A Review of the National Electrical Code Articles that Affect Data Center Design

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JACOBS (CH2M)

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Safety Moment

Here are five quick tips to remember before leaving your house and while walking, running or biking:

1. Don’t wear headphones; Use your ears to be aware of your surroundings.
2. Carry identification including your name and phone number. Include any medical information.
3. Don’t run or bike alone.
4. Wear reflective material if you must run before dawn or after dusk.
5. Look both ways before crossing a street and obey traffic signs and signals.

Schedule

9:00 to 10:30

10:30 – **15 minute break**

10:45 to 11:45

11:45 Q&A and wrap up

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Outline of this Course

1. Overview of the NEC
2. What's a Data Center?
3. Applicable NEC Articles

- Article 110.26 Clearances
- Article 250 Grounding
- Article 392 Cable Tray
- Article 480 Battery Systems
- Article 645 IT Equipment
- Article 646 Modular Data Centers
- Article 725 Cabling
- Article 770 Fiber Optic Cable
- Article 800 Communication
- NFPA 72 and 75

4. Looking Back - Looking Forward - Trends

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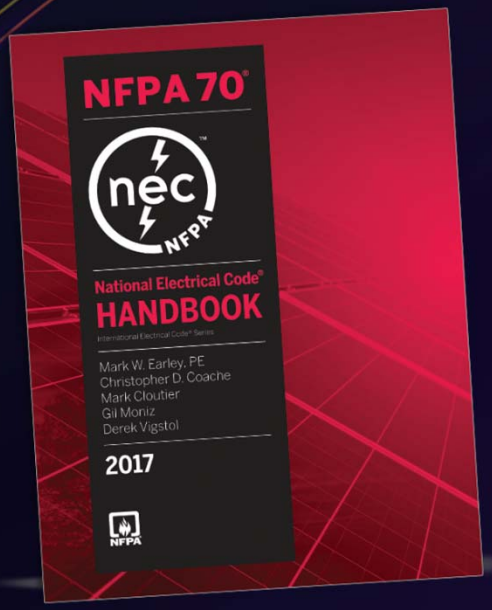
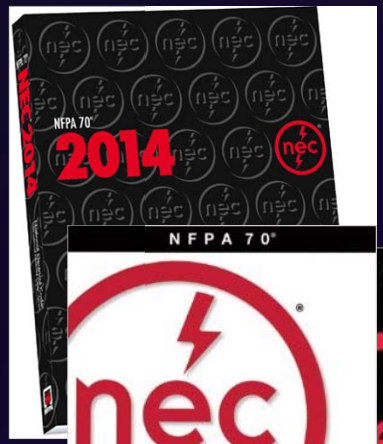
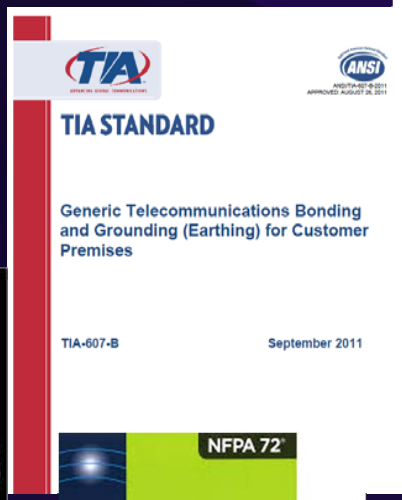
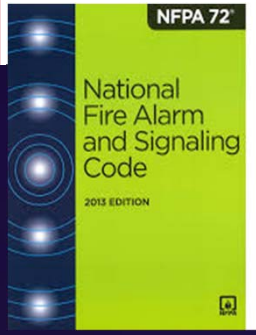
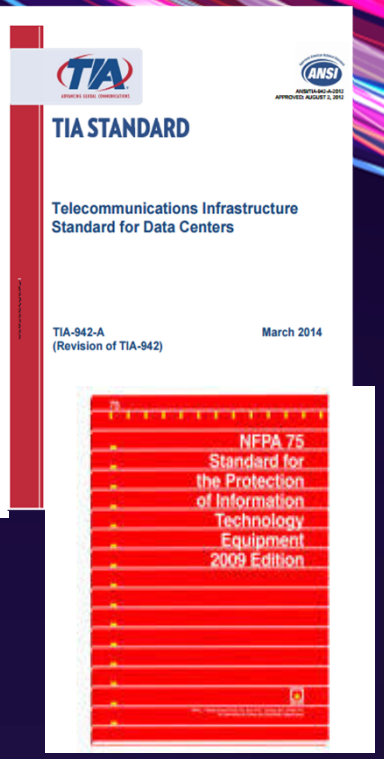
References











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Codes Vs Standards

Codes are set of rules or definitions that specifies the minimum acceptable attributes for a particular product, service, result and technical issue.

For example: National Fire Prevention Association (NFPA) obligates the incorporation of Fire Protection into building construction.

Codes Vs Standards

Standards are sets of the detailed requirements and guidelines developed as good practices.

Example: ANSI/BICSI 002-2014, *Data Center Design and Implementation Best Practices*

Codes are required for safety; Standards are guidelines for proper operation

Purpose of Codes

- Ensure public health and safety throughout a building.
- Most have come into play “after-the-fact” as a learning experience from a major tragedy.
- They are primarily concerned with
  - Construction requirements
  - Hazardous materials or equipment used in the building
  - 75% of all codes and standards deal with fire
  - Energy conservation
  - Accessibility

History of US Codes

- First on record was in 1625 in what was know as New Amsterdam (New York).
- Addressed fire prevention and governed the types of roofing materials that could be used to protect from chimney sparks.
- Chicago fire of 1871 caused many large cities to create their own municipal building codes

National Fire Protection Association (NFPA)

NFPA's code and standard-making process began in 1896

The National Fire Protection Association (**NFPA**) is a United States trade association, albeit with some international members, that creates and maintains private, copyrighted standards and codes for usage and adoption by local governments.

National Electrical Code
NFPA 70

The initial Code was developed in 1897

It is generally updated every 3 years

Each cycle the NFPA receives about 3 to 4 thousand recommended changes in which about a forth result in changes

National Fire Protection Association

NFPA develops about 300 Codes,
some of the ones relevant to us include:

- NFPA 70 National Electrical Code
- NFPA 70E Standard for Electrical Safety in the Workplace®
- NFPA 72 National Fire Alarm and Signaling Code
- NFPA 13 Standard for the Installation of Sprinkler Systems
- NFPA 75 Standard for the Fire Protection of IT Equipment
- NFPA 101 Life Safety Code

Purpose of NEC 90.1

(A) Practical Safeguarding. The purpose of this *Code* is the practical safeguarding of persons and property from hazards arising from the use of electricity. This *Code* is not intended as a design specification or an instruction manual for untrained persons.

(B) Adequacy. This *Code* contains provisions that are considered necessary for safety.

Scope of NEC 90.2

(A) Covered. This *Code* covers the installation and removal of electrical conductors, equipment, and raceways; signaling and communications conductors, equipment, and raceways; and optical fiber cables and raceways for the following:

(1) Public and private premises, including buildings, structures, mobile homes, recreational vehicles, and floating buildings

(2) Yards, lots, parking lots, carnivals, and industrial substations

(3) Installations of conductors and equipment that connect to the supply of electricity

(4) Installations used by the electric utility

Scope -Not Covered

1. Ships and watercraft other than floating buildings
2. Mines
3. Railways
4. Communication equipment under the exclusive control of communication utilities

Code Adoption 90.4

This Code is intended to be suitable for mandatory application by governmental bodies that exercise legal jurisdiction over electrical installations, including signaling and communications systems, and for use by insurance inspectors.

Code Adoption 90.4

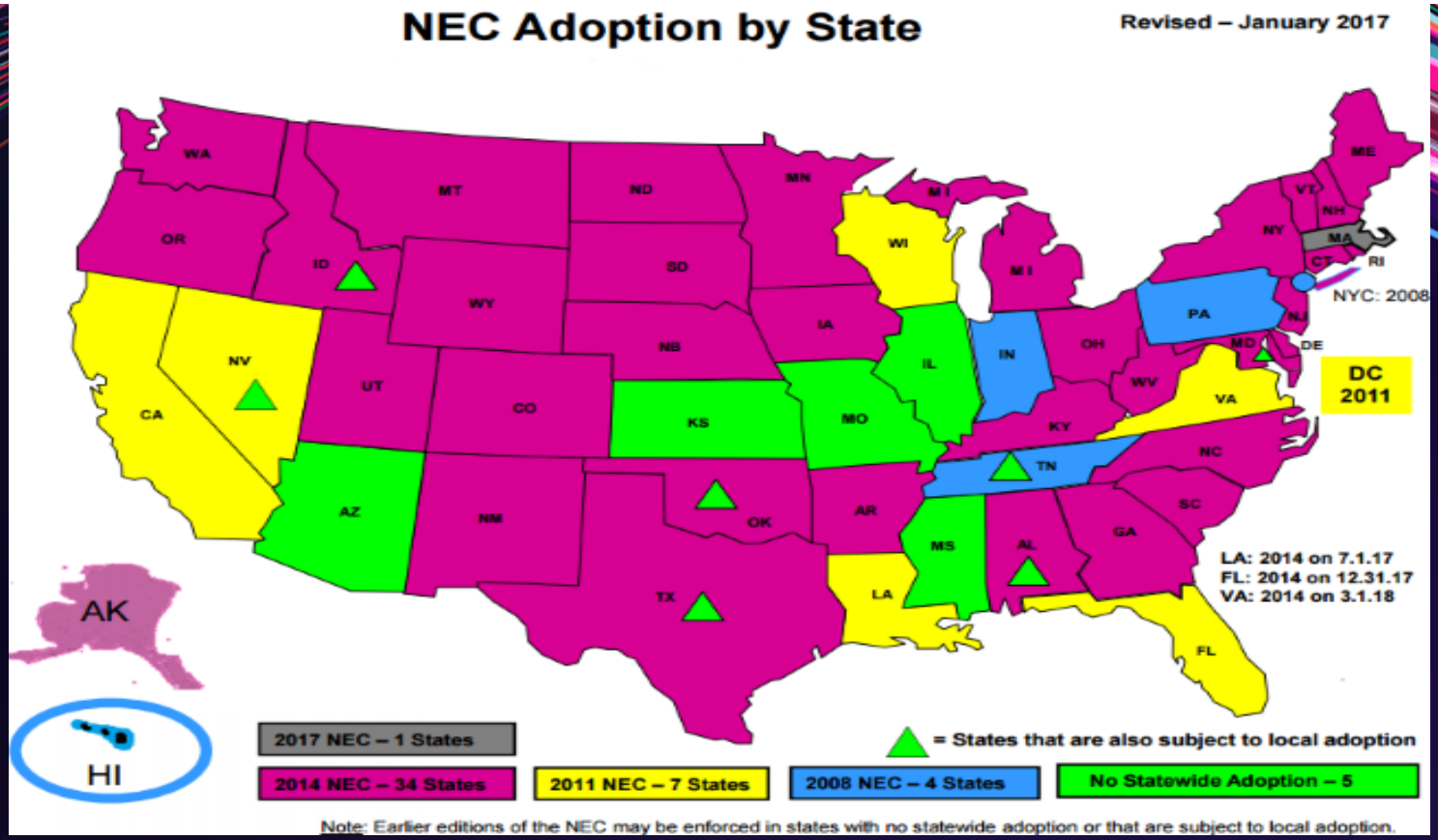
The authority having jurisdiction for enforcement of the Code has the responsibility for making interpretations of the rules, for deciding on the approval of equipment and materials, and for granting the special permission contemplated in a number of the rules.

All materials and equipment used under the requirements of the Code are subject to the approval of the AHJ.

Code Adoption

Some localities do not adopt the NEC, but, even in those localities, installations that comply with the current NEC are prima facie evidence that the electrical installation is safe.

By special permission, the authority having jurisdiction may waive specific requirements in this Code or permit alternative methods where it is assured that equivalent objectives can be achieved by establishing and maintaining effective safety.



Code Arrangement

- Chapter 1 — General
- Chapter 2 — Wiring and Protection
- Chapter 3 — Wiring Methods and Materials
- Chapter 4 — Equipment for General Use

→ Applies generally to all electrical installations

Supplements or modifies Chapters 1 through 7

- Chapter 5 — Special Occupancies
- Chapter 6 — Special Equipment
- Chapter 7 — Special Conditions

- Chapter 8 — Communications Systems → Chapter 8 is not subject to the requirements of Chapters 1 through 7 except where the requirements are specifically referenced in Chapter 8.
- Chapter 9 — Tables → Applicable as referenced
- Informative Annex A through Informative Annex J → Informational only; not mandatory

Using the NEC

Use the NEC Handbook as an expert opinion of the Code.

The editorial notes, in blue, provide insight to the meaning of the Code.

(B) Support of Communications Wires and Cables. Raceways shall be used for their intended purpose. Communications wires and cables shall not be strapped, taped, or attached by any means to the exterior of any raceway as a means of support.

Exception: Overhead (aerial) spans of communications wires and cables shall be permitted to be attached to the exterior of a raceway-type mast intended for the attachment and support of such wires and cables.

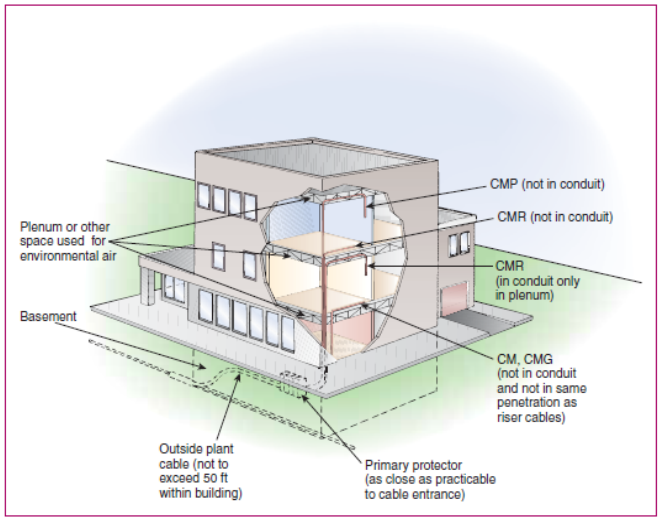
In some instances, the only way to achieve the proper clearance above roadways, driveways, or structures is by use of a mast. The exception Table 800.154(c)

The permitted applications shall be subject to the installation requirements of 800.110 and 800.113. The substitutions for communications cables listed in Table 800.154(d) and illustrated in Figure 800.154 shall be permitted.

