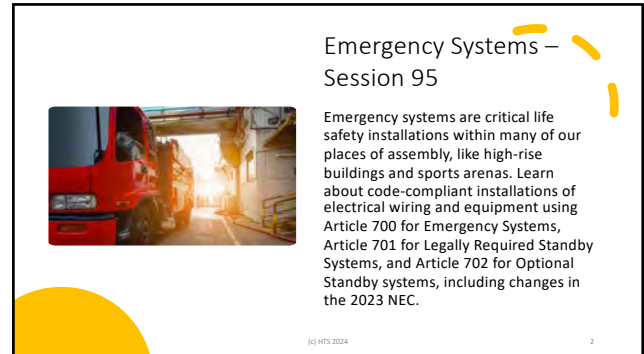
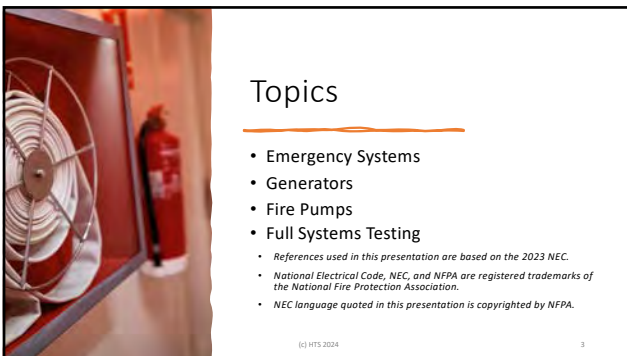




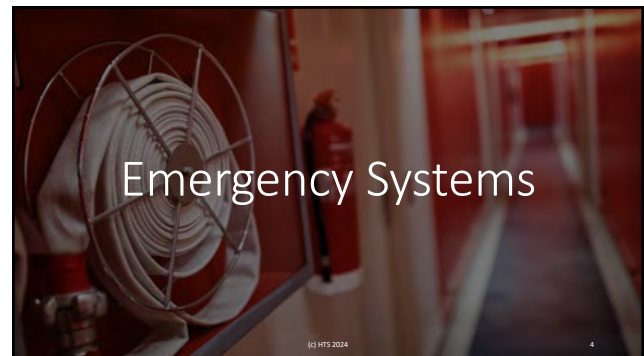
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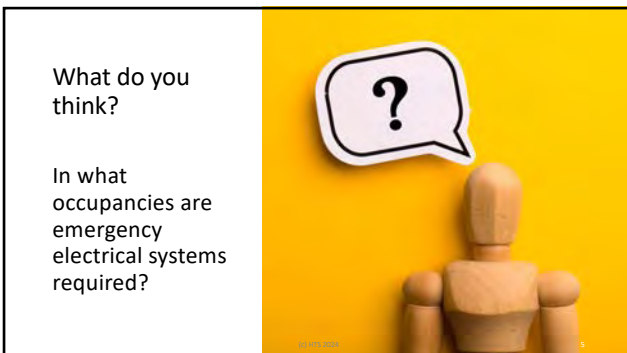
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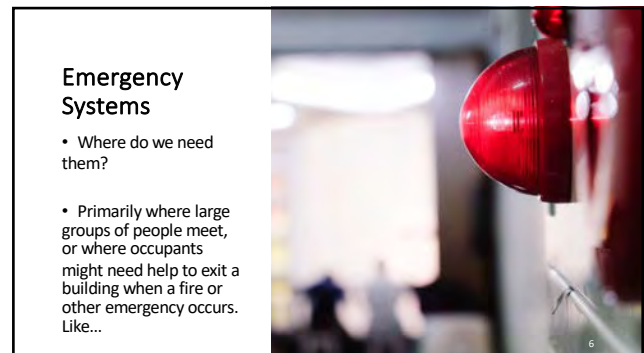
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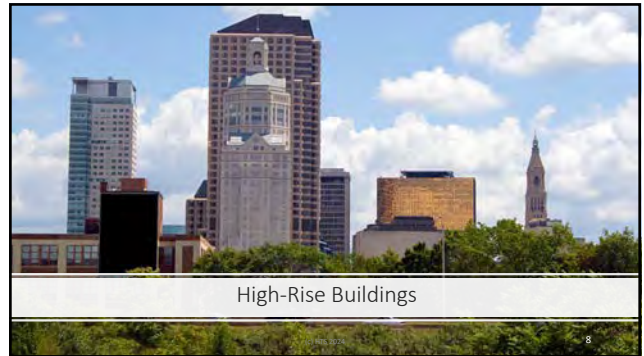


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Educational Occupancies

7



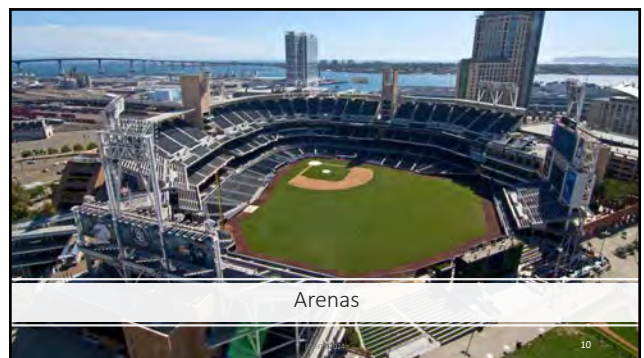
High-Rise Buildings

8



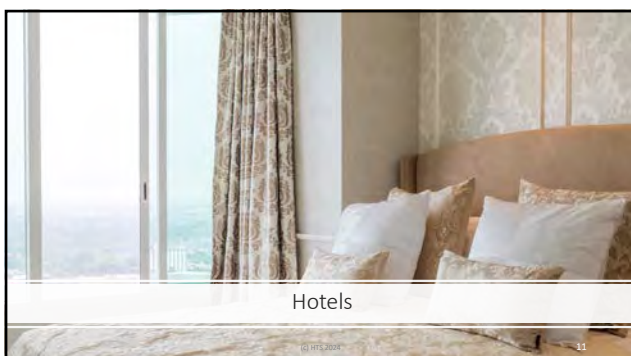
Health Care Facilities

9



Arenas

10



Hotels

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## NFPA 101 Life Safety Code

NFPA 101 is the primary standard for emergency system requirements. For electrical, NFPA 101 says...

**9.1.2 Electrical Systems.**

**Electrical wiring and equipment shall be in accordance with NFPA 70 unless such installations are approved existing installations, which shall be permitted to be continued in service.**

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## 2021 International Building Code

### 2021 IBC has requirements for Elevator Electrical Systems...

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#### 3008.8 Electrical power.

The following features serving each occupant evacuation elevator shall be supplied by both normal power and Type 60/Class 2/Level 1 standby power:

1. Elevator equipment.
2. Ventilation and cooling equipment for elevator machine rooms, control rooms, machinery spaces and control spaces.
3. Elevator car lighting.

#### 3008.8.1 Determination of standby power load.

Standby power loads shall be based on the determination of the number of occupant evacuation elevators in Section 3008.1.1.

#### 3008.8.2 Protection of wiring or cables.

Wires or cables that are located outside of the elevator hoistway, machine room, control room and control space and that provide normal or standby power, control signals, communication with the car, lighting, heating, air conditioning, ventilation and fire-detecting systems to occupant evacuation elevators shall be protected using one of the following methods:

1. Cables used for survivability of required critical circuits shall be listed in accordance with UL 2196 and shall have a fire-resistance rating of not less than 2 hours.
2. Electrical circuit protective systems shall have a fire-resistance rating of not less than 2 hours. Electrical circuit protective systems shall be installed in accordance with their listing requirements.
3. Construction having a fire-resistance rating of not less than 2 hours.

**Exception:** Wiring and cables to control signals are not required to be protected provided that wiring and cables do not serve Phase II emergency in-car operation.

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## National Electrical Code

NFPA 70 is the National Electrical Code (NEC)

So where do we go in the NEC to find requirements for emergency system electrical installations?

And more specifically, what about the equipment and wiring?

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### Article 700 Emergency Systems

#### 700.1 Scope.

This article applies to the electrical safety of the installation, operation, and maintenance of emergency systems consisting of circuits and equipment intended to supply, distribute, and control electricity for illumination, power, or both, to required facilities when the normal electrical supply or system is interrupted.



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Emergency Lighting

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Emergency Power

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## Article 700

Informational Note No. 1: Emergency systems are generally installed in places of assembly where artificial illumination is required for safe exiting and for panic control in buildings subject to occupancy by large numbers of persons,

... may also provide power for such functions as ventilation where essential to maintain life, fire detection and alarm systems, elevators, fire pumps, public safety communications systems, industrial processes where current interruption would produce serious life safety or health hazards, and similar functions.

