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# **Fire Alarm System Fundamentals**

## **A Review of Recent Changes**

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# Outline

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- Codes and Standards**
  - ✓ History and Terminology
- Hardware**
  - ✓ FACU, Adders, Annunciators, Power Supplies, etc.
  - ✓ Wiring Methods and Materials
- Devices**
  - ✓ Automatic and Manual Initiating Devices & Modules
- Appliances**
  - ✓ Horns, Bells, Buzzers, Chimes, Strobes, & Speakers
- Holistic Fire Protection**

# Codes and Standards

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- **Why are fire alarm systems installed?**
- **Where do Building and Fire Codes fit?**
- **What about Installation Standards?**
- **“Let’s get ready to RUMBLE!”**

# Codes and Standards

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## Question #1

**When your State Building Code (e.g. IBC) disagrees with its referenced Installation Standard (e.g. NFPA 72), which one prevails?**

- 1) State Building Code**
- 2) Referenced Installation Standard**

**IBC-2012 102.4.1 Conflicts. Where conflicts occur between provisions of this code and referenced codes and standards, the provisions of this code shall apply.**



# Terminology

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- ✓ **“Circuit”** refers to an electrical interface, (e.g. IDC, SLC, and NAC).
- ✓ **“Zone”** refers to an area, which may include devices and/or appliances.
- ✓ **Circuit “Class”** refers to the circuit’s fault tolerance. How the circuit will perform during a fault condition, by labeling it Class A, B, C, D, E, N or X.

# Hardware

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- ✓ **Fire Alarm Control Panel**
- ✓ **Adder Module(s)**
- ✓ **Remote Annunciator(s)**
- ✓ **Remote Power**
- ✓ **Circuits and Pathways**

# FACP Correlations

## Condition → Signal → Response

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**Alarm Condition.** An abnormal condition that poses an immediate threat to life, property, or mission. 3.3.58\*

**Alarm Signal.** A signal that results from the manual or automatic detection of an alarm condition. 3.3.253\*

**Alarm Response.** The response to the receipt of an alarm signal. 3.3.240\*

**IFTTT**

# Hardware Adder Modules

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- Network Card
- Conventional, Non-addressable Circuit adder
- Loop Adder (SLC)
- Graphic Driver
- Transmitter



# Transmitter

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## Communications Methods for Supervising Station Alarm Systems.

**NFPA 72-2016 26.6**

**It is not the intent of Section 26.6 to limit the use of listed equipment using alternate communications methods, provided these methods demonstrate performance characteristics that are equal to or superior to those technologies described in Section 26.6 ...**

**NFPA 72-2016 A.26.6.2.2**

# Remote Annunciator

## Distribute Control



# Remote Power Boosters

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## Distribute Power



# Secondary Power Supply

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**Sized to operate the system for 24 hours in the non-alarm condition and then for 5 or 15 minutes in the alarm condition.**

**(Emergency Voice/Alarm Communication systems for 15 minutes at full load.)**

**NFPA 72-2016 10.6.7.2\***

# Battery-set Size Calculation

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## 3-step Process

**Step 1: Total quiescent (non-alarm) load times 24 hours (AH) plus;**

**Step 2: Total alarm load times 5 minutes (AH) (15 minutes for EVAC systems)**

**Step 3: Add a 20% safety margin (AH)**

**Step 1 + Step 2 + Step 3 = Battery-set Size**

**NFPA 72-2016 10.6.7.2**

# Circuits and Pathways

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## Pathway Class Designations.

Pathways shall be designated as Class A, Class B, Class C, Class D, Class E, Class N, or Class X, depending upon their performance in a fault condition.

**NFPA 72-2016 12.3\***

# Compatibility

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All devices and appliances that receive their power from the initiating device circuit or signaling line circuit of a control unit shall be listed for use with the control unit.

**NFPA 72-2016 10.3.3\***

This requirement does not apply to notification appliance circuits.

**NFPA 72-2016 A.10.3.3**

# Addressable Device

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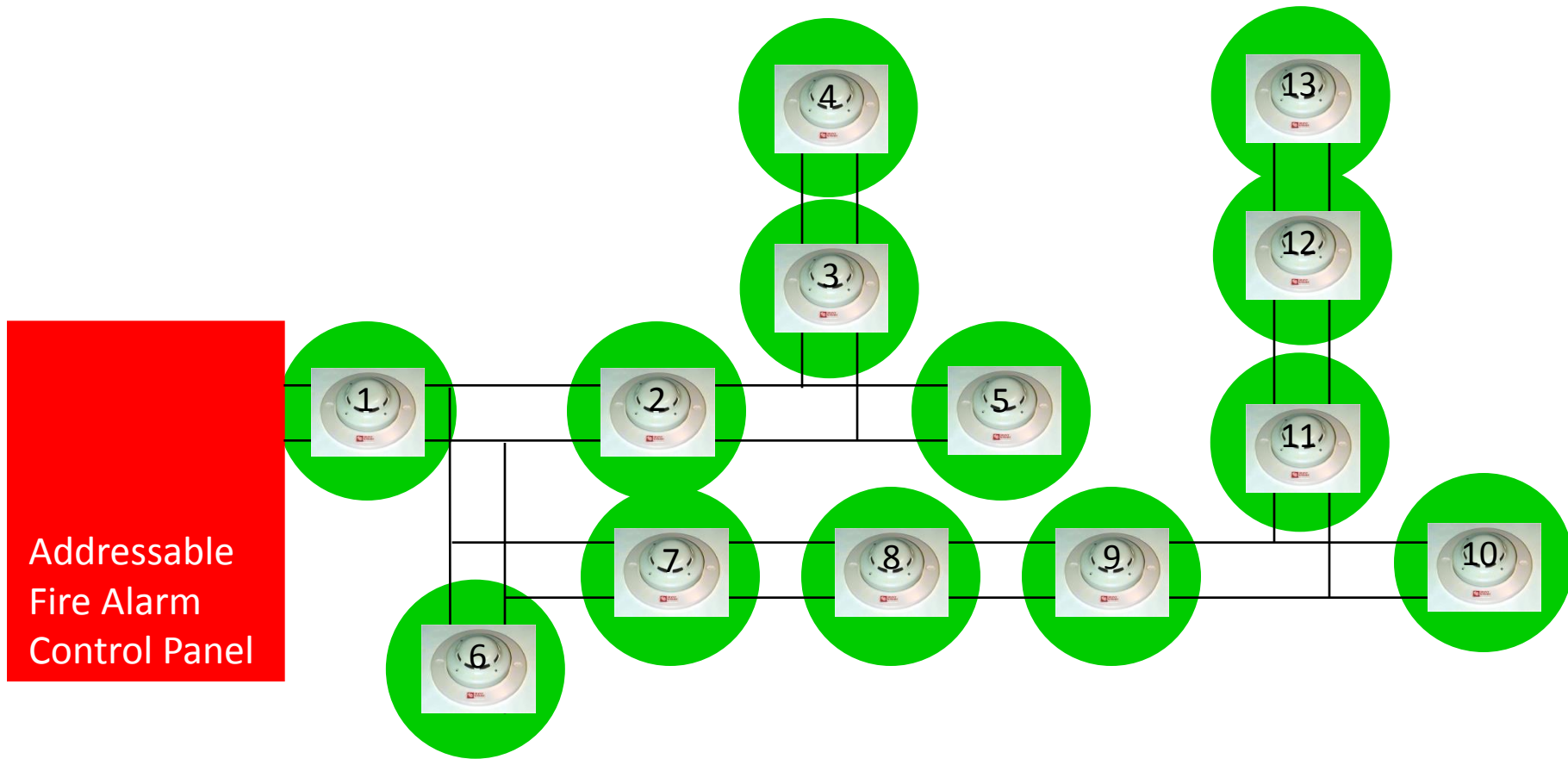
A fire alarm system component with discrete identification that can have its status individually identified or that is used to individually control other functions.

## **NFPA 72-2016 3.3.8**

Input devices are polled, changes in their condition (variable) affect an algorithm, which when satisfied will result in an output (e.g. Alarm, Supervisory, Trouble, SO, Relay, etc.)



# SLC Supervision

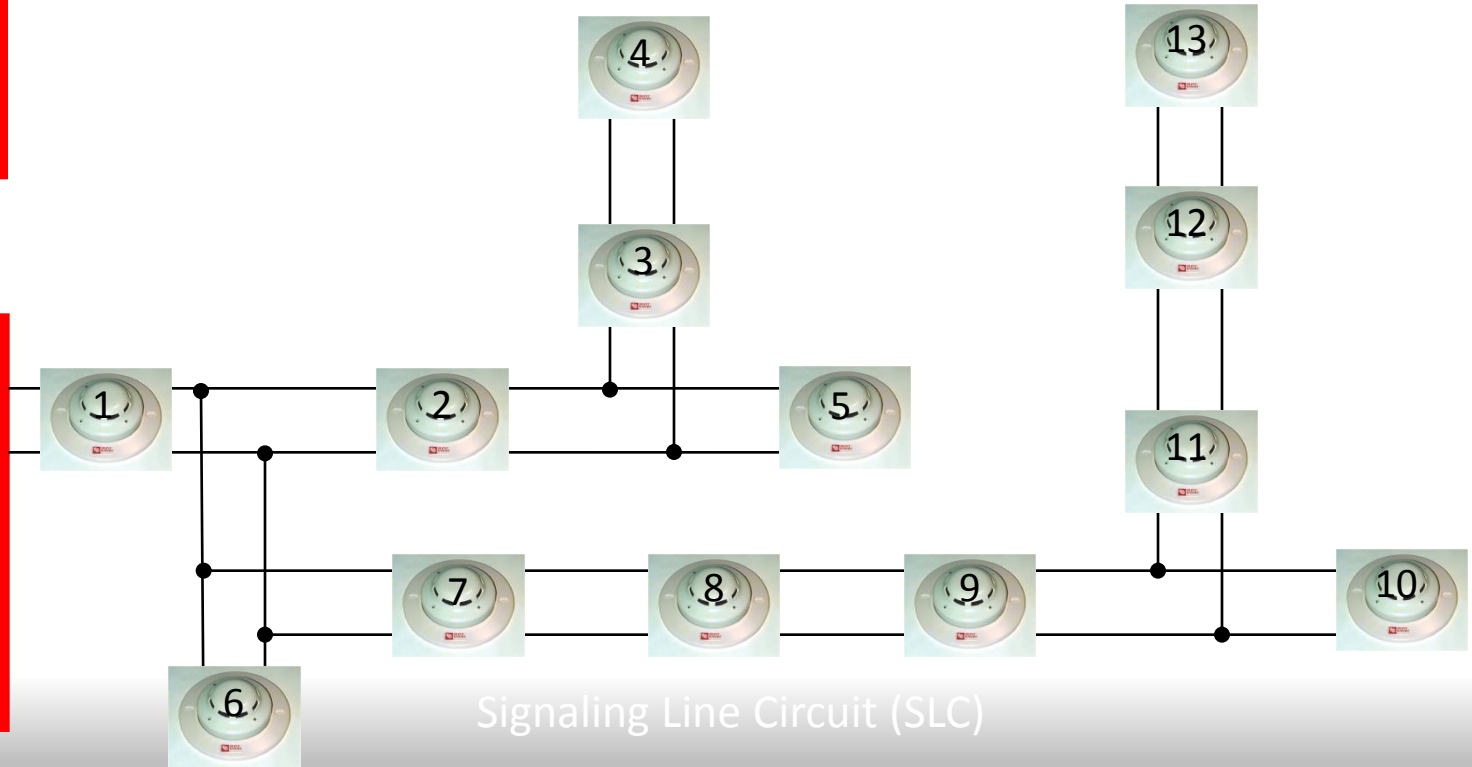


# Conventional IDC vs. Addressable SLC

Conventional  
Fire Alarm  
Control Panel



Addressable  
Fire Alarm  
Control Panel



# SLC Supervision

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## Question #2

**Are you permitted to t-tap a Class B SLC?**

# Fire Alarm System Wiring Methods

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The installation of all pathway wiring, cable, and equipment shall be in accordance with NFPA 70 and the applicable requirements of 12.2.3.1 [FO], 12.2.3.2 [NFPA 70 Article 760], and 12.2.3.3 [Survivability].

**NFPA 72-2016 12.2.3**

## Installation and Use.

Listed or labeled equipment shall be installed and used in accordance with any instructions included in the listing or labeling.

**NFPA 70-2014 110.3(B)**



# Wiring Methods and Materials

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## NFPA 70-2014 Chapter 3

### Wiring Methods and Materials

#### I. General Requirements

##### **300.1 Scope.**

All Wiring Installations. This article covers general requirements for wiring methods and materials for all wiring installations unless modified by other articles in Chapter 3.

##### **760.130 Wiring Methods and Materials on Load Side of the PLFA Power Source.**

760.130(A) [NPLFA], (B) [PLFA], or a combination of (A) & (B).

# Voltage Drop

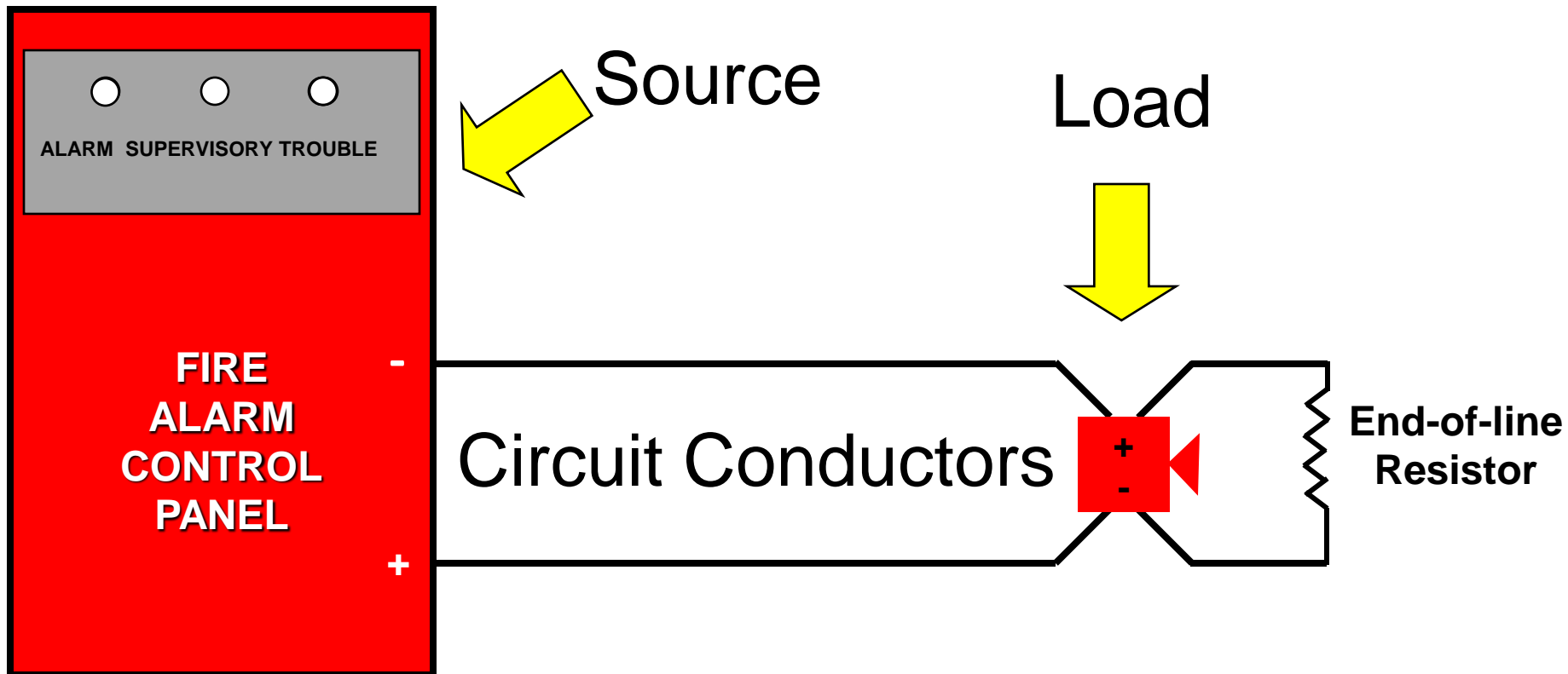
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**Equipment shall be designed so that it is capable of performing its intended functions under the following conditions:**

- (1) \*At 85% and at 110% of the nameplate primary (main) and secondary (standby) input voltage(s)
- (2) At ambient temperatures of 32°F and 120°F
- (3) At a relative humidity of 85% and an ambient temperature of 86°F

**NFPA 72-2016 10.3.5**

# Circuit Fundamentals



# Voltage Drop

- ✓ Is a function of current and resistance.  $E=IR$
- ✓ Resistance is a function of conductor length and size.

<b>AWG</b>	<b>DC Resistance <math>\Omega/1000'</math></b>
<b>10</b>	<b>1.24</b>
<b>12</b>	<b>1.98</b>
<b>14</b>	<b>3.07</b>
<b>16</b>	<b>4.89</b>
<b>18</b>	<b>7.77</b>



# Voltage Drop

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## Question #3

Voltage drop is a function of;

- 1) Wire size
- 2) Battery-set size
- 3) Distance between source and load
- 4) Avogadro's Number
- 5) 1 & 3

# Devices

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## Automatic

- ✓ Heat, Smoke, Flame, Gas, Waterflow, Spark, Video Image, ...

## Manual

- ✓ Box; single action, double action

## Supervisory Signal

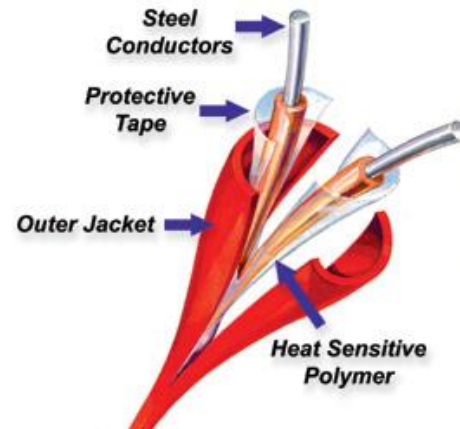
- ✓ Valve Position, Air Pressure, Fire Pump

## Addressable Modules

- ✓ Monitor (input), SO & Relay (output)

# Heat-Sensing Fire Detectors

NFPA 72-2016 17.6



# Smoke-sensing Fire Detectors

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NFPA 72-2016 17.7



# Radiant Energy-Sensing Fire Detectors



Detect      Control      Extinguish

Spark Detection can eliminate the early causes of fires or dust explosions.

**FM**  
APPROVED

**NFPA 72-2016 17.8**

# Combination, Multi-Criteria, and Multi-Sensor Detectors

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**NFPA 72-2016 17.9**

# Gas Detection

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**NFPA 72-2016 17.10**

# Manually Actuated Alarm-Initiating Devices

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**NFPA 72-2016 17.14**



# Manual Fire Alarm Box Protective Covers



# Manual Fire Alarm Box Protective Covers

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## Question #4

**Are you permitted to install a manual fire alarm box protective cover over a double action manual box?**

**NFPA 72-2016 17.14.7** Listed protective covers shall be permitted to be installed over single- or double-action manually actuated alarm-initiating devices.

**IBC-2012 907.4.2.5 Protective covers.** The fire code official is authorized to require the installation of listed manual fire alarm box protective covers to prevent malicious false alarms ...



# Fire Extinguisher Electronic Monitoring Device

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**NFPA 72-2016 17.15**

# Supervisory Signal–Initiating Devices

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**NFPA 72-2016 17.16**

# Notification Appliances

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**NFPA 72-2016 18.1**



# Public Mode Audible Requirements

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To ensure the audible public mode signals are clearly heard, they shall be:

- ✓ 15 dBA above average ambient SPL or;
- ✓ 5 dBA above maximum SPL (having a duration of at least 60 seconds)

Whichever is greater, in the area required to be served by the system on the A-weighted scale (dBA).

**NFPA 72-2016 18.4.3.1\***

# Average Ambient Sound Level

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<b>Business Occupancies.....</b>	<b>55 dBA</b>
<b>Education Occupancies.....</b>	<b>45 dBA</b>
<b>Industrial Occupancies.....</b>	<b>80 dBA</b>
<b>Institutional Occupancies.....</b>	<b>50 dBA</b>
<b>Mercantile Occupancies.....</b>	<b>40 dBA</b>
<b>Piers &amp; Water Surrounded Structures.....</b>	<b>40 dBA</b>
<b>Places of Assembly.....</b>	<b>55 dBA</b>
<b>Residential Occupancies.....</b>	<b>35 dBA</b>
<b>and so on ...</b>	

**NFPA 72-2016 Table A.18.4.3**

# Voice Intelligibility

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## Voice Intelligibility.

Within the acoustically distinguishable spaces (ADS) where voice intelligibility is required, voice communications systems shall reproduce prerecorded, synthesized, or live (e.g., microphone, telephone handset, and radio) messages with voice intelligibility.

**NFPA 72-2016 18.4.10\***

**Intelligible.** Capable of being understood; comprehensible; clear.

**NFPA 72-2016 3.3.135\***



# Voice Intelligibility

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## Question #5

**Are you permitted to determine voice intelligibility with a Sound Pressure Level meter?**

## **NFPA 72-2016 Annex D.2.4.2**

... There are two basic categories of intelligibility testing: (1) subject (human) based testing and (2) instrument based test methods ... CIS ... STI ...



# Visible Notification Appliance

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**NFPA 72-2016 18.5**

# Visible Signaling Requirements

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Visible notification appliances shall be installed in accordance with Table 18.5.5.4.1(a) or Table 18.5.5.4.1(b) using one of the following:

- (1) A single visible notification appliance.
- (2) \*Two groups of visible notification appliances, where visual appliances of each group are synchronized, in the same room or adjacent space within the field of view. This shall include synchronization of strobes operated by separate systems.

**NFPA 72-2016 18.5.5.4.2**



# Textual Audible Appliance

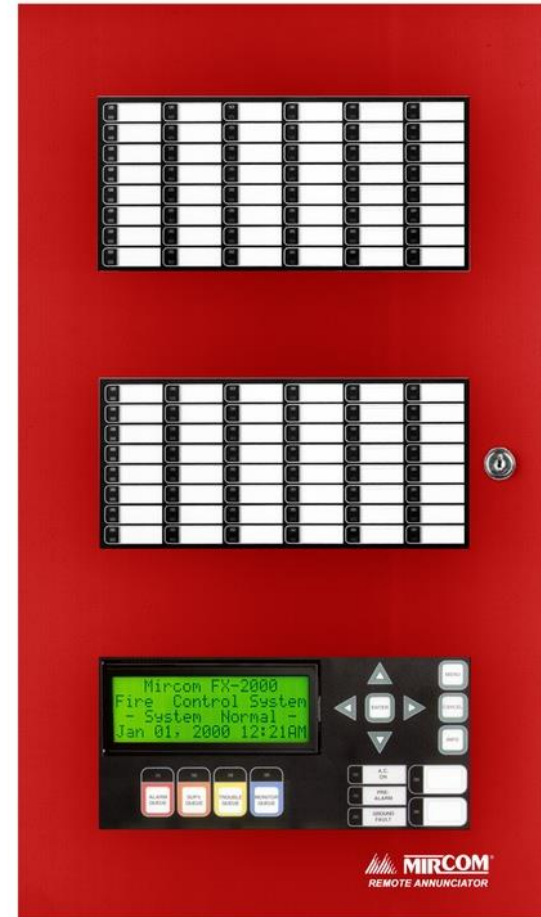
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Where no listed loudspeaker exists to achieve the intelligibility requirements of the Code for a notification zone, non-listed loudspeakers shall be permitted to be installed to achieve the intelligibility for that notification zone.

**NFPA 72-2016 24.3.1.2\***



# Textual and Graphical Visible Appliances



NFPA 72-2016 18.9\*

# Emergency Communication System (ECS)

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- ✓ One-Way Emergency Communications System.
- ✓ Distributed Recipient Mass Notification System (DRMNS).
- ✓ In-Building Fire Emergency Voice/Alarm Communications System.
- ✓ In-Building Mass Notification System.
- ✓ Wide-Area Mass Notification System.
- ✓ Two-Way Emergency Communications System.
- ✓ Area of Refuge (Area of Rescue Assistance) Emergency Communications
- ✓ Elevator Emergency Communications Systems
- ✓ Stairway Communications

# Survivability

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**For systems employing relocation or partial evacuation, a Level 2 or Level 3 pathway survivability shall be required.**

*Exception No. 1: Level 1 shall be permitted where notification zones are separated by less than 2-hour fire-rated construction.*

*Exception No. 2: Level 1 shall be permitted where there are at least two pathways that are separated by at least one-third the maximum diagonal of the notification or signaling zones that the pathways are passing through and the pathway is Class X or N.*



**NFPA 72-2016 24.3.13.4.1 → 12.4 Survivability**





# NFPA 72-2016 Chapter 21

## Emergency Control Function Interfaces

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- ✓ **Elevator Recall for Fire Fighters' Service**
- ✓ **Elevator Shutdown**
- ✓ **Fire Service Access Elevators**
- ✓ **Occupant Evacuation Elevators**
- ✓ **HVAC Systems**
- ✓ **Door and Shutter Release**
- ✓ **Electrically Locked Doors**
- ✓ **Exit Marking Audible Notification Systems**

# Elevator Code

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## Phase I Emergency Recall Operation by Fire Alarm Initiating Devices

Fire alarm initiating devices shall be installed in conformance with NFPA 72, and located:

- ✓ At each floor served by the elevator;
- ✓ In the associated elevator machine room;
- ✓ In the elevator hoistway, when required.

ASME A17.1 2.27.3.2

# Elevator Recall for Firefighters' Service

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**21.3.7\* When sprinklers are required in elevator hoistways by other codes or standards, fire alarm initiating devices shall be installed to initiate elevator recall IAW ASME A.17.1 2.27.3.2.1(c) and the following:**

- (1) Where sprinklers are located above the lowest level of recall, the fire detection device shall be located at the top of the hoistway.
- (2) Where sprinklers are located in the bottom of the hoistway (the pit), fire detection device(s) shall be installed in the pit in accordance with Chapter 17.
- (3) Outputs to the elevator controller(s) shall comply with 21.3.13. [**Satisfy ASME A17.1**]

# Smoke Detectors for Control of Smoke Spread

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**Classifications.** Smoke detectors installed and used to prevent smoke spread by initