ZURICH
Resilience Solutions

RiskTopics

Modern vehicle parking and electric vehicle charging
Zurich Resilience Solutions - Risk Engineering

Modern vehicles are changing. Demands for comfort have led to larger vehicles. Climate and sustainability goals have led to alternative energy sources and lighter components. These changes have increased the vehicle fire load. Electric vehicle use has also created demands for vehicle charging and dedicated parking areas. This document provides an overview of modern vehicles hazards and controls from a property risk assessment perspective.

Introduction

This document offers guidance to help control potential fire hazards associated with modern vehicle parking and electric vehicle parking and charging.

Research on the protection of car parks in general and electric vehicles parking and charging in particular is ongoing. As such, be aware the guidance on this topic may be subject to change.

Discussion

Modern cars in general

Cars have changed over the past 50 years. Customer demands for more comfort and space, the demand for more efficient driving performance, and the need for more cost-effective production methods has boosted the use of plastic materials in all aspects of the automotive manufacturing process – body work, chassis, plastic fuel tanks, interior – with the result that the overall fire load has increased. Experience indicates fires involving plastics in modern vehicles may be more challenging and spread more readily from car-to-car. Recent cases of fires involving modern vehicles have led to significant property damage and even structural collapse.

Electric vehicles

The awareness of climate change has led to an accelerating move away from internal combustion engines towards electric vehicles. These vehicles, including hybrid cars, typically store energy in lithium-ion batteries of different chemistries and capacities to supply vehicle power demand. Recent fire experience indicates fires involving lithium-ion batteries may present a challenge to both automatic and manual fire protection.

Compared to other conventional battery types, lithium-ion batteries provide much higher energy densities and extended lifetimes. The high energy density of lithium-ion batteries may increase the fire risk, which – based upon the particular chemistry – may be difficult to control.

Therefore, use and operate lithium-ion batteries strictly per manufacturer's guidance to reduce the risk of failure, malfunction or even fire. Unwanted conditions may nevertheless occur over the lifetime of a battery due to:

- Usage and application outside of design specifications
- Unauthorized modifications of batteries or their electrical and electronic control systems
- Physical damage to batteries (e.g. accident/impact, mechanical stress, extreme vibrations, etc.)
- Thermal stress; usage and application outside of given temperature bands
- Malfunction of the charging system and the electrical system in general
- Aging

In the worst case, the above-mentioned conditions may cause electrical short circuits within the battery cells leading to thermal runaway and the release of flammable and explosive gases.

Burning gases escaping from affected battery cells may thermally abuse adjacent cells, creating a chain reaction.

Gaseous components generated during a fire may involve the following substances:

- Volatile organic compounds
- Hydrogen
- Carbon dioxide
- Carbon monoxide
- Soot and particles made up of the oxides of Nickel, Aluminum, Lithium, Copper and Cobalt.
- Phosphorus-containing pentafluorides, POF3 and HF vapors

The application of water to cool and control lithium-ion fires may create hydrogen, hydrogen fluoride and other toxic, corrosive, and flammable components which may present an increased risk to firefighters and others. Particularly in enclosed or below ground charging and parking areas, the presence of toxic and flammable gases may pose challenges that delay or preclude manual firefighting.

The release and generation of chemical products may also increase property damage due to contamination and corrosive effects.

Besides the high energy content and the associated fire hazard of lithium-ion batteries, also consider the fire load presented by the vehicle in general (both electric and conventional). With the wide-spread use of plastic materials, the fire load presented by a vehicle has increased over the past decades.

Guidance

Modern car parking

Automatic sprinkler protection

Research shows automatic sprinkler protection may confine lithium-ion battery fires to their area of origin (such as within a vehicle). Sprinkler protection offers a means to initiate an alarm, help stop fire spread between vehicles and limit damage to the building structure. However, considering the location of batteries inside a vehicle, it is unlikely sprinkler water will reach or cool the burning vehicle battery itself.

In view of recent research conducted for modern cars*, consider providing sprinkler protection designed for Extra Hazard 1 (EH 1) in accordance with NFPA 13 with at least 12.2 mm/min (0.3 gpm/ft^2) over 230 m^2 (2.500 ft^2) or High Hazard Process 3 (HHP 3) in line with BS EN 12845 incorporating LPC Rules or VdS CEA 4001.

* Research on modern car fires and their control is ongoing and may lead to different requirements.

Wet-type sprinkler systems are preferred. If dry-type sprinkler systems are installed due to ambient conditions, design the dry-pipe system in line with applicable standard.

As with any fixed fire protection system, provide inspection, testing and maintenance in accordance with sprinkler standards and manufacturer's guidelines.

Electric vehicle charging indoors

Where electric vehicle charging and parking is located inside buildings, consider the following guidance.

Figure 1 – Underground vehicle charging station inside with ventilation grid (Photo source: Zurich)

Charging station location

Locate charging and parking areas as close as possible to car park entrances or exits, preferably on the ground level to facilitate public fire service access.

Compartmentation

Where the building is not dedicated to car parking, provide the car park area with at least a 1-hour fire-rated separations from other building occupancies to reduce the potential fire and smoke damage to other building areas.