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## Article 700

Informational Note No. 2: See Article 517, **Health Care Facilities**, for further information regarding wiring and installation of emergency systems in health care facilities.

Informational Note No. 3: See NFPA 99-2018, **Health Care Facilities Code**, for further information regarding performance and maintenance of emergency systems in health care facilities.

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## Article 700

Informational Note No. 4: See NFPA 101-2018, **Life Safety Code**, for specification of locations where emergency lighting is considered essential to life safety.

Informational Note No. 5: See NFPA 110-2019, **Standard for Emergency and Standby Power Systems**, and NFPA 111-2019, **Standard on Stored Electrical Energy Emergency and Standby Power Systems**, ... **performance** of emergency and standby power systems. Emergency systems are considered Level 1 systems when applying **NFPA 110**.

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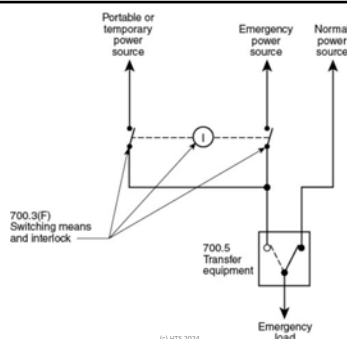
## Article 700

### 700.3 Tests and Maintenance

- (A) Commissioning Witness Test – “full systems test”
- (B) Tested Periodically
- (C) Maintenance
- (D) Written Record
- (E) Testing Under Load
- (F) Temporary Source of Power for Maintenance or Repair of the Alternate Source of Power

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## Article 700

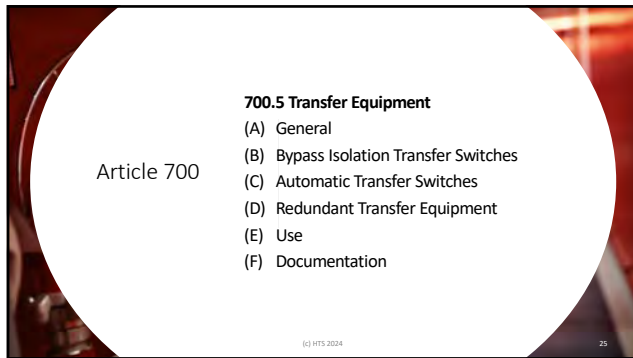
### 700.4 Capacity and Rating

- (A) Capacity
- (B) Selective Load Management
- (C) Parallel Operation

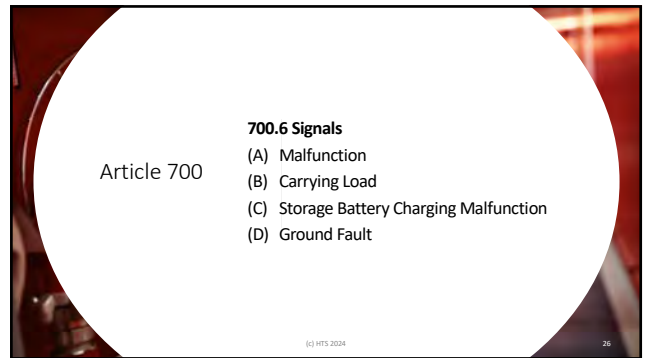
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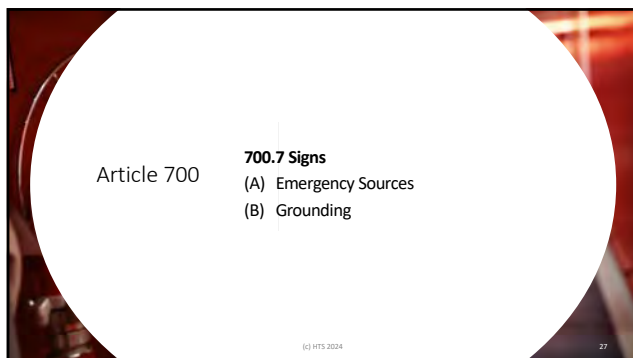




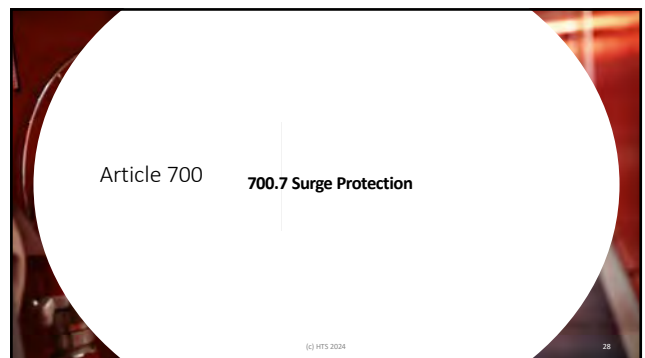
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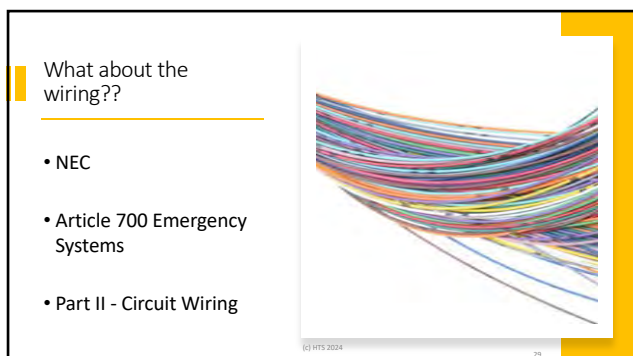
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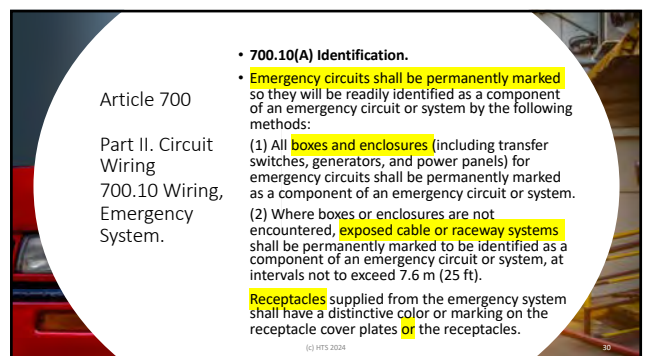
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## Emergency System

From NFPA LiNK Enhanced Content:

*The required marking can be by color code, the words "emergency system," or any other method acceptable to the AHJ that identifies the box or enclosure as a component of the emergency system.*

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## Article 700

### 700.10(B) Wiring.

Wiring from an emergency source or emergency source distribution overcurrent protection to emergency loads shall be kept entirely independent of all other wiring and equipment unless otherwise permitted in the following:

- (1) Wiring from the normal power source located in transfer equipment enclosures
- (2) Wiring supplied from two sources in exit or emergency luminaires
- (3) Wiring from two sources in a listed load control relay supplying exit or emergency luminaires, or in a common junction box, attached to exit or emergency luminaires

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## Article 700

### 700.10(B) Wiring.

Wiring from an emergency source or emergency source distribution overcurrent protection to emergency loads shall be kept entirely independent of all other wiring and equipment unless otherwise permitted in the following:

...

- (4) Wiring within a common junction box attached to unit equipment, containing only the branch circuit supplying the unit equipment and the emergency circuit supplied by the unit equipment
- (5) Wiring within a traveling cable to an elevator

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## Article 700

### 700.10(B) Wiring.

(6) Wiring from an emergency source to supply emergency and other (nonemergency) loads in accordance with the following:

- a. Separate vertical switchgear sections or separate vertical switchboard sections, with or without a common bus, or individual disconnects mounted in separate enclosures shall be used to separate emergency loads from all other loads.

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## Article 700

### 700.10(B) Wiring.

b. The common bus of separate sections of the switchgear, separate sections of the switchboard, or the individual enclosures shall be either of the following:

- (i) Supplied by single or multiple feeders without overcurrent protection at the source
- (ii) Supplied by single or multiple feeders with overcurrent protection, provided that the overcurrent protection that is common to an emergency system and any nonemergency system(s) is selectively coordinated with the next downstream overcurrent protective device in the nonemergency system(s)

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## Article 700

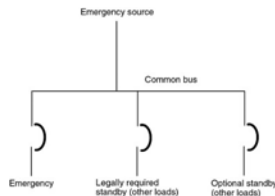
### Informational Note:

See Informational Note Figure 700.10(B)(1) and Informational Note Figure 700.10(B)(2) for further information.

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## Article 700

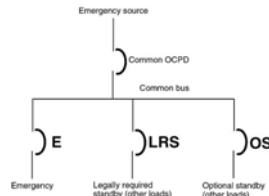


Informational Note Figure 700.10(B)(1)  
Single or Multiple Feeders **Without**  
Overcurrent Protection.

