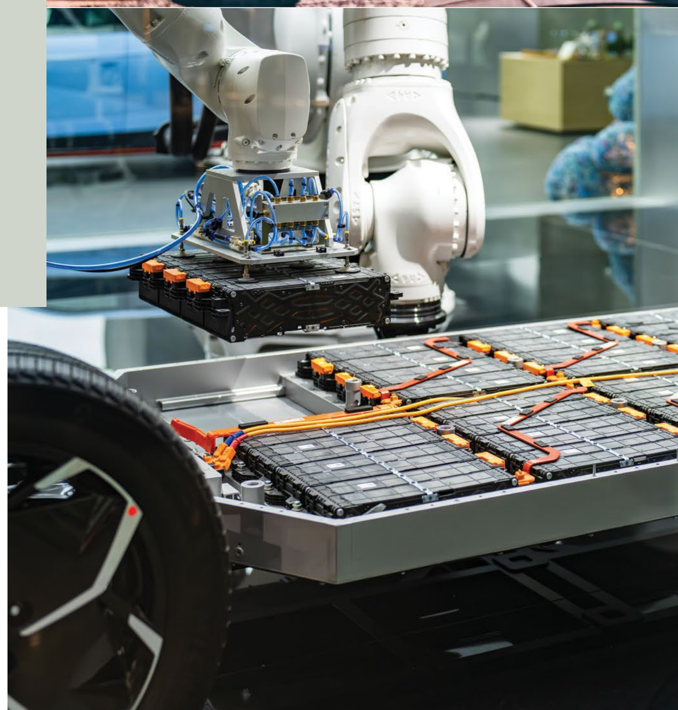
AD-HOC BATTERY AND ENERGY STORAGE SYSTEMS (AH-BES)

COMMITTEE REPORT



April 2025

ICC FAMILY OF SOLUTIONS

EXECUTIVE SUMMARY

Emerging technology and its intricate relationship with building and fire codes have always posed significant challenges for users of codes and standards. The rapid pace of advancement in lithium-ion battery technology has left architects, engineers, construction professionals, first responders, subject matter experts and code officials struggling to keep up. In response to this challenge, the International Code Council (ICC) devised a strategic approach to identify gaps in the built environment that pertain to the use, manufacturing, storage, testing and recycling of lithium-ion batteries and stored energy. The resulting analysis will serve as a roadmap and valuable resource for the code community, particularly as the model codes work to keep pace with rapidly evolving energy technologies.

Over the past two code development cycles, the collaborative efforts of ICC Code Action Committees and various Code Development Committees have established and enhanced a minimum level of battery safety across the built environment. This progress is evident in the 2024 suite of International Codes® (I-Codes) including the *International Fire Code® (IFC), International Building Code® (IBC) and International Residential Code® (IRC)*.

A primary challenge remains in updating the codes with research and science-based building safety information corresponding with the pace of the ever-evolving nature of technology related to the energy storage systems (ESS). Striking a balance between codes, standards, education, science and data while addressing emerging issues, trends and hazards is crucial.

The work of this committee has been rapid and thorough. It will help ensure that the built environment continues to adapt to the emerging hazards associated with batteries and energy storage.

Michael O'Brian
Battery & Energy Storage Committee Chair

PREFACE

Established by the ICC Board of Directors, the Ad-Hoc Battery and Energy Storage Committee (AH-BES) explored how building safety is impacted by the manufacturing, storage, use and recycling of batteries and ESS. The committee identified increased risks to the built environment and pinpointed gaps in codes and standards needing to be addressed to strengthen building, fire and life safety requirements for batteries and ESS.

The committee identified code gaps and areas of change to the ICC Board of Directors related to relevant codes and standards. Upon completion of its stated objectives, the committee submits this final report of its activities and findings to the Board.

AH-BES Committee Objectives

1. Research, analyze and publish findings regarding how the manufacture, storage, use and recycle of batteries and ESS influence building safety.
2. Prepare and submit an initial report of activities and findings to the ICC Board of Directors within three months of the first meeting of the committee.
3. The initial report of activities and findings shall include a series of outcomes and criteria deemed necessary to successfully accomplish and conclude the activities of the committee.
4. Prepare and submit quarterly briefings for the ICC Board.
5. Identify and recommend areas of change to the ICC Board for relevant codes and standards.
6. Upon completion of stated objectives, prepare and submit a final report on the activities and findings of the committee to the ICC Board of Directors.

AH-BES Committee Composition

The committee was composed of a broad cross section of experts representing the building industry, building owners and facility managers, fire and building code officials, engineers, architects and standards development organizations.

The committee's diverse background and interest brought strength to the development of this report. Due to the wide range and complexity of issues, the committee and interested parties were broken into four workgroups to provide focus for their research. The workgroups were (1) Personal Mobility and Electric Vehicles, (2) Commercial and Utility-Based ESS, (3) Residential Energy Storage Systems and (4) Manufacturing, Storage and Recycling.

Workgroup research and data served as the basis for a gap analysis of the I-Codes and recommended actions to address the gaps. This report provides insights for consideration related to the complexities of this evolving segment of the built environment and the associated complexities impacting the safety related to the pace of its evolutionary nature. It further provides focus to inform ICC's next steps to effectively support the industry in the areas where ICC is best positioned to assist this global effort. ICC, and its strong base of committed expert committee members, brings strength and leadership to this area through partnerships, education and media presence that can significantly contribute to bridge these gaps.

AD HOC COMMITTEE ON BATTERY AND ENERGY STORAGE SYSTEMS (AH-BES)

Committee Members:

O'Brian, Michael (Chair)	Fire Chief, Brighton Area Fire Authority/International Association of Fire Chiefs (IAFC)
Kerchner, George (Vice Chair)	Executive Director, PRBA – The Rechargeable Battery Association
Anwar, Abid	Regulatory Engineer, Tesla Motors
Ayers, Scott	Fire Program Area Manager, Consumer Product Safety Commission (CPSC)
Barowy, Adam	Research Engineer, UL Fire Safety Research Institute (FSRI)
Bartlett, Nicholas	Fire Marshal, National Renewable Energy Laboratory (NREL)
Baughman, Brian	Midwest Technical Field Representative, National Electrical Manufacturers Association (NEMA)
Brigmon, Todd	Electric Vehicle Occupational Safety Team Leader, General Motors
Bush, Kenneth	Fire Protection Engineer, Maryland State Fire Marshal's Office
Davidson, Bob	Managing Partner/Code Consultant, Davidson Code Concepts
DeCrane, Sean	Director, Health and Safety - International Association of Fire Fighters (IAFF)
Dunkel, Jeff	Fire Protection Engineer, National Fire Sprinkler Association (NFSA)
Fok, Kevin	Director of Compliance, LG Energy Solution Vertech, Inc
Gao, Ningshengjie	Engineer, FDNY Bureau of Fire Prevention
Javorka, John	Deputy Commissioner, Fire Protection Bureau, City of Chicago
Koffel-Sr., Bill	Director, Special Projects, California Solar & Storage Association (CAL SSA)
Labriola-Cuffe, Luci	Deputy State Fire Administrator, NY Department of Homeland Security and Emergency Services
Maughmer, Cameron	Building Official, De Soto, Kansas
O'Connor, Brian	Fire Protection Engineer, National Fire Protection Association (NFPA)
Orlowski, Steve	Founder/CEO, Sundowne Building Code Consultants, LLC (SBCC) - Representing NAHB
Rogers, Paul	Battery Energy Storage Systems Specialist, Energy Safety Response Group
Sehlmeyer, Kevin	State Fire Marshal, State of Michigan/National Association of State Fire Marshals
Sujeski, Crystal	Chief, Code Development & Analysis, CAL FIRE Office of the State Fire Marshal

International Code Council:

Hampton, Ron	Board Member/Board Liaison
Metz, Randy	Board Member/Board Liaison
Reed, Christine	Fire and Disaster Mitigation Program Manager (Lead Committee Coordination)
Fippinger, Karl	Vice President - Fire and Disaster Mitigation (Lead Staff SME Fire)
Stenger, Kristopher	Director of Energy Programs (Lead Staff SME Energy)
Manning, Russ	Senior Vice President - Technical Services (Secretariat)

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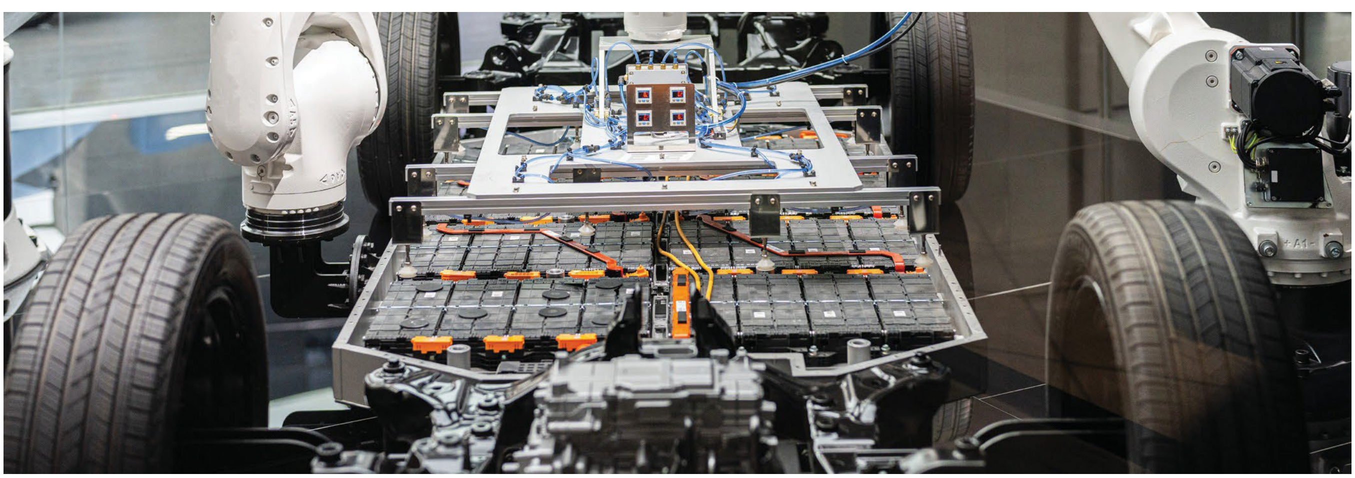
CHAPTER 1 – INTRODUCTION

Emerging technologies can be difficult to enforce using adopted building and fire codes if the adopted codes do not address such technology. From delays in code adoption by governing bodies to the limitations of supporting science, emerging technologies can be challenging for currently adopted codes and standards to address. In the case of lithium-ion batteries, the complexity increases due to the rapid development and use of the product as well as working to understand the hazards associated with the technology. These hazards arise in numerous areas including battery manufacturing, use for energy storage or mobility devices and collecting batteries at end-of-life for recycling. Developing an understanding of the associated hazards which can be present as well as developing minimum safety requirements has proven complicated.

The use and manufacturing of batteries is not a new concept with the involvement of codes and standards. For some time, traditional battery chemistries have served to power industrial equipment, provide back-up power and much more. Facilities which have been used to manufacture, store and use batteries have drastically expanded. Therefore, the use of current model codes is critical in ensuring success and consistent implementation of emerging technologies. Manufacturers, installers and code officials rely on code requirements to maintain reliability in creating, using and maintaining a safe building environment for occupants and the communities. By extension, retailers and consumers expect a minimum standard of protection and education of best practices, proper use and maintenance of these new technologies.

