

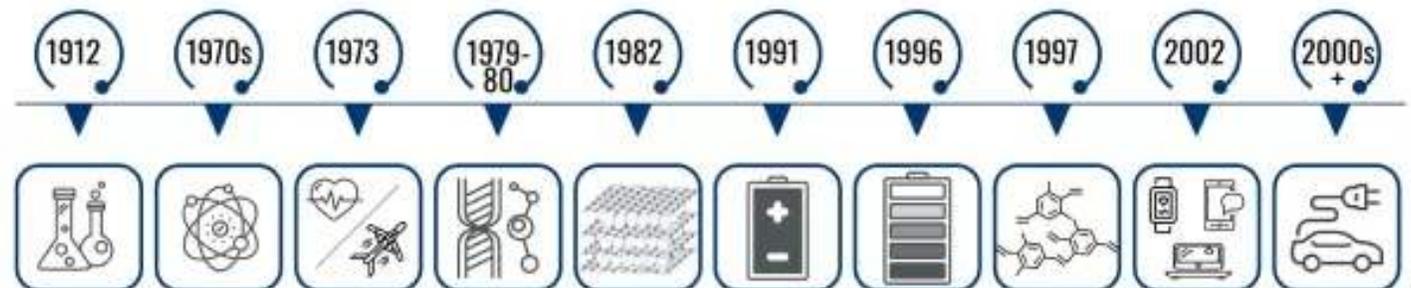
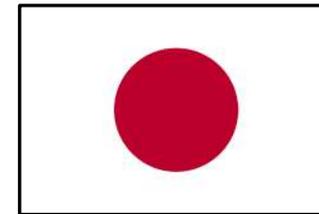
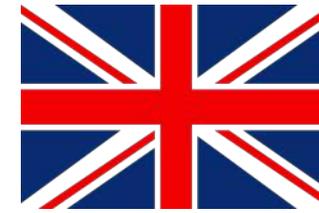


Programme

- A description of the R&D undertaken by the FRMG / C of IOSH over the past 7 years
- Why? Li-ion batteries present Fatal Risks in occupational and public safety and health
- Purpose? To inform, educate and 'entertain' (Gosh!! I never knew that moments ...) for members and like-minded professionals and
- To advocate for safety and better understanding of **good** fire risk management
- And I've made this a CPD moment!

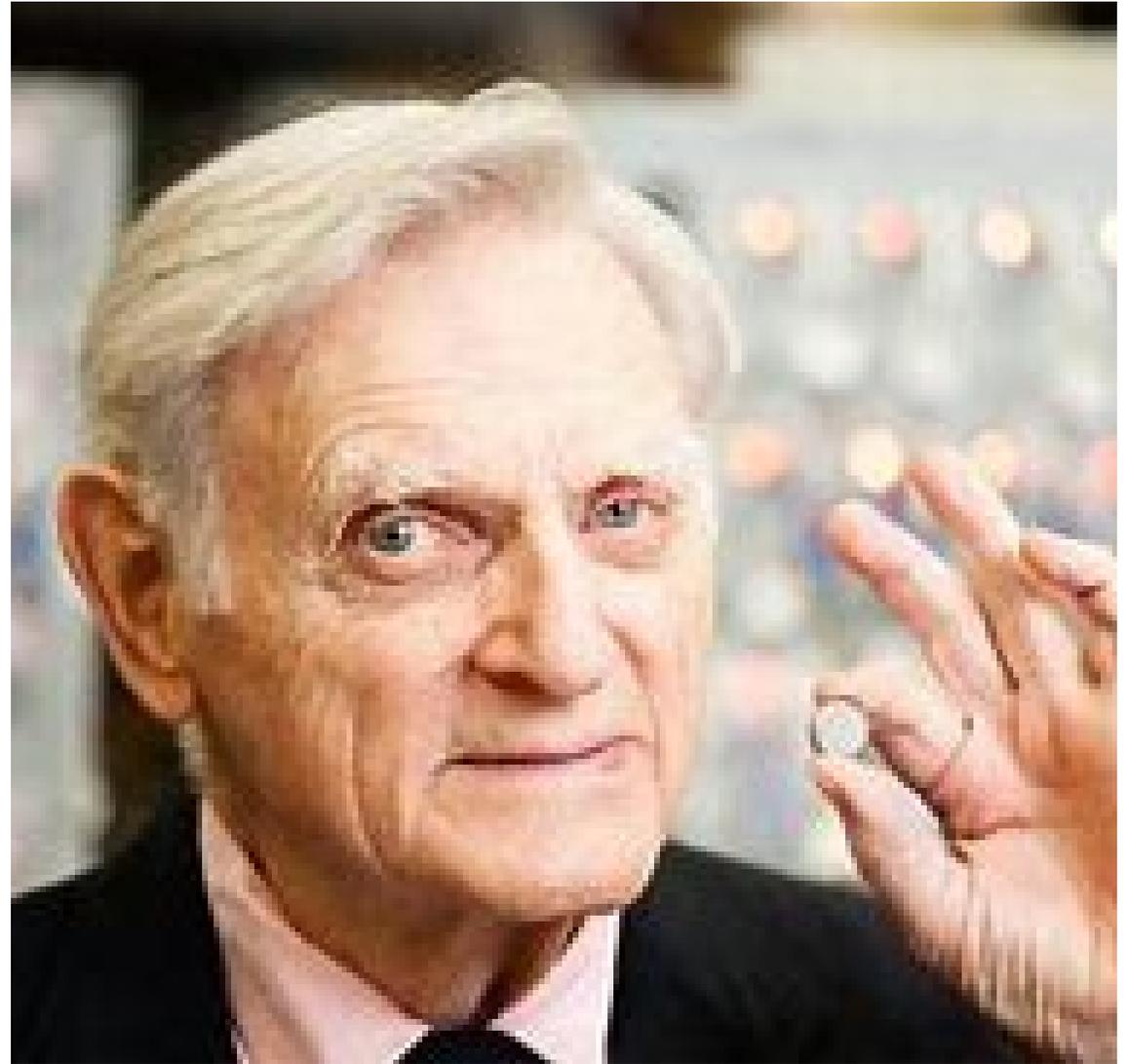
Development timeline

- 1970: Stanley Whittingham. Initial research
 - 1980: John Goodenough. Cathode discovery
 - 1985: Akira Yoshino. Commercial battery
 - 1982: Sony development
-
- Compare with: Jack Kilby
 - 1958: Invented the Integrated circuit for TI, Co-invented the electronic calculator
 - Nobel Prize for Physics, 2000, aged 77



John Bannister Goodenough

- Nobel Prize in Chemistry 2019, aged 97
- Royal Society, Copley Medal, 2019
- b. 25 July 1922, Jena, Germany
- d. 25 June 2023, Austin, TX, USA, aged 100
- Prof. Mechanical, Materials Science and Electrical Engineering at the University of Texas, Austin, USA
- Prize motivation: “For his crucial role in development of lithium-ion batteries”





EBATT X-2E 3.3V 15AH +

Early interactions with Li batteries
MBT waste management: new
environmental management
technology

1/28/2026

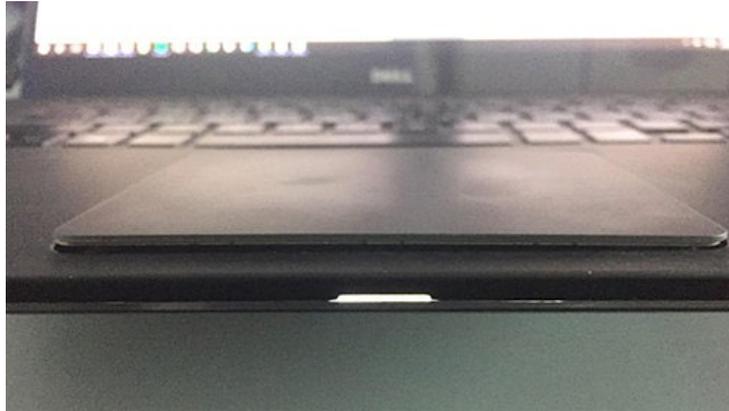
© IOSH FRMG

Signs of imminent or immediate failure

Swollen keyboard



Swollen battery case



Charred laptop





A notorious case: The Samsung Galaxy Note 7: January 2017 press conference







MV Felicity Ace 2022



Freemantle Highway 2023

MY Kanga, MY Siempe: electric surfboards



Li-ion batteries and cargo aircraft

- Swissair Flight 111
- UPS Airlines Flight 6
- Fed Express Flight 1406
 - [FedEx Express Flight 1406 - Wikipedia.](#)



E-bikes & E-scooters

- Faulty third-party e-bike batteries, and batteries bought for 'modified' e-bikes (to gain enhanced performance) are blamed in recent fires
- Firefighters ask residents to only use trusted batteries and be careful to charge and store them correctly
- 'Overcharged' batteries are a huge problem
- **BE VERY CONSCIOUS OF DROPPED BATTERIES** and cracked cases



In normal operations ... E-scooters

- Follow the safety and rider guidance from the provider
- Follow the rules of the road
- Use protective equipment
- Check road conditions
- Always ride solo
- Never ride under the influence
- Luggage
- Mobile phones
- Take a test ride
- Leave the rental e-scooter in a designated parking bay

Check before you ride

1. Tyres
2. Brakes
3. Battery
4. Throttle
5. Damage



Sackville Close, Cambridge

- 0108 Friday, 30 June 2023
- The mother died at the scene and two children(4 and 8) died later in hospital
- The partner was later recovering in hospital

Electric bike blamed for deadly fire at family home

Laurence Sleator

An e-bike is likely to have caused a fire in Cambridge that killed a mother and her two young children, investigators have said.

Gemma Germeney, 31, and her son Oliver Peden, four, and daughter Lily Peden, eight, died after the blaze at their flat in the King's Hedges area of Cambridge in the early hours of Friday morning.

Emergency services, including more than 30 firefighters from six crews, were called to the two-story maisonette in the north of the city about 1am. Officers were able to rescue the two children but they died in hospital. Germeney was pronounced dead at the scene.

A man in his 30s, believed to be Germeney's partner, Scott Peden, escaped but remains in a critical condition. Neighbours said he had tried to rescue his partner and two children. The family's two dogs also perished.

After an investigation over the weekend, the Cambridgeshire Fire and Rescue service said yesterday that it believed the fire began accidentally, with an e-bike that was charging being "the most probable" cause. Stuart Smith, the area commander, said: "Fire service and specialist fire investigators, together with police forensic teams and a fire dog, have spent the weekend carrying out a thorough investigation of the maisonette. A fire investigation looks for the most probable cause and in this case, we believe that to be an electric bike that was charging."

"We know e-bikes and e-scooters are popular modes of personal transport at the moment and we are urging any-

one with one to be aware of the risks and follow simple precautions to reduce the likelihood of the batteries overheating."

One neighbour called Debbi told The Sun: "Gemma loved her kids to bits. She was a devoted mum and had a heart of gold. We heard that Scott had tried to rescue them all when the fire broke out in the middle of the night. He was a hero but he couldn't save them. Our thoughts and prayers are with him."

Sarah Merritt, head teacher at King's Hedges School, where the two children were pupils, said: "The children were part of our King's Hedges family and the whole school is devastated by this terrible tragedy."

The fire service urged anyone with e-bikes or scooters to avoid charging the battery overnight and not to leave it connected to power for any longer than it needed to fully charge. The lithium-ion batteries used in the devices contain an electrolyte fluid component that is highly flammable and can be a fire-risk if batteries overheat.

Last week London Fire Brigade said that it had attended an e-bike or scooter fire every two days. Up to April 20, there had been 102 recorded e-bike fires this year from 38 fire services across the country.

Sofia Duarte, a 21-year-old bartender, was killed in a fire at a flat on Old Kent Road on New Year's Day after a converted e-bike battery burst into flames. Maria Frasilho Macarro, Duarte's mother, has since campaigned to raise awareness about the dangers of e-bikes and lithium batteries.

"I really want to make sure her death is not in vain," she said. "If we can save someone else's life, I will take great comfort in that because at the moment I am hurting — I don't want others to suffer as much as I have done."

Gemma Germeney, Oliver Peden, four, and Lily Peden, eight, died. Scott Peden is in a critical condition



Josh Pearson (28) & Danielle Bamber (24)

- Peter Street, Blackpool
- 'Early hours' of 17 July 2024
- HM Coroner recorded CO poisoning after "inhaling fatal fumes"
- "The fire most likely started due to an electrical fault on the batteries of electric bikes"



Look what Li-ion cells are used for now!