The length of unlisted outside plant cable permitted in a building depends on the location of the primary protector in accordance with 800.48 and 800.90(B).

Exhibit 800.4 illustrates applications of listed communications cables.

EXHIBIT 800.4 *Applications of listed communications cables within various locations of a building.*



Using the NEC

Most Definitions are in Chapter 1 General, Article 100 however each section may have additional definitions

For example, there are a number of definitions in Article 800

EXHIBIT 800.1 *A private automatic branch exchange, which is one part of telecommunications equipment.*

than where Chapter 8 specifies a requirement. In some cases, telephone system wiring is also used for data transmission, which is covered by Article 800. However, 90.2(B)(4) exempts telephone company central offices from Article 800. Exhibit 800.1 shows an example of the type of equipment that is subject to the requirements of Article 800.

Although information technology equipment systems are often used for or with communications systems, Article 800 does not cover wiring of this equipment.

Block. A square or portion of a city, town, or village enclosed by streets and including the alleys so enclosed, but not any street.

Cable. A factory assembly of two or more conductors having an overall covering.

Cable Sheath. A covering over the conductor assembly that may include one or more metallic members, strength members, or jackets.

Communications Circuit. The circuit that extends voice, audio, video, data, interactive services, telegraph (except radio), outside wiring for fire alarm and burglar alarm from the communications utility to the customer's communications equipment up to and including terminal equipment such as a telephone, fax machine, or answering machine.

Communications Circuit Integrity (CI) Cable. Cable used in communications systems to ensure continued operation of critical circuits during a specified time under fire conditions.

Exposed (to Accidental Contact). A circuit that is in such a position that, in case of failure of supports or insulation, contact with another circuit may result.

Informational Note: See Part I of Article 100 for two other definitions of *Exposed*.

Point of Entrance. The point within a building at which the communications wire or cable emerges from an external wall or from a concrete floor slab.

Premises. The land and buildings of a user located on the user side of the utility-user network point of demarcation.

Wire. A factory assembly of one or more insulated conductors without an overall covering.

800.3 Other Articles.

(A) Hazardous (Classified) Locations. Communications circuits and equipment installed in a location that is classified in accordance with 500.5 and 505.5 shall comply with the applicable requirements of Chapter 5.

(B) Wiring in Ducts for Dust, Loose Stock, or Vapor

Using the NEC

There are many technical words used in the NEC. It is **crucial** that you understand the meanings of words. Important to us includes:

Information Technology Equipment (ITE): Equipment and systems rated 1000 v or less, normally found in offices, that are used for creation and manipulation of data, voice, video, and similar signals that are not communications equipment as defined in Part I of Article 100 and do not process communications circuits as defined in 800.2. and do not process communication circuits as defined in 800.2.

Using the NEC

Communication Circuit: The circuit that extends voice, audio, video, data, interactive services, telegraph (except radio), outside wiring for fire alarm and burglar alarm from the communication utility to the customer's communication equipment up to and including terminal equipment.

Plenum. A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system.

Using the NEC

Composite Optical Fiber Cable: A cable containing optical fibers and current-carrying conductors.

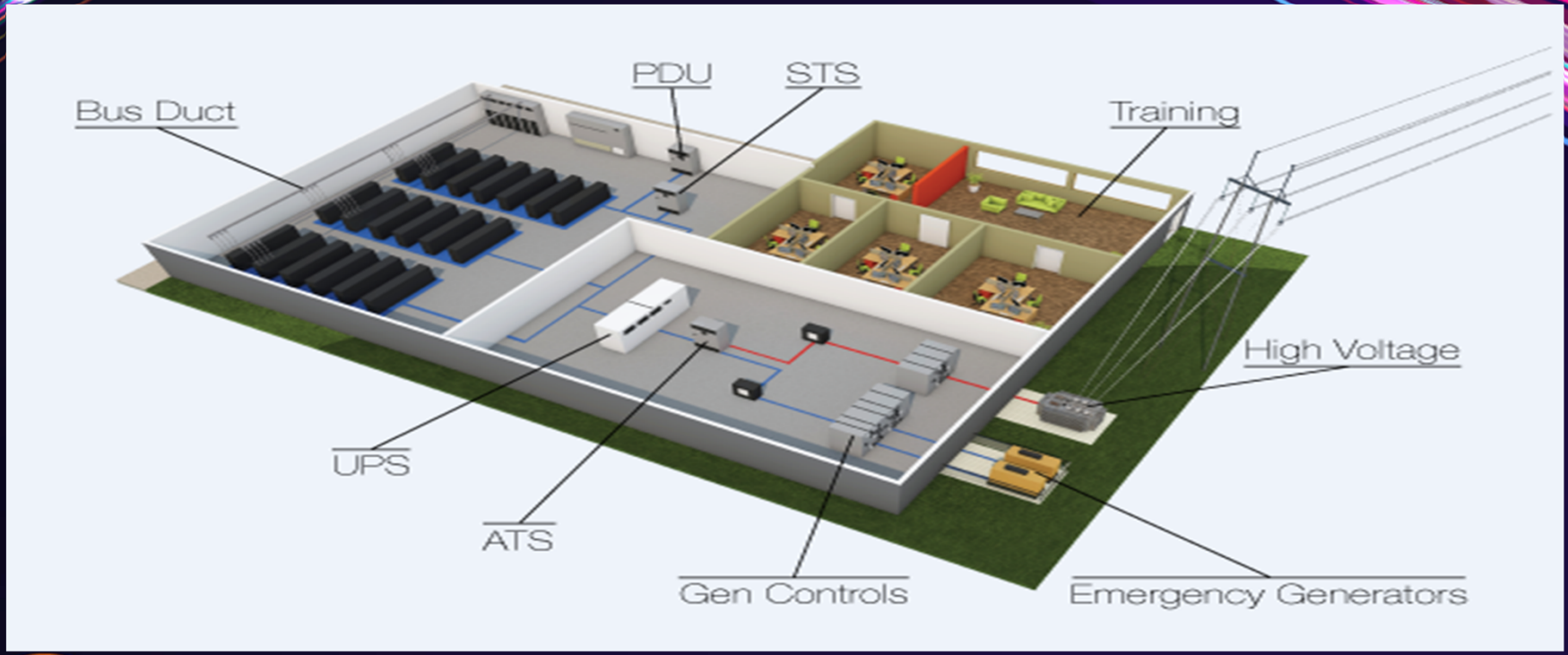
Conductive Optical Fiber Cable: A factory assembly of one or more optical fibers having an overall covering and containing non-current-carrying conductive member(s) such as a metallic strength member(s), metallic vapor barrier(s), metallic armor or metallic sheath.

Effects of Electrical Current* on the Body[3]

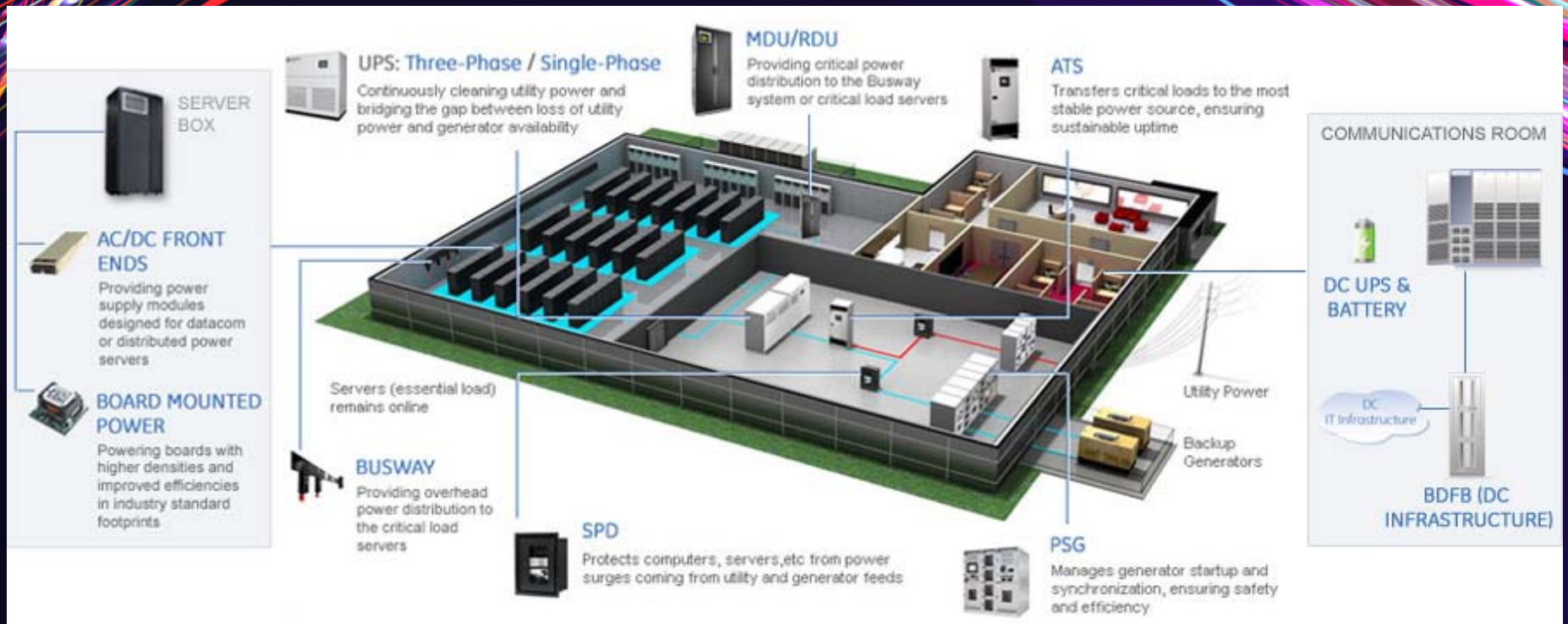
Current	Reaction
1 milliamp	Just a faint tingle.
5 milliamps	Slight shock felt. Disturbing, but not painful. Most people can "let go." However, strong involuntary movements can cause injuries.
6–25 milliamps (women)† **9–30 milliamps** (men)	Painful shock. Muscular control is lost. This is the range where "freezing currents" start. It may not be possible to "let go."
50–150 milliamps	Extremely painful shock, respiratory arrest (breathing stops), severe muscle contractions. Flexor muscles may cause holding on; extensor muscles may cause intense pushing away. Death is possible.
1,000–4,300 milliamps (1–4.3 amps)	Ventricular fibrillation (heart pumping action not rhythmic) occurs. Muscles contract; nerve damage occurs. Death is likely.
10,000 milliamps (10 amps)	Cardiac arrest and severe burns occur. Death is probable.
15,000 milliamps (15 amps)	Lowest overcurrent at which a typical fuse or circuit breaker opens a circuit!

*Effects are for voltages less than about 600 volts. Higher voltages also cause severe burns.
†Differences in muscle and fat content affect the severity of shock.

What's a Data Center



What's in a Data Center



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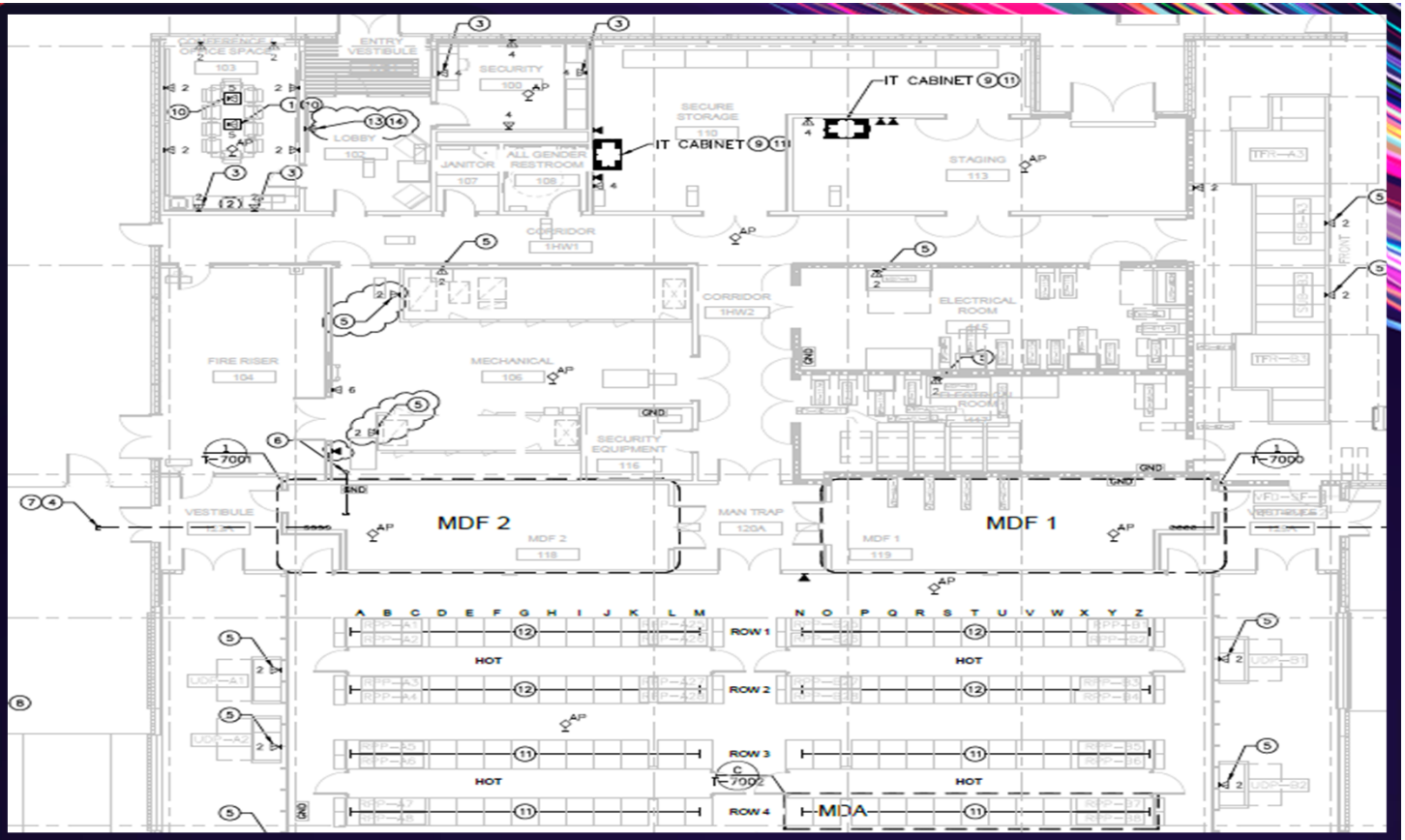