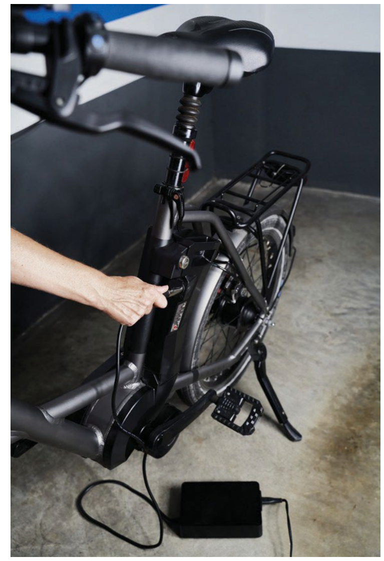
"The changing built environment and developing current codes, standards, resources and training are vital to our code officials across the globe" said Michael O'Brian, Committee Chair. "The use of modern codes and standards is vital for our communities in ensuring the built environment is safe in the places we live, work and visit."

Our daily lives are increasingly dependent on rechargeable batteries, much of which is powered by lithium-Ion batteries. From personal electronics to mobility devices, and the need for consistent power, the consumer demand for reliable stored energy is drastically increasing. These needs are further increased by the desire for more clean energy in our automotive sector as well as the growing demand for improvements to our utility systems and the desire for more stored energy.



In the early 2000s, the U.S. automotive sector began development of lithium-ion technology to power private and commercial vehicles. This expanded the role of batteries throughout our built environment in many areas, including their manufacture and use, from the needs of laboratory space for development and testing of a battery cell's abilities, to large and small production and storage.

Many authorities having jurisdictions (AHJs) saw these as a one-off and limited application. However, as time has passed, the use of lithium-ion batteries has expanded and has become more pervasive in everyday life and through many areas of the built environment. This includes, but is not limited to, battery energy storage systems for commercial and residential buildings, portable back-up power units and personal micro-mobility and telephone devices. New technologies and battery chemistries continue to be developed, challenging manufacturers, code officials and consumers to stay current in operational best practices of this growing and complex technology.



As increased development, manufacture and use of batteries goes on into the future, attention to storage, handling, disposal and recycling of new and aged battery units is crucial. This attention is focused to ensure health and safety in the built environment and develop future code considerations that address battery chemistries and technologies.

Lithium-Ion Definition and Design

According to UL Research Institute [1], a lithium-ion battery uses rechargeable battery technology consisting of multiple lithium-ion cells electrically connected within a protective casing. When a battery discharges energy, lithium ions within each cell move between internal current collectors, creating electrical current. When a battery charges, it receives energy from an external source and stores it as electrical potential energy waiting to be used. The IFC defines lithium-ion battery as a ”storage battery with lithium ions serving as the charge carriers of the battery. The electrolyte is a polymer mixture of carbonates with an inorganic salt and can be in a liquid or a gelled polymer form. Lithiated metal oxide is typically a cathode, and forms of carbon or graphite typically form the anode.” [2]

It is important to look at why lithium-ion battery failures can create a different hazard than other occupancy uses. Lithium-ion batteries can fail for many reasons including improper manufacturing, damage to the battery such as thermal abuse or mechanical abuse and in some cases, due to improper charging or power to the devices. Lithium-ion battery failure may be caused by either an internal or external condition. Internal failure is a result of a short circuit within the cell, called thermal runaway. External failure may be caused by incompatibility between the battery and a connected charger, damage to the battery or extreme heat or cold. An ensuing failure causes cell chemical off-gassing, very high temperatures, smoke and fire. When batteries fail there can be little or no early indications of failure. Typical signs of failure can include off-gassing (smoke) and/or flames. When one cell fails as part of a battery pack, it could create an uncontrolled chain reaction where additional cells are damaged and then have a thermal event of their own. The gas that is produced as part of a thermal event is typically flammable in most cases.

The quality of cell and pack design over the last five years has drastically increased. The manufacturing community has provided many safeguards for battery equipment. This can include different cell designs of chemistry types, battery pack design or the role of a battery management system, all with the goal of increasing battery safety.

The rapid development of this technology, with the decreasing costs have proven to be beneficial in aiding with many energy goals across the world.

Federal and State Support on Battery Infrastructure

At the federal level, the Bipartisan Infrastructure Law [3] that was signed into law by President Biden on November 15, 2021, directs the U.S. Department of Energy (DOE), through the Office of Manufacturing and Energy Supply Chains (MESC), to develop a diversified portfolio of projects to help deliver a secure battery manufacturing supply chain in the U.S. As part of the Battery Materials Processing and Battery Manufacturing and Recycling Program [4], the DOE is enabling $16 billion in total investment for battery manufacturing, processing and recycling. These projects are intended to bolster a domestic supply chain and enhance U.S. energy security and economic competitiveness.

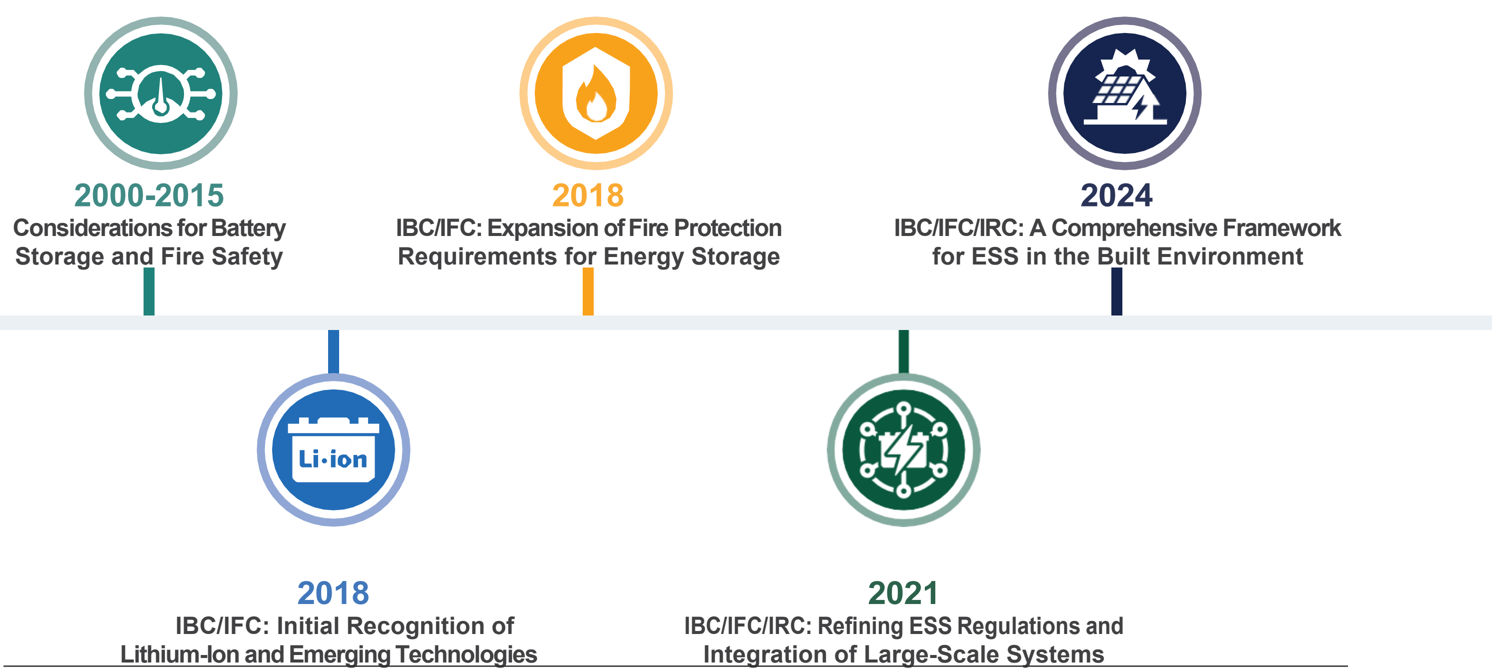
There is also enormous growth in battery energy storage systems throughout the U.S., particularly in New York and California. In New York, the state's Public Service Commission recently approved a new framework to achieve six gigawatts (GW) of energy storage by 2030, which doubles the energy storage goals established in 2018 and represents approximately 20 percent of the peak electricity load of New York. In California, the stated goal is to transition to 100 percent clean energy by 2045. The California Energy Commission (CEC) website [5] tracks statewide information on more than 122,000 residential, commercial, and utility-scale battery installations. The Agency is also tracking 1,900 megawatts (MW) of energy storage projects expected to be online by the end of the year for a total of 8,500 MW.

New lithium-ion battery manufacturing facilities and recycling facilities have recently been constructed or are in the process of being constructed in the following states: Alabama, Arizona, California, Georgia, Illinois, Indiana, Kansas, Kentucky, Michigan, Mississippi, Nevada, New York, North Carolina, Ohio, Oklahoma, South Carolina and Tennessee. The growth of the lithium-ion battery market in the U.S. coincides with the global demand for these batteries. Market data shows that each year from 2010 through 2020, the worldwide sale of rechargeable lithium-ion batteries increased by no less than 25 percent. [6]

Code Development

The International Code Council, through its membership, code action committees and the code development process, has rapidly developed the I-Codes since the 2015 editions of the IRC, IBC and IFC as battery chemistries and technologies evolved and advanced throughout the country. [7]

ESS Development Time frame



2000-2015
Early Considerations for Battery Storage and Fire Safety

- Prior to 2018, codes primarily addressed traditional lead-acid battery systems, with limited provisions for emerging lithium-ion and advanced battery chemistries.
- The 2015 IFC included general battery system safety provisions, primarily for stationary lead-acid storage.
- As lithium-ion and other high-energy-density storage technologies gained traction, fire protection concerns around thermal runaway, explosion hazards, and emergency response started surfacing in the industry.

2018
IBC/IFC: Initial Recognition of Lithium-Ion and Emerging Technologies

- The 2018 IFC introduced some of the first requirements distinguishing lithium-ion and other newer battery chemistries from traditional lead-acid systems.
- These updates began addressing fire suppression, ventilation, and separation requirements but lacked a comprehensive framework for ESS fire risk mitigation.
- Research and real-world fire incidents (such as failures in electric vehicle battery storage applications) began to inform regulatory discussions.

2018
IBC/IFC: Expansion of Fire Protection Requirements for Energy Storage

- The 2018 IFC Chapter 12 was significantly expanded to include specific provisions for energy storage systems, marking the first substantial integration of dedicated ESS regulations.
- Key requirements included:
  - Size and capacity thresholds for ESS installations.
  - Fire suppression and thermal runaway mitigation strategies.
  - Separation distances and clearance from structures.
  - Firefighter safety provisions, including emergency shutoffs.
- This code cycle also recognized the emerging role of UL 9540 listing as key standards for evaluating battery energy storage system (BESS) fire behavior.

2021
IBC/IFC/IRC: Refining ESS Regulations and Integration of Large-Scale Systems

- The 2021 IFC saw significant refinements to energy storage fire safety provisions based on real-world fire testing and updated research.
- Notable advancements included:
  - Expanded use of UL 9540A testing for thermal runaway risk assessment.
  - Updated spacing and fire protection criteria for large-scale installations in commercial and industrial applications.
  - New emergency planning and response provisions to ensure safer operations for fire service personnel.
  - Refinements to indoor and outdoor ESS siting criteria, including specific considerations for rooftop and multi-family residential deployments.
- The 2021 IFC also introduced structural requirements for ESS installations in buildings, ensuring fire-rated construction, ventilation, and accessibility for maintenance. The 2021 IFC and IRC included extensive requirements for detached one- and two-family dwellings and townhouse units.

2024
IBC/IFC/IRC: A Comprehensive Framework for ESS in the Built Environment

- The 2024 IFC builds on past progress by further refining thermal runaway prevention strategies and requiring detailed fire and explosion risk assessments based on ESS chemistry and configuration.
- The IFC 2024 updates ensure that building-integrated energy storage installations adhere to clear structural, electrical, and fire protection requirements.
- The IRC 2024 introduces new provisions for residential energy storage, addressing:
  - Location restrictions (e.g., prohibiting ESS in sleeping areas or near exits).
  - Integration with renewable energy systems (e.g., solar PV and battery backup).
  - Enhanced safety measures for attached garages and living spaces.
  - Additional refinements align international codes with evolving standards such as NFPA 855 (Standard for Installation of Stationary Energy Storage Systems).

