GOOD INTENTIONS POORLY EXECUTED -
CODE "BLOOPERS" FOR STATIONARY BATTERY SYSTEMS

Dan McMenamin
Dan McMenamin and Associates

Steve McCluer
APC by Schneider Electric

Hollen E. Crim, P.E.
Crim Sales & Engineering

INTRODUCTION

Across North America, the industry generally follows IEEE standards, the National Electrical Code and industry best practices for the engineering, handling and installation, commissioning and maintenance of stationary battery systems. Typical applications are telecommunications, life-safety (emergency) systems, energy utilities, or Uninterruptible Power System (UPS) applications. These standards and practices provide very detailed and well vetted direction for the safe management of the many steps and skill levels needed for a safe and reliable job.

The industry also faces a sometimes daunting phalanx of local codes with esoteric criteria that can complicate the installation. Sometimes it's a matter of jumping through a few extra hoops and maybe adding cost. In other cases, the complications introduced by local requirements can actually reduce the reliability of the system, with a corresponding possible compromise of life safety. The role of the Authorities Having Jurisdiction (AHJ) is an important one as they are significant players to assure that the interest of public safety is well represented on the team that provides a stationary battery system. With safety and reliability being key goals of that team, a cooperative approach between the players usually produces the best result... but not always.

One example of a code-blooper is the demand for spill containment systems for Valve Regulated Lead Acid batteries. By design, the electrolyte in this battery technology is so solidly immobilized that it couldn't produce more than a few drops of fluid if someone cut the battery cells in half! It is for this reason that the transportation requirements for such cells are not overly demanding. Yet, in some municipalities it is forbidden to place a VRLA battery without a spill containment system. Aside from the obvious conflict of putting spill containment on a battery that is clearly identified as "non-spillable," the containment system can cause the battery space to project further into an aisle, possibly causing a trip and fall hazard to a first responder wearing bulky turn-out gear groping his or her way through a vision obscured environment.

This paper will describe the problem and offer other-examples where local codes – or code interpretations - produced sub-optimized systems or even outright problems. They beg the question whether it is perceptions or reality that drives local codes. The paper will speak to batteries in both battery rooms and cabinetized systems in computer rooms or other equipment spaces, or even in administrative areas.

TO EPO OR NOT TO EPO – THAT IS THE QUESTION

More than one U.S. jurisdiction has issued an ordinance amending the National Electrical Code (NFPA 70) to require a kill switch on the outside of the building so that the fire department can kill all power in the building with the turn of a key…including battery back-up. On the surface this "Emergency Power Off" (EPO) looks like a good feature and certainly the safety of fire service personnel is a critically important matter. The problem arises by the use of the word "all power" when describing a power disconnect for a telecommunications central office, often called an "exchange" or a "Central station", or in cellular telephone lingo, a Mobile Service Center (MSC) or Mobile Telephone Switching Office (MTSO).

It is significant that in more than 114 years of telephone service in the United States, there have been only seven significant central office fires and no loss of life during those events.

Dating back to the introduction of Telecommunications services in the late 1800's, public safety depends heavily on communication between first responders and the public they serve. For decades, even people without telephones in their homes relied on the telecom network because street corner "Pull-boxes" and other coded signaling apparatus used central office circuits (and dc power) to alert fire service to a need for their response. When a fire occurred in a Los Angeles central office dc power plant during modifications, the fire area was only 50 square feet. Yet, the loss of dc power to switching and circuit transport equipment caused a widespread outage to more than 150,000 lines, including lines and alarm circuits to firehouses throughout Los Angeles. At the time of the fire in March of 1994, it was a common practice for firemen to turn off the station radios and sleep, relying on telephones and alarm circuits to alert them to a need for their services. Other fire dispatch stations observed a large number of trouble indications from commercial alarm transmitting units throughout the valley but they had no way to know what might be a fire and what wasn't. [1]

Throughout the world, the nature of the telecommunications network is that a central office serves the telephone customers within a radius of perhaps five miles and as few as a few hundred to as many as 80,000 lines. A cellular telephone central office serves a much wider geographical radius, perhaps much or most of a state and as many as 500,000 lines. In addition to the customers lines that they serve directly, circuits called "Trunks" connect central offices together in a lattice type arrangement. It would be technologically and economically impossible for every central office in the world to have trunks to every other central office and so the trunks interconnect through circuitry and switching systems to accomplish a worldwide network. If a central office loses dc power, that facility with all of its customers and any circuits working through it fail, probably for hours as a detailed restart procedure is needed to recover from even a momentary dc power loss.

A small, contained central office fire of approximately 1,200 square feet in May of 1988 at the Hinsdale IL Central Office, a suburb of Chicago, made it necessary for fire fighters to shut down dc power to the facility. While the fire area was small, the interruption of dc power to the building's network systems caused major problems. The result was the loss of telephone services in Hinsdale and in 6 communities around it (Please see Figure 1), including Mutual Aid between other fire departments due to the lack of telephone service. Further, the service lapse interrupted Air Traffic Control data between Aurora IL, through Hinsdale to the control towers at O'Hare International Airport causing massive flight delays. [2]

Loss of dc power to a central office cripples telecommunications for a very wide area and in large part was the impetus for the Federal Communications Commission to create an organization called the Network Reliability and Interoperability Council (NRIC). In their practices, NRIC warns against disconnects for telecommunications dc power plants. [3]

NRIC Best Practice 6-6-5210 reads: "Service Providers and Network Operators should discourage use of Emergency Power Off (EPO) switches between the primary battery supplies and the main power distribution board. EPO switches are not recommended for use in traditional -48V DC battery plants."

Best Practice 6-5-0546 reads: "No single point of failure should exist in paths linking network elements deemed critical to the operations of a network (with this design, two or more simultaneous failures or errors must occur at the same time to cause a service interruption)."

Finally, Best Practice 6-5-0676 reads: "Low voltage disconnects should not be used at the battery plant."

Telecom dc plants, by design, are not required to have any sort of an "EPO" button or feature that de-energizes everything. In fact quite the opposite is the case. Recognizing the criticality of the relationship of telecommunications services to public safety, NFPA 76, *Standard for the Fire Protection of Telecommunications Facilities* [4] specifically requires a disconnect plan and a means of disconnect, rather than an EPO. NFPA 76 provides that fire service has four power disconnect intervention points at which to interrupt power depending on the scope of the incident (Figure 2). This method permits fire service to interrupt only the level of power necessary to safely put down the fire without taking undue risk, either to himself or to the community at large as might be experienced during a major telecommunications failure.

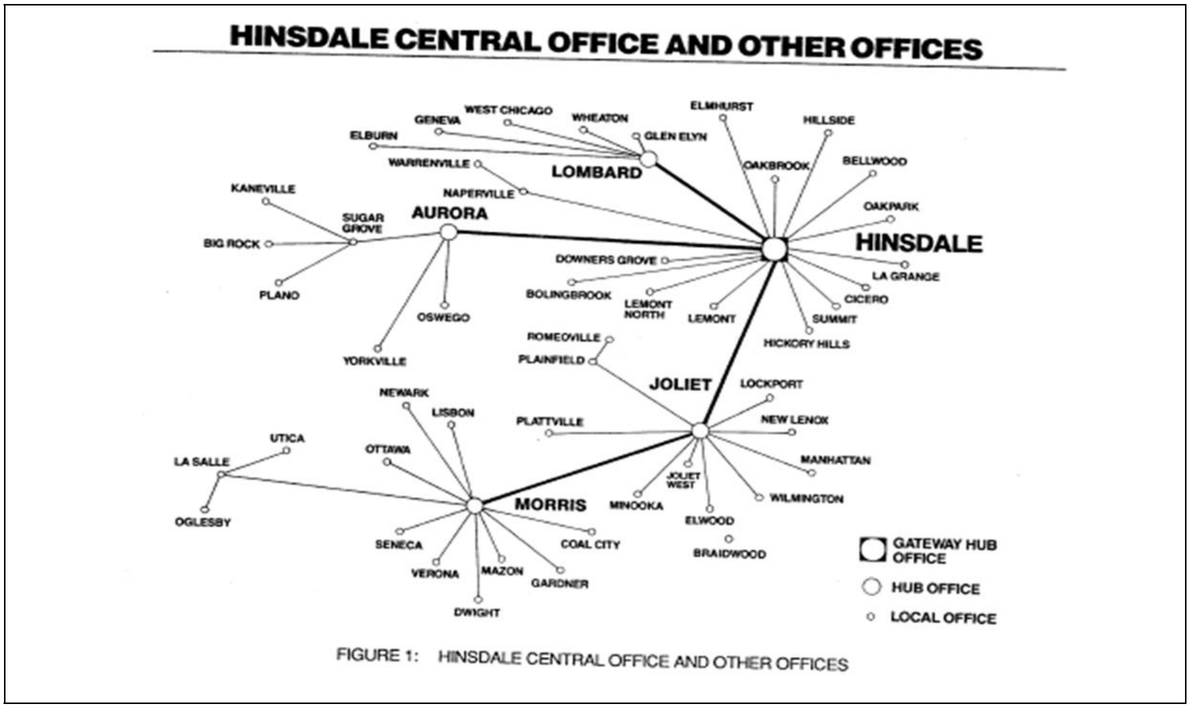


Figure 1 -- Trunking relationship between central offices. A dc power lapse to the Hinsdale IL central office caused a widespread network failure for Hinsdale and six communities around it. (Source: Hinsdale Fire Report)

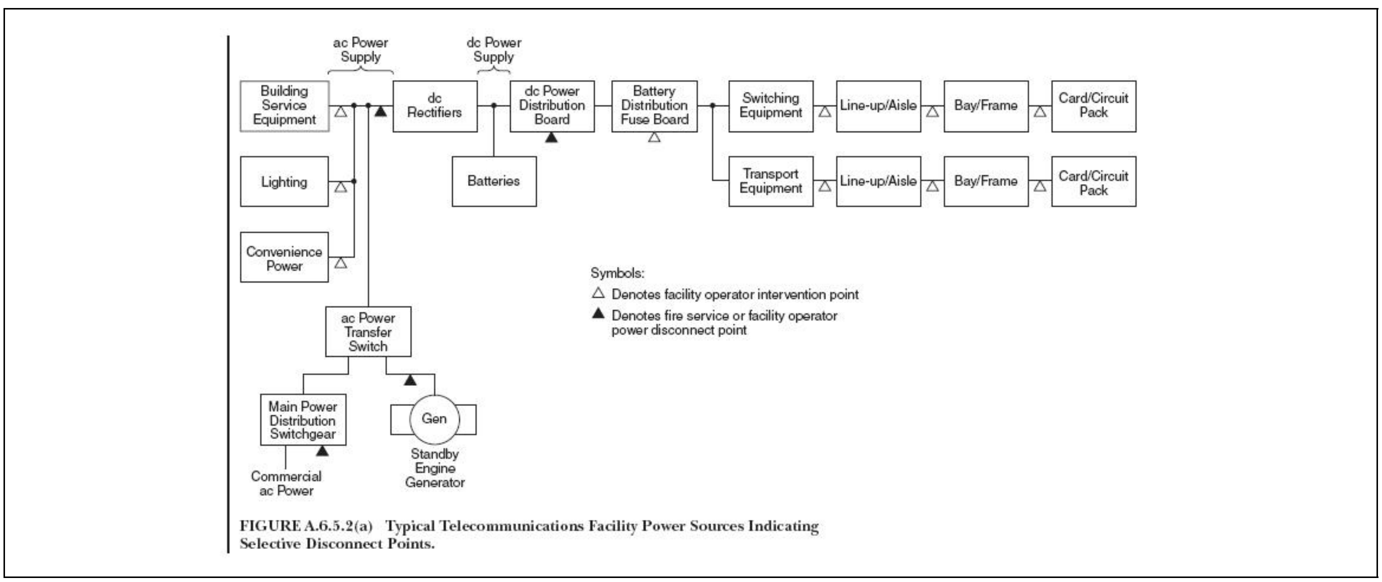


Figure 2 -- NFPA 76 power intervention points.

From the NFFPA 76 plan, members of fire service and the telecom industry designed Zoned Disconnect Plans. A zoned disconnect plan is a set of plans and reflective floor marking decals that lead fire service directly to the intervention points as are identified in NFPA 76 (and Figure 2). The same decals that lead a fireman into the building show him a safe path back out. These plans have been well received by fire service in the areas where the system is deployed. The plan includes training for fire department personnel. This has not been the case for non-telecom ITE installations (a.k.a. “data centers”) where, for almost 40 years, a disconnecting means has been mandated by every exit per NEC Article 645 and NFPA 75. Their precise purpose is to shut down battery supported information technology equipment.

How are the dc plants designed?

The telecommunications industry standard for dc power plants is ANSI Standard T1.311-1998. [5] The standard specifically states: “8.8.1 This standard shall not require any circuit disconnect devices between the battery and chargers/rectifiers or between the battery and the input to the primary distribution.” In jurisdictions where the local ordinances insisted upon an EPO for dc plants, the only way to accomplish that task was to order dc distribution bays with low voltage disconnect contactors and then field modify the bays so that the contactor was under control of an external push button for operation. The reason that the FCC didn’t want low voltage disconnect circuits in the first place was that they are unreliable and suffer from false operations that could cripple the network. Adding non-standard, undocumented field modifications to these contactors only degrades network reliability still further.

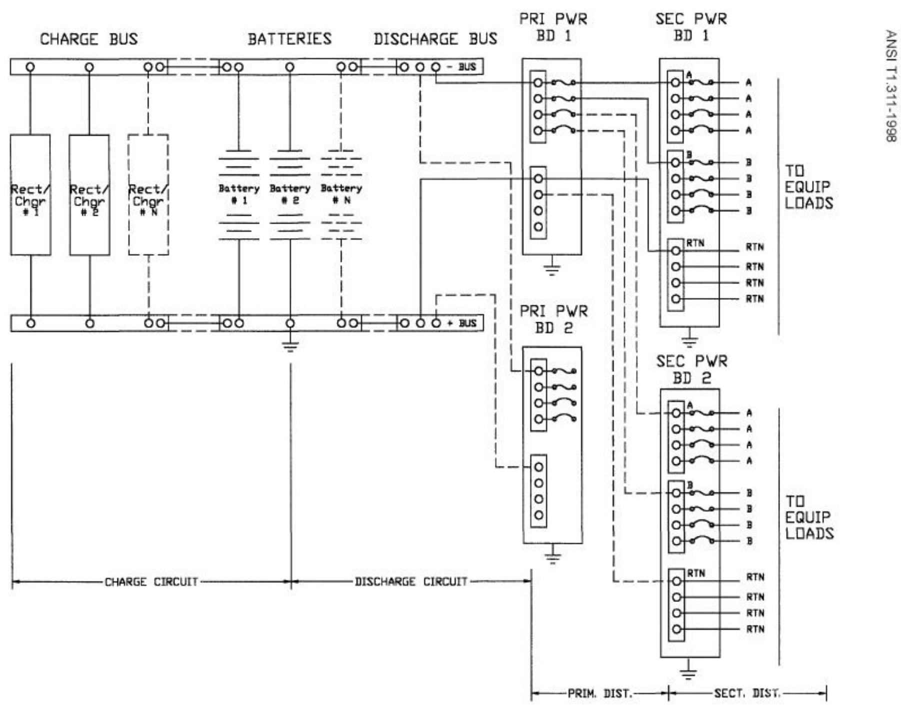


Figure 1 – Typical DC Power System

Figure 3 – ANSI T1.311 Figure 1 shows a standard telecommunications dc power plant. Note that no disconnect is shown between the battery strings and the bus, nor between the bus and the individual fuses or circuit breakers feeding equipment loads.

As a final thought, many telecommunications central offices are equipped with smoke evacuation systems. Given the presence of such a feature, killing all input power to a central office would disable this important system and perhaps place fire service personnel in greater danger due to obscured vision and a toxic atmosphere. It sometimes happens that firemen get lost in a smoke obscured environment. A high rise fire in 1991 in Philadelphia’s Meridian Bank building claimed the lives of a Captain and two firefighters when they became lost in dense smoke and their air tanks exhausted before rescuers could reach them with fresh tanks (see Figure 5). [6] The fire floor(s) were highly “Grandfathered” code-wise which contributed to the difficulties faced while fighting this fire and is one instance where a smoke evacuation system might have saved lives.

Local AHJs should seriously consider exempting telecommunications central offices from their local requirements for an EPO, particularly where Zoned Disconnect Plans have been deployed to lead firefighters safely into and out of the facility.

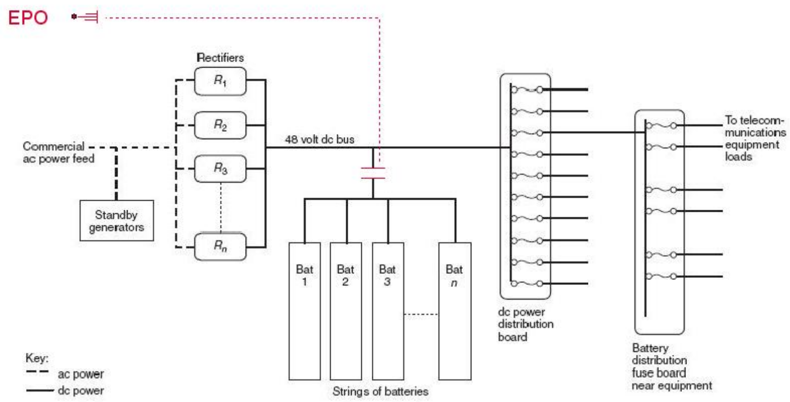
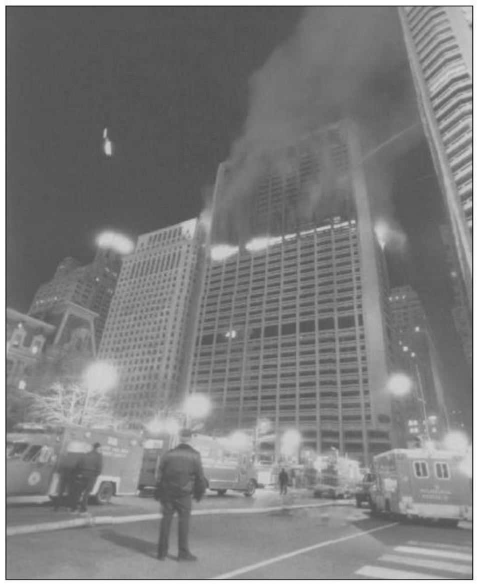


FIGURE A.6.5.2(b) Typical Telecommunications Facility dc Power Distribution.

Figure 4 -- Another version of the same design, this one from NFPA 76. Neither design includes dc disconnects; however, in this drawing a low voltage disconnect contactor as an EPO has been modified into the sketch in red in order to provide some sort of an EPO feature. Such modifications are usually non-standard and not well understood.

WHEN ARE SPRINKLERS A BIGGER THREAT THAN FIRE?

NFPA 13 is the installation guide for sprinkler systems.[7] There is little doubt that properly designed and installed fire suppression systems do a yeoman's job of ensuring fire safety in almost any structure. We use the word "almost" advisedly. Because the damage to the telecommunications network looms large when water pipes are placed above network equipment, NFPA 76 has several tables with criteria that exempt central offices from automatic fire suppression systems when certain other criteria are met. These criteria include such factors as Early Warning Fire Detection Systems, equipment room compartmentization, intumescent fire-stopping materials at wall or floor penetrations, and network equipment that is certified flame retardant and self-extinguishing. Some municipalities refuse to grant building permits for new central offices or expansions to existing central offices if the plan does not include water suppression in equipment spaces. The fact is that water pipes leak; even so- called "dry" pre-action systems sometimes manage to leak water onto whatever is below the system. When water comes into contact with energized equipment an irreversible corrosion cycle begins that spells doom to that equipment, and when equipment fails, lives can be put at risk.



Philadelphia Inquirer photo by Michael S. Wirtz

Figure 5 -- The Meridian Plaza fire in Philadelphia claimed the lives of three firemen when they became lost in the smoke and their air tanks ran out.

Telecommunications Equipment Area	Detection	Automatic Suppression	Smoke Management System	Equipment Characteristics Scenario	Telecommunications Equipment Area: Common Area Containing Some or All of the Following: Signal-Processing Equipment Area, Power, Main Distribution Frame, and Contiguous Technical Support Area										Signal-Processing Equipment Area Including Contiguous Technical Support Area		Power Area Including Contiguous Technical Support Area	
	Detection				VEWFD										VEWFD		EWFD	
		Automatic Suppression			No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes	No		No	Yes
			Smoke Management System		No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	
				Equipment Characteristics Scenario	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Common Area Containing Some or All of the Following: Signal-Processing Equipment Area, Power, Main Distribution Frame, and Contiguous Technical Support Area	VEWFD	No	No	1 Level A Compliant Equipment*, Wire or Cable*	NR	1	1	1	1	1	1	1	1	1	NR	1	NR	1
		No	Yes	2 Level A Compliant Telecommunication Equipment* Except Level C Compliant Power Equipment*, Wire or Cable*	1	NR	1	NR	1	NR	1	1	1	1	1	1	1	1
		Yes	Yes	3 Level A Compliant Telecommunication Equipment* Except Level C Compliant Power Equipment*, Wire or Cable*	1	1	NR	1	NR	1	NR	NR	NR	NR	1	1	1	1
		No	Yes	4 Level A Compliant Telecommunication Equipment* Except Level C Compliant MDF Equipment*, Wire or Cable*	1	NR	1	NR	1	NR	1	1	1	1	1	1	1	1
		Yes	Yes	5 Level A Compliant Telecommunication Equipment* Except Level C Compliant MDF Equipment*, Wire or Cable*	1	1	NR	1	NR	1	NR	NR	NR	NR	1	1	1	1
		No	Yes	6 Level A Compliant Telecommunication Equipment*, Wire or Cable* - Some Level C Signal-Processing Equipment*	1	NR	1	NR	1	NR	1	1	1	1	1	NR	1	1
		Yes	Yes	7 Level A Compliant Telecommunication Equipment* Except Level C Compliant Power and MDF Equipment*, Wire or Cable*	1	1	NR	1	NR	1	NR	NR	NR	NR	1	1	1	1
		Yes	Yes	8 Level A Compliant Telecommunication Equipment* Except Level C Compliant Power and MDF Equipment*, Wire or Cable*	1	1	NR	1	NR	1	NR	NR	NR	NR	1	1	1	1
		Yes	Yes	9 Compliant Telecommunications Equipment or Wire or Cable* — Except Level C MDF and Signal-Processing Equipment, Wire or Cable*	1	1	NR	1	NR	1	NR	NR	NR	NR	1	1	1	1
		Yes	Yes	10 Level C Compliant Equipment or Noncompliant Wire or Cable*	1	1	NR	1	NR	1	NR	NR	NR	NR	1	NR	1	NR
Signal-Processing Equipment Area Including Contiguous Technical Support Area	VEWFD	No	No	11 Level A Compliant Equipment* or Wire or Cable*	NR	1	1	1	1	1	1	1	1	1	NR	1	NR	1
			Yes	12 Level C Compliant Equipment* or Noncompliant Wire or Cable *	1	1	1	1	1	NR	1	1	1	NR	1	NR	1	NR
Power Area Including Contiguous Technical Support Area	EWFD	No	No	13 Level A Compliant Equipment and Wire or Cable*	NR	1	1	1	1	1	1	1	1	1	NR	1	NR	1
		Yes		14 Level C Compliant Equipment* or noncompliant Wire or Cable*	1	1	1	1	1	1	1	1	1	NR	1	NR	1	NR
Main Distribution Frame Including Contiguous Technical Support Area	VEWFD	No	No	15 Level A Compliant Equipment, Wire and Cable*	NR	1	1	1	1	1	1	1	1	1	N/A	1	NR	1
				16 Level C Compliant Equipment* or Noncompliant Wire or Cable*	1	1	1	1	1	1	1	1	1	1	1	N/A	1	NR
Cable Entrance Facility	EWFD	Yes	No	17	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		No	No	18	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	VEWFD	No	No	19 Direct Termination on MDF Level A Compliant Equipment* and Wire or Cable*	NR	1	1	1	1	1	1	1	1	1	NR	1	NR	1
Standby Engine Area	STD Heat or Flame	No	No	20 Automatic Fuel Cutoff	2	2	2	2	2	2	2	2	2	2	2	2	2	2
		Yes	No	21 Automatic Fuel Cutoff	2	2	2	2	2	2	2	2	2	2	1	1	1	1
Nontelecommunications Equipment Area																		
Administration Area	STD	No	No	22	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	NR	Yes	No	23	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Building Service and Support Area	STD	No	No	24	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	NR	Yes	No	25	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Space Occupied by Third Parties	N/A	N/A	N/A	26	2	2	2	2	2	2	2	2	2	2	2	2	2	2

1: Rating in table refers to minimum floor, ceiling, and wall separation recommendations only. Additional separation may be required for structural elements due to building type.
2: Additional provisions may be required as per 4.1.2 in multiple-tenant buildings not controlled by telecommunications operator.
*: as per Section 8.8
NR: No rating
SABC: See applicable building code.

FIGURE A.6.1 Telecommunications Facilities with Signal-Processing Equipment Areas Greater Than 232 m^2 (2500 ft^2).

Figure 6 -- Table excerpt from NFPA 76 showing under what conditions automatic fire suppression systems are not required.

Interestingly, burn-lab tests performed on a Lucent Technologies #5 ESS switching system (a commonly used telephone switching system) performed by Factory Mutual Global Insurance carriers proved that sprinkler heads would not trigger with a Class C fire (electrical fire) burning inside the equipment cabinets. Essentially, the burning equipment does not produce enough heat to trigger a sprinkler head. Because the sprinkler heads won't operate during a Class C fire inside the equipment cabinets but might leak water onto batteries and electronic equipment, sprinklers impose significant risk to the telecommunications with no commensurate reward in terms of protection.

The places in a central office that actually need fire suppression are clearly identified in NFPA 76 and they include, administrative areas, power rooms, battery rooms, cable entrance facilities (cable vaults) and storage rooms. It is a very serious mistake with public safety consequences to impose suppression on a network equipment room.

					Telecommunications Equipment Area							Nontelecommunications Equipment Area				
					Main Distribution Frame Including Contiguous Technical Support Area		Cable Entrance Facility			Standby Engine Area		Administration Area		Building Service and Support Area		Space Occupied by Third Parties
	Detection				VEWFD		EWFD		VEWFD	STD Heat or Flame		STD	NR	STD	NR	N/A
		Automatic Suppression			No		Yes	No	No	No	Yes	No	Yes	No	Yes	N/A
			Smoke Management System		No		No	No	No	No	No	No	No	No	No	N/A
Telecommunications Equipment Area				Equipment Characteristics Scenario	15	16	17	18	19	20	21	22	23	24	25	26
Common Area Containing Some or All of the Following: Signal-Processing Equipment Area, Power, Main Distribution Frame, and Contiguous Technical Support Area	VEWFD	No	No	1 Level A Compliant Equipment*, Wire or Cable*	NR	1	1	2	NR	2	1	1	1	2	1	2
		No	Yes	2 Level A Compliant Telecommunication Equipment* Except Level C Compliant Power Equipment*, Wire or Cable*	1	1	1	2	1	2	1	1	1	2	1	2
		Yes	Yes	3 Level A Compliant Telecommunication Equipment* Except Level C Compliant Power Equipment*, Wire or Cable*	1	1	1	2	1	2	1	1	1	2	1	2
		No	Yes	4 Level A Compliant Telecommunication Equipment* Except Level C Compliant MDF Equipment*, Wire or Cable*	1	1	1	2	1	2	1	1	1	2	1	2
		Yes	Yes	5 Level A Compliant Telecommunication Equipment* Except Level C Compliant MDF Equipment*, Wire or Cable*	1	1	1	2	1	2	1	1	1	2	1	2
		No	Yes	6 Level A Compliant Telecommunication Equipment*, Wire or Cable* - Some Level C Signal-Processing Equipment*	1	1	1	2	1	2	1	1	1	2	1	2
		Yes	Yes	7 Level A Compliant Telecommunication Equipment* Except Level C Compliant Power and MDF Equipment*, Wire or Cable*	1	1	1	2	1	2	1	1	1	2	1	2
		Yes	Yes	8 Level A Compliant Telecommunication Equipment* Except Level C Compliant Power and MDF Equipment*, Wire or Cable*	1	1	1	2	1	2	1	1	1	2	1	2
		Yes	Yes	9 Compliant Telecommunications Equipment or Wire or Cable* — Except Level C MDF and Signal-Processing Equipment, Wire or Cable*	1	1	1	2	1	2	1	1	1	2	1	2
		Yes	Yes	10 Level C Compliant Equipment or Noncompliant Wire or Cable*	1	1	1	2	1	2	1	1	1	2	1	2
Signal-Processing Equipment Area Including Contiguous Technical Support Area	VEWFD	No	No	11 Level A Compliant Equipment* or Wire or Cable*	1	1	1	2	1	2	1	1	1	2	1	2
			Yes	12 Level C Compliant Equipment* or Noncompliant Wire or Cable *	N/A	1	1	2	NR	2	1	1	1	2	1	2
Power Area Including Contiguous Technical Support Area	EWFD	No	No	13 Level A Compliant Equipment and Wire or Cable*	1	N/A	1	2	1	2	1	1	1	2	1	2
		Yes		14 Level C Compliant Equipment* or noncompliant Wire or Cable*	NR	1	1	2	NR	2	1	1	1	2	1	2
Main Distribution Frame Including Contiguous Technical Support Area	VEWFD	No	No	15 Level A Compliant Equipment, Wire and Cable*	1	NR	1	2	1	2	1	1	1	2	1	2
				16 Level C Compliant Equipment* or Noncompliant Wire or Cable*	NR	1	1	2	NR	2	1	1	1	2	1	2
Cable Entrance Facility	EWFD	Yes	No	17	1	NR	1	NR	1	2	1	1	1	2	1	2
		No	No	18	1	1	NR	2	1	2	2	1	1	2	1	2
	VEWFD	No	No	19 Direct Termination on MDF Level A Compliant Equipment* and Wire or Cable*	2	2	2	NR	2	2	1	2	2	2	2	2
Standby Engine Area	STD Heat or Flame	No	No	20 Automatic Fuel Cutoff	2	2	2	2	2	NR	2	2	2	2	2	2
		Yes	No	21 Automatic Fuel Cutoff	1	1	1	2	1	2	NR	2	2	2	2	2
Nontelecommunications Equipment Area																
Administration Area	STD	No	No	22	1	1	1	2	1	2	2	NR	NR	1	1	SABC
	NR	Yes	No	23	1	1	1	2	1	2	2	NR	NR		1	SABC
Building Service and Support Area	STD	No	No	24	2	2	2	2	2	2	2	1	1	NR	NR	SABC
	NR	Yes	No	25	1	1	1	2	1	2	2	1	1	NR	NR	SABC
Space Occupied by Third Parties	N/A	N/A	N/A	26	2	2	2	2	2	2	2	SABC	SABC	SABC	SABC	SABC

1: Rating in table refers to minimum floor, ceiling, and wall separation recommendations only. Additional separation may be required for structural elements due to building type.
2: Additional provisions may be required as per 4.1.2 in multiple-tenant buildings not controlled by telecommunications operator.
*: as per Section 8.8
NR: No rating
SABC: See applicable building code.

FIGURE A.6.1 *Continued*

Figure 7 -- More of the NFPA76 table from Figure 6

MODESTY ASIDE, WHY PUT A DIAPER ON MICHELANGELO'S STATUE OF DAVID?

A marble David isn't going to leak anything and neither are Valve Regulated Lead Acid batteries, often called Sealed batteries. Yet many local codes will not permit the installation of a valve regulated battery without a spill containment. VRLA battery cells utilize one of two means of immobilizing electrolyte.

The most common method is the Absorbed Glass mat (AGM cell). With this type of battery, the electrolyte is absorbed into a spun glass mat material, not unlike a diaper or paper towel. The amount of electrolyte not absorbed or so-called "Free electrolyte" is extremely small, usually less than a teaspoon full even in a quite large battery cell. The other immobilizing technology is the "Gell cell". With gell cells, the electrolyte is mixed with a silica material that sets up with the consistency of petroleum jelly or tar. Like the AGM cell, gell cells have a very tiny amount of free electrolyte. With both cell technologies, the cells wouldn't leak if they were sawn in half, yet some AHJs doggedly insist on spill containments for these cells, even when marking on the side of the container says "non-spillable battery."

Spill containment for a VRLA battery adds no useful feature but does serve to narrow the available aisle space in installations such as cell or microwave relay stations where space already is tight. This condition results in an increased trip and fall potential for a fireman navigating narrow equipment aisles while wearing bulky boots, bunker pants and turnout gear. In plain talk, spill containments for VRLA cells are all risk and cost with no reward except for the guy selling absorption systems.

HYPERVENTILATION OVER HYDROGEN

Several years ago an event occurred that caused a lot of excitement among fire fighters. A business park building in California had lost its only tenant, leaving the building empty for several months. Included in the building was a very large UPS system in the same room with a very large vented battery system. Details have not been made public, but it appears that the batteries were left on charge with no load… a logical thing to do in order to avoid killing the batteries. Somebody (nobody will admit to it) turned off the lights and the air conditioning system. Again, it was a logical thing to do in order to conserve energy in an unoccupied building. But one small detail -- they also shut down all cooling and ventilation in the UPS room, where the UPS was creating heat and charging the batteries. For three months of no air movement, the vented batteries did what they do – they vented. Hydrogen accumulated to a level suspected to be above 8% concentration of the air in the room. Hydrogen detectors actually worked and sounded alarms… only there was nobody but the neighbors to hear them. The alarm system was not tied to a remote location such as a fire department. After two days – Kaboom! The ceiling lifted off the building, there was a big puff of smoke, and the alarms quit ringing. By the time the fire department got there, the smoke was clearing and there was little or no fire to deal with.

