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Inland Transport Committee

Working Party on the Transport of Dangerous Goods

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Any other business

30 November 2019

**Firebox – Fire Prevention for damaged or defective Lithium
Batteries in Battery Electric Vehicles (BEV)**

Transmitted by the Government of Switzerland

Firebox – Fire Prevention for damaged or defective Lithium Batteries in Battery Electric Vehicles (BEV)

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WP 15 Meeting, November 2019**

Introduction

- Damaged lithium batteries may catch fire or self-ignite.
- These battery fires are difficult to extinguish.
- Firefighters have had different experiences and know how; important it is to react quickly.
- After extinguishing, quarantine and monitoring is necessary due to re-ignition.
- We should be prepared for a fire with a lithium battery.

Content

1. Fire Report of Lithium Batteries
2. What do we know about Lithium Batteries and Fires
3. Comparison of portable Fire Extinguishers
4. The Firebox. What is it?
5. Aerosol Extinguisher. How does it work?
6. Sales Forecast of Vehicles
7. Conclusions

Fire of Lithium Batteries on a Truck Semi-Trailer

- A truck semi-trailer with 20 tons used Lithium Batteries took fire.
- When the first emergency vehicles arrived shortly after the alarm was sounded, the trailer was already completely on fire. "Smaller and larger explosions forced us to retreat again and again," said a spokesman for the Hilden fire brigade. Four hours after the outbreak, the fire was almost under control. However, the fire-fighters had to cool and extinguish the cargo for 16 hours under a foam carpet until the fire was completely extinguished.



Incident Hilden; NRZ, Neue Ruhr Zeitung March 2016

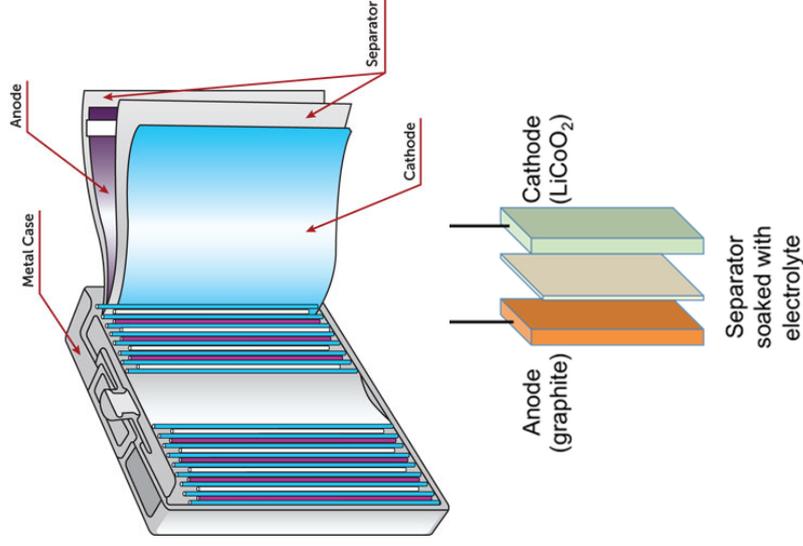
Fire of an Electric Car

- From start to a full fire in minutes.
- 10'000 liters of water have been necessary to extinguish the fire.
- Even after extinguishing the fire re-ignited spontaneously.
- After that, it's also recommended that the car be put in "quarantine" for 48 hours, just in case of a new fire.
- Transport of the car to a quarantine site is necessary.



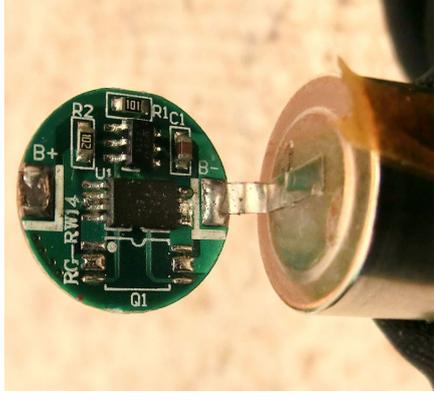
Incident Kent (WA); NBC News October 2013

Construction of Li-Ion Batteries



Basically a lithium ion battery is made of an:

- anode
- cathode
- separator
- and electrolyte
- and a BMS



BMS = battery monitoring electronics (control and management of the battery)

