BATTERY ROOM SAFETY AND CODE REQUIREMENTS. WHAT HAS CHANGED?

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Abstract
Changes in requirements to meet battery room compliance can be a challenge. Local Authorities Having Jurisdictions often have varying requirements based on areas they serve. This paper addresses the minimum requirements from Local, State and Federal requirements and historical trends in various areas where local AHJs have changed requirements in their jurisdictions. Based on data collected, we will identify additional requirements that AHJs may impose on facilities in various regions or cities. Also, addressed are updates in the building code as it relates to battery racks and seismic protection. We will discuss the differences between UBC, IBC, IEEE and NEBS seismic requirements.

Introduction
Those responsible for compliance in a battery room may be in facility management, EH&S and also risk mitigation. The history of regulatory evolution has been a challenge to follow as the code writers went from regional to national organizations and committees. However, the responsibility for adoption and enforcement remains at the state or local level. With authorities required to meet basic requirements imposed by state oversight, local requirements based on local government demands and other safety and environmental requirements pertinent to the specific area.

State adoption is sometimes slow and also not inclusive of the entire code or a modified version of specific sections in the code. We will give some examples of this in this paper. We will also focus on the building codes as it relates to racks and what states have adopted more recent codes and which ones are still operating under legacy codes. Nevertheless, codes typically have a cycle for review and adoption. In most states it is 2-3 years, however as we will discover in this paper, it can be longer.

The difference between Model Codes and Codes
According to the National Institute of Standards and Technology (NIST) Circular No. A-119, Revised, a standard is "[t]he definition of terms; classification of components; delineation of procedures; specification of dimensions, materials, performance, designs, or operations; measurement of quality and quantity in describing materials, processes, products, systems, services, or practices; test methods and sampling procedures; or descriptions of fit and measurements of size or strength." In layman's terms, a standard provides minimum requirements and/or instructions in agreement within the industry for common reference. Common standards in the battery room include those from American Society of Testing Materials (ASTM) and Institute of Electrical and Electronic Engineers (IEEE).

Model codes are standards developed by committees with the intent to be adopted by states and local jurisdictions. Subject matter experts develop “voluntary consensus standards” that are saving the jurisdictions time and money by creating an industry-wide standard to follow. Once the model codes are adopted, they are enacted into law and become code.

Model Code and Regulation History

In Figure 1, you will notice Federal Regulations dictate how hazardous materials will be managed to protect the environment and people from Hazardous Reporting Management Plans (HMMP) to communications plans and protecting personnel from hazardous voltage. The Environmental Protection Agency (EPA) and the Occupational Health and Safety Administration (OSHA) must be mentioned as they enforce laws to protect the environment and people and may, in some cases, parallel industry standards. For example, OSHA may reference a standard or model code while enforcing the regulation.

A good example is NPA 70E. While NFPA 70E is not adopted in all areas as fire code, OSHA may reference NFPA 70E while enforcing the following regulation:

- 29 CFR 1910.147 The control of hazardous energy (lockout/tagout)
- 29 CFR 1910.331-336 Electrical
    - *Note: OSHA 1910.335(a)(2)(ii) addresses protective shields protecting personnel from high voltage*
- 29 CFR 1910.132, 137 Personal Protective Equipment

Model codes organizations are developed to give state guidelines for adoption of building codes and fire codes. These model codes have evolved over time, from regional to national organizations and have become the standard for state adoption. International model codes that are often times referred to as "I-codes" and are typically updated every few years. However, it often doesn't stop at the state level and moves on to local amendments and/or revisions by the local governments and enforcement agencies.

