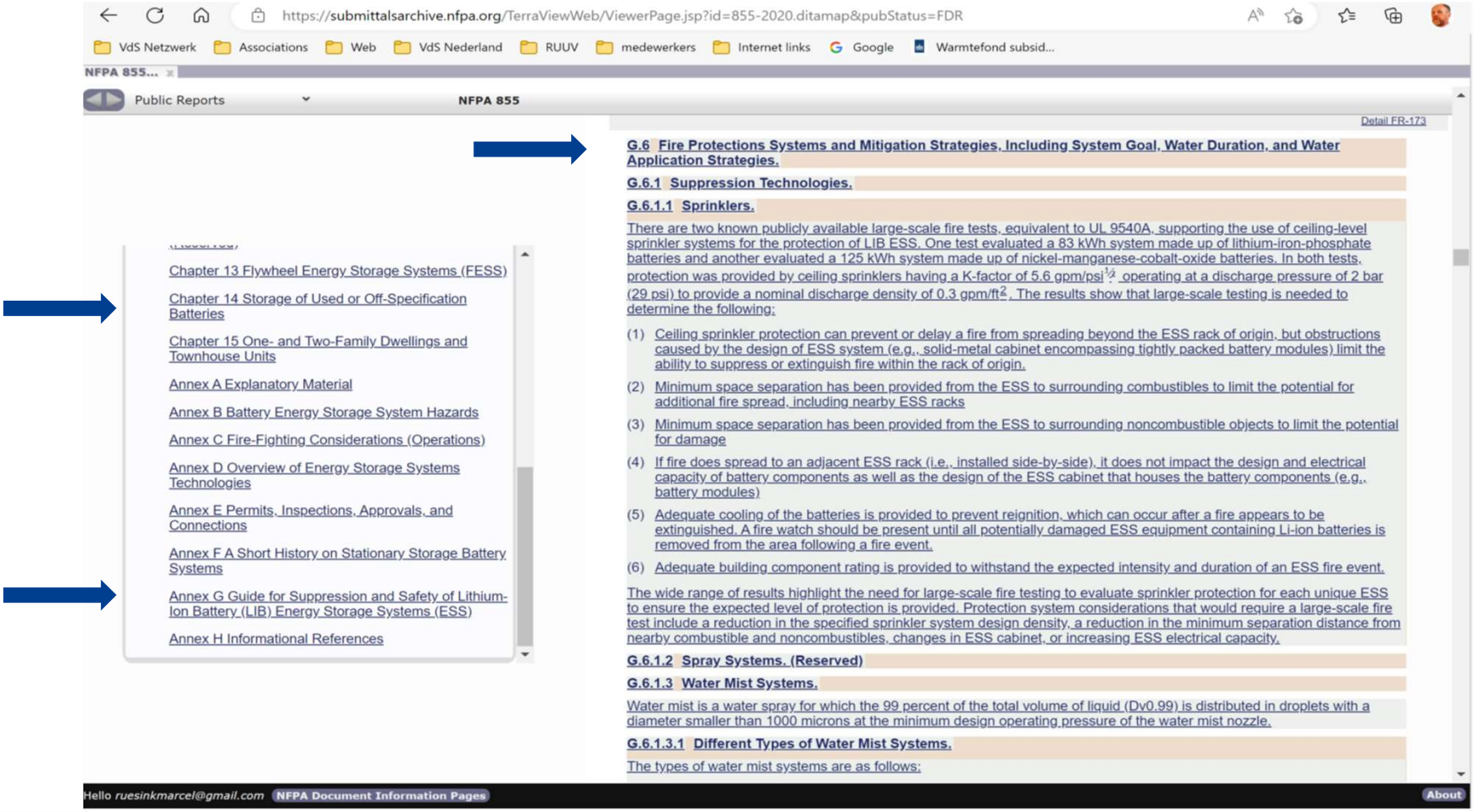
This standard ~~applies~~ shall apply to ESS installations exceeding the values shown in Table 1.3 and lithium metal or lithium-ion storage .

Table 1.3 Threshold Quantities per Each Fire Area

ESS Technology	Aggregate Capacity[a] kWh	MJ
Battery ESS		
Lead-acid, all types	70	252
~~Nickel including~~ Ni-Cad, Ni-MH, and Ni-Zn[b]	70	252
Lithium-ion, all types	20	72
Sodium nickel chloride	20 (70 [b])	72 (252 [b])
Flow batteries[c]	20	72
Other battery technologies	10	36
Batteries in one- and two-family dwellings and townhouse units	1	3.6
Capacitor ESS		
Electrochemical double layer capacitors[d]	3	10.8
Other ESS		
All other ESS	70	252
Flywheel ESS (FESS)	0.5	1.8

Hello ruesinkmarcel@gmail.com NFPA Document Information Pages

NFPA 855, Sprinkler protection



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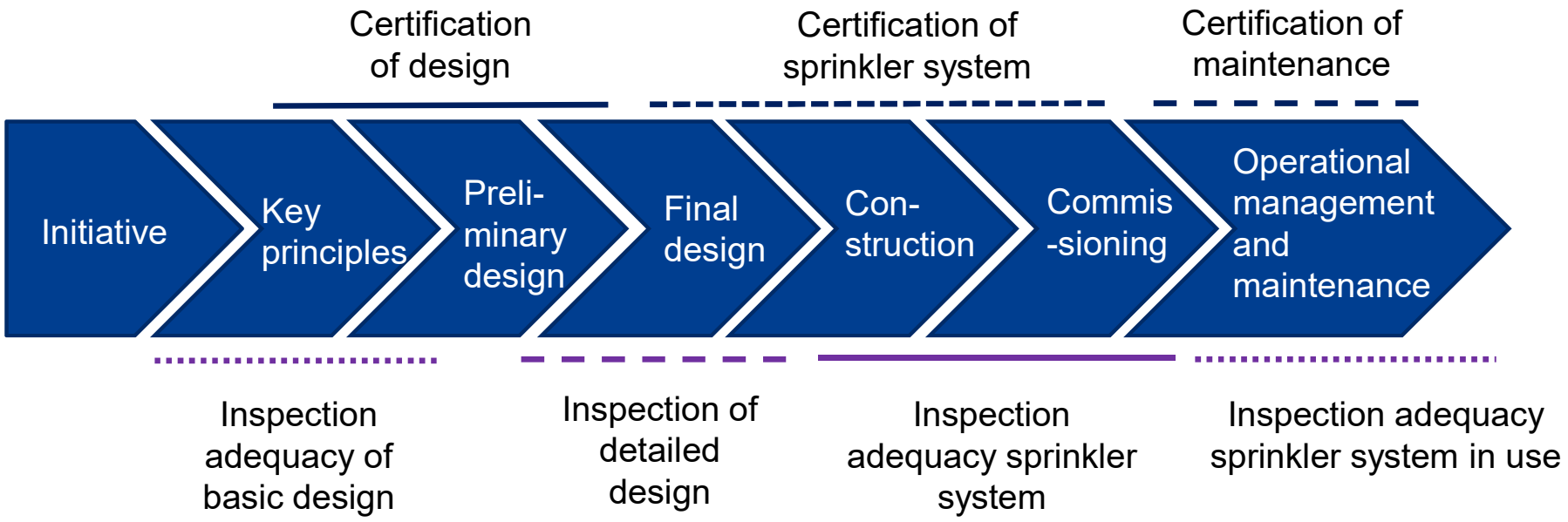
04 | Dutch CCV inspection protocol

Dutch system of quality assurance



- Independent third party certification and inspection bodies
- Inspection and certification accredited by Dutch accreditation body RvA

https://vds-nederland.nl/wie-we-zijn/accreditaties/

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VdS Nederland is niet zomaar een inspectie-instelling!

Accreditaties

VdS Nederland B.V. is een volledig onafhankelijke inspectie-instelling en voldoet aan de vereisten van een Type A inspectie-instelling conform EN ISO/IEC 17020. VdS Nederland B.V. voert alle inspectie-activiteiten onafhankelijk, onpartijdig en op een deskundige en betrouwbare wijze uit en is op geen enkele wijze betrokken bij het te inspecteren product.

Er zijn geen partijen betrokken bij het eigendom of het bestuur van VdS Nederland B.V. die mogelijk een belang hebben bij de items/objecten die door VdS Nederland B.V. worden geïnspecteerd.

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INSPECTIE RvA I 336

Certificaat accreditatie EN ISO/IEC 17020

Bijlage bij accreditatieverklaring: scope van accreditatie (PDF, 1,3 Mb).

Daarnaast mag VdS Nederland B.V. met trots het EBN certificaat Veiligheidsmanagementsysteem voeren;

Thanks for your attention