Composition of Li-Ion Batteries

		LiCoO ₂	LiCoNiAlO ₂	LiFePO ₄	Mass-%
Electrolyte	Salt	LiPF ₆ (Lithium hexafluorophosphate)			0.1 – 5
	Solvent	Ethylene Carbonate Diethyl Carbonate Propylene Carbonate (C ₃ H ₄ O ₃) (C ₅ H ₁₀ O ₃) (C ₄ H ₆ O ₃)			3 – 10
Separator		PVDF (Polyvinylidene fluoride)			1
Cathode (+)	Aluminum				2 – 10
	LiCoO ₂	LiCoNiAlO ₂	LiFePO ₄		20 – 50
Anode (-)	Copper				3 – 15
	Graphite				10 – 30
Housing / Case		Iron, Nickel, Aluminum, etc.			Balance

Hazardous Substances in Li-Ion Batteries

	LiCoO ₂	LiCoNiAlO ₂	LiFePO ₄	Mass-%
Electrolyte	LiPF ₆ (Lithium hexafluorophosphate)			0.1 – 5
Separator	Ethylene Carbonate		(C ₃ H ₄ O ₃)	3 – 10
	Diethyl Carbonate		(C ₅ H ₁₀ O ₃)	
	Propylene Carbonate		(C ₄ H ₆ O ₃)	
Cathode (+)	PVDF (Polyvinylidene fluoride)			1
	Aluminum			2 – 10
Anode (-)	LiCoO ₂	LiCoNiAlO ₂	LiFePO ₄	20 – 50
	Copper			3 – 15
Housing / Case	Graphite			10 – 30
	Iron, Nickel, Aluminum, etc.			Balance

Fire reactive and dangerous substance in lithium batteries.

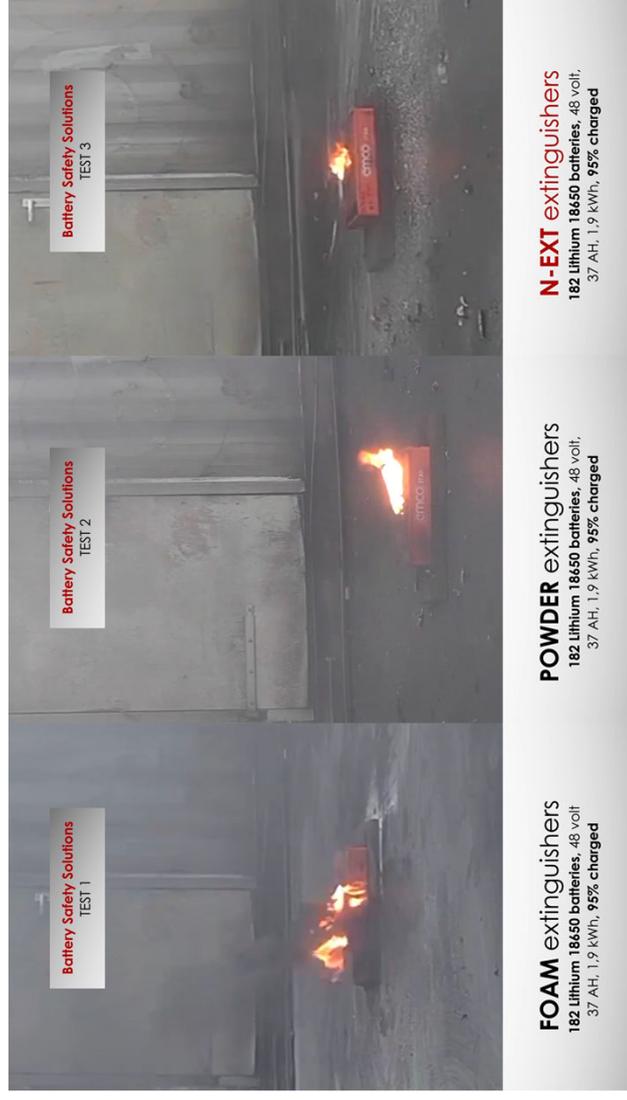
What do we know about Li-Ion Battery Fires

- Rapid development from fire outbreak to full fire.
- Release of hazardous substances.
- Difficult to extinguish.
- After extinguishing the battery must be cooled down.
- Batteries can reignite.

