

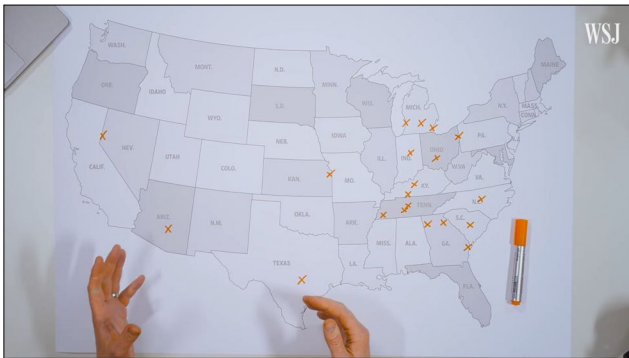


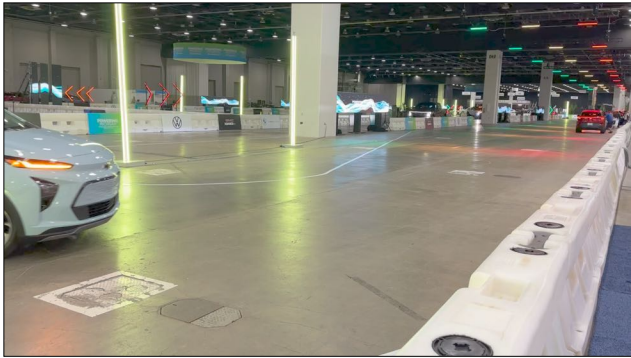


87 Days later !!!



Lithium Ion Batteries, More than Operations





## Ford Recalls 18 F-150 Lightning EV Trucks to Fix Battery Defect

Auto maker says root cause of a vehicle fire tied to supplier's battery-cell factory

AUTOS INDUSTRY

By **Nora Eckert** [@nora](#)  
Updated March 18, 2023 11:56 pm CST

Ford [F-150](#), a Motor Co. is recalling 18 F-150 Lightning electric pickup trucks after determining that a battery-cell manufacturing problem led to a vehicle fire in early February.

The root cause of the Feb. 4 fire, which occurred during a pre-shipment quality check, was related to an internal battery short circuit that can occur when the vehicle is at a high state of charge, a Ford spokeswoman said.

The auto maker said the flawed battery cells were made over a four-week period starting late last year at battery supplier SK On's cell factory in Georgia. Ford said it has identified the specific trucks it believes were affected by the problem.

"The 18 affected vehicles can still be driven and charged," the spokeswoman said. "We are encouraging customers to make an appointment for the battery



Battery-powered F-150 Lightning trucks on a production line at the Rouge Electric Vehicle Center in Dearborn, Mich.

production after identifying the cause of the issue, saying it wasn't a fundamental problem with the technology or its manufacturing system. SK On has taken action to address the problem with any vehicles that may have been shipped to dealers, he said.

during an investigation of the vehicle fire.

Late last month, Ford said it didn't believe the issue affected F-150 Lightnings that had already been delivered to customers.

The pause in Lightning production,

as startup EV companies such as Rivian Automotive Inc. have been striving to increase production of their early offerings.

Ford sold about 15,600 Lightnings last year, and another 3,600 through February of this year. The Dearborn-based auto maker is aiming to ramp up production of the electric truck to an annualized rate of 150,000 vehicles by later this year.

The Feb. 4 fire occurred in one of the company's holding lots, Ford has said. The blaze spread to two other trucks, according to a fire department incident report reviewed by The Wall Street Journal. All three vehicles were plugged into charging stations at the time, the report said.

A representative for the National Highway Traffic Safety Administration, the industry's top auto-safety regulator that manages vehicle recall campaigns, didn't immediately respond to a request for comment.

Ryan Felton contributed to this article.



Lithium Ion Response Resources - Google Drive

[drive.google.com](https://drive.google.com)



# What Codes and How

- IFC/IBC 2024 major changes to the battery environment
- NFPA 855 which includes a chapter 14 on battery storage and recycling

---

---

---

---

---


---

---

---

**2018 IBC**

**[A] 101.3 Intent.**  
The purpose of this code is to establish the minimum requirements to provide a reasonable level of safety, public health and general welfare through structural strength, means of egress facilities, stability, sanitation, adequate light and ventilation, energy conservation, and safety to **life and property from fire, explosion and other hazards, and to provide a reasonable level of safety to fire fighters** and emergency responders during emergency operations.



---

---

---

---

---


---

---

---

**2021 IBC**

**[A] 101.3 Purpose.**  
The purpose of this code is to establish the minimum requirements to provide a reasonable level of safety, health and general welfare through structural strength, means of egress, stability, sanitation, light and ventilation, energy conservation, and for providing **a reasonable level of life safety and property protection from the hazards of fire, explosion or dangerous conditions**, and to provide a reasonable level of safety to fire fighters and emergency responders during emergency operations.



---

---

---

---

---

---

---

---

**[A] 104.1 General.**

The building official is hereby authorized and directed to enforce the provisions of this code. The building official shall have the authority to render interpretations of this code **and to adopt policies and procedures in order to clarify the application of its provisions.** Such interpretations, policies and procedures shall be in compliance with the intent and purpose of this code. Such policies and procedures shall not have the effect of waiving requirements specifically provided for in this code.



**[A] 101.4.5 Fire prevention.**

The provisions of the International Fire Code shall apply to matters affecting or relating to structures, **processes and premises from the hazard of fire and explosion** arising from the storage, handling or use of structures, materials or devices; from conditions hazardous to life, property or public welfare in the occupancy of structures or premises; **and from the construction, extension, repair, alteration or removal of fire suppression, automatic sprinkler systems and alarm systems or fire hazards in the structure or on the premises from occupancy or operation.**



**[A] 101.2 Scope.**

This code establishes regulations affecting or relating to structures, processes, premises and safeguards regarding all of the following:

1. **The hazard of fire and explosion arising from the storage, handling or use of structures, materials or devices.**
2. **Conditions hazardous to life, property or public welfare** in the occupancy of structures or premises.
3. **Fire hazards** in the structure or on the premises from occupancy or operation.
4. Matters related to the construction, extension, repair, alteration or removal of fire suppression or alarm systems.
5. **Conditions affecting the safety of fire fighters and emergency responders during emergency operations.**



[A] 101.3 Intent.

The purpose of this code is to establish the minimum requirements consistent with nationally recognized good practice for providing a reasonable level of life safety and property protection from the hazards of fire, explosion or dangerous conditions in new and existing buildings, structures and premises, and to provide a reasonable level of safety to fire fighters and emergency responders during emergency operations.

Note: 2021 [A] 101.3 "Purpose". Editorial change.



[A] 102.8 Subjects not regulated by this code.

Where applicable standards or requirements are not set forth in this code, or are contained within other laws, codes, regulations, ordinances or bylaws adopted by the jurisdiction, compliance with applicable standards of the National Fire Protection Association or other nationally recognized fire safety standards, as approved, shall be deemed as prima facie evidence of compliance with the intent of this code. Nothing herein shall derogate from the authority of the fire code official to determine compliance with codes or standards for those activities or installations within the fire code official's jurisdiction or responsibility.



[A] 102.9 Matters not provided for.

Requirements that are essential for the public safety of an existing or proposed activity, building or structure, or for the safety of the occupants thereof, that are not specifically provided for by this code, shall be determined by the fire code official.

[A] 102.10 Conflicting provisions.

Where there is a conflict between a general requirement and a specific requirement, the specific requirement shall be applicable. Where, in a specific case, different sections of this code specify different materials, methods of construction or other requirements, the most restrictive shall govern.



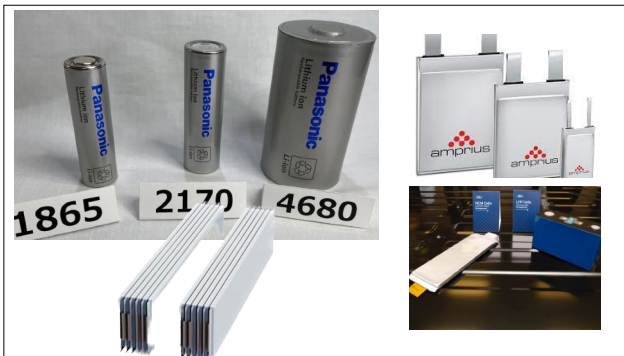
## Authority

Chapters 1 of the IBC and the IFC provide you the authority to use other standards and newer code language to address recognized hazards your current code does not provide guidance on.



