# Electric Vehicles (EV) and EV charging equipment in the built environment

PROCEDURAL

**POSITION**
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## Disclaimer

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## Citation

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## Review period

This AFAC guideline should be reviewed by the doctrine owner by July, 2023.

# Contents

# About AFAC and AFAC Doctrine

## AFAC

The Australasian Fire and Emergency Service Authorities Council (AFAC) is the Australian and New Zealand National Council for fire, emergency services and land management. It is a collaborative network of fire, emergency services and land management agencies that supports the sector to make communities safer and more resilient.

## AFAC Doctrine

AFAC develops doctrine to support the practice of emergency management. The information in doctrine publications is evidence based and drawn from academic research and the collective expert knowledge of member agencies. Doctrine is regularly reviewed and represents the official AFAC view on a range of topics.

Doctrine does not mandate action; rather, it sets aspirational measures. Publishing nationally agreed views, shared approaches and common terminology enhances cooperation and collaboration within and between agencies and jurisdictions.

## Types of AFAC Doctrine

AFAC Doctrine is classified as follows:

**Capstone doctrine** – includes publications, such as 'strategic intents', that are high-level accounts of the concepts of emergency management operations and service delivery. They describe the principles of what is practical, realistic and possible in terms of protecting life, property and the environment.

**Fundamental doctrine** – includes 'positions', which AFAC members are expected to support, as well as 'approaches' and some 'frameworks'. Fundamental doctrine may become agency or jurisdictional policy on a matter if adopted by individual services or jurisdictions.

**Procedural doctrine** – includes 'guidelines', some 'frameworks', and 'specifications'. AFAC members are expected to be aware of procedural doctrine. A guideline is an advisable course of action; a framework provides a linking of elements to create a supporting structure to a system, and specifications are a detailed description of a precise requirement to do something or build something.

**Technical doctrine** – includes 'technical notes', 'training material' and the *Australasian Inter-Service Incident Management System* (AIIMS). Technical doctrine provides guidance of a technical nature: the how to do something, or the technical meaning relative to a situation.

# About this document

This publication is a Procedural Position. At the time of publishing it is supported by the following guidelines (procedural doctrine):

- AFAC Guideline for incidents involving electric vehicles

## Source of authority

The AFAC National Council endorsed this position on 20 December, 2022.

## Purpose

This position is to state AFAC Member agencies' approach towards Electric Vehicles (EVs) and the installation of EV charging equipment in the built environment-in relation to fire prevention and preparedness.

This position seeks to identify and inform on the risks to the community and emergency responders in and around EVs and EV charging infrastructure in the built environment.

As stated in Principle 2 of AFAC's Position on Fire Safety in the Built Environment, fire agencies have a role in the regulatory chain of responsibility to minimise fire risk in the built environment.

## Scope

The aim of this position is to highlight issues and provide guidance relating to EVs within the built environment, and the planning and design for installation of EV charging facilities.

It excludes the environmental, social and economic issues associated with EVs and charging infrastructure.

It does not provide any judgments on the values or otherwise of EVs and charging infrastructure. While the focus of this position is on Class 2-9 buildings, the considerations may also be applicable to Classes 1 and 10.

## Statement of engagement

This position was developed collaboratively by the Built Environment and Planning Technical Group and the Alternative and Renewable Energy Technologies Working Group and in consultation with the Fire Engineering Network.

## Audience

This position is intended for AFAC Member agencies and all public and private stakeholder groups, such as property and EV owners, developers, building designers, engineers, urban planners, legislative and regulatory consent authorities, and the insurance industry.

## Definitions, acronyms and key terms

### Acronyms

AC – alternating current

ARET- AFAC Alternative and Renewable Energy Technologies Working Group

BESS – battery energy storage system

BEPTG – AFAC Built Environment and Planning Technical Group

DC – direct current

ESS – energy storage systems

EV – electric vehicle (including fully electric, HEV, PHEV and FCEV)