Shortly afterward, spectacular photos circulated on a firefighters' web site showing the damaged batteries still sitting in their racks… and in the sunshine. That would have been OK except that the person who circulated the photos added an editorial stating that the accident could have been avoided… which is true. Be he added a prescription solution: a circuit between a ventilation fan failure detector and the UPS to shut down the charging system as soon as ventilation is lost. The story did NOT suggest that the accident ALSO could have been avoided IF the space had been occupied and/or IF the fans had not been deliberately shut down and/or IF somebody had responded to the warning alarms and/or IF somebody had actually gone into the battery room at least once in three months.

Based upon this once-in-a-century perfect storm of human errors, code writers got to work. Codes are supposed to set the "minimum" requirements based upon conditions of "normal operation." The International Fire Code (IFC) has a chapter on stationary storage battery systems. Under a paragraph titled "Ventilation" it states that there can be no more that 1% hydrogen concentration or there must be a one cubic foot of air movement for every square foot of space. It also states that battery rooms shall be ventilated in accordance with the International Mechanical Code (IMC). If you go to the IMC today and look up batteries in the Ventilation chapter, you won't find anything. Batteries are only covered in the *Exhaust* section. The code makers want to suck the bad air out, but they apparently are not concerned about replacing the bad air with good air.

The silly result of this is that in some jurisdictions a battery cabinet in a computer room is treated the same as a stove in a restaurant. They require hoods and fans above VRLA battery systems to duct air out of the building. If a fan fails the circuit described above will shut down the UPS system even though there is typically greater than 10,000 cfm of air circulating through the space for the computer equipment. Unlike the scenario described above in which nobody entered the room for months, a loss of ventilation in a computer room would get immediate attention because the computers would be affected long, long before any VRLA batteries started to release gas. A VRLA battery, by design, is not supposed to release gas. If it does, it dies. But that doesn't stop the AHJ from requiring $10,000 worth of unnecessary ducting. Nor does it seem to matter that shutting down the battery back-up system for a million dollar installation because of a failure on a $10 fan switch could jeopardize life safety. Explain that decision when a power sag knocks down the telephone system so that nobody can call 9-1-1 and perhaps 9-1-1 can't answer even if someone did.

NOBODY DOES IT BETTER

As the economy drills itself into oblivion and construction jobs wane, many electricians' unions are approaching local AHJs and state electrical boards to claim that they - and not systems installers - should be the ones installing batteries, dc power plants and communications systems. Some AHJs have taken the step of allowing only electricians licensed in their state to perform this work going forward. The problem is that installing these systems requires very specialized training, and most electrical contractors are not getting this training for their people. And, for many jobs contractors pick up talent from a local union hall. Is it fair to ask how many AHJs would hire an electrician to fix their car when the chief commonality between electricians and mechanics is that both know how to pull wrenches?

Telephone companies that had used electricians to install batteries, dc power systems and especially network equipment soon stopped doing so because the installations were not even close to standard. Worse yet, one state board has ruled that going forward only electricians licensed in their state may install any systems or equipment covered by Article 800 of the National Electrical Code. Article 800 covers "communications systems" - virtually any and all telephone switching and transport equipment. Equipment installers undergo years of training and experience to become able to install and commission these systems properly. There isn't much chance that an electrical contractor is going to have such people available, nor is he likely to invest the tens of thousands of dollars per installer to train them.

Figures 8 and 9 show a summary of data gleaned from major US telecom network failures learned in a Telcordia study. [8] While numerous reasons for network failures were trending down, the one element trending upwards was failures due to equipment procedural errors. As can be seen in the pie chart, (Figure 9) poor supervision, inadequate training and documentation total 88% of the failures. If such problems are rising with experienced equipment installers performing the work, it's likely that these percentages will remain about the same, but the number of network failures due to them will increase dramatically when inexperienced electricians perform jobs that had once been performed by trained and experienced installer-technicians. Additionally, we believe that the incidence of injury will increase dramatically as persons unfamiliar with dc "live work" step into the central office environment.