Core considerations with codes and standards have strived to provide a minimum level of fire and life safety. Basic codes aim to prevent fires and other issues which can arise during the use of the built environment (i.e. occupancy requirements, staff training and listing of electrical equipment). This includes the basic concepts of building safety during an emergency. When fires or other emergencies arise, our codes and standards work to keep incidents small using protectives like active fire protection systems, fire separations or various types of alarm devices. Therefore, the code community has had a vested interest in understanding the effects of codes as part of a failure analysis. When incidents occur, many in the code development community strive to understand which codes and standards were used in the protected premise at the installation or time of the incident.

A prime example of how an incident involving batteries and/or an ESS was evaluated for intended future actions through the code development process is the Surprise, Arizona incident. On April 19, 2019, around 5 pm local time, the local fire department of Surprise, Arizona received phone calls for smoke from a building. Upon investigation, it was found the building was an energy storage system facility under the operation of APS known as the McMicken site. After approximately three hours into the incident, the door to the facility was opened by firefighters causing an explosion that greatly injured two firefighters and threw them through a chain link fence and approximately 75 feet away from the building. [8]

This incident has been used as supporting evidence in the development of the 2021 I-Codes and has served as a reminder of how dangerous new battery technologies can be without proper building and safety protection, and understanding of the risks associated with their use. [9]

Beyond Energy Storage Systems, Evolving Codes

With the development of the 2024 IBC and IFC [2], a series of changes were approved as part of the code development process (see Appendix C for associated 2024 I-Code related references). This necessary code language provided needed clarification on the various occupancy use and classification in the IBC. The addition of many new facilities required the user of the code to properly classify the various occupancies and how batteries could affect the occupancy type and have been instrumental in designing, inspecting and developing facilities across the world.

The work continued to develop a series of changes which include:

1. Added multiple definitions to cover the various new terms associated with batteries.
2. Changes to special detailed requirements based on occupancy and use to include motor vehicle charging stations and systems and public parking garages.
3. Changes to automatic sprinkler system requirements for the various occupancy use and classification where lithium-ion and lithium-metal batteries are present.
4. Clarification on large scale fire testing to support the design of automatic sprinkler systems in certain occupancies with lithium-ion and lithium-metal batteries.
5. Added requirements for detection and alarm notification in many occupancies where lithium-ion batteries and lithium-metal batteries are stored, tested, sold, recycled and assembled.
6. Multiple revisions to Chapter 3 of the IFC to cover powered industrial trucks and equipment and powered mobility devices.
7. Added requirements for lithium-ion and lithium-metal battery storage.
8. Added needed language to include emergency and mitigation response planning in our various occupancy classes.

The use of current codes is rapidly evolving in many areas, where other initiatives have limited the application of current codes. The State of California has seen a rapid increase in energy storage systems as well as many facilities in the battery ecosystem. Through their code development process, many of the battery provisions were adopted as part of the intervening code cycle and incorporated in the 2022 California Building Code and 2022 California Fire Code.

Application of modern codes related to batteries has proven beneficial to not only meet minimum safety requirements, but it has served as a commonly accepted rule set for many uses, allowing for standard practice. Unfortunately, many code officials have been unaware of the new code provisions as well as the ability to use Chapter 1 for adopting rules or providing reasonable safeguards when adopted codes do not include minimum requirements.

CHAPTER 2 – GAP ANALYSIS

Overview

The AH-BES committee has received multiple presentations, including an update on the ICC family of solutions related to recent code development of lithium-ion and lithium-metal batteries. This update included a detailed review of changes from the 2018 IBC and IFC to the 2021 editions. [9]

The work completed by the ICC Fire Code Action Committee (FCAC) during the ICC development cycles was instrumental in leading the overall code community to begin to address the changing built environment. This work continued to include the changes found in the 2024 IRC, IFC and IBC, and is continuing through the 2027 code development process with multiple changes submitted in the Group A cycle of the ICC Code Development process. [9,7]

These code documents not only address the use of stored energy products but began to address the built environment on the use of buildings that now included use, manufacture, laboratory, storage and assembly. Appendix C highlights the many changes that have been developed through proactive work by the ICC Code Action Committees as well as the ICC membership.

The AH-BES committee also reviewed other regulations affecting the national battery space. This included a general understanding of transport regulations affecting completed batteries and personal electronics, the impact of guiding documents by the Society of Automotive Engineers (SAE) and similar work completed by the National Fire Protection Association (NFPA) and their technical committee on energy storage systems.

Research

From universities to UL's Fire Safety Research Institute, there are many research projects related to lithium-ion batteries that have been completed as well as are under development. There is no doubt that additional study is needed on the effects of lithium-ion batteries on the built environment.

Post Disaster Consideration

The role of code officials also includes the need for involvement after a disaster. The use of lithium-ion batteries in our homes, as energy storage or as the power source for our vehicles, can create a need for early identification in post incident mitigation and evaluation. Containment, collection and disposal of batteries impacted by a disaster, especially involving fire or flood, takes much care and consideration as part of the response and recovery phases of disaster management. Training responders and managers to stay current in codes, regulations and best practices of battery handling is critical to maintain community awareness and safety.

Approach

Within the AH-BES committee, four working groups were established to evaluate specific focus areas of battery and ESS. Committee members and interested parties joined one or more work groups, all of whom met at least monthly and followed guidelines outlined in the work group's charter document. All work groups accessed a shared electronic document repository program to keep working documents, research information and meeting notes.

The four work groups:

1. Personal Mobility and Electric Vehicles
2. Residential Energy Storage Systems

3. Commercial and Utility-Based ESS
4. Manufacturing, Storage and Recycling

The approach of the committee and it's work groups for following the committee's guiding scope included:

1. Gather and review relevant information currently out in distribution. This may include resources, white papers and other information that can be utilized in meeting the workgroup scope.
2. Organize information – Identify gaps and opportunities where existing codes and standards, trainings, applications and resources are lacking and may serve as an opportunity in our goal of supporting safe application by our membership.
3. Identify areas for future research, resources and effort.
4. Identify areas of overlap between workgroups.

Monthly reporting of work group activities was presented to the general committee during monthly meetings, allowing for collaboration of discussion topics between all attendees.

Findings

With any emerging technology there is a needed balance between providing building, fire and life safety while not limiting the advancement of a technology. The typical three-year code development cycle, coupled with the delay in adoption by a governing body, can lead to many concerns among the code community that on-going and new technology is not addressed in the codes.

To reference a different emerging technology, ICC has been instrumental in providing users with up-to-date information, draft code changes and the like as it relates to the transition of mechanical refrigeration and the change into A2L refrigeration. This approach has been invaluable to the community and serves as a model for other advancing technologies.

For this gap analysis, the committee and work groups focused on the completed work although the application of the 2024 provisions has been limited in some communities, or the knowledge associated with the changes made to the 2024 editions has been limited. The discussions as well as analysis did highlight much of the work indicated in the 2027 code development process that is underway or complete in part of the Group A code development process.

ICC is the leader in information, tools and resources that members rely on, building safety professionals turn to and the public trusts. As such a leader, an opportunity exists for providing critical information in a timely fashion on such an emerging topic.

This report outlines the work of the committee. The committee's guiding scope and focus was to identify and articulate issues in codes or awareness, not necessarily to provide a solution at this time.

CHAPTER 3 – ELECTRIC VEHICLES AND PERSONAL MOBILITY DEVICES

Overview

Many countries have witnessed a significant surge in fires associated with lithium-ion batteries. Notably, New York City alone has reported over 277 fires and six fatalities in 2024. [10] The issue is further exacerbated by the widespread use of unlisted products and the rapid expansion of the battery market.

The widespread adoption of batteries in personal products has experienced exponential growth globally. From everyday devices like portable computers and smartphones to mobility options such as electric bicycles and scooters, the convenience and ease of maintenance of these products have driven their increased usage and ownership.

Electric vehicles (EVs) are commonly observed on highways and roads across the U.S. Consequently, their under-vehicle location of battery storage poses additional challenges in extinguishing fires. EV fires in the built environment have become more difficult to manage, particularly when vehicles are stored in private residential garages or parked in multi-level commercial parking facilities.

While there has been an increase in educational efforts aimed at both the fire service and consumers regarding the safe use of lithium-ion batteries, further information and education are necessary to address various aspects of battery usage, maintenance and recycling.

Approach

The work group had multiple open meetings and did an in-depth review of the various codes and standards in the 2024 I-Codes. The work group reviewed many educational resources as well as held discussions with other industry groups.

Findings

This chapter covers multiple items related to the use of batteries from personal electronics and mobility, the growing use of industrial equipment and the processes around the use of electrical vehicles powered by lithium-ion batteries.

Personal Mobility and Electronic Devices

Codes and standards beginning in the 2024 I-Codes have attempted to provide minimum code requirements for the use of lithium-ion battery rechargeable devices. The IFC brings forward requirements in Chapter 3 that are intended to cover non-personal use mobility devices. This includes code requirements for charging areas located in a multi-family residential or commercial building, charging equipment used at a mercantile establishment or the charging of equipment in a tool-crib at a manufacturing facility. A new chapter proposed for the 2027 IFC is meant to cover many of the changes related to the rapid growth of industrial vehicles and other battery related topics.

One of the biggest impacts on the built environment is the personal use of battery powered equipment, from the charging of a mobility device such as an electric bicycle in a two-story apartment building to the proper storage of a personal mobility device in an office building. The impact of improper chargers, non-listed equipment or even improper use (or care) of personal devices can have an impact on the built environment. The regulation of singular devices for personal use in the residential space is outside the scope of many current codes and standards so this provides an opportunity for ICC to utilize its use of media to educate users on the proper use and charging of personal devices.

There is a need for minimum requirements related to mobility devices in certain residential occupancies such as independent living and care facilities, where the impact from use of battery powered mobility devices can have profound consequences to the residents in the event of a fire involving a battery within a mobility device.

Regulation enforcement of mobility device use and maintenance is challenging in individual residential units due to a code official's restricted authority within these occupancies in some communities. Given this, the use, charging and disposal of batteries in the devices is the primary responsibility of the owner to understand best practices and compliance with regulations. With the increase of battery-related fires occurring in residential occupancies, the question is how to reduce these fires through education and creating safe practices.

The damage from a fire caused by a personal mobility device can be extensive to the residence, impacting the ability for the owner to remain in the dwelling. Additional actions including post-incident operations in the handling and disposal of damaged batteries and the manner which it is secured may take special considerations to do so.

Battery Charging

Education and training on proper use, charging, storage and disposal of battery-operated personal mobility devices currently on the market is limited. [11] Greater availability of educational materials for the public would aid in providing information to end users. Additionally, training opportunities for public assembly, building maintenance and residential care facility staff would also aid in minimizing the potential damage incurred by a battery fire incident.

