

**Submission
No 8**

ELECTRIC AND HYBRID VEHICLE BATTERIES

Organisation: EV FireSafe

Date Received: 22 November 2023



evfiresafe.com

EV FireSafe

Enhancing safety for emergency responders at electric vehicle fires

Response to NSW Parliamentary Inquiry
on Electric Vehicle Fires

Supported by:



Australian Government
Department of Defence

In partnership with:





About this submission

EV FireSafe have a wealth of information on the mitigation, management & teaching of electric vehicle battery fires, & we appreciate the opportunity to make this submission to the New South Wales Parliamentary enquiry.

We have split this submission into three parts:

- An introduction to EV FireSafe & our research
- Our response to the Terms of Reference
- Where we're heading & sample tools/resources we've developed



Introduction to EV FireSafe

EV FireSafe **evfiresafe.com**

EV FireSafe is an Australian company funded by the Department of Defence to research electric vehicle battery fires & emergency response globally, particularly where the vehicle was connected to energised charging.

We developed the world's first database of electric vehicle battery fires, from which we draw learnings to assist emergency agencies build incident management strategies.

EV FireSafe for Business **evfiresafe.business**

Leveraging our data-driven learnings, EV FireSafe for Business was established in early 2023 to provide consulting & training for both the emergency & non-emergency sectors.

Our team are currently working with major clients in the fire, airports, military, shipping, property & automotive space, & have developed a dedicated online learning management platform to build specialist training.



