Non-Electrical Considerations for Electrical Rooms

Mark A. Sorrells, PE
Senior Member – IEEE
msorrells.ee85@ieee.org

Driving force behind presentation – Air core reactor, Grey market generator installation

Learning Goals

- Identify code & standard concerns
- Identify non-code coordination issues
  - Methodology
  - Physical interferences
- Encourage the use of a checklist to ask the right questions

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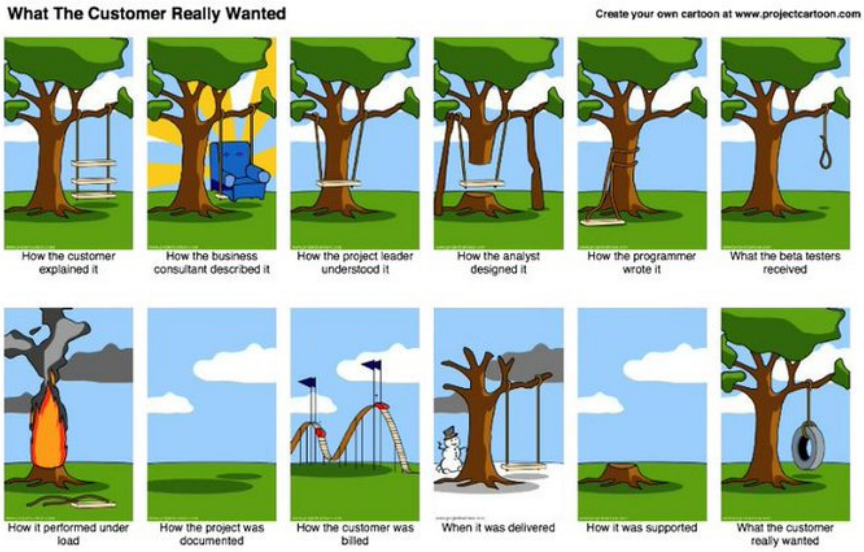
Engineering: the art or science of making practical application of the knowledge of pure sciences, such as physics or chemistry, as in the construction of engines, bridges, buildings, mines, ships, and chemical plants.

Code: A systematically arranged and comprehensive collection of laws (The real purpose of building codes is primarily to save lives; preventing damage to the building is only secondary, as the building is expected to 'sacrifice itself' in order to protect occupants)

Standard: An acknowledged measure of comparison for quantitative or qualitative value; a criterion

Electrical Room (or not)



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According to Project Managers the best place for electrical room containing Switchgear and a couple of MCCs is a shared space with the janitor's closet, preferably mounted on the ceiling, so that the janitors can store their cleaning supplies under it

Picture from https://twitter.com/jaymehoffman/status/991408768171855873

Google search "How the Customer Wanted It" cartoon

Electrical Room

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Definition: NEC: None; NFPA 70E: None; NFPA 70B: None;

IEEE C2: electric supply station. Any building, room, or separate space within which electric supply equipment is located and the interior of which is accessible, as a rule, only to qualified persons. This includes generating stations and substations, including their associated generator, storage battery, transformer, and switchgear rooms or enclosures, but does not include facilities such as pad-mounted equipment and installations in manholes and vaults.

NEC 2020: Added definition Electrical Datum Plane – A specified distance above a water level above which electrical equipment can be installed and electrical connections can be made.

Electrical Room

aka

- IPA
- PCR
- PDU
- PDC
- E-House
- ECR

Integrated Power Assembly; Power Control Room; Power Distribution Unit; Power Distribution Center; E-House; Electrical Control Room

ELECTRICAL Rooms interface with:

Primary

- Civil / Structural / Architectural
- HVAC, Dust/Fume Control
- Materials Handling / Piping / Process

Secondary

- Instrument & Control Systems
- Fire Protection

Solid, Gas, Liquid (CSA, HVAC, Piping / Process)

10 Disciplines ± to coordinate with

Sprinklers: “The elephant in the room”

Shutdowns due to animals: Snakes, rats, squirrels

Broken sprinkler piping, Leaking sprinkler heads?