Model Code and Regulation History

Type	Legacy Code	Current Code
Environmental	**Environmental Protection Agency** 40 CFR 264.175 "Containment" 40 CFR 266.80 "Applicability and requirements" 40 CFR Part 370 “Hazardous Chemical Reporting: Community Right-To-Know”	
Health & Safety	**Occupational Safety & Health Administration** 29 CFR 1926.441 " Batteries and battery charging" 29 CFR 1910.268 "Telecommunications" 29 CFR 1910.151 "Medical services and first aid" 29 CFR 1910.333(a) " Selection and use of work practices" OSHA Directive CPL 02-02-079 / 29 CFR 1910.1200 [HCS 1994] Inspection Procedures for the Hazard Communication Standard (HCS 2012) 29 CFR 1910.335 "Safeguards for personnel protection"29 CFR 1910.333(c)(5) "Confined or enclosed workspaces" 29 CFR 1910.308 "Special systems"	
State & Local Building Code	**Uniform Building Code (UBC) 1927-1994** Section 304.8	**International Building Code (IBC)** *See State Adoption Table Fig 2*
	Building Officials and Code Administrators, National Building Code (BOCA/NBC) 1950-1999 Section 417	
	Standard Building Code (SBC) Section 407 & 2203	
	Southern Building Code Congress International (SBCCI)	
	NFPA 5000 (NFPA's version of the Building Code)	
State & Local Fire Code	**National Fire Code (NFC)** Section F-2315, F-2802	**International Building Code (IBC)** Section 608 "Stationary Storage Battery Systems"
	Uniform Fire Code (UFC) Stationary Lead-Acid Battery Systems Article 64, Section 80.304 & 80.314	**National Fire Protection Association (NFPA)** NFPA 1, Article 52 "Fire Code" NFPA 1 101 "Life Safety Code" NFPA 70 "National Electric Code" NFPA 70E 130 - 130.6(F) "Standard for Electrical Safety in the Workplace"
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Figure 1. Model Code History. Past to Present

State Adoption

In most cases, code adoption occurs at the state level, however, local jurisdictions have the option to modify as long as they meet minimum requirements as adopted in the state. In rare instances, codes are adopted by local municipalities. As mentioned earlier, code adoption can be a 3-year cycle, and many areas may use older versions of the code. Generally, codes are adopted at the state level but can be changed at the local level to meet requirements in that area, as long as they meet minimum codes the state adopted. Codes may be adopted from one model code or could be a blend of multiple model codes. There are exceptions to this rule in states that do not have statewide adoption, “deferred jurisdiction” or “Home Rule” which gives adoption authority to the local jurisdiction. In the table below, notice the state codes, how they are adopted at a state or local level, and the version currently adopted. A good example of a published local code is NYC B-29. Though NYC adopted the IFC as the state code, New York City’s population demands more regulation.

State Adoption of Fire Code

State	Fire Code	Adoption	State	Fire	Adoption
AL	IFC (2009)[1]	State	MT	IFC (2012)	State
AK	IFC (2012)	State & Local	NE	NFPA 1-UFC (2003)	Local
AZ	IFC (2012)	Local	NV	IFC (2012)	Local
AR	IFC (2012)	State	NH	NFPA1-UFC (2009) with amendment	State
CA	IFC (2015)	State	NJ	IFC (2006)	State
CO	No statewide code[2]	Local	NM	IFC (2003) for new construction, NFPA 1	State
CT	Portions of NFPA 1-UFC (2003), IFC (2003),	State	NY	IFC (2015)	State
DE	NFPA 1-FC with Amendments	Local	NC	IFC (2009) with Amendments	State
DC	IFC (2012) with amendments	City	ND	IFC (2015) with NFPA standards	State
FL	NFPA 1-FC with Amendments	State	OH	IFC (2015)	State
GA	IFC (2012) with amendments	State	OK	IFC (2009)	State
HI	NFPA1-UFC (2006) with amendment	State	OR	IFC (2012) reference only	State & Local
ID	IFC (2015) with state revisions	State	PA	UCC adopted by IFC (2009), IFC (2015)	Local
IL	NFPA Life Safety Code (2000)	Local	RI	NFPA 1-UFC (2012)	State
IN	IFC (2012) with amendments	State	SC	IFC (2015)	State
IA	IFC (2015) by reference	State & Local	SD	IFC (2015)	Local
KS	IFC (2006) and NFPA standards	Local	TN	IFC (2012)	Local
KY	NFPA 1-FC (2012) and other NFPA standards	State	TX	NFPA 1-FC (2012)	State & Local
LA	NFPA 1-FC (2012)	State	UT	IFC (2015)	State
ME	NFPA 1-UFC (2006) with Amendments	State	VT	NFPA 1-FC (2012), NFPA 101 Life Safety	State
MD	NFPA 1-FC (2015)	State	VA	IFC (2012) with amendments	State
MA	NFPA 1-FC (2012) with Amendments	State	WA	IFC (2015)	State
MI	NFPA 1-UFC (2006) with Amendments	State	WV	NFPA 1-FC (2012)	State
MN	IFC (2012) with amendments	State	WA	NFPA 1-FC (2012)	State
MS	IFC (2012)	Local	WY	IFC (2015) with Appendices	State
MO	None	Local	PR	IFC (2009)	State

