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Chiefs Council

The professional voice of the
UK Fire & Rescue Service

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(On behalf of) Office for Zero Emission Vehicles

Submitted via email: Christopher-C.Gray@arup.com

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Electric Vehicle Parking in Enclosed Spaces - Ove Arup & Partners Ltd

The National Fire Chiefs Council (NFCC) is pleased to respond as a relevant stakeholder for the production of interim guidance on the installation of electric vehicle (EV) charge points in covered car parks and thank you for your time at the introductory meeting on 18 February 2022.

The NFCC is the professional voice of the UK fire and rescue services and is comprised of a council of UK Chief Fire Officers. This submission was put together by NFCC's Protection Policy and Reform Unit (PPRU), the NFCC's Alternative Fuels and Energy Systems Lead and NFCC's Senior Technical Advisor on Lithium-Ion Batteries (LiB). This response to the posed questions was also drafted in consultation with our members across the Fire and Rescue Services (FRS) and other international stakeholders.

General Comments

NFCC is supportive of environmental policies such as the Road to Zero strategy and recognises the need to adapt to changing technologies regarding alternative fuel sources for transportation. In this regard, it is sensible to outline minimum requirements for charging infrastructure for new buildings to enable the adoption of EVs and to provide guidance on the minimum standards expected.

However, NFCC is concerned to ensure the implementation of new requirements in the built environment is not taken in isolation, but forms part of the overall Building Safety Programme being led by the Department for Levelling Up, Housing & Communities (DLUHC) in response to the Independent Review of Buildings Regulations and Fire Safety. The standard of safety expected in car parks, (particularly covered car parks or those in basements) should not be undermined by the introduction of technology which did not exist when the original guidance was written. As part of our submission for the *Technical Review of Approved Document B*, (ADB), NFCC has called for a review of the requirements for car parks to take account of the products and materials used in modern cars, and to consider additional requirements for automatic water suppression systems and structural safety above those specified in the current guidance.

Whilst the full technical review of ADB is still underway, NFCC considers the introduction of new requirements for EV in car parks should also consider issuing appropriate additional

guidance detailing considerations that need to be made to comply with Part B of the Buildings Regulations 2010 (as amended) and the Regulatory Reform (Fire Safety) Order 2005.

This is essential to ensure the proposed EV charge points and supporting infrastructure can be safely integrated into the built environment, both for new construction and retrospectively. We can foresee numerous challenges regarding firefighting and fire safety which should be addressed in any guidance provided to support the Building Regulations. We all need to be cognisant we are not creating the next legacy fire safety issue in a drive to achieve other goals.

Whilst some of the questions go beyond the scope of NFCC expertise, it is considered appropriate for comment to be made on areas that may affect fire safety features of buildings and the ability of firefighters to tackle any incidents that may occur. If you require information on specific research topics and papers, please contact the NFCC Senior Technical Advisor Professor Paul Christensen, paul.christensen@ncl.ac.uk. We trust you find our answers to the questions of some assistance, if you wish to discuss any of the above then please contact us at pbruadmin@nationalfirechiefs.org.uk.

Questions

1. If the NFCC were creating a guidance document about EV charging points in enclosed/covered car parks, what fire safety recommendations would the NFCC make? And why?

Prior to making any fire safety recommendations, NFCC would initially garner sufficient information supported by robust and evidenced research to inform those fire safety recommendations and hence ensure they were sufficient to mitigate any risk identified. NFCC considers that whilst there is ongoing research into the risks posed by not only EVs but primarily LiBs, there is insufficient information at this time to inform the above, and therefore, further research is required to address these risks.

NFCC consider that the issue is not simply the risk from installing EV charging points (EVCPs) in enclosed/covered car parks, as these can be relatively easily mitigated by ensuring any electrical works comply with current regulations and standards, is carried out by competent persons in accordance with manufacturer's instructions and the relevant codes and standards, and subject to routine testing and maintenance (although well documented issues with competence across the sector need to be acknowledged).