Electrical Room Considerations

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Name at least 7 potential coordination points
Piping, HVAC, Architectural, Inst & Cntl, Fire Protection, Structural, Process

Electrical Room Considerations

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Electrical Room Considerations

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Name at least 4 potential coordination points
HVAC / Fume Control, Architectural, Material Handling, Civil

Electrical Room Considerations

Georgia Codes

- Dept Community Affairs (https://www.dca.ga.gov/)
  - Mandatory Codes
    - IBC (International Building Code) 2018 w/ GA amendments
    - IFC (International Fire Code) See SFM
    - IPC, IMC, IFGC
    - National Electrical Code 2017 2020 adoption effective 01/01/2021
    - IECC (International Energy Conservation Code) 2015 w/ GA supplements and amendments

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https://www.dca.ga.gov/local-government-assistance/construction-codes-industrialized-buildings/construction-codes
https://www.dca.ga.gov/sites/default/files/ga_state_codes_adoption_history_2020.pdf

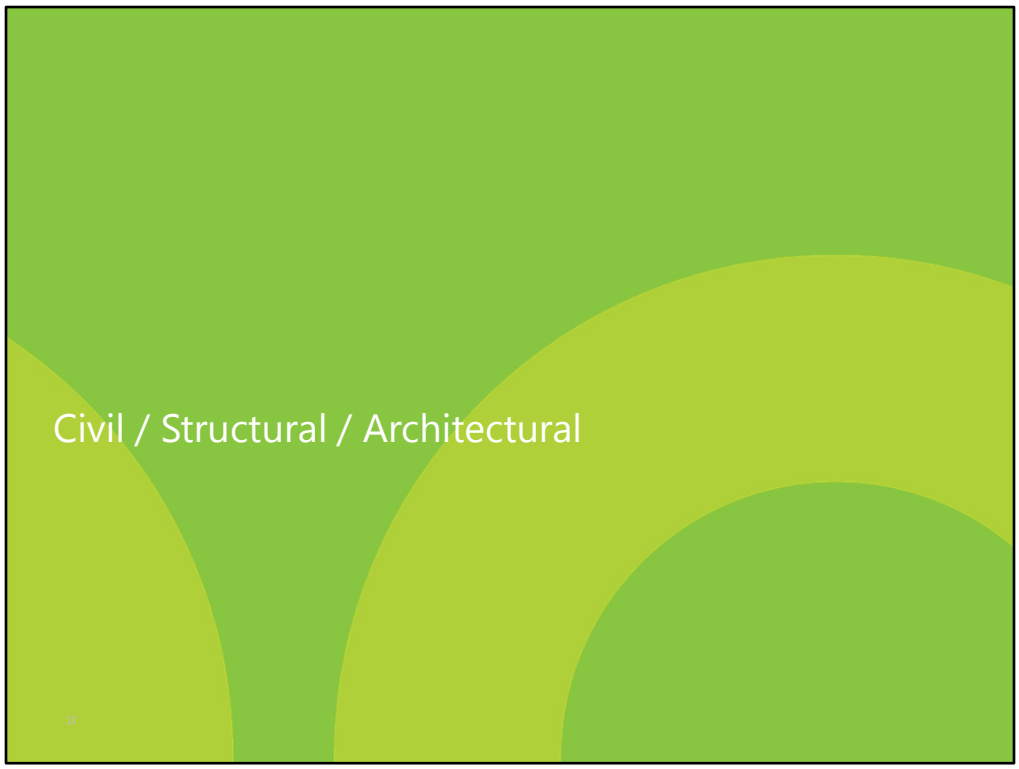
International Residential Code, 2018 Edition, with Georgia Amendments: Not applicable
International Plumbing Code, 2018 Edition, with Georgia Amendments
International Mechanical Code, 2018 Edition, with Georgia Amendments
International Fuel Gas Code, 2018 Edition, with Georgia Amendments
National Electrical Code, 2017 Edition (No Georgia Amendments)
International Energy Conservation Code, 2015 Edition, with Georgia Supplements and Amendments
International Swimming Pool and Spa Code, 2018 Edition, with Georgia Amendments: Not applicable

https://www.oci.ga.gov/firemarshal/home.aspx

https://www.oci.ga.gov/firemarshal/Rules%20and%20Regulations.aspx

The Office of the Secretary of State now provides an electronic version of the Rules and Regulations of the State of Georgia. NOTE: The Rules and Regulations of the State of Georgia is a compilation of the rules and regulations of state agencies that have been filed with the Office of Secretary of State pursuant the Georgia Administrative Procedures Act, O.C.G.A.§ 50-13-1 et seq.

