BATTERIES AND CODES: WHO WANTS WHAT?

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ABSTRACT

Fire Codes, Building Codes, Electric Codes, Safety Codes, Environmental Regulations… they all have force of law, and they all want to say something about batteries. Sometimes a user can feel pulled in many directions. What do the codes really say? Which one matters? This paper identifies the codes in North America that regulate the installation and operation of battery systems, and it summarizes what they have to say. Some codes are surprisingly lax, while others are unnecessarily narrow and sometimes out of step with battery technology. The appendix includes a table that summarizes it all for quick reference.

UNDERSTANDING CODES

First we need to clarify that "Codes" and "standards" are not the same. Standards are voluntary, even though failure to comply with standards may result in undesirable consequences. For example, manufacturers use standards to make their products acceptable to users, so that the thread of a nut corresponds to the thread of a bolt no matter who makes it. Other standards are recommended practices or guidelines. For example, a user can get maximum life from a battery by choosing to follow standard installation and maintenance guidelines.

Codes, on the other hand, are not voluntary. Codes are laws. There are criminal codes, safety codes, building codes, civil codes, tax codes, etc. Codes are created by local, regional, state or federal governments and are enforced by government officials. For example, the police, sheriff, or FBI will enforce whichever criminal codes is appropriate for their jurisdiction. Likewise, fire marshals, electrical inspectors, mechanical inspectors, etc. will enforce building codes. On any given construction project, inspection and/or approval by one or all of these inspectors may be required. They are collectively referred to as the Authorities Having Jurisdiction (AHJ).

A battery room, for example, might be visited by the electrical inspector who will approve it once he is satisfied that cables have been properly sized, protected and run in appropriate raceways. The same room might be "red tagged," however, by a fire marshal who is dissatisfied with the method of electrolyte spill containment. Or a mechanical inspector whose jurisdiction covers ventilation might prevent commissioning of the system because he is dissatisfied with the way air is exhausted.

We create codes with the hope that everybody will get to work on a "level playing field." Inspectors should not be able to capriciously favor one installation over another. In practice it does not always work that way, although the system works pretty well. Codes, languages, and people are all imperfect. The AHJ has the final say based upon their *interpretation* of "the code," and their interpretation might be different from yours.

In the United States, each city, township, county or state gets to decide what code it wishes to enact. Each of these entities could assign a committee to sit down and write a set of rules for its residents. However, that is obviously impractical, so they look around for a code that already exists that they can "adopt." They don't have to look far. A number of organizations exist whose sole purpose is to write "model codes." The community simply shops among the competing model codes and adopts the one it likes best. The community is not obligated to have a code on any particular issue; so one city might have a mechanical code while another city does not. Likewise, once a code is enacted, the city is not compelled to update or revise it just because the model code has been updated. A large number of cities, such as Chicago, New York, and Phoenix have modified the model codes to suit their own local needs. Model code organizations usually wish to continue their existence, so they have little motivation to duplicates a competing organization's model code. Consequently, instead of harmony and consistency, each model code is intentionally different. The result is a hodgepodge of codes that differ from one place to the next.

Take fire codes, for example. In the U.S.A., three organizations are responsible for almost all of the fire codes that are in place. For many years the Western Fire Chiefs Association wrote the Uniform Fire Code (UFC) that was used by most cities west of the Mississippi River. Recently that group relinquished publication of the UFC to the National Fire Protection Association (NFPA), which rewrote it and now publishes the Uniform Fire code in place of its previous NFPA-1 document. A third organization is the International Code Council (ICC), which publishes more than a dozen International Codes (or "I-Codes"), one of which is the International Fire Code (IFC). There are communities that still use Uniform Fire Code versions from as far back as the 1980's. Most communities are more up to date, but only a few have adopted the most current versions. NFPA is trying hard to get the current UFC adopted nation-wide, but so far only California, Phoenix, New York City, Las Vegas and a handful of other localities have adopted it. Meanwhile, cities and states from the east coast to the west coast are adopting the IFC.

T he National Electric Code (NFPA 70, or NEC) is an exception to the rule. NFPA has been publishing the NEC for decades. It pretty much stands alone as the only electric code in the U.S.A. Its use is so pervasive that even the International Electric Code incorporates the NEC by reference.

The federal government publishes its rules in an enormous set of documents called the Code of Federal Regulations (CFR). One of these, #40, covers all the rules for the Environmental Protection Agency (EPA). Another, #29, covers all the rules for the Occupational Safety and Health Administration (OSHA). Both of these organizations sweep with a wide brush that includes consideration for batteries, some of which are complementary and some of which are contradictory.