Construction Fire Safety

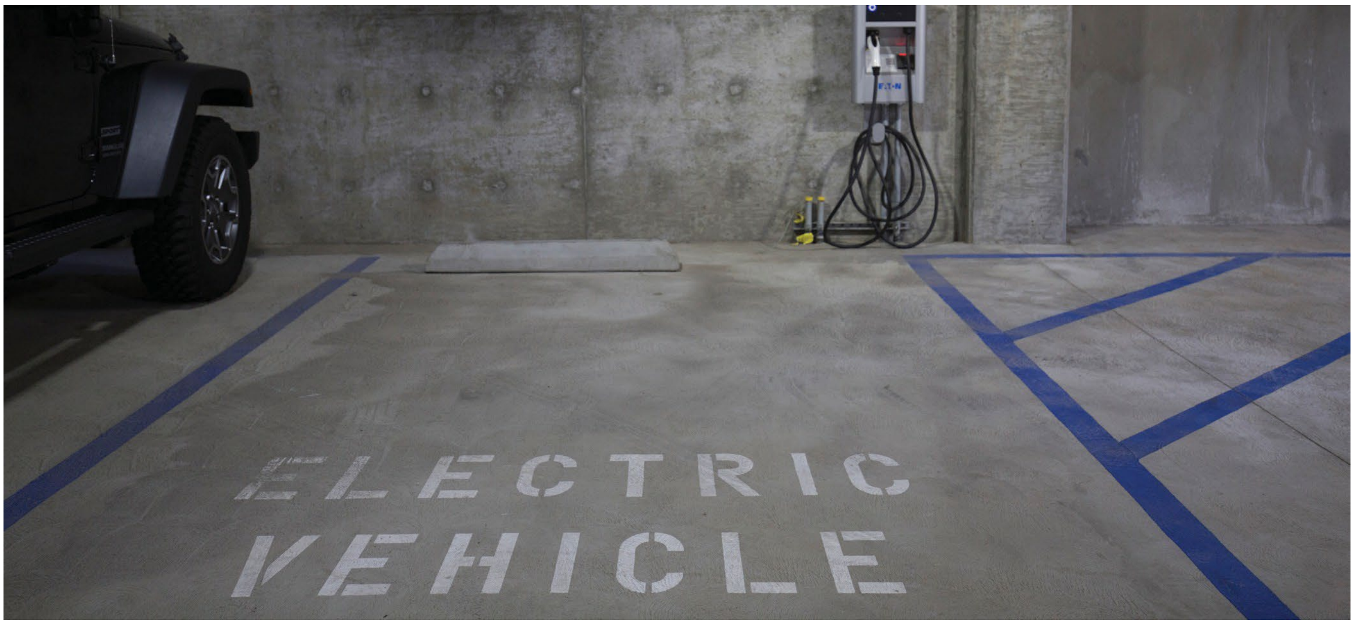
The IFC has robust provisions for construction fire safety and the modern construction site. A modern construction site is filled with battery powered equipment from power tools to radios and construction vehicles and equipment, so battery hazards exist from many sources. Further examination of the construction safety requirements in the codes is needed to identify pointers to references related to battery safety and use in construction areas. This can include IBC Chapter 33, IEBC Chapter 15, IFC Chapter 33 and NFPA 241 Construction Safeguards.

Battery Powered Electrical Vehicles, Electrical Boats and Industrial Vehicles

With the changing power source for vehicles, more users of the code are looking for the application and requirements as it relates to battery powered electric vehicles. The 2024 IFC Chapter 3 addresses requirements for the presence of display vehicles indoors. Code users have been looking for guidance on indoor display as well as how to apply the fire and building codes on indoor display shows as the codes are silent or limited in clarification regarding the display of electric vehicles in numerous occupancies, including mercantile, atriums and malls. Additional considerations such as building fire protection systems, ventilation and smoke control as well as restrictions of the battery's maximum state of charge (SOC) and acceptable types of vehicles must be taken to ensure the safety of the building occupants.

Parking Garages with Electric Vehicles

The current and existing construction of parking garages designed to accommodate EVs has been a subject of considerable debate, primarily focused on ensuring adequate area protection and the provision of charging stations. The structural integrity of the garage building is paramount to support the additional vehicle weight attributed to the electric batteries. This consideration becomes particularly critical when retrofitting existing parking structures with EV charging stations, which could potentially increase the number of EVs occupying specific areas. Concerns consist of proper design due to changing weight of vehicles, impact of EV fires on the structure and proper ventilation during an incident. These considerations have prompted some communities to restrict the parking of EVs within parking garages.



The changing vehicle environment has been a subject of considerable research. The National Fire Protection Association (NFPA) Research Foundation issued a report titled Classification of Modern Vehicle Hazards in Parking Structures & Systems – Ph II. [12] This report identifies many of the concerns as well as the changing landscape of all vehicles.

Tactical firefighting operations involving EVs currently rely on the utilization of water for extinguishment. However, these operations become more complex when vehicles are located within car stacking systems or automated parking structures, where access to the battery pack of the involved vehicles is restricted. Relying solely on built-in fire protection systems for extinguishing the fire is of utmost importance.

Regrettably, current fire sprinkler design standards do not explicitly address the protection of EVs and charging stations within parking areas. Enclosed parking structures primarily rely on mechanical ventilation systems for vehicle exhaust; however, these systems do not adequately consider the explosion hazard generated by an electric vehicle battery fire. Consequently, emergency electrical shutdown of the charging stations should be considered as part of mitigation measures.

Repair Facilities

Code users have seen an increase in concern over the need for additional protective measures on EV vehicle repair. The 2024 IFC and IBC provide needed guidance on use group classifications and fire suppression and alarm requirements. As such, emerging technology in our vehicles has needed additional requirements in our fire and building codes and is not limited to electrified platforms.

Additional requirements can apply depending on the facility. For instance, the storage of an EV battery pack for future use or the process of a vehicle that has been subject to damage from a vehicle accident would require additional emergency response planning, building design and compliance with battery storage provisions. In most EV vehicles, manufacturers have provided emergency response cards designed in accordance with SAE J2990. These response guides will indicate that damaged EV vehicles and their storage should be 60’ from structures or other vehicles. This can add some difficulty in many site layouts.

In addition, the process of damaged battery packs and their handling is not clearly articulated in the I-codes and relies heavily on employee training and emergency response planning as part of the overall code process.

Vehicle Charging

The 2027 ICC Group A Code Development process has brought forward multiple code changes related to vehicle charging. Industry-wide, there are multiple workgroups looking to cover open issues of vehicle charging, with close coordination between the I-Codes as well as other industry standards such as the National Electric Code and NFPA 30A, Motor Fuel Dispensing Facilities and Repair Garages. NFPA 30A has established a workgroup to work through the open concerns with vehicle charging and its proximity to fueling equipment.

Vehicle charging has been subject to many additional community restrictions. This can include banning of charging of vehicles in certain structures which have created community hardship. These community restrictions can lead to non-listed or non-approved temporary charging conditions. Additional studies are needed as to the protective efficacy of a building’s fire and life safety systems when vehicles within it are charging.

Evolving technology also encompasses a combination of conditions. This may include vehicle charging in a mobile setting or a fixed setting that may include the use of batteries to aid in the power delivery system. In some cases, the battery power would require compliance with various code requirements on Mobile ESS as well.

The 2024 International Energy Conservation Code® (IECC) highlights the need for single- and multi-family residential occupancies to have parking spaces be either EV capable or EV ready. Appendix RE in the IECC outlines requirements for electric vehicle power transfer infrastructure for future installation of electrical vehicle supply equipment. There have been concerns raised about clarifying the intent of this section and the equipment needed to meet the requirement. Some inconsistencies in application of the code could imply this to just meet the transformer and switching equipment, while other cases could include additional equipment within proximity of a possible charging location.

The ability for all to have access to EV charging is imperative for safety as well as supporting governmental agencies’ desire for electrification of our vehicles. As a proactive measure, the State of Colorado House Bill 23-1233 outlines electrical vehicle charging and parking requirements and addresses allowance of local installation of charging stations within multi-family residential buildings, including limiting the state’s restrictions of such installations and provides incentives to a tenant or owner who installs the charging station.

To acknowledge the importance of code compliant installations, communities must continue to evolve parking standards to include EV capable parking spaces, and proper charging equipment in accessible parking spaces including van accessible spaces. By doing so, non-compliant and potentially dangerous installations by unqualified installers using unlisted inferior products can be reduced.

CHAPTER 4 – RESIDENTIAL ENERGY STORAGE SYSTEMS

Overview

The focus for the Residential Energy Storage Systems work group is based on residential ESS and defining opportunities in our code process, opportunities with related standards, training, application and resources needed in a rapidly growing market.

With the growing number of residential households owning electric vehicles, personal electronic devices or a household appliance with new integrated battery technology, proper and compliant installation of ESS to accommodate these electronic needs is crucial to reduce the potential for a fire incident caused by a lithium-ion battery or an ESS. Depending on the type of personal electronic device used within a home, confirmation of a permitted installation using listed equipment, such as a battery charger, is not required by the code official. Therefore, homeowners need to be informed of conforming listing and certification of equipment and their uses through educational and informational opportunities by the local code officials.

Approach

The work group reviewed current and proposed code language found in the 2024 editions of the IRD, IFC and the IBC. Three subtask groups within the work group were established to evaluate potential code issues, educational and training needs and new home appliance technology. Each task group identified code gaps or issues related to battery storage and use in residential occupancies.

Findings

Typical residential ESS are covered by Section R330 in the 2024 IRC. This section was originally provided in the 2021 IRC and has been expanded into the 2024 edition. In some cases, such as multi-family and other residential settings, the IBC and IFC would be the guiding principles for the installation of energy storage systems. Through the review, it appears there is a desire for future code development as part of the 2027 editions of the IRC related to reference to the specific residential chapters within NFPA Standard 855, Standard for the Installation of Stationary Energy Storage Systems.

The growth of energy storage systems in residential situations has rapidly evolved as more occupants see the opportunity that can exist with a properly installed residential ESS. In many areas around the world, financial incentives have been provided to owners for deploying stored energy. In addition to incentives or goals by the governmental entities, stored energy is becoming a commodity desired by the owner and occupants, to ensure proper power or to harness the full effects of photovoltaic systems.

The use of ESS in the built environment is a growing demand in our residential construction as well as existing construction which is increasing additional requests to the code enforcement community as well as energy system designers and contractors.

Communities and code officials have an opportunity for information sharing during the permitting process, however critical information is necessary for the approval, installation, commission and use of an ESS. Without this information, it may provide processing delays which is counterproductive to the interest in streamlining review and approval of such permits. Providing guiding safety information for homeowners who consider installing a system would be beneficial to help them make decisions when choosing an installation designer and contractor.

The need for evolving education is critical for the users of these products. From understanding the limitations of do-it-yourself systems to portable batteries used as stationary energy systems and the need for a proper contractor, all are vital to the overall success of the emerging markets.

The 2024 IRC has included various updates related to residential energy storage, including requirements for indoor installation. Nevertheless, some states have restricted adoption of the current edition of the code, which can lead to limitations on using code requirements that may drastically aid in the application of an emerging technology

Emerging Home Technologies

There are many emerging products beyond typical stand-alone ESS that are being designed for use in residential settings, but code development has been based on the use of listed products for whole building use. That said, there appears to be an increase of desire for more products to be included with batteries over 1kwh which would trigger the use of many of the standards found in the IRC and could limit the installation of the devices in habitable spaces. The challenge becomes timely regulation of such technologies of products installed by homeowners when they do not require an installation permit.

Technical Data on Residential Energy Systems

With the advancing technology and increasing installations of residential energy systems, research, testing and evaluation of building infrastructure needs to continue to ensure the development of code requirements in response to this technology within residential settings. As buildings constructed under the IRC expand, further evaluation is needed on the impacts of energy storage to determine allowable locations of ESS, adequate separation and protection through construction, ventilation and fire sprinkler design. The resulting technical data can serve as supporting information during a future code development process.

CHAPTER 5 – COMMERCIAL ENERGY STORAGE SYSTEMS

Overview

The installation and use of ESS within commercial settings has grown across the country. These installations include providing a critical path for our utility systems to store energy for higher demands or to accommodate the increasing level of electrical demands of larger buildings, electrical systems needing back-up power capability in the event of primary power loss and protection of valuable building components. While the installation of commercial ESS is covered by codified regulations with code official permitting and oversight responsibilities, there is still a lack of detailed code requirements and guidance documents for the use and maintenance of these systems.

The design of these systems includes many key items that come from technical data provided during the testing and design phase of the product. In most cases, the system design should be supported from technical data through large-scale fire tests. These tests should provide sufficient data which supports the site layout and limits propagation of a fire from one unit to the next. This resulting design would assume limited interaction from responding fire fighters, but a purely defensive stance to a fire event can appear challenging to the fire service.