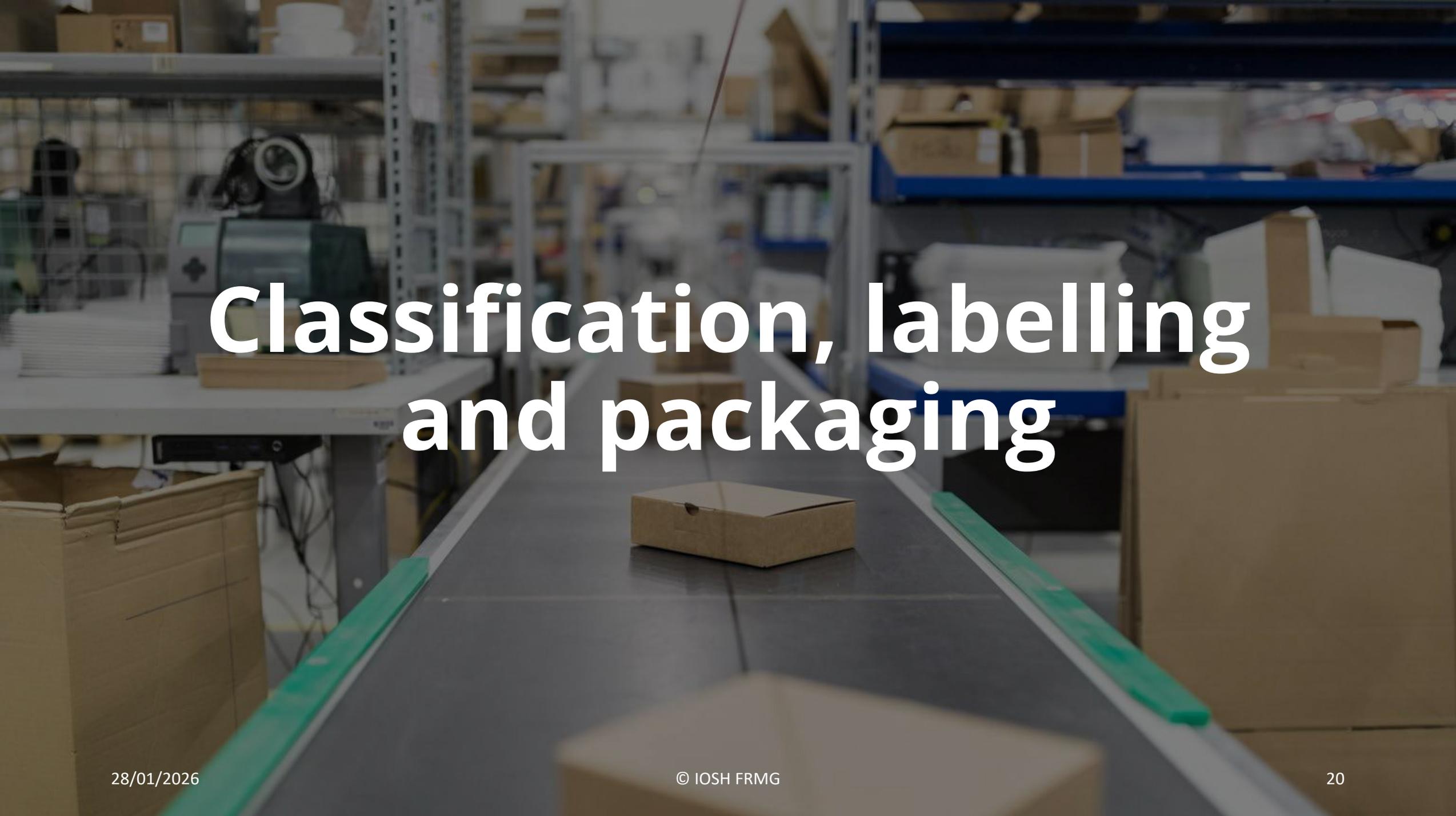


D4FS: Designing for fire safety

- Using OEM chargers and batteries and equipment that is designed with Poke-yoke in mind
- Note that only the right battery will fit in the correct charger!



From small wearable technology (Fitbit and Whoop) to power walls and battery storage

A photograph of a warehouse conveyor belt system. A small cardboard box is positioned on the grey conveyor belt, which is flanked by green safety rails. In the background, there are metal shelving units filled with various boxes and equipment, including a scanner or scale on a table to the left. The scene is brightly lit, typical of an industrial environment.

Classification, labelling and packaging

UN hazard classifications for packaging for road and rail transport

- Classes:
 - Explosives
 - Gases
 - Flammable liquids
 - Flammable solids
 - Oxidisers, incl. org peroxides
 - Toxics
 - Radioactive
 - Corrosive
 - Miscellaneous

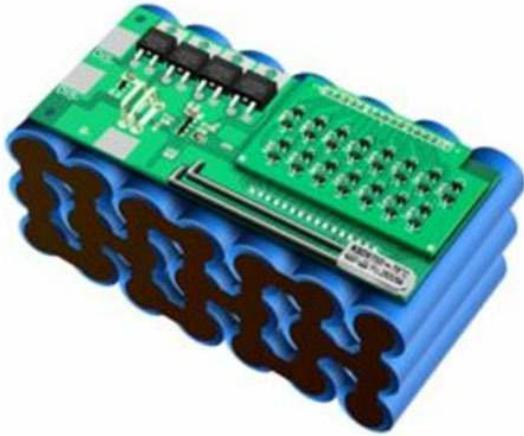


Transport of Lithium-ion batteries

- A new Class 9 hazard label for all types of Lithium batteries, and a new Lithium battery handling mark for packages containing any type of Lithium battery came into force on 1 January 2017 for all transport modes
- The former hazard label and handling mark continued to be used until 31 December 2018
- Batteries **MUST** be transported **ONLY** in their approved packaging **AND** by approved methods
- NB: In the UK it is illegal to send Lithium / Li-ion batteries in the post by Royal Mail!!!



What packaging for transport looks like

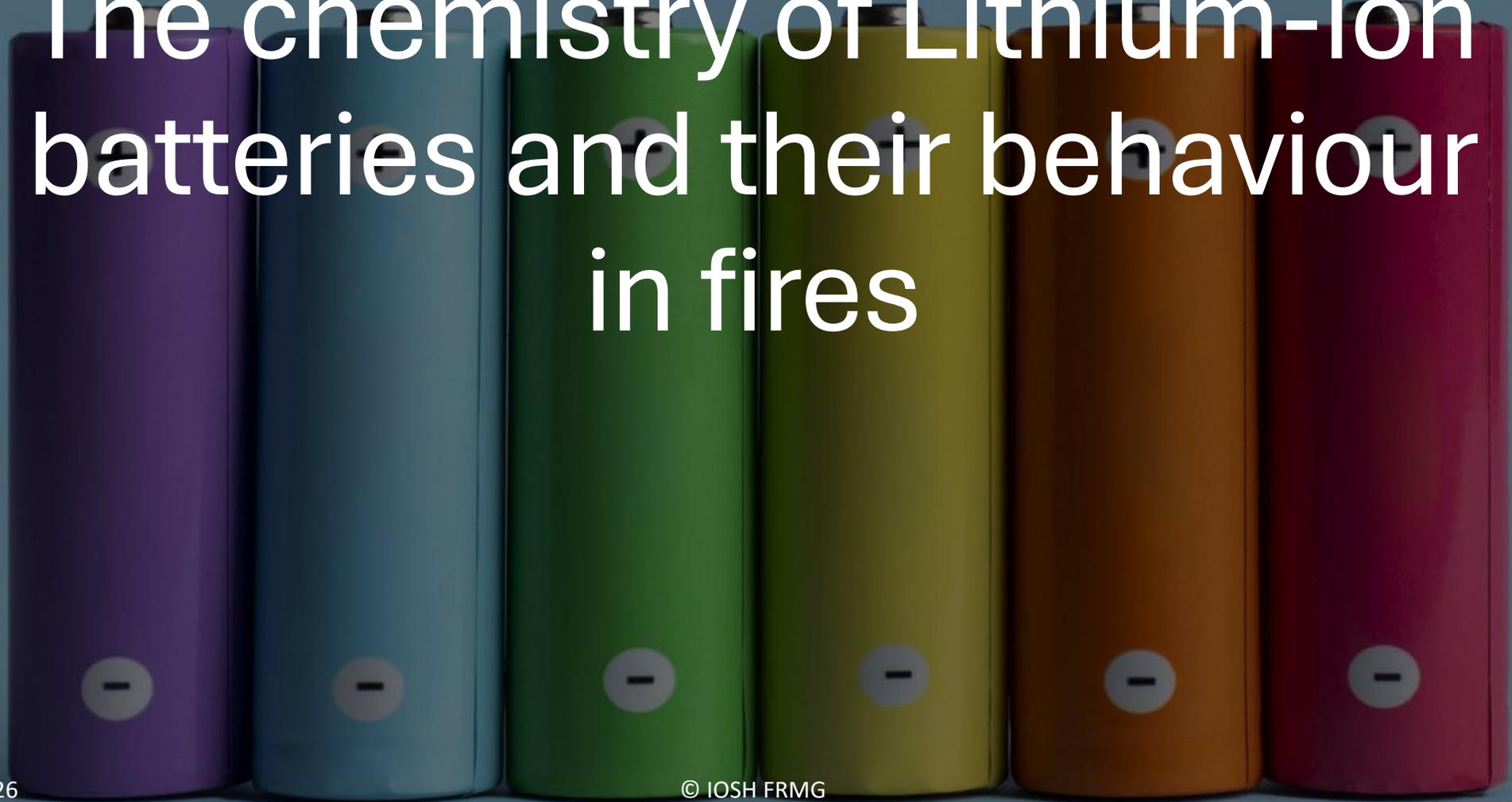


Consignee		SERPAC		TATA	
Two completed and signed copies of this Declaration must be handed to the operator.					
TRANSPORT DETAILS This shipment is within the limitations prescribed for: see reverse side.			WARNING Failure to comply with the applicable Dangerous Goods Regulations is in breach of the applicable law.		
PASSENGER AND CARGO AIRCRAFT ONLY		AIRPORT OF DEPARTURE:		AIRPORT OF DESTINATION:	
NATURE AND QUANTITY OF DANGEROUS GOODS		DANGEROUS GOODS IDENTIFICATION			
UN or ID No.	Proper Shipping Name	Quantity and form of packing	Packing Group	Administration	
Additional Information					
Name/Title of Signatory					





The chemistry of Lithium-ion batteries and their behaviour in fires





What are the operational factors?

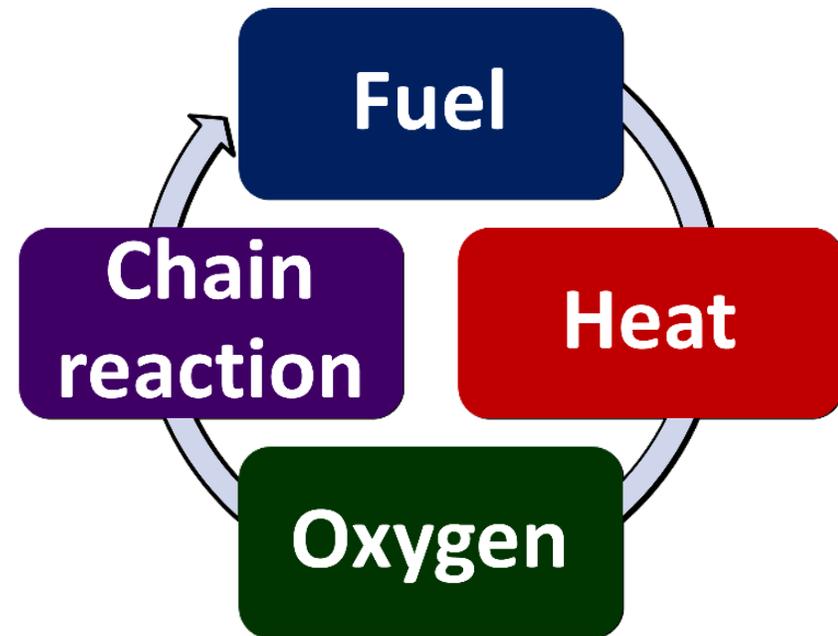
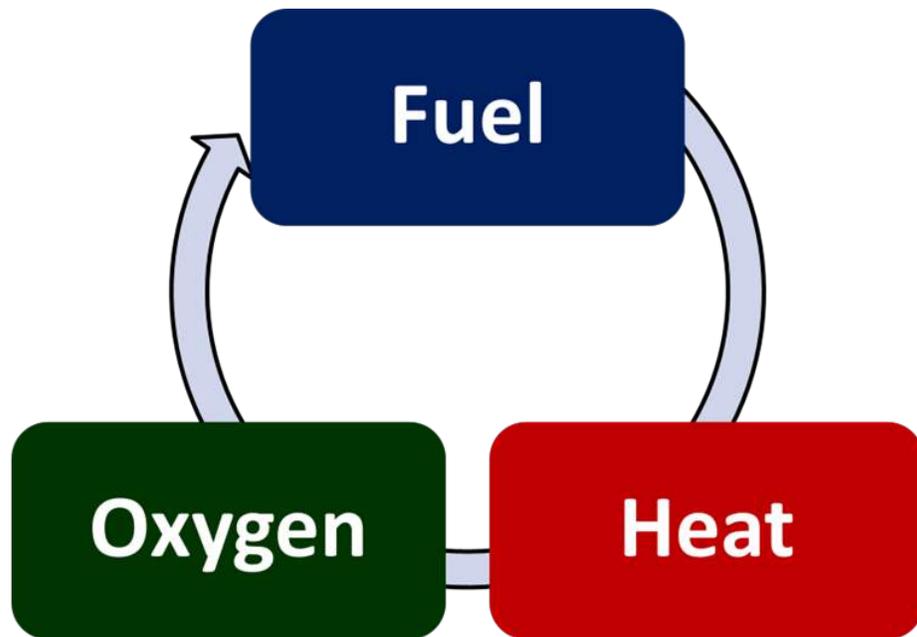
- What are the hazards?