## Lithium-ion Batteries – A Family of Chemistries

- NMC: Lithium Nickel Manganese Cobalt Oxide  $\text{LiNi}_x\text{Mn}_y\text{Co}_z\text{O}_2$
- NCA: Lithium Nickel Cobalt Aluminum Oxide  $\text{LiNiCoAlO}_2$
- LMO: Lithium Manganese Oxide  $\text{LiMn}_2\text{O}_4$
- LFP: Lithium Iron Phosphate  $\text{LiFePO}_4$
- LCO: Lithium Cobalt Oxide  $\text{LiCoO}_2$
- LTO: Lithium Titanate  $\text{Li}_4\text{Ti}_5\text{O}_{12}$



## New Chemistries

- There are a rise of new chemistries
- Battery Types
- New Materials for Anode and Cathode Materials

### What If Your Tesla Could Run on Sodium?

Can the batteries of today's electric vehicles have a healthier new competitor?

HEARD ON THE STREET

By Stephen Willmet  
April 19, 2023 10:44 AM EDT

If sodium is the new lithium, investors may need to rethink a favorite energy-transition trade.

One of the most potentially disruptive snippets of news to come out of the financial press since this week wasn't from Tesla or one of its flashy Chinese competitors but from a company that doesn't make vehicles at all: CATL. The world's largest battery producer said its first sodium-ion battery would power electric vehicles built by Chinese brand Cherry, though it didn't say when.

This adds to a drip-drip of signals that the next sodium-ion battery chemistry is moving out of the science lab and onto streets. Another one: Chinese EV maker BYD on Tuesday launched a hatchback, the Seagull, one variant of which may run on a sodium-ion battery, according to some reports that the company hasn't confirmed. If the Seagull doesn't use the new chemistry, other coming BYD models may not.

New technologies usually seep into the car industry from the top-end, where consumers can afford the latest gadgets. Battery innovations, where the big goal is reducing cost, are shaping up differently.

Cheaper but less powerful lithium iron phosphates, or LFP, batteries once weren't considered a mainstream alternative to those that drive most EVs outside China today, which are rich in

nickel and cobalt. Then nickel cobalt prices rocketed, forcing makers to find alternatives and prepared their EV supply chain growth. In 2023, Tesla said it adopted LFP for some lower-cost models. Ford, Volkswagen and others have since taken the same route. Could sodium-ion be the pattern? LFP replaced as and cobalt with abundant

Chinese electric vehicle maker BYD's Seagull at an auto show in Shanghai on Tuesday.







## Battery Responses Fall Into

- Mobility/Consumer grade (ebikes, scooters, hover boards etc)
- Electrical /Hybrid Vehicle (Car/Bus/ Vehicle)
- Recycling (hauling, storing, moving, in waste stream)
- ESS (Energy Storage Systems)
- Storage/Manufacture



---

---

---

---

---

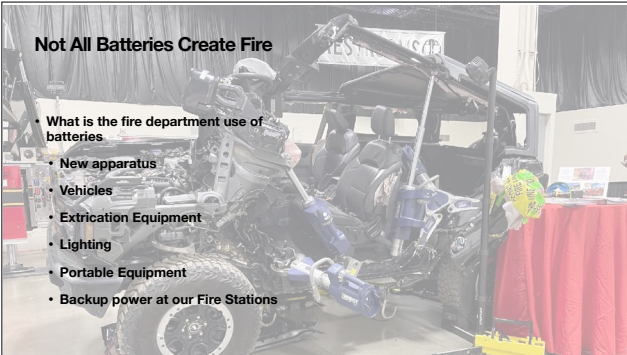
---

---

---

## Not All Batteries Create Fire

- What is the fire department use of batteries
  - New apparatus
  - Vehicles
  - Extrication Equipment
  - Lighting
  - Portable Equipment
  - Backup power at our Fire Stations



---

---

---

---

---

---

---

---

## Mobility Device/Personal Electronics

- Charging
- Location
- Changes to Battery Pack
- Wrong Battery for Equipment
- Wrong Charger for Equipment
- Damage to battery pack
- Rapid fire development
- Flammable gas and smoke
- Secondary events

---

---

---

---

---

---

---

---



## Ebike and E-Scooter



The popularity of electric bikes and e-scooters has been skyrocketing in the last few years. Lithium-ion batteries are usually the source of power for both, and if not used correctly, or if damaged, from batteries can catch on fire or explode. Whether you're a leisure or commuter on your main way of getting around, or just for fun, there are important safety tips to keep in mind when charging or using these devices.

**The Problem**

- Damaged or defective batteries can overheat, catch fire, or explode.
- Lithium-ion batteries can give off toxic gases and they burn extremely hot.

**Safety Tips**

- Only purchase and use devices, batteries, and charging equipment that are listed by a nationally recognized testing lab and listed accordingly.
- Always follow the instructions from the manufacturer.
- Only use the battery in the storage that were designed for, and came with, the device. Do not transport the device or device battery after it is fully charged.
- Only charge your device or device battery at a time to prevent overheating the circuit.
- Avoid batteries at room temperature when possible. Do not charge them at temperatures below 32°F (0°C) or above 105°F (40°C).
- Do not store batteries in direct sunlight or inside hot vehicles, and keep them away from children and pets.

**Signs of a Problem:**

- Stop using the bike or e-scooter if you notice any of these problems with the battery: unusual odor, charge trouble, too much heat, change in shape, swelling, smoking, or not keeping a charge.

**If you see a fire:**

- Leave the building immediately.
- Don't try to fight the fire.
- Call 911.

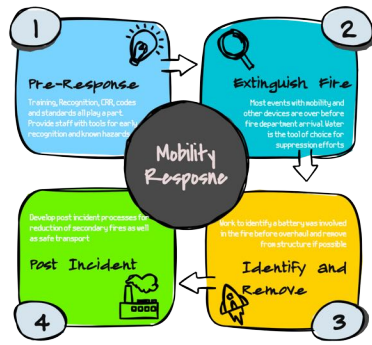
**LEARN MORE**

Visit [nfpa.org](http://nfpa.org)

- Production of various tools by the National Fire Protection Association
- Visit [www.nfpa.org](http://www.nfpa.org)

## Mobility Device Response

- Speed of fire in our homes
  - Continuing education for all homeowners
  - Push for smoke alarms in all homes of vital importance
- Post extinguishment
- Fire watch
  - Mitigation strategy with cells
  - Company Officers alert to cells involved in the fire
  - Overpack and transport for recycling
  - No secondary events!







### 323.1 General

Lithium-ion and lithium metal battery powered micromobility devices shall be operated and maintained in accordance with this section.

Exceptions:

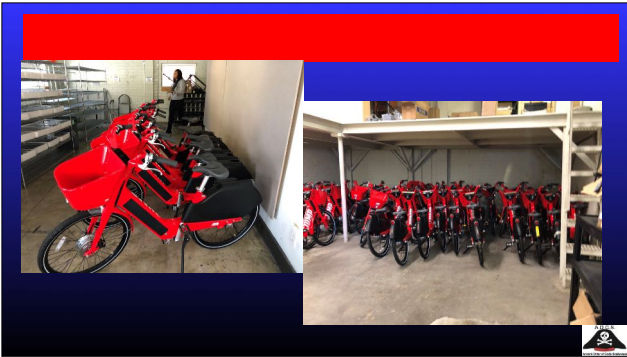
1. Storage, repair and charging in residential occupancies of battery powered mobility devices , provided that such devices are for personal use by its owner.
2. Charging of a single powered mobility device in any occupancy by its owner.



### 323.1.1 Prohibited locations

The use of a residential occupancy as a business for the charging of commercially owned powered mobility devices as part of a rental or sales service shall not be permitted.





---

---

---

---

---

---

---

---

---

---

### Manufacturer instructions/Listing

#### 323.2 Battery chargers and equipment.

Powered micromobility devices shall be charged in accordance with their listing and the manufacturer's instructions using only the original equipment manufacturer-supplied charging equipment or charging equipment in accordance with the listing and manufacturer's instructions.

#### 323.3 Listing.

Powered micromobility devices shall be listed and labeled in accordance with UL 2272 or UL 2849, as applicable.



---

---

---

---

---

---

---

---

---

---

### 323.4 Battery charging areas

Where approved, powered micromobility devices shall be permitted to be charged in a room or area that complies with all of the following:

1. Only listed devices utilizing listed charging equipment shall be permitted to be charged.
2. Is provided with sufficient electrical receptacles to allow the charging equipment for each device to be directly connected to a receptacle. Extension cords and relocatable power taps shall not be used.
3. Storage of combustible materials, combustible waste or hazardous materials shall not be permitted.