NFCC believes it is the wider risks that are introduced by the EVs that are subjected to fire or are the source of the fire i.e., once thermal runaway has commenced (which is acknowledged as almost impossible to stop once started) within the LiBs of the EV, that need to be considered (not exhaustive):

- The production of directional jet-like flames with temperatures around 1000°C
- The production of explosive gases (that are often confused with smoke) that can lead to a vapour cloud explosion (VCE). This is very important as it is not just the fire risk from EVs that needs to be considered, VCEs involving EVs have taken place and have also been experienced in other LiB applications, e.g., Battery

Energy Storage Systems (BESS), and it is reasonable to assume this as a potential hazard given the enclosed nature of basements/enclosed car parks.

- The production of toxic gases and substances and their potential to cause harm to occupants of the car park, the building, firefighters and other emergency service personnel, the local/wider community as well as the environment, be they contained in a plume or in water run-off. This is also exacerbated through the increased use of plastics and other materials in modern vehicles.
- Risk of lower visibility due to toxic gases; it is considered that EV LiB fires emit a far greater quantity of toxic gases than an ICE vehicle prior to ignition, however more testing is required.
- The potential for vehicle-to-vehicle fire spread, e.g., as a result of the highly direction flares, to realise a multi-vehicle fire that may prove outside of the resource of the FRS to suppress and pose a risk to the structural integrity of the premises. This is significantly concerning given the position of basement/enclosed car parks beneath/adjacent to premises and the multi vehicle car park fires being recorded internationally.
- The risk of continuing ignition of the LiBs. LiBs in EVs (and other applications) have been known to emit flames and toxic/flammable gases/substances over many hours.
- The differing risks that can be created i.e., an energised electrical fire or a LiB fire.
- Because of the above hazards, the risk of FRS firefighters not being able to enter a car park to commence firefighting operations also needs to be considered.
- The tendency of LiBs to reignite also create risks and difficulties associated with the recovery of EVs. This is particularly the case when considering how to recover these vehicles from enclosed car parks. Until such point as an EV is recovered from such a space, the risk of further fire / VCE cannot be fully mitigated.

The research on EV thermal runaway in enclosed spaces is extremely limited to date, and confined to EV fires: thus, in the absence of sufficient and detailed research, the NFCC consider that installing EVCPs in covered car parks may result in hazards that are not yet fully understood. However, if EVCPs are to be installed, the NFCC recommend the following are mandated as minimum requirements:

- An appropriate automatic water-based fire suppressions system (AWFSS) with a FRS inlet so water can be supplied for extended periods of time.
- An adequate water supply that will last for an extended period given the need to apply copious amounts of water for extended durations.
- Adequate ventilation to control the toxic/flammable gases.
- Interceptor tanks/system to control contaminated water run-off (from suppressions systems and/or FRS intervention).
- Increased spacing between vehicles and/or the provision of appropriate barriers to reduce the chance of vehicle-to-vehicle fire spread.
- An automatic fire detection and alarm system (AFD) throughout the car park/building to ensure all of those at risk are made aware as early as possible.
- Electric isolation mechanism, either connected via relays to the AFD or manual in places easily accessed.

- Signage for the FRS and public to make all aware of the presence of LiB/EV charging points and EVs themselves. The need to identify if the fire involves an EV/LiB for the public and for them to contact the emergency services as a matter of priority.
- The general reduction of risk from fire by ensuring good management and promoting good housekeeping and sensible measures to reduce the risk of fire (that may then spread to EVs and other vehicles) i.e., place EVCPs away from flammable infrastructure such as recycling/refuse bins, gas tanks etc.

Whilst they will be difficult to quantify without further research, consideration should also be given to:

- Enhanced structural protection (although subject to an appropriate assessment by a competent person the provision of an appropriate AWFSS may mitigate this).
- Enhanced access and facilities for the FRS, this may need to be done on an individual premises until further research is available. It should be recognised that fire and rescue commanders may choose not to commit fire fighters to such structures without a full appreciation of the risks and hazards. Furthermore, it may be unrealistic to expect FRS intervention to be able to extinguish such a fire within a short space of time.

