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

TechNotes

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This edition of TechNotes was written by Jeff Dunkel, P.E., Fire Protection Engineer for the NFSA.

Code Responses to Lithium-Ion Battery Technology to Date

Since the early 90's Li-ion Batteries have been used in commercial products. While the potential for thermal runaway has always been present, this hazard did not come to the forefront until the 2000's. Traditional batteries have always been a fire and explosion hazard due to regular hydrogen emissions. Li-ion batteries do not have the same hydrogen discharge as Lead Acid batteries; however, the threat of thermal runaway is a unique hazard in its own right. Another challenge is the fact that the risk and severity of an event changes greatly depending on the situation. Hazards change greatly depending on if the batteries are used in an energy storage system, Electric Vehicle (EV), Micro Mobility Device, being stored, or even in manufacturing, likewise the protection of these hazard should be different.

As with any new hazard, the technology progresses faster than the codes and standards can evolve. While guidance in codes and standards is still limited, enough time has passed where there has been some guidance provided. The intent of this edition of TechNotes is to provide a summary of the criteria available for the different uses of batteries.

Energy Storage Systems

Energy Storage Systems (ESS) can be used for battery backup for a single-family home or provide peak shaving for the entire electrical grid. In 2020 NFPA provided the first prescriptive guidance to protect Lithium-Ion Batteries with the first edition of NFPA 855 *Standard for the Installation of Stationary Energy Storage Systems*. The International Fire Code (IFC) followed suit with the addition of Chapter 12 in the 2018 edition and major modifications provided in the 2021 edition. Both the IFC and NFPA 855 have similar criteria for Li-ion based ESS systems, below is a summary:

- Both NFPA 855 and IFC Chapter 12 only apply to Li-ion ESS systems when the total capacity exceeds 20 kWh.
- The maximum allowable capacity in a single fire area cannot exceed 600 kWh unless it is a dedicated use building.
- ESS systems must be segregated into groups no more than 50 kWh, each group must be separated by a minimum of 3 feet.
- The sprinkler design criteria is 0.3 gpm/ft2 over 2,500 square feet only in cases where the size and separation requirements listed above are met.
- When the size and separation criteria cannot be met large scale testing must be provided via UL 9540A.

A battery rack size of 50 kWh for commercial applications is small, it is not uncommon for a commercial battery rack to exceed 100 kWh, for this reason most, if not all, commercial applications are protected using criteria developed through the UL 9540A process.

FM Global also has publicly available testing for large scale energy storage systems. The FM global report titled: *Development of Sprinkler Protection Guidance for Lithium Ion Based Energy Storage Systems*, details the testing conducted resulting in sprinkler criteria based on the chemistry type of the batteries used:

Lithium Iron Phosphate batteries (LFP):

- The Sprinkler design criteria is 0.3 gpm/ft2 over 2,500 square feet.
- The maximum size ESS rack is 83.6 kWh of electrical capacity.
- ESS system must be separated 3 feet from non-combustible objects, and 5 feet from combustible objects.
- Water supply capacity must be a minimum of 90 minutes.

Lithium Manganese Oxide/Lithium Nickel Oxide batteries (LMO/LNO):

- The Sprinkler design criteria is 0.3 gpm/ft2 over the entire ESS room.
- The maximum size ESS rack is 125 kWh of electrical capacity.
- ESS system must be separated 6 feet from non-combustible objects, and 9 feet from non-combustible objects.
- Water supply duration must be a minimum of 45 minutes for each ESS rack.

Bulk Battery Storage

If you are looking for criteria for the storage of Li-ion batteries in NFPA 13, you will not find it. Table A.20.4(a) in the 2022 edition of NFPA 13 lists Li-ion batteries as a commodity not addressed within the standard. The hazard for bulk storage or warehouse storage is reduced significantly when compared to ESS since most of the mechanisms that cause thermal runaway are not present. However, the hazard is still considerable because if the storage did ignite, the fire is still difficult if not impossible to control.

The only prescriptive criteria is provided by FM Global Data Sheet 8-1 *Commodity Classification* which recommends the following criteria:

- Maximum Ceiling Height: 40 feet.
- Maximum Stage of charge: 60%.
- Maximum 3 levels of storage up to 15 feet in height.
- Minimum criteria is 12, K22.4 or K25.2 sprinklers flowing at 35 psi.

- Storage of batteries with a ceiling higher than 40 feet or state of charge greater than 60% requires in-racks consisting of K8.0 or K11.0 sprinklers, 6 sprinklers flowing for a single level or 8 sprinklers for two or more levels flowing at 60 gpm each. Barriers spaced 12 feet vertically.

Electric Vehicles (EV's)

The primary concern with EV's in regard to sprinklers is of course parking garages. Statistically EV's are less likely to catch fire than an internal combustion engine; however, when they do it is difficult to put out. Though less likely to ignite, EV's have the potential to enter into thermal runaway with little outside influence, or they can be damaged, and thermal runaway may happen hours after the damage.

This increases the potential for a fire in commercial parking garages, as well as residential garages, which are mostly non-sprinklered. The increased number of EV's on the market and in parking garages, along with the fact that modern cars are mostly plastic, have pushed the codes and standards to update. The 2022 edition of NFPA 13 has increased the recommended hazard classification for parking garages from Ordinary Hazard Group 1 to Ordinary Hazard Group 2. In addition, the 2023 NFPA 88A now requires sprinklers for all parking garages, and the 2021 International Building Code (IBC) now requires sprinklers in open parking garages higher than 55 feet or over 48,000 square feet.

The currently available prescriptive criteria are minimal; however, the use of Li-ion batteries is only growing which will likely result in a greater need for guidance which surely will be provided as more is learned and time has passed.
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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
Non-members: $4,400.00 – **Join here** to save 50%!

Registration Deadline for Fundamental & Application	Layout Technician: Fundamentals Completion Deadline	Layout Technician: Application Class Dates	Location
2-Jan-24	29-Jan-24	January 30-February 1, 2024	FL
20-Feb-24	18-Mar-24	March 19-21, 2024	Online

Check Out All Options Here

Join us for Tech Tuesdays in 2024!

Our next Tech Tuesday will be January 16, 2024, from 12:30 pm to 1:30 pm eastern time. The topic will be Defining Lithium-Ion Battery Hazards Based on Application.

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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