---

---

---

---

---

---

---

---

---

---

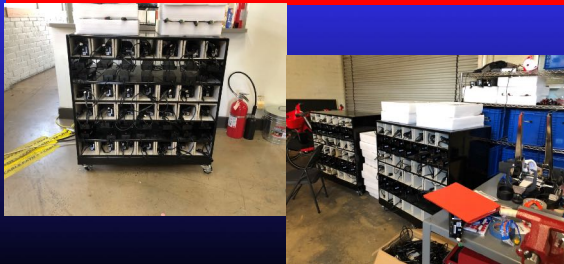
323.4 Battery charging areas (Cont.)

4. The charging operation shall not be conducted in or obstruct any required means of egress.
5. Removable storage batteries shall not be stacked or charged in an enclosed cabinet unless the cabinet is specially designed and approved for such purpose.
6. A minimum distance of 18 inches (457.2 mm) shall be maintained between each removable storage battery during charging operations unless each battery is isolated from neighboring batteries by an approved fire-resistant material.



323.4 Battery charging areas (Cont.)

7. A minimum of 18 inches (457.2 mm) shall be maintained between the locations of the batteries on each powered micromobility devices during charging operations.
8. The indoor room or area shall be protected by a fire alarm system utilizing air-aspirating smoke detectors or radiant energy-sensing fire detection.



# CellBlock

Fire Containment Systems

- Fire resistant barriers between each battery
- Electrical outlet in each charging bay allows safe charging
- CellBlockEX deployment system halts propagation
- Equipped with heavy-duty locking wheels
- Extremely durable
- Battery Rack FireShield



## 323.5 Fire safety plan

A fire safety plan shall be provided in accordance with Section 403.10.6. In addition, the fire safety plan shall include emergency response actions to be taken upon detection of a fire or possible fire involving lithium-ion or lithium metal battery storage.



## Battery Laboratory

- Startup to existing battery manufacture
- Small scale equipment and storage of materials
- Clean room or separation
- Use group, in 2024 codes and standards places it as a B-use group
- Material storage and emerging changes needed



---

---

---

---

---

---

---

---

---

---

## Battery Pack Break Down

- There are locations for testing, pack break down
- Testing could include shake, submersion, fire, etc
- Spaces typically fall in S1/F1/B
- Need for contingency planning, post incident stabilization
- Consider additional ventilation



---

---

---

---

---

---

---

---

---

---

## Cell Manufacturing

- Very large buildings as companies move from cell lab to production
- Cell type produces different results
- Typically a S-1/F-1/B use groups and some H2/H3/H4 occupancies
- Lots of separations to keep anode and cathode materials clean
- Specific process and response plans



---

---

---

---

---

---

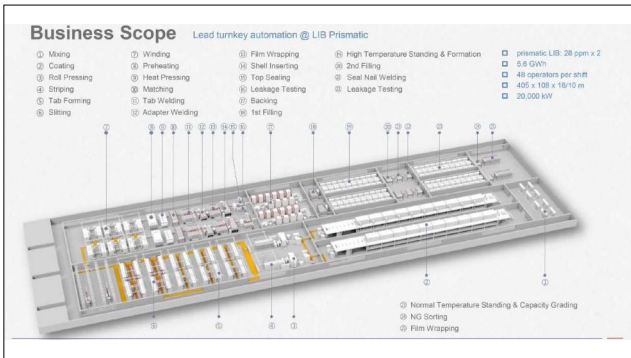
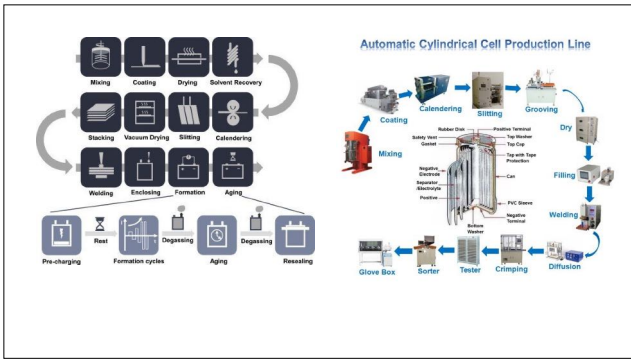
---

---

---

---





## Storage

- Cells to modules, complete battery packs
- Damaged, Defective, Recalled batteries
- Difficulty on fire sprinkler requirements because of changes in what is used
- State of Charge (SOC), under 30%

## Vehicle Assembly

- Typical automotive facility,
- Automation
- Paint Spray
- Battery pack storage
- Connection to equipment



---

---

---

---

---

---

---

---

---

---

## 2024 International Building Code Changes



---

---

---

---

---

---

---

---

---

---

### 2024 IBC Occupancy Group

#### 304.1 Business Group B

Lithium-ion or lithium metal battery testing, research and development

#### 306.2 Moderate-hazard factory industrial, Group F-1

Energy storage systems (ESS) in dedicated use buildings

Energy storage systems (ESS) and equipment containing lithium-ion or lithium metal batteries

Lithium-ion batteries

Vehicles powered by lithium-ion or lithium metal batteries



---

---

---

---

---

---

---

---

---

---



2024 IBC/IFC  
SECTION 903 AUTOMATIC SPRINKLER SYSTEMS

903.2.4 Group F-1

4. A Group F-1 occupancy used to manufacture lithium-ion or lithium metal batteries.

5. A Group F-1 occupancy used to manufacture vehicles, energy storage systems or equipment containing lithium-ion or lithium metal batteries where the batteries are installed as part of the manufacturing process



2024 IBC/IFC  
SECTION 903 AUTOMATIC SPRINKLER SYSTEMS

903.2.7 Group M

903.2.7.3 Lithium-ion or lithium metal battery storage. An automatic sprinkler system shall be provided in a room or space within a Group M occupancy where required for the storage of lithium-ion or lithium metal batteries by Section 322 or Chapter 32 of this code



2024 IBC/IFC  
SECTION 903 AUTOMATIC SPRINKLER SYSTEMS

903.2.9 Group S-1

5. A Group S-1 fire area used for the storage of lithium-ion or lithium metal powered vehicles where the fire area exceeds 500 square feet (46.4 m2).

903.2.9.1 Repair garages. An automatic sprinkler system shall be provided throughout all buildings used as repair garages in accordance with Section 406.8 of the International Building Code, as shown:

5. A Group S-1 fire area used for the repair of vehicles powered by lithium-ion or lithium metal batteries that exceeds 500 square feet (46.4 m2).



907.2.2 Group B.

907.2.2.2 Laboratories; research and development or testing. A fire alarm system activated by an air sampling-type smoke detection system or a radiant energy-sensing detection system shall be installed throughout the entire fire area utilized for the research and development or testing of lithium-ion or lithium metal batteries.



907.2.4 Group F.

907.2.4.1 Manufacturing involving lithium-ion or lithium metal batteries. A fire alarm system activated by an air sampling-type smoke detection system or a radiant energy-sensing detection system shall be installed throughout the entire fire area where lithium-ion or lithium metal batteries are manufactured; and where the manufacturer of vehicles, energy storage systems or equipment containing lithium-ion or lithium metal batteries where the batteries are installed as part of the manufacturing process.



907.2.7 Group M.

907.2.7.2 Storage of lithium-ion or lithium metal batteries. A fire alarm system activated by an air sampling-type smoke detection system or a radiant energy-sensing detection system shall be installed in a room or space within a Group M occupancy where required for the storage of lithium-ion or lithium metal batteries by Section 321.

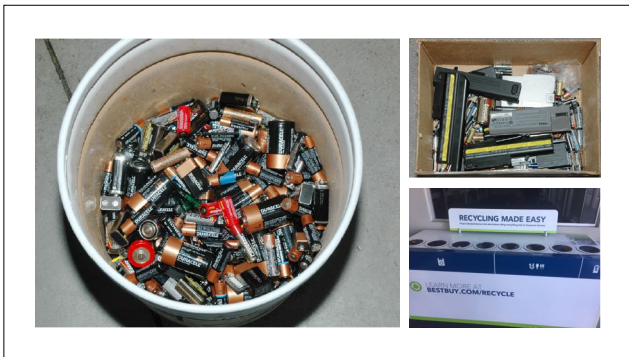




2024 IBC/IFC  
SECTION 907 FIRE ALARM AND DETECTION SYSTEMS

907.2.10 Group S.

907.2.10.2 Storage of lithium-ion or lithium metal batteries. A fire alarm system activated by an air sampling-type smoke detection system or a radiant energy-sensing detection system shall be installed throughout the entire fire area where required for the storage of lithium-ion batteries or lithium metal batteries By Section 321 of this code.