Fire detection

Equip electric vehicle charging and parking areas with automatic fire detection. Locate fire detectors to monitor the charging stations and electric vehicles. Automatically communicate alarms to a constantly attended location where action may be taken to report the fire to the public fire service.

Ventilation

As discussed earlier, battery failure and thermal runaway events may involve the release of flammable gases. Should this occur in a confined area (such as inside buildings), the flammable gases may accumulate and develop into an explosion hazard.

Provide ventilation to keep flammable vapors below 25% of their lower flammable limit. This may involve mechanical exhaust ventilation operating continuously or activated by combustible gas detectors.

Electric vehicle charging outdoors

Ideally, electric vehicle charging, and parking should be located at least 10 m (33 ft.) from combustible walls or at least 7.5 m (25 ft.) from unprotected openings in non-combustible walls.

The hazard of a burning electric vehicle should be discussed with the public fire service and a pre-fire plan should be established.

Electric vehicle charging stations

For charging stations, consider the following:

- Keep charging and parking areas for electric vehicles free of combustible materials other than the vehicles themselves. Maintain a minimum distance of at least 2 m (7 ft.) to combustible materials other than vehicles.
- Inspect charging stations at least daily and disconnect charging station from electric power where they show signs of damage.
- Provide adequate space and access for the public fire service to facilitate actions should a fire occur.
- Provide designated cable holders (reels) near the charging stations and keep the cable lengths as short as possible to help protect cables from mechanical damage.
- Protect charging stations from mechanical impact.
- Fixed charging stations are preferable to mobile charging devices.
- For charging station electrical installation and distribution, consider the following:
  - Have qualified contractors install charging stations in accordance with local regulations and manufacturer's specifications.
  - Provide residual current devices to automatically disconnect the charging station from electric power in case of a ground fault.
- Install charging station isolation switches (disconnects) where they will be accessible during an electric vehicle fire.
- Automatically disconnect charging stations from electric power upon fire detection, sprinkler activation, or electrical malfunction.
- Provide inspection, testing, and maintenance of the electric vehicle charging systems in accordance with local regulations and manufacturer's specifications by a qualified contactor. Include annual thermographic surveys.

Pre-fire planning for electric vehicles

- Before installing electric vehicle charging stations, review the plans with the public fire service and insurers.
- Mark the location of electric vehicle charging stations on the location fire plan.
- Mark the location of fire hydrants and hose connections on the location fire plan. Where needed, provide additional fire hydrants or hose connections. Verify the availability of a water supply that will support the firefighting plan.
- Advise the public fire service as to the location of electric vehicle charging stations.
- Support the public fire service as they develop a pre-fire plan to access electric vehicle charging stations, conduct firefighting activities, and remove fire-damaged vehicles. Verify the public fire service will have the needed equipment, especially for the removal of fire-damaged vehicles.

Conclusion

Fire experience involving modern, electric, and hybrid cars indicate fires involving plastics and lithium-ion batteries may be more challenging and difficult to control. The generally increased fire load of modern cars due to the extensive use of plastic materials and the presence of high-energy-density batteries may pose an increasing challenge to firefighters and fixed fire protection systems. The fire challenge may magnify if a fire spreads from one car to another.

To reduce the challenges posed by modern vehicles as well as electric vehicle, consider the guidance offered in this document.

References

Boehmer, Haavard; Michael Klassen, Ph.D., PE; Steven Olenick, PE. Modern Vehicle Hazards in Parking Structures and Vehicle Carriers. Quincy, MA, USA. NFPA Research Foundation. 2020. Web. Web accessed 20210628. http://www.nfpa.org//-/media/Files/News-and-Research/Fire-statistics-and-reports/Building-and-life-safety/RFModernVehicleHazards-in-ParkingGarages.pdf

EN IEC 61851-1. Electric vehicle conductive charging system - Part 1: General requirements. Brussels, Belgium. European Committee for Electrotechnical Standardization (CENELEC). 2019. Print.

EN ISO 15118-1. Road vehicles - Vehicle to grid communication interface. Brussels, Belgium. European Committee for Electrotechnical Standardization (CENELEC). 2019. Print.

LPC Rules for automatic sprinkler installations incorporating BS EN 12845. United Kingdom. Fire Protection Association (FPA), 2015. Print.

NFPA 13. Standard for the Installation of Sprinkler Systems. Quincy, MA, USA. National Fire Protection Association (NFPA). 2022. Online.

NFPA 70. National Electrical Code. Quincy, MA, USA. National Fire Protection Association (NFPA). 2020. Online.

NFPA 70B. Recommended Practice for Electrical Equipment Maintenance. Quincy, MA, USA. National Fire Protection Association (NFPA). 2019. Online. (see Chapter 34, Electrical Vehicle Charging Systems).

VdS 3471: Ladestationen für Elektrostrassenfahrzeuge (Charging stations for electric road vehicles). Cologne, Germany. VdS Schadenverhütung GmbH. 2021. PDF.

VdS 3885: Elektrofahrzeuge in geschlossenen Garagen (Electric vehicles in closed garages). Cologne, Germany. VdS Schadenverhütung GmbH. 2020. PDF.

March, 2022

The Zurich Services Corporation
Zurich Resilience Solutions I Risk Engineering
1299 Zurich Way Schaumburg, Illinois-60196-1056
800.982.5964 www.zurichna.com