NFSA NATIONAL FIRE SPRINKLER ASSOCIATION
The Voice of the Fire Sprinkler Industry

TechNotes

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# Fire Hazards with Electric Vehicles – It's Not Just the Battery

As electric vehicles (EVs) become more common, there has been much concern with the lithium-ion (li-ion) batteries which allow EVs to perform similar to vehicles using internal combustion engines (ICEs). Several codes have changed to address concern with these batteries. These were addressed in last month's TechNotes. Manufacturers are also taking steps that will improve battery safety; however, batteries are not the only automotive technology that should concern fire protection professionals.

## Vehicles and Batteries

For most of us, our experience with vehicle batteries involves only the lead-acid battery installed to start our diesel or gasoline powered vehicles. Societal concerns with greenhouse gases have led to the development of vehicles powered only by electricity. Although we see this as new technology, in fact, the very first electric vehicle (EV) was on the road in the 1830s, preceding the invention of the internal combustion engine (ICE) by almost fifty years[1]. This early vehicle was not practical as it used replaceable, not rechargeable, batteries. However, by the late 19th century, several manufacturers were making practical, rechargeable electric vehicles. They were forgotten when Henry Ford and others brought cheap, reliable ICE vehicles to market.

Today's EVs are nothing like those of the past. Almost all use li-ion batteries due to their very high energy density (KWH/pound), their relatively fast recharge times, and their ability to discharge quickly, allowing for rapid acceleration. Battery packs necessary to power today's vehicles typically weigh about 1,000 pounds[2]. These packs consist of many individual battery cells (similar to D-cell batteries) wired together and secured in a protective case. Designed properly, the case protects the batteries and prevents the release of the vast energy stored within. When they fail, fires often occur.

## EV Battery Failures

The main concern with an EV battery failure is thermal runaway. In simple terms, thermal runaway occurs when heat buildup causes a chemical chain reaction within the cell. Heat and internal pressure eventually cause the battery shell to fail[3]. The flammable electrolyte is released in a vapor cloud that will often ignite in a fireball. Because cells are closely packed within the battery pack, it is likely that adjacent cells will also fail.

When EVs catch fire, they often make front page or even national news. Because of this, it is easy to believe that they are a common occurrence. In fact, they are rare. In 2020, NTSB reports there were almost 200,000 fires involving ICE vehicles. There were only 52 involving fully electric vehicles[4]. Accounting for the fact that ICE vehicles significantly outnumber EVs on the road, ICE vehicles are still 20 times as likely to catch fire as EVs[5].

Moving forward, it is likely that the hazards of EVs will decrease even further. Starting in 2024, Rivian and Ford recently announced that their EVs would be manufactured using Lithium Iron Phosphate (LFP) rather than li-ion technology. 2024 Tesla will also use this technology, except for their high-performance models. LFP has several advantages over li-ion batteries. One of these is a reduced risk for thermal runaway[6]. One reason for this is that LFP batteries have a lower energy density than li-ion batteries and have a lower energy release rate. Also, since LFP batteries use a non-flammable electrolyte, flammable vapors are not released if a cell fails.

## So, Batteries Aren't the Only Problem: What Else is?

A 2015 study in France compared hundreds of vehicle fires within parking garages. For fires occurring between 1997 and 1999, only 1% involved more than five vehicles. Between 2010 and 2014, that figure increased by a factor of 8[7]! EVs were extremely rare at the beginning of the last decade. So li-ion batteries cannot be the reason for this sharp increase.

A much more likely culprit is plastics. The same materials that go into modern furnishings, allowing modern homes to reach flashover in only 3-4 minutes are increasing the intensity of vehicle fires. Cars and trucks were originally made with steel body panels, used fiber insulation, and had seats padded with natural fibers. Today's vehicles use polypropylene body panels and polyurethane insulation and padding. Even fuel tanks are plastic.

A typical car contains over 400 pounds of group A plastic, about 10% of the car's weight but comprising about 50% of the volume of materials which make up the vehicle[8]. This does not account for synthetic textiles, which add another 100 pounds, or synthetic rubber, which adds another 200 pounds. To get an idea how much fuel these synthetics contribute to a fire, understand that a fuel tank containing 20 gallons of gasoline only contributes about 120 pounds of hydrocarbons to the fire (140 pounds for diesel). So, the modern car, rather than resisting the spread of fire, contributes about four times the amount of fuel as the liquid fuel which runs it.



## Suppressing EV Fires

Car fires will occur. Our goal as sprinkler designers should be to minimize fire spread. For years, the standards focused on closed parking garages, assuming fire would not spread in open garages. Several recent incidents have shown this is no longer tenable, encouraging a 2021 IFC requirement for sprinklers in open garages with a *fire area* over 48,000 square feet. (903.2.10). Also, the 2022 edition of NFPA 13 now recognizes parking garages as OH2 instead of OH1 (A4.3.3.2). (This is a step in the right direction. Whether this is the appropriate classification will require testing.)