Figure 2. State Adoption of Fire Code

[1] State Buildings IFC (2015)
[2] IFC (2015) for Schools, Jr. Colleges, IFC (2012) Healthcare Facilities
[3] CT State Fire Safety Code

Rack Seismic Requirements

Rack seismic requirements have evolved over the years as well. The Uniform Building Code (UBC) has been around for over 30 years and was created simply with a map easily understood by all. The last update to UBC was in 1997 and since then, new codes have replaced and have been widely adopted throughout the country with IBC 2012 and later model codes. These new seismic codes and standards also come with their own various and unique testing and certification methods, which have a great effect on battery rack design. In Figure 3, notice that most states have adopted newer versions of the building code. Also noted is the version the adopted and if they are state or locally adopted. In real life, you will find exception taken to the new IBC seismic codes due to its complexity, but the question remains…for how long? At some point, enforcement will catch up.

State	Building Code	Adoption
AL	IBC (2009)[4]	Local
AK	IBC (2012)	State
AZ	IBC (2012)	Local
AR	IBC (2012)	State
CA	ICC (2016)	State
CO	IBC (2015)	Local
CT	SBC (2016)	State
DE	ICC (2015)	Local
DC	ICC (2012)	City Counsel
FL	FBC (2010)	State
GA	IBC (2012)	State
HI	IBC (2006)	State & Local
ID	IBC (2012)	State
IL	IBC (2009)	State
IN	IBC (2012)	State
IA	IBC (2015)	Local
KS	IBC (2003)	Local[5]
KY	KBC (2013)	State
LA	IBC (2012)	State
ME	IBC (2015)	State
MD	IBC (2015)	State
MA	IBC (2009)	State
MI	IBC (2015)	State
MN	IBC (2012)	State
MS	IBC 2015	Local
MO	IBC (2012)	Local*[6]

State	Building Code	Adoption
MT	IBC (2012)	State
NE	IBC (2012)	Local
NV	IBC (2012)	Local
NH	IBC (2009)	State
NJ	IBC (2015)	State
NM	IBC (2015)	State & Local
NY	IBC (2015)	State
NC	IBC (2015)	State
ND	IBC (2012)	State & Local
OH	IBC (2015)	State
OK	IBC (2009)	State
OR	IBC (2012)	State
PA	IBC (2009)	State
RI	IBC (2012)	State
SC	IBC (2012)	State
SD	IBC (2015)	Local
TN	IBC (2012)	State & Local
TX	IBC (2006)	State & Local
UT	IBC (2015)	State
VT	IBC (2015)	State
VA	USBC (2012)	State
WA	IBC (2012)	State
WV	IBC (2015)	State
WA	IBC (2009)	State
WY	IBC (2015)	State
PR	IBC (2009)	State

Figure 3. Building Code by State

[4] Except state government buildings which adopted IBC 2015
[5] State government buildings follow state adoption
[6] State government buildings follow state adoption

Comparison Summary

IBC, CBC, and OSHPD all require triaxial shake testing to be certified for an (Ip) of 1.5. The (Ip) of 1.5 is a factor assigned to a component required to function for life safety purposes or if the component contains hazardous material. It is also assigned to “components in Essential Facilities where the component failure could impair the continued operation of the facility." These three codes use site-specific SDS values that account for the specific site factors rather than Zones or Levels which is the case with IEEE 693, UBC and NEBS.

NEBS and UBC when qualified by shake testing only requires the testing of one axis at a time. UBC only requires the X and Y axes (side to side and front to back) while NEBS also includes the vertical axis. Both NEBS and UBC use zones rather than site-specific parameters when selecting the seismic level required for any given site. IEEE 693 shake testing is triaxial but it also uses zones similar to NEBS and UBC rather than site-specific parameters. IEEE 693, NEBS and UBC can also be certified through finite element analysis (FEA) since there is no "Essential Facility" rating that requires shake testing. Some end users, however, may require or prefer that rack and cabinet designs be based on shake table test data.