BATTERY CODES

Time and space do not permit a detailed analysis and description of every code, each of which could be a paper of its own. Table 1 attempts to identify the main organizations and to highlight what their documents say about stationary batteries. This paper offers only the briefest summary. The reader is encouraged to examine the actual documents to find the exact wording, and to determine what codes have been adopted in the reader's locality. A close inspection will reveal that (1) some codes overlap, and (2) some documents contradict one another, so that one could not comply with one without violating another.

For example, NFPA's National Electric Code (NFPA 70), in Article 480, says that batteries must be segmented so that no segment has over 250 volts. Another NFPA document, NFPA-70E (Standard for Electrical Safety Requirements for Employee Workplaces), says that no battery segment should have more than 120 volts.

A couple pieces of good news in the above example are, (1) while the NEC is adopted almost everywhere, only a handful of jurisdictions cite the NFPA-70E document; and (2) NFPA-70E is a standard, not a code. Its purpose, as stated in the foreword, is to elaborate on the NEC in order to make it more understandable. Where contradictions or omissions occur, the NEC is the guiding document. Some other (possibly) surprising requirements in NFPA 70-E:

- No more than four strings of batteries can be paralleled
- Battery jars must have a minimum of one inch separation
- Batteries in cabinets must have a minimum of twelve inch clearance above them

The reader may discover other inconsistencies. In such cases, one may choose to comply with the most stringent. If caught in a compliance issue with the AHJ, one can try to persuade the inspector that the installation complies with a different document (but don't expect to win with this very often). Anyone who has the time can request a change in a code. This requires compliance to a very strict procedure. Changes must be made on the appropriate form and must be submitted within a narrow time frame. Information on how to change a code is usually available on the model code organization's Internet web site. Once again, remember that changes to the model code do not automatically drive changes to the local code. It may be necessary to follow a similar change request at the local level.

SUMMARY

Examples of other battery related code requirements:

- Spill containment is required on flooded battery systems with greater than 1,000 gallons of electrolyte under the current Uniform Fire Code, but spill containment may be required on flooded batteries with as little as 50 gallons under the International Fire Code or older UFC
- The International Fire Code has rules only for lead-acid batteries; NiCad or other battery types can only be covered under rules for hazardous locations
- The NEC requires batteries used on legally-required standby systems to have a minimum of 1.5 hours backup
- NFPA 70E requires 3-foot aisles in battery rooms. The NEC (NFPA 70) Article 110.26 is not specifically for batteries, but also requires at least a 3-foot aisle to allow maintenance on energized equipment
- NFPA 75 says that any system larger than 750 VA installed in a data center must include a battery disconnect
- NFPA 110 requires that batteries used on emergency and standby power systems must be inspected weekly and discharged quarterly. Lead-acid batteries must be replaced every 24-30 months, irrespective of manufacturer's design life
- NFPA 111 requires that standby power systems in which batteries are the primary energy reserve must be partially discharge tested quarterly and fully discharged annually
- OSHA requires material safety data sheets (MSDS) for batteries
- EPA requires large battery installations to submit "Tier I" and/or "Tier II" inventory reports in March of every year to local and state agencies
- EPA requires reporting of battery spills that go beyond the boundary of the facility
- The National Electrical Safety Code applies to Utilities and large industrial users. It has rules for electrolyte in lead-acid batteries but NiCad batteries are not mentioned
- The official NFPA Glossary of Terms is supposed to identify terms used in multiple documents so that they don't have to be repeatedly defined. The glossary says that a battery is a collection of fireworks. (Is this true? If the battery is properly installed and maintained it shouldn't be!)

Many codes have sections that stipulate rules for battery sites. Most applicable codes are identified in the table attached to this paper, although only a few of the regulations are listed here. Many of the codes may not apply to your particular location. The user needs to consider the size of the battery and what rules have been adopted by the local jurisdiction. The AHJ is always right, but sometimes he or she can be reasoned with if you show that you have complied with a different section or code. Anybody can request a change to a code, but the process is long and challenging.