NFPA 70E, 2018 Edition, Standard for Electrical Safety Requirements for Employee Workplaces is adopted with modifications.



Codes, Standards & Non-Code Issues

Civil / Structural / Architectural

Codes & Standards

- IBC Chapter 3 OCCUPANCY CLASSIFICATION AND USE
  - 10 major Groups i.e. classifications
  - Some groups have breakout by use
  - e. g. Assembly group A, uses A-1 through A-5
    - A-3: Indoor swimming pool *without* spectator seating
    - A-4: Indoor swimming pool with spectator seating
  - Educational Group E – no breakouts based on use
  - NOTE: No "special occupancy classification" for Electrical Rooms

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(All except for B {Business}, E, M {Mercantile}, and U {Utility and Miscellaneous} have multiple subgroups. The variations between the uses have to do with different types of hazards or different expected occupant loading per group.)
(Other architectural considerations: Building Construction Type determines the combustibility and protection requirements for the overall building--in other words, is it constructed of wood frame with wood siding, or is it steel framed with concrete roof slab and metal wall panels? Construction Type and Occupancy Use Group are the two main factors in the allowable square footage and height for any new construction. Also type, number, and placement of doors, whether any and which exit routes are required to be accessible, and clear overhead height--the layering of structure, ductwork, cable trays, light fixtures, etc. must not protrude lower than 80" above the floor. All of these things are Code issues.)

IBC Chapter 6 is Types of Construction. Construction types I through V defined by combustibility / fire resistance rating of elements (exterior walls, load bearing & non-load bearing walls, etc. NFPA 220 define construction types I through V. State Fire Marshall rules give a chart equating the two.

(Electrical rooms are generally classified on Code Compliance Plans as "B-Mechanical", "F-1 Mechanical", etc., because the occupant load calculations are very different based on whether this is an actual Business office versus an electrical room for a Business office. The occupant load calculations are important in that they determine the number and size of egress doors.)

Civil

Codes & Standards

- IBC Chapter 16 STRUCTURAL DESIGN § 1603 CONSTRUCTION DOCUMENTS
  - Per 1603.1 documents shall show:
    - 1603.1.6 Geotechnical information: Load bearing values of soils
    - § 1610 SOIL LATERAL LOADS
    - 1603.1.7 Flood design data: Located in *flood hazard areas*
    - § 1612 FLOOD LOADS

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Load bearing of soils can affect how the standalone Elec Rm is supported. The coordination of piers, etc. and underfloor trays may become very important.

Flood zone may determine how high the ER is raised.

Civil / Structural

Codes & Standards

- 1603.1.5 Earthquake design data
  - 1. Risk category
  - 2. Seismic importance factor, I_e
  - 3. Mapped spectral response acceleration parameters
  - 6. *Seismic design category* NOTE: The term Design Zone is no longer in use.
  - and other factors
- § 1613 EARTHQUAKE LOADS
  - invokes Minimum Design Loads for Buildings and Other Structures (ASCE 7-16). Includes chapters 11-13 specifically

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Risk Category Table 1604.5 Category I through IV partially based on Occupancy Classification

Seismic design category A through D partially based on risk category (I through IV). Seismic design categories E & F based on risk category & spectral response acceleration parameters

Civil / Structural

Codes & Standards

- ASCE 7-16 Chapter 11 SEISMIC DESIGN CRITERIA
  - "11.1.1 Purpose. Chapter 11 presents criteria for the design and construction of buildings and other structures subject to earthquake ground motions."
  - "11.1.2 Scope. Every structure and portion thereof, including nonstructural components, shall be designed and constructed to resist the effects of earthquake motions as prescribed by the seismic requirements of this standard."

Civil / Structural

Codes & Standards

- ASCE 7-16 Chapter 12 SEISMIC DESIGN REQUIREMENTS FOR BUILDING STRUCTURES
- ASCE 7-16 Chapter 13 SEISMIC DESIGN REQUIREMENTS FOR NONSTRUCTURAL COMPONENTS
  - "13.1.1 Scope. …nonstructural components that are permanently attached to structures and for their supports and attachments."
  - "13.1.2 Seismic Design Category. For the purposes of this chapter, nonstructural components shall be assigned to the same Seismic Design Category as the structure that they occupy or to which they are attached."

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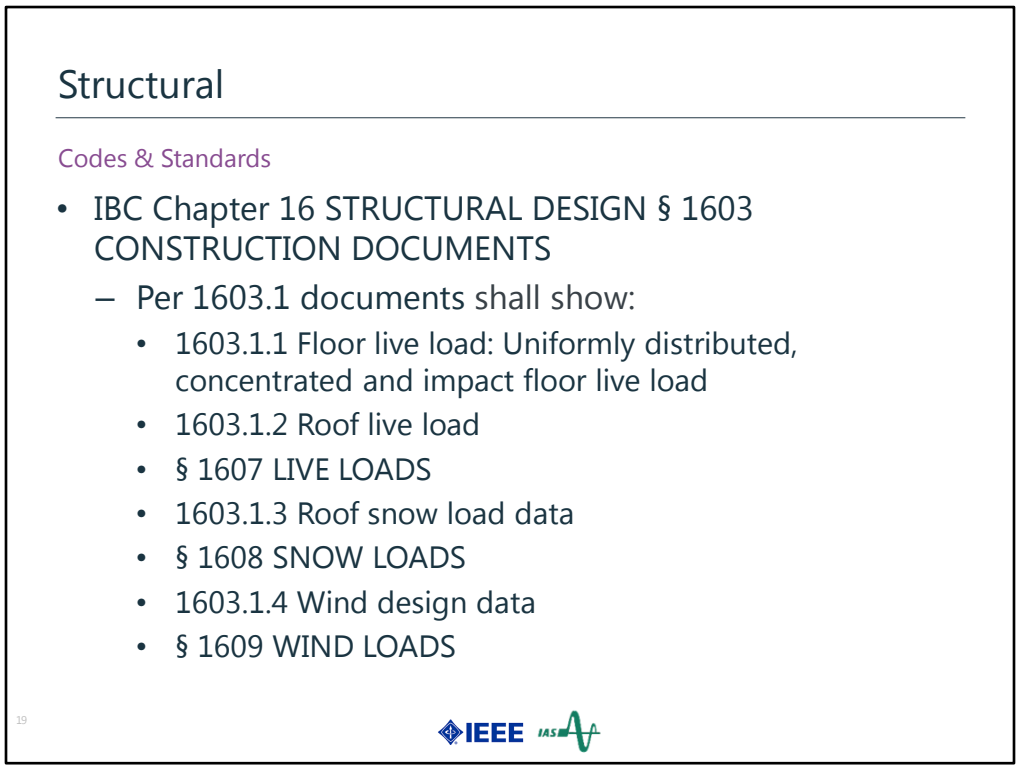

Floor psf for heavy equipment (e.g. battery racks), particularly in retrofit applications

Snow load data can be significant – must also consider for tray loading, especially if tray is covered

1609.1 Decrease in wind loads shall not be made for the effect of shielding by other structures

Architectural

Codes & Standards

- IBC Chapter 7 FIRE AND SMOKE PROTECTION FEATURES
  - § 706 FIRE WALLS
    - 706.4 *fire resistance rating* not less than table …

TABLE 706.4
FIRE WALL FIRE-RESISTANCE RATINGS

GROUP	FIRE-RESISTANCE RATING (hours)
A, B, E, H-4, I, R-1, R-2, U	3[a]
F-1, H-3[b], H-5, M, S-1	3
H-1, H-2	4[b]
F-2, S-2, R-3, R-4	2

a. In Type II or V construction, walls shall be permitted to have a 2-hour fire-resistance rating.
b. For Group H-1, H-2 or H-3 buildings, also see Sections 415.7 and 415.8.