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What's in a Data Center

From ANSI/TIA-942-A

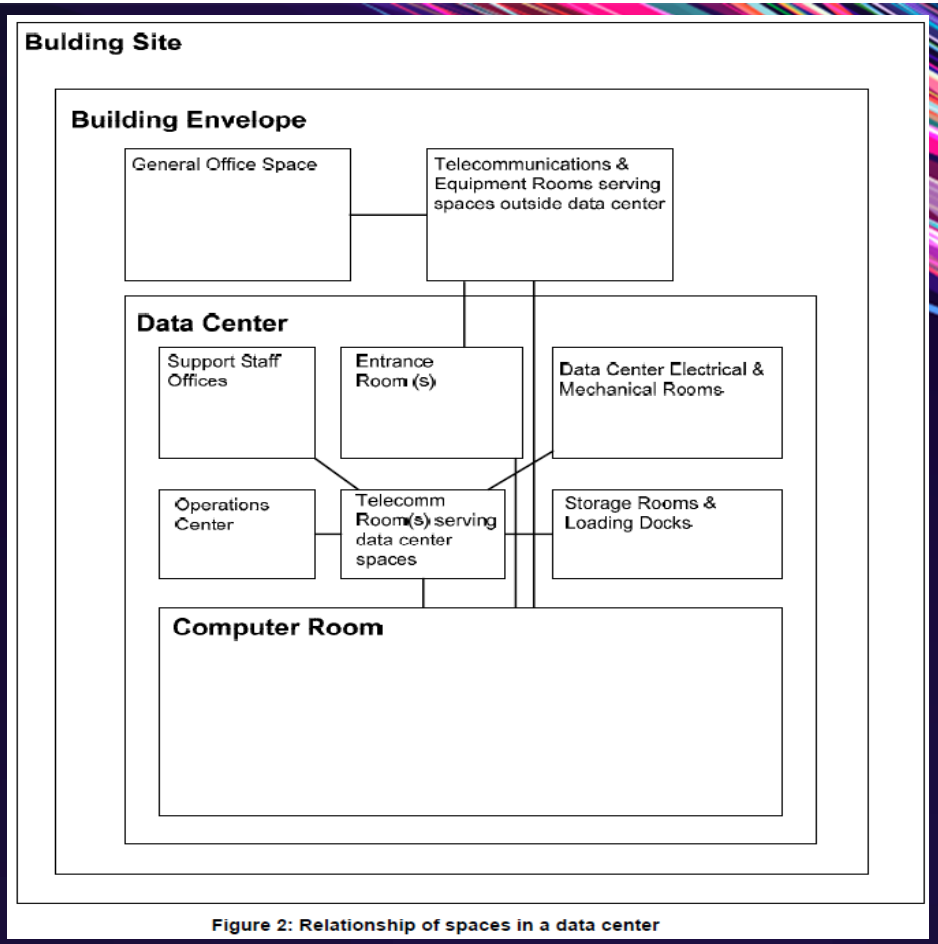


Figure 2: Relationship of spaces in a data center

How's it configured?

From ANSI/TIA-942-A

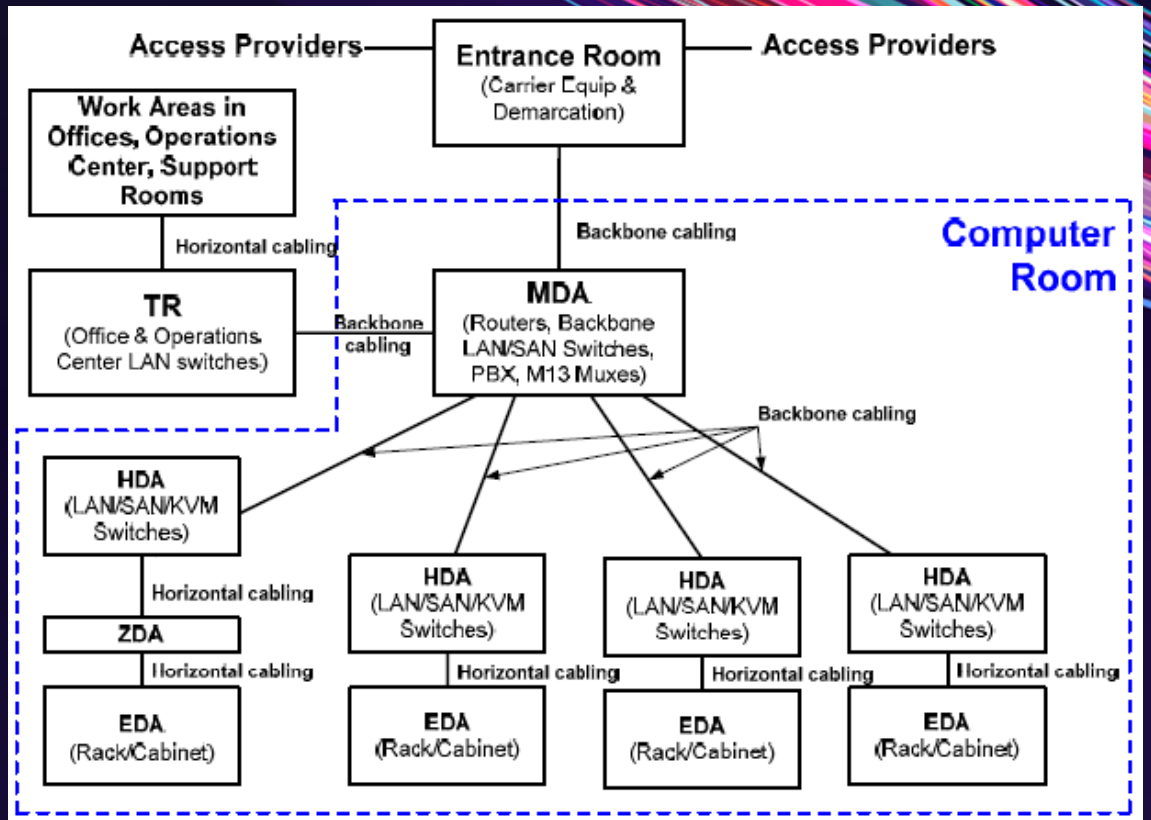


Figure 5: Example of a basic data center topology

How's it configured?

MDA – Main Distribution Area

HDA – Horizontal Distribution Area

ZDA – Zone Distribution Area

EDA – Equipment Distribution Area

From ANSI/TIA-942-A

How's it configured?

From ANSI/TIA-942-A

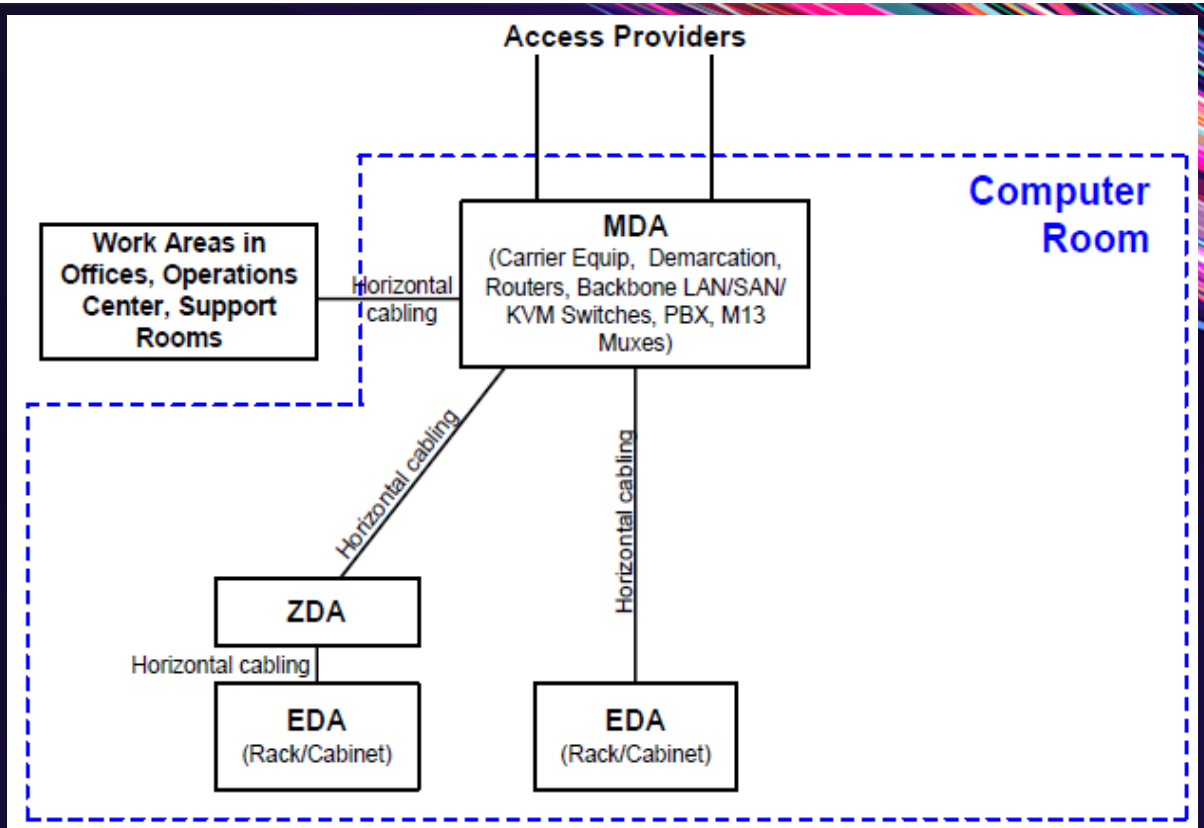
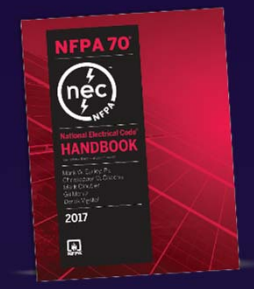


Figure 6: Example of a reduced data center topology

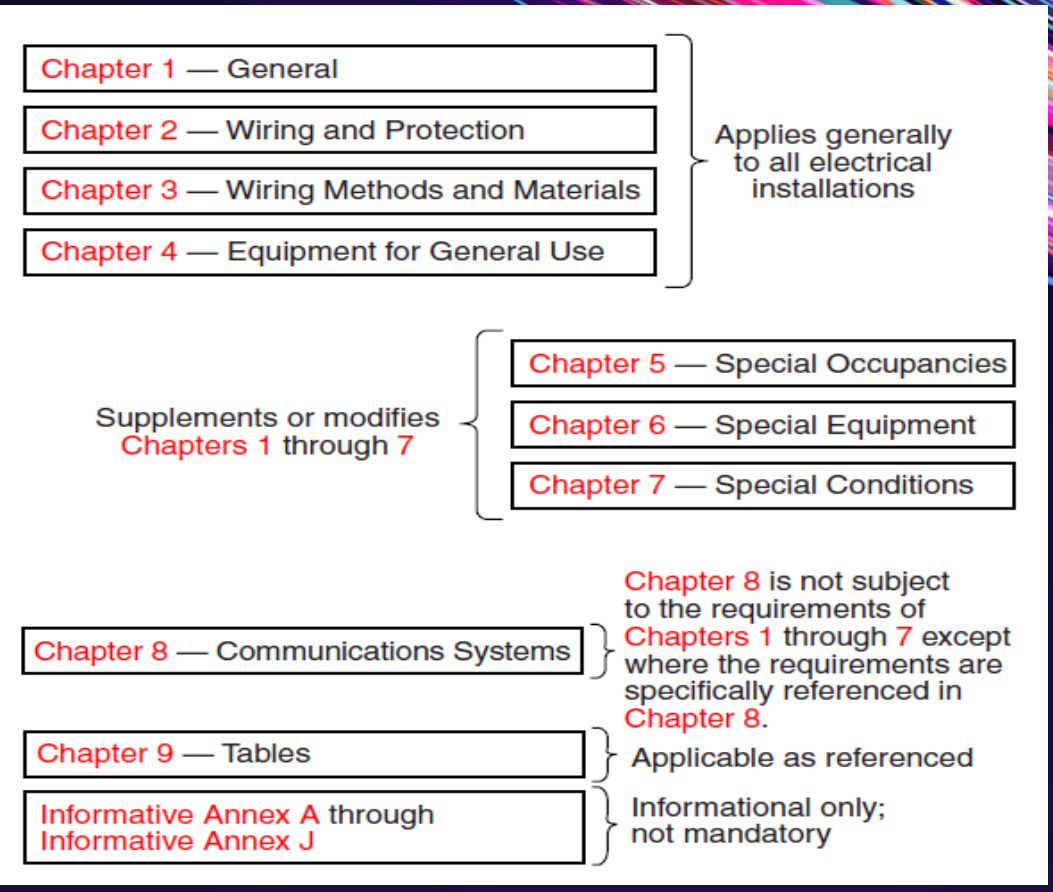
NEC Code Articles

Article 110.26 Clearances
Article 250 Grounding
Article 392 Cable Tray
Article 480 Battery Systems
Article 645 IT Equipment

Article 646 Modular Data Centers
Article 725 Cabling
Article 770 Fiber Optic Cable
Article 800 Communication
NFPA 72 and 75