BIBLIOGRAPHY

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Table 1: SUMMARY OF BATTERY CODES & STANDARDS

ORGANIZATION	DOCUMENT NAME &/or NUMBER	SECTION, PARAGRAPH, &/or ARTICLE	SIGNIFICANCE FOR STATIONARY BATTERY SYSTEMS
National Fire Protection Association **(NFPA)** www.nfpa.org	**NFPA 1** Uniform Fire Code	CHAPTER 52 - Stationary Lead Acid Battery System	• Applies to systems >50 gal electrolyte (100 gal if sprinklered) • Spill containment on flooded battery systems >1,000 gallons of electrolyte • Neutralization for 1 jar • Controlled access • Ventilation 1 cu ft/ min / sq ft of floor space • Safety signs required • Seismic bracing when applicable • Smoke Detection
	NFPA 70 National Electric Code	ARTICLE 480 – Storage Batteries	• Applies to all stationary batteries, including lead-acid and alkali (nicad) • Over-current protection is required • Batteries must be segmented, so no segment has >250V • Ventilation required to prevent explosive mixture (NEC Handbook says treat VRLA and VLA the same)
		ARTICLE 110.27 Guarding of Live Parts	• Live parts must be guarded against accidental contact if >50V • Warning signs required
		ARTICLE 250, Part VIII Grounding of Direct Current Systems 250.160 through 250.169	• Grounding required on systems supplying premises wiring > 50V but <300VDC
		ARTICLE 701 Legally required standby systems	• Periodic maintenance is required by AHJ on batteries used for control, starting, or ignition of prime movers; written records must be kept • Batteries must supply 87.5% of nominal load for 1.5 hours • Automatic charging, independent of gen set, must be provided on batteries used for control or signal power or for starting prime mover

ORGANIZATION	DOCUMENT NAME &/or NUMBER	SECTION, PARAGRAPH, &/or ARTICLE	SIGNIFICANCE FOR STATIONARY BATTERY SYSTEMS
	NFPA 70 National Electric Code (Continued)	ARTICLE 702 Optional Standby Systems	UPS is mentioned, but batteries are not
NFPA (National Fire Protection Association) [Continued]	**NFPA-70E** Standard for Electrical Safety Requirements for Employee Workplaces	PART IV, Chapter 3 Safety Requirements Related to Batteries and Battery Rooms	• Battery rooms are intended for batteries & have no other protective enclosure • Cells of unequal capacity should not be connected in series • Maximum 4 strings in parallel • Fault level = 20X nominal capacity at 3-hour rate • Bus bars must be insulated • Very specific monitoring alarms • Minimum 1" space between adjacent battery jars • Ventilation must exhaust to outside • Minimum 36" aisle • 12" minimum space above a battery in a rack • Batteries must be segmented, so no segment has >120V • Ground fault detector on batteries >120V • Isolating switch required • Warning signs for arc hazard • Protective equipment must be worn • Where mechanical ventilation is installed… all exhaust air must be discharged outside the building

ORGANIZATION	DOCUMENT NAME &/or NUMBER	SECTION, PARAGRAPH, &/or ARTICLE	SIGNIFICANCE FOR STATIONARY BATTERY SYSTEMS
NFPA (National Fire Protection Association) [Continued]	**NFPA-75** Standard for the Protection of Electronic Computer/Data Processing Equipment	All	• UPS & battery permitted in the IT room • Battery disconnect is required on UPS > 750 VA
	NFPA-76 Recommended Practice for the Fire Protection of Telecommunications Facilities		Defers to the National Electric Code (NFPA-70) for battery
	NFPA-90A	Standard for the Installation of Air Conditioning and Ventilation Systems	• Refers to NFPA 70 (NEC) and NFPA 75, considered part of the requirements of this document • Batteries or UPS are not mentioned
	NFPA 101	Life Safety Code	• Batteries for emergency lighting & smoke detectors – installation, operation, & maintenance • Refers to NFPA 70 (NEC)
	NFPA 110 (Revised 2004)	Standard for Emergency and Standby Power Systems Article 5.6.4 ~	• Starting batteries for prime movers - Installation, operation & maintenance requirements • Nicad or Lead Acid • Quarterly discharge testing & weekly maintenance / inspection • Revised to allow impedance testing vs. specific gravity test • Revised to allow VRLA • LA replacement interval 24-30 months