Approach

This work group identified nine topic areas to research as part of the gap analysis. Topic areas included review of the IFC, IBC, International Existing Building Code® (IEBC), International Zoning Code® (IZC), and IECC, and NFPA standards related to battery energy storage systems. Additionally, relevant standards from outside of the U.S., guidance documents from other sources and training and code enforcement perspectives were considered. Subtask groups were created to evaluate the topic areas and develop recommendations for future efforts.

Findings

The installation of ESS is based on Chapter 12 of the IFC. The installation requirements rely heavily on NFPA 855 as well as other referenced standards such as NFPA 70, NFPA 110 and NFPA 853.

IFC 1207 does not allow ESSs in dwelling units other than detached one- and two-family units and townhouses. Installation of energy systems within buildings housing live-work units is not addressed in the codes, causing confusion in how existing code requirements apply to this special occupancy type.

The use of the IEBC has been rapidly evolving. The IEBC does not detail battery requirements, only uses a pointer to direct the user to the IFC. Detailed requirements for new battery installations within existing buildings could be outlined or better referenced back to the appropriate code.

There have been increasing opportunities to provide communities with insight into the work completed in code development to aid in the safeguard of energy storage systems. There is a common theme on the needed support for planning and zoning administrators and staff. This need for education is also vital for this staff as their role is critical in overall site layout.

Currently there is no guidance in the IZC for ESS or other green items such as large or small windmills. Communities and code officials are relying on word-of-mouth references or limited online information for guidance on how to address necessary requirements at time of initial project design and evaluation or reviewing requirements of industrial energy system installations for lack of any more pertinent information.

The subtask group raised questions related to reference documents needing to be addressed in the update process for those individual documents, one area being the maintenance requirements and the path to those maintenance documents. Initial work on what is covered by the other documents will serve as the basis for guidance on provisions within each reference document that the user of the I-Codes may not be aware of. Monitoring referenced standards and their implications has typically been done by ICC members and the vital role of referenced documents may require more collaboration with staff and standards organizations. This coordination is vital to ensure proper design and installation of new and existing systems.

One important aspect is the role of the I-Codes as it relates to the inspection, testing and maintenance of critical systems that are a part of the equipment or facility design. These requirements are needed within the I-Codes and would be coordinated accordingly with referenced codes and standards.

IECC – Coordination and Reference

The IECC needs to be reviewed in connection to what is regulated in the IBC, IFC and NFPA 855 to provide for proper coordination with the IECC.

Relevant Standards of Other Countries

The I-Codes are used in other countries around the world, however, evaluation of standards in other countries relevant to batteries and ESS is needed for consideration of any future proposed codes or standards in the ICC family of solutions.

Guidance Documents from Other Sources

Numerous organizations, universities and governmental agencies are producing guidance documents dealing with various battery topics which can be essential sources of information in code developments. This subtask group identified 19 agencies or organizations that have reference resources available for guidance. Providing these resources to code officials and users of the code can be vital in providing base line information if the information is properly vetted.

Training, Code Enforcement and Response

As with any new technology, a weak point has always been getting guidance information out to designers, code officials and emergency first responders. ICC can be a primary source of information and education on various topic areas related to batteries and ESS. ICC can also be a collaborative partner with other associated organizations to assist in promoting and participate in training of battery technology related information.

CHAPTER 6 – MANUFACTURING, STORAGE AND RECYCLING OF LITHIUM BASED BATTERIES

Overview

Other sections of this report are based on the installation and utilization of battery-based products within the built environment. This chapter has a significant impact on the facilities that manufacture, assemble, store, test and recycle rechargeable lithium-ion and lithium-metal batteries.

Over the past two decades, these areas within the built environment have been limited but are now rapidly expanding. In part, this rapid growth is driven by the desire to meet manufacturing requirements for batteries in energy storage, electric vehicles and mobility devices. Given the widespread adoption of battery technology and the production of portable batteries in various aspects of daily life, older batteries reaching the end of their lifespan are replaced with new batteries, leading to a surplus of batteries that enter the waste stream or are collected for recycling. However, damaged, defective and recalled batteries placed in the course of waste or recycling have been ignition sources of destructive fires. A fire event in Morris, IL, demonstrated how destructive a lithium-ion battery fire can be when batteries are stored in mass and the jurisdiction is not aware that the building is used as such. Despite this, codes addressing these methods of processing are limited.

With the introduction of the Inflation Reduction Act of 2022, there has been an increase in lithium-ion battery manufacturing facilities. This coincides with the European Union's European Green Deal, which includes clean energy objectives for achieving full carbon neutrality by 2050. [13]

Facility types can include:

- Laboratory
- Cell Manufacture
- Module and Pack Assembly
- Vehicle Assembly
- Automative Repair
- Energy Storage Assembly
- Storage
- Recycling Collection Facilities
- Recycling Battery Facilities

The 2024 IBC has incorporated much needed clarification to the occupancy use group classifications. As part of the Group A code development process for the 2027 I-Codes, nearly 60 changes have been submitted, and changes have been recommended through the code development committee.

Approach

This work group created three subtask groups that focused on each topic area – manufacturing, storage and recycling. Each subtask group evaluated gaps in codes that could address situations being seen and experienced in the built environment today. They also considered the locations and processes which are not currently fully recognized in current codes.

Findings

The occupancies involved with battery technology in the built environment vary. Technical data to support building and life safety system design is limited at times and the use is expanding rapidly in the built environment. In many cases, the requirements found in the 2024 I-Codes are limited or agnostic to lithium-ion and lithium-metal chemistries. There are rapid changes occurring in chemistry types, so codes and standards need to address the various chemistries for clarification of requirements.

Section 320 of the 2024 IFC as well as many changes located in Chapter 9 of the IFC/IBC have begun to cover requirements for these occupancies.

When cells or batteries experience a thermal event, there can be added complications due to the difficulty in fire suppression due to the explosive nature of the event. Consideration of additional requirements outside of typical life safety are needed in properly designed buildings. Additional suppression methods and materials should be explored for efficacy against the rapid spread of a battery-caused fire.

The SOC of a battery is a very key issue in various code requirements related to the storage of batteries. Where storage occurs and the SOC is less than 30 percent[1] there is a reduction in certain requirements in the IFC. From time to time during the code development process or during a permit process, there have been requests to increase the 30 percent SOC in the built environment although technical data is limited on supporting the increase.

Keeping Up with Changing Battery Chemistries

The I-Codes have focused on traditional battery chemistries as well as rechargeable lithium-ion and lithium-metal batteries. Many advancements have been made with new chemistries which can add to confusion on the application of the various code provisions found in the 2024 I-Codes. The speed of advancement in battery chemistries and technologies coupled with the currently limited information of such technologies makes comprehension and application of adopted codes difficult for many designers and code officials. As a result, decision-making of appropriate code application on chemistries not fully understood in current code has an effect in safe design and installation.

Coordination of Codes

Battery-based industries have been working to balance transportation requirements with that of fire and life safety in the built environment. A priority for coordination between codes and other regulations where applicable can work to provide consistency and understanding of standardized requirements and referenced codes. Foundational items like definitions, if not coordinated, lead to confusion and inconsistent application of code requirements.

Members of ICC, Code Action Committees and Code Development Committees can play a key role in identifying other codes and standards practices that require coordination. For instance, in the 2027 code development process, the Fire Code Action Committee worked to correlate requirements found in the IFC and NFPA 855 to limit conflicting technical provisions. In fact, many members worked to also provide that same recommended practice in the development of the second edition of NFPA 855.

Battery Collection and Recycling

One of the growing areas is the application of codes and standards in the collection, handling, storage and recycling process of batteries. With the advent of increased use of lithium-ion batteries especially for EVs, the production of recycling facilities is expected to increase throughout the country. Therefore, issues regarding used battery storage, accumulation of hazardous material during recycling steps and questions of how the hazard is classified throughout the recycling process and how the fire service can respond become important. The 2024 IFC and the proposed changes to the 2027 IFC have multiple provisions affecting these occupancies as well as the use. It is forecasted that many states as well as other governmental agencies are exploring laws regulating the collection of ‘end of life’ and DDR batteries. This will increase the need by many communities to be educated on the code provisions found in the IFC currently and serve as a best practice in many applications.

There is a need for additional research in understanding the hazards associated with collection and recycling occupancies. Unlike a manufacturing facility, recycling facilities can include batteries of different chemistries, unknown SOCs and unknown handling of devices. Battery recyclers have developed closely held proprietary methods to recycle the material back to a grade suitable for manufacture into new batteries. The two primary methods are:

1. Incinerating, then refining the leftover material back to cathode production.
2. Hydro-chemical processing to a grade suitable for re-manufacture.

Different steps in the recycling process can present different hazards. There is hesitancy from recyclers to release specifics about their proprietary process (i.e. chemicals and related materials). In doing so, it is difficult to verify compliance to code unless they are encouraged to participate in code and standard development.

These challenges would need to be addressed in facility design and application of various fire and life safety systems. The opportunity exists to provide code users with the best methods of code application as well as continued study of hazards associated with the collection and recycling process.

Special Considerations

Beyond building and use requirements, battery and ESS raise the need for special considerations. Facilities involving the manufacture and storage of batteries have distinctive needs that require special emergency planning and procedures for incident management and battery decommissioning. Understanding the needs of a facility to create associated plans is necessary to allow for safe response and mitigation of batteries by the facility staff, code officials and emergency responders.

Batteries have been proven to become an additional consideration in post disaster mitigation. When damaged because of a disastrous event, batteries can create unique problems that may not have been thought of prior to the event. From the devastating effects of wildfires to hurricanes, the ability to identify, process and properly handle damaged batteries has become critical. When these devices are not handled correctly post disaster incident, they can lead to further complications of the overall situation and could cause secondary fire events.

For example, after the 2023 Maui wildfires, the U.S. Environmental Protection Agency collected hundreds of batteries from EVs and decommissioned residential and commercial ESS. The batteries were considered hazardous materials and were transported off the island in shipping containers only after they were deemed deenergized. Unable to transport by air, transporting the batteries to the mainland by sea took considerable time and effort.

References

The following are other references used to inform the content of this report as identified by the committee members and participating interested parties.

Citation	Reference and Description
[14]	DOT: Understanding the Risks of Damaged, Defective, or Recalled (DDR) Lithium Batteries
[15]	FAA: “Lithium Batteries” Federal Aviation Administration Fire Safety
[16]	FAA: PackSafe for Passengers, United States Department of Transportation Federal Aviation Administration
[17]	FAA: Reports, Federal Aviation Administration Fire Safety Reports Database (Filtered related to Batteries)
[18]	Factory Mutual: FM Data Sheet Manufacturing 7-112 Lithium-Ion Battery Manufacturing and Storage

CHAPTER 7 – CONCLUSION

The work of the Ad-Hoc Committee has been wide-reaching and diverse. From how we utilize stored energy in our home, to supporting our utility system with large scale ESS, the growth of products has expanded and growing in demand.

To meet this growth as well as the growing demand for electrification of our vehicles, communities have seen an influx of new construction and development in the manufacture and storage of batteries. The work of this committee is just the initial step in beginning to identify and address codes and issues in the changing built environment.

ICC is the trusted source to many communities, members and code officials. Due to the action of the membership, ICC is poised to continue to lead communities through one of the most prolific changes to our built environment since the inception of the organization. The opportunities to provide our communities with needed resources, training and best practices through sound code development are critical.

The ICC family of solutions is the core foundation to begin addressing many of the gaps found in this report. This may include leveraging the education and training department of ICC to develop strategic partnerships and aid in research and development of future codes and standards.

This report highlights the dedication of the members and staff to supporting the built environment and providing safe places where people live, work and visit. The work of the membership and staff will continue beyond this initial gap analysis and must work to meet the mission of the ICC.

To provide the information, tools and resources that members rely on, building safety professionals turn to, and the public trusts.