Code Arrangement



Article 110.26 Clearances

TABLE 110.26(A)(1) Working Spaces

Nominal Voltage to Ground	Minimum Clear Distance		
	Condition 1	Condition 2	Condition 3
0–150	900 mm (3 ft)	900 mm (3 ft)	900 mm (3 ft)
151–600	900 mm (3 ft)	1.0 m (3 ft 6 in.)	1.2 m (4 ft)
601–1000	900 mm (3 ft)	1.2 m (4 ft)	1.5 m (5 ft)

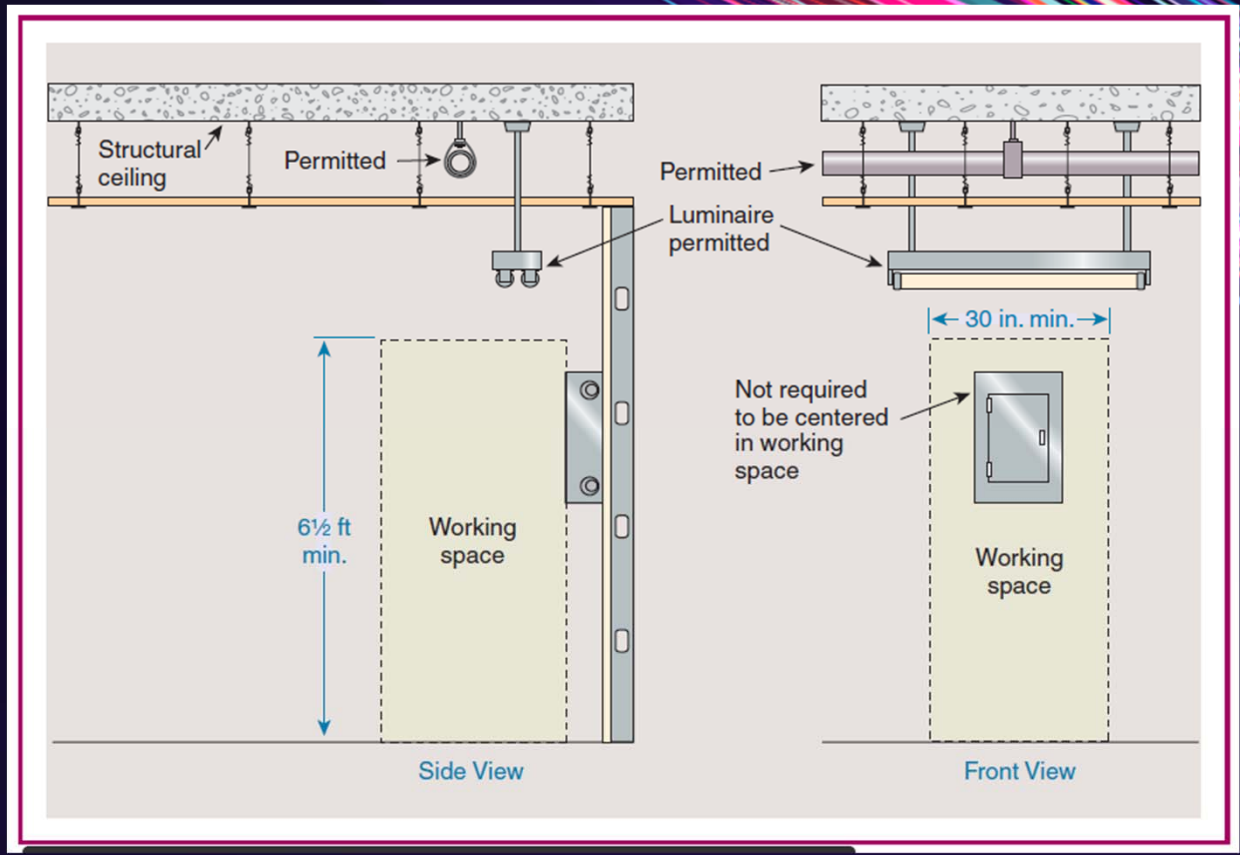
Note: Where the conditions are as follows:

Condition 1 — Exposed live parts on one side of the working space and no live or grounded parts on the other side of the working space, or exposed live parts on both sides of the working space that are effectively guarded by insulating materials.

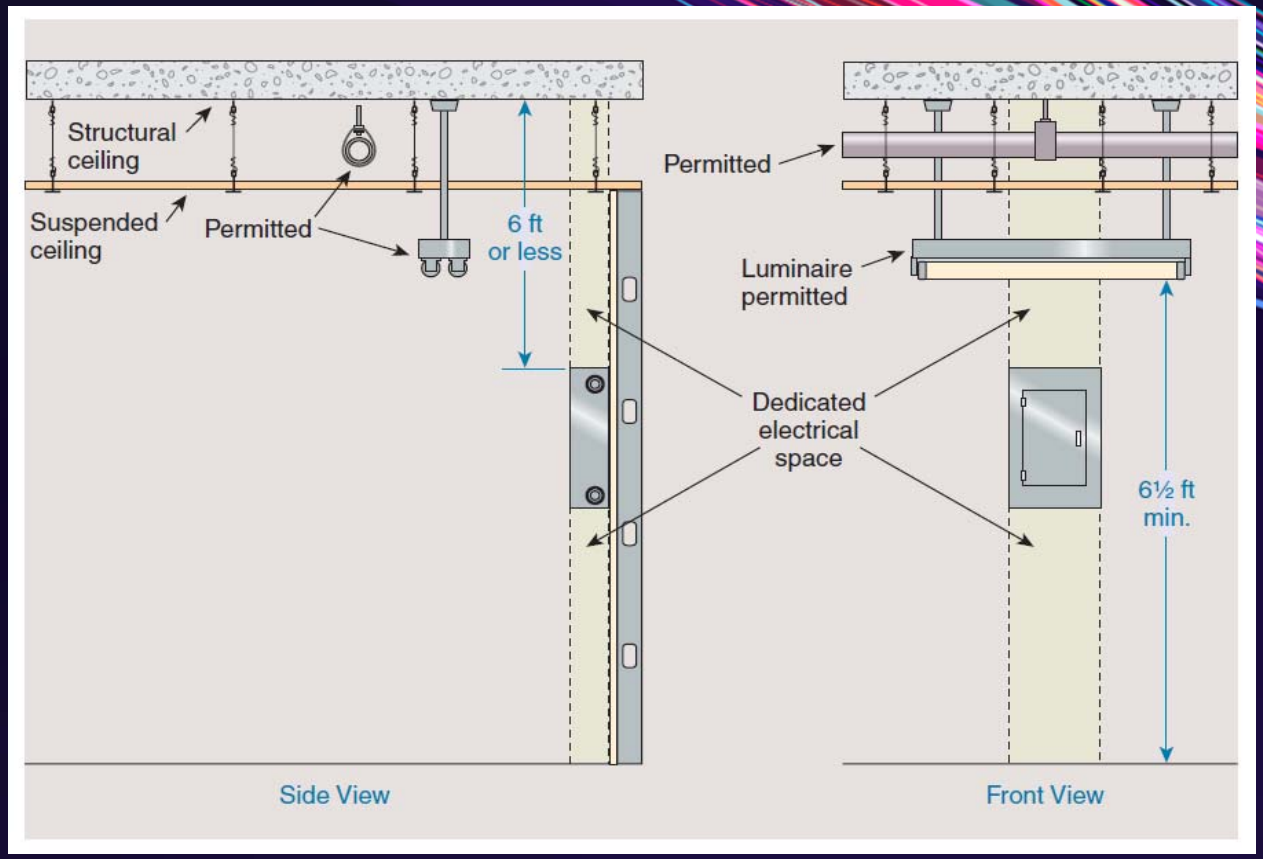
Condition 2 — Exposed live parts on one side of the working space and grounded parts on the other side of the working space. Concrete, brick, or tile walls shall be considered as grounded.

Condition 3 — Exposed live parts on both sides of the working space.