ORGANIZATION	DOCUMENT NAME &/or NUMBER	SECTION, PARAGRAPH, &/or ARTICLE	SIGNIFICANCE FOR BATTERY SYSTEMS
NFPA (National Fire Protection Association) [Continued]	**NFPA 111** (Revised 2004)	Standard on Stored Electrical Energy and Standby Power Systems	• Stationary Nicad & LA batteries (VRLA and flooded) for emergency power supplies >500 VA • Requires a central battery system – open rack, &/or console or package style (excludes unit equipment w/ self-contained batteries) • Quarterly load tests, 5-minutes minimum, and annual 100% DOD test • Quarterly voltage equalize charge
	NFPA 5000	Building Construction & Safety Code	• Corrosive material in batteries exempt from "high hazard" contents • Rules for batteries in emergency lighting & smoke alarms
	NFPA Glossary of Terms	www.nfpa.org/PDF/definitions.pdf?svc=nfpa	• **Battery: A collection of fireworks** devices • **BATTERY CERTIFICATION:** The certification by a battery manufacturer that a battery was built to industry standards • **BATTERY RESERVE CAPACITY: The** number of minutes for which a new, fully charged battery at **80°F** can be discharged at **25 amperes** while maintaining a voltage of **1.75 volts per cell** or higher (10.5 volts for a 12-volt battery or 5.25 volts for a 6-volt battery)

ORGANIZATION	DOCUMENT NAME &/or NUMBER	SECTION, PARAGRAPH, &/or ARTICLE	SIGNIFICANCE FOR BATTERY SYSTEMS
International Code Council (ICC) www.iccsafe.org	**International Fire Code IFC**	Chapter 608 – Flooded batteries	• Applies to vented battery systems w/ >50 gallons of electrolyte • Spill control & neutralization required • No special fire-resistive separation requirements or occupancy classifications • Ventilation 1 cu ft/ min / sq ft of floor space (no more than 1% hydrogen per volume of room) • Smoke detectors required • Seismic bracing required where appropriate
		Chapter 609 – VRLA batteries	• Applies to VRLA battery systems w/ >50 gallons of electrolyte • No Spill control • Neutralization of one jar required • Thermal runaway method is required • No special fire-resistive separation requirements or occupancy classifications • Ventilation 1 cu ft/ min / sq ft of floor space (no more than 1% hydrogen per volume of room) • Smoke detectors required • Seismic bracing required where appropriate
	International Mechanical Code IMC	Section 403 – Mechanical Ventilation Section 510 – Hazardous exhaust systems	• Batteries, battery rooms, IT centers, telecommunication centers, or UPS are not mentioned in IMC • *International Mechanical Code Commentary* describes hydrogen lower & upper flammability level (LFL = 1%)
	International Building Code IBC	Section 1615 – Earthquake Loads	• The words batteries, battery rooms, IT centers, telecommunication centers, hydrogen, electrolyte, acid or UPS are not mentioned in IBC • Earthquake zone maps are basis for battery rack seismic ratings

ORGANIZATION	DOCUMENT NAME &/or NUMBER	SECTION, PARAGRAPH, &/or ARTICLE	SIGNIFICANCE FOR BATTERY SYSTEMS
Federal Government of the United States **TITLE 29 – DEPT. of LABOR** Ch XVII **OSHA** Occupational Health and Safety Agency Subpart Z **Toxic & Hazardous Substances** www.gpoaccess.gov/ecfr/index.html	29 CFR 1910.1000 Air Contaminants	Table Z1 – Limits for Air Contaminants Table Z2 1910.1025 App C	• Limits for hydrogen sulfide, lead, sulfuric acid, & hydrogen sulfide • Additional limits for hydrogen sulfide • Medical Surveillance Guidelines – Health Effects of Lead (lead-acid battery mfg)
	29 CFR 1910.1200 Hazard Communication	Appendix A – Definitions	• Defines terms used by EPA incl.: Acute, Chronic, Carcinogen, Corrosive, Toxic, Highly Toxic, Irritant, & Sensitizer
		Appendix E - Guidelines for employer compliance	• Requires a hazard communication program • Requires Material Safety Data Sheets (MSDS) – responsibilities for manufacturers, distributors, and employers • Compliance checklist •
	29 CFR 1926 – Subpart K – Safety Requirements for Special Equipment	1926.441 – Batteries and chargers	• Safety requirements for unsealed batteries & chargers in new construction projects • Well ventilated, acid protected, eye wash & neutralization required •