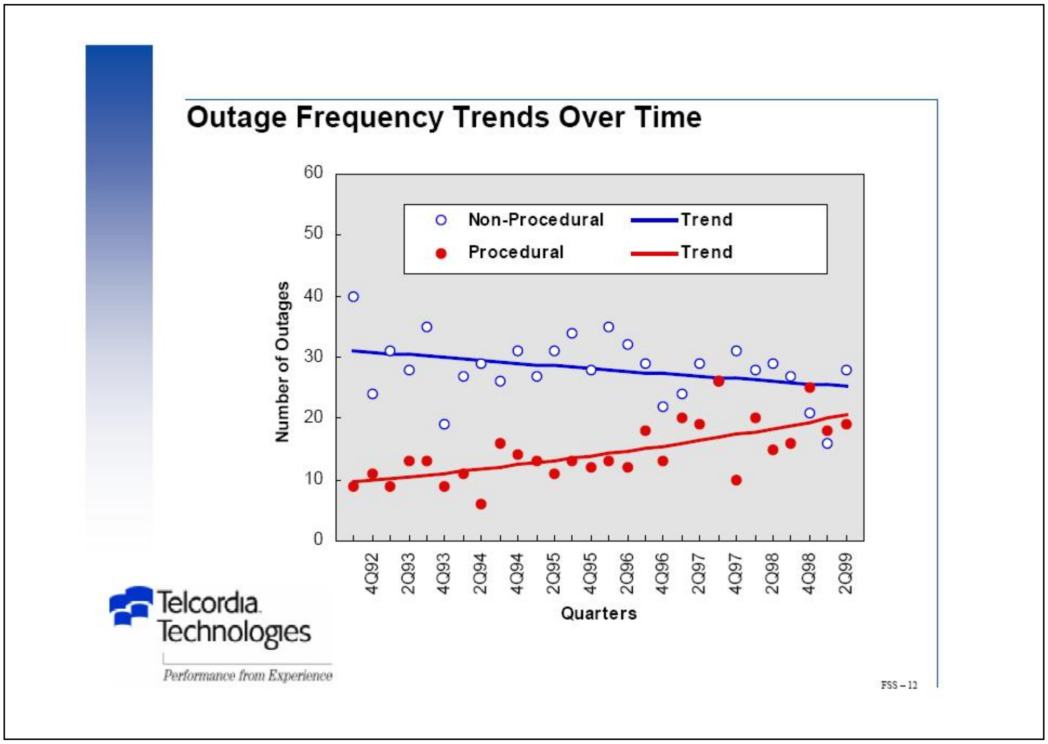


Figure 8 -- Slide from a presentation by Françoise S. Sandroff, Ph.D. to the IEEE Communications Quality and Reliability (CQR) Council showing the trending of network failures caused by procedural errors and non-procedural ones.

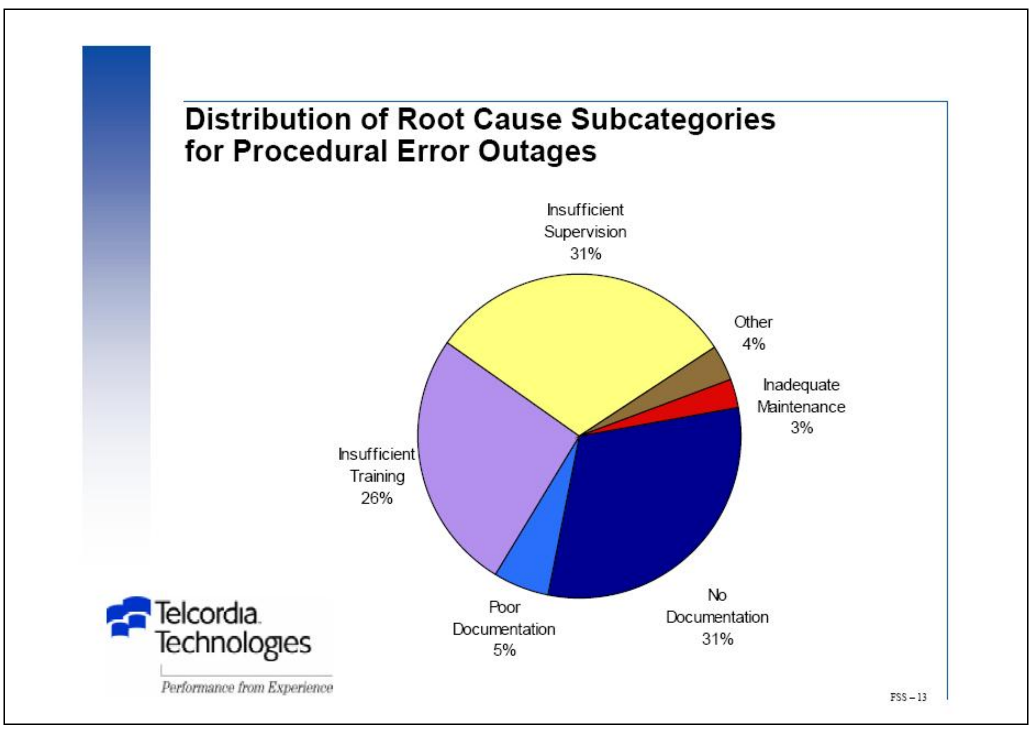


Figure 9 -- Slide from a presentation by Françoise S. Sandroff, Ph.D. to the IEEE Communications Quality and Reliability (CQR) Council showing the root causes of network failures caused by procedural errors[9]

CONCLUSIONS

Codes and standards are written by teams of industry professionals who are committed to safety and to furthering the state of the art in the technical fields. As such, the codes and standards are well thought out as the code making bodies consider each word in the document – often to the point of belaboring – in an effort to consider all relevant "What-if" scenarios might befall a system. Codes are supposed to set the *minimum* requirements.

When local jurisdictions decide to "one-up" the prevailing code, "Code Bloopers" can come in as an unintended result. It would be safer and much better for the industry as a whole if knowledgeable AHJs bring their talent into the code making process and participate with subject matter experts on the code and standards panels on the front-end of the endeavor rather than to try and script their own standards as an overlay onto the existing body of work.

REFERENCES

[1] Isner, Michael S, Fire Investigation Report: "Telephone Exchange Fire – Los Angeles, California, March 15, 1994," National Fire Protection Association

[2] Isner, Michael S, Fire Investigation Report: "Telephone Central Office – Hinsdale, Illinois, May 8, 1988," National Fire Protection Association

[3] "Network Reliability – A report to the Nation – Key Learnings and Best Practices," Network Reliability and Interoperability Council (NRIC).

[4] NFPA 76, *Standard for the Fire Protection of Telecommunications Facilities,* National Fire Protection Association (2009 current edition)

[5] ANSI Standard T1.311-1998, *American National Standard for Telecommunications DC Power Systems – Telecommunications Environment Protection*

[6] "Highrise Office Building Fire - One Meridian Plaza Philadelphia, Pennsylvania," USFA-TR-049/ February 1991, FEMA

[7] NFPA 13, *Standard for the Installation of Sprinkler Systems,* National Fire Protection Association (2007 current edition)

[8] GR-63-CORE *NEBS Requirements* – "Physical Protection." Telcordia Technologies

[9] Sandroff, Françoise S, Ph.D., "Strategic Network Reliability for World Class Events," *Proceedings* IEEE CQR 2000 Telecommunications: World Class Quality & Reliability for World Class Events Crete, Greece April 17-21, 2000