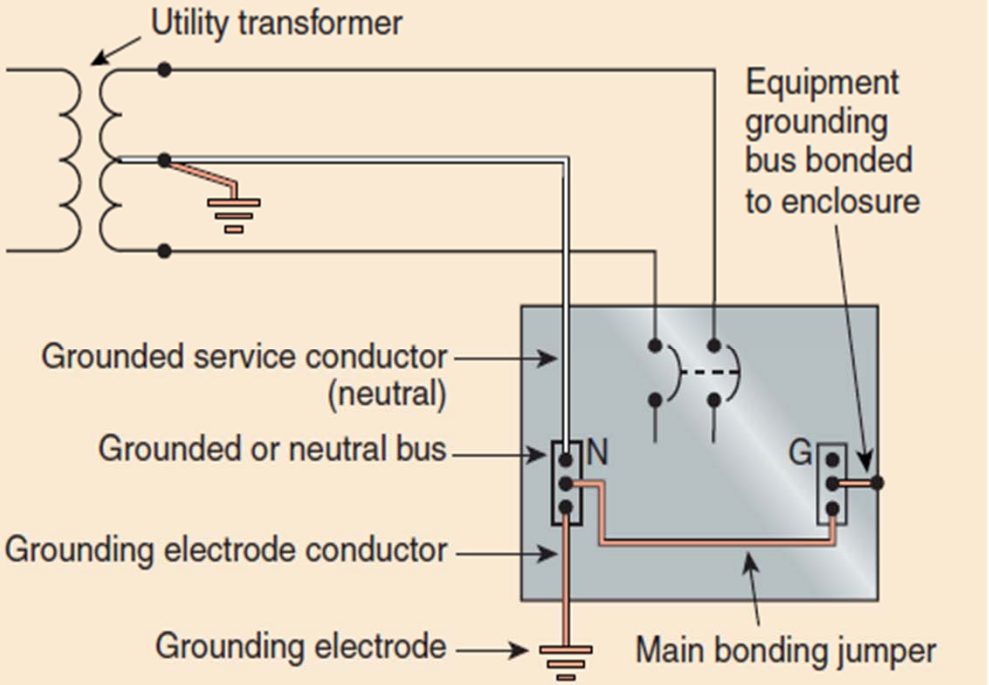
Article 110.26 Clearances



Article 110.26 Clearances

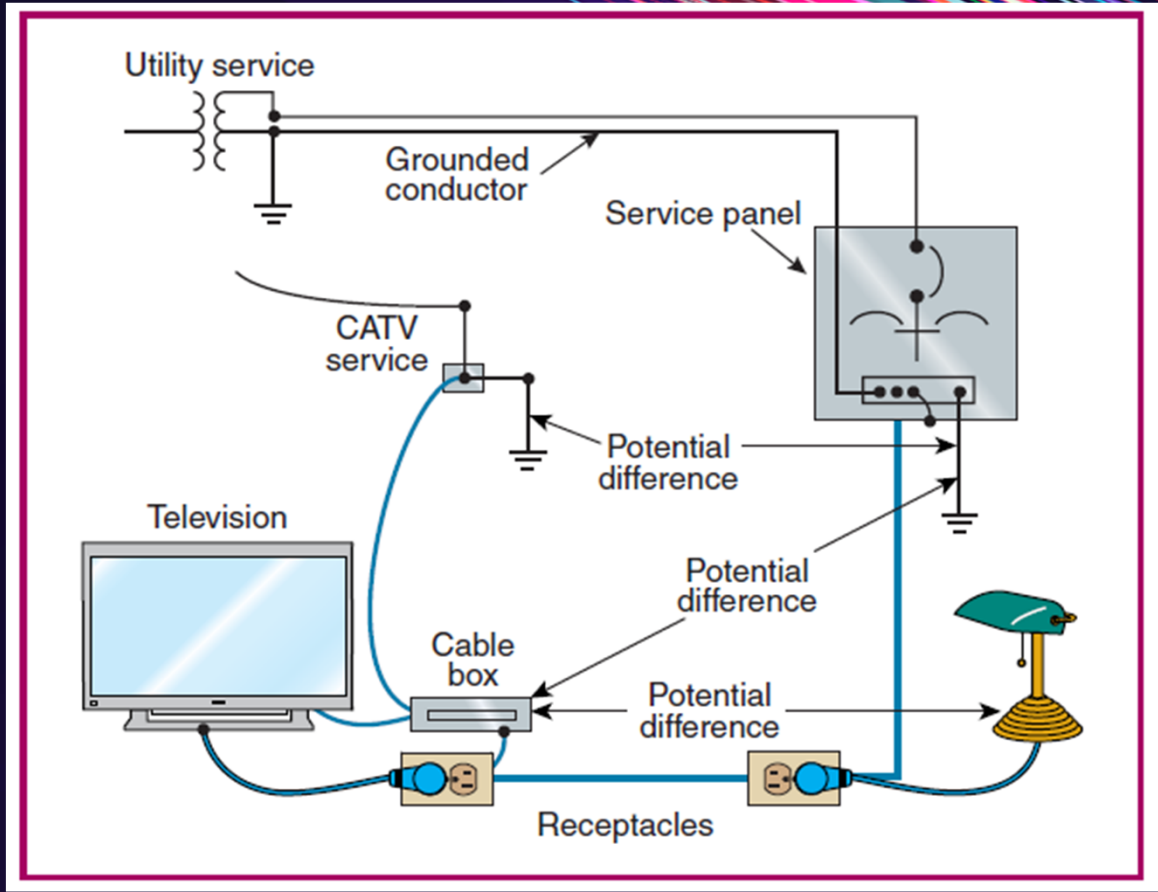


Article 250 Grounding



Article 250 Grounding Bad

NEC 250.94 Bonding for Communication Systems



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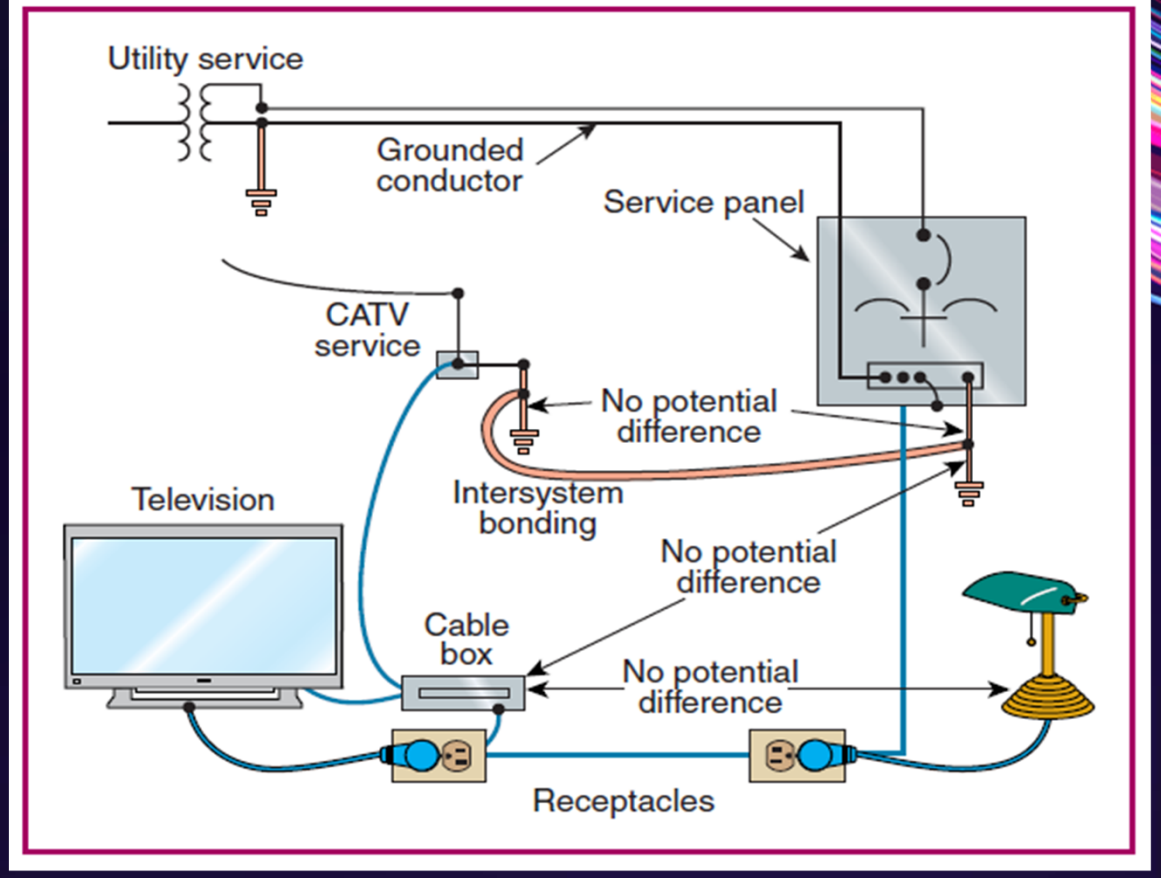
Article 250 Grounding Good

NEC 250.94 Bonding for Communication Systems



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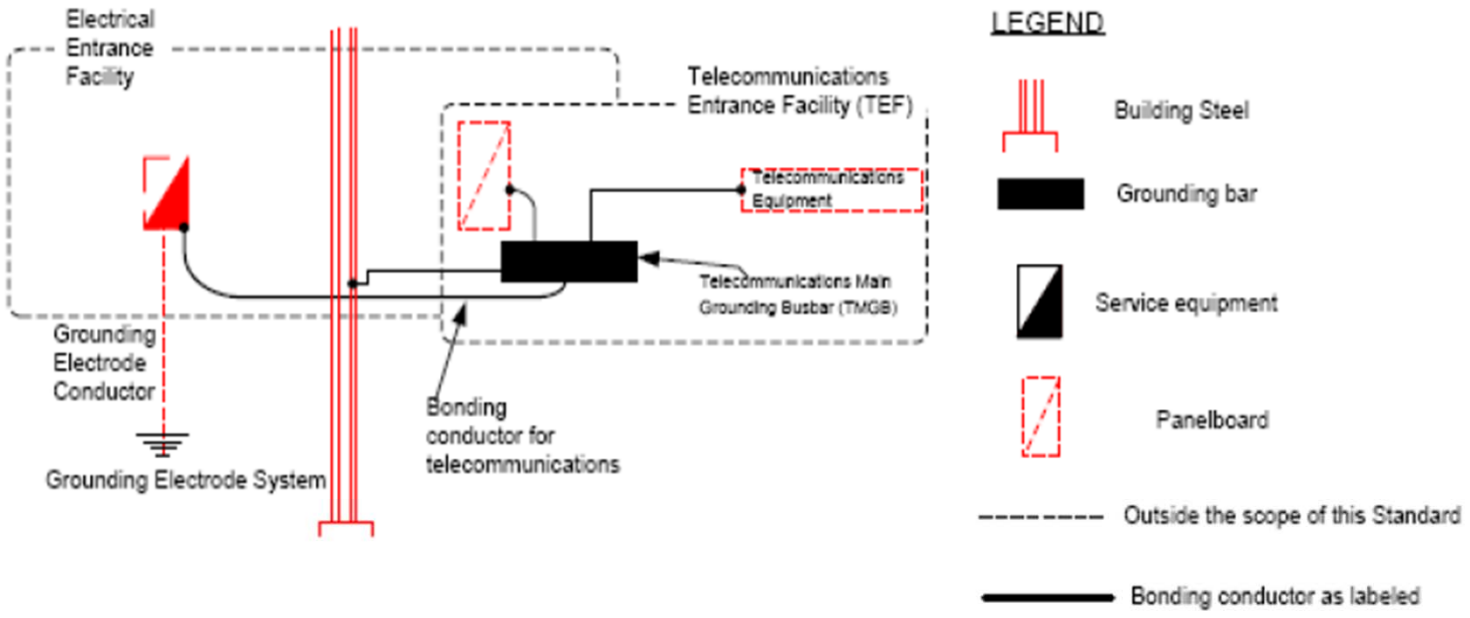
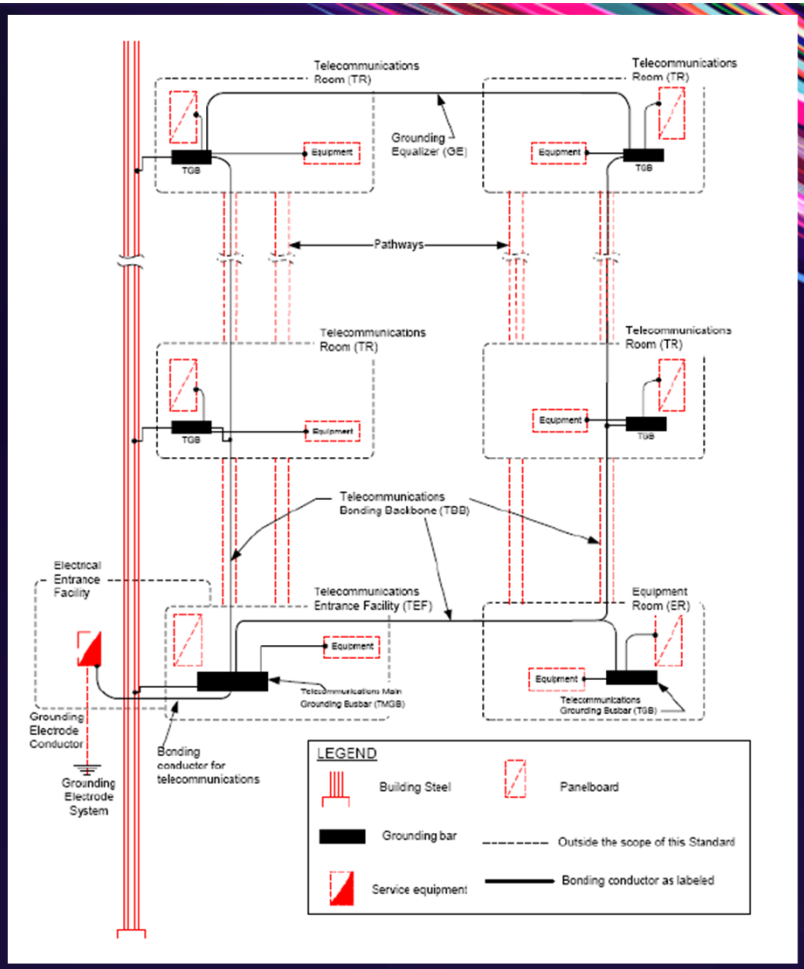
Grounding TIA 607- B



Grounding
TIA 607- B



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Article 392 Cable Tray

(2) Ladder or Ventilated Trough Cable Trays Containing Multiconductor Control and/or Signal Cables Only. Where a ladder or ventilated trough cable tray having a usable inside depth of 150 mm (6 in.) or less contains multiconductor control and/or signal cables only, the sum of the cross-sectional areas of all cables at any cross section shall not exceed 50 percent of the interior cross-sectional area of the cable tray. A depth of 150 mm (6 in.) shall be used to calculate the allowable interior cross-sectional area of any cable tray that has a usable inside depth of more than 150 mm (6 in.).

Article 392 Cable Tray

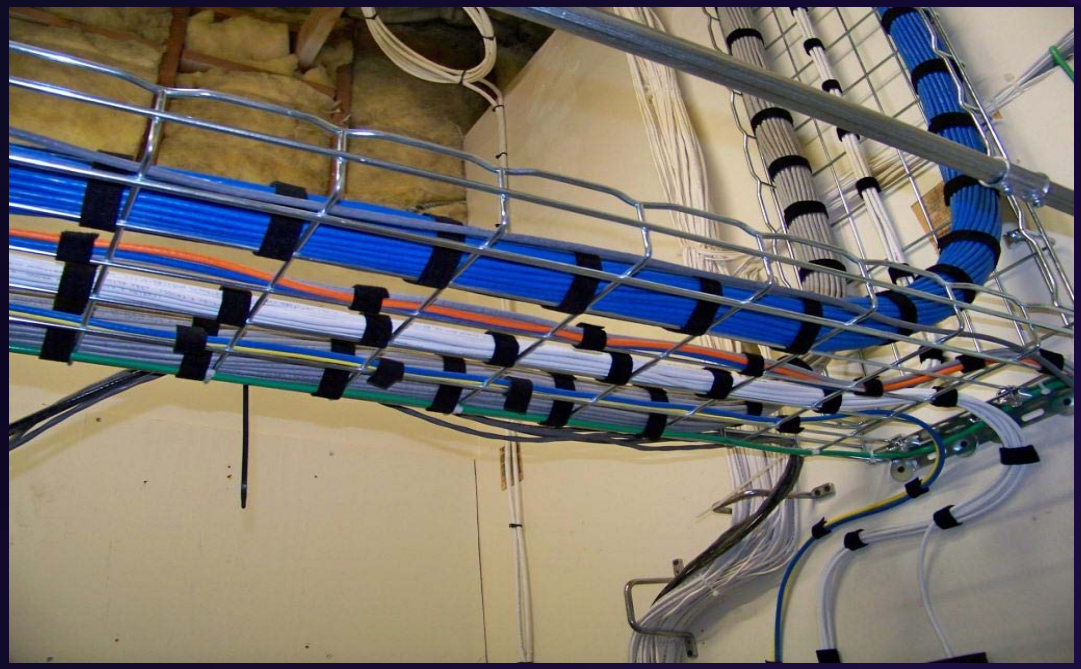
392.30 Securing and Supporting.

(A) Cable Trays. Cable trays shall be supported at intervals in accordance with the installation instructions.

Load & Fill Chart

Series Part Number	Size height x width	Lbs/Ft (max) 5'-0"	6'-0"	7'-0"	8'-0"	Actual Area Inside Tray (in²)	Cable Fill (50% fill)** Number of CAT 5e Cables***	Number of CAT CAT 6 Cables***	Number of CAT CAT 6A Cables**
FT1.5X12	1 1/2" x 12"	29	17	14	11	12.2	176	124	95
FT2X2	2" x 2"	34	28	24	20	4.3	61	43	33
FT2X4	2" x 4"	52	43	35	27	8.2	118	83	64
FT2X6	2" x 6"	66	47	35	27	12.1	175	123	95
FT2X8	2" x 8"	66	47	35	27	16.1	231	163	125
FT2X12	2" x 12"	68	47	35	27	23.9	345	243	187
FT2X16	2" x 16"	68	47	35	27	31.8	459	324	249
FT2X18	2" x 18"	68	47	35	27	35.8	516	364	280
FT2X20	2" x 20"	68	47	35	27	39.7	573	404	311
FT2X24	2" x 24"	68	47	35	27	47.5	686	484	372
FT2X30	2" x 30"	68	47	35	27	59.8	862	608	468
FT2X32	2" x 32"	77	53	39	30	63.3	914	645	496
FT4X4	4" x 4"	58	49	42	36	15.8	227	160	123
FT4X6	4" x 6"	93	77	60	46	23.6	341	240	185
FT4X8	4" x 8"	94	78	61	47	31.5	454	321	247
FT4X12	4" x 12"	119	83	61	47	47.5	686	484	372
FT4X16	4" x 16"	119	83	61	47	63.5	917	647	498
FT4X18	4" x 18"	119	83	61	47	71.5	1032	728	560
FT4X20	4" x 20"	119	83	61	47	79.5	1148	810	623
FT4X24	4" x 24"	128	89	65	50	95.5	1379	973	749
FT4X30	4" x 30"	128	89	65	50	119.5	1725	1217	936
FT6X8	6" x 8"	111	77	57	43	47.3	682	481	370
FT6X12	6" x 12"	124	86	63	48	71.6	1034	729	561
FT6X16	6" x 16"	128	89	65	50	95.3	1375	970	746
FT6X18	6" x 18"	128	89	65	50	107.3	1549	1092	840
FT6X20	6" x 20"	141	98	72	55	118.9	1716	1211	932
FT6X24	6" x 24"	154	107	78	60	143.3	2068	1459	1123

Article 392 Cable Tray



Article 480 Battery Systems

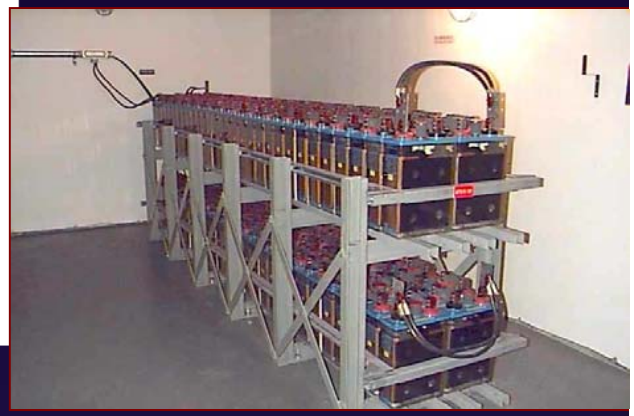
480.7 DC Disconnect Methods.