## 2024 International Fire Code

### SECTION 322 STORAGE OF LITHIUM-ION AND LITHIUM METAL BATTERIES

#### Exceptions:

1. New or refurbished batteries installed in the equipment, devices, or vehicles they are designed to power.
2. New or refurbished batteries packed for use with the equipment, devices, or vehicles they are designed to power.
3. Batteries in original retail packaging that are rated at 300 watt-hours or less for lithium-ion batteries or contain 25 grams or less of lithium metal for lithium metal batteries.
4. Temporary storage of batteries or battery components during the battery manufacturing process prior to completion of final quality control checks.
5. Temporary storage of batteries during the vehicle manufacturing or repair process.

**322.2 Permits**  
More than 15 cubic feet (0.42 m<sup>3</sup>) of lithium-ion and lithium metal batteries, other than batteries listed in the exceptions to Section 322.1

**322.3 Fire safety plan** per 403.10.6

#### 322.4 Storage requirements

##### 322.4.1 Limited indoor storage in containers

Container size 7.5 cu.ft. each/15 cu.ft. max

Separation 3 ft. open space from other containers and combustible mats; or 10 feet of combustibles.

5 ft. from exits;

Open top non-combustible or approved

#### 322.4.2 Indoor storage areas

##### 322.4.2.1 Technical opinion and report

- evaluate the fire and explosion risks; deflagration potential, sprinkler density

##### 322.4.2.2 Construction requirements

- 2-hour fire separation; Exceptions – prefab structures, new batteries in packaging that can contain an event

##### 322.4.2.3 Fire protection systems

- NFPA 13 sprinkler

##### 322.4.2.4 Fire alarm systems

- Air-aspirating smoke or radiant energy-sensing detection

##### 322.4.2.5 Explosion control

##### 322.4.2.6 Reduced requirements for storage of partially charged batteries

- Not exceeding 30% SOC no application of 322.4.2.1, 322.4.2.2 and 322.4.2.5



#### 322.4.3 Outdoor Storage

##### 322.4.3.1 Distance from storage to exposures

- 20 feet from exposures
- 3 feet from exposures with 2-hour fire barrier
- 3 feet from exposures if in 2-hour fire prefab structure

##### 322.4.3.2 Storage area size limits and separation

- Max. 900 sq.ft. / max 10 ft. high / 10 ft. separation from each area

##### 322.4.3.3 Fire detection

- Radiant energy-sensing fire detection





---

---

---

---

---

---

---

---

---

---



---

---

---

---

---

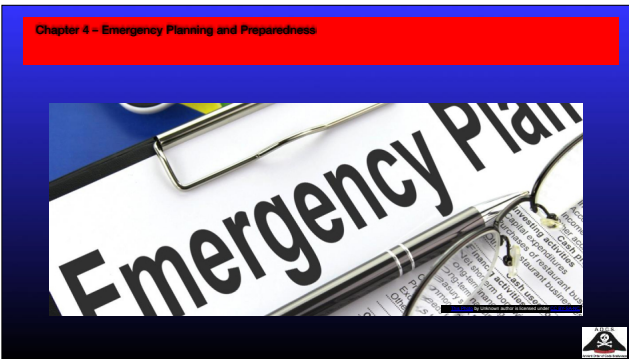
---

---

---

---

---



---

---

---

---

---

---

---

---

---

---





## 2023 NFPA 855

### Chapter 14

#### Storage of Lithium Metal or Lithium-ion Batteries

##### Except:

- Areas - 30% SOC or less (AHJ review of procedure)
- Areas - fire and fault condition testing; suppressed
- New/Refurbish in devices or packed with
- New/Refurbished max 300 Watt-hours or max 25 g of lithium metal are in their original retail packaging

##### Collection Locations

Container size 7.5 cu.ft. each/15 cu.ft. max

Separation 3 ft. open space from other containers and combustible mats.

5 ft. from exits; open top non-combustible or approved

##### Rooms or spaces

2-hour fire (air- aspirating or Radiant-energy detection / sprinklers)

Prefab Bldgs – same as above

##### Metal drums

900 sq ft / 10 ft separation / air- aspirating or Radiant-energy detection / sprinklers

##### Transportation containers

900 sq ft / 10 ft separation / air- aspirating or Radiant-energy detection / sprinklers

##### Prevention & mitigation plan

###### Deflagration analysis

###### Outdoor –

900 sq ft / 10 ft separation / 3 ft with 3-hour barrier

3,600 sq.ft. weather protection open 3 sides / 10 ft. separation  
Radiant-energy detection



## 30% SOC – What's the Magic?

Energy needed to spontaneously go into thermal runaway

Energy needed to propagate to a neighboring cell if a cell goes into thermal runaway

<https://www.fire.tc.fas.gov/systems/Lithium-Batteries>



## NFPA 13-2022

### Chapter 20

#### General Requirements for Storage

### 20.4 \*

#### Commodity Classes

Table A.20.4(a) Examples of Commodities Not Addressed by Classifications in Section 20.4

Ammunition Components
- Bulk primers and powder
<b>Explosives</b>
- <b>30% SOC and other similar multi-cells</b>
- <b>Lithium-ion and other rechargeable batteries that contain combustible electrolyte</b>
Boat Storage
- Stored on racks
Boxes, Crates
- Empty, wood slatted
Carpet Rolls
Combustible Metals — unless specifically identified otherwise
Compressed or Liquefied Flammable Gases (i.e., "Ned propane cylinders) — unless specifically identified otherwise
Explosives
- Blasting primers and similar items
Fertilizers (strates)
Fireworks
- Consumer and display
Flammable and Combustible Liquids — unless specifically identified otherwise
- Liquids that contain greater than 20 percent alcohol
Hanging Garments, Bulk Storage
Lighters (butane)
- Loose in large containers (Level 3 aerosols)
Storage Container
- Large container storage of household goods

\*Should be treated as idle pallets.





Table A.20.4(b) Alphabetical Listing of Commodity Classes

Product Heading	Product	NFPA 13
Batteries	Dry cells (excludes lithium, lithium-ion, and other similar exotic metals or combustible electrolyte), without blister packing (if blister packed refer to commodity classification definitions)	Class I
	Vehicle, any size (e.g., automobile or truck), empty plastic casing	Group A Nonexpanded
	Vehicle, large (e.g., truck or larger), dry or wet (excludes lithium-ion and other cells containing combustible electrolyte) cells	Group A Nonexpanded
	Vehicle, small (e.g., automobile), wet (excludes lithium-ion and other cells containing combustible electrolyte) cells	Class I



Fire Suppression = Water + Data

NFPA 13-2022

Chapter 24 Alternative Sprinkler System Designs for Chapters 20 Through 25

24.1.6 A series of large-scale fire tests involving challenging test scenarios that address the range of variables associated with the intended application of the sprinkler shall be conducted to evaluate the ability of the sprinkler to protect storage fire risks that are representative of those described in the manufacturer's installation and design parameter instructions and referenced in the listing.



NFPA 13-2022 Section 24.1.7

The manufacturer's installation and design parameter instructions for these sprinklers shall specify in a standardized manner the end-use limitations and sprinkler system design criteria including at least the following:

- (1) Commodity or commodities to be protected
- (2) Storage arrangements allowed
- (3) Installation guidelines including obstruction and ceiling construction limitations
- (4) Maximum ceiling and storage heights with associated minimum operating pressures and number of sprinklers required to be included in the hydraulic calculation
- (5) Hose stream allowance and duration



24.1.8

The number of sprinklers to be used in the sprinkler system design shall be based on the worst-case result obtained from the full-scale fire test series increased by a minimum 50 percent

24.1.8.1

Regardless of the number of sprinklers that operated during the worst-case full-scale fire test, the number in the sprinkler system demand shall be no less than one of the following:

- (1) Twelve sprinklers for standard coverage sprinklers
- (2) Eight sprinklers for extended-coverage sprinklers based on a spacing of 12 ft x 12 ft (3.7 x 3.7 m)
- (3) Six sprinklers for extended-coverage sprinklers based on a spacing of 14 ft x 14 ft (4.3 m x 4.3 m)



Fire Suppression = Water + Data

2024 IBC/IFC

903.3.1.1.3 Lithium-Ion or lithium metal batteries. Where automatic sprinkler systems are required by this code for areas containing lithium-ion or lithium metal batteries, the design of the system shall be based upon a series of fire tests conducted or witnessed and reported by an approved testing laboratory involving test scenarios that address the range of variables associated with the intended arrangement of the hazards to be protected