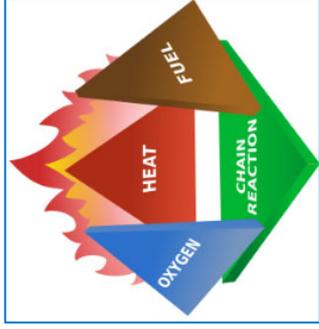


Lithium Battery Fire Extinguishing Test

- Video compares three extinguishing agents:
 - Foam
 - Powder
 - N-EXT
- Test setup:
 - 182 Li-Ion 18650 batteries
 - 48Volt, 37Ah, 1.9kWh



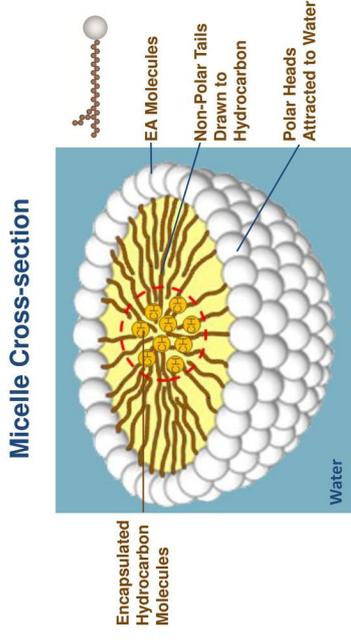
N-EXT / F-500



The fire tetrahedron explains the four elements required to make a fire: heat, oxygen, fuel and free radicals. Eliminating any one of these elements will extinguish a fire. F-500 EA removes three elements.

Properties of N-EXT

- Reduce the surface tension of the water
- Rapidly absorb the heat
- Encapsulate the fuel
- Interrupt the free radical chain reaction



FireBox

SECURE YOUR LOGISTICS FOR LITHIUM BATTERIES AND ELECTRIC VEHICLES

STORAGE



20- or 40-foot-container

EV-SALVAGE



LOGISTICS



Integrated FirePro fire alarm and Aerosol extinguishing system



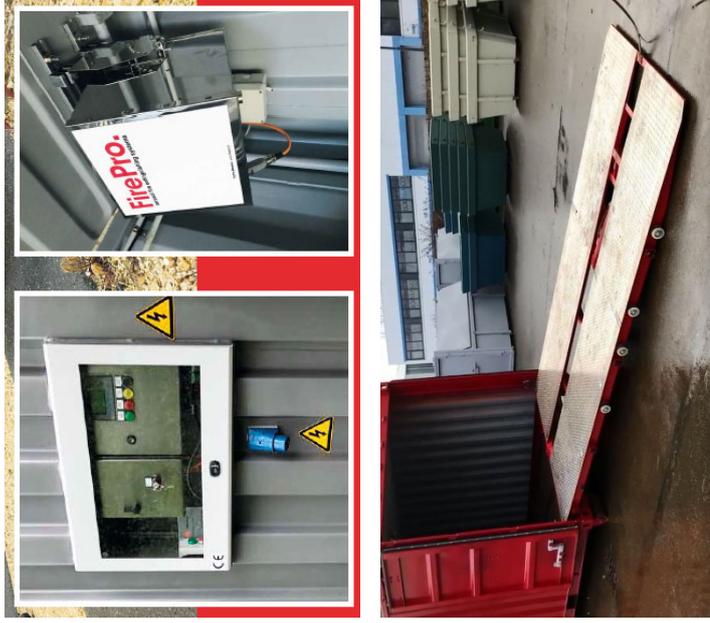
The Firebox



- It is a solution for the safe storage and transport of lithium batteries and devices with lithium batteries.
- With an integrated fire alarm and Aerosol extinguishing system.
- For permanent monitoring and automatic extinguishing within a few seconds after the outbreak of the fire.



The Firebox Options



- 20 or 40 foot container.
- LED light.
- Sprinkler system with Storz connection
- Collection tray for liquids.
- Battery power supply.
- Winch.
- Sliding platform for the salvage of damaged EV.
- Hook system for use as roll-off container.
- Side doors.
- Fire extinguishers.

The Firebox Salvage Container



- Made for the salvage and transport of damaged electric vehicles.
- The fire alarm and extinguishing system protects you during transport.
- In the event of ignition and fire during transport, the system sounds the alarm and extinguishes the fire.
- You can continue the transport to a quarantine station and alert the fire brigade.

Extinguishing of a Battery Fire in the Firebox

- Video shows a fire of Li Ion batteries and how it is extinguished in the Firebox.
- Test setup:
 - 182 Li-Ion 18650 batteries
 - 48Volt, 37Ah, 1.9kWh

FirePro.