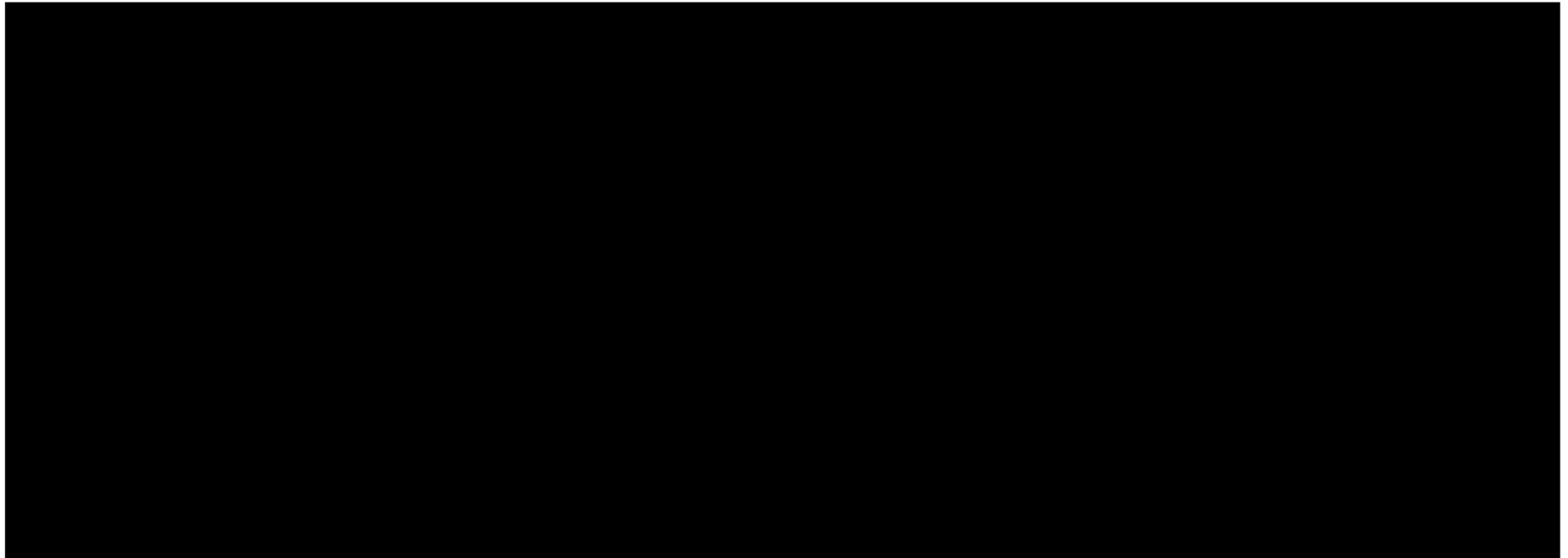
EV FireSafe leadership team

Emma Sutcliffe

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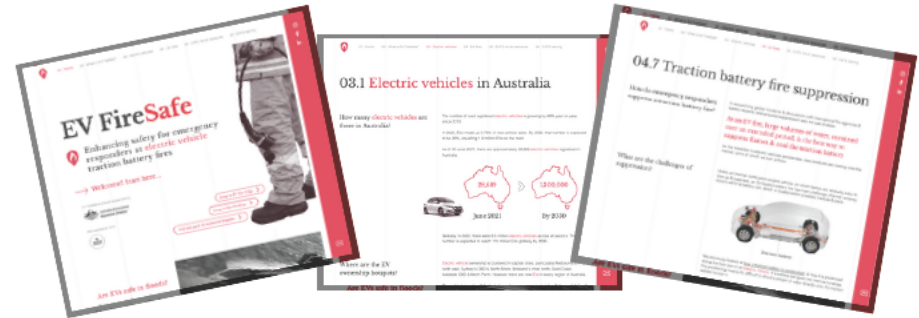


EV FireSafe's global work

Research funded by:



Australian Government
Department of Defence



Our work is referenced by &/or we collaborate with:



NFCC
National Fire
Chiefs Council



Nederlands
Instituut
Publieke
Veiligheid



We are invited Technical Panel members for Fire Protection Research Foundation's (at the National Fire Protection Association, US), 2 year testing & training program:

"Assessment of Electric Vehicle Firefighting Techniques, Technologies & the Impact of Stranded Energy"

Introduction: Global EV battery fires are very rare

In passenger plug-in EVs, we have verified*:

433 EV traction battery fires globally, 2010-today
+ 52 currently being cross checked



“...the total number of electric cars on the world's roads to 26 million, up 60% relative to 2021, with BEVs accounting for over 70% of total annual growth...As a result, about 70% of the global stock of electric cars in 2022 were BEVs

International Energy Agency, Global EV Outlook 2023



Introduction:

There have been 6 EV battery fires in Australia

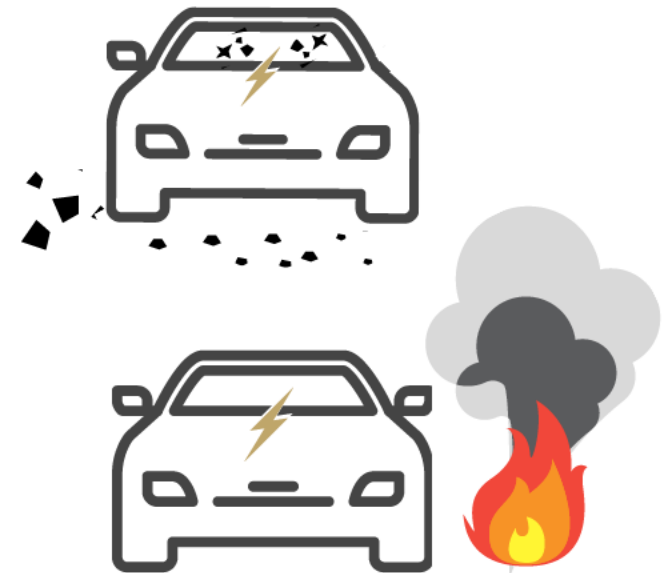
In Australia, there has been a total of six electric vehicle battery fires, caused by battery abuse from:

- Arson x 1
- External fire (structure burnt down around EV) x 3
- Collision x 1
- Road debris x 1



None of the EVs:

- Were on charge at the time
- Were spontaneous or unexplained
- Caused a vapour cloud explosion



In these incidents:

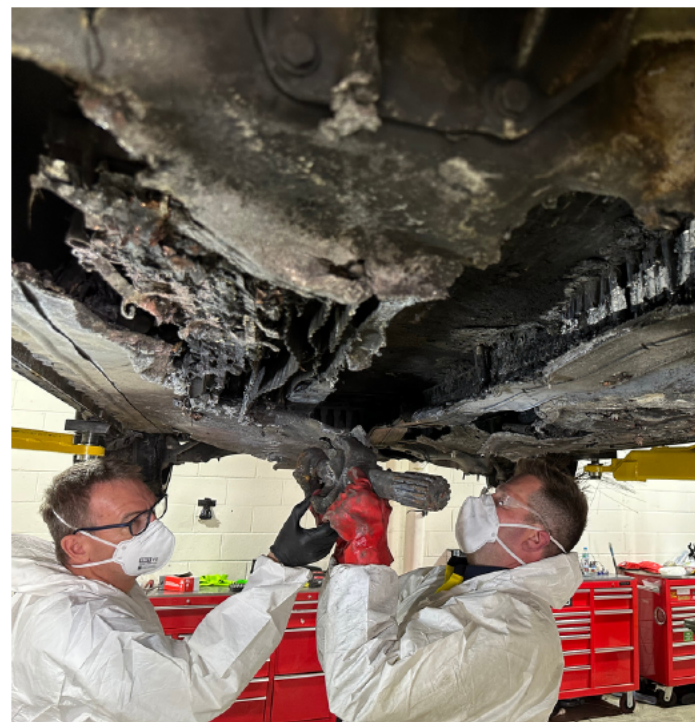
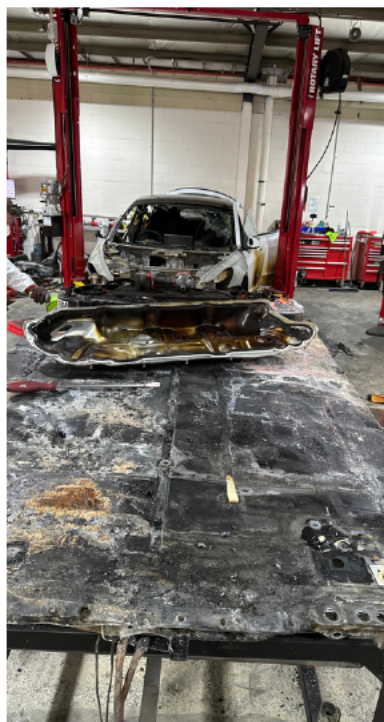
- Most required 10,000+ litres of water
- 2 x were brought under control in <30 minutes
- There were no injuries requiring hospitalisation
- 1 x fatality, cause currently under investigation



EV FireSafe's work - investigation into the Goulburn EV fire

In September 2023, a Tesla Model 3 sustained an impact by an 18kg steel tailshaft from a truck to the underside of the EV where the battery is located.






Tesla provided the damaged EV to EV FireSafe, & together we tore down the vehicle to investigate damage & thermal propagation through the pack itself. A full investigation is due to be released in early December 2023.



Introduction: Risk profiles of lithium-ion batteries



Lithium-ion batteries are used in a range of ways, however based on our research we are able to determine risk profiles as follows. ERG is Emergency Response Guide, an OEM written set of steps for how to manage a battery fire.

Category	Smaller Devices	Personal Mobility Devices (PMD's)	Light delivery EV (LDEV)	Road registered EV (EVs)	Battery energy storage systems (BESS)
OEM guidance	 No ERG	 No ERG	 No ERG	 Most ERGs available	 Some ERGs available
Risk	Low risk	High risk	Moderate risk	Very low risk	Very low risk
Response	Submerge	Burn Submerge	Cool	Cool Burn Submerge	Protect exposures Burn