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## Article 700



Informational Note Figure 700.10(B)(2)  
Single or Multiple Feeders **with**  
Overcurrent Protection.

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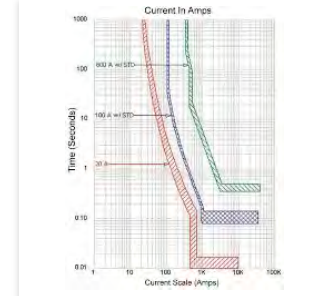
38

## Selective Coordination

- **Coordination, Selective. (Selective Coordination)**
- Localization of an overcurrent condition to restrict outages to the circuit or equipment affected,
- accomplished by the selection and installation of overcurrent protective devices and their ratings or settings
- for the full range of available overcurrents, from overload to the available fault current, and
- for the full range of overcurrent protective device opening times associated with those overcurrents. (CMP-10)

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## Time Current Curve

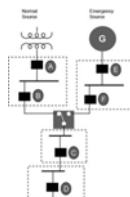


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## Selective Coordination

- Informational Note
- Figure 700.32 Emergency System Selective Coordination.
- **OCPD D** selectively coordinates with OCPDs C, F, E, B, and A.
- **OCPD C** selectively coordinates with OCPDs F, E, B, and A.
- **OCPD F** selectively coordinates with OCPD E.
- **OCPD B** is not required to selectively coordinate with OCPD A because OCPD B is not an emergency system OCPD.



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## 700.10(B) Wiring.

(6)


c. Emergency circuits **shall not originate from the same** vertical switchgear section, vertical switchboard section, panelboard enclosure, or individual disconnect enclosure as other circuits.

d. It shall be permissible to use single or multiple feeders to supply distribution equipment **between an emergency source and the point where the emergency loads are separated from all other loads.**



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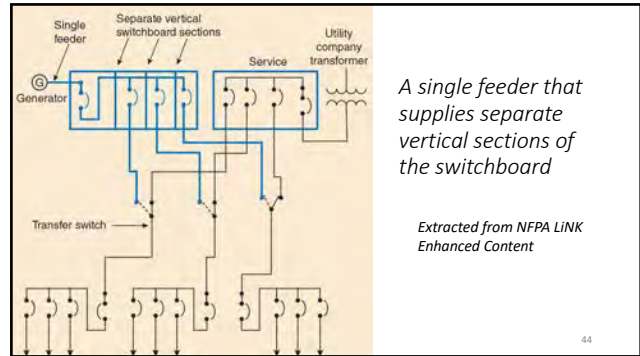
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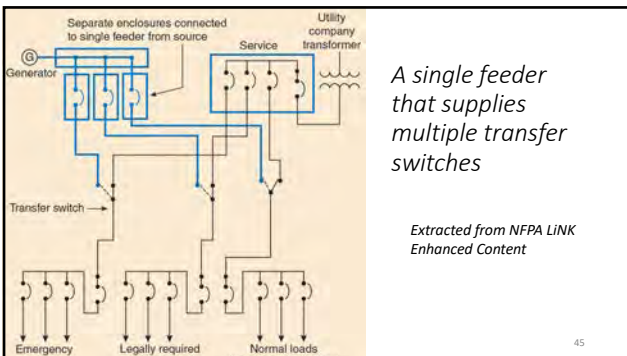
**700.10(B) Wiring.**  
(6)  
e. At the **emergency power source**, such as a generator, multiple integral overcurrent protective devices shall each be permitted to supply a designated emergency or a designated nonemergency load, provided that there is complete separation between emergency and nonemergency loads beginning immediately after the overcurrent protective device line-side connections.  
**Wiring of two or more emergency circuits supplied from the same source shall be permitted in the same raceway, cable, box, or cabinet.**

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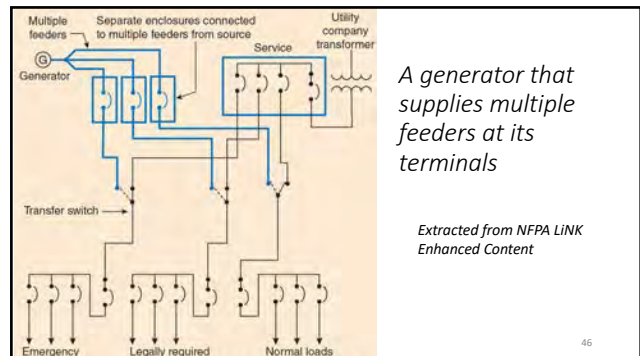
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**Article 700**

**700.10(C) Wiring Design and Location.**  
Emergency wiring circuits shall be designed and located so as to **minimize the hazards that might cause failure** due to flooding, fire, icing, vandalism, and other adverse conditions.

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**Article 700**

**700.10(D) Fire Protection.**  
**700.10(D)(1) Occupancies.**  
Emergency systems shall meet the additional requirements in 700.10(D)(2) through (D)(4) in the following occupancies:

- (1) Assembly occupancies for not less than 1000 persons
- (2) Buildings above 23 m (75 ft) in height
- (3) Educational occupancies with more than 300 occupants

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## Article 700

### 700.10(D)(2) Feeder-Circuit Wiring.

Feeder-circuit wiring shall meet one of the following conditions:

- (1) The cable or raceway is installed in spaces or areas that are fully protected by an approved **automatic fire protection system**.
- (2) The cable or raceway is protected by a **listed electrical circuit protective system** with a minimum 2-hour fire rating.

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## Article 700

### 700.10(D)(2) Feeder-Circuit Wiring.

...

Informational Note No. 1: See UL 1724, *Fire Tests for Electrical Circuit Protection Systems*, for one method of defining an electrical circuit protective system. The *UL Guide Information for Electrical Circuit Integrity Systems (FHIT)* contains information to identify the system and its installation limitations to maintain a minimum 2-hour fire-resistive rating and is available from the certification body.

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## Article 700

- (3) The cable or raceway is a **listed fire-resistive cable system** with a minimum 2-hour fire rating.

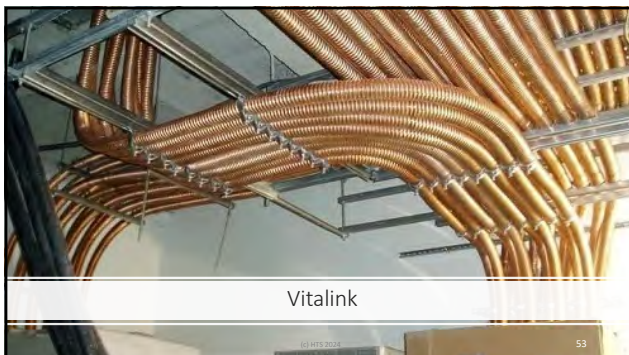
Informational Note No. 2: See UL 2196-2017, *Standard for Fire Test for Circuit Integrity of Fire-Resistive Power, Instrumentation, Control and Data Cables*, for one method of defining a fire-resistive cable system.

- (4) The cable or raceway is protected by a **listed fire-rated assembly** that has a minimum fire rating of 2 hours and contains only emergency circuits.
- (5) The cable or raceway is encased in a minimum of 50 mm (**2 in.**) of **concrete**.

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Vitalink

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## Article 728

- **ARTICLE 728 Fire-Resistive Cable Systems**
- **728.1 Scope.**

- fire-resistive cables, fire-resistive conductors, and other system components
- used for survivability of critical circuits to ensure continued operation during a specified time under fire conditions

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## FIRE RATED ELECTRICAL CABLE SYSTEMS

- All systems can be found on the Web:
  - Pyrotech MI cable is UL/ULC FHIT/FHITC "SYSTEM No. 1850"
  - UL On-Line Certifications \ Category "FHIT"
- The system listing identifies basic installation requirements. The detailed requirements are in the Installation Manual provided with every shipment:
  - the manufacturer's latest updates/changes
  - conductor sizes and configurations tested
  - splices if tested, and types of splices
  - support materials (steel, masonry or concrete) and method
  - horizontal distance between supports
  - vertical distance between supports

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## Current UL Listings for Fire rated Cables

- FHIT System 1850 MI cable: Full 2-hour Listing 18 AWG thru 500 MCM
- FHIT System 120: Type MC cable for 2 hours. Field splice is rated at 1 hour.
- FHIT System 25A: Type RHW-2 in conduit – very restricted, horizontal installation, specific conduit, and coupling, no pull boxes, no pulling lube, only, etc.... In short, be careful with this listing!!
- FHIT System 28A: Type CIC 2-hour fire alarm – unshielded only, specific conduit and couplings, must terminate vertically every 28 ft
- FHIT System 41: Type CI cable 2-hour fire alarm – shielded and unshielded. Specific conduits and couplings must terminate vertically every 33 ft

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## Fire-Rated Assembly

- National Gypsum Fire Testing
- <https://youtu.be/lqgDx646s-U>

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## Article 700

### 700.10(D)(3) Feeder-Circuit Equipment.

Equipment for feeder circuits (including transfer switches, transformers, and panelboards) shall be located either in

- spaces fully protected by an approved automatic fire protection system
- spaces with a 2-hour fire resistance rating.