FCEV- fuel cell electric vehicle

FRL – fire resistance level

HEV – hybrid electric vehicle

HV – high voltage

ICE – internal combustion engine

NCC – National Construction Code

PHEV – plug in hybrid electric vehicle

## Definitions and key terms

| | |
|---|---|
| Applications for building/ development | Building approval means the final certification that is required before building activity can commence, where building activity includes construction of new buildings, alterations and additions to existing buildings, the relocation of buildings between sites and other structural work.<br>**Note:** In some jurisdictions this may also be referred to as the 'building permit', 'building consent', 'construction certificate', or 'building authorisation'. (Building Confidence Glossary, ABCB, 2021) |
| Causes of cell failure | **Physical (mechanical) abuse**<br>Puncture, dent, crush or impact.<br>**Thermal abuse**<br>Prolonged heat source above 50°C. Can also include cold temperatures or cycling between extreme temperatures.<br>Overcharge failure of the battery management system, where there is differing voltages across cells in modules/batteries, when too many lithium-ions are removed from the cathode, leading to decomposition of the cathode materials, releasing oxygen and thermal energy.<br>**Rapid discharge**<br>Failure of the battery management system, where there is differing voltages across cells in modules/ batteries caused by releasing energy too quickly.<br>**Internal cell failure**<br>Poor cell/pack design, resulting in electrochemical or mechanical failure. Impurities in the cell. Metal deposits can form on the battery's anode creating dendrite growth structures that look like horizontal stalactites. |
| Deflagration | Propagation of a combustion zone at a velocity that is less than the speed of sound in the unreacted medium. (NFPA 921, 2021) |
| Electric Vehicle | Cars or other vehicles with motors that are powered by electricity rather than liquid fuels. (ARENA, 2022) Note that EV, HEV, PHEV and FCEV are referred to throughout this document as 'EV'. |
| Fire resistance level | The grading periods in minutes determined against the criteria: structural adequacy, integrity, and insulation. |
| Flammable limits | The upper or lower concentration limit at a specified temperature and pressure of a flammable gas or a vapor of an ignitable liquid and air, expressed as a percentage of fuel by volume that can be ignited. (NFPA 921, 2021) |
| Light Electric Vehicle | Light electric vehicles are defined as battery, fuel cell, or hybrid-powered 1, 2-or-3-wheel vehicles generally weighing less than 200 pounds (100 kg). Of this group, electric bicycles (e-bikes) are most common. (LEVA, 2009) |
| Secondary ignition | A secondary ignition is a recurrent or new failure in a cell occurring in a damaged battery due to the initial failure event. Secondary ignition incidents can occur hours, days, or weeks after the initial failure and without warning. |
| Stranded energy | As with most electrical equipment there is a shock hazard present, but what is unique about ESS is that often, even after being involved in a fire, there is still energy within the ESS. This is difficult to discharge since the terminals are often damaged and presents a hazard to those performing overhaul after a fire. (NFPA, 2022) Stranded energy can also cause secondary ignition of the fire hours or even days later. |
| Thermal runaway | Thermal runaway is a term used for the rapid uncontrolled release of heat energy from a battery cell; it is a condition when a battery creates more heat than it can effectively dissipate. Thermal runaway in a single cell can result in a chain reaction that heats up neighbouring cells. As this process continues, it can result in a battery fire or explosion. This can often be the ignition source for larger battery fires. (NFPA, 2022) |
| Vapour Cloud Explosion | The explosion resulting from the ignition of a cloud of flammable vapor, gas or mist in which flame speeds accelerate to sufficiently high velocities to produce significant overpressures. (FM Global, 2019) Most batteries create toxic and flammable gases when they undergo thermal runaway. If the gases do not ignite before the lower explosive limit is reached, it can lead to the creation of an explosive atmosphere inside of the ESS room or container. (NFPA, 2022) |

# Introduction

This position informs and provides awareness to AFAC Member agencies and stakeholder representatives of the potential risks and hazards presented by electric vehicles (EVs) and associated EV charging infrastructure.

EV manufacturers use a variety of battery types to store energy. The most common type of battery used is a lithium-ion (or Li-ion) battery, a type of rechargeable battery in which lithium ions move from the negative electrode (anode) through an electrolyte to the positive electrode (cathode) during discharge, and back when charging.

The presence of EV or plug in hybrid EVs (HEV or PHEV) across Australia and New Zealand is increasing significantly. There are several industry, societal and governmental initiatives that are driving a transition from internal combustion engine-powered vehicles (ICE) to electrically powered vehicles.

Note: Fully electric vehicles, HEV, PHEV and FCEV are referred to throughout this document as 'EV'.

The competition in the battery energy storage system (BESS) market revolves around the intellectual property associated with battery chemistries, i.e. in the electrolyte and materials used for the anode and cathode.

This represents an increase in the varying levels of hazards and risks faced by first responders and emergency service personnel when attending incidents involving EVs.

# Background

## Hazards with Electric Vehicles

Whilst failure events are currently reported to be occurring at a low frequency, the potential risks that can eventuate from a thermal runaway event may be of high consequence.

The increase in the uptake of EV is anticipated to incrementally impact the frequency of failure events.

A failure event within an EV battery (such as mechanical, thermal abuse, rapid discharge, or internal cell failure) has the potential to lead to a thermal runaway event within the EV battery, which may pose significant challenges for firefighters in the management of the incident.

The types of hazards that may be represented at a failure event include but are not restricted to the following;

- Potential for the fire event to impact on the structural integrity of the structure.
- Exposure to high voltage direct current (DC) and alternating current (AC) electricity.
- Toxic and combustible vapour production.
- Potential for vapour cloud explosion.
- Potential for a rapid rate of fire spread.
- Significant fire duration (4+ hours) and protracted incident.
- Potential for secondary ignition.
- Potential for stranded electrical energy.
- Potential for contaminated run-off from firefighting water streams.
- Post-fire management of potentially hazardous waste material.