APPENDIX A

Ad-Hoc Committee Work Groups

The Ad-Hoc Committee relied heavily on the contributions of work groups with a broad range of expertise. Each work group was led by a Chair coordinating the group's efforts, and attendance was open to committee members and interested parties.

Personal Mobility and Electric Vehicles

Name	Affiliation
Scholl, Brian (Chair)	Phoenix Fire Department
Amiri, Shahriar	Arlington County, Virginia
Anwar, Abid	Tesla Motors
Ayers, Scott	Consumer Product Safety Commission
Barowy, Adam	UL Fire Safety Research Institute
Bartlett, Nicholas	National Renewable Energy Laboratory
Baughman, Brian	National Electrical Manufacturers Association
Bostrom, Alyssia	Dolav USA
Brouillette, Ken	Seattle Fire Department, WA
Bush, Ken	Maryland State Fire Marshal's Office
Cardinali, Sarah	National Renewable Energy Laboratory
Cervantes, Joseph	Space Age Electronics
Cheung, Janice	Redwood City Fire Department, CA
Cocco, Larry	Toronto Fire Services, Ontario, Canada
DeCrane, Sean	International Association of Fire Fighters
DeJoseph, Joelle	Senez Co. - Fire Science & Engineering
Diehl, Tim	Howard County, MD
Donohue, David	Federal Emergency Management Agency
Dunkel, Jeff	National Fire Sprinkler Association
Engle, Brian	Amphenol
Finegan, Donal	National Renewable Energy Laboratory
Francis, Christina	Tesla Motors
Greene, Chris	Seattle Fire Department, WA
Gao, Ningshengjie	Fire Department of New York Bureau of Fire Prevention
Hanson, Shawn	Greater Naples Fire Rescue District, FL
J Davidson, Robert	Davidson Code Concepts
Ladiola- Cuffe, Luci	Department of Homeland Security and Emergency Services, NY
Lefebvre, Brendan	Tesla Motors
McElvaney, Joe	Hiller Companies
Metzger, Brian	United States Fire Administration
O'Connor, Brian	National Fire Protection Association
Orlowski, Steve	Sundowne Building Code Consultants, LLC - Representing NAHB
Paiss, Matthew	Pacific Northwest National Laboratory

Name	Affiliation
Petrakis, Nick	Energy Safety Response Group
Pfaff, Chris	West Pierce Fire & Rescue, Lakewood WA
Plonski, Rob	National Nuclear Security Administration
Reynolds, Rick	Orr Protection
Rogers, Greg	Fire & Life Safety Section, International Association of Fire Chiefs
Sauer, Nathaniel	Fire Safety Research Institute
Sharma, Ankit	Case Western Reserve University, OH
Sujeski, Crystal	CAL FIRE Office of the State Fire Marshal
Tummala, Raghavender	General Motors

Commercial and Utility Based Energy Storage Systems

Name	Affiliation
Davidson, Robert (Chair)	Davidson Code Concepts
Alfsen, Jennifer	Fluence Energy
Anwar, Abid	Tesla Motors
Ashton, Curtis	American Power Systems
Barowy, Adam	UL Fire Safety Research Institute (FSRI)
Bartlett, Nicholas	National Renewable Energy Laboratory
Baughman, Brian	National Electrical Manufacturers Association
Bowden, John	Orange County Fire Authority, CA
Brouillette, Ken	Brouillette, Ken
Burke, Tanner	ACS Group
Bush, Ken	Maryland State Fire Marshal’s Office
Cervantes, Joseph	Space Age Electronics
Distaso, Robert	Orange County Fire Authority, CA
Dunkel, Jeff	National Fire Sprinkler Association
Eckstein, Scott	Richardson Fire Department, TX
Elmagraby, Emad	Arlington County, VA
Fok, Kevin	LG Energy Solution Vertech, Inc
Francis, Christina	Tesla Motors
Gao, Ningshengjie	Fire Department of New York Bureau of Fire Prevention
Hinds-Aldrich, Matt	American Association of Insurance Services
Kluge, Richard	NEBScore
Koffel, William	California Solar & Storage Association
Ladiola- Cuffe, Luci	Department of Homeland Security and Emergency Services, NY
Maulik, Mitch	Arapahoe County, Colorado
Miller, Richard	International Association of Fire Chiefs
O’Connor, Brian	National Fire Protection Association
Paiss, Matthew	Pacific Northwest National Laboratory
Picard, Charles	Solar Energy Industries Association
Rallo, Rob	Solar System Services

Name	Affiliation
Rogers, Paul	Energy Safety Response Group
Sauer, Nathaniel	Fire Safety Research Institute
Scholl, Brian	Phoenix Fire Department, AZ
Searles, Chris	CGS and Associates
Sujeski, Crystal	CAL FIRE Office of the State Fire Marshal
Ventola, Michael	Space Age Electronics

Residential Energy Storage Systems

Name	Affiliation
DeCrane, Sean (Chair)	International Association of Fire Fighters (IAFF)
Amiri, Shahriar	Arlington County, Virginia
Anwar, Abid	Tesla Motors
Ayers, Scott	Consumer Product Safety Commission
Barowy, Adam	UL Fire Safety Research Institute
Baughman, Brian	National Electrical Manufacturers Association (NEMA)
Brouillette, Ken	Seattle Fire Department, WA
Bush, Ken	Maryland State Fire Marshal’s Office
Climer, Randy	STIHL
Dunkel, Jeff	National Fire Sprinkler Association
Eckstein, Scott	Richardson Fire Department, TX
Fields, Chrishana	El Dorado Hills Fire Department, CA
Greene, Chris	Seattle Fire Department, WA
Gao, Ningshengjie	Fire Department of New York Bureau of Fire Prevention
Hinds-Aldrich, Matt	American Association of Insurance Services
Hren, Rebekah	Solar Tech Collective
Davidson, Robert	Davidson Code Concepts
Jahp, Alex	Solar Tech Collective
Koffel, William	California Solar & Storage Association
Marley, Ron	San Ramon Valley Fire Protection District, CA
Maulik, Mitch	Arapahoe County, Colorado
Miller, Richard	International Association of Fire Chiefs
Nicholas, Mike	Hiller Companies
O’Connor, Brian	National Fire Protection Association (NFPA)
Orlowski, Steve	Sundowne Building Code Consultants, LLC - Representing NAHB
Paiss, Matthew	Pacific Northwest National Laboratory
Picard, Charles	Solar Energy Industries Association
Rallo, Rob	Solar System Services
Rogers, Paul	Energy Safety Response Group
Scholl, Brian	Phoenix Fire Department, AZ
Searles, Chris	CGS and Associates
Sehlmeyer, Kevin	State of Michigan/National Association of State Fire Marshals

Name	Affiliation
Spies, Jeff	Planet Plan Sets
Stoler, Lyn	Impulse Labs
Sujeski, Crystal	CAL FIRE Office of the State Fire Marshal

Manufacture, Storage and Recycling

Name	Affiliation
Brigmon, Todd (Chair)	General Motors
Baughman, Brian	National Electrical Manufacturers Association
Brouillette, Ken	Seattle Fire Department, WA
Davidson, Robert	Davidson Code Concepts
DeJoseph, Joelle	Senez Co. - Fire Science & Engineering
Diehl, Tim	Howard County, MD
Dunkel, Jeff	National Fire Sprinkler Association
Goforth, Stephen	North County Regional Fire Authority, WA
Hanson, Shawn	Greater Naples Fire Rescue District, FL
Hucker, Joshua	City of Lake Forest, IL
Khourjian, Erica	Orr Protection
Maughmer, Cameron	City of De Soto, Kansas
Metzger, Brian	United States Fire Administration
Mishra, Dhanaanjay	General Motors
Nicholas, Mike	Hiller Companies
Redman, John	Toyota
Tummala, Raghavender	General Motors

APPENDIX B

Interested Parties to Committee

The Committee appreciates the large number of interested parties who attended monthly Committee meetings and participated in work group discussions.

Name	Affiliation
Adams, Scott	International Code Council
Adcox, Amy	Republic Services
Alexander, Rex	Five- Alpha (& Infrastructure Advisor for Vertical Flight Society)
Alfsen, Jennifer	Fluence Energy
Amiri, Shahriar	Arlington County, Virginia
Ashton, Curtis	American Power Systems
Ayers, Benjamin	Republic Services
Banfield, Jacob	Pasadena Fire Department, CA
Betts, Cole	EV Engineering Consulting
Bostrom, Alyssi	Dolav USA
Bowden, John	Orange County Fire Authority, CA
Brouillette, Ken	City of Seattle Fire Department, WA
Burke, Tanner	ACS Group
Cantor, Bill	TPI Engineering
Cardinali, Sarah	National Renewable Energy Laboratory
Carr, Kelly	FDNY
Carter, Sarah	Poudre Fire Authority, CO
Cervantes, Joseph	Space Age Electronics
Chen, Kai	Metropolitan Transportation Authority Construction and Development

Name	Affiliation
Costello, Joshua	County of Los Angeles Fire Department, CA
Davis, Cole	Draeger, Inc.
DeJoseph, Joelle	Senez Co. - Fire Science & Engineering
Dempwolf, Chris	City of Rockville, MD
Diehl, Tim	Howard County, MD
Distaso, Robert	Orange County Fire Authority, CA
Donohue, David	Federal Emergency Management Agency
Dushynkskiy, Andrew	FDNY
Eckstein, Scott	Richardson Fire Department, W
Engle, Brian	Amphenol
Feak, Kevin	LaBella Associates
Ferretti, Timothy	Ferretti Salvage and Recycling
Fields, Chrishana	El Dorado Hills Fire Department, CA
Finegan, Donal	National Renewable Energy Laboratory
Gardener, Richard	Amazon
Gikas, Alex	Lucid Motors
Goforth, Steve	North County Regional Fire Authority, WA
Greene, Chris	Seattle Fire Department, WA

Cheung, Janice	Redwood City Fire Department, CA
Climer, Randy	STIHL
Cocco, Larry	Toronto Fire Services, Ontario Canada
Conzen, Jens	Jensen-Hughes
Jahp, Alex	Solar Tech Collective
Judah, Lindsay	St. Petersburg Fire Rescue, FL
Kaminski, Ed	Clark County Fire Department, N
Hanes, Brett	Henry County, GA
Hanson, Shawn	Greater Naples Fire Rescue District, FL
Hinds-Aldrich, Matt	American Association of Insurance Services
Hren, Rebekah	Solar Tech Collective
Hucker, Joshua	City of Lake Forest, IL
Plonski, Rob	National Nuclear Security Administration
Rallo, Rob	Solar System Services

Name	Affiliation
Khourjian, Erica	Orr Protection
Kinsman, Corey	The Fire Protection International Consortium, Inc.
Kluge, Richard	NEBScore
LeFebvre, Brendan	Tesla Motors
Marley, Ron	San Ramon Valley Fire Protection District, CA
Maulik, Mitch	Arapahoe County, CO
McDaniel, Steve	City of Corning, NY
McElhinny, Christy	Eaton Bussmann
McElvaney, Joelle	Hiller Companies
Meintz, Andrew	National Renewable Energy Laboratory
Metzger, Brian	United States Fire Administration
Miller, Richard	International Association of Fire Chiefs
Milne, Justin	Jensen-Hughes
Mishra, Dhananjay	General Motors
Mullen, John	Chicago Fire Department, IL
Ng, Sze-Sze	Dow
Nicholas, Mike	Hiller Companies
Nicolello, Kelly	UL Solutions
Paiss, Matthew	Pacific Northwest National Laboratory
Paschke, Dena	Lompoc Fire Department, CA
Pesaran, Ahmad	National Renewable Energy Laboratory
Petrakis, Nick	Energy Safety Response Group
Pfaff, Chris	West Pierce Fire & Rescue, Lakewood WA
Picard, Charles	Solar Energy Industries Association
Walser, John	Fairfax County Fire and Rescue Department, VA
Weisel, Ben	Plus Power
Westbrook, Robert	San Antonio Fire Department, TX
Wren, Carl	Georgetown Fire Department (GFD), TX
Yeruva, Sesha	Siemens Emobility