NFCC further considers, acknowledgement should be given to post-incident actions, including access to recovery vehicles, forensic teams etc.

2. Is the NFCC able to obtain statistics/incident reports on fires regarding EV charging points/ EV fires within enclosed car parks from fire and rescue services around England/UK?

- **As mentioned in our call we have made contact with LFB and West Midlands Fire Service, however input from other authorities would be greatly appreciated.**

As you are aware, the UK FRS report all incidents via the Incident Recording System (IRS) with the Home Office publishing regular updates [Fire statistics - GOV.UK \(www.gov.uk\)](https://www.gov.uk/government/statistics/fire-statistics). This is the only data NFCC/UK FRSs would have access too, and the Home Office can be contacted by email in the above link as they may be able to provide additional information on request. The data would also need to consider the different types of EV i.e., hybrid technology or pure EV/LiB.

NFCC considers any guidance based on data and statistics would not be commensurate with the current UK approach to *'one fire at one time'*. Also, and given the relative 'newness' of EVs and 'we don't know what we don't know', there is the potential for data to not include or consider:

- The impact of the exponential rise in their popularity.
- The effect of continuous charging/use of EVs e.g., ageing.
- The potential effect of frequency of use e.g., charging 1 or 2 times a week or multiple charges daily.

- The effect of rapid charging on EV safety: rapid charging is well-documented in the academic literature as causing the destabilising of LiBs. However, it can be reasonably assumed that people will not want to wait for their EVs to charge and will actively pursue rapid charging where available.
- The effect of poor maintenance of EVCP and EVs.
- The effect of unauthorised alterations and additions to EVCP infrastructure e.g., people already abuse electrical systems at home/work through 'daisy chaining'.
- General use and abuse of EVCPs and cables e.g., being driven over, abused, not stored correctly etc., also known as 'snip and trip' hazards in the EV charging sector
- Public charging sites should consider installing universal AC chargers (i.e., socket only, no attached cable). This will require EV drivers to carry their own cable, therefore removing public cables that are frequently damaged from common usage.

3. From these reports we would like to understand the following;

- **How many EV fires in enclosed car parks have been attended?**
- **What are the main causes for these EV fires?**
- **If there is limited information on EV fires within enclosed car parks, can you provide incident reports for fires involving EVs?**
- **What different approaches/equipment do the fire service consider necessary to tackle an EV fire compared to a traditional internal combustion engine fire?**

Regarding the first 3 bullet points please see answer to question 2 above.

Regarding the 4th bullet point, FRSs worldwide are researching operational tactics and resources to assist us in fighting fires involving EVs given their different behaviour in event of fire to internal combustion engine (ICE) vehicles. It should be acknowledged that ICE vehicle fires present their own challenges with these ever evolving given the increased use of plastics (including fuel tanks) and other materials in modern vehicles which has seen an increase in energy release rates and vehicle to vehicle fire spread. The operational tactics and techniques to fight these have been developed over 100 years' of experience and research. In contrast, LiB EVs have only been produced since 2008

In the ongoing research to date, it is considered there is no single solution as, as with most fire incidents, there are multiple informing factors and influences. Potential approaches and resources being considered, and issues to overcome, to fight EV fires include (not exhaustive):

- The application of copious amounts of water for extended periods of time from a safe distance (dependant on the provision of water in existing premises). Access to any batteries involved in fire is often difficult however, due to protective casings etc.
- The complete submersion of an EV either by flooding (where there are boundary walls by design to allow this to occur) or the removal of the vehicle and placing it in a large container. There are obvious impracticalities with this approach in retrieving the vehicle initially, as well as having the resources to fully submerge a vehicle. NFCC are also aware there are questions now being asked over the suitability of this method given some of the by products that can be produced when a LiB is fully submerged and other risks e.g., it is noted Tesla do not recommend

this as a suppression method as it may increase risk of reignition upon removal of EV from water.

- The use of vehicle 'fire blankets' although their limitations must be acknowledged with the potential for a delayed VCE and that they do not cool the LiB/fire.
- The use of a limited number (only select appliances across some FRSs) of existing high pressure water lances with the addition of coarse additives that allow water to be injected directly into the LiB once the casing has been breached. These trials are in their very early stages and require not only easy access to the LiB, but places firefighters very close/inside the EV and exposes them to the directional jet flames/toxic/flammable products. Their use/application is being questioned by many due to the limitations/risk and vehicle manufacturers also warn against breaching the protective casing the LiBs are contained within.
- Establishing data-driven emergency response training in collaboration with EV and LiB manufacturers, to better understand EV technology, emergency response guidance & suppression methods.
- The use of mobile data terminals (MDTs) and manufacturers databases to assist in the suppression of certain vehicles.
- The use of 7.2.d information and/or site familiarisation visits (under the Fire & Rescue Services Act 2004) to collate information that can inform a Site-Specific Risk Information (SSRI) record to allow FRS to carry out a certain amount of pre-planning given a known risk.

NFCC are of the opinion this is not just a matter for the FRS to address, this is for the whole sector including manufacturers, designers, developers, government (in producing statutory guidance) etc. There cannot be a '*carte blanche*' approach to the expectation that the FRS will be able to deal with any introduced fire risk, FRS intervention has limitations that need to be acknowledged.

4. Is the NFCC aware of guidance produced by other countries/organisations on the fire risk of EVs, the fire risk of charging EVs or the fire risk of EV charging points within enclosed car parks? If so, would the NFCC be able to gain access to these and share with Arup?

As identified in our answer to question 1, NFCC considers it is not just fire risk that needs to be considered but also the risk of a VCE and the production of toxic substances.

NFCC are aware [EV Fire Safe](#) have published some extremely useful guidance and research into the potential effects of charging EVs, with approximately one third of EV fires occurring when the vehicle is on charge.

Research supplied by EV Fire Safe confirms the following numbers of charging and/or underground EV LiB fire and VCE verified incidents globally, since 2010:

- 43 EV LiB fires in enclosed spaces.
- 35 EV LiB fires while connected to energised charging.
- 6 EV LiB fires in enclosed spaces with vapour cloud explosion.
- 6 EV LiB fires while connected to energised charging with vapour cloud explosion.
- 13 EV LiB fires in enclosed spaces while connected to energised charging.
- 4 EV LiB fires in enclosed spaces while connected to energised charging with vapour cloud explosion.

At the present time incidents involving EVs are rare, but it should be noted that EVs are also relatively rare compared to ICEVs. The effects of the ageing of EVs (LiBs are unique in that they become less safe with age, unlike all other batteries), rapid charging (which is known to destabilise LiBs), wear & tear, poor servicing, minor collisions, exposure to elements etc are all unknowns.”

NFCC are aware you have contacted EV Fire Safe and would direct you to them for further info and data.

5. Is the NFCC aware of any EV fire tests that have been undertaken or are being undertaken which are relevant/transferrable to EVs sold in the UK?

NFCC are not aware of any such tests, assuming the question relates to EVs in their entirety, currently. However, NFCC are aware there are some planned tests as identified in Professor Paul Christensen’s email of 11 March 2022 to members of the Arup team. NFCC obviously welcomes any such testing and considers it necessary to inform the risk.

6. Is the NFCC aware of any research examining the impact of charging an EV battery? And if this increases the risk of fire? Does the charger power have an impact on the risk of fire?

NFCC are unaware of any specific research examining the impact of charging on an EV battery, however, NFCC believe there is research available investigating the effect different types of charging may have on a LiBs in general e.g., slow/trickle charging compared to rapid.

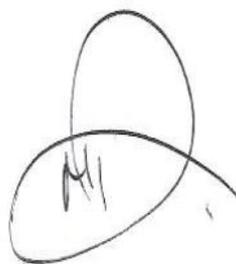
7. Is the NFCC aware of any research examining the impact of EV battery fires/EV charging point fires on current fire-fighting practices/equipment (either internally or within local fire authorities)?

See answer to question 3.

Yours sincerely,



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