FirePro Benelux

Safety for
storage and transport
of Lithium batteries

Extinguishing of a Battery Fire in the Firebox

- Video shows a fire of Li Ion batteries and how it is extinguished in the Firebox.
- Test setup:
 - Li-Ion 18650 batteries
 - 144x36Volt/14.5Ah, 75kWh



FirePro Aerosol Extinguishing Technology

**FirePro
extinguishes fires
at the molecular
level by inhibiting
chemical chain
reactions!**



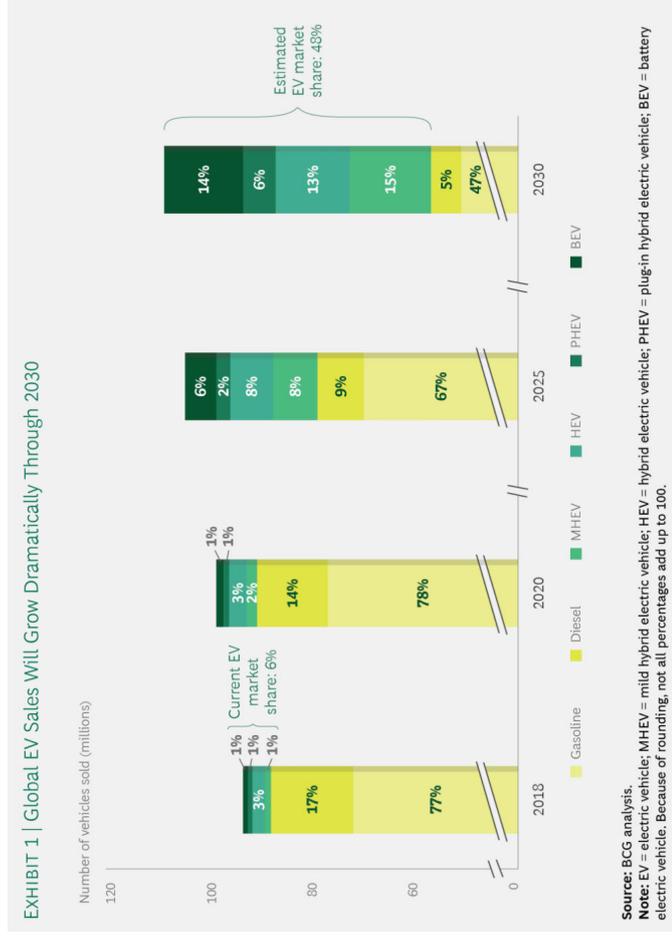
1. After activation, the solid FPC compound transforms into a rapidly spreading condensed extinguishing aerosol, consisting mainly of potassium salt based K_2CO_3 , H_2O (steam), N_2 and CO_2 .
2. When the condensed aerosol reaches and reacts with the flame, Potassium radicals (K^*) are formed mainly from the disassociation of K_2CO_3 . The K^* 's bind to other flame free radicals (hydroxyls - $OH\cdot$) forming stable products such as KOH . This action extinguishes fire without depleting the ambient oxygen content. KOH reacts further in the presence of CO_2 and forms K_2CO_3 .
3. The solid particles of Potassium Carbonate (K_2CO_3) remain in suspension in the protected room/enclosure for at least 30 minutes, preventing further re-ignition of the fire.

Source: FirePro Systems 2019



Sales Forecast of Vehicles

- We are at the beginning of a new era.
- Dieselgate and global warming are pushing carmakers to produce EV.
- The current global EV market share in 2018 is 6%.
- It will increase to 8% by 2020, to 24% by 2025 and to 48% by 2030.



Source: Boston Consulting Group, 2018

Why an ADR restriction for the transport of BEV with damaged or defective batteries?

1. Transport of damaged or defective batteries is restricted under ADR.
2. But the transport of BEV with damaged or defective batteries is **not** restricted under ADR.
3. We all agree that damaged or defective batteries represent a high-risk potential.
4. Without restriction, this transport of BEV with damaged or defective batteries is carried out by non-professionals without any risk precautions.
5. The restriction should apply to the transport of BEV with damaged or defective batteries from the roadside assistance car park to the garage or to third parties.
6. Roadside assistance and rescue personnel are rescue experts and exempt from ADR regulations.
7. The transport of a BEV, secured in a container with an automatic fire extinguishing system, creates safety and prevents careless transport.

Conclusions

1. There is no safety check for lithium batteries that guarantees you that no incident will occur.
2. Fires from lithium batteries are difficult to extinguish and release dangerous and toxic substances.
3. Sooner we start extinguishing the fire, greater the chances of success.
4. The extinguishing aerosol reaches every source of fire.
5. The Firebox is a smart solution for the safe transport of BEV with damaged of defective lithium batteries.

Be prepared!

FireBox

SECURE YOUR LOGISTICS FOR LITHIUM BATTERIES
AND ELECTRIC VEHICLES

STORAGE



20- or 40-foot-container

EV-SALVAGE



LOGISTICS



Integrated FirePro fire alarm and
Aerosol extinguishing system

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