- If a battery cell creates more heat than it can effectively dissipate, it can lead to a rapid uncontrolled release of heat energy, known as 'thermal runaway', that can result in a fire or explosion

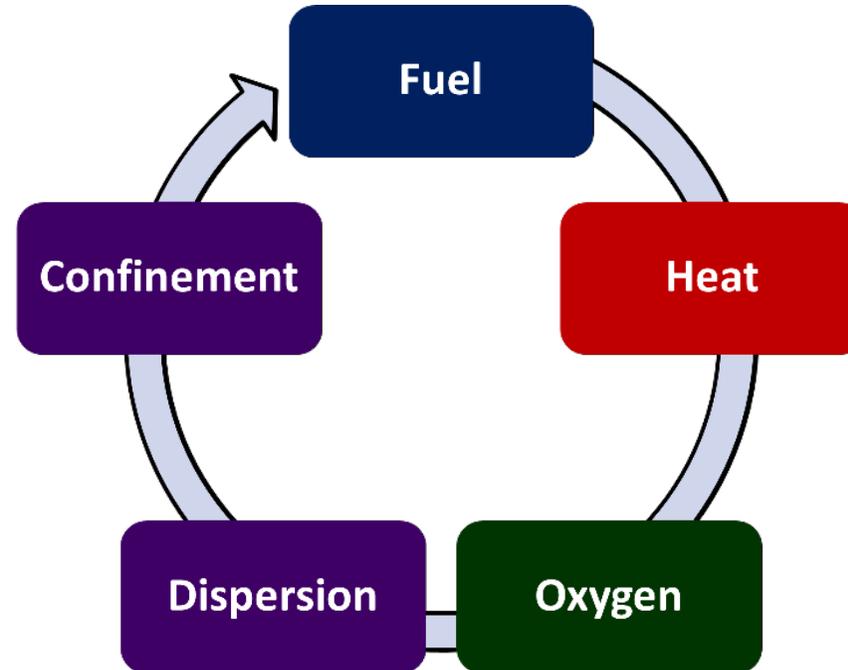
- This typically develops through the following events:

1. Temperature increase
2. Venting/gassing-off of flammable/toxic electrolyte vapours
3. Flare
4. Steady burn
5. Flash fireball
6. Explosion

Fire triangle and tetrahedrons

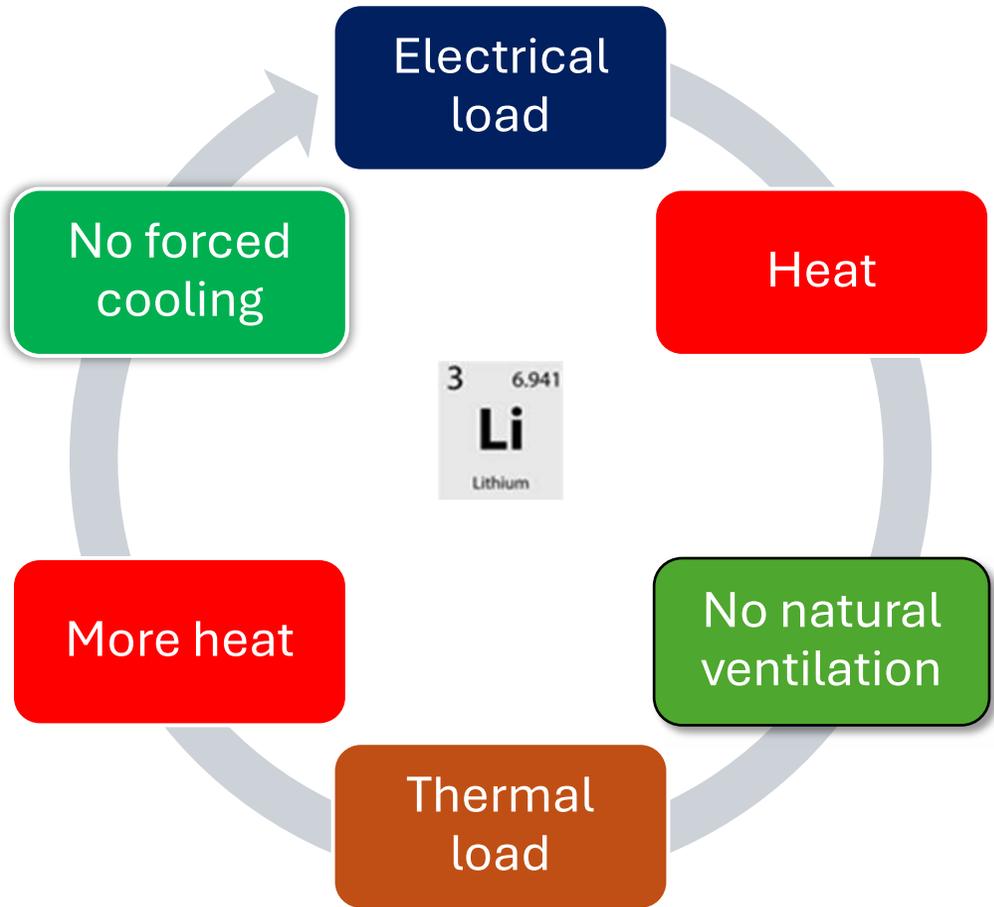


Dust explosion pentagon



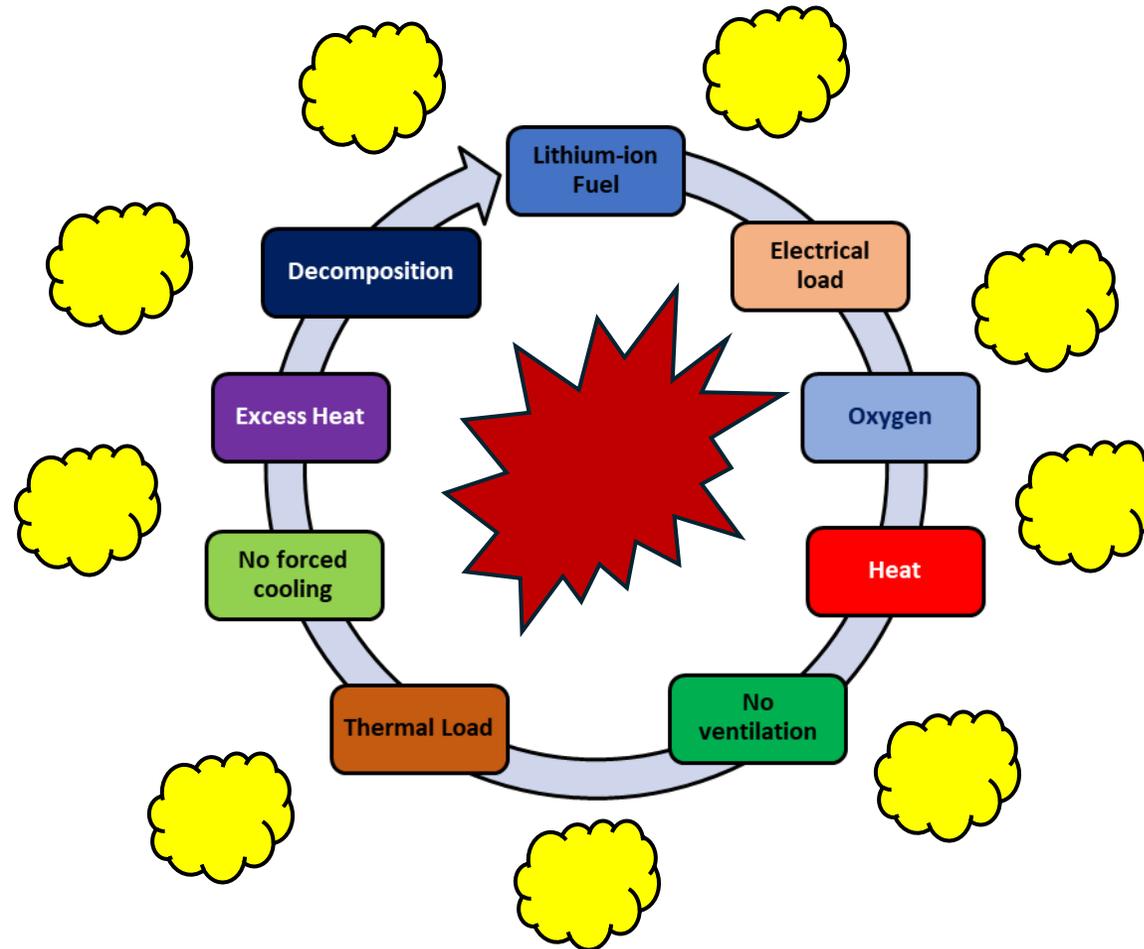


A circle or a spiral?



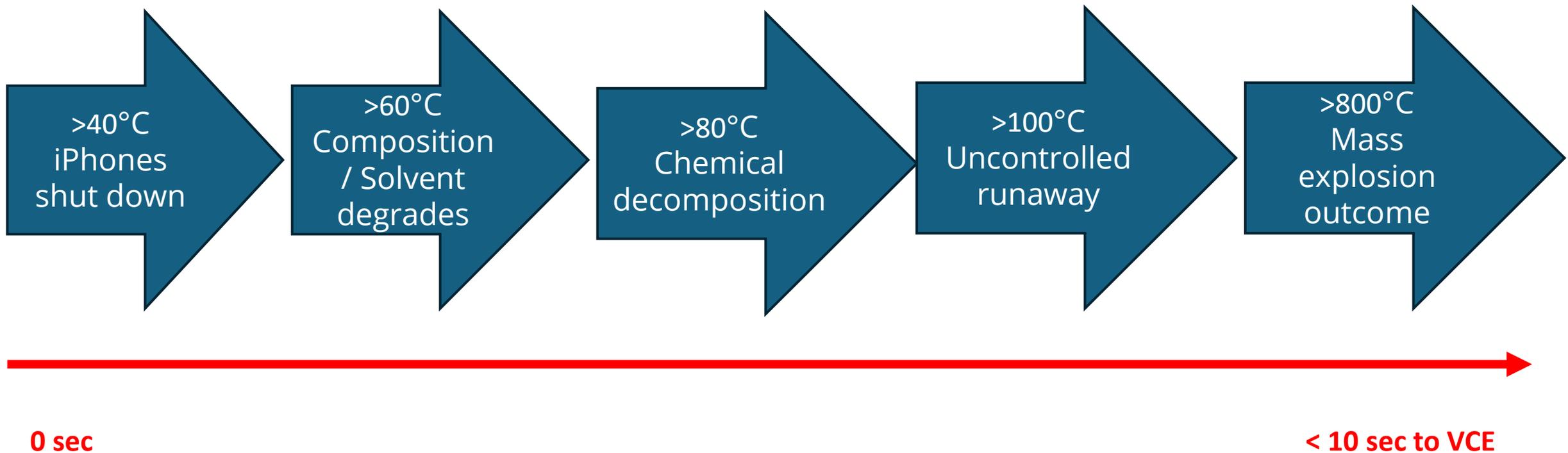
- A Li-ion battery fire involving a high voltage battery is not actually a fire. It is the overheating of one cell causing overheating of adjacent cells, without the benefit of ventilation or forced cooling
- A significant risk associated with thermal runaway is the chemical exchange within battery cells generates significant heat with toxic and potentially explosive gases