Finally, the 2023 edition of 88A *Standard for Parking Structures* requires sprinklers in all parking structures in accordance with NFPA 13 and 13R (6.4.1). Since NFPA 88A is not referenced by the IFC, this will likely not have an impact in areas enforcing the I-Codes.

## Additional Resources and References

[1] Worth the Watt: A Brief History of the Electric Car, 1830 to Present, Car and Driver, Wilson, Kevin. Car and Driver 3/31/23.
[2] https://www.hertz.com/us/en/blog/electric-vehicles/how-much-does-an-electric-car-battery-weigh, accessed 1/11/24.
[3] A Review of Thermal Runaway Prevention and Mitigation Strategies for Lithium-Ion Batteries, Energy Conversion and Management Vol 16 Shahis, Seham and Agelin-Chaab, Martin, 12/23.
[4] Gas vs. Electric Car Fires [2024 Findings], Justin Wright, 12/19/23.
[5] Hybrids are twice as likely to catch fire as ICE vehicles. *Ibid.*
[6] The Latest Trends in Electric Vehicles Batteries, Molecules, Gatti, Carlo *et al.* June 26, 2021.
[7] Why Fires in Parking Garages Present a Multi-Level Risk, GenRe, Ronken, Leo *et al*, 2021.
[8] Chemistry and Automobiles: Lighting the Way to the Future of Motor Vehicles, Gilchrist Moore, Martha *et al,* March 2023.


# Training and Education

LTP
LAYOUT TECHNICIAN PATHWAY

## Sign-Up for one of our Layout Technician Pathway Courses

NFSA's newly updated fire sprinkler Layout Technician Pathway (LTP) prepares fire sprinkler layout and design professionals for NICET Levels I & II certifications. It also provides a great refresher for those who have been designing systems but need a comprehensive refresher. Students will receive a hard copy of the recently updated and revised "Layout Book" as well as a copy of the 2022 edition of the NFPA 13 standard.

The LTP consists of two parts. Students must first complete the on-line Part 1: Fundamentals before attending the in-person Part 2: Application session. The 25 self-paced online modules cover everything from "Parts of a Sprinkler" to "Introduction to Fire Sprinkler Calculations." The 3-day in-person instructor-led Part 2: Application class applies the content learned in the previous Fundamentals course. There are four in-person and one virtual session offered in 2023.

NOTE: Students must register for Part 1: Application at least one month before the start of in-person Part 2: session in order to allow enough time to complete the on-line modules.

Layout Technician Pathway cost:

Members: $2,200.00

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| Registration Deadline for Fundamental & Application | Layout Technician: Fundamentals Completion Deadline | Layout Technician: Application Class Dates | Location |
|---|---|---|---|
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| 23-Apr-42 | 20-May-24 | May 21-23, 2024 | TX |
| 1-Jul-24 | 28-Jul-24 | July 29-31, 2024 | CO |

**Check Out All Options Here**



## 2024 Tech Tuesdays are NOW available for registration!

Our next Tech Tuesday will be February 20, 2024 from 12:30 pm to 1:30 pm eastern time. The topic will be Fire Hazards with Electric Vehicles- It's Not Just the Battery.

Lithium-Ion Batteries uses and applications are growing, and each application creates unique hazards. A Li-ion battery used in a cell phone creates a different hazard than a Li-ion battery used in an energy storage system. Depending on how a battery is being used or stored will impact the level of risk, the type of hazard and the applicable codes or standards to be applied. This course will discuss Li-Ion battery applications including, BESS, Bulk Storage, Mobile electronics, and Electric vehicles and identify the key hazard for each and mitigation methods to reduce risk.

Member Cost: Free

Non-member Cost: $50.00 Learn more about membership.

*** As of October 2023, NFSA has transitioned back to Microsoft Teams using the Webinar client to deliver Tech Tuesdays.

With this process, once you have registered for the event you be sent an email with a Microsoft link that will bring you to the Microsoft Teams Event registration page. You must provide simple identifying information here to generate your email with the "Join" link to

the Webinar.

We must be able to identify each participant as accessing, being present, engaging, and evaluating the course to issue a CEU Certificate.

Thank you for your patience, we will continue to improve the user experience as we continue this transition back to Microsoft Teams. Your feedback is always welcome!

**Register for the next Tech Tuesday Here**


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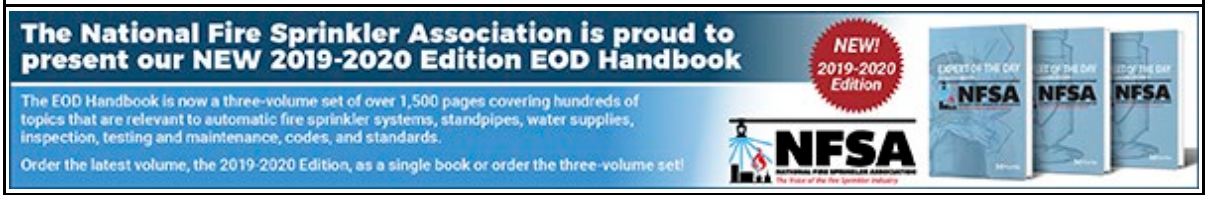





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