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(True "Fire Walls" are fairly rare, in that these are very complex and expensive to construct. The typical Electrical Room that is required to be fire-rated is likely to be surrounded by Fire Separation Barriers or Fire Separation Walls, which are much closer to 'normal' construction and far less costly than Fire Walls, which require two completely separate structural systems whereas one side of the wall could completely collapse, and yet the other side would remain, maintaining the protection of the other side. Fire Walls are normally found where a building needs to be larger than the allowable areas for its Construction Type and Use Group.)

H: High Hazard Group

F: Factory Industrial, S: Storage; R: Residential

IFC (International Fire Code) 2018: 701.2 The fire resistance rating of the following (*3. fire walls, fire barriers, fire partitions)* shall be maintained.

Architectural

Codes & Standards

- IBC Chapter 7 FIRE AND SMOKE PROTECTION FEATURES
  - § 707 FIRE BARRIERS
    - 707.3.10 **Fire areas** … single occupancy … *fire resistance rating* not less than table …

TABLE 707.3.10
FIRE-RESISTANCE RATING REQUIREMENTS FOR FIRE BARRIERS, FIRE WALLS OR HORIZONTAL ASSEMBLIES BETWEEN FIRE AREAS

OCCUPANCY GROUP	FIRE-RESISTANCE RATING (hours)
H-1, H-2	4
F-1, H-3, S-1	3
A, B, E, F-2, H-4, H-5, I, M, R, S-2	2
U	1

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NFPA 101

"**8.3 Fire Barriers. 8.3.1 General.**

8.3.1.1 Fire barriers used to provide enclosure, subdivision, or protection under this *Code* shall be classified in accordance with one of the following fire resistance ratings:

(1) 3-hour fire resistance rating

(2) 2-hour fire resistance rating

(3) 1-hour fire resistance rating

(4)* 1⁄2-hour fire resistance rating"

Architectural

Codes & Standards

- FM Global Property Loss Prevention Data Sheet 5-4 Transformers **2.3 Fire Protection for Outdoor Transformers 2.3.1 Location and Construction**

Table 5. Separation for Exposure Protection of Main Building Walls (also refer to Figure 3)

Fluid or Transformer Type	*Fluid Volume, gal (m^3)*	*Minimum Horizontal Distance from Containment to Exposed Building Wall (Dimension X in Figure 3)*		
		2-hour fire-rated wall, ft (m)	Non-combustible wall,[1] ft (m)	Combustible Wall,[1] ft (m)
FM Approved transformer	Per Approval Listing	3 (0.9)		
FM Approved Liquid in non-Approved transformer	<10,000 (38)	5 (1.5)		25 (7.6)
	>10,000 (38)	15 (4.6)		50 (15.2)
Non-Approved transformer liquid	<500 (1.9)	5 (1.5)	15 (4.6)	25 (7.6)
	≤5,000 (1.9-19)	15 (4.6)	25 (7.6)	50 (15.2)
	>5,000 (19)	25 (7.6)	50 (15.2)	100 (30.5)

[1] For definition of combustible and noncombustible construction materials, see Appendix of Data Sheet 1-1, *Firesafe Building Construction and Materials*

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FMDS0504 **2.3 Fire Protection for Outdoor Transformers 2.3.1 Location and Construction** Table 5

Side note: I've never found any national code or standard which regulates how close to a roadway a transformer may be placed, with or without protection (bollards, etc.). There are utility requirements but these obviously vary by utility.

Architectural

Codes & Standards

- IBC Chapter 10 MEANS OF EGRESS
  - § 1003 GENERAL MEANS OF EGRESS
    - 1003.5 Elevation change. Ramp if less than 12 inches. Exception 1 Single step with maximum riser of 7 inches … at exterior doors not required to be accessible …
  - § 1011 STAIRWAYS
    - "1011.6 Stairway landings. There shall be a floor or landing at the top and bottom of each stairwell."