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Redman, John	Toyota
Reinertson, Kevin	Riverside County Fire Dept., Office of the Fire Marshal, CA
Reynolds, Rick	Orr Protection
Rice, Jessica	Generac
Rodriguez, David	Anaheim Fire & Rescue, CA
Rogers, James	Town of Oak Bluffs, Baystate Inspectional Agency, MA
Roth, Heather	New York State Office of Fire Prevention and Control
Sauer, Nathaniel	Fire Safety Research Institute
Scholl, Brian	Phoenix Fire Department, AZ
Scott, Lisa	U.S. Consumer Product Safety Commission
Searles, Chris	CGS and Associates
Shapiro, Steve	Shapiro & Associates LLC
Sharma, Ankit	Case Western Reserve University, Ohio, USA
Shaw, Chad	Harris County Fire Marshal, TX
Short, Robin	EPMA (APMA)
Snelling, Scott	Storey County Fire Protection District, NV
Spies, Jeff	Planet Plan Sets
Stoler, Lyn	Impulse Labs
Sullivan, Bob	National Fire Protection Association
Toomey, Sean	State Fire Marshal, NH
Towski, Chris	International Association of Fire Fighters
Tubbs, Beth	International Code Council
Tummala, Raghavender	General Motors
Ventola, Michael	Space Age Electronics
Villoria, Ashley	Redwood Materials

APPENDIX C

2024 ICC Battery Related Code Language

2024 International Building Code

Chapter 3 Occupancy Classification and Use

304.1 Business Group B.

Business Group B occupancy includes, among others, the use of a building or structure, or a portion thereof, for office, professional or service-type transactions, including storage of records and accounts. Business occupancies shall include, but not be limited to, the following:

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

306.1 Factory Industrial Group F.

Factory Industrial Group F occupancy includes, among others, the use of a building or structure, or a portion thereof, for assembling, disassembling, fabricating, finishing, manufacturing, packaging, repair or processing operations that are not classified as a Group H hazardous or Group S storage occupancy.

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

Factory industrial uses that are not classified as Factory Industrial F-2 Low Hazard shall be classified as F-1 Moderate Hazard and shall include, but not be limited to, the following:

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

311.1 Storage Group S.

Storage Group S occupancy includes, among others, the use of a building or structure, or a portion thereof, for storage that is not classified as a hazardous occupancy.

311.2 Moderate-hazard storage, Group S-1.

Storage Group S-1 occupancies are buildings occupied for storage uses that are not classified as Group S-2, including, but not limited to, storage of the following:

Lithium-ion or lithium metal batteries

Vehicle repair garages for vehicles powered by lithium-ion or lithium metal batteries

Chapter 4 Special Detailed Requirements Based on Occupancy and Use

SECTION 406

MOTOR-VEHICLE-RELATED OCCUPANCIES

406.2.7 Electric vehicle charging stations and systems.

Where provided, electric vehicle charging systems shall be installed in accordance with NFPA 70. Electric vehicle charging system equipment shall be listed and labeled in accordance with UL 2202. Electric vehicle supply equipment shall be listed and labeled in accordance with UL 2594. Accessibility to electric vehicle charging stations shall be provided in accordance with Section 1107.

406.4 Public parking garages.

Parking garages, other than private garages, shall be classified as public parking garages and shall comply with the provisions of Sections 406.2 and 406.4 and shall be classified as either an open parking garage or an enclosed parking garage. Open parking garages shall also comply with Section 406.5. Enclosed parking garages shall also comply with Section 406.6. See Section 510 for special provisions for parking garages.

406.5 Open parking garages.

Open parking garages shall comply with Sections 406.2, 406.4 and 406.5.

[F] 406.5.8 Standpipe system.

An open parking garage shall be equipped with a standpipe system as required by Section 905.3.

406.6 Enclosed parking garages.

Enclosed parking garages shall comply with Sections 406.2, 406.4 and 406.6.

[F] 406.6.3 Automatic sprinkler system.

An enclosed parking garage shall be equipped with an automatic sprinkler system in accordance with Section 903.2.10.

[F] 406.8.3 Automatic sprinkler system.

A repair garage shall be equipped with an automatic sprinkler system in accordance with Section 903.2.9.1.

2024 International Building Code and International Fire Code - Automatic sprinkler system requirements

[F] 903.2.2 Group B.

An automatic sprinkler system shall be provided for Group B occupancies as required in Sections 903.2.2.1and 903.2.2.2.

[F] 903.2.2.2 Laboratories involving testing, research and development.

An automatic sprinkler system shall be installed throughout the fire areas utilized for the research and development or testing of lithium-ion or lithium metal batteries.

[F] 903.2.4 Group F-1.

An automatic sprinkler system shall be provided throughout all buildings containing a Group F-1 occupancy where one of the following conditions exists:

5. A Group F-1 occupancy is 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.

[F] 903.2.7 Group M.

An automatic sprinkler system shall be provided throughout buildings containing a Group M occupancy where one of the following conditions exists:

[F] 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 320 of the International Fire Code or Chapter 32 of the International Fire Code.

[F] 903.2.9 Group S-1. An automatic sprinkler system shall be provided throughout all buildings containing a Group S-1 occupancy where one of the following conditions exists:

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).

[F] 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, as shown:

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).

[F] TABLE 903.2.11.6 ADDITIONAL REQUIRED FIRE PROTECTION SYSTEMS

IFC Automatic sprinkler system requirements as set forth in Section 903.2.11.6 of the International Fire Code

(The IBC Table refers to IFC Table for additional)

2024 International Fire Code

TABLE 903.2.11.6 ADDITIONAL REQUIRED FIRE PROTECTION SYSTEMS

320 Lithium-ion and lithium metal battery storage

Table 1206.9, Table 1206.10, Table 1207.7, Table 1207.8 Stationary and mobile

Energy storage systems

2024 International Building Code and International Fire Code - Fire detection system requirements

[F] 907.2.2 Group B.

[F] 907.2.2.2 Laboratories involving 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.

[F] 907.2.4 Group F.

[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 when the batteries are installed as part of the manufacturing process.

[F] 907.2.7 Group M.

[F] 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 in accordance with Section 320 of the International Fire Code.

[F] 907.2.10 Group S.

A fire alarm system shall be installed in a Group S occupancy as required by Sections 907.2.10.1 and 907.2.10.2.

[F] 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 in accordance with Section 320 of the International Fire Code.

2024 International Fire Code

320.4.2.4 Fire alarm systems.

Indoor storage areas for lithium-ion and lithium metal batteries shall be provided with an approved automatic fire detection and alarm system complying with Section 907. The fire detection system shall use air-aspirating smoke detection, radiant energy-sensing fire detection or both.

[F] 907.2.23 Energy storage systems.

An automatic smoke detection system or radiant-energy detection system shall be installed in rooms, areas and walk-in units containing energy storage systems as required in Section 1207.5.4 of the International Fire Code.

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Chapter 3

POWERED INDUSTRIAL TRUCK. A forklift, tractor, platform lift truck or motorized hand truck powered by an electrical motor or internal combustion engine. Powered industrial trucks do not include farm vehicles or automotive vehicles for highway use.

POWERED MICROMOBILITY DEVICES. Motorized bicycles, motorized scooters and other personal mobility devices powered by a lithium-ion or lithium metal battery. The term does not include motor vehicles that are required to be registered with the Department of Motor Vehicles for the state or jurisdiction

SECTION 309

POWERED INDUSTRIAL TRUCKS AND EQUIPMENT

309.1 General.

Powered industrial trucks and similar equipment including, but not limited to, floor scrubbers and floor buffers, shall be operated and maintained in accordance with Sections 309.2 through 309.7.

309.2 Use in hazardous (classified) locations.

Powered industrial trucks used in areas designated as hazardous (classified) locations in accordance with NFPA 70 shall be listed and labeled for use in the environment intended in accordance with NFPA 505.

309.3 Battery chargers.

Battery chargers shall be of an approved type. Combustible storage shall be kept not less than 3 feet (915 mm) from battery chargers. Battery charging shall not be conducted in areas open to the public.

309.4 Ventilation.

Ventilation shall be provided in an approved manner in battery-charging areas to prevent a dangerous accumulation of flammable gases.

309.5 Fire extinguishers.

Battery-charging areas shall be provided with a fire extinguisher complying with Section 906 having a minimum 4-A:20-B:C rating within 20 feet (6096 mm) of the battery charger.

309.7 Repairs.

Repairs to fuel systems, electrical systems and repairs utilizing open flame or welding shall be done in approved locations outside of buildings or in areas specifically approved for that purpose.

SECTION 312

VEHICLE IMPACT PROTECTION

312.1 General.

Vehicle impact protection required by this code shall be provided by posts that comply with Section 312.2 or by other approved physical barriers that comply with Section 312.3.

312.2 Posts.

Guard posts shall comply with all of the following requirements:

1. Constructed of steel not less than 4 inches (102 mm) in diameter and concrete filled.
2. Spaced not more than 4 feet (1219 mm) between posts on center.
3. Set not less than 3 feet (914 mm) deep in a concrete footing of not less than a 15-inch (381 mm) diameter.
4. Set with the top of the posts not less than 3 feet (914 mm) above ground.
5. Located not less than 3 feet (914 mm) from the protected object.

312.3 Other barriers.

Barriers, other than posts specified in Section 312.2, that are designed to resist, deflect or visually deter vehicular impact commensurate with an anticipated impact scenario shall be permitted where approved.

SECTION 314
INDOOR DISPLAYS

314.1 General.

Indoor displays constructed within any occupancy shall comply with Sections 314.2 through 314.4.

314.4 Vehicles.

Liquid-fueled or gaseous-fueled vehicles, aircraft, boats or other motorcraft shall not be located indoors except as follows:

1. The engine starting system is made inoperable or ignition batteries are disconnected except where the fire code official requires that the batteries remain connected to maintain safety features.
2. Fuel in fuel tanks does not exceed any of the following:

2.1. Class I, II and III liquid fuel does not exceed one-quarter tank or 5 gallons (19 L), whichever is less.

2.2. LP gas does not exceed one-quarter tank or 6.6 gallons (25 L), whichever is less.

2.3. CNG does not exceed one-quarter tank or 630 cubic feet (17.8 m3), whichever is less.

2.4. Hydrogen does not exceed one-quarter tank or 2,000 cubic feet (57 m3), whichever is less.

3. Fuel tanks and fill openings are closed and sealed to prevent tampering.
4. Vehicles, aircraft, boats or other motorcraft equipment are not fueled or defueled within the building.

SECTION 320
LITHIUM-ION AND LITHIUM METAL BATTERY STORAGE

320.1 General.

The storage of lithium-ion and lithium metal batteries shall comply with Section 320.

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 not more than 300 watt-hours for lithium-ion batteries or contain not more than 25 grams 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.

320.2 Permits.

Permits shall be required for an accumulation of more than 15 cubic feet (0.42 m3) of lithium-ion and lithium metal batteries, other than batteries listed in the exceptions to Section 321.1, as set forth in Section 105.5.29.

320.3 Fire safety plan.

A fire safety plan shall be provided in accordance with Section 404. 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.

320.4 Storage requirements.

Lithium-ion and lithium metal batteries shall be stored in accordance with Section 320.4.1, 320.4.2 or 320.4.3, as applicable.

320.4.1 Limited indoor storage in containers.

Not more than 15 cubic feet (0.42 m3) of lithium-ion or lithium metal batteries shall be permitted to be stored in containers in accordance with all of the following:

1. Containers shall be open top and constructed of noncombustible materials or shall be approved for battery collection.
2. Individual containers and groups of containers shall not exceed a capacity of 7.5 cubic feet (0.21 m3).
3. A second container or group of containers shall be separated by not less than 3 feet (914 mm) of open space or 10 feet (3048 mm) of space that contains combustible materials.
4. Containers shall be located not less than 5 feet (1524 mm) from exits or exit access doors.