Solutions



- <https://cellblockinc.com/>
- <https://www.cellblockinc.com/products/cellblock-1-1-3/>



# EV Response

Developed by Firefighters and tech experts  
Discussion on training/SOP  
When to let it burn  
Post incident



**IAFC BULLETIN** | October 2019

**EV Response Plan**

**Incident Action Plan**

**Pre-Incident**

**Incident Action Plan**

**Post-Incident**

**Total Vehicle Power**

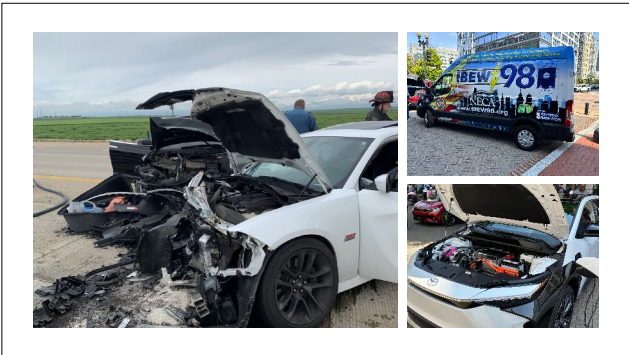
**Battery Power**

**IC Engine Power**

**Fuel Cell**

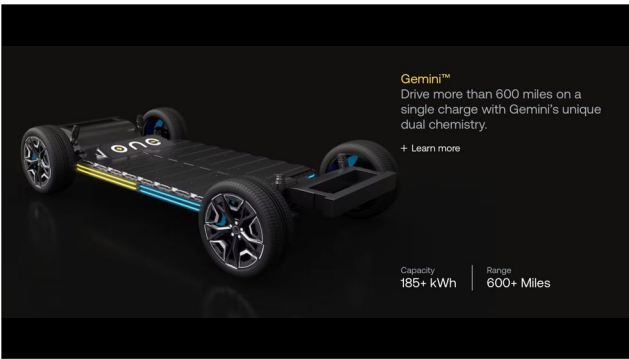
<p><b>Start-Stop Hybrid</b></p> <ul style="list-style-type: none"> <li>Engine start / stop at idle</li> </ul>	<p><b>eAssist (Mild Hybrid)</b></p> <ul style="list-style-type: none"> <li>Engine off/on deceleration</li> <li>Regen braking</li> <li>Electric assist</li> </ul>	<p><b>Hybrid (HEV)</b></p> <ul style="list-style-type: none"> <li>Complete cycle regen braking</li> <li>Electric launch</li> <li>Engine cycle optimization</li> </ul>	<p><b>Plug-In Hybrid (PHEV)</b></p> <ul style="list-style-type: none"> <li>SOC drop during drive</li> <li>Charge via grid power</li> </ul>	<p><b>Extended Range EV (EREV)</b></p> <ul style="list-style-type: none"> <li>Battery only operation</li> <li>Engine on at low SOC or high power demand</li> </ul>	<p><b>Battery Electric Vehicle (BEV)</b></p> <ul style="list-style-type: none"> <li>Large ESS</li> <li>No on-vehicle charge method.</li> </ul>	<p><b>Fuel Cell Electric Vehicle (FCEV)</b></p> <ul style="list-style-type: none"> <li>Energy from stored H2</li> <li>Fuel Cell runs at optimum output</li> <li>ESS buffers power load</li> </ul>
---	--	---	--	--	--	---

SAE INTERNATIONAL









---

---

---

---

---

---

---

---

---

---



---

---

---

---

---

---

---

---

---

---



---

---

---

---

---

---

---

---

---

---













# Response Guides

Visit the manufacture response guides for  
**Vehicle Extrication**  
**Vehicle Fire**  
**Towing**  
**Submerged Vehicle**

**CONTENTS**

0. Emergency Response Sheet	Page 1
1. Identification / recognition	Page 2
2. Immobilization / stabilization / lifting	Page 3
3. Double check hazards / safety regulations	Page 7
4. Access to the accident	Page 11
5. Stored energy / fluids / gases / solids	Page 20
6. In case of fire	Page 23
7. In case of submersion	Page 25
8. Towing / transportation / storage	Page 26
9. Important additional information	Page 28
10. Explanatory pictograms used	Page 29

Page 2 Emergency Response Guide





**IMPORTANT**  
 Rivian believes that electric vehicle fires are best addressed with defensive firefighting and management of the environment to minimize risk. Only attempt to extinguish a fire if you have a specific need to do so.

Perform these steps to extinguish a vehicle battery fire.

1. Wear proper personal protective equipment (PPE) with full SCBA when approaching any vehicle fire.
2. Use a sustained, high-volume water application. A minimum of 1000-1500 gallons (7500-11,000 liters) will be needed. Consider an established water supply, a tender, or additional units to shuttle water to the burning engine.
3. If water is not readily available, use defensive firefighting tactics to prevent the fire from spreading until a clear need to extinguish the fire is identified and water is available. If necessary, use CO<sub>2</sub>, dry chemicals, or other foam extinguishing agents to suppress the fire, for example, to seal cable penetrations, until water is available.
4. Use a thermal imaging camera (TIC) or infrared (IR) to monitor the battery temperature during the cooling process. Look for ambient temperatures at or below 212°F (100°C). The battery still needs to cool down if it is at or above 212°F (100°C).
5. Continue evaluating the battery structure and supply water directly to any exposed areas. Submerge loose battery cells or modules in water for at least 24 hours.

**6. In case of fire**

**Firefighting**

**DO NOT SUBMERGE VEHICLE TO EXTINGUISH/COOL BATTERY FIRE**

**USE LARGE AMOUNTS OF WATER**

**POSSIBLE BATTERY RE-IGNITION!**









**MONITOR HV BATTERY TEMPERATURE FOR AT LEAST 24 HOURS**

USE WATER TO FIGHT A HIGH VOLTAGE BATTERY FIRE. If the battery catches fire, is exposed to high heat, or is generating heat or gases, use large amounts of water to cool the battery. It can take between approximately 3,000- 8,000 gallons (11,356- 30,285 liters) of water, applied directly to the battery, to fully extinguish and cool down a battery fire; always establish or request additional water supply early. If water is not immediately available, use CO2, dry chemicals, or another typical fire-extinguishing agent to fight the fire until water is available.

**NOTE:** Tesla does not recommend the use of foam on electric vehicles.

Apply water directly to the battery. If safety permits, lift or tilt the vehicle for more direct access to the battery (see chapter 2). Water may be applied from a safe distance ONLY if a natural opening (such as a vent or opening from a collision) already exists. Do not open the battery for the purpose of cooling it.

Tesla does not recommend placing the vehicle in a large container full of water. The use of a Thermal Imaging Camera, or Infrared (TIC or IR) is recommended to monitor battery

6. In case of fire	
	High Voltage Warning, potential for electric shock
	A battery on fire will not explode
	A battery on fire will not explode. If battery cells reach high enough temperature, they vent and release electrolyte. Battery electrolyte is flammable.
	Gases emitted from the battery pack are toxic
	Skin contact may cause irritation. Prolonged contact with electrolyte mixture may result in more severe irritation. Flush contaminated skin with plenty of water.
	Potential for eye, nose, and throat irritation with prolonged exposure.
	Use copious amounts of water to cool the battery and to extinguish a fire. Do NOT use an ABC dry chemical extinguisher because it will not extinguish a battery fire.
	Potential for Battery Re-ignition.


## Key items

- Follow the high voltage disconnect procedures.
- When using the high voltage shut down methods high voltage power is typically isolated to the battery.
- The high voltage battery is always energized.

**5. Disable direct hazards / safety regulations**


**ACCESS**

1. Open the Hood Case (chapter 4: Access to the Occupants)
2. Remove the access panel by pulling it forward to release the clips that hold it in place.



**MAIN (DISABLE) METHOD**

1. Disable out the first responder loop and then remove the cut section.
2. Disable the HV battery.



## Defensive Firefighting or Lots of Water

1. Entrapment
2. Compartment vs battery pack
3. Exposures
4. Limited involvement
5. Charger shutdown
6. Vehicle from roll away



---

---

---

---

---

---

---

---

---

---

## When is the Incident Over

- Use thermal imaging camera at battery pack
- Allow to cool for 45-60 minutes
- Post event towing protocol
- Post event storage



---

---

---

---

---

---

---

---

---

---

## Post Incident

Use a thermal imaging camera to ensure that the high voltage battery is completely cooled before leaving the incident. The battery must be **monitored** for at least one hour after it is found to be completely cooled. **Smoke or steam indicates that the battery is still heating.** Do not release the vehicle to second responders, such as law enforcement and towing personnel, until there has been no heating detected for one hour.