Lithium-ion combustion



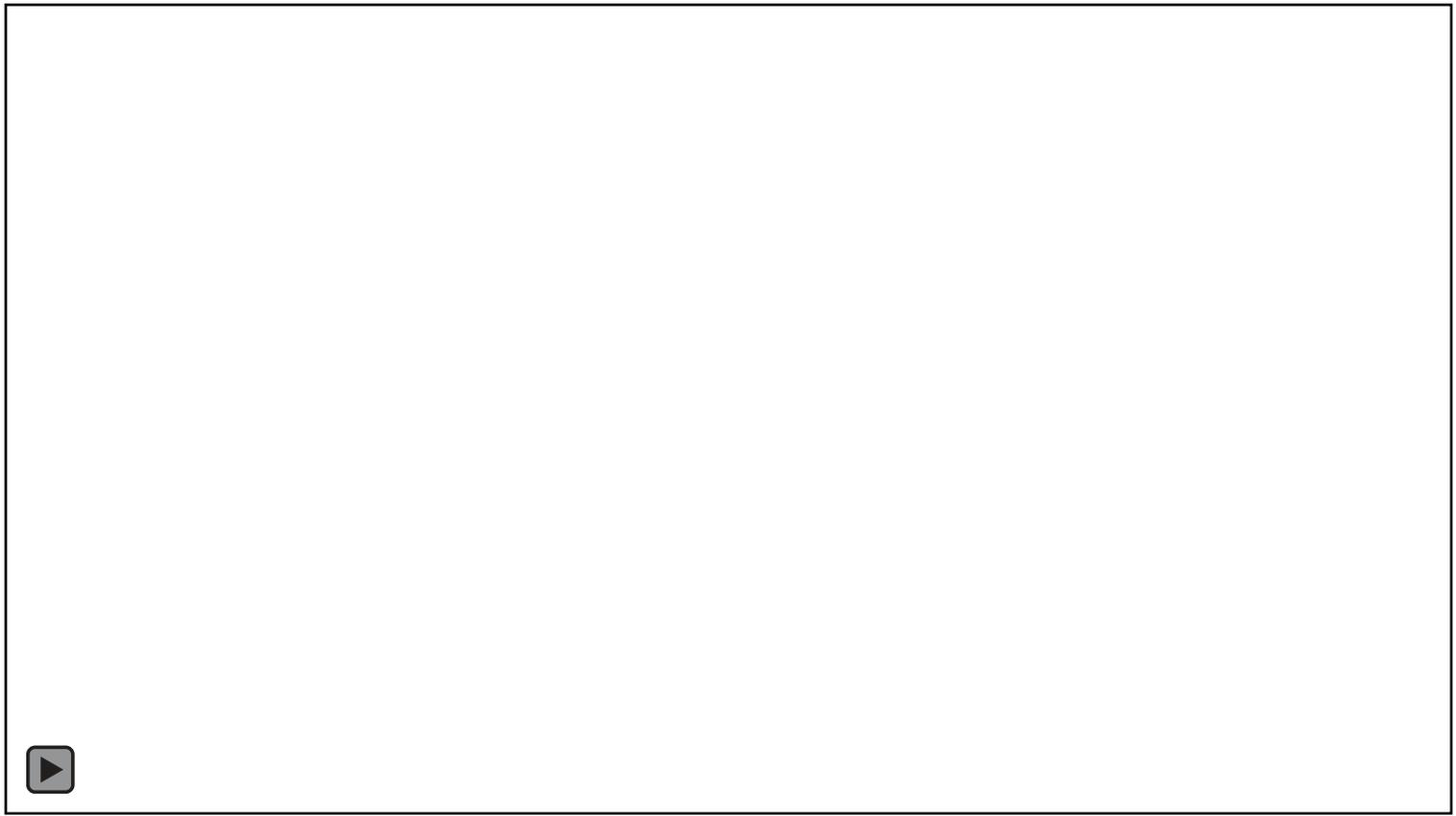
How does this fire develop?

- Temperature timelines:





From The Daily Telegraph



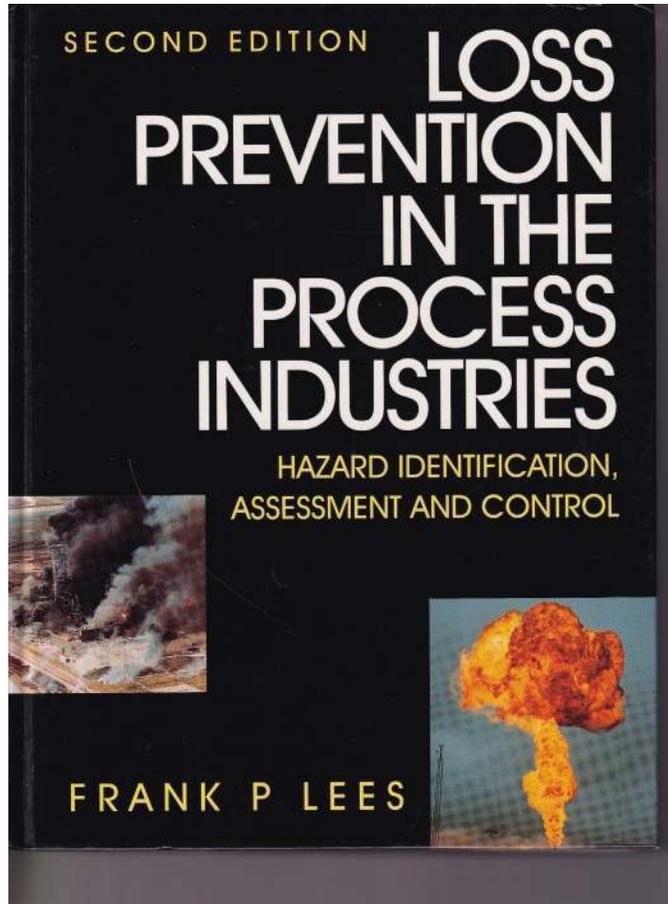
Consequences

Life safety & health
Property protection
Business continuity

Occupational
Environmental
Human factors

Public safety
Public health
Mass fire risk /
Catastrophic loss

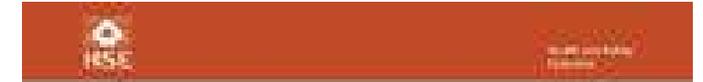
Back to the books ...



Formulae by which the quantity-distances published in the Explosives Regulations are calculated

Table 1: Hazard Type 1 explosive in a brick-built mounded store

Class	NEQ Range (kg)	Formula
A	All ranges	Class A = $\frac{ClassC}{3}$
B	All ranges	Class B = $\frac{ClassC}{2}$
C	<25	Class C = 100
	25-52	Class C = $\left(\frac{73.84 \times Q}{-3.364 + Q} \right) + \left(\frac{249.2 \times Q}{413.1 + Q} \right)$
	52-500	Class C = $0.2167 \times Q + 95.9167$
	500-1647	Class C = 204
	>1647	Class C = $\frac{22.4 \times Q^{1/3}}{\left(1 + \left(\frac{3175}{Q} \right)^2 \right)^{1/6}}$
D	<25	Class D = 100
	25-250	Class D = $\left(\frac{73.84 \times Q}{-3.364 + Q} \right) + \left(\frac{249.2 \times Q}{413.1 + Q} \right)$
	250-300	Class D = $\frac{Q}{50} + 164$
	300-350	Class D = $\frac{Q}{25} + 158$
	350-385	Class D = $\frac{Q}{5} + 102$
	385-500	Class D = $0.2167 \times Q + 95.9167$
	500-600	Class D = 204
	600-2000	Class D = $\left(\frac{73.84 \times Q}{-3.364 + Q} \right) + \left(\frac{249.2 \times Q}{413.1 + Q} \right)$
	2000-2908	Class D = 281
	>2908	Class D = $\frac{22.4 \times Q^{1/3}}{\left(1 + \left(\frac{3175}{Q} \right)^2 \right)^{1/6}}$

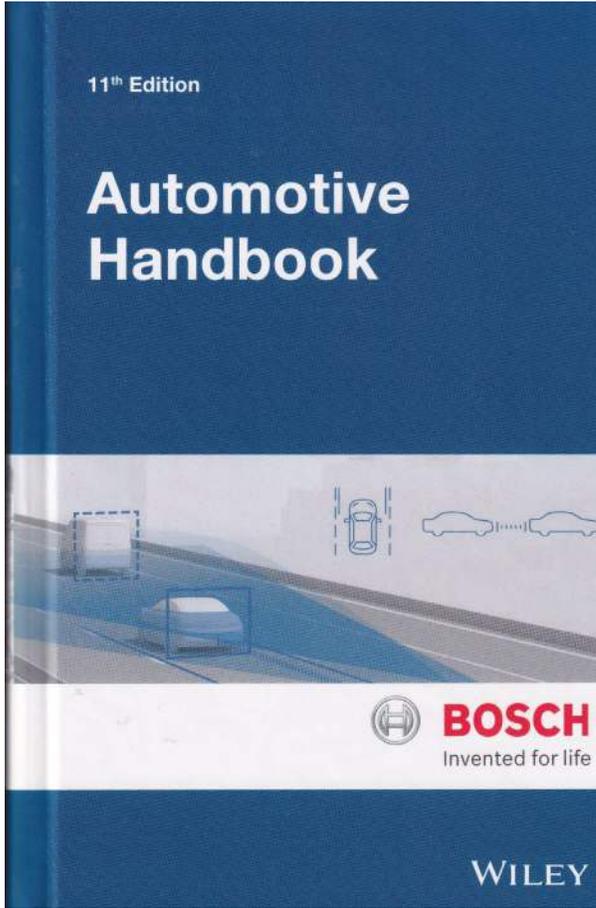
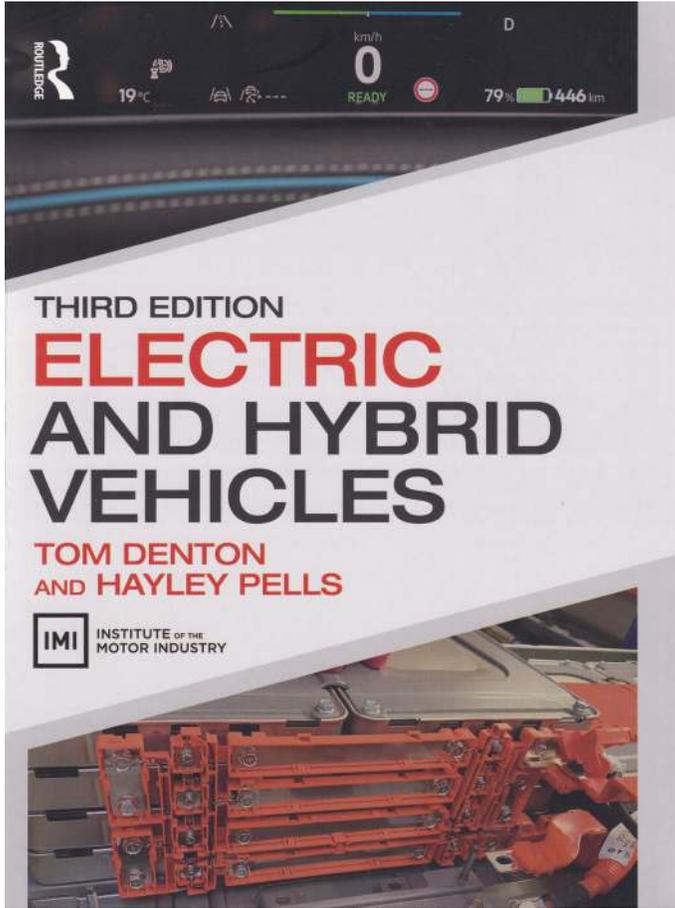
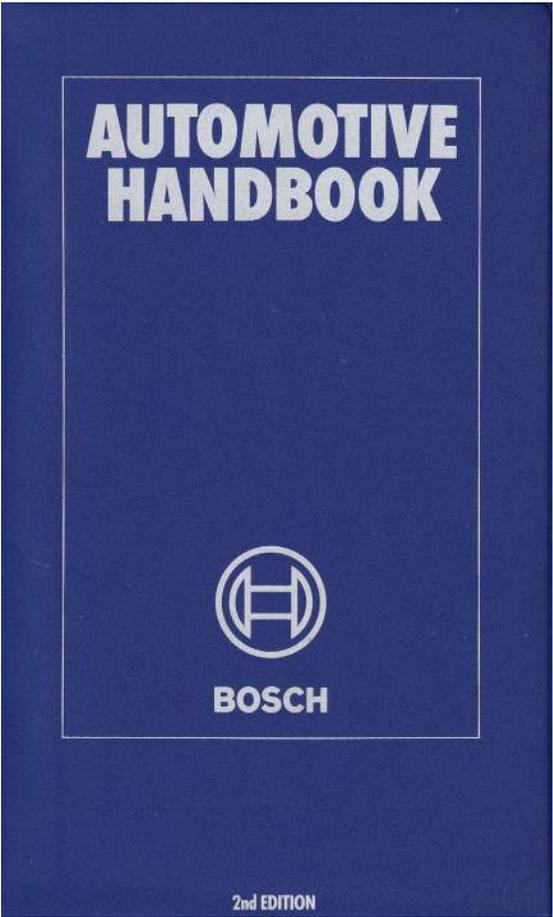


Explosives Regulations 2014

Safety provisions



And even some new ones ...