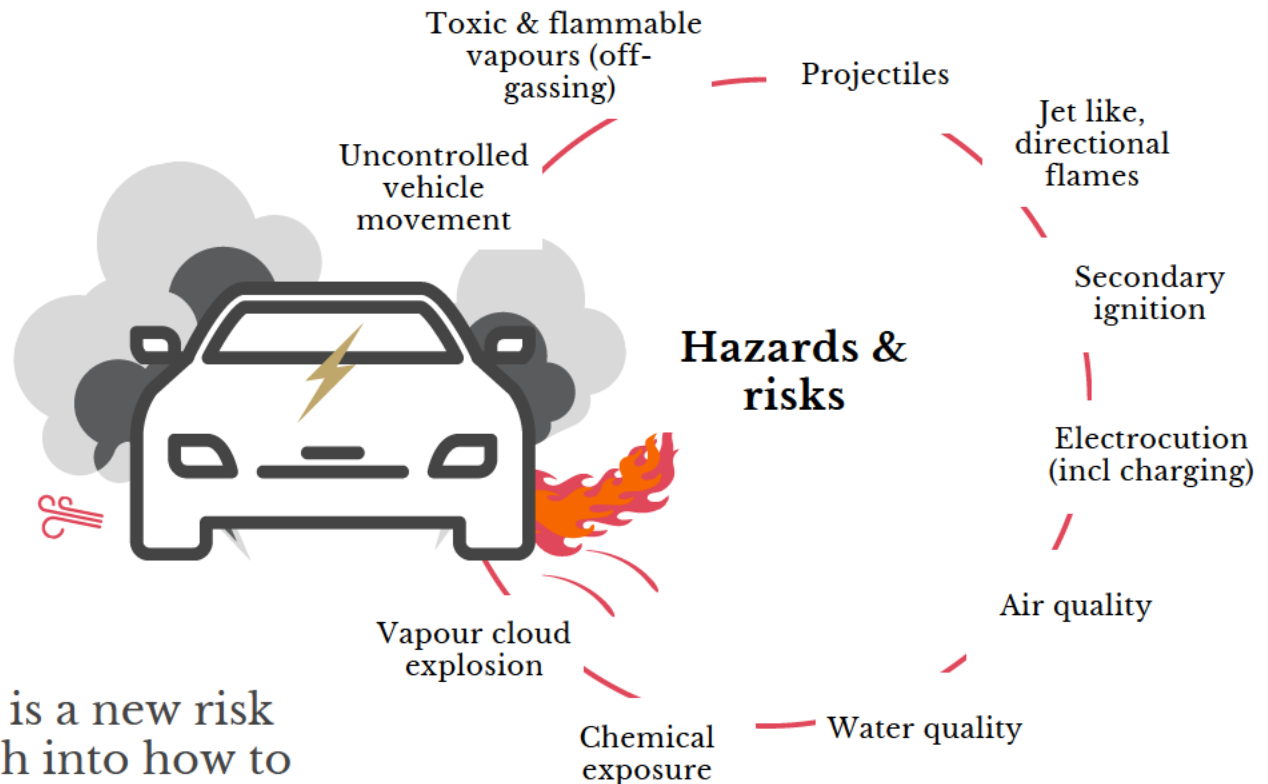
Introduction: Emergency responders - new risks & hazards

There are a range of new risks & hazards to emergency & secondary responders managing electric vehicle battery fires.

Globally, research & testing is still emerging & these risks are not yet well understood.

Of particular risk to all responders:

- The long term effects of exposure to toxic off-gases are unknown
- Jet like flames may appear rapidly
- Vapour cloud explosion is a new risk with insufficient research into how to identify or mitigate




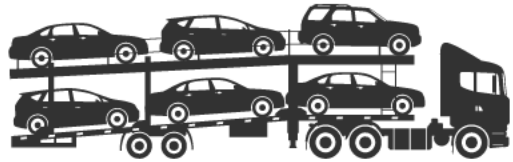


While EV FireSafe's research funding has enabled an incident database, any hands-on testing we are currently undertaking remains unfunded.