---

---

---

---

---

---

---

---

---

---



## Post Incident

- Storage for Police
- Inside or outside
- Fire or just an accident
- Discussion with towing yards
- Recycle?

**7. In case of submersion**


The high voltage battery is isolated from the vehicle chassis. If the vehicle is immersed in water, you will not be electrocuted by touching the vehicle.

After the vehicle was removed from the water, do the following:

1. Allow the vehicle to dry out.
2. Perform the high voltage disabling procedure in Section 3.

**8. Towing / Transportation / storage**

**Tow Hooks**



The vehicle is equipped with two front tow hooks used to pull the vehicle onto a flatbed carrier from a flat road surface.

The vehicle may be equipped with two optional rear tow hooks to pull the vehicle onto a flatbed carrier from a flat road surface.

**Vehicle Towing and Transportation**

General Motors recommends a flatbed carrier to transport a disabled vehicle.

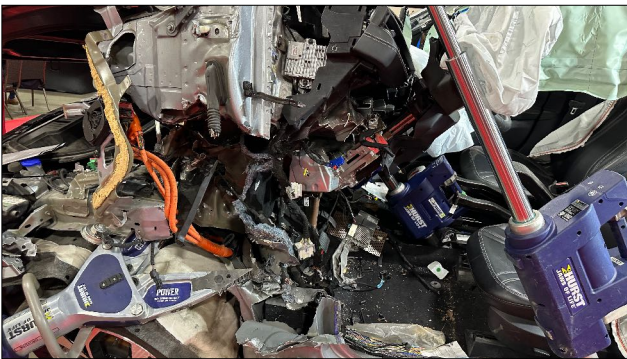
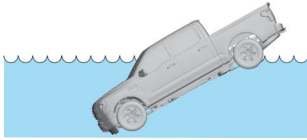
**WARNING: DAMAGED ELECTRIC VEHICLES SUBMERGED IN WATER PRESENT A POTENTIAL HIGH VOLTAGE ELECTRICAL SHOCK HAZARD. EXERCISE CAUTION AND WEAR APPROPRIATE PERSONAL PROTECTIVE EQUIPMENT (PPE) INCLUDING HIGH VOLTAGE SAFETY GLOVES AND BOOTS. REMOVE ALL METALLIC JEWELRY INCLUDING WATCHES AND RINGS. DO NOT ATTEMPT TO EXTRACT THE VEHICLE UNITS. THE HIGH VOLTAGE BATTERY HAS DISCHARGED INDICATED BY THE ABSENCE OF SUBBLING OR FIZZING. FAILURE TO FOLLOW THESE INSTRUCTIONS MAY RESULT IN SERIOUS PERSONAL INJURY OR DEATH.**

If the vehicle is submerged in water, varying degrees of arcing/shorting within the battery will take place. Do not touch any high voltage components or orange cables while removing the occupant(s). Do not remove the vehicle until you are sure the high voltage battery is completely discharged. A submerged high voltage battery may produce a fizzing or bubbling reaction to the water. If fizzing or bubbling is observed, the high voltage battery will be discharged when the fizzing or bubbling has completely stopped. The battery should still be treated as if it is not discharged.

Battery Electric and Hybrid vehicles when submerged should only be handled while wearing the appropriate Personal Protective Equipment (PPE) for water rescue and vehicle extraction.

Vehicles that have been submerged in water may have potential risk of a high voltage electrical battery fire therefore should be handled with increased caution.

Once the vehicle has been removed from the water proceed to the high voltage depower procedure, as outlined in section 3 of this document.





# What should happen

- Are all incidents involving EV the same
- How do we hand off the incident
- Red/Yellow/Green
- Train our first responders for proper handoff to second responders



---

---

---

---

---

---

---

---

---

---

# The EV messaging

EV post incident messaging. CRR-staff are in a key position to utilize expertise in a couple of arenas to aid in success

Many of our business partners will be looking for safety education on proper storage and use of batteries

1. Build strong relationships with Law Enforcement and towing agencies for proper post incident
  - a. Towing considerations
  - b. Storing considerations
  - c. Buy a Thermal Camera
2. Incidents can occur weeks later
3. Incident management more than 30 min
4. Community Charging Push with listed equipment

Lithium Ion Batteries, More than Operations

---

---

---

---

---

---

---

---

---

---

# Charging of EV



---

---

---

---

---

---

---

---

---

---



## Best Practices

Never attempt to charge a HV Battery that has been submerged, is gasping or exhibits signs of external damage  
 Partner with towing/removal agencies

Simple start to training of firefighters  
 Vehicle knowledge, how to shut vehicle down or place in park

Pre-plan charging locations and shut down of equipment

Find response guides

Charging options	LEVEL 1 120 volts	LEVEL 2 240 volts	LEVEL 3 Fast charging
<b>How fast they charge</b>	About 5 miles of range per hour of charging*	About 25 miles per hour of charging*	About 100 to 200+ miles per 30 minutes of charging†
<b>Where they may be located</b>	Your home Possibly at your apartment or workplace	Your home‡ Possibly at your apartment or workplace Public charging stations	Public charging stations
<b>Charge port on vehicle</b>	 J1772  Tesla combo	 J1772  Tesla combo	 CCS  CHAdeMO  Tesla combo

\*Power levels vary among charging equipment; Level 1 estimate of recharging time assumes 19 kilowatts, and Level 2 assumes 6.6 kilowatts.  
 †Charging time may be shorter depending on station power and vehicle. Higher-powered stations that can charge cars more quickly are becoming available, along with vehicle models that can accept the faster charge.  
 ‡Can require expensive rewiring.  
 Sources: Environmental Protection Agency; Con Edison

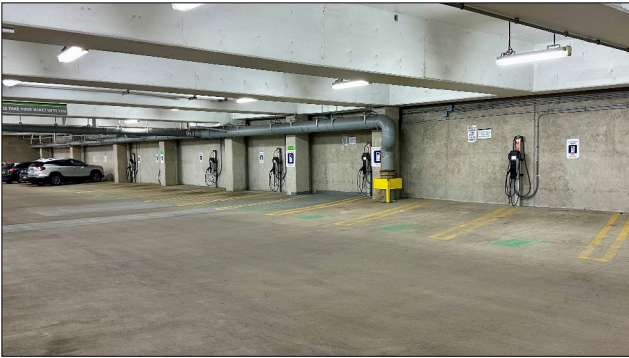


Caption



Caption





---

---

---

---

---

---

---

---

---

---

## Charging Best Practices

Pre-plan data, from single to multi site  
Major change



---

---

---

---

---

---

---

---

---

---

## Residential Charging



- Listed equipment
- Liscensed contractor
- Post incident charging
- What is our role in education (CRR) now in our communities

---

---

---

---

---

---

---

---

---

---

## Public Charging Best Practices

- Protect equipment with stand up curbs, bollards
- Know shut off location in pre-incident planning
- Who is contact for damage equipment
- Proximity to fueling equipment
- Batteries in the equipment, what additional requirements apply?



---

---

---

---

---

---

---

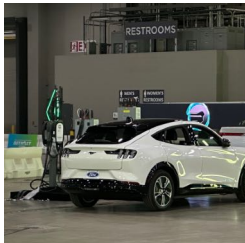
---

---

---

## Indoor Charging

- Residential vs commercial
- Commercial parking vs indoor show, or showroom
- UL Listed equipment, know
- School and other non-vehicle related occupancy
- Shut off, pre plan, and protection
- A bit of silence on fire and building codes, for non-typical charging areas



---

---

---

---

---

---

---

---

---

---

## Boost Charger with 160 kWh Integrated Lithium-ion Battery



---

---

---

---

---

---

---

---

---

---

# Charging

High quality charging equipment in our homes

Commercial occupancies protect the space

1. Charging General
  - a. Post incident, do not charge until evaluated
  - b. Only use listed equipment
  - c. Use a qualified electrician in the home
2. Commercial sites, know the shut offs
3. Support community charging, what happens when there is not
4. Community Charging Push with listed equipment

Lithium Ion Batteries, More than Operations

# Key Takeaways

- Know your jurisdiction
- Enforcement staff must be on the look out for collection points and work to develop safe processes
- Movement of used batteries is all around us
- Watch for signs and observations

# IAFC Response to ESS

Residential Setting vs Commercial or Utility  
Use of pre-incident planning  
Contact manufacture for technical assistance  
Do not enter ESS walk-in units  
Ventilation is key

**IAFC BULLETIN** August 3, 2022

Recommended Pre-Incident Planning for Energy Storage Systems (ESS) Part 1

Always wearing PPE because with lithium ion batteries can be extremely dangerous. All fire crew must follow department policy and rules of staff in response to incidents involving ESS. Emergency responders can be serious and possibly injurious to personnel if inadequate precautions are taken.

