NSW RURAL FIRE SERVICE

OP 1.2.21 OPERATIONAL PROTOCOL FOR INCIDENTS INVOLVING ELECTRIC AND HYBRID VEHICLES

Prepared by the Preparedness & Capability Directorate

Document control

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Related documents

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1 LINKS

- NSW RFS Fireground SOPs
- FRNSW Operations Bulletin 2021-01: Electric Vehicle Fires
- 2018 Australian Emergency Response Guidebook
- NSW RFS Village Firefighter training package
- Various manufacturers' emergency response guides.

2 SUPERSEDED PROCEDURE

Nil

3 PURPOSE

This Operational Protocol outlines the guidance and procedures specific to fires in vehicles with fully or partially electric power plants. It does not re-visit established processes for motor vehicle incidents to which the vehicle power plant is not relevant.

4 HAZARDS AND PRECAUTIONS

4.1 Hazards

Hazards include those present at all incidents involving motor vehicles and working on roads, such as traffic, and movement of unstable vehicles. In addition, specific hazards may exist that are only present when an electric vehicle (EV) is involved. These may include:

- High-voltage direct current (DC) electricity. Voltage detectors currently in use do **not** detect DC.
- Toxic and flammable gases and vapours from lithium-ion batteries, which may have serious health effects if inhaled or ingested. Breathing apparatus is to be worn whenever dealing with an EV fire; if it is not available, firefighters must stay clear of smoke and vapour issuing from an EV.
- High-pressure flame from batteries. Structural PPC and Compressed Air Breathing Apparatus (CABA) should be worn wherever possible. If it is not available, full bush fire PPC must be worn including gloves, eye protection, and turned-up collars (flash hoods should be considered), and firefighters must remain at least 3m clear of the vehicle.
- Secondary ignition which may occur hours or days after the initial incident. Use Thermal Imaging Cameras (TICs) and cool battery casings to ambient temperature (this may take considerable time and volume of water).

4.2 Thermal Runaway

Thermal runaway is a chemical reaction where a cell fails inside a battery and a short circuit ignites the electrolyte, releasing excessive heat, toxic gases, and flammable vapours. The heat may affect surrounding cells also sending them into thermal runaway.

Indicators of thermal runaway in a battery are:

- Intense or uneven areas of heat on the battery surface
- Smoke or vapour from the battery.

Cooling with water can potentially prevent thermal runaway. Water is the best extinguishing agent as foam does not assist in cooling and may inhibit use of a TIC to identify affected areas of the battery.

A large and sustained supply of water may be required (at least 4000 litres). The battery needs to be cooled with water and its temperature checked with a thermal imaging camera. If its temperature is elevated above ambient temperature, continue to cool it and check its temperature every 15 minutes. When the battery is at ambient temperature, the battery needs to be monitored for 60 minutes, checking with a TIC to ensure that its temperature is stable. If no TIC is carried by the appliance on scene, request the attendance of an appliance that carries one, through Firecom.

5 PERSONAL PROTECTIVE EQUIPMENT

When an EV is involved in fire, structural PPC and Compressed Air Breathing Apparatus (CABA) is to be used in offensive or defensive firefighting, and overhaul of the vehicle(s).

If structural PPC and CABA is not available, full bush fire PPC is to be used, including hand and eye protection; flash hoods and any available respiratory protection should be considered due to the potential for high temperature/velocity flames to be present. Firefighters without structural PPC and CABA must stay well clear of any smoke and vapours, should remain 3m clear of the vehicle wherever possible, and request the dispatch of a crew with structural PPE and CABA, from Firecom.

6 OPERATIONAL PROCEDURES

6.1 Operations

Use standard firefighting strategies and tactics to extinguish fires in EVs. When safe to do so:

- Identify – look for EV signage on number plate or other EV identifiers.
- Immobilise and stabilise the vehicle – approach from the 45º or side and chock wheels with wheel chocks and apply the brake.
- Disable the vehicle – disable the vehicle as instructed by the manufacturers' instructions (eg turn off the ignition). Avoid contact with orange HV cabling. Do not cut, pierce, or touch damaged batteries.
- If there is crash damage and the vehicle battery casing appears compromised, whether or not fire is present, there is a risk of exposure to electrical current. Do not touch the vehicle.

6.2 Fire involving a battery

- Attack the battery fire from uphill and upwind, to avoid toxic smoke and products of combustion. Be aware that projectiles may be released from the battery.
- Use water from a 38mm hose line with 700kpa at the branch. Do not use a live reel as water runoff may contaminate the hose, which may need to be discarded at the scene.
- If the vehicle has not been immobilised, commence fire attack from 45º to the wheels, to avoid unexpected vehicle movement or high-pressure flames.
- Use a TIC to identify areas of highest temperature within the battery.
- Once the battery fire is extinguished, follow procedures for smoke or vapour no fire below.

6.3 Smoke or vapour – no fire

If there is smoke or vapour but no fire, or a thermal runaway is suspected or occurring:

- Implement a 3 metre Exclusion Zone. Operate outside of the smoke or vapour.
- Protect exposures.
- Use a TIC to identify areas of highest temperature within the battery on the outer casing.

- Apply a constant stream of cooling water to that area of the battery casing for 15 minutes.
- After 15 minutes cooling, stop and monitor the battery casing with a TIC for 15 minutes, to identify any temperature increase.
- Continue cooling and monitoring until ambient temperature is achieved.
- After ambient temperature is reached, monitor for an additional 60 minutes before handover.

6.4 Overhaul

- Do not forcibly open the casing of a high voltage battery to access burning cells as this may expose firefighters to high voltage DC electricity and toxic chemicals.
- During all post-fire operations wear full structural firefighting PPE and CABA, wherever possible. Firefighters without structural PPC and CABA must stay well clear of any smoke and vapours, should remain 3m clear of the vehicle wherever possible, and request the dispatch of a crew with structural PPE and CABA, from Firecom.
- Consider all hoses used in water run off as contaminated and discard, following processes in OP 1.2.6 Management of Asbestos Incidents.

6.5 Handover

During handover to the owner or other responsible person (or NSW Police), advise the following:

- Damaged EVs and plug-in hybrid electric vehicles (PHEVs) must be stored a minimum of 15 m from other exposures for up to 4 weeks due to the risk of re-ignition (secondary ignition) of the battery, which could occur at any time until the battery is made safe by a qualified person.
- There is an electrocution risk from the high voltage DC in damaged batteries. A unique property of damaged high voltage batteries is the presence of trapped lethal levels of DC electricity known as stranded energy.
- There are toxic products of combustion of electrolyte on the surfaces of a battery compartment, and electrolytes that can have acidic or basic corrosive properties.

7 OPERATIONAL GUIDANCE

Indicators that a vehicle is an EV or PHEV include:

- EV signage on the vehicle number plate
- QR codes on the vehicle's windscreen
- Hybrid or Electric labelling.

EV and PHEVs have high voltage cabling connecting the battery to the motor. Cabling colour is standardised as orange. However, the location of these cables varies between vehicle makes and models.

The location of the battery varies:

- For EVs, the battery is usually under the floor pan of the vehicle, or runs under the centre console and rear seats.
- For PHEVs, the battery is usually in the boot space of the vehicle.

For larger vehicles such as buses, trams, and trucks, the operator or owner of the vehicle may know the battery location.

Manufacturers provide information for emergency workers on their websites and through the ANCAP Rescue App about the location of cables, location of batteries, as well as instructions for disabling the vehicle.

There is further information about the management of battery-powered vehicles (with lithium-ion batteries) in the 2018 Australian Emergency Response Guidebook:
UN: 3171
Guide: 147
Name of material: Battery-powered vehicle (with lithium ion batteries)

Incident closure messages to Firecom should note that the incident involved an EV.

In the event of a ruptured battery compartment, consider requesting that Firecom contacts FRNSW for Hazmat advice and support.

Electrocution while fighting a fire in an EV is extremely unlikely, as high voltage energy stored in the battery is electrically isolated from the vehicle's chassis, so does not seek a path to ground and will not travel up the hose stream.

However, if the outer casing of a battery is damaged or compromised in some way, there is a DC electricity hazard with the risk of electrocution. In this case, implement the available controls:

- Set up an Exclusion Zone around the hazard.
- Communicate the hazard to those at the site.

7.1 Procedural Checklist

- ☐ Have hazards and risks been evaluated as for any incident on roads or involving motor vehicles?
- ☐ Has a 360-degree size-up included looking for badging or markers to indicate that the vehicle is electrically-powered?
- ☐ If there is no smoke or evidence of fire, is the incident managed as for traditionally-powered vehicles?
- ☐ If there is smoke but no fire, have you implemented a 3m exclusion zone?
- ☐ If there is fire, are firefighters wearing structural PPC and CABA, or remaining uphill and upwind?
- ☐ If there is fire, and firefighters do not have structural PPE and CABA, have you requested the attendance of a crew with this equipment from Firecom?
- ☐ Are you using a TIC to check that the battery casing remains around ambient temperature?
- ☐ If a TIC is not carried, have you requested the attendance of a crew with this equipment from Firecom?
- ☐ If there is fire, have you identified and accessed a large volume water supply (eg reticulated water, further tanker response, etc).
- ☐ Have you briefed the person taking possession of the damaged vehicle (eg owner, tow operator, Police officer) regarding safety issues?

For further information regarding OP 1.2.21, please contact the NSW Rural Fire Service by email operational.performance@rfs.nsw.gov.au