Introduction: Auto transport sector - data

We've tracked the following AUTOMOTIVE TRANSPORT sector incidents:

	<i>Number of incidents (global)</i>	<i>Primary causes</i>
Salvage yard 	5	4 - EV reignition due to collision 1 - unknown
Towing 	8 <i>At least 6 driver injuries requiring hospitalisation</i>	2 - EV reignition due to collision 3 - EV reignition due to submersion 1 - external fire 2 - unknown
Transport (non-EV) 	11	2 - collision of truck itself* 9- unknown
Transport (EVs) 	3 (+1 train carrying EVs)	3 - all due fire starting in brakes of truck Train due to impact with power line

**In transport of non-EV LiBs trucks were carrying; 1 x e-motorbikes, 2 x Tesla battery packs, 2 x e-mopeds/scooters & 5 x assorted smaller LiBs (phone, laptop, vapes etc)*



Introduction: Auto workshop/dealership sector - data

These are four samples of at least 9 incidents in the AUTOMOTIVE WORKSHOP / DEALERSHIP sector:



12 September, 2023
Frankfurt, Germany

Multiple Tesla vehicles parked in a dealership parking lot were reportedly set alight by arsonists.. 15 vehicles were destroyed by the fire, with firefighters responding to the scene at approximately 3am Wednesday.



6 October, 2023
Chignin, Chambéry, France

Cars were parked in the parking lot of a Tesla service centre, witnesses reported hearing loud pops and explosions, likely the wheels popping. Over 40 firefighters attended the scene, 14 cars in total were affected by the fire. It has been suggested that this could have been arson, or a spread from a charging vehicle to the others, no conclusive cause has been found as yet.



5 May, 2017
Gruber Motors - Phoenix, Arizona, USA

Fire started at the Gruber Motors Company building, cause was listed as the experimental repair of a Tesla roadster. Several Tesla Roadsters, original AC Propulsion Tzero, EV Smart, along with several other unspecified evs and parts were lost in the fire.



18 October, 2021
Gruber Motors - Phoenix, Arizona, USA

Initial investigation found the cause was isolated to an electrical panel failure. Over 30 Tesla vehicles were destroyed by fire when an electrical panel fault resulted in a fire within the main service and repair center. The fire started at around 2.15am and torn through the building. No injuries were reported as the site was closed.

Terms of Reference

This submission is in response to the following Terms of Reference:

That the Joint Standing Committee on Road Safety inquire into and report on:

(a) the risk and management of fires and other issues caused by batteries in electric and hybrid vehicles, including light electric vehicles

(b) the risk to workers in the automotive industry and emergency services personnel caused by batteries in electric and hybrid vehicles

(c) the adequacy of training and equipment for workers in the automotive industry and emergency services personnel regarding potential hazards of batteries in electric and hybrid vehicles

(d) any other related matters.

a) Risk and management of fires



(a) the risk and management of fires and other issues caused by batteries in electric and hybrid vehicles, including light electric vehicles

Risk mitigation:

- Driver & user awareness can be an effective tool for mitigating risk of battery fire, & reducing life & property risk when it does occur
- **EV FireSafe have developed:**
 - **EV Charging Hubs & Fire Safety online course (based on our work for the Australian Building Code Board) that provides fire awareness & safety tools for building owners & drivers installing or operating EV charging**
 - **We would welcome the opportunity to work with the NSW Climate & Energy Action (EV Fast Charging & Destination Charge Grants) to provide advice to applicants**
 - **A charging site safety poster (currently with the Electric Vehicle Council for approval)**

Emergency management:

- EV FireSafe have developed the IAIIIM method for emergency management of electric vehicles in collision, fires & submersion (see IAIIIM page)
- We have additionally delivered standard operating procedures for one Australian fire agency & are working on draft SOPs for private sector clients

Extinguishing methods:

- EV FireSafe has stopped using the word 'extinguish' in relation to lithium-ion battery fires, as there are currently only three options for management; cool, burn or submerge
- **Urgent research & testing is needed on how to use these methods most effectively**

Road rescue & patient extrication:

- There are no SOPs for road rescue involving EVs
- EV FireSafe wrote a foundational EV Extrication pack in partnership with Victorian SES
- **This work needs updating with latest best practice & to include flood rescue, but is currently unfunded**

a) Risk and management of fires (con't)



(a) the risk and management of fires and other issues caused by batteries in electric and hybrid vehicles, including light electric vehicles