The guide serves as a resource for emergency responders with specific public community lithium-ion battery storage systems (ESS) that are not covered by specific regulations. The guide is not intended to be a replacement for local codes and regulations.

**Pre-Incident**

Make an attempt to determine the location of the ESS. If the location is not known, the fire crew should be alerted to the location of the ESS. The fire crew should be alerted to the location of the ESS. The fire crew should be alerted to the location of the ESS.

**INCIDENT ACTIONS**

The primary goal is to remove the battery from the hot spot, being which is a secondary goal. The fire crew should be alerted to the location of the ESS. The fire crew should be alerted to the location of the ESS. The fire crew should be alerted to the location of the ESS.

**Response to a working ESS problem**

If a battery is working, the fire crew should be alerted to the location of the ESS. The fire crew should be alerted to the location of the ESS. The fire crew should be alerted to the location of the ESS.

## Background

2 MW/2.16 MWh lithium-ion battery ESS

- Average home in AZ consumes 1 MWh/month
- ESS owned by local electric utility (APS)
- Batteries manufactured by LG Chem
- ESS designed by integrator (Fluence)
- ESS maintained by contractors to the integrator (Sturgeon)

Four firefighters (Peoria HAZMAT team) seriously injured

Four firefighters (Surprise E304) held overnight for suspected exposure to HCN



Courtesy of APS

Photo's courtesy of APS



# Tesla unveils its giant Megapack battery project in Texas

Fred Lambert | Jan 6 2022 - 12:48 pm PT 0 Comments



## Incident Response

The fire crew should allow the battery to burn itself out, during which it is recommended to apply water spray to neighboring battery enclosures and exposures to further mitigate the spread of the hazards rather than directly onto the burning unit.

Applying water directly to the affected enclosure will not stop the thermal runaway event, as the fire will be located behind several layers of steel material, and direct application of water has shown to only delay the eventual combustion of the entire unit.

## Response Tips

Firefighters must wear full personal protective equipment, including SCBA with face-piece. If identified in pre-incident plan, shut off the unit/system by operating any visible disconnects or E-stops (shutting off the disconnect does not remove the energy from the battery). To isolate any PV system and ESS in an emergency, multiple disconnects may need to be shut off. This could include circuit breakers, knife-blade disconnects, or other switches. Lithium ion batteries that are in thermal runaway or off gasing will create hazardous atmospheres. Firefighters must stay out of the vapor cloud and not rely on gas monitors (without consideration of cross contamination of the gas sensors) Due to construction of the unit, thermal imaging cameras may not give true thermal conditions.



## Venting ESS System

- Evacuate the area. Never open any doors or remove panels to ESS units.
- Contact vendor-specific technical support for assistance including BMS data.
- Residential units that are located inside a dwelling unit or garage, the space should be properly ventilated with charged hand-lines in place.
- Maintain a safe distance from the ESS and monitor. A remote FDC may be present on larger commercial or utility ESS to support a sprinkler system inside the enclosure.
- Each manufacturer will have a recommended time for a battery pack to cool down. This can be near a full work cycle of 12 hours or more.

---

---

---

---

---

---

---

---

---

---

## Defensive Firefighting

- Water spray is the preferred agent for response to lithium-ion battery fires (Lithium-ion is not water reactive).
- If a fire has not developed and only smoke is visible, take a defensive stance toward the system and be prepared to apply water spray.
- If a fire develops, take a defensive stance toward the burning unit and apply water spray to neighboring battery enclosures and exposures.
- Maintaining a safe distance from the unit involved (large commercial systems, at least 300').
- Response crews should allow the battery to burn out. Water should be applied to adjacent battery enclosures and exposures (building).

---

---

---

---

---

---

---

---

---

---

## Patience during response

What is happening

Fire that is treating an ESS installation

Fire that is a result of an ESS installation

Ventilation is key (Basement/Garage Installations)

Cool exposures

Get resources at our finger tips

Time

---

---

---

---

---

---

---

---

---

---

# What is in the Response guide?

- 1 Introduction and Scope..... 2
- 2 Company, Contact, & Hazard Precautions.....17
- 3 Handling, Use, & Hazard Precautions.....17
- 4 In Case of Emergency.....21
- 5 Firefighting Measures.....25
- 6 First Aid Measures.....28
- 7 First Aid Measures.....28
- 8 Storage Precautions.....29
- 9 Damaged Product Handling.....30
- 10 Disposal Procedures.....31
- 11 Maintenance or Repair.....32
- 12 Transportation.....33
- Revision History.....34



Lithium-Ion Battery Emergency Response Guide  
For Tesla Energy Products Powerwall, Powerpack, and Megapack

Revision 23 © Copyright 2022 TESLA INC. All Rights Reserved.

### 5 Firefighting Measures

**WARNING:** Response should only be performed by trained professionals, in the event of a response to a fire involving the product, contact Tesla Sales, Tesla Technical Support for guidance (see Identification of Company and Contact Information on page 8).

**5.1 Responding to a Venting Tesla Energy Product**  
 Periods of electrical arcing involving Tesla Energy Products can be hazardous to an operator and potentially a condition. If any electrical arcing is observed for a period of minutes, the arcing is likely to have become a fire. The fire can spread to other electrical components of a system and potentially Tesla Energy Products or any other fire involving the following should be performed:

1. Evacuate **all** of the system area (see Identification of Company on page 8).
2. Activate the area.
  - WARNING:** When responding to a fire with the Megapack System, do not approach the Megapack units from the front door as it may have an open door. Do not approach the front door of any Megapack unit until the fire is extinguished. Do not approach the front door of any Megapack unit until the fire is extinguished.
  - WARNING:** When responding to a fire with the Megapack, do not approach the unit and attempt to open the door. The door is designed to remain closed until the fire is extinguished and the door is opened by trained personnel.
3. Find a nearby fire-rated Tesla Energy Technical Support for assistance (see Identification of Company on page 8).
4. Maintain a safe distance for the unit and monitor (see Identification of Company on page 8) for extended periods of time.
- WARNING:** There may be a risk of up to 3 hours of a fire during which the thermal runaway products may be ejected from the battery. Avoid such work. The battery may not provide the signs of thermal event although the word "off" is visible and the battery can function.
  - a. If a fire has developed and units are in a fire, take a defensive stance toward the system and do not attempt to enter until the fire is extinguished.
  - b. At the fire location:
    - Continue to take a defensive stance toward the burning unit. Apply water to the ground and not to the unit to reduce temperature (see Identification of Company on page 8).
    - Avoid fire, apply water to neighboring battery enclosures. If containment cannot be maintained with this, apply water to the adjacent fire enclosures.
    - At the discretion of fire responders, apply water to other neighboring enclosures.

5. Allow the battery pack to cool down for a minimum of 12 hours after all fire and smoke have visibly dissipated.

### 6 Firefighting Measures

**6. Monitor the temperature of the battery pack using a thermal imaging camera to determine if a safe environment exists.**

7. Contact Tesla Energy Technical Support for assistance (see Identification of Company and Contact Information on page 8).

**5.2 Defensive Firefighting**  
 Tesla recommends that a Tesla Energy Product fire be fought by a fire crew should maintain a safe distance of at least 100 feet (30.5 meters) from the front door of the unit.

- 50 ft from Powerwall
- 50 ft from Powerpack
- 20 ft from Megapack

**WARNING:** Cautioning the combustibility of the front door as location of the burning battery will depend on the location of the front door. A safe distance may be higher than those listed above.

**WARNING:** Cautioning the combustibility of the front door as location of the burning battery will depend on the location of the front door. A safe distance may be higher than those listed above.

As outlined in the procedure above, the fire crew should allow the battery to burn itself out. To further mitigate the extent of the fire, the fire crew should use the front door of the unit to apply water to the front door and the surrounding area. The fire crew should use the front door of the unit to apply water to the front door and the surrounding area. The fire crew should use the front door of the unit to apply water to the front door and the surrounding area. The fire crew should use the front door of the unit to apply water to the front door and the surrounding area.