Safety consequence and severity: Thermal energy?

- Types of fires relevant to Li-ion battery fires
 - Flare and jet fires, ejected particle fires;
 - Fireballs, engulfing fires
- Look at fireball diameters ...
- Thermal radiation intensity limit $\leq 1.0 \text{ kW.m}^{-2}$. (Fully clothed, HSE data)
 - Pain threshold $> 1.0 - 1.5 \text{ kW.m}^{-2}$
 - (Atallah & Allan, 1971: Lees Vol 2 16/249)
 - Solid propellant $T_{\text{max}} 2500\text{K}$. (Frank Lees, Loss Prevention in the Process Industries). (Vol 2 16/196)

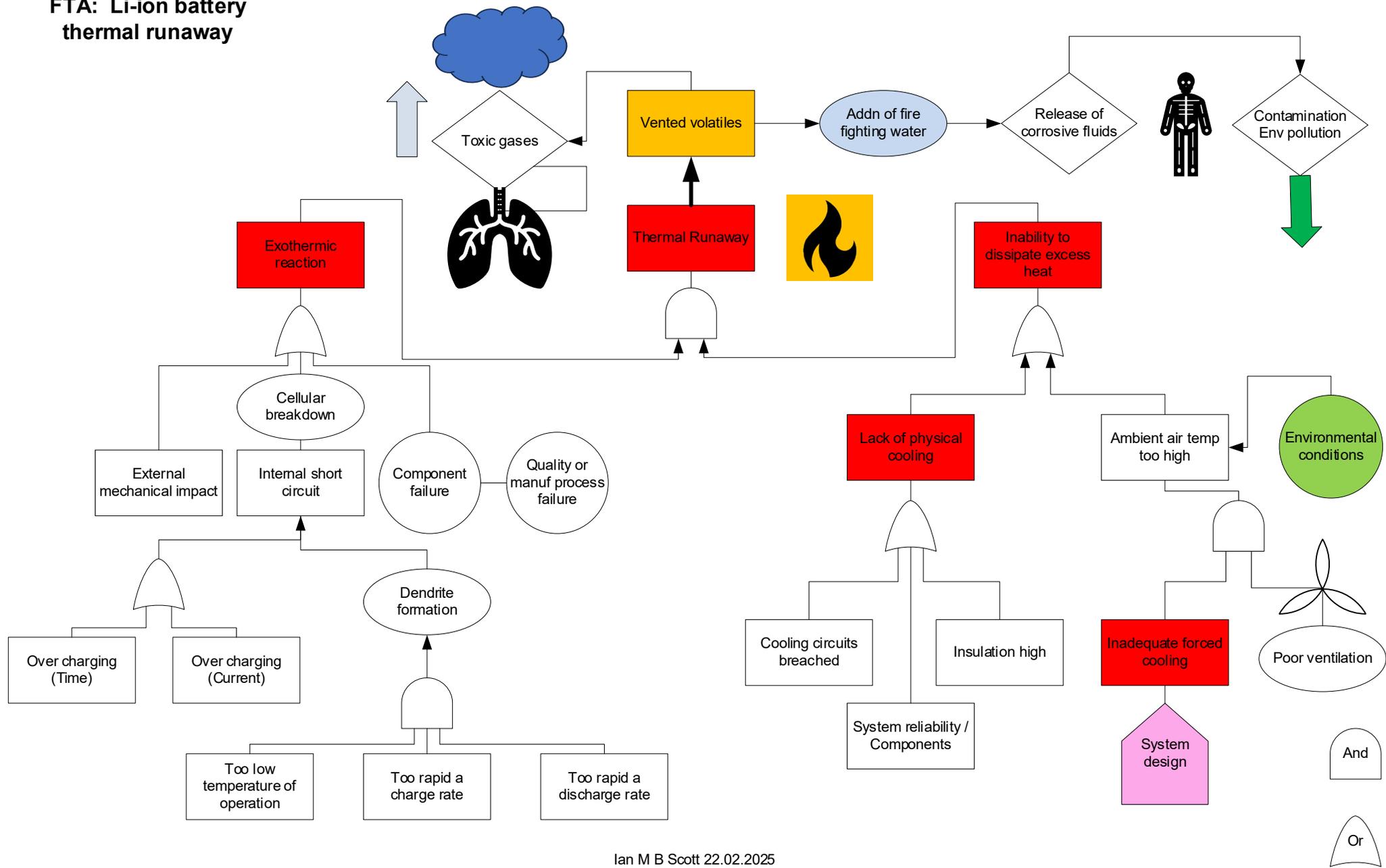
	Fireball diameter (m)	2 tonnes (E-bus)	1 tonne (BEV)	550kg Tesla battery
Liquid propellants	$D=3.77M^{0.349}$	53.5m	42.0m	34.1m
Bi-propellants	$D=3.86M^{0.32}$	43.9m	35.2m	29.0m
High explosives	$D=3.30M^{0.34}$	44.0m	34.7m	28.4m
TNT	$D=2.95M^{0.32}$	33.5m	26.9m	22.2m

Public exclusion zone of 87m to 132m minimum.

**Why? Safety distance of $> 3 \times$ Fireball diameter.
(UK DOT 15m: Most other agencies 30m)**



FTA: Li-ion battery thermal runaway





Where does the F come from?

- Lithium-ion batteries are the most common battery type in modern electric vehicles, because of its lightweight, longer battery run time in relation to the battery size, and because of its rechargeability
- The **TYPES** describe the **Cathode material**

6 **type(s)** of lithium-ion batteries:

1. Lithium cobalt oxide (LiCoO_2)
2. Lithium manganese oxide (LMO)
3. Lithium nickel manganese cobalt (NMC)
4. **Lithium-iron-phosphate** (LiFePO_4) (LFP, lithium ferro phosphate)
5. Lithium nickel cobalt aluminium oxide (NCA)
6. Lithium titanate (LTO)



Where does the F come from?

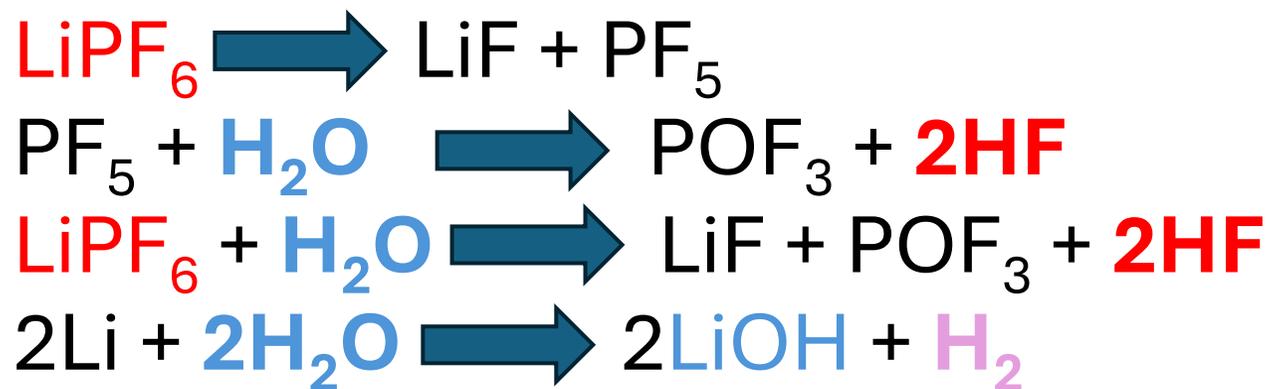
- The ELECTROLYTE
- Defined as: a compound that in solution **conducts an electric current** AND is decomposed or dissociated by it
- The current is carried NOT by electrons, as it is in metals such as copper, but **by ions**: e.g. lithium ions and fluorine ions
- Electrolytes MAY be acids (sulphuric acid in ‘lead-acid’ batteries), alkalis or salts ...
- One of the most popular ‘salts’ used in Li-ion batteries is:
 - **Lithium hexafluorophosphate.**
 - Which we will return to in a minute...



Health consequence and severity: What happens in 'combustion' / thermal runaway?

- Large volumes of **hydrogen fluoride gas** (HF) may be generated
 - 20 - 200mg/Wh of nominal battery energy capacity
 - For a 100kWh battery this equates to 20kg of HF gas, which is a lot! (22.7m³)
 - Plus 15 - 22mg/Wh of another potentially toxic gas, **phosphoryl fluoride** (POF₃). (No tox. data though, although imagined to be more toxic than HF!)
- 'Fluoride' gas emission can pose a serious toxic threat, as well as Cl₂
- Why is this? So! Some chemistry now ...

What's the chemistry? What happens in 'combustion' / thermal runaway?



Ref: [Reactions of alkali metals with water - Group 1 alkali metals - GCSE Chemistry \(Single Science\) Revision - WJEC - BBC Bitesize](#)

NB: We are coming back to look at lithium hexafluorophosphate again in a minute!



Image credit: Science photo library

What is in the battery?



- Anode: (Invariably) Carbon
- Cathodes, typically ...
 - Lithium cobalt oxide. LiCoO_2
 - Lithium iron phosphate. LiFePO_4
- Organic solvents: **Fluorophosphates**
- Additives, binders: PVdF
 - Polyvinylidene fluoride
- Gel polymers (electrolytes)
- **F can be 'released' through decomposition from a low as: $50 < T < 80^\circ\text{C}$**
- Electrolytes provide **Li ion salts** and comprise ...
 - Lithium salts: LiPF_6 , LiClO_4
 - **Lithium hexafluorophosphate is a FLAMMABLE electrolyte**
 - **Lithium perchlorate is a strong oxidizer.**
 - https://en.wikipedia.org/wiki/Lithium_hexafluorophosphate
- Leading reference:
 - www.nature.com/scientificreports
 - 7: 10018: DOI: 10.1038/s41598-017-09784-z
 - Toxic fluoride gas emissions from lithium-ion battery fires. 2017.
 - Larsson, Andersson, Blomqvist & Mellander.
 - Dept Physics, Chalmers Univ, Gothenburg, Sweden.

What is the toxicology?

- Check out <https://www.hse.gov.uk/pubns/priced/eh40.pdf>
- Routes of entry to the body: Which 'harms' most readily?
 - Inhalation, ingestion, injection, skin or eye absorption

	Toxicity	WEL			
		LTEL (8 hr)		STEL (15 minutes)	
	LC ₅₀ , LD ₅₀ or LC _{Lo}	ppm	mg.m ⁻³	ppm	mg.m ⁻³
HBr	814 ppm (mouse)	-	-	3	10
HCl	3000 ppm (human)	1	2	5	8
HCN	179 ppm (human)	0.9	1	4.5	5
HF	17 ppm (rat)	1.8	1.5	3	2.5
H₂S	600 ppm (human)	5	7	10	14
NO₂	64 ppm (dog)	0.5	0.96	1	1.91
COCl₂	3 ppm (human)*	0.02	0.08	0.06	0.25
PCB			0.1		
SO₂	1000ppm (human)	0.5	1.3	1	2.7
	*1 ppm = 4mg/m ⁻³				

$C^n t = \text{Constant}$,
 $n = \text{Toxic Index}$
Where $1 < n < 3$
Depending on how many effects a toxic gas has on you!