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## Article 700

### 700.10(D)(4) Source Control Wiring.

Control conductors installed between the emergency power supply system/stored-energy power supply system and transfer equipment or control systems that initiate the operation of emergency sources or initiate the automatic connection to emergency loads shall be

- kept entirely independent of all other wiring and
- shall meet the conditions of 700.10(D)(2).

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## Article 700

### 700.10(D)(4) Source Control Wiring.

...

The integrity of source control wiring shall be monitored for broken, disconnected, or shorted wires. Loss of integrity shall result in the following actions:

- (1) Generators. Shall start the generator(s).
- (2) All other sources. Shall be considered a system malfunction and initiate the designated signal(s) in 700.6(A).

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## Knowledge Check

- Cable or raceway used in emergency systems feeder circuits must have a 2-hour fire rating in assembly occupancies with at least \_\_\_\_\_ occupants.
- A) 100
- B) 300
- C) 500
- D) 1000

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## WHERE WILL YOU FIND GENERATORS?



2024

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- Healthcare (NEC 517)
- Fire Pumps (NEC 695)
- Emergency Systems (NEC 700)
- Legally Required Standby (NEC 701)
- Optional Standby (NEC 702)
- Critical Operations Power Systems (NEC 708)

## WHAT ARE THE KEY CODES & STANDARDS FOR GENERATORS?



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## NEC Classifications

- **Emergency Systems (NEC 700)**
  - Loads essential for the safety of human life
    - Exit lights, egress lighting, egress elevators
    - Fire monitoring and exhaust fans
    - Healthcare life safety and critical circuits
- **Legally Required Standby (NEC 701)**
  - Loads that could create hazards, hamper rescue or fire fighting
    - Elevators, communication & lighting systems
    - Hazardous industrial processes (heating & refrigeration)
    - Ventilation and smoke removal
    - Sewage disposal
- **Optional Standby (NEC 702)**

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## NFPA 110 Fuel Consideration



- Fuel options (5.1.1): Diesel, LP, Natural Gas, and Hydrogen gas
- BUT doesn't the fuel need to be on-site for Level 1 applications?
  - Most AHJs assume on-site fuel is reliable and NG is unreliable. What does the standard say?
- 5.1.1.1: For Level 1 installations in locations where the probability of interruption of off-site fuel supplies is high, on-site storage of an alternate energy source sufficient to allow the full output of the EPSS to be delivered for the class specified shall be required...
- ❖ NFPA 110 does not assume off-site fuel is unreliable.

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NEC ALARMS & INSTRUMENTATION REQUIRED

NEC 700 (Emergency Systems)  
Derangement, carrying load,  
battery charger failure, ground  
fault indication (conditional)

NEC 701 (Legally Required Standby)  
Derangement, carrying load,  
battery charger failure

NEC 702 (Optional Standby)  
Derangement, carrying load



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NFPA ALARMS & INSTRUMENTATION REQUIRED

Table 55.5.2(d) Safety Indications and Shutdowns

| Indicator Function<br>(or Battery Voltage) | Level 1 |   |      |      | Level 2 |      |  |  |   |   |   |   |
|--|---------|---|------|------|---------|------|--|--|---|---|---|---|
|  | C.V.    | S | R.A. | C.V. | S       | R.A. |  |  |   |   |   |   |
| (a) Overcrank                              | X       | X | X    | X    | X       | O    |  |  | (j) Low voltage in battery                      | X | O |   |
| (b) Low water temp. GWP (212°C)            | X       | X | X    | X    | O       |      |  |  | (k) Battery charger ac failure                  | X | O |   |
| (c) High engine temperature per alarm      | X       | X | O    |      |         |      |  |  | (l) Lamp test                                   | X | X | X |
| (d) High engine temperature                | X       | X | X    | X    | X       | O    |  |  | (m) Generator for local and remote common alarm | X | X | X |
| (e) Low lube oil pressure per alarm        | X       | X | O    |      |         |      |  |  | (n) Audible alarm silencing switch              | X | O |   |
| (f) Low lube oil pressure                  | X       | X | X    | X    | X       | O    |  |  | (o) Low starting air pressure                   | X | O |   |
| (g) Overspeed                              | X       | X | X    | X    | X       | O    |  |  | (p) Low starting hydraulic pressure             | X | O |   |
| (h) Low coolant level                      | X       | O | X    | X    | O       | X    |  |  | (q) Air shutdown - disengages when used         | X | X | X |
| (i) EPS supplying load                     | X       | X | O    |      |         |      |  |  | (r) Remote emergency stop                       | X | X |   |
| (j) Control switch not in auto. position   | X       |   |      |      |         |      |  |  |   |   |   |   |
| (k) High battery voltage                   | X       |   |      | O    |         |      |  |  |   |   |   |   |

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WHAT IS THE REQUIRED GENERATOR SIZE (CAPACITY)?

- NEC 700.5 (Emergency System)
  - "...adequate capacity and rating for all loads to be operated simultaneously"
- NEC 701.6 (Legally Required Standby)
  - "supply of all equipment intended to be operated at one time"
- NEC 702.5 (Optional Standby)
  - "...in accordance with article 220 or by another approved method."
  - Assuming PE stamp will meet AHJ approval
  - NEC 2005 required: "supply of all equipment intended to be operated at one time"
- NEC 517.30 D (Health Care Facilities)
  - "Meet the demand of the essential load at any given time."
  - "NEC 700.5 shall not be applied to hospitals"
  - Practical sizing based on actual likely demand

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HOW QUICKLY MUST A GENERATOR STARTUP & TRANSFER?

- 10 sec start-up time (Type 10)
  - NEC 700.12 (Emergency Systems – General Requirements)
  - NFPA 20, 9.6.2.1 (Fire Pumps)
  - NEC 517.31, & NFPA 99 3-4.3.1 (Health Care Facilities)
    - Critical & life safety loads
- 60 sec start-up time (Type 60)
  - NEC 701.11 (Legally Required Standby)
- Variably defined start-up
  - NFPA 110 4.1 (Emergency & Standby Power Systems)
- No defined start-up time
  - NEC 702 (Optional Standby)

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WHAT ARE THE GENERATOR SIGNAGE REQUIREMENTS?

- NEC 700, 701, & 702 (all generator applications)
  - Generator on-site sign
    - Located at the service
    - Generator type & location indicated
- Generator grounding sign
  - Indicate all sources connected to the grounding electrode
  - Only applies if the connection point is remote from the generator
  - Point where the grounding conductor connects to the grounding electrode conductor
  - Typically, at the service

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## Acceptance Testing/Commissioning

- Why do we test?
  - To certify the proper functioning of *all* the components of the Emergency Power Supply System (EPSS)
  - To establish a baseline performance to which future tests can be compared

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## Acceptance Testing/Commissioning

**All tests should be performed without utility power available**

- Building load test – 1-1/2 hours
  - The test should include all loads that the EPSS serves
    - No minimum loading requirement for this portion of the test
- Full load test – 2 hours: Progressive test

Load bank types:  
 Resistive (Unity/1.0 Power Factor): Engine test  
 Reactive (.8 Power Factor): Alternator test

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## Acceptance Testing Requirements

- Building load test
  - Not less than 1-1/2 hours
- Full load test – 2 full hours
  - 30% nameplate rating for 30 minutes
  - 50% nameplate rating for 30 minutes
  - 100% nameplate rating for 60 minutes
    - (less applicable derating factors for site conditions)

(Not less than 5 minutes engine cool down between tests)

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## Items To Be Observed and Recorded

- Time delay on start
- Cranking time until prime mover starts
- Time taken to reach operating speed
- Time between loss of power and ATS transfer
- Time taken to achieve steady-state condition after transfer
- Voltage, Frequency, and Current (every 15 minutes)
- Oil pressure and water temperature (every 15 minutes)
- Voltage and Frequency transients after load changes
- Time to retransfer after normal power returned (Not less than 5 minutes)

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## NFPA 110 Testing – Operational



- Weekly**
  - Preventative maintenance (8.1.1 and suggested schedule A.8.3.3)
  - Inspect cranking batteries (8.3.6)
  - Testing based on manufacturer recommendations (8.1.1)
- Monthly**
  - Exercise generator with load (8.4.2)
  - Operate all transfer switches monthly (8.4.6)
- Continued...