ORGANIZATION	DOCUMENT NAME &/or NUMBER	SECTION, PARAGRAPH, &/or ARTICLE	SIGNIFICANCE FOR BATTERY SYSTEMS
Federal Government of the United States **TITLE 40 –** Protection of the Environment **Ch I** **EPA** Environmental Protection Agency **Subchapter J** **Superfund, Emergency Planning, and Community Right to Know Act (EPCRA)** www.gpoaccess.gov/ecfr/index.html	40 CFR 302 – Designation, Reportable Quantities, and Notification	Table 302.4 Reportable Quantities – Hazardous Substances	• Requires verbal & written notification to authorities for accidental or intentional spill or release of ➢ 10 lbs lead dust ➢ 10 lbs lead sulfate ➢ 1,000 lbs sulfuric acid beyond the boundaries of a facility
	40 CFR 355 Emergency Planning and Notification	Threshold Planning Quantities-Extremely hazardous substances 355.50 - Penalties for non-compliance	• Requires facility to develop & implement state & local emergency proactive response plans for extremely hazardous substances ➢ 500 lbs sulfuric acid ➢ w/in 60 days after receipt • Civil: $25,000 - $75,000/day/each violation • Criminal: $25,000 - $50,000 fine &/or 2 yrs in prison / each conviction
	40 CFR 370 Hazardous Chemical Reporting: Community Right to Know	Subparts A – General Provisions: Purpose, Definition, & Penalties B – Reporting Requirements: Applicability, MSDS reporting, Inventory reporting, mixtures C – Public Access & Availability of Information: Requests-for & provisions-of information D - Inventory FORMS: Tiers I & II	• Requires annual Tier I or Tier II reporting of hazardous chemicals present on a facility exceeding Threshold Planning Quantity (TPQ): ➢ 10,000 lbs lead ➢ 500 lbs sulfuric acid • Requires submittal of Material Safety Data Sheets to local & state jurisdictions • Penalties for non-compliance - $10,000/day – Failure to provide MSDS - $25,000/day – Failure to submit Tier I/II reports
	40 CFR 372 Toxic Chemical Release Reporting: Community Right-to-Know	PART 372, Subparts: - A – General & Definitions - B – Reporting Requirements - C – Supplier Notification - D – Toxic Chemical Listings - E – Forms & Instructions	• Suppliers in certain SIC codes must notify persons to whom they distribute products containing toxic chemicals • Battery manufacturers annually report (July 1) on Toxic Release Inventory "Form R" presence of chemicals that are manufactured or processed in a year in quantities above threshold quantities: ➢ 100 lbs lead ➢ 10,000 lbs sulfuric acid

ORGANIZATION	DOCUMENT NAME &/or NUMBER	SECTION, PARAGRAPH, &/or ARTICLE	SIGNIFICANCE FOR BATTERY SYSTEMS
Federal Government of the United States **Department of Transportation** www.myregs.com/dotrspa	49 CFR Chapter I Subchapter C Hazardous Material Regulations	Part 172 Table 172.101 Hazardous Materials Parts 173 – Shippers 174 – Rail 175 – Aircraft 176 – Vessel 177 – Public Highway 178 – Packaging 180 – Continuing qualification	• Marking, Labeling & Placarding Reqmts • Nicad & Lead-Acid batteries Hazard Class 8 – Corrosive Material (defined in 173.136) • All batteries must be protected against short-circuit & be firmly secured to skids or pallets capable of withstanding shock • Nonspillable wet electric storage batteries excepted for other requirements but must be marked NONSPILLABLE BATTERY & must pass vibration & pressure differential tests
IEEE Institute of Electrical & Electronics Engineers www.ieee.org	ANSI C2 National Electrical Safety Code (NESC)	Part 1 – Electric Supply Stations Section 14 – Storage Batteries Part 4 – Operation of Electric Lines Section 42, General Rules for Employees 420: Personal General Precautions	• Applies to electric supply station systems & equipment operated by utilities or large industrial establishments • Space sufficient to safely maintain batteries • Accessible only to qualified personnel • Ventilate to < explosive level • Firmly anchor racks • Floors coated w/ acid-resistant material; spill containment • Proper eye protection & clothing • Safety signs required
State of California Environmental Protection Agency **Office of Health Hazard Assessment** www.oehha.ca.gov/prop65/prop65_list/newlist.html#download	Proposition 65 Safe Drinking Water & Toxic Enforcement Act of 1986	25249.6 Required Warning Before Exposure to Chemicals Known to Cause Cancer or Reproductive Toxicity 25249.7(b)(1) Enforcement	• Labeling requirement: Battery posts, terminals, & related accessories contain lead & lead compounds, chemicals known to the State of California to cause cancer & reproductive harm. Wash hands after handling • Penalty for non-compliance $2,500/day