(A) Disconnecting Means. A disconnecting means shall be provided for all ungrounded conductors derived from a stationary battery system with a voltage over 60 volts dc. A disconnecting means shall be readily accessible and located within sight of the battery system.

Article 480 Battery Systems

(C) Spaces About Battery Systems. Spaces about battery systems shall comply with 110.26. Working space shall be measured from the edge of the battery cabinet, racks, or trays.

For battery racks, there shall be a minimum clearance of 25 mm (1 in.) between a cell container and any wall or structure on the side not requiring access for maintenance. Battery stands shall be permitted to contact adjacent walls or structures, provided that the battery shelf has a free air space for not less than 90 percent of its length.



Safety Shower - Monitoring

Article 645 IT Equipment

645.1 Scope. This article covers equipment, power-supply wiring, equipment interconnecting wiring, and grounding of information technology equipment and systems in an information technology equipment room.

Article 645 is NOT MANDATORY

- Just because there is IT equipment in the room does not mean that Article 645 must be applied
- Article 645 allows alternate construction from Chapter 3 and parts of Article 725 of the Code, such as permits certain non-plenum rated cable under floors and allows the cabling to be unsecured

Article 645 IT Equipment

645.4 Special Requirements for IT Equipment Room. The alternative wiring methods are acceptable where all of the following 6 conditions are met:

(1) Disconnecting means complying with 645.10 are provided.

(2) A heating/vent/air-conditioning (HVAC) system is provided as identified below:

a. A separate HVAC system dedicated for information technology equipment.

b. An HVAC system that serves other occupancies and serves the IT equipment room is provided with fire/smoke dampers

(3) Information technology and communications equipment installed is listed.

Article 645 IT Equipment

645.4 Special Requirements for IT Equipment Room (continued)

(4) The room is occupied by, and accessible to, only those personnel needed for the maintenance and functional operation of the installed information technology equipment.

(5) The room is separated from other occupancies by fire-resistant- rated walls, floors, and ceilings with protected openings.

(6) Only electrical equipment and wiring associated with the operation of the information technology room is installed in the room.

Article 645 IT Equipment-Advantages

The advantages to using this option are:

- Relaxed restrictions on cabling installed below the raised floor that is used as an HVAC air path.
- Electrical raceway restrictions are reduced.
- Cable tray may be used beneath the raised floor.
- Raceways and devices are not required to be securely fastened.
- Corded equipment receptacle connections may be made below the raised floor.

Article 645 IT Equipment- Disadvantages

- An approved, manually initiated means to disconnect power to all electronic equipment in the space. "EPO" system.
- A separate HVAC system that is dedicated for the ITE space use.
- The ITE space can only be occupied by personnel needed to maintain and operate the installed ITE equipment.
- The ITE space must be have fire-resistant-rated walls, floors, and ceilings.
- **Finally, having the EPO system and HVAC shutdowns will not increase the availability (uptime) of the computer equipment.**

Article 645 IT Equipment-Exceptions

(B) Remote disconnecting controls shall not be required for critical operations data systems when all of the following conditions are met:

(1) An approved procedure has been established for removing power and air movement.

(2) Qualified personnel are continuously available.

(3) A smoke-sensing fire detection system is in place.

(4) An approved fire suppression system is in place.

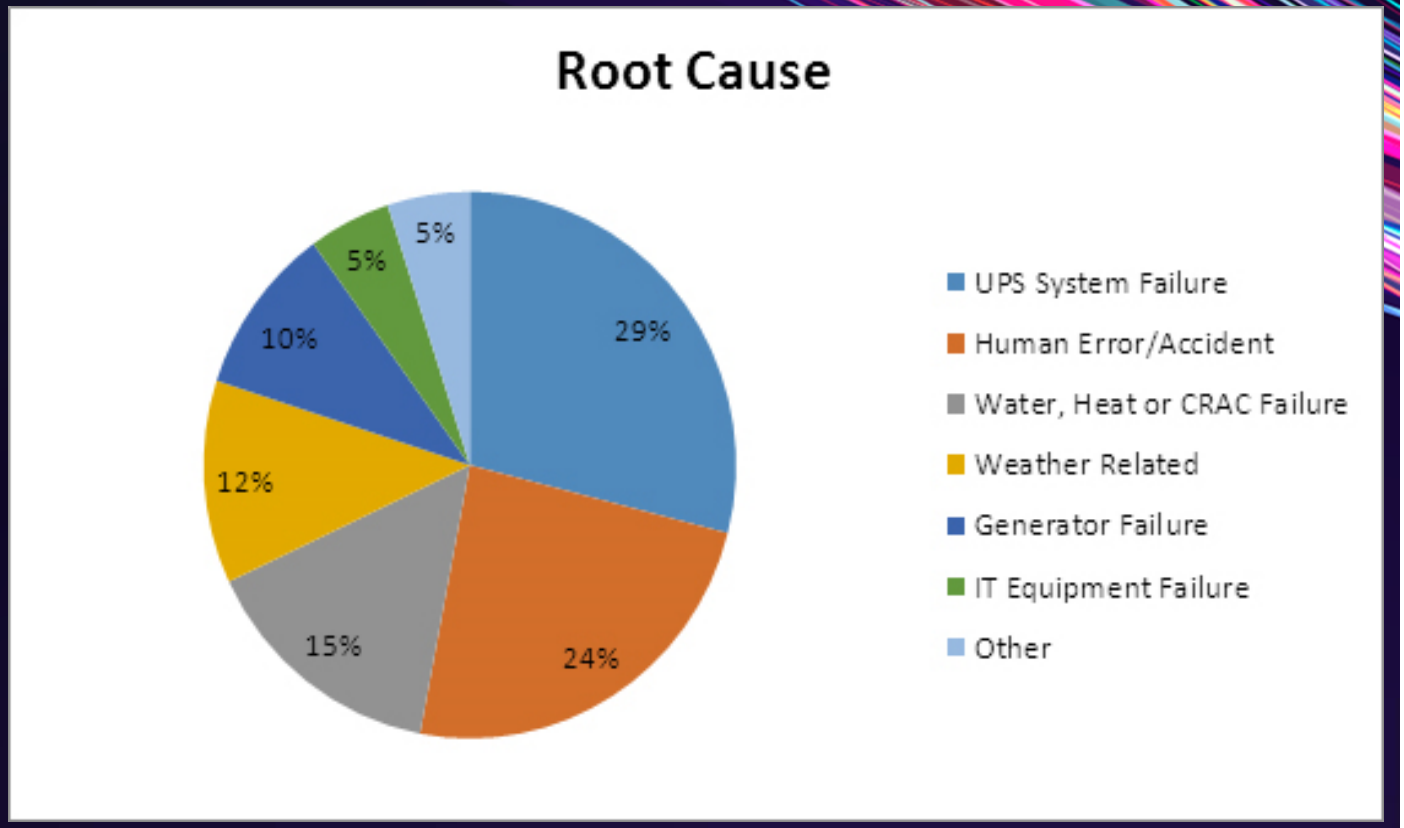
(5) Cables installed under a raised floor, other than branch circuit wiring, and power cords are installed in compliance with 645.5, or Table 645.10(B)(5).

Article 645 IT Equipment-Exceptions

Critical Operations Data System. An information technology equipment system that requires continuous operation for reasons of public safety, emergency management, national security, or business continuity.

Only those data systems designated as critical in function based on that definition are permitted to implement the provision for not installing the remote disconnect control covered in 645.10(A).

Reliability



Break

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Article 646
Modular Data Centers

646.2 Definitions. The definitions in 645.2 shall apply. For the purposes of this article, the following additional definition applies.

Modular Data Center (MDC). Prefabricated units, rated 1000 volts or less, consisting of an outer enclosure housing multiple racks or cabinets of information technology equipment (ITE) (e.g., servers) and various support equipment, such as electrical service and distribution equipment, HVAC systems, and the like.

Article 646
Modular Data Centers

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Article 646 Modular Data Centers

Why?

- Scalability
- Quick deployment
- Low PUE
- Mobility

Article 646 Modular Data Centers

PUE is Power Usage Effectiveness (PUE) is a metric used to determine the energy efficiency of a data center.

PUE is determined by dividing the amount of power entering a data center by the power used to run the computer infrastructure within it.

PUE is therefore expressed as a ratio, with overall efficiency improving as the quotient decreases toward 1.

Article 646 Modular Data Centers

- Issues fire stopping, grounding, disconnecting means.


Disconnects with provision for adding lock

Article 725 Cabling

Class 1, Class 2 and Class 3 Remote-Control, Signaling and Power-Limited Circuits

725.1 Scope. This article covers remote-control, signaling, and power-limited circuits that are not an integral part of a device or of utilization equipment.

Informational Note: The circuits described herein are characterized by usage and electrical power limitations that differentiate them from electric light and power circuits; **therefore, alternative requirements to those of Chapters 1 through 4 are given with regard to minimum wire sizes, ampacity adjustment and correction factors, overcurrent protection, insulation requirements, and wiring methods and materials.**

Article 725 Cabling

Class 1, Class 2 and Class 3 Remote-Control, Signaling and Power-Limited Circuits

From Article 800:

> **Article 725**, which provides requirements for wiring that extends beyond a computer room and for wiring of local area networks within buildings

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Article 725 Cabling

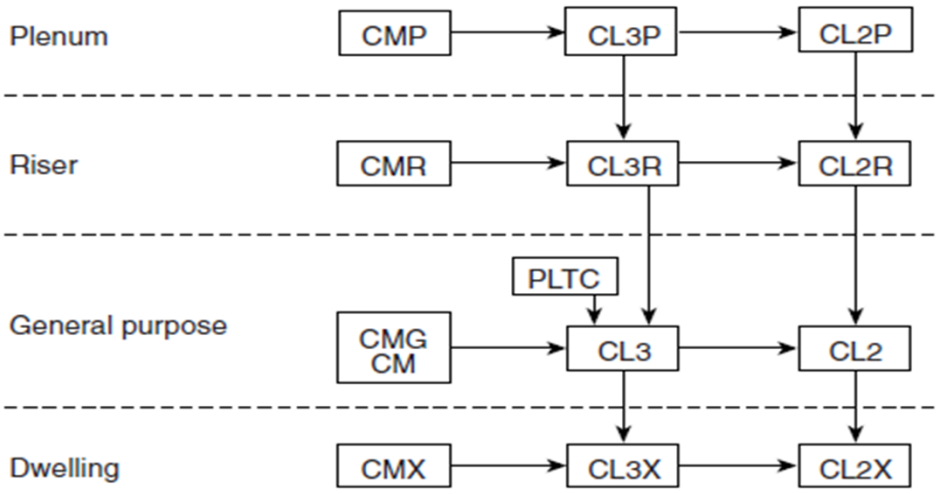


FIGURE 725.154(A) Cable Substitution Hierarchy.

Article 725 Cabling

Plenum Areas

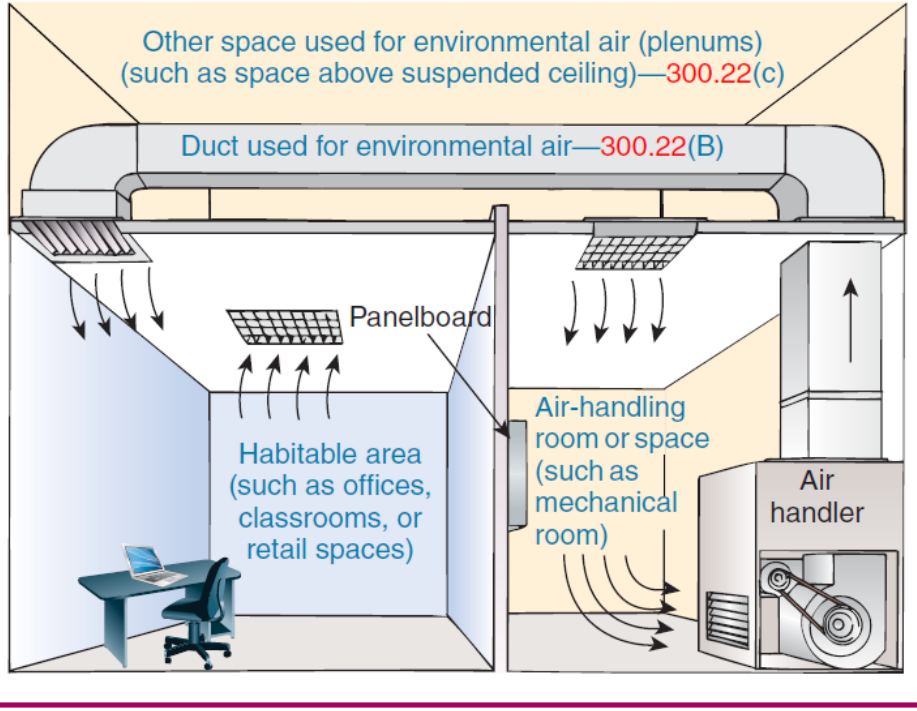
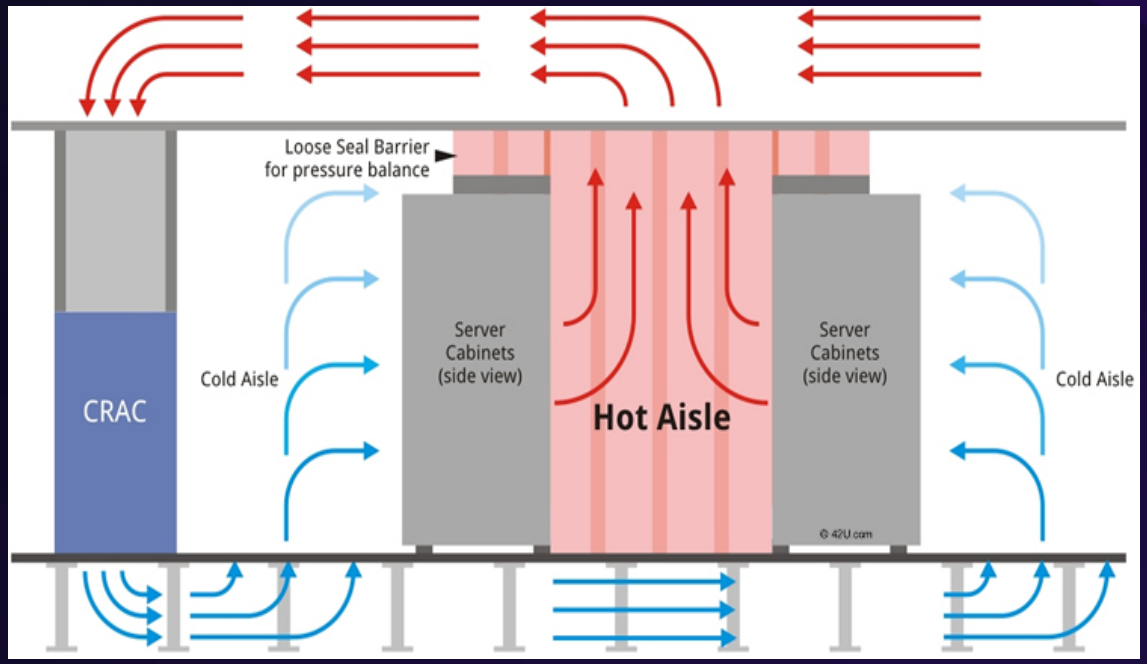