**WARNING:** Do not approach the front door of the unit until the fire is extinguished. Do not approach the front door of the unit until the fire is extinguished. Do not approach the front door of the unit until the fire is extinguished.

**WARNING:** Do not approach the front door of the unit until the fire is extinguished. Do not approach the front door of the unit until the fire is extinguished. Do not approach the front door of the unit until the fire is extinguished.

Water spray has been observed to act as a coolant for an adjacent Tesla Energy Product. Water is not used to extinguish the fire. The fire crew should use the front door of the unit to apply water to the front door and the surrounding area. The fire crew should use the front door of the unit to apply water to the front door and the surrounding area. The fire crew should use the front door of the unit to apply water to the front door and the surrounding area.

A battery fire may continue for several hours and it may take 24 hours or longer for the battery pack to cool after it has been fully extinguished by a thermal imaging camera after all fire and smoke have visibly dissipated for at least 12 hours in a room or hallway. Camera can be used to actively measure the temperature of the unit and determine if it is safe to touch.

**5.3 Firefighter PPE**  
 Firefighters should wear and use Personal Protective Equipment (PPE) as outlined in the identification of company. Firefighters should wear and use Personal Protective Equipment (PPE) as outlined in the identification of company. Firefighters should wear and use Personal Protective Equipment (PPE) as outlined in the identification of company.

# Best practices for Installation

- Follow the most current edition of the IFC 2021 and NFPA 855
- Require UL 9540 and UL 9540A testing per most current standard
- Training and support of fire services





## Response Changes

- Victoria Big Battery Project
- Initial testing July 30, 2021
- Consumed 2 mega packs
- leak with cooling system
- exposure control by responding fire department

---

---

---

---

---

---

---

---

---

---

## PGE, Tesla Megapack at Elkhorn Battery at Moss Landing

- Tuesday that two companies and four fire engines responded to the incident starting around 1:40 a.m.
- The fire fighters used hydrants and water supply installed at the facility, and worked to prevent flames from spreading to adjoining batteries and structures in the larger system. By around 11:00 a.m. local time, fire fighters shut the water off but some were staying on location overnight to ensure that the system did not re-ignite.
- **"We let the initial Megapack burn out,"** he explained as per protocols recommended by PG&E and Tesla to the fire department. "It's too early to know what was the cause of the fire," he added, but an investigation will follow in coming weeks.

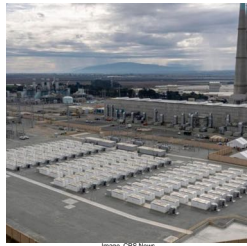


Image: CBS News

---

---

---

---

---

---

---

---

---

---

## Decommissioning Plan

- Overview of the process specific to the ESS
- Roles and responsibilities of those involved
- Means and methods
- Plans and specifications necessary to understand the operation and safety controls will be maintained
- Checklists

---

---

---

---

---

---

---

---

---

---



Battery Storage Code History

2012-2015 International Fire Code and NFPA 1 Fire Code

- Stationary Storage Battery Systems
- No significant changes

2018 International Fire Code and NFPA 1 Fire Code

- Electrical Energy Storage Systems
- Extensive re-write
- Cycling as compared to stand-by
- Recognition of hazards of Lithium-ion thermal runaway



Battery Storage Code History

2012-2015 International Fire Code and NFPA 1 Fire Code

- Stationary Storage Battery Systems
- No significant changes

2018 International Fire Code and NFPA 1 Fire Code

- Electrical Energy Storage Systems
- Extensive re-write
- Cycling as compared to stand-by
- Recognition of hazards of Lithium-ion thermal runaway



Code Development Timelines

- 2018 IFC - June 2015 to October 2016
- 2018 NFPA 1 - June 2015 to October 2016
- NFPA 855 - January 2017 to September 2018
- 2020 NEC - January 2018 to February 2019
- 2021 IFC - March 2017 to October 2018



- 2020 NFPA 855 and 2021 International Fire Code
  - **Electrical Energy Storage Systems**
  - Extensive re-write recognizing additional installation locations
  - **No longer an incidental use. All indoor installations require 2-hour separation**



## 2024 IFC SECTION 1107 ENERGY STORAGE SYSTEMS

**1107.1 Lithium-ion technology energy storage systems.** The owner of an energy storage system (ESS) utilizing lithium-ion battery technology having capacities exceeding the values in Table 1207.1.1 and that was installed prior to the jurisdiction's adoption of the 2018 or later edition of the International Fire Code shall provide the fire code official a failure modes and effects analysis (FMEA) or other approved hazard mitigation analysis in accordance with Section 104.8.2 for review and approval.

Exception: Detached one- and two-family dwellings and townhouses.

**1107.1.1 Early detection.** In addition to the requirements of Section 1207.1.4.1 and 1207.1.4.2, the analysis shall include an assessment of the ability of the installed protection systems to provide for early detection and notification of a thermal runaway event in relation to the ability of emergency responders to safely mitigate the size and impact of a thermal runaway event.

**1107.1.2 Corrective action plan.** Where hazards are identified by the analysis, a plan that includes a timetable for corrective action shall be submitted to the fire code official for review and approval. The plan shall include actions and system improvements necessary for eliminating or mitigating any identified hazards, including listed methods for early detection and notification of a thermal runaway event.



### What should be submitted?

**1207.1.3 Construction documents.** The following information shall be provided with the permit application: ...

- 1207.1.4 Hazard mitigation analysis (If required)
- 1207.1.5 Large scale fire test. (If triggered)

**1207.2 Commissioning, decommissioning, operation and maintenance.** Commissioning, decommissioning, operation and maintenance shall be conducted in accordance with this section.

- 1207.2.1 Commissioning
- 1207.2.3 Decommissioning.







## What about better use of our batteries?

---

---

---

---

---

---

---

---

## Codes and Standards

- Manufacture, storage of lithium ion batteries has been limited in current codes and standards.
- 2024 editions of International Fire Code, International Building Code begin to provide requirements for storage, manufacture of lithium ion batteries
- Energy Storage systems (ESS) have comprehensive requirements found in the 2018/2021 IFC and in the last two edition of NFPA 855

---

---

---

---

---

---

---

---

## Best Practices

- Submission of changes through alternate means and methods (utilizing the changes found in the 2024 fire and building codes)
- Laboratory, work, storage, manufacture only in buildings provided with automatic sprinkler protection
- Additional requirements for smoke sensing and/or thermal detection on an approved alarm system

---

---

---

---

---

---

---

---

# Stop the Secondary Event

- Time after incident, how long?
- What is our role with third party recycling and storage
- Process for removing stored energy developed in our processes and procedures

---

---

---

---

---

---

---

---

# What is Your Plan?

- Develop a culture of safety, where accidents and one offs are reported and evaluated
- Do not underestimate the potential of these fires
- Based on processes what safe guards do you need?
  - Sprinkler system match the storage configuration or use
  - Fire Extinguisher use
  - Storage in approved containers
- What is your state of charge?
- What about exterior storage?
- Ventilation concerns?

---

---

---

---

---

---

---

---

## Involvement of LiB in fires and confinement of unburned battery gas create new hazards for home occupants and the fire service.

Potential sources of battery gas:

1. E-mobility devices
2. Electric vehicles
3. Energy storage systems, stationary and portable
4. Battery storage cabinets



---

---

---

---

---

---

---

---



---

---

---

---

---

---

---

---

---

---



---

---

---

---

---

---

---

---

---

---

**Fire Investigation**



---

---

---

---

---

---

---

---

---

---

# What's Next?

- Changing technologies
- Increased demand
- Desire for continuous up time
- Changes in manufacture process as was a limited group and now growing
- Ability to provide information and increase in technical reports

---

---

---

---

---

---

---

---

---

---

**2023 FIREFIGHTER SAFETY STAND DOWN**

ABOUT RESOURCES PLANNING PARTNERS SUCCESS STORIES

### Safety Stand Down 2023

#### Lithium-ion Battery Response

The 2023 Safety Stand Down focuses on responder safety during incidents involving lithium-ion batteries. Training materials and resources are available. Stay tuned in the coming months as more will be added.

[Access Resources](#)

#### SAFETY STAND DOWN QUIZ

Test your knowledge of this year's theme of lithium-ion battery response. 200 quiz takers will win a limited-edition Safety Stand Down challenge coin, courtesy of NFPA.

[Coming soon!](#)

---

---

---

---

---

---

---

---

---

---

**Michael O'Brian**

[mobrian@codesavvyconsultants.com](mailto:mobrian@codesavvyconsultants.com)

810-459-0116



---

---

---

---

---

---

---

---

---

---