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## NFPA 110 Testing – Operational



Continued...

- Annually**
  - Generator 1.5 hr full load test (if monthly, test 30% of full load) (8.4.2)
  - Exercise breakers between generator and transfer switches annually (Level 1 only) (8.4.7)
  - Fuel tested to ASTM standards (8.3.7)
- Every 36 months**
  - Generator run with building load for a period of 4 hours (Level 1 only) (8.4.9)

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## Weekly Inspection/Testing



- Exercise
  - 15 to 20-minute run (typically without load)
- Fuel
  - Main tank/day tank levels
  - Piping, hoses, and connectors
  - Transfer pump (if equipped)
  - Water in system
- Oil
  - Level
  - Oil heater (if equipped)

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## Weekly Inspection

- Cooling System
  - Coolant Level
  - Coolant temperature
  - Water Pump (check for leaks)
  - Jacket Water Heater
  - Belts, Hoses, Fan
- Battery/Charging System
  - Corrosion on battery cables
  - Electrolyte level
  - Battery Charger
  - Belt driven alternator

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## Monthly Testing

- Exercised 30 minutes with one of the following
  - Loading that maintains the minimum exhaust gas temperature as recommended by the manufacturer or
  - Not less than 30% of nameplate rating\*
- Transfer switches are to be operated monthly

\*See exception

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## Annual Testing (Exception to Monthly Testing)

*Diesel generators that do not meet the monthly requirements shall be exercised annually with not less than 50% of the kW nameplate rating for 30 continuous minutes and then not less than 75% for one continuous hour for a total duration of 1-1/2 hours.*

- Exercise breakers between the generator and ATS's
- Fuel tested to ASTM standards

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## Testing Every 36 Months

- Level 1 EPS shall be tested continuously for the duration of it's assigned class
- Where the assigned class is greater than 4 hours, test can be terminated after 4 hours
- This test can be combined with other monthly or annual tests
  - 1<sup>st</sup> 3 hours – 30% nameplate rating
  - 4<sup>th</sup> hour – 75% of nameplate rating

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### Transfer Switch Types

- Open Transition
- Closed Transition (CTTS)
- Special Function Switches
  - Bypass Isolation
  - Service Entrance Rated
- Soft-load Closed Transition
- Grid Parallel Operation

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### WHAT DOES AN ATS LOOK LIKE?

- Controller
- Indicating lights
- Test switch
- Transformers
- Contactor
- UL 1008 Sticker

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### CONTROLLER OPTIONS

- Market offers various features
  - Control, monitoring & protection
  - Programmable flexibility
  - Alarms & event logs
  - Communications & annunciators
- Most application
  - Still only require basic control
  - Over specifying features may lead to controller & cost increases

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### WHAT ARE THE CODE REQUIREMENTS FOR TRANSFER SWITCHES?

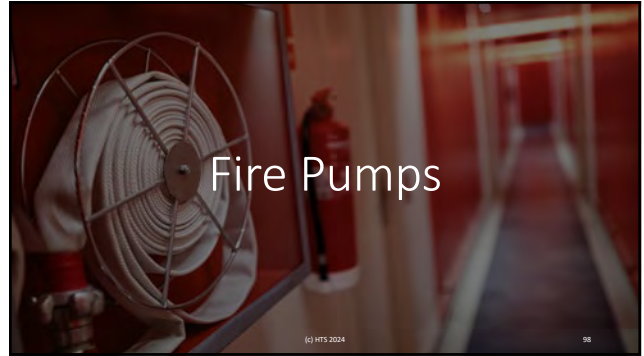
- NEC 700.6 (Emergency Systems – Transfer Equipment)
- NEC 701.7 (Legally Required Standby – Transfer Equipment)
  - Automatic
  - Approved (listed)
  - Mechanically held
  - Interlocked against inadvertent grid interconnect
  - Dedicated to emergency loads (NEC 700 only)
  - Bypass Isolation allowed
  - Grid paralleling allowed
- NEC 517.30 (Healthcare)
  - Separation of loads (life safety, critical, and equipment)
  - Priority loading and Load shedding

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## Article 695 Fire Pump

### 695.6 Power Wiring

#### (A) Supply Conductors

##### (1) Services and On-Site Power Production Facilities.

Service conductors and conductors supplied by on-site power production facilities shall be

- physically routed outside a building(s) and
- installed as service-entrance conductors in accordance with 230.6, 230.9, and Parts III and IV of Article 230.

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## Article 695 Fire Pump

### 695.6 Power Wiring

#### (A) Supply Conductors

##### (1) Services and On-Site Power Production Facilities.

...

Where supply conductors cannot be physically routed outside of buildings, the conductors shall be permitted to be routed through the building(s) where installed in accordance with 230.6(1) or (2).

*Exception: The supply conductors within the fire pump room shall not be required to meet 230.6(1) or (2).*

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## Section 230.6

### 230.6 Conductors Considered Outside the Building.

Conductors shall be considered outside of a building or other structure under any of the following conditions:

- (1) Where installed under not less than 50 mm (2 in.) of concrete beneath a building or other structure
- (2) Where installed within a building or other structure in a raceway that is encased in concrete or brick not less than 50 mm (2 in.) thick

...

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## Article 695

### 695.6(A)(2) Feeders.

Fire pump supply conductors on the load side of the final disconnecting means and overcurrent device(s) permitted by 695.4(B) or conductors that connect directly to an on-site standby generator shall comply with all of the following:

- (1) *Independent Routing.* The conductors shall be kept entirely independent of all other wiring.
- (2) *Associated Fire Pump Loads.* The conductors shall supply only loads that are directly associated with the fire pump system.
- (3) *Protection from Potential Damage.* The conductors shall be protected from potential damage by fire, structural failure, or operational accident.

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## Article 695

(4) *Inside of a Building.* Where routed through a building, the conductors shall be **protected from fire for 2 hours** using one of the following methods:

- a. The cable or raceway is encased in a minimum 50 mm (2 in.) of **concrete.**
- b. The cable or raceway is part of a **listed fire-resistive cable system.**

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## Article 695

Informational Note No. 1: See UL 2196, *Fire Test for Circuit Integrity of Fire-Resistive Power, Instrumentation, Control and Data Cables*, for one method of defining a fire-resistive cable system.

Informational Note No. 2: See UL *Guide Information for Electrical Circuit Integrity Systems* (FHIT) for identifying the system and its installation limitations to maintain a minimum 2-hour fire-resistive rating.

Informational Note No. 3: The listing organization provides information for fire-resistive cable systems on proper installation requirements to maintain the fire rating.

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## Article 695

- c. The cable or raceway is protected by a **listed electrical circuit protective system.**

Informational Note No. 4: See UL 1724, *Fire Tests for Electrical Circuit Protective Systems*, for one method of defining an electrical circuit protective system.

Informational Note No. 5: See UL *Guide Information for Electrical Circuit Integrity Systems* (FHIT) for identifying the system and its installation limitations to maintain a minimum 2-hour fire-resistive rating.

Informational Note No. 6: The listing organization provides information for electrical circuit protective systems on proper installation requirements to maintain the fire rating.

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## Article 695

*Exception to 695.6(A)(2)(4): The supply conductors located in the electrical equipment room where they originate and in the fire pump room shall not be required to have the minimum 2-hour fire separation or fire-resistance rating unless otherwise required by 700.10(D) of this Code.*

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Fire Pump  
and  
Controller