EXHIBIT 300.19 *An example of spaces used for environmental air.*

Article 725 Cabling

Hot Isle containment



Article 725 Cabling

TABLE 725.144 *Ampacities of Each Conductor in Amperes in 4-Pair Class 2 or Class 3 Data Cables Based on Copper Conductors at an Ambient Temperature of 30°C (86° F) with All Conductors in All Cables Carrying Current, 60°C (140°F), 75°C (167°F), and 90°C (194°F) Rated Cables*

AWG	Number of 4-Pair Cables in a Bundle																				
	1			2–7			8–19			20–37			38–61			62–91			92–192		
	Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating		
	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C
26	1	1	1	1	1	1	0.7	0.8	1	0.5	0.6	0.7	0.4	0.5	0.6	0.4	0.5	0.6	NA	NA	NA
24	2	2	2	1	1.4	1.6	0.8	1	1.1	0.6	0.7	0.9	0.5	0.6	0.7	0.4	0.5	0.6	0.3	0.4	0.5
23	2.5	2.5	2.5	1.2	1.5	1.7	0.8	1.1	1.2	0.6	0.8	0.9	0.5	0.7	0.8	0.5	0.7	0.8	0.4	0.5	0.6
22	3	3	3	1.4	1.8	2.1	1	1.2	1.4	0.7	0.9	1.1	0.6	0.8	0.9	0.6	0.8	0.9	0.5	0.6	0.7

Note 1: For bundle sizes over 192 cables, or for conductor sizes smaller than 26 AWG, ampacities shall be permitted to be determined by qualified personnel under engineering supervision.

Note 2: Where only half of the conductors in each cable are carrying current, the values in the table shall be permitted to be increased by a factor of 1.4.

Informational Note: The conductor sizes in data cables in wide-spread use are typically 22–26 AWG.

Article 770 Fiber Optic Cable

770.1 Scope. This article covers the installation of optical fiber cables. This article does not cover the construction of optical fiber cables.

Article 770 Fiber Optic Cable

770.48 Unlisted Cables Entering Buildings.

(A) Conductive and Nonconductive Cables. Unlisted conductive and nonconductive outside plant optical fiber cables shall be permitted to be installed in building spaces, other than risers, ducts used for environmental air, plenums used for environmental air, and other spaces used for environmental air, where the length of the cable within the building, measured from its point of entrance, does not exceed 15 m (50 ft) and the cable enters the building from the outside and is terminated in an enclosure.

The point of entrance shall be permitted to be extended from the penetration of the external wall or floor slab by continuously enclosing the entrance optical fiber cables in rigid metal conduit (RMC) or intermediate metal conduit (IMC) to the point of emergence.

Article 800 Communication

Article 800 Communication

800.1 Scope. This article covers communications circuits and equipment.

Informational Note No. 1: See 90.2(B)(4) for installations of communications circuits and equipment that are not covered.

Informational Note No. 2: For further information for remote-control, signaling, and power-limited circuits, see Article 725.

Informational Note No. 3: For further information for fire alarm systems, see Article 760.

Article 800 Communication

- Part I General
- Part II Wires and Cables Outside and Entering Buildings
- Part III Protection
- Part IV Grounding Methods
- Part V Installation Methods Within Buildings
- Part VI Listing Requirements

Article 800 Communication

Although information technology equipment systems are often used for or with communications systems, Article 800 does not cover wiring of this equipment.

See also

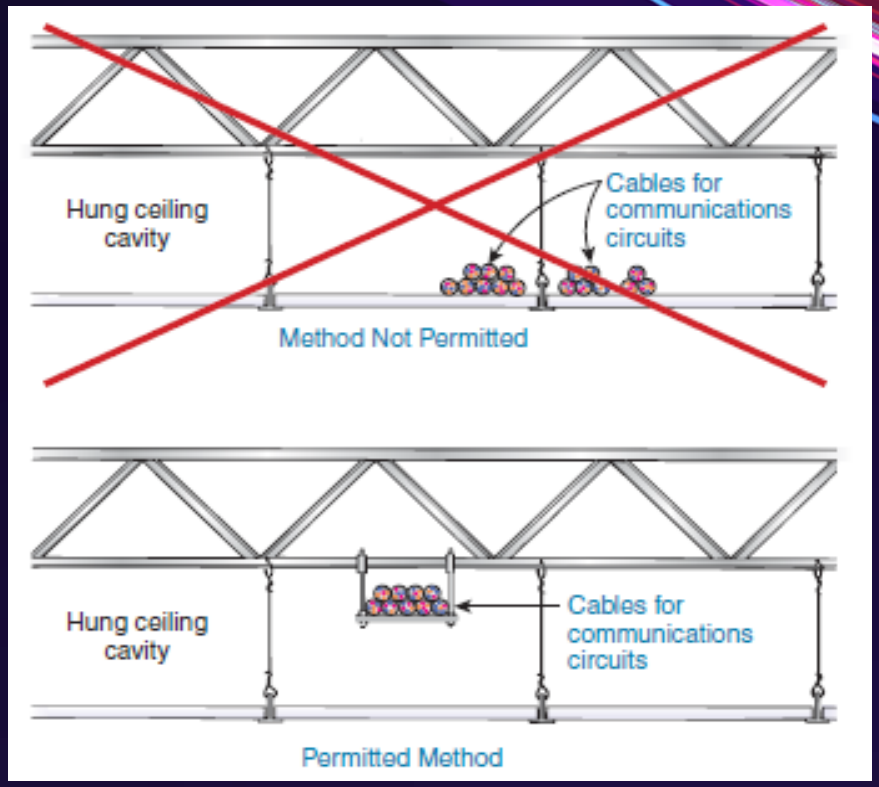
Article 645, which provides requirements for wiring contained solely within an information technology equipment room

Article 725, which provides requirements for wiring that extends beyond a computer room and for wiring of local area networks within buildings

Article 760, which covers wiring requirements for fire alarm systems

Article 800 Communication

- Part I General



Article 800 Communication

- Part I General

Article 300.4 Protection against Physical Damage

Article 300.11 Securing and Supporting

800.25 Abandoned Cables. The accessible portion of abandoned communications cables shall be removed. Where cables are identified for future use with a tag, the tag shall be of sufficient durability to withstand the environment involved.

800.26 Spread of Fire or Products of Combustion. Installations of communications cables, communications raceways, cable routing assemblies in hollow spaces, vertical shafts, and ventilation or air-handling ducts shall be made so that the possible spread of fire or products of combustion will not be substantially increased. Openings around penetrations of communications cables, communications raceways, and cable routing assemblies through fire-resistant-rated walls, partitions, floors, or ceilings shall be firestopped using approved methods to maintain the fire resistance rating.

Article 800 Communication

- Part II Wires and Cables Outside and Entering Buildings

800.48 Unlisted Cables Entering Buildings. Unlisted outside plant communications cables shall be permitted to be installed in building spaces other than risers, ducts used for environmental air, plenums used for environmental air, and other spaces used for environmental air, where the length of the cable within the building, measured from its point of entrance, does not exceed 15 m (50 ft) and the cable enters the building from the outside and is terminated in an enclosure or on a listed primary protector. The point of entrance shall be permitted to be extended from the penetration of the external wall or floor slab by continuously enclosing the entrance cables in rigid metal conduit (RMC) or intermediate metal conduit (IMC) to the point of emergence.

Article 800 Communication

- Part II Wires and Cables Outside and Entering Buildings

800.50 Circuits Requiring Primary Protectors. Circuits that require primary protectors as provided in 800.90 shall comply with 800.50(A), 800.50(B), and 800.50(C).

(A) Insulation, Wires, and Cables. Communications wires and cables without a metallic shield, running from the last outdoor support to the primary protector, shall be listed in accordance with 800.173.

(B) On Buildings. Communications wires and cables in accordance with 800.50(A) shall be separated at least 100 mm (4 in.) from electric light or power conductors not in a raceway or cable or be permanently separated from conductors of the other systems by a continuous and firmly fixed nonconductor

Article 800 Communication

- Part II Wires and Cables Outside and Entering Buildings

800.53 Lightning Conductors. Where practicable, a separation of at least 1.8 m (6 ft) shall be maintained between communications wires and cables on buildings and lightning conductors.

Informational Note: Specific separation distances may be calculated from the sideflash equation in NFPA 780-2014, *Standard for the Installation of Lightning Protection Systems*, 4.16.2.

Article 800 Communication

Part III Protection

Part III. Protection

800.90 Protective Devices.

(A) Application. A listed primary protector shall be provided on each circuit run partly or entirely in aerial wire or aerial cable not confined within a block. Also, a listed primary protector shall be provided on each circuit, aerial or underground, located within the block containing the building served so as to be exposed to accidental contact with electric light or power conductors operating at over 300 volts to ground. In addition, where there exists a lightning exposure, each interbuilding circuit on a premises shall be protected by a listed primary protector at each end of the interbuilding circuit. Installation of primary protectors shall also comply with 110.3(B).

Article 800 Communication

Part III Protection

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Article 800 Communication

Part IV
Grounding
Methods

Part IV. Grounding Methods

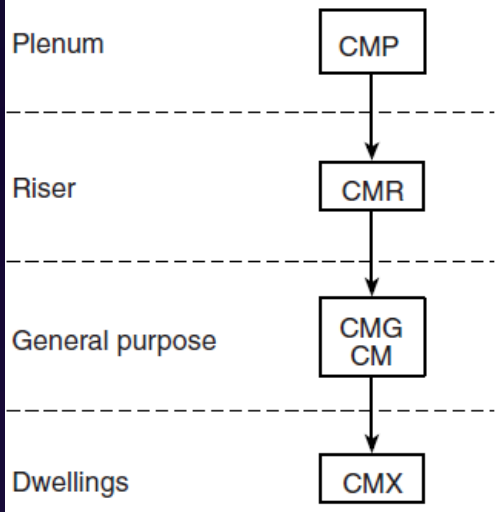
800.100 Cable and Primary Protector Bonding and Grounding. The primary protector and the metallic member(s) of the cable sheath shall be bonded or grounded as specified in 800.100(A) through 800.100(D).

(3) **Size.** The bonding conductor or grounding electrode conductor shall not be smaller than 14 AWG. It shall have a current-carrying capacity not less than the grounded metallic sheath member(s) and protected conductor(s) of the communications cable. The bonding conductor or grounding electrode conductor shall not be required to exceed 6 AWG.

Article 800 Communication

Part V Installation Methods Within Buildings

CMR	CMP
CMG, CM	CMP, CMR
CMX	CMP, CMR, CMG, CM



Type CM—Communications cables

A → B Cable A shall be permitted to be used in place of cable B.

Article 800 Communication

Part V Installation Methods Within Buildings

TABLE 800.154(a) *Applications of Listed Communications Wires and Cables in Buildings*

Applications		Wire and Cal				
		CMP	CMR	CMG CM	CMX	CMUC
In ducts specifically fabricated for environmental air as described in 300.22(B)	In fabricated ducts	Y*	N	N	N	N
	In metal raceway that complies with 300.22(B)	Y*	Y*	Y*	Y*	N
In other spaces used for environmental air as (plenums) described in 300.22(C)	In other spaces used for environmental air	Y*	N	N	N	N
	In metal raceway that complies with 300.22(C)	Y*	Y*	Y*	Y*	N
	In plenum communications raceways	Y*	N	N	N	N

Article 800 Communication

300.22 Wiring in Ducts Not Used for Air Handling, Fabricated Ducts for Environmental Air, and Other Spaces for Environmental Air (Plenums). The provisions of this section shall apply to the installation and uses of electrical wiring and equipment in ducts used for dust, loose stock, or vapor removal; ducts specifically fabricated for environmental air; and other spaces used for environmental air (plenums).

Article 800 Communication

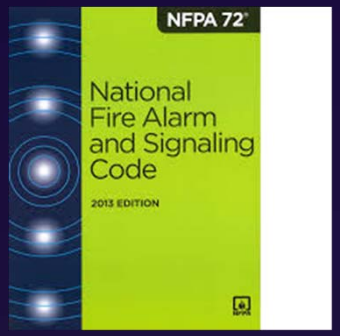
Part VI Listing Requirements

(C) **Plenum Grade Cable Ties.** Cable ties intended for use in other space used for environmental air (plenums) shall be listed as having low smoke and heat release properties.

NFPA 72

- NFPA 72 National Fire Alarm and Signaling Code

In addition to the core focus on Fire Alarm systems, this Code includes requirements for Mass Notification Systems and Distributed Antenna Systems (DAS).