Secondary ignition:

- Lithium-ion batteries can reignite in around 10% of incidents (according to our research), causing unexpected risks to life & property, particularly for people who do not have protective PPC.
- Secondary ignition often occurs following major flooding events
- Urgent training is required for flood rescue for EVs & other lithium-ion battery vehicles/products
- **EV FireSafe developed the Electric Vehicle Assessment of Battery Condition (EV ABC) method for post-incident visual & thermal check to determine best practice to avoid secondary ignition; currently unfunded**
- **We have also started to develop online training for flood rescue involving EVs; not funded**

Responsible disposal:

- Safe methods for the removal of burnt or damaged lithium-ion batteries need to be developed, particularly for households who have a damaged lithium-ion battery or have experienced a fire

'Snake-oil' products:

- Products are being aggressively marketed to both emergency & automotive claiming to 'extinguish' lithium-ion battery fires. Many are untested or undertested, & may actually increase risks to users & responders
- EV FireSafe is writing draft SOPs for private sector clients who have already purchased such products



b) Risk to responders & workers

(b) the risk to workers in the automotive industry and emergency services personnel caused by batteries in electric and hybrid vehicles

As identified, the global emergency & secondary responder community has been 'leapfrogged' by rapidly evolving electric vehicle & lithium-ion battery technology.

Injuries & fatalities:

- 2 x firefighters were killed by a vapour cloud explosion from a battery energy storage system
- 7 x firefighters were seriously injured in a similar event, with numerous near-misses globally
- At least 6 x tow truck drivers have been hospitalised following secondary ignition of EV battery fires

Electric vehicles:

In road-registered & highly regulated electric vehicles, where emergency response guides are provided, incident management methods are emerging, but:

- Awareness of the risks is very low
- There is no standardised training amongst agencies
- Standard operating procedures are only just being written
- There is a high level of concern amongst responders about EVs
- Besides EV FireSafe's database there is little research into real-world incidents
 - Our research is only funded until March 2024
- **EV FireSafe is establishing a 2024 training calendar for emergency agencies, which is based on latest data-driven knowledge & global best practice; this is not funded**

Personal mobility devices or light electric vehicles:

- For unregulated personal mobility devices, such as ebikes & scooters, where the highest number of incidents, injuries & fatalities are occurring, emergency agencies are increasingly unable to protect people & property
- **EV FireSafe's PMD Specialist is working on risk mitigation measures for PMD users & building owners, in collaboration with leading ride share & bike companies; this is not funded**
- **She is additionally working on a school-age awareness package; not funded**

b) Risk to responders & workers (con't)



Automotive:

- The risks to tow truck drivers, dealerships, salvage, service centres & other related industries is unknown in the sector, & there appears to be too few coordinated efforts to raise awareness or develop training for these workers.
- **EV FireSafe is establishing a 2024 training calendar for the automotive, towing & transport sectors, based on latest data-driven knowledge & global best practice; this is not funded**



c) Adequacy of training

(c) the adequacy of training and equipment for workers in the automotive industry and emergency services personnel regarding potential hazards of batteries in electric and hybrid vehicles

There is no independent or standardised training - globally - that adequately addresses the ever changing nature of EV fire risks to emergency & automotive workers.

Of the training that is emerging in other countries, none fully understands or adapts to the incident learnings as they occur. Some companies have developed training for the purpose of selling products that do not extinguish lithium-ion battery fires & may increase life risk.