It is recommended that stakeholder groups are informed on the potential hazards and liaise with the relevant fire authority to discuss suitable management or intervention strategies.

# AFAC Position

AFAC continues to seek and consider the available knowledge and information on EVs and EV charging facilities to inform fire authorities' preparedness and response to incidents involving these systems when reviewing the suitability of existing legislative requirements.

AFAC recommends that when reviewing building approval applications, the building surveyor/certifier implements Clause E1.10 and Clause E2.3 of the National Construction Code (NCC) 2019 Volume One Amendment 1 (and Clause E1D17 and Clause E2D21 of NCC 2022 Volume One) respectively.

Fire authorities will review each design solution in terms of their community safety obligations and operational response requirements relating to expected activities and the ability to satisfactorily interact with the installed systems.

## EVs and related infrastructure as a special hazard

AFAC considers the implementation of Clauses E1.10 and E2.3 as appropriate mechanisms by which to document and address any requirements for the implementation of proposed or associated installations of EVs and EV charging equipment within the built environment in consideration of their assessment of the relevant NCC performance requirements.

**E1.10 Provision for special hazards**

Suitable additional provision must be made if special problems of fighting fire could arise because of—

(a) the nature or quantity of materials stored, displayed or used in a building or on the allotment; or

(b) the location of the building in relation to a water supply for fire-fighting purposes.

*NCC 2019 Building Code of Australia - Volume One - Amendment 1 – p182*


**E2.3 Provision for special hazards**

Additional smoke hazard management measures may be necessary due to the—

(a) special characteristics of the building; or

(b) special function or use of the building; or

(c) special type or quantity of materials stored, displayed or used in a building; or

(d) special mix of classifications within a building or fire compartment, which are not addressed in Tables E2.2a and E2.2b.

*NCC 2019 Building Code of Australia - Volume One - Amendment 1 – p194*


## Consultation with fire authorities

AFAC advocates for appropriate engagement, as early in the design phase as possible, with the relevant fire authorities. This will allow all parties to understand the risks and improve consultation in the development of acceptable solutions utilising fire engineering principles. Engaging with the fire authorities early will potentially save time and money later in the process.

In alignment with recommendations of the Shergold-Weir Building Confidence Report, AFAC recommends that all relevant considerations be made during the concept and design phase of a development project, enabling a tailored approach to the specific characteristics of the proposed development.

## New and existing buildings

AFAC recommends the same approach be taken to consider the hazards and reduce risk to the community and emergency services personnel when installing EV charging infrastructure to both new and existing buildings. AFAC recognises that compliance with the relevant electrical regulations does not consider fire safety risks and operational needs of the fire authorities, and therefore, recommends engaging with the relevant fire authority before installing systems to existing buildings.

## Considerations for EV and EV charging equipment within the built environment

AFAC recognises that all buildings are unique. The considerations below should be discussed with relevant stakeholders, including the fire authorities, during the planning and design phase for the implementation of EV charging equipment and the introduction of EVs within the built environment.

Considerations include, but are not limited to:

- Location of EV charging stations and the proximity to other vehicles, exits, other fire safety systems, building utilities and critical infrastructure. Note: open air or external charging points should always be considered before installation of internal charging points.
- Establishing that the appropriate fire resistance (FRL) is applied to building elements.
- Suitability of fire safety systems and their location in proximity to the risk, including fire hydrants, fire detection systems, occupant warning systems, automatic fire sprinkler systems, and ventilation and smoke hazard management systems.
- The adequacy of vehicle separation to prevent fire spread with respect to directional flame jetting in EV fires. This includes special considerations for vehicle access in stacked parking arrangements or automatic vehicle parking systems.
- Intervention capabilities of the local fire authority
- Potential for contaminated fire-water run-off
- Provision of remote emergency shutdown controls and/or automatic shutdown for EV charging stations.
- Vehicle impact protection (e.g. bollards) for EV charging stations.
- Application of any best practice standards for EV charging equipment.
- Implementation of a regular maintenance schedule for EV charging equipment.

## Light EVs

AFAC also recognises the risks posed by light EVs such as electric bikes, scooters and mobility scooters and recommends that a separate and dedicated area is provided for charging of these devices and relevant similar considerations for EVs are also applied.

# Supporting discussion


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- South Australia Metropolitan Fire Service Position Statement EVs & EV Charging Stations in Buildings v1.0
- State of Queensland (Queensland Fire and Emergency Services), Position Statement Ver 04/2022 Electric vehicle charging stations and electric vehicle carparks
- Standards Australia, AS/NZS 3000:2018 Electrical installations (known as the Australian/New Zealand Wiring Rules): Appendix P, 2018, Standards Australia