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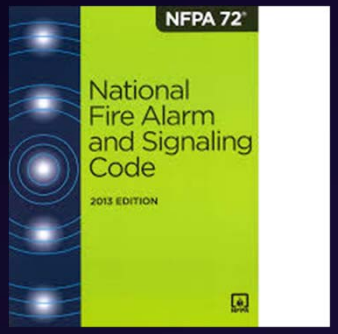
NFPA 72

- NFPA 72 National Fire Alarm and Signaling Code

Mass Notification 24.4.3

24.4.3* In-Building Mass Notification Systems. The requirements of 24.4.3 shall apply to mass notification systems installed in buildings or structures for the purpose of notifying and instructing occupants in an emergency.



DAS 24.5.2.2

24.5.2.2 Radio Coverage. Radio coverage shall be provided throughout the building as a percentage of floor area as specified in 24.5.2.2.1 through 24.5.2.2.3.

24.5.2.2.1 Critical Areas. Critical areas, such as the fire command center(s), the fire pump room(s), exit stairs, exit passageways, elevator lobbies, standpipe cabinets, sprinkler sectional valve locations, and other areas deemed critical by the authority having jurisdiction, shall be provided with 99 percent floor area radio coverage. **[ROP-445a]**

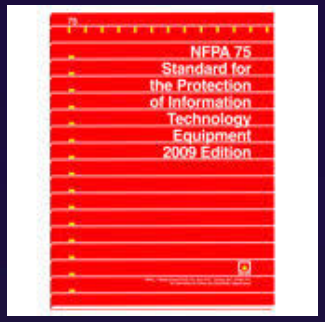
24.5.2.2.2 General Building Areas. General building areas shall be provided with 90 percent floor area radio coverage.

24.5.2.2.3 Amplification Components. Buildings and structures that cannot support the required level of radio coverage shall be equipped with a radiating cable system or a distributed antenna system (DAS) with FCC-certified signal boosters, or both, or with a system that is otherwise approved, in order to achieve the required adequate radio coverage.

NFPA 75

- NFPA 75 Standard for the Fire Protection of IT Equipment

This standard covers the requirements for the protection of information technology equipment and information technology equipment areas from fire damage by fire or its associated effects--smoke, corrosion, heat, and water.

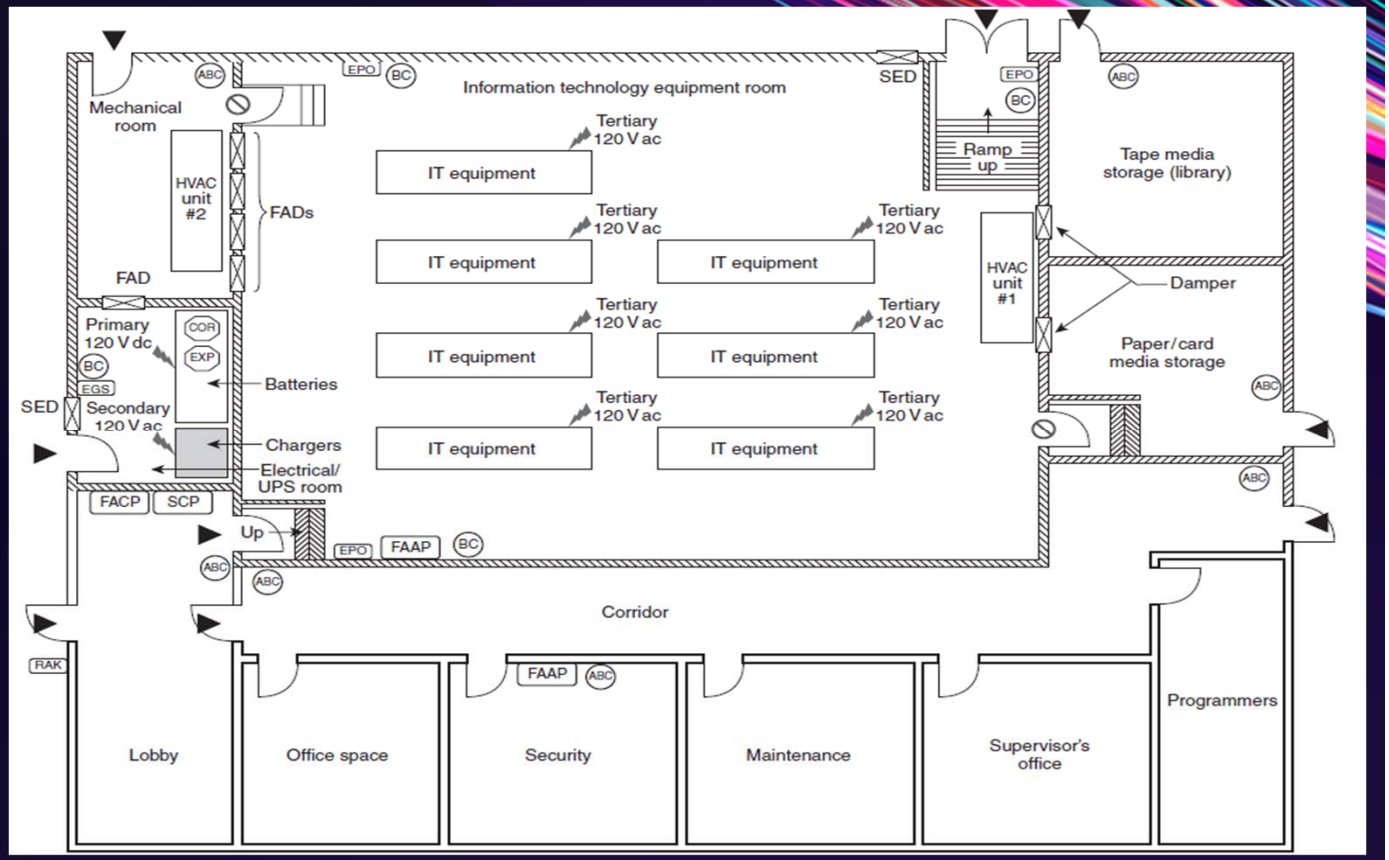


NFPA 75

LEGEND

Symbol	Description	Symbol	Description
FACP	Fire alarm control panel	EGS	Emergency generator shutoff switch
FAAP	Fire alarm annunciator panel	ABC	Type ABC portable fire extinguisher
SCP	Smoke control panel	BC	Type BC portable fire extinguisher
▶	Fire fighter access	⊠	Damper
⊘	No fire fighter access—contamination hazard	⊠ SED	Smoke exhaust damper
⚡	Power supply and voltage	⊠ FAD	Fresh air damper
COR	Corrosive material	RAK	Rapid access keyboard
EXP	Explosive gas potential	▨	1-hour rating
▭	Equipment containing PCBs	▨	2-hour rating
EPO	IT and HVAC equipment emergency power off switch		

NFPA 75



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Looking Back

Looking Forward

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What year were these?

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1927

1956

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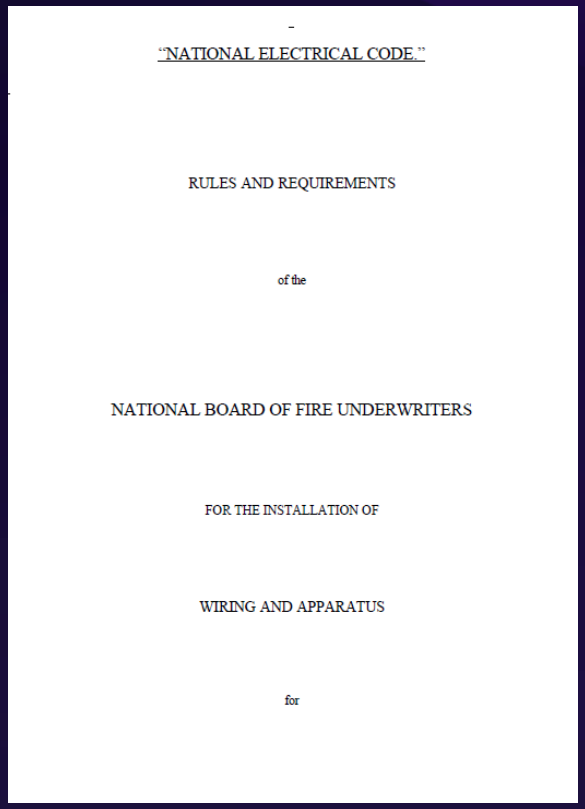
Looking Back- 1899

NEC 1899

41 pages



"NATIONAL ELECTRICAL CODE."

RULES AND REQUIREMENTS

of the

NATIONAL BOARD OF FIRE UNDERWRITERS

FOR THE INSTALLATION OF

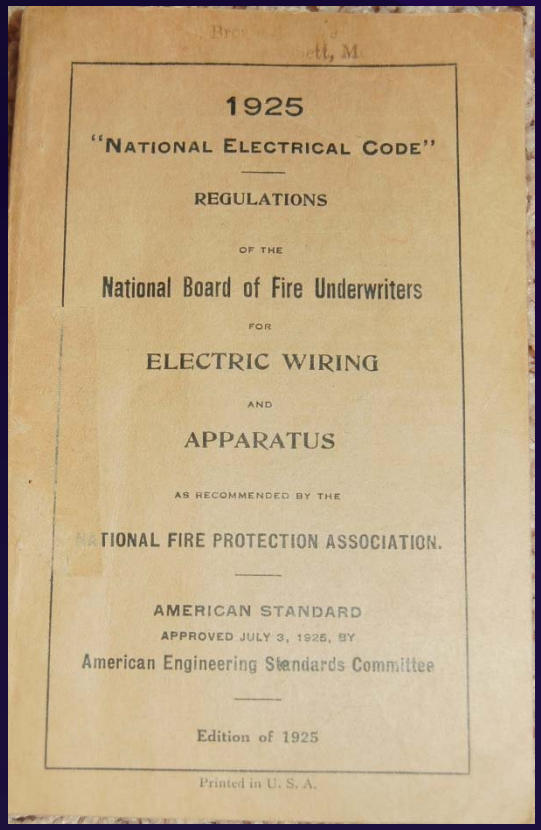
WIRING AND APPARATUS

for

Looking Back- 1925

NEC 1925

182 pages



Looking Back- 2002-2005-2008

2002	Article 690 Solar Photovoltaic Systems
	Article 692 Fuel Cell Systems
2005	Article 353 High Density Polyethylene Conduit
	Article 506 Zone 20, 21 and 22 Locations for Combustible Dusts etc.
	Article 682 Natural and Artificially made Bodies of water
2008	Article 355 Reinforced Thermosetting Resin Conduit
	Article 522 Control Systems for Permanent Amusement Attractions
	Article 626 Electrified Truck Parking Spaces
	Article 708 Critical Operations Power Systems (COPS)

Looking Back- 2011-2014

2011 Article 399 Outdoor Overhead Conductors over 1000v

Article 694 Wind Electric Systems

Article 840 Premise-Powered Broadband Communication Systems

2014 Article 393 Low Voltage Suspended Ceiling Power

Article 646 Modular Data Centers

Article 728 Fire Resistant Cable Systems

2017 Revisions

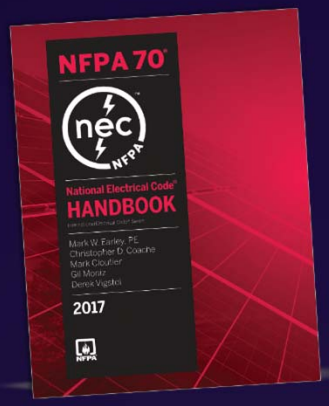
Article 425 Fixed Resistance and Electrode Industrial Process Heating Equipment

Article 691 Large-Scale Photovoltaic Electric Power Production Facility

Article 706 Energy Storage Systems

Article 712 Direct Current Microgrids

Added section to Article 725.144 PoE



Who are we?

- Cable pullers
- Cable terminators
- Cable testers
- Cable labelers

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We're more than that !

We design and install:

- Security systems
- Data Electronics
- Wireless Access points
- Public Address Systems
- Building Automation
- A/V Systems

And we're looking to do more!

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Looking Forward

What's easy to predict ?

- New buildings
- Building renovations
- Higher bandwidth, WDM & MTP
- More wireless including DAS

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Looking Forward

What's easy to predict ?

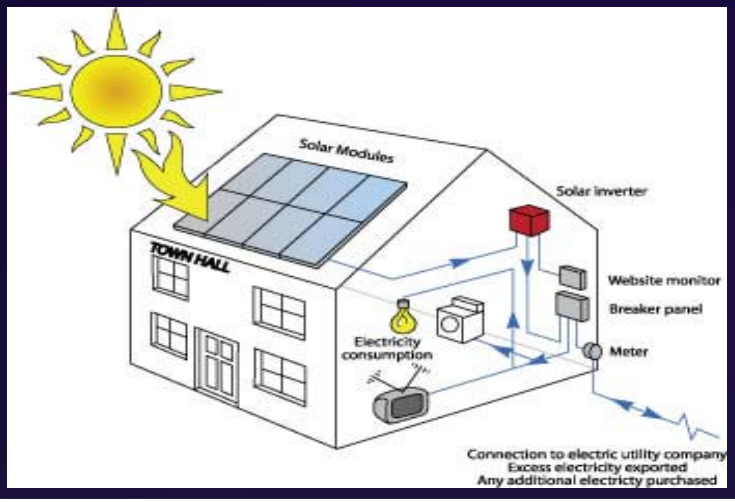
- More PoE
- Bigger video screens
- More non-metallic components
- Better insulators
- Less data in our phones/computers

Current Trends

- Green Design
  - Energy efficiency
  - Sustainability
- Battery advances
- Home automation
- Artificial intelligence
- Mass transportation advances
- Smart cities
- Modular Data Centers
- Wider tolerances on IT equipment
- Diversified power
  - Wind farms
  - Photovoltaic panels

Trends that impact us

- More Data Centers - moving data away from our palms to the cloud
- Focus on Energy efficiency
- Modular Data Centers – Standardization
- Automation – Home – City
- Photovoltaic systems



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Conclusions

1. Data Centers are becoming more standardized.
2. More non-metallic devices are being used.
3. Insulation materials are getting better.
4. Power generation is becoming more diverse.

Summary

1. Know how the NEC is organized
2. Know where to find Data Center related codes items and how to interpret them.
3. Carefully consider new opportunities by looking at the past changes and current trends

Contact info

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