Automotive trade training focused agencies & RTO's:

- Seem to not fully understand or appreciate the hazards related to lithium-ion batteries, possibly from years of experience of 12 & 24 volt lead acid batteries building a dangerous level of complacency
- Do not have the requisite skills, knowledge or expertise to provide applicable emergency response training or awareness to emergency responder organisations

Emergency response agencies:

- Often don't have the depth of technical knowledge & as such any training packages developed risk being ineffective & rapidly out of date

EV FireSafe has developed a dedicated learning management platform to provide our extensive SME knowledge. That knowledge is backed by our research & collaboration with a global network of experts, fire agencies & vehicle OEMs. Our LMS is currently unfunded.



d) other matters

Other matters we would like to raise include:

Data:

- The ACCC recently released a paper calling for national data to be collected for EV & other lithium-ion battery fires
 - EV FireSafe already holds national & international data & is able to formally track data in collaboration with each state agency
- Risk mitigation through design, installation, maintenance & emergency planning should be considered for:
 - Complex car parks
 - Airports
 - Bus depots
 - Fleets
- Emergency responder training cannot be static or all in a classroom:
 - Information moves quickly & training by some RTOs & TAFEs has been developed with old information that may put responders at risk
 - EV FireSafe has found 'hands on' learning with EVs is vital for understanding

EV FireSafe - where we're heading

Emergency responder training:

- EV FireSafe have been engaged for automotive trade & emergency responder training in Queensland, Victoria, Western Australia & Tasmania for 2024.
- International training is also planned for New Zealand, United Kingdom, United Arab Emirates, Netherlands & Norway

Testing programs:

EV FireSafe are engaged in lithium-ion battery testing & research programs for 2024/25, primarily with the National Fire Protection Association in the US, but also on smaller scale programs here in Australia

Experience centre:

EV FireSafe is in early stage discussions for establishment of a world-leading Electric Vehicle Experience Center, with OEM support, to provide global best practice training for all sectors.

The EVEC will embrace & encourage the uptake of EVs & charging infrastructure, while supporting safer transition paths for emergency responders, automotive workers & the wider community. It would also become a global focal point for centralising global data, testing & research, leveraging the pioneering work of EV FireSafe.

In collaboration with current partnerships, the EVEC will conduct new lithium-ion battery research & testing.

EV FireSafe - 2024 Training Calendar

All training is conducted via our dedicated learning management platform - evfiresafe.business All courses listed are online, dates to be confirmed early December 2023.

- EV Battery Fire Strategies & Tactics for Firefighters (2 hours)
- EV Battery Fire Strategies & Tactics for Brigades (2 hours)
- EV Battery Fire Strategies & Tactics for Road Rescue
- EV Battery Fire Strategies & Tactics for Police
- EV Battery Fire Strategies & Tactics for Ambulance
- EV Pack Teardown - A Timeline of an EV Battery Fire
- Battery Fire & Explosion Risks Deep Dive (how to ID, diag w water)
- EV Fire Risk at Charging Sites
- Can an EV Electrocute me? How to Isolate EV HV Systems/EVSE
- Flood Rescue Considerations for EVs & Lithium-ion Batteries
- Can EVs Catch Fire Twice?
- How to Tow, Transport & Store an EV for Battery Fire Risk
- EV Fire Risk for Servicing & Repair Workshops
- EV Fire Safety for Airports
- EV Fire Safety for Mining
- EV Fire Safety for Military
- EV Fire Safety for Shipping
- EV Fire Safety for Agriculture

Our work in EV charging

In collaboration with the Australian Building Code Board, we developed a report that led to the ABCB Advisory Notice



EV ABC - sample

Electric Vehicle Assessment of Battery Condition; an adaptable risk assessment, including a visual & thermal check, to build a risk matrix with associated action:

<i>Risk</i>	<i>EV has:</i>	<i>Therefore take:</i>
Very low	Very light damage	Action A
Low	Light damage	Action B
Medium	Moderate damage	Action C
High	Heavy damage	Action D
Very high	Multiple points of damage	Action E

IAIIM - emergency management

This method has been developed by EV FireSafe for use by emergency responders, however it **should** be adapted as a priority for all sectors.

1. Identify

Are you
dealing with
an EV?