320.4.2 Indoor storage areas.

Indoor storage areas for lithium-ion and lithium metal batteries, other than those complying with Section 320.4.1, shall comply with Sections 320.4.2.1 through 320.4.2.6.

320.4.2.1 Technical opinion and report.

A technical opinion and report complying with Section 104.2.2 shall be prepared to evaluate the fire and explosion risks associated with the indoor storage area and to make recommendations for fire and explosion protection. The report shall be submitted to the fire code official and shall require the fire code official's approval prior to issuance of a permit. In addition to the requirements of Section 104.2.2, the technical opinion and report shall specifically evaluate the following:

1. The potential for deflagration of flammable gases released during a thermal runaway event.
2. The basis of design for an automatic sprinkler system or other approved fire suppression system. Such design basis shall reference relevant full-scale fire testing or another approved method of demonstrating sufficiency of the recommended design.

320.4.2.2 Construction requirements.

Where indoor storage areas for lithium-ion and lithium metal batteries are located in a building with other uses, battery storage areas shall be separated from the remainder of the building by 2-hour rated fire barriers or horizontal assemblies. Fire barriers shall be constructed in accordance with Section 707 of the International Building Code, and horizontal assemblies shall be constructed in accordance with Section 711 of the International Building Code.

Exceptions:

1. Where battery storage is contained in one or more approved prefabricated portable structures providing a complete 2-hour fire-resistance-rated enclosure, fire barriers and horizontal assemblies are not required.

2. Where battery storage is limited to new batteries in packaging that has been demonstrated to and approved by the fire code official as sufficient to isolate a fire in packaging to the package interior, fire barriers and horizontal assemblies are not required.

320.4.2.3 Fire protection systems.

Indoor storage areas for lithium-ion and lithium metal batteries shall be protected by an automatic sprinkler system complying with Section 903.3.1.1 or an approved alternative fire suppression system. The system design shall be based on recommendations in the approved technical opinion and report required by Section 320.4.2.1.

320.4.2.4 Fire alarm systems.

Indoor storage areas for lithium-ion and lithium metal batteries shall be provided with an approved automatic fire detection and alarm system complying with Section 907. The fire detection system shall use air-aspirating smoke detection, radiant energy-sensing fire detection or both.

320.4.2.5 Explosion control.

Where the approved technical opinion and report required by Section 320.4.2.1 recommends explosion control, explosion control complying with Section 911 shall be provided.

320.4.2.6 Reduced requirements for storage of partially charged batteries.

Indoor storage areas for lithium-ion and lithium metal batteries with a demonstrated SOC not exceeding 30 percent shall not be required to comply with Sections 320.4.2.1, 320.4.2.2 and 320.4.2.5, provided that procedures for limiting and verifying that the SOCwill not exceed 30 percent have been approved.

320.4.3 Outdoor storage.

Outdoor storage of lithium-ion or lithium metal batteries shall comply with Sections 320.4.3.1 through 320.4.3.3.

320.4.3.1 Distance from storage to exposures.

Outdoor storage of lithium-ion or lithium metal batteries, including storage beneath weather protection in accordance with Section 414.6.1 of the International Building Code, shall comply with one of the following:

1. Battery storage shall be located not less than 20 feet (6096 mm) from any building, lot line, public street, public alley, public way or means of egress.
2. Battery storage shall be located not less than 3 feet (914 mm) from any building, lot line, public street, public alley, public way or means of egress, where the battery storage is separated by a 2-hour fire-resistance-rated assembly without openings or penetrations and extending 5 feet (1524 mm) above and to the sides of the battery storage area.
3. Battery storage shall be located not less than 3 feet (914 mm) from any building, lot line, public street, public alley, public way or means of egress, where batteries are contained in approved, prefabricated portable structures providing a complete 2-hour fire-resistance-rated enclosure.

320.4.3.2 Storage area size limits and separation.

Outdoor storage areas for lithium-ion or lithium metal batteries, including storage beneath weather protection in accordance with Section 414.6.1 of the International Building Code, shall not exceed 900 square feet (83.6 m2). The height of battery storage in such areas shall not exceed 10 feet (3048 mm). Multiple battery storage areas shall be separated from each other by not less than 10 feet (3048 mm) of open space.

320.4.3.3 Fire detection.

Outdoor storage areas for lithium-ion or lithium metal batteries, regardless of whether such areas are open, under weather protection or in a prefabricated portable structure, shall be provided with an approved automatic fire detection and alarm system complying with Section 907. The fire detection system shall use radiant energy-sensing fire detection.

SECTION 322

POWERED MICROMOBILITY DEVICES

322.1 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 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.

322.1.1 Prohibited locations.

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

322.2 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.

322.3 Listing.

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

322.4 Battery charging areas.

Where approved, powered micromobility devices shall 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.
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.

7. A minimum of 18 inches (457.2 mm) shall be maintained between the location of the battery on each powered micromobility device 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.

322.5 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.

CHAPTER 12 ENERGY SYSTEMS

SECTION 1201

GENERAL

1201.1 Scope.

The provisions of this chapter shall apply to the installation, operation, maintenance, repair, retrofitting, testing, commissioning and decommissioning of energy systems used for generating or storing energy, including but not limited to energy storage systems under the exclusive control of an electric utility or lawfully designated agency. It shall not apply to equipment associated with the generation, control, transformation, transmission, or distribution of energy installations that is under the exclusive control of an electric utility or lawfully designated agency. Energy storage systems regulated by Section 1207 shall comply with this chapter, as appropriate, and NFPA 855.

1202.1 Definitions.

The following terms are defined in Chapter 2:

BATTERY SYSTEM, STATIONARY STORAGE.

BATTERY TYPES.

CAPACITOR ENERGY STORAGE SYSTEM.

CRITICAL CIRCUIT.

EMERGENCY POWER SYSTEM.

ENERGY STORAGE MANAGEMENT SYSTEMS.

ENERGY STORAGE SYSTEM (ESS).

ENERGY STORAGE SYSTEM, ELECTROCHEMICAL.

ENERGY STORAGE SYSTEM, MOBILE.

ENERGY STORAGE SYSTEM, WALK-IN UNIT.

ENERGY STORAGE SYSTEM CABINET.

ENERGY STORAGE SYSTEM COMMISSIONING.

ENERGY STORAGE SYSTEM DECOMMISSIONING.

FUEL CELL POWER SYSTEM, STATIONARY.

PORTABLE GENERATOR.

STANDBY POWER SYSTEM.

SECTION 3201

GENERAL

3201.1 Scope.

High-piled combustible storage shall be in accordance with this chapter. In addition to the requirements of this chapter, the following material-specific requirements shall apply:

6. General storage of combustible material shall be in accordance with Chapter 3.

SECTION 3202

DEFINITIONS

3202.1 Definitions.

HIGH-PILED COMBUSTIBLE STORAGE.

…

HIGH-PILED COMBUSTIBLE STORAGE. *Storage of combustible materials in closely packed piles or combustible materials on pallets, in racks or on shelves where the top of storage is greater than 12 feet (3658 mm) in height. Where required by the fire code official, high-piled combustible storage also includes* ***certain high-hazard commodities****, such as rubber tires, Group A plastics, flammable liquids, idle pallets and similar commodities,* ***where the top of storage is greater than 6 feet (1829 mm) in height.***

SECTION 3203

COMMODITY CLASSIFICATION

3203.1 Classification of commodities.

Commodities shall be classified as Class I, II, III, IV or high hazard in accordance with Sections 3203.2 through 3203.10.3. Materials listed within each commodity classification are assumed to be unmodified for improved combustibility characteristics. Use of flame-retarding modifiers or the physical form of the material could change the classification.

3203.6 High-hazard commodities.

High-hazard commodities are products presenting special fire hazards beyond those of Class I, II, III or IV. Group A plastics not otherwise classified are included in this class.

3203.8 Examples of commodity classification.

Table 3203.8 shall be used to determine the commodity classification for various products and materials. Products not found in the list shall be classified based on the classification descriptions in Sections 3203.2 through 3203.6 and the products they most nearly represent in Table 3203.8. Table 3203.8 considers the product and the packaging if listed with the item. Products with additional packaging consisting of Group A plastics shall be classified in accordance with Section 3203.9.

The commodity classifications are based on products with, or without, wood pallets. Where plastic pallets are used, the commodity classification shall be modified in accordance with Section 3203.10.

TABLE 3203.8EXAMPLES OF COMMODITY CLASSIFICATION

PRODUCT CATEGORY	PRODUCT	CLASSIFICATION
Batteries	Lithium-ion	High-hazard

SECTION 3206

GENERAL FIRE PROTECTION AND LIFE SAFETY FEATURES

3206.1 General.

Fire protection and life safety features for high-piled storage areas shall be in accordance with Sections 3206.2 through 3206.11.

3206.2 Type of protection.

Where required by Table 3206.2, fire detection systems, smoke and heat removal and automatic sprinkler design densities shall be provided to protect the high-piled storage area.

TABLE 3206.2 GENERAL FIRE PROTECTION AND LIFE SAFETY REQUIREMENTS

COMMODITY CLASS	SIZE OF HIGH-PILED STORAGE AREA[a] (square feet) (see Sections 3206.2 and 3206.3)	ALL STORAGE AREAS (see Sections 3206, 3207 and 3208)[b]				SOLID-PILED STORAGE, SHELF STORAGE AND PALLETIZED STORAGE (see Section 3207.3)		
		Automatic fire-extinguishing system (see Section 3206.4)	Fire detection system (see Section 3206.5)	Fire department access doors (see Section 3206.7)	Smoke and heat removal (see Section 3206.8)	Maximum pile dimension[c] (feet)	Maximum permissible storage height[d] (feet)	Maximum pile volume (cubic feet)
High hazard	0–500	Not Required[a]	Not Required	Not Required	Not Required	60	Not Required	Not Required
	501–2,500 Open to the public	Yes	Not Required	Not Required	Not Required	60	30	75,000
	501–2,500 Not open to the public (Option 1)	Yes	Not Required	Not Required	Not Required	60	30	75,000
	501–2,500 Not open to the public (Option 2)	Not Required[a]	Yes[g]	Yes	Yes[h, i]	60	20	50,000
	2,501–300,000	Yes	Not Required	Yes	Yes[h, i]	60	30	75,000
	Greater than 300,000[f]	Yes	Not Required	Yes	Yes[h, i]	60	30	75,000

403.10.6 Lithium-ion and lithium metal batteries.

An approved fire safety and evacuation plan in accordance with Section 404 shall be prepared and maintained for occupancies that involve activities for the research and development, testing, manufacturing, handling, storage of lithium-ion batteries or lithium metal batteries or the repair or servicing of vehicles powered by lithium-ion batteries or lithium metal batteries.

Exceptions. A fire safety and evacuation plan is not required for the storage or merchandizing of any of the following:

1. New or refurbished batteries installed for use in the equipment or vehicles they are designed to power
2. New or refurbished batteries packed for use with the equipment or vehicles they are designed to power for merchandizing purposes;
3. New or refurbished lithium-ion batteries rated at no more than 300 Watt-hours and lithium metal batteries containing no more than 25 grams of lithium metal in their original retail packaging;
4. The storage, repair and charging activities in detached one- and two-family dwellings and townhouses, provided that such devices are for personal use.
5. The storage, repair and charging activities associated with personal use in sleeping units and dwelling units of Group R-1 and R-2 occupancies.

403.10.6.1 Mitigation planning.

The approved fire safety and evacuation plan shall include thermal runaway event mitigation measures addressing activities undertaken to prevent thermal runaway, early detection of a thermal runaway event and mitigations measures to be undertaken to limit the size and impact of the event on occupants and the facility.

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