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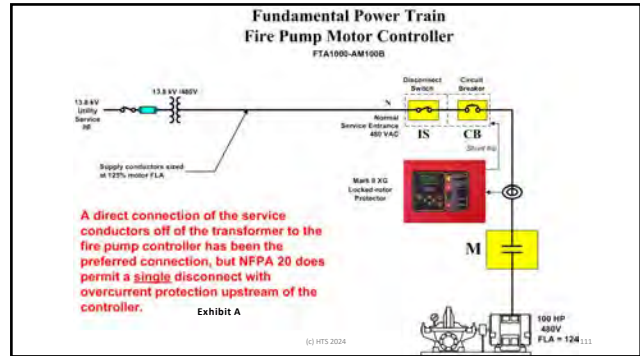
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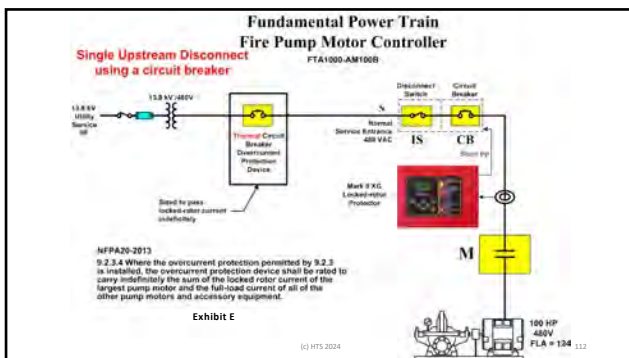
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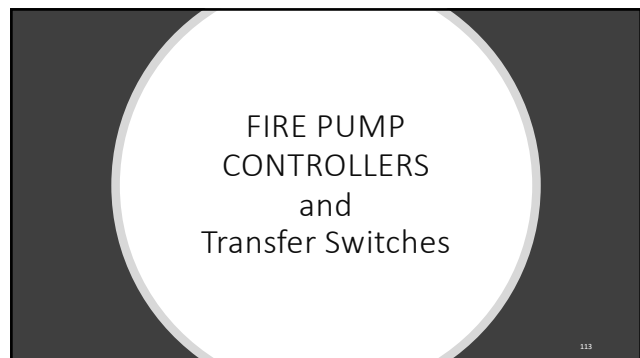
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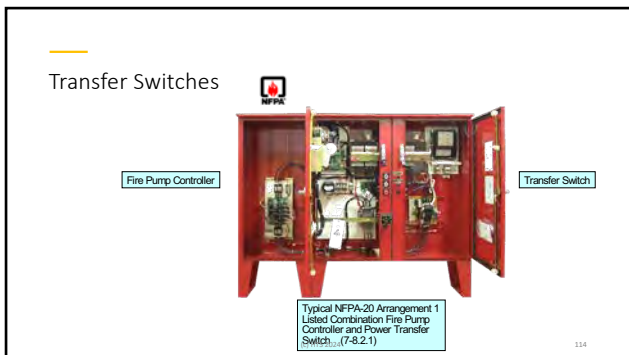
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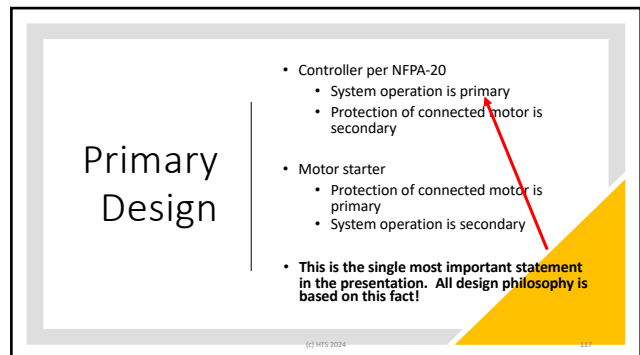
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## Fire Pump Circuit Breaker



- Fire pump controller circuit breaker
- Magnetic only
- Special trip curve per NFPA 20, 2013 10.4.4.1
- Trip characteristics
  - carry a minimum of 300% MFLC for 3 minutes
  - trip at locked rotor in 8-20 seconds (600% Motor FLC)
- Short circuit trips instantaneously
- Isolating switch and circuit breaker assembly
- Note single handle operator

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## Circuit Breaker (continued)

- Controller per NFPA-20
  - Maintains Locked Rotor Current for:
    - **8 Seconds MIN**
    - **20 Seconds MAX**
  - LRC = 600% of Motor FLA
- Motor Starter
  - Not Permitted
  - Possible Damage to Motor or Controller

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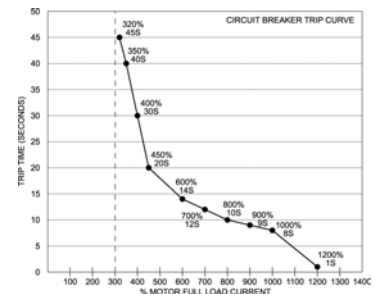
## Circuit Breaker (continued)

- Controller per **NFPA-20**
  - Instantaneous Trip at 2000% of Motor Full Load Amps
- Motor Starter
  - Not Permitted
  - Possible Damage to Motor or Controller

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## Circuit Breaker Trip Curve



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## NFPA 20 Chapter 14 Acceptance Testing, Performance, and Maintenance

- **Hydrostatic Tests and Flushing.**
  - Flushing shall occur prior to the hydrostatic test.
  - The installing contractor shall furnish a certificate for **flushing and hydrostatic tests** before the fire pump field acceptance test starts.
- **Field Acceptance Tests.**
  - **Pump Room Electrical Wiring.** All electric wiring to the fire pump motor(s), including control (multiple pumps) interwiring, normal power supply, alternate power supply where provided, and jockey pump, shall be completed and checked by the electrical contractor prior to the initial startup and acceptance test.
  - The **pump manufacturer**, engine manufacturer (when supplied), controller manufacturer, transfer switch manufacturer (when supplied), or **factory authorized representatives** shall be present for the field acceptance test.

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## NFPA 20 Chapter 14 Acceptance Testing, Performance, and Maintenance

- **Certified Pump Curve**
  - A copy of the manufacturer's certified pump test characteristic curve shall be available for comparison of the results of the field acceptance test.
- **Field Acceptance Test Procedures**
  - Test Equipment
- **Fire Pump Flow Testing(s).**
- **Measurement Procedure - Electric Motor-Driven Units - Engine-Driven Units - Alternate Power Supply - Tests to Run - Simulated Conditions (for alarms) - Test Duration - Record Drawings, Test Reports, Manuals, Special Tools, and List of Recommended Spare Parts** shall be available for inspection by the authority having jurisdiction at the time of the field acceptance test.

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## Flow Testing a Fire Pump

- As per NFPA 20 the system shall have a full and a flow test performed prior to any full system test.



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## Health Care Facilities



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## Article 517 Health Care Facilities

**Health Care Facilities do not have "Emergency Systems" subject to the requirements in Article 700**



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## Article 517 Health Care Facilities

### 517.26 Application of Other Articles.

The **life safety branch** of the **essential electrical system** shall meet the requirements of Article 700, except as amended as follows:

- (1) Section 700.4 shall not apply.
- (2) Section **700.10(D)** shall not apply.
- (3) Section 700.17 shall be replaced with the following: Branch circuits that supply emergency lighting shall be installed to provide service from a source in accordance with 700.12 when normal supply for lighting is interrupted or where single circuits supply luminaires containing secondary batteries.

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## Article 517

- (4) Section **700.32** shall not apply.

Informational Note No. 1: See NFPA 110-2019, Standard for Emergency and Standby Power Systems, for additional information.

Informational Note No. 2: See 517.29 and NFPA 99-2021, Health Care Facilities Code, for additional information.

➤ That means full Selective Coordination does not apply in Health Care Facilities.

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## Critical Operations Power Systems



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## Article 708

- 708.1 Scope
- Informational Note No. 1: Critical operations power systems are generally installed in **vital infrastructure facilities** that, if destroyed or incapacitated, would disrupt national security, the economy, public health or safety; and where enhanced electrical infrastructure for continuity of operation has been deemed necessary by governmental authority.
- Examples? Police stations, fire stations, 911 call centers

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## Article 708 Critical Operations Power Systems

### 708.10(C)(2) Fire Protection for Feeders.

Feeders shall meet one of the following conditions:

- (1) The cable or raceway is protected by a **listed electrical circuit protective system** with a minimum 2-hour fire rating.

Informational Note No. 1: See UL 1724, *Fire Tests for Electrical Circuit Protective Systems*, for one method of defining an electrical circuit protective system, by establishing a rating when tested. UL *Guide Information for Electrical Circuit Integrity Systems* (FHIT) contains information to identify the system and its installation limitations to maintain a minimum 2-hour fire resistive rating.

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## Article 708

(2) The cable or raceway is a **listed fire-resistive cable system** with a minimum 2-hour fire rating.

Informational Note No. 2: See UL 2196-2017 ...

Informational Note No. 3: The listing organization provides information for fire-resistive cable systems on proper installation requirements to maintain the fire rating.

(3) The cable or raceway is protected by a **listed fire-rated assembly** that has a minimum fire rating of 2 hours.

(4) The cable or raceway is encased in a minimum of 50 mm (**2 in.**) of concrete.

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## Knowledge Check

- The requirement to provide a protection method to localize an overcurrent condition to the circuit conductors or equipment in which an overload or fault has occurred is called:
  - A) Series rating
  - B) Emergency rating
  - C) Life safety assurance
  - D) Selective coordination

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## What is a Life Safety System?



In general terms, it is any part of a building or infrastructure that monitors for smoke and fire emergency conditions along with associated systems to react to such change in a manner that reduces and eliminates the risk of injury or property damage.

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### What Falls within the Scope of a Life Safety System?

- Generators and other alternative power sources
- Automatic electrical transfer equipment
- Automatic fire sprinklers, standpipes, Fire pumps, controllers
- Water supplies
- Smoke control systems such as dampers, stairway pressurization, exhaust fans, and similar
- Fire alarm and detection systems
- Passive building systems, rated doors, corridors, exit passageways, stairwell towers, elevator shafts
- Signage
- Elevators

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### Owner Obligations - Not just writing the checks!

- Clearly state the project scope, budget, and general completion timeframe (*This is always a challenge*)
- Site selection - This can have a big impact on the desired product. (Zoning, access, environmental, and most of all - cost)
- Selection of a design team that includes consultants (MEPF engineers) and general contractor
- Selection of an owner's representative for the project who can make decisions and resolve issues

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### Design Phase

- The design team has an obligation to design a facility that meets all the code requirements and provides a safe venue for its occupants while providing good value for the owner.
- More often than not, when a project fails, it is due to a lack of communication! No single part of the team can complete the project without the others.

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### Construction Phase

Contractors are responsible for building the facility per the design documents and meeting or exceeding the code.

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### Jurisdiction Responsibilities

#### Plan Review

Plans are submitted and reviewed to a level of confidence so that a permit can be issued. That is not the end of the story, as I am unaware of any project that did not have some level of changes due to design changes, site conditions, or just mistakes (they happen).

Projects can have numerous multiple discipline reviews. **Not likely that a set of drawings will be perfect! That is why we have inspectors!**

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### Jurisdiction Responsibilities

#### Inspections

- Fire
- Structural
- Plumbing
- Mechanical
- Architectural
- Electrical
- Off and on sites
- and each is responsible for ensuring code compliance is met with adopted codes and standards as they are applied to the project

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- There must be regular coordination between the different inspection teams. There are systems and processes that may require numerous inspections.

*Example: Electrical inspectors will inspect the conduit and box supports for the fire alarm system, while the fire inspector will verify that the installed locations meet the minimum requirements for the device placement, correct device has been installed and proper functionality.*

- A simple ceiling install needs a bit of coordination...electrical, plumbing, mechanical and fire all need to have eyes on the areas prior to losing up the space.

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So, what is needed prior to even scheduling the all-systems test?

- All sub-systems shall have been pre-tested individually
  - Sprinkler systems / Fire Pump(s) / Controller(s)
  - Standpipe systems
  - Fire Alarm / Voice Communication / Backup battery capability
  - Generator load testing

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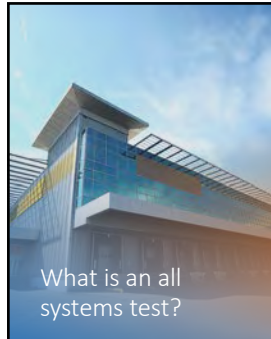
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Subsystems continued:

- Shunt capability
- Ductwork leak testing
- Zone barrier or compartment verification
- Stair pressurization/Passive and active smoke control functionality
- Egress components/Lighting
- Water supplies/tanks

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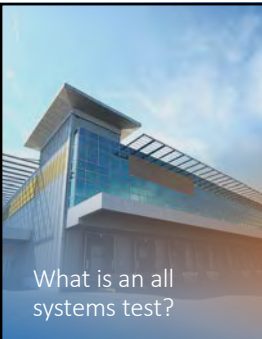
What is an all systems test?

Tests all individual life safety systems working together to ensure that the overall design will operate as desired and meet the design criteria and minimum code requirements under regular conditions and specific failures. (Fun part!)

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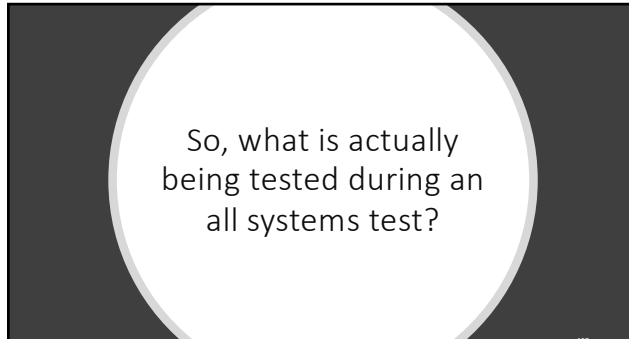
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What is an all systems test?

- This test requires representation from each of the jurisdiction's inspection groups (building, mechanical, electrical, fire).
- Depending on the project, you may have up to 20 or more jurisdictional staff present to confirm compliance.
- Representation from each responsible group within the fire life safety design scope needs to be present: fire protection engineers, mechanical engineers, and elevator contractors.
- It will sometimes include the equipment suppliers, owner representatives, etc.

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So, what is actually being tested during an all systems test?

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Everything....



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Not so fast!

Before all systems testing, a series of scenarios that will demonstrate that all systems have been integrated to function and meet the design criteria for life safety are developed by the fire protection engineering team and submitted to the jurisdiction for approval.

Now we get to test!

Using the approved scenarios as a guide, here is a taste of systems and or functions that are verified for all parts of the building from the basement to the rooftop:

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## Fire Alarm System

- This is life safety central! Whatever type of device has been designed to activate the building's life safety system, (smoke detector, water flow...etc.), the fire alarm panel programming starts to react and initiate alarm notification to the impacted area(s), send control commands to the related building systems, and verify positive operation - all within just a few moments.

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| SMOKE CONTROL SYSTEM TEST SCENARIOS  |         |  |        |        |        |     |     |           |      |
|--|---------|--|--------|--------|--------|-----|-----|-----------|------|
| Revision 1   |         |  |        |        |        |     |     |           |      |
| Project: San Diego City Hall Mechanical Smoke Control System   |         |  |        |        |        |     |     |           |      |
| Test No.: Test Scenario #10 (Per LSC/PH/CHS) - Subject: 10.1, Rev. 10.1 (10/10/2021) - Revision 10.1.1 (prepared by: JRM Consulting Engineers) |         |  |        |        |        |     |     |           |      |
| Title: Activation of Smoke Zone 02   |         |  |        |        |        |     |     |           |      |
| Location: Basement   |         |  |        |        |        |     |     |           |      |
| System: Basement   |         |  |        |        |        |     |     |           |      |
| Initiation of the Manual Smoke Detector or Pull Station at the Fire Alarm Control Panel for Zone 02  |         |  |        |        |        |     |     |           |      |
| Initiation of the Manual Smoke Detector or Pull Station at the Fire Alarm Control Panel for Zone 02  |         |  |        |        |        |     |     |           |      |
| Test #   | Device  | Description of Tested Event  |        |        | Status |     |     | Pass/Fail |      |
|  |         | 1  | 2      | 3      | 1      | 2   | 3   | 1         | 2    |
| 1.   | MANUAL  | Initiation of the Fire Alarm Control Panel for Smoke Detector and the Control Control Station (see required) |        |        | YES    | YES | YES |           |      |
| 2.   | SPN     | SPN-01   | SPN-02 |        |        |     |     | PASS      | PASS |
| 3.   | SPN-01  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 4.   | SPN-02  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 5.   | SPN-03  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 6.   | SPN-04  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 7.   | SPN-05  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 8.   | SPN-06  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 9.   | SPN-07  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 10.  | SPN-08  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 11.  | SPN-09  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 12.  | SPN-10  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 13.  | SPN-11  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 14.  | SPN-12  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 15.  | SPN-13  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 16.  | SPN-14  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 17.  | SPN-15  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 18.  | SPN-16  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 19.  | SPN-17  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 20.  | SPN-18  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 21.  | SPN-19  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 22.  | SPN-20  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 23.  | SPN-21  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 24.  | SPN-22  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 25.  | SPN-23  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 26.  | SPN-24  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 27.  | SPN-25  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 28.  | SPN-26  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 29.  | SPN-27  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 30.  | SPN-28  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 31.  | SPN-29  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 32.  | SPN-30  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 33.  | SPN-31  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 34.  | SPN-32  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 35.  | SPN-33  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 36.  | SPN-34  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 37.  | SPN-35  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 38.  | SPN-36  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 39.  | SPN-37  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 40.  | SPN-38  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 41.  | SPN-39  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 42.  | SPN-40  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 43.  | SPN-41  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 44.  | SPN-42  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 45.  | SPN-43  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 46.  | SPN-44  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 47.  | SPN-45  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 48.  | SPN-46  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 49.  | SPN-47  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 50.  | SPN-48  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 51.  | SPN-49  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 52.  | SPN-50  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 53.  | SPN-51  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 54.  | SPN-52  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 55.  | SPN-53  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 56.  | SPN-54  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 57.  | SPN-55  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 58.  | SPN-56  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 59.  | SPN-57  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 60.  | SPN-58  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 61.  | SPN-59  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 62.  | SPN-60  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 63.  | SPN-61  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 64.  | SPN-62  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 65.  | SPN-63  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 66.  | SPN-64  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 67.  | SPN-65  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 68.  | SPN-66  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 69.  | SPN-67  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 70.  | SPN-68  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
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| 72.  | SPN-70  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 73.  | SPN-71  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 74.  | SPN-72  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 75.  | SPN-73  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 76.  | SPN-74  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 77.  | SPN-75  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 78.  | SPN-76  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 79.  | SPN-77  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 80.  | SPN-78  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 81.  | SPN-79  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 82.  | SPN-80  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 83.  | SPN-81  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 84.  | SPN-82  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 85.  | SPN-83  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 86.  | SPN-84  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 87.  | SPN-85  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 88.  | SPN-86  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 89.  | SPN-87  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 90.  | SPN-88  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 91.  | SPN-89  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 92.  | SPN-90  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 93.  | SPN-91  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 94.  | SPN-92  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 95.  | SPN-93  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 96.  | SPN-94  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 97.  | SPN-95  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 98.  | SPN-96  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 99.  | SPN-97  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 100.   | SPN-98  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 101.   | SPN-99  | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |
| 102.   | SPN-100 | SPN-01   | SPN-02 | SPN-03 |        |     |     | PASS      | PASS |

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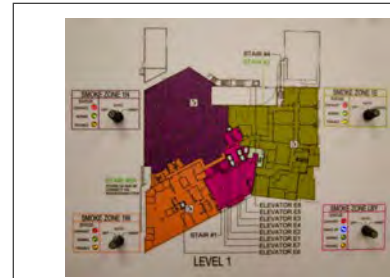
### Fire Fighters Smoke Control Panel

- The Fire Fighters smoke Control panel is located within the fire command center.
- This panel will have provide visual confirmation that proper pressures across active barriers, fan configurations and similar
- All panel switches are supervised and configured that an accidental change or position will not impact the automatic system control. Yes there are some manual functions that can be configured.

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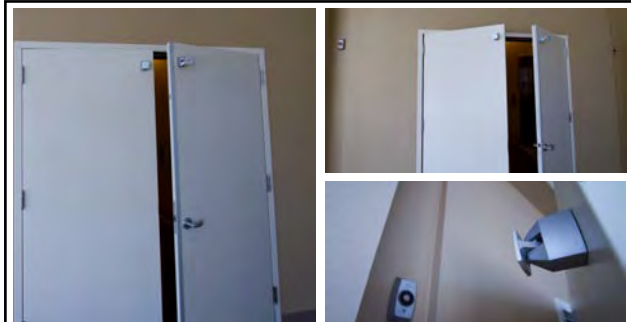


Exhaust and pressurization fans, dampers, door closers, seals opening protection

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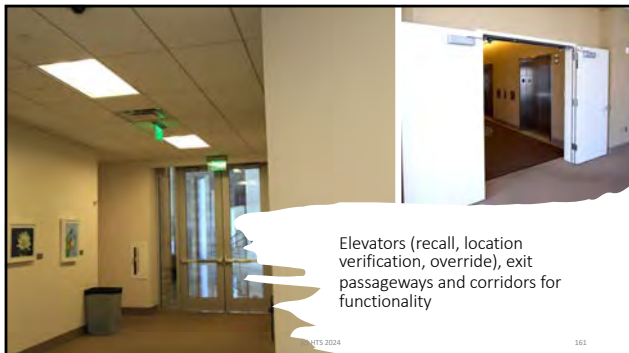
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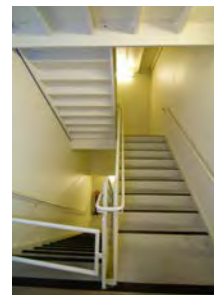


Elevators (recall, location verification, override), exit passageways and corridors for functionality

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Stairwell pressurization levels and lighting

Door opening pressures (maximum opening and swing testing under fire conditions)

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## Dampers

- Dampers are mechanical devices that assist in the isolation or exhaust of air within a building.
- Not only do they have to be tested for functionality, but they also need to be installed to allow maintenance and replacement.
- Field verification of proper power source and proper alignment. In both cases, if they are not verified to be on the proper power source or exercised for a full range of motion, it typically leads to test failures.



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## Exhaust, Pressurization Fans

- Fans shall be listed for such use, have been bump tested to assure proper rotation for the condition, have proper belts installed, and shall be tested to operate under both normal power and emergency power properly.
- Positive configuration verification in “smoke mode” is done electronically.

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## “Tidbits”

- Smoke Control is intended and designed to provide a tenable environment to allow for evacuation or relocation of occupants. Some of the methods are:
- **Stairway pressurization:** prevents or reduces smoke intrusion into egress stairways.
- **Active pressurization across barriers:** uses the HVAC system and dampers to create a “sandwich” above and below the fire floor
- **Passive fire protection system:** Uses floor-ceiling assemblies, doors, walls, and spray-applied fire-resistant materials.
- **Elevator hoistway pressurization:** similar to stairway pressurization

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## “Tidbits” continued...

- **Barrier Doors**
  - Used as part of the passive smoke compartment scheme.
  - Doors in the system are often held open by electromagnets that are released upon fire alarm panel activation. Used in conjunction with approved seals and closers.
  - Multi-leaf units have specific coordinators.

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## So what does Electrical have to do with all of these?

- As we review each of these systems, you will notice that almost all of them have some electrical component.
- The fire alarm system is covered in Chapter 7.
- Mechanical equipment motors are covered in Chapter 4
- Fire Pump/controller, Generator Chapter 6
- Generator, ATS, Emergency lights Chapter 7

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Start  
over!

Basically, everything that is tested for operation on normal power shall also be demonstrated on **backup power**

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## Emergency Generator

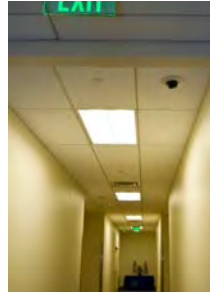


- The generator is the backbone of the emergency system and plays a vital role in the overall life safety scheme.
- It must be able to provide enough load for all required life safety systems and come back online upon normal power failure within 10 seconds.
- On-site fuel capacity to remain operational for a minimum of two hours

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## Generator (emergency circuiting, lighting)



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Automatic transfer switch(es)

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## Automatic Transfer Switch(s)

- What good is a generator if nothing tells it to turn on?
- Many failures are due to the lack of adjustments in the overcurrent device settings!

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## Shunt trip



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## Shunt Trip



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- A fire command center will have been configured in buildings where you have a comprehensive all-systems test.
- Building shunt trips are located within this room, along with others, as required by the electrical code.
- Depending on the size and location of the service, there may only be one shunt located in an accessible location; check with the fire department.

## Fire command center functions



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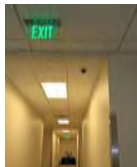
## Exit signage operation during normal power and emergency power



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## Emergency Lighting

- Emergency lighting is installed per the code and design documents during construction.
- Although functionality testing has been done during the construction phase under ideal conditions (location and levels), the lighting may be obstructed by smoke or fire conditions.

International Building Code Section 1008

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## EXIT PASSAGEWAYS & CORRIDORS

- Are these building elements intact and clear?
- Is the lighting operating at the minimum levels during normal power and emergency power?
- Does the exit signage work properly, and is it spaced per code with directional arrows in the right direction?
- Is ground-level exit signage required?

## Elevators

- Do the elevators recall properly from the appropriate alarm-initiating devices?
- Have they been configured to not open on the floor of such activation?
- Do they function as designed under firemen's control?
- Do they maintain proper lighting when under emergency power?
- Do the elevator landing or lobby doors close properly during alarm conditions (if applicable)?



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## Stairways

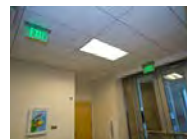
- Lighting levels proper for both emergency and normal power?
- Are the pressurization fans working and providing proper pressure levels with the proper opening and swing pressures?
- Are they clear and ready for use?
- Locks and latches, do they release?
- Luminous Egress path markings. Have they been installed in accordance with the code? These we get to test with the lights out!



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## Exit Signage

- Is the signage working under normal power?
- Does it continue to work under Emergency Power?
- Does it lead people in the right direction to the public way?
- Are these paths through rated building assemblies?
- If battery-powered or nuclear-powered, do they last the appropriate time?

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# The End...

- Well, not really - only the beginning, as we are sure we have opened up a new view of a Life Safety System...
- Thanks for your attention
- Questions?

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