Assess

Find ERG
Approach
Exposures
Ventilate

2. Immobilise

Chock wheels
Place in 'P'

3. Isolate

Manually shut
down high
voltage systems

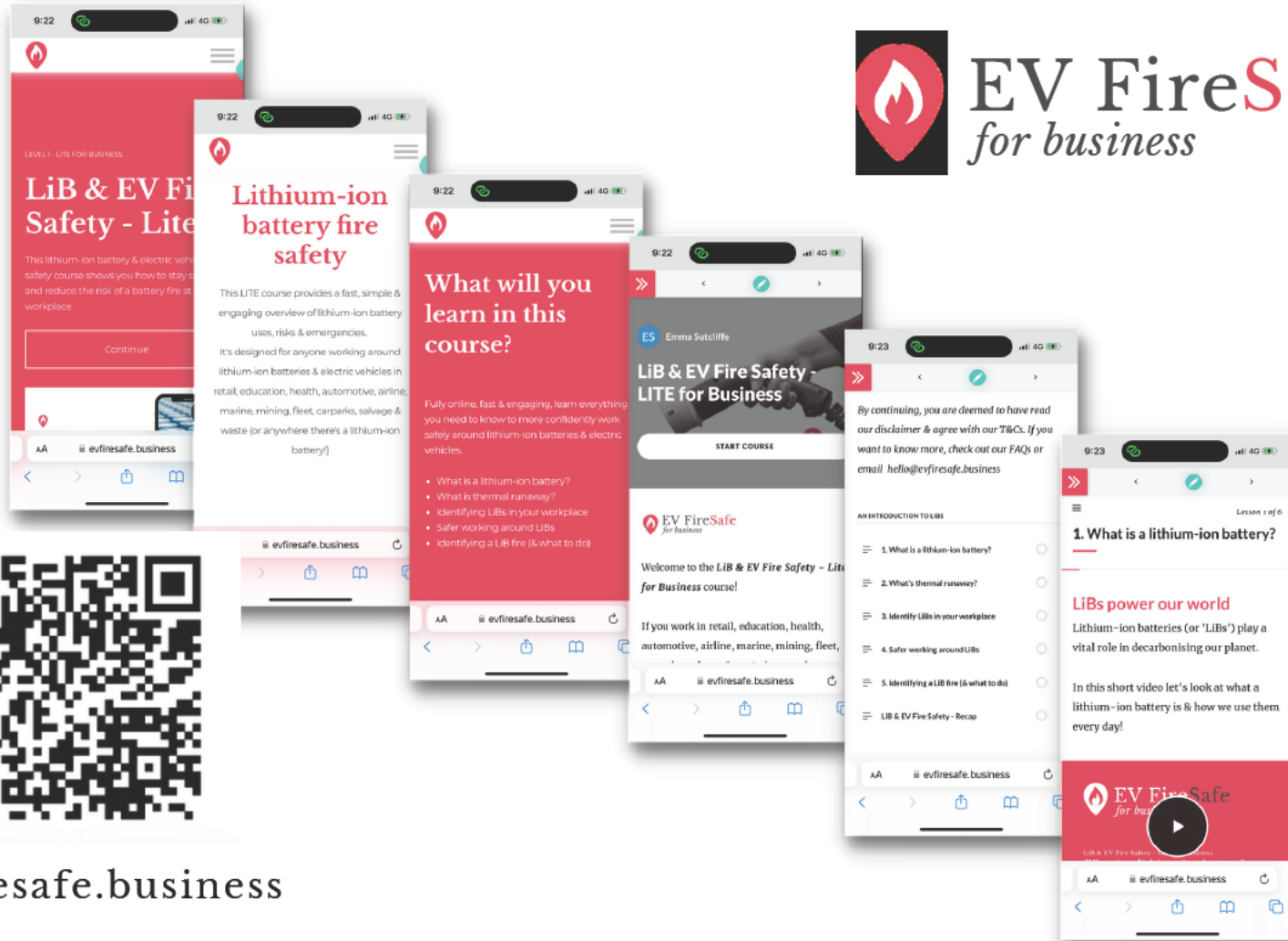
Monitor

For signs of
thermal
runaway:
Popping
Hissing
Vapour cloud



Online training

Online training for non-emergency sector



evfiresafe.business



evfiresafe.com

**Many thanks for your
kind attention**

**Emma Sutcliffe
Project Director**



**Dan Fish
Technical Specialist**