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NFPA 101

Table 7.2.8.4(a) Fire Escape Stairs Maximum riser height 9 in. (230 mm) (> 10 Occupants) 12 in. (305 mm) (<= 10 Occupants)

7.2.2.3.2.1 Stairs shall have landings at door openings, except as permitted in 7.2.2.3.2.5 (existing buildings)

Architectural

Codes & Standards

- IBC Chapter 10 MEANS OF EGRESS
  - § 1020 CORRIDORS
    - 1020.2 Width and capacity. The required capacity of corridors shall be determined as specified in Section 1005.1, but the minimum width shall not be less than that specified in Table 1020.2.

TABLE 1020.2
MINIMUM CORRIDOR WIDTH

OCCUPANCY	MINIMUM WIDTH (inches)
Any facility not listed in this table	44
Access to and utilization of mechanical, plumbing or electrical systems or equipment	24
With an occupant load of less than 50	36

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NFPA 101:

"7.3 Capacity of Means of Egress. 7.3.4 Minimum Width.

7.3.4.1.1* The width of exit access serving not more than six people and having a length not exceeding 50 ft (15 m) shall meet both of the following criteria:

(1) The width shall be not less than 18 in. (455 mm), at and below a height of 38 in. (965 mm), and not less than 28 in. (710 mm) above a height of 38 in. (965 mm).

(2) A width of not less than 36 in. (915 mm) for new exit access, and not less than 28 in. (710 mm) for existing exit access, shall be capable of being provided without moving permanent walls"

Civil / Structural / Architectural

Non – Code Issues

- Opening
  - Wall Penetration: Size & Location
  - Floor Penetration: Size & Location
- Overhead
  - Ceiling height: NEC 110.26(E)(1)(a) *Dedicated Electrical Space* 1.8m (6ft)
    - Cable trays – 3 layers minimum 1.37m (4½ ft)
- Load Support
  - Wall loads: small transformers
  - Leveling channels
  - "Housekeeping" pads

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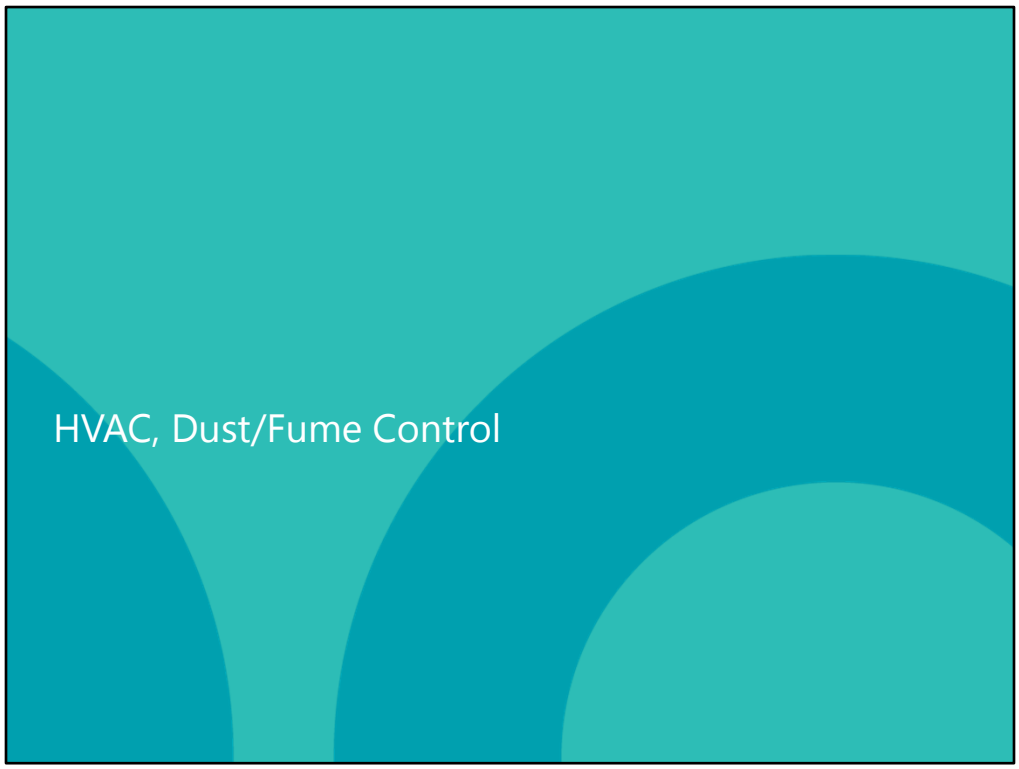
(6 inch side rail + 12" separation) * 3 layers = 54 inches.