Data from HSE EH40 & Wikipedia

Dealing with fires involving BEVs

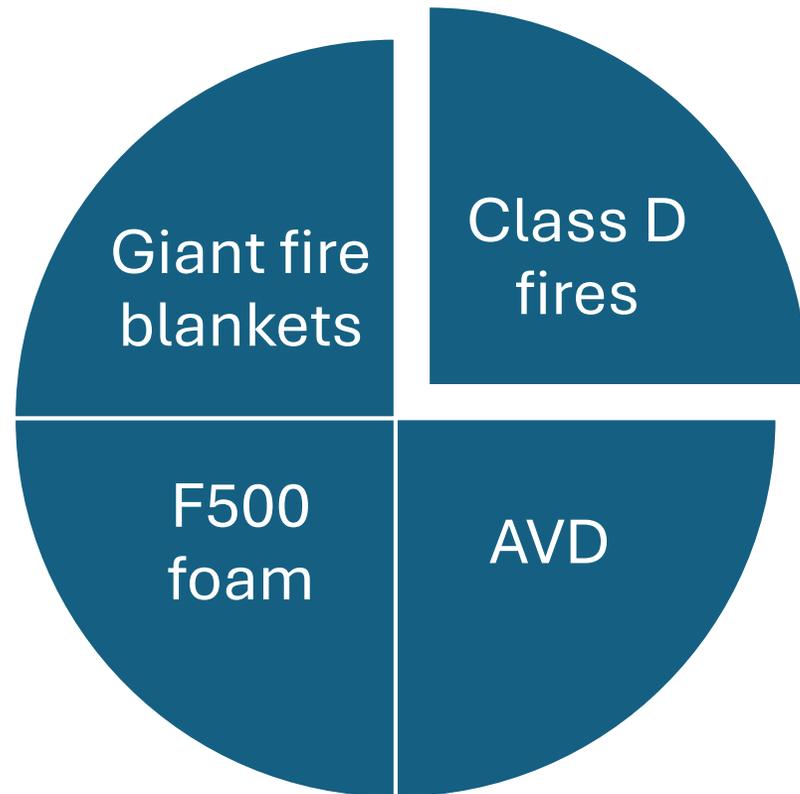


Vehicle fire blankets



<https://vehiclefireblanket.com/product/electric-hybrid-fire-blanket/>

Fire fighting media



Fire precautions for small Li battery fires

Seven options are currently available

1. Do nothing except **get the people out**
2. Copious water / water immersion
3. Smothering by a purpose made fire blanket
4. **Lith-EX with AVD**
5. **LiCell with AVD. (USA Spec)**
 1. [What is Aqueous Vermiculite Dispersion? - AVD Fire](#)
 2. Suitable for Li and Mg (metal) fires
6. Dry powder or foam extinguishant
7. **ALSO: Clean Agent extinguishers**
FM 200 (heptafluoropropane) and Novec 1230
F500 foam



[Battery-Fire-Blanket-2pp-Artwork-9.2020.pdf \(avdfire.com\)](#)



Fireblock Lithium gel



- 2, 6 and 9 litre fillings
- 6 & 9 litre fillings are Kitemark certified to BS EN3, CE and UKCA certificated
 1. Cools thermal runaway
 2. Prevents thermal propagation
 3. Provides containment
 4. 9 Litre Lithium-ion Battery FIREBLOCK Fire Extinguisher - Jactone

Fire protection for lithium-ion (rechargeable) batteries

Fire prevention

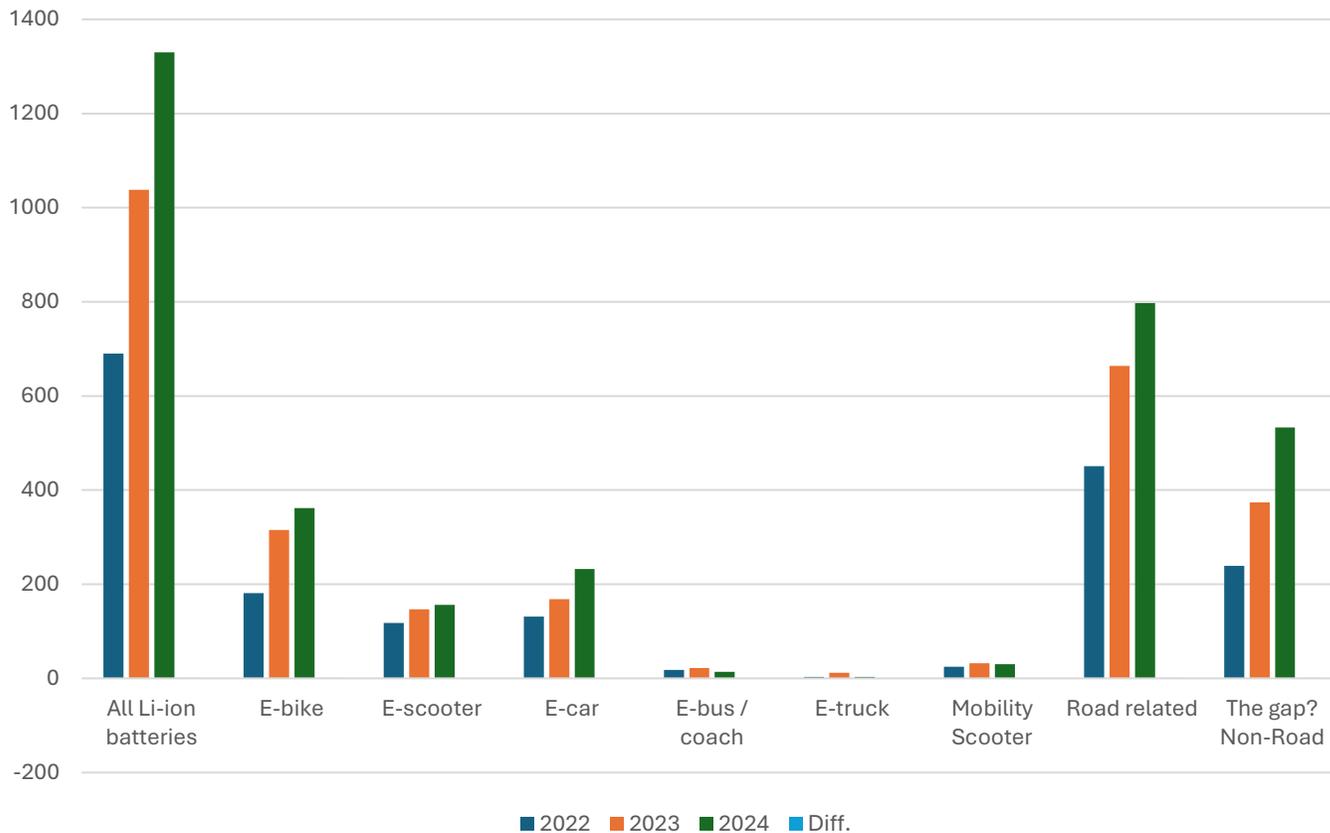
Replace	Replace damaged chargers and damaged batteries.
Use	Only use chargers, devices and batteries from reputable manufacturers.
Remove	Immediately remove the batteries from the charger when they are full.
Supervise	Supervise the battery while charging.
Do not store	Do not store batteries in direct sunlight.

Fire precautions

- Place a smoke detector near the battery charging point
- Provide appropriate fire extinguishers
- Keep the number of batteries in process or in stock to a minimum
- Charge in a designated well-lit place
- Observe. Only charge the batteries if they can be physically seen and monitored or if they are charged in a fire resisting cabinet with an internal power supply

What is the size of the problem?

QBE data for Li-ion battery vehicle fires



- [Lithium \(Li-ion\) Batteries \(bbc.co.uk\)](https://www.bbc.co.uk)
- Fire related data:
- HSE?
- Off. Rail & Road / Dept Transport?
- Home Office: GOV.UK
 - FIRE0601-FIRE0605 tables
- Fire and Rescue Services?
 - LFB are ace for LEVs!
- **Insurance sector**
 - QBE data
- [Fires in e-bikes and e-scooters – 2024 - GOV.UK](https://www.gov.uk)



QBE Insurance sector data

Category	2022	2023	2024	Diff.
All Li-ion batteries	690	1038	1330	+93%
E-bike	181	315	362	+100%
E-scooter	118	147	156	+24%
E-car	131	168	232	+32%
E-bus / coach	18	22	14	-22%
E-truck	3	12	3	Nil
Mobility Scooter	25	32	30	+20%
Road related	451	664	797	+76%
The gap? Non-Road	239	374	533	+123%

Reported bus fires: DVSA data, 2026

2020	2021	2022	2023	TOTAL
25	63	101	53	242

Causation	No. of reports
Engine failure	29
Maintenance	29
Electrical faults	38
Vehicle components	46
Arson	6
Fuel	6
Unknown	88
TOTAL	242

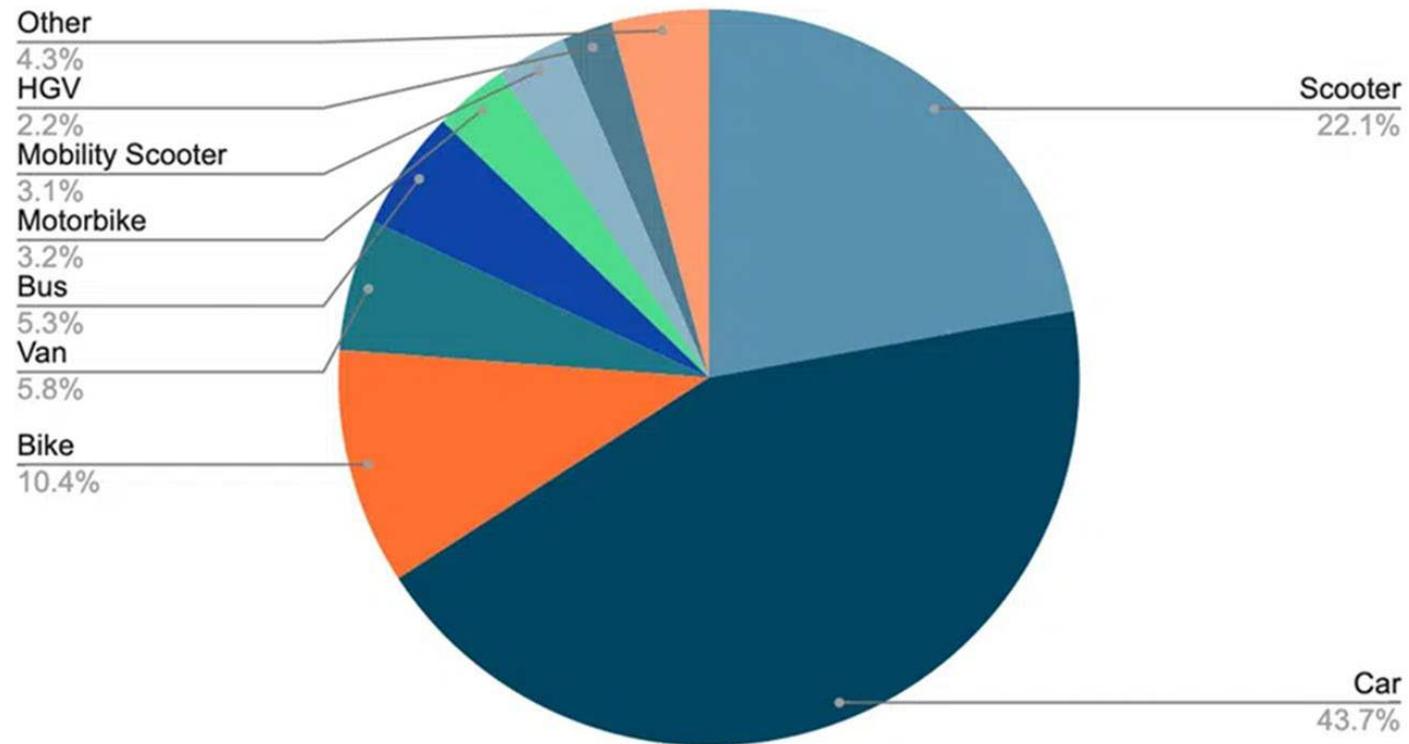
[Investigation into bus fires reported to DVSA from 2020 to 2022 - GOV.UK](#)