One of the principal differences between all of these seismic codes and standards (other than the levels they are tested to and/or certified) is the use of **seismic zones vs. site-specific parameters**. The method of using zones makes engineering projects simpler compared to looking up site-specific parameters to get an SDS value. Design of spectral accelerations at short periods is required in IBC 2012 and later model codes. However, when looking at site-specific factors such as soil class and location in the building, the exact level of seismic protection required may be lower or higher than using a map with broad zones.

The chart below (FIG 4) indicates the various seismic standards and regulations based on industry segment.

UBC	Data Center and General	1997	Uses Color-coded map for Zones. X and Y axis have forces applied through shake testing or analysis. No vertical forces are accounted for in UBC. Shake testing is one axis at a time front to back and then side to side only. Rack design required is based on the "Zone" only. No individual site factors are taken into account.
IBC	Data Center and General	2018	IBC uses SDS value that takes into account not only the area the site is in but also individual site factors such as Soil Class, Location in the building and Site Class or Importance Factor (Essential or Non-Essential Facility). There are no "Zones" with IBC and instead, each individual site has its own SDS value. Shake testing is required to be certified for “Essential Facilities”. The Shake testing method is Tri-Axial (all three axes hitting randomly) and should follow International Code Council Evaluation Service Acceptance Criteria for Seismic Certification of Nonstructural Components (ICC-ES AC 156).
CBC	Data Center and General	2016	CBC is essentially a carbon copy of IBC which is why it is released 1 year after the latest version of IBC. Once IBC 2015 came out CBC 2016 came out the following year.
IEEE 693	Utility	2005	IEEE 693-05 qualification can be achieved in three levels: Low, Moderate and High. Qualification can be gained through shake table testing or through FEA. As with IBC Shake testing the IEEE 693 seismic shake table testing will follow ICC-ES AC 156. Qualification through FEA will follow ASCE-7-10 guidelines and requirements. There are three Qualification levels for IEEE 693 based on seismic severity: Low, Moderate and High.
GR-63, NEBS™ Requirements	Telecommunications	2017	NEBS Seismic Certification is typically only accepted by end users though Shake table testing. The Standard for Earthquake testing is found in GR-63-CORE. This shake testing does test all three axes but one at a time. There are criteria for passing Zone 2 and more severe testing criteria for Zone 4.
OSHPD	Hospital	2016	Requires Triaxial Shake testing to a target SDS like IBC only OSHPD requires the test be done with live batteries. The batteries must be running before and after the shake test which makes this arguably the most expensive test to administer because live batteries are required and likely would not be used in the field.

Figure 4. Rack Seismic Requirements

Aforementioned, there is a difference between Codes and Standards. NEBS is classified as standard whereas IBC is classified as a model code, which can become law when adopted by the proper state or local authority. Even if a company installs a NEBS-certified battery rack in a site, the building inspector can still require the rack to be certified to IBC or any other building code that city or state has adopted.

Which seismic code or standard is the best fit?

The best seismic code or standard may be subjective and depending on the industry, options might be limited. There are many Telecommunication companies that use NEBS and many in the Utility Industry that use IEEE 693 for their seismic standards related to battery racks and cabinets. Industry standards can be met while maintaining certification to IBC and other building codes. Check with your local AHJ to what standard applies to your application and meets your local area's code requirement.

Summary

Last year during a question and answer session, one person stood up and referred to the topics covered in this paper as "Kangaroo Codes." That person was very close to the truth about following and complying with codes. Various codes and many times industry standards can create a web of confusion for the person responsible for managing these aspects of a site. Federal agencies write regulations for protecting the environment and people. The states have unique requirements for their particular areas and may adopt model codes (I-Codes) and enact them into law, but the primary responsibility for protecting the people and their surroundings is the local governments. In the majority of states, the local government and authority having jurisdiction (AHJ) have the ability to modify the state adopted code. In reality, the federal code can supersede any state or local code. In short, do your homework and cover your bases. Requirements in each area can differ from state-to-state, county-to-county, and even city-to-city.

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