Codes, Standards & Non-Code Issues

HVAC, Dust/Fume Control

Codes & Standards

- IECC Section C401 GENERAL
  - "C401.1 Scope: The provisions in this chapter are applicable to commercial *buildings* and their *building sites*."
  - "C401.2 Application: Commercial buildings shall comply with one of the following:
    - 1. The requirements of ANSI/ASHRAE/IESNA 90.1"
- ASHRAE/IES 90.1 (Energy Standard for Buildings Except Low-Rise Residential Buildings) [2013]
    - TABLE 9.6.1 Lighting Power Density Allowances …

HVAC

Codes & Standards

- NFPA 72 Chapter 21 Emergency Control Function Interfaces
  - 21.7 Heating, Ventilating and Air-Conditioning (HVAC) Systems.
    - 21.7.1 through 21.7.8 describe various interconnections. NO prescribed interlocks
  - *"N 2*1.8 **High Volume Low Speed (HVLS) Fans.** Where required by NFPA 13, all HVLS fans shall be interlocked to shut down …"

HVAC

Codes & Standards

- NFPA 13 Chapter 19 Design Approaches
  - 19.2 General Design Approaches.
    - "**19.2.7* High Volume Low Speed (HVLS) Fans.** The installation of HVLS fans in buildings equipped with sprinklers, including ESFR sprinklers, shall comply with the following:"
      - (1), (2), (3) …
      - "(4) All HVLS fans shall be interlocked to shut down immediately upon a waterflow alarm. Where the building is protected with a fire alarm system, this interlock shall be in accordance with the requirements of NFPA 72."

Dust/Fume Control

Codes & Standards

- National Electrical Code 2017 § 480 Storage Batteries
  - § 480.10 Battery Locations.
    - **"(A) Ventilation.** Provisions appropriate to the battery technology shall be made for sufficient diffusion and ventilation of gases from the battery, if present, to prevent the accumulation of an explosive mixture."
      - Info. Note 1: NFPA 1-2015 Chapter 52. No interlock / interconnection requirements.
      - Info. Note 2 …
      - Info. Note 3: IEEE 1635 /ASHRAE GD 21 – 2012 No interlock / interconnection *requirements*. Potential interlock with outside air flow.

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1 Fire Code Chapter 52 **Stationary Storage Battery Systems**
1635 Guide for the Ventilation and Thermal Management of Batteries for Stationary Applications

HVAC, Dust/Fume Control

Non – Code Issues

- Inlet air vent location(s)
- Distribution ductwork
- MV AFD cooling
- Arc Flash exhaust vents

Non-Code Issues

Materials Handling / Piping / Process

Non – Code Issues

- Hallways, Aisles
- Removal egress for equipment
  - Large frames
  - Shafts

- Clear area adjacent to cable exit pathway
  - Piping
  - HVAC ductwork

- Location of loads (i.e. which direction)
- Feeder lengths (VFD's)

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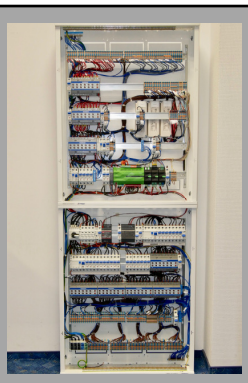