E-bus fires

- [Investigation into bus fires reported to DVSA from 2020 to 2022 - GOV.UK](#)
- Findings:
- DVSA could find no evidence that **engine bay temperatures** lead to premature degradation or engine fires when maintained correctly
- DVSA found evidence that showed repairs carried out to address an initial fault were often focused on the fault, **and not the effect the fault may have had on other systems**
- **DVSA found evidence of drivers continuing to drive the vehicle when warning systems advise the vehicle should be stopped, and of drivers being given incorrect advice by depots to continue driving**

EV fires by vehicle type

No. of fires by vehicle



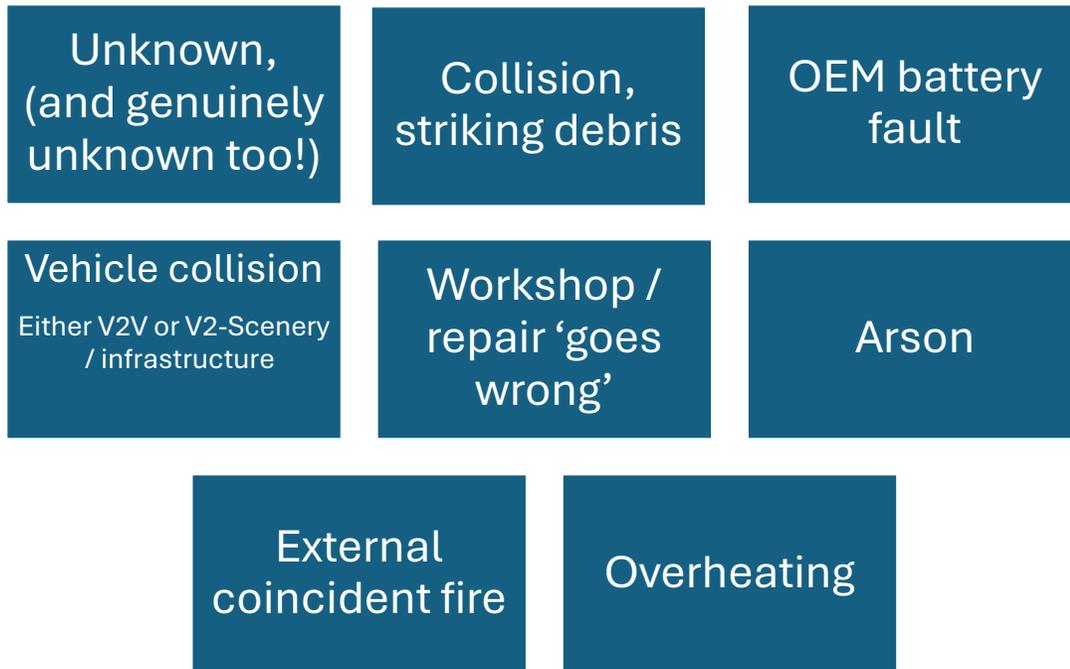
Electric vehicle fires

- The people: **Get them out!**
- The vehicle will be a total loss
- The environment, transmitted heat, adjoining vehicles
- Car parks, especially MSCPs
- Fire responders: multiple hazards including air bags and electric shock, HF, contaminated water run-off.
- Delayed re-ignition risks
- Remote handling solutions? There is one on the next slide



Critical factors in EV battery fires?

Causation, in descending order.



'No evidence' causation of fires.

- Electrocutation, although it is always a risk
- Car wash
- Directed jets of water
- Submersion
- Extrication of the passengers
- 'Stranded energy'.
 - Residual energy that remains after cells have been discharged

How many EVs on the road?

- **Dec 2021:** 396,945 electric cars, (1.2% of all cars on the road).
- **2023:** 314,684 electric cars were sold. (267,203 in **2022**). Up 18%.
- New BEV have grown from 11.6% in 2021, to 19.6% in 2024
- **2024:** 381,970 new fully electric cars sold, 19.6% market share of all new cars registered that year. More BEV were sold in **2024** than any other and represented 21% more than in **2023**
- **January 2025:** <1.4M fully electric cars (BEV) in the UK.
- 4.09% of the c.34 million cars on UK roads.
- 29,634 new fully electric cars were sold, which was 21.3% market share of all new cars registered this year.
- EV fraction of new car sales has stayed stable. But it is now increasing as the impact of the ZEV directive, and growing consumer demand, comes into effect.
- Conversely, the number of new diesel cars sold has fallen significantly



Vehicle fires data

- In the UK, there are roughly 100,000 car fires every year - electric car fires make up a fraction of this figure. One report found that **23 passenger EVs caught fire** due to a faulty battery from January 1 to March 31, 2023
- Around 18% of EV fires occur while the car is plugged in and charging, but the percentage could be as high as 30%. This includes incidents of thermal runaway occurring within an hour of the car being disconnected from its charger (AC or DC)
- EV sales could increase by 80% by 2030
- Electric car fires accounted for just **0.4% of total car fires** in Norway from 2013 to 2015
- **24 EV fires** were reported in Sweden in 2023
- **Fewer than 500 EV battery fires** have ever been verified globally, out of around 20 million EVs currently on the road worldwide

BEV fires commentary



- Thermal runaway within the battery is one of the most common causes of electric car fires
- Hybrid cars are more likely to catch fire than electric or ICE vehicles
- Putting out an electric car fire can take over five hours
- More than half of electric car fires start with spontaneous battery combustion
- 83 people have died in Tesla car fire incidents since 2014

Conclusions

- Consequences include thermal effects, blast, jet fires and fireballs, toxic gases AND environmental pollutants
- Large safety distances are required, and fires may burn for ~6 hours. Vast water supplies will be required to extinguish



© BBC Images.

How do you know it's an EV?

- Which of these are true?

1. It's a car on a cable ...
2. The name (Q8 e-tron) suggests it!
3. It's heavy, expensive, & a green stripe on the registration plate
4. Odd 'hatches' in the bodywork
5. No 'tail pipes'
6. It catches fire readily?



Propulsion energy identification

CTIF & ISO 17840 Rescue Information

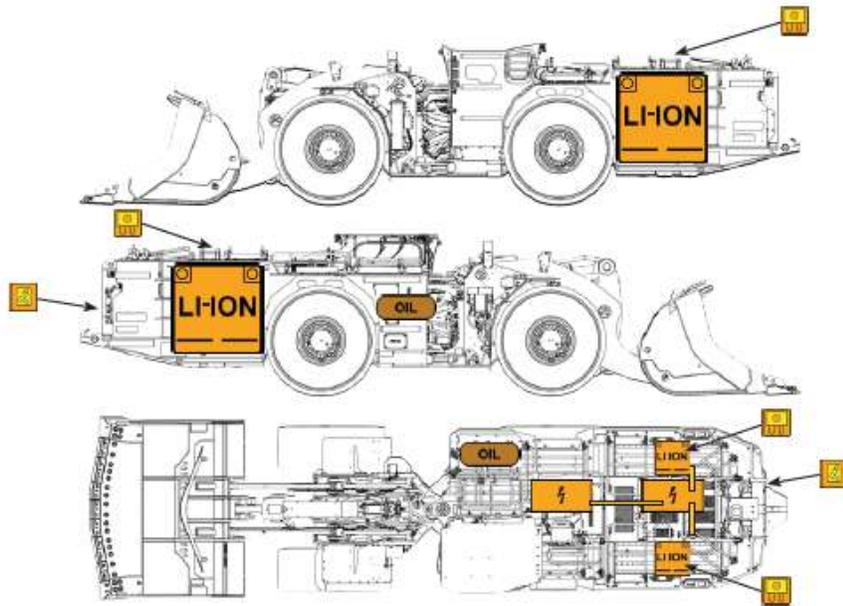


GREY	DIESEL
RED	GASOLINE
GREEN	GAS
WHITE	CRYOGEN LNG
BLUE	HYDROGEN
ORANGE	HIGH VOLTAGE





Caterpillar R1700 XE
Load Haul Dumper (2021 – Present)



High Voltage lithium-ion battery



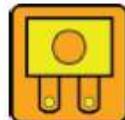
High voltage cable



Oil tank



High voltage component



Fuse box disabling high voltage system



Low voltage device that disconnects the high voltage

Construction equipment

- Civils plant and equipment etc.
- **Risks: Low.** V large battery mass. Difficult to fiddle with. Rugged machinery working hard in rugged conditions!! Good levels of observation and maintenance. Good BMS. Extensive use
- **Action: EXCELLENT ERG.** NFPA and manufacturer's guidance
- **FFA:** Cool and deluge with water. Potential burn-out

So, what's next?

- FSMS, Fire Risk strategy, FRAs
- Review, identify, prioritise, plan
- Back-to-basics approach with the introduction of new site hazards: matching fire extinguishers to hazards etc
- What else can be so easily compromised?
- E.g. BEV charging for visitors?
- Wallboards / posters
- ALL 3 top level objectives stand: Life safety, property protection and business continuity
- Evacuation priorities are NOW
- Active and passive protection
- Compartmentation and FIRE DOORS

D4FS: The TWO (philosophical) equations for life!

- Designing for fire safety.

- $N \geq M + 1$ and ...

- $S \leq N - 1$. Or $S \neq N - 1$

- Always argue for more! Go large, have at least one more than you thought you needed!

- Never compromise on survivability. Never go less than N - 1.

- It is time to look at fire protection in much more detail ...

AFP & PFP: Fire protection is key!

- Detect, warn, alarm, evacuate

- Invest in AFP and PFP

- Design in compartmentation

- Fit and test dampers in air handling systems

- Install and test sprinklers

- Maintain everything, often ...

ACTIVE & PASSIVE FIRE PROTECTION

INTRODUCTION

Every building needs to have adequate fire protection in place to ensure the life safety of employees, customers and the public, to protect the structure and equipment and to maintain the integrity of your business assets which would be harmed in the fire incident.

Passive fire protection comprises fire doors, dampers, fire stopping and passageway, cables and services, fire resistant walls, wall enclosures, wall and cable coatings and glazing, fire proof cladding, fire stopping and spraying on the protruding etc. This is a form of the safety provision that remains constant, or static, during normal conditions but becomes active in the event of an incident or is supported by other active measures including smoke curtains.

PFP is an integral component of structural fire protection or compartmentation within a building and is designed to contain fire or slow its spread to building safe escape.

Commonly, Fire Risk Assessments are used to identify, among other issues, shortcomings in the proper provision of active and passive requirements in fire protection.

CRITICAL FACTORS IN ACTIVE FIRE PROTECTION

The performance of fire protection systems for your building depends on the size, nature, building use, location, type, classification of construction or item made of materials, as well as local regulations or sector guidance.

Active fire protection includes those measures which are activated in the event of a fire. This involves alerting people to the fire to ensure the building safety and that responses are given.

AFP systems are programmed to initiate a predetermined response to fire, smoke, fumes, or heat. Those responses include detection, warning, activating sprinklers, sounding an alarm, alerting the local fire and Rescue Service (FRS), or automatically closing off the door.

EXAMPLES OF PASSIVE SYSTEMS

A fire risk analysis will provide recommendations for a passive fire protection measures unique to each building. This will usually concentrate on a set range of the following fire protection measures:

Fire and smoke doors: A fire and smoke door with its resistance and smoke control rating reduces the spread of the fire and smoke between compartments and helps to maintain time for occupants to escape from a building.

Fire hydrants: Hydrants or mains water connection points are there for firefighters to access water to fight fires. In some houses, they are located close to the point of heat.

Fire and smoke dampers: Fire and smoke dampers respond to the detection of fire in controlling ducts automatically. The device permits the flow of air in ventilation systems where fire-rated structural walls, floors or other fire barriers are penetrated.

Fire walls: Fire walls are fire resisting barriers installed into the building structure to sub-compartmentation and prevent the spread of fire between areas. Fire walls may also be used as walls to separate a building for other purposes such as access, security, business separation or aesthetics.

Heat-activated coatings: Fire resistant coatings are designed to keep the materials they are protecting from reaching their maximum temperature. PFP coating limits the temperature of the substrate, helping to maintain structural load-bearing capacity by rapidly responding when exposed to heat to form a stable, carbonaceous, insulating char.

DEFINITIONS, CONCEPTS AND ROLES

Active and passive fire protection are not complementary elements to any building's overall fire safety strategy. Being familiar with the subtle differences between active and passive fire protection is crucial for understanding why you can not have one without the other in your building, if it is to be safe and compliant.

DIFFERENCES BETWEEN ACTIVE AND PASSIVE FIRE PROTECTION

Passive fire protection is a crucial element of any building's overall fire safety strategy. The purpose of passive fire protection (PFP) is to slow or prevent the spread of fire within a building through the use of fire-resistant materials. Unlike active fire protection systems such as sprinkler systems, fire alarms, smoke detectors, fire extinguishers and fire hoses, passive systems generally do not activate in the event of a fire, merely remaining in place to resist the fire. However, with the advent of more sophisticated systems, such as manual or automatic fire containment systems, the line between active and passive systems has become increasingly blurred.

All systems which are expected to operate in the event of a fire, including passive systems such as fire doors, need regular testing and ongoing maintenance to ensure their effectiveness.

Active and passive fire protection systems work independently of each other, but if several fire strategies in a building are taken together, the presence of both to provide good building fire protection is necessary, either in the event of a fire, while these systems will not prevent a fire starting, they aim to detect, warn, restrict, and ultimately suppress or contain the fire.

In summary, passive fire protection systems work to reduce the spread of fire throughout a building and limit structural damage, while active systems work to detect and suppress a fire. Both systems need to function correctly to provide the intended fire protection for the building.

EXAMPLES OF ACTIVE SYSTEMS

Smoke detectors: Smoke and light sensors are used to alert occupants of smoke, warning an early evacuation and response to fire.

Sprinkler systems: Sprinklers automatically activate when heat from a fire causes the mechanism to fracture, releasing the water and spraying water or foam to suppress the fire.

Fire extinguishers: The most visible means of active fire protection. A person must locate the extinguisher and spray, hopefully a small fire with a substance that cuts the burning mechanism or deprives them of oxygen.

Fire curtains: Fire curtains may also be used to help prevent fire from spreading throughout a building. They are actuated by fire alarms or smoke detectors which allows the curtain to roll vertically and obstruct the path of the fire. Fire curtains are often used in open plan buildings which do not have the infrastructure to support other PFP systems such as fire doors.

PURPOSE OF PASSIVE FIRE PROTECTION

The purpose of passive fire protection (PFP) is to slow or prevent the spread of fire within a building through the use of proper fire-rated materials. Passive systems do not extinguish a fire or alarm, but through their containment on minimizing the spread of fire throughout a building. Passive fire protection systems work by using fire-resistant doors, walls, and floors to contain fire, heat, and smoke, with the aim of limiting the spread to the single compartment where the building is properly tested or certified.

COMPARISON BETWEEN ACTIVE AND PASSIVE FIRE PROTECTION

Passive protection from fire requires BOTH active and passive fire protection systems. Active systems provide immediate response in the event of a fire, while passive systems contain and slow the spread. They work together to protect lives, property, and the environment in the event of a fire.

COMPARTMENTATION

Compartmentation in passive fire protection systems work by containing a fire to its area of origin, providing safe means of escape for the occupants of the building and containing the fire to a comparatively small size such that the fire and rescue service can deal with the fire more easily. Limiting the spread of the fire to the compartment results in a smaller, contained fire which also provides greater resilience for the building structure. Effective PFP systems work by dividing a building into fire protected 'areas', this is referred to as compartmentation of the structure.

Compartmentation protects the building by containing the fire and slowing its spread, means of escape (MSE), passageways, stairwells, and fire walls. Passive fire protection systems also aim to limit structural damage to avoid areas of a building which would otherwise result in collapse or large financial loss.

MAINTENANCE

Although you may think that dormant PFP systems are benign and require no maintenance to exist, the could be not further from the truth. As with any other safety critical system, both active and passive fire protection systems need to be tested to regular planned periods in maintenance (PFD) periods and procedures to maintain their reliability or effectiveness. In addition to advice and guidance from equipment manufacturers, specialist contractors should be involved to test and draw up the PFD schedule. Any scheme of thought or test to test from the same will be actually unnecessary. It may be more effective to engage them to undertake the work to ensure at prescribed intervals. Tests that evidence of maintenance may be a requirement of your insurance cover for the business and for building or public liability purposes.

FURTHER INFORMATION

For further information regarding fire risk management strategies, contact your Fire Safety Manager, fire or safety department or Director of Safety, www.firo.gov.uk, www.wsp.org.uk, www.firmdoorsafetyworks.co.uk, www.britnords.com, www.fpe.com, www.safefix.co.uk, www.fireprotectedonline.co.uk, www.jacture.com, www.afl.co.uk

Fire Risk Assessment on
 Fire Risk Management
www.firo.gov.uk

KNOW YOUR FIRE EXIT,
 KNOW YOUR MEANS OF ESCAPE

Fundamental fire protection: Fire Doors

- In buildings and infrastructure:

- Fire doors 'seal' compartments and prevent 'smoke' spread.

Check them frequently

- In any circumstances, an open fire door is useless

- In domestic accommodation,

never re-charge batteries unattended, at night, or on an MOE, and close doors

INSPECTION OF FIRE DOORS

INTRODUCTION

Passive fire protection comprises fire doors, dampers, the stopping around pipework, cables and services, fire resistant glass, smoke curtains etc. This is a form of fire safety provision that remains dormant, or inert, during normal conditions but becomes active in a fire situation. It is an integral component of ensuring the protection or compartmentation within a building and is designed to contain fires or slow their spread to buildings and escape routes. We walk past and through fire doors every day without a second thought, but the doors play a vital role in life safety, property protection and business continuity and are a fundamental defence against fire.

KEY PHASES AND ROLES

Design and Construction phase: CDM (occupied), NB: CDM applies through to the FM phase.
Occupation phase: The Occupier is responsible for fire safety management. Hospitals, NHS, Schools, Local Authority, Universities, the governing body.
Facilities management phase: FM Company, in cooperation with the building occupier and operator.

Fire doors should be inspected by Competent Persons with appropriate KATE: knowledge, approach, training and experience.

KEY RISK FACTORS

- Sleeping risk and type of occupancy
- Specific purpose of the building
- Presence of occupants
- Height of the top storey above the ground
- Depth of the lowest basement level below ground

Fire doors are specialist doors with a building or structure that are specifically designed, manufactured, installed and maintained to provide life safety to occupants and users within a building. We walk past and through them every day without a second thought, but fire doors play a vital role in the defence against fire. They provide a vital aspect of passive fire protection to prevent the passage of fire, smoke and products of combustion including toxic gases.

Fire doors have many vital safety features and are essential to the survival of people in a building that is on fire. Two of the most important functions fire doors are to form an impermeable barrier to stop the spread of fire and restrict fire, when open, to provide people with an easy means of access and passage around the building and also a secure means of escape. To these ends, it is fundamental that the door 'works' properly as the designer intended it to.

A fire door that is wide open or wedged open is useless at preventing the passage of fire and smoke and compromises the complementary aspects of passive fire protection within the building. One open door at the wrong moment can put at risk the whole building.

CRITICAL FACTORS IN THE PROVISION OF FIRE DOORS

For everyone's safety it is vital that fire doors are:

- Properly specified, designed, produced, manufactured and competently installed.
- Certified to required standards and that their use is managed.
- Replaced or repaired in a timely and correct manner, respectively meet and test.
- Maintained on a PMN schedule. (Planned preventative maintenance).
- Replaced or repaired if conditions warrant or standards are breached.
- Replaced to the correct standards using the OEM parts, correct materials and door furniture.

COMPONENTS OF FIRE DOORS

Fire doors comprise various components designed to protect against the spread of fire and smoke. The frame with the components of a fire door. All components on fire doors i.e. door furniture must comply with British Standard Certification which is issued by the British Standard Institute. The components include:

The door leaf: Typically made from timber or metal and fitted with a fire-resistant core.

The frame: Designed to provide an airtight seal around the door, helping to prevent the spread of smoke, ideally, it should be made from the same material as the door and welded together.

Seals: Intumescent strips, which expand when heated, and cold smoke seals should be fitted to the door frame or door edge to resist the passage of smoke and flames. Different types and sizes of seals activate at temperatures above human survival levels, so it is crucial to fit the correct seal to the right door.

Glazing and heat transfer grilles: The glazing in a fire door is designed to resist the spread of fire and heat while still allowing light to pass through. Glazing and heat transfer grilles are installed only in a factory-controlled environment by trained individuals, using appropriate components such as fire-rated glass and intumescent beading. Intumescent glass can result in radiant heat transfer through the glass, potentially starting a fire on the other side of the door.

Hardware: Fire-rated handles, hinges, and other door furniture.

Signage: "Fire Door Keep Shut" sign, preferably screwed in place.

RATINGS OF FIRE DOORS

The rating of a door is represented by FD and then a number (30, 60, 90, 120, or 240). This number represents the minimum amount of fire (minutes) that a door maintains its structural integrity for in the event of a fire. When the rating number is followed by E, the door is smoke rated. Fire doors with a rating in excess of FD60 are rarely used on escape routes or to protect people that may be found where the penetration of property is important e.g. data storage areas where documents cannot be removed in the event of fire or in security sensitive environments. Some of these doors have the appearance of timber but may be constructed with a mineral core.

5-STEP SIMPLE FIRE DOOR CHECK

Principally check for the correct certification.

Are gaps around the door are between 2mm and 4mm and seals are intact and undamaged.

Are hinges in good condition and that 3 hinges are fitted.

Does the door close properly? Is the wall closer in good condition?

If a hold-open is fitted, does it work properly?

PRACTICAL FIRE DOOR INSPECTION

Fundamentals of inspection of fire doors comprise the following questions:

1. Has the door the correct fire rating for its location and purpose etc?
2. Is the door fitted properly, without the gap of door edge gaps that can put at risk the integrity of the compartmentation in the building?
3. Is the fire door in excellent serviceable and functional condition and not damaged in any way that would impair its performance in the event of a fire?
4. Is the door fitted with the correct intumescent, hardware and closes, and that these things are tested regularly and function correctly?
5. Does the fire door have the correct intumescent strips fitted?
6. Is the door properly identified on both the door safety labels and fire signage and in the building's asset register?

Where appropriate, has the door been installed with the correct type of fire glazing and that it is fitted correctly? Because of their importance in protecting lives, it is imperative that fire doors receive regular inspections. The frequency of inspections is likely to depend on many factors, including the age and condition of the door, it had been inspected and a regular quarterly inspection schedule may be applied when the new Fire Safety Bill 2021 is implemented, as a recommendation from Phase One of the Grenfell Tower Inquiry. The Fire Door Inspection Scheme (FDIS) recently highlighted that three-quarters of all fire doors inspected in 2019 were condemned as unfit for purpose.

CERTIFICATED OR NOMINAL FIRE DOORS?

Certificated Fire Doors may be marked with Certification statements from organisations such as BSI, TMA or Exova. Marks may include labels, coloured plugs or fixed metal plates and data should be recorded. The door will have been rigorously tested by a technician to relevant British Standards. Certificated doors will be marked into a frame of the same standard and will carry Certificated hardware and fire safety signs. However, in some circumstances, such as typically in domestic or historic premises, the door will have been installed to other certification standards were available. In these cases, the door may be described as a Nominal Fire Door. Additionally, it may have been upgraded to above that a Certificated fire door or have been fire-panelled, stained or painted.

FOR FURTHER ADVICE ON FIRE DOOR CERTIFICATION

KNOW YOUR FIRE EXIT, KNOW YOUR MEANS OF ESCAPE

FIRE RISK MANAGEMENT GROUP

FURTHER INFORMATION

For further information regarding fire risk management strategies contact your Fire Safety Manager, fire or safety department or Director of Safety.

www.fsm.gov.uk | www.iosh.co.uk | www.firestonem/works.co.uk | www.sirtraco.com | www.fst.com | www.safes.co.uk | www.firesafetycheck.co.uk | www.jacksons.com | www.sdc.co.uk



Latest International interest

- Austroads Research Report AP-R746-25
- Incident Response for Low and Zero Emission Vehicles

Incident Response for Low and Zero Emission Vehicles

Standards for safe working etc

- BSI PAS 43:2018 – TC
- **Safe working of vehicle breakdown, recovery and removal operations. Management system specification**
- UK Dept Transport guidance
- [Recovery operators: working with electric vehicles - GOV.UK](#)
- To ID an electric vehicle
- [Enter the registration number of the vehicle - Check if a vehicle is taxed and has an MOT - GOV.UK](#)
- [Vehicle Tax and MOT status results - Check if a vehicle is taxed and has an MOT - GOV.UK](#)

EV conversions: 1970 Mercedes-Benz SL



Images credit: Channel 10 News Melbourne



EV FireSafe: Thermal Runaway
<https://www.youtube.com/watch?v=52mfE2w9t1c>