Instrument & Control Systems
Fire Protection

Non-Code Issues & Codes, Standards

Instrument & Control Systems

Non – Code Issues

- Separate or Integrated Rack Room
  - Heating & Cooling Loads
  - Power requirements for I/O & processor(s)
    - Normal Power
    - UPS requirements (essential NOT emergency)
- Type of I/O: Cabling requirements
  - Ethernet, Profibus, etc.
  - Distributed racks or Integrated into MCC's

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Fire Protection: Sprinkler Ratings

Norbulb Model	Fast Response per NFPA 13 RTI < 50 $(ms)^{1/2}$	Nominal Dia. in mm	Operating Time in Seconds	Response Time Index (RTI) $(ms)^{1/2}$ $(fts)^{1/2}$
N2.5	Yes	2.5	9	25 / 45
N3	Yes	3	11.5	33 / 59
N3.3	Yes	3.3	13.5	38 / 68
NF5	No	5	23	65 / 115
N5	No	5	32	90 / 162
	(https://en.wikipedia.org/wiki/Fire_sprinkler)			

Maximum Ceiling Temperature	Temperature Rating	Temperature Classification	Color Code (with Fusible Link)	Liquid Alcohol in Glass Bulb Color
100 °F / 38 °C	135-170 °F / 57-77 °C	Ordinary	Uncolored or Black	Orange (135 °F / 57 °C) or Red (155 °F / 68 °C)
150 °F / 66 °C	175-225 °F / 79-107 °C	Intermediate	White	Yellow (175 °F / 79 °C) or Green (200 °F / 93 °C)
225 °F / 107 °C	250-300 °F / 121-149 °C	High	Blue	Blue
300 °F / 149 °C	325-375 °F / 163-191 °C	Extra High	Red	Purple
375 °F / 191 °C	400-475 °F / 204-246 °C	Very Extra High	Green	Black
475 °F / 246 °C	500-575 °F / 260-302 °C	Ultra High	Orange	Black
NFPA 13-2019 Table 7.2.4.1 Temperature Ratings, Classifications, and Color Codings				

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MacGyver or Hollywood effect

https://en.wikipedia.org/wiki/Fire_sprinkler

NFPA 13-2019 3.3.205.2* General Sprinkler Characteristics. The following are characteristics of a sprinkler that define its ability to control or extinguish a fire.
(1) Thermal sensitivity. A measure of the rapidity with which the thermal element operates as installed in a specific sprinkler or sprinkler assembly. One measure of thermal sensitivity is the response time index (RTI) as measured under standardized test conditions.

(a) Sprinklers defined as fast response have a thermal element with an RTI of 50 (meters-seconds)1⁄2 or less.

(b) Sprinklers defined as standard response have a thermal element with an RTI of 80 (meters-seconds)1⁄2 or more.
(2) Temperature rating.

Under standard testing procedures (135 °C air at a velocity of 2.5 m/s [8.2 fps] [5.9 mph]), a 68 °C sprinkler bulb will break within 7 to 33 seconds.

Fire Protection

Codes & Standards

- NFPA 13 (To Sprinkle or Not To Sprinkle)
  - Chapter 9 Sprinkler Location Requirements
    - 9.3.20 Electrical Equipment.
      - "9.3.20.1* Unless the requirements of 9.2.6 are met, sprinkler protection shall be required in electrical equipment rooms."
    - "9.2.6* Sprinklers shall not be required in electrical equipment rooms where all of the following conditions are met:
      - (1) The room is dedicated to electrical equipment only.
      - (2) Only dry-type or liquid-type with listed K-class fluid electrical equipment is used.
      - (3) Equipment is installed in a 2-hour fire-rated *enclosure (emphasis added)* including protection for penetrations.
      - (4) Storage is not permitted in the room."

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See also NFPA 13 Chapter 26 **Special Occupancy Requirements** § 26.30 **National Electrical Code** (§ 26.30 mimics information out of the NEC 110.26).

Learning Goals

- Identify code & standard concerns
- Identify non-code coordination issues
  - Methodology
  - Physical interferences
- Encourage the use of a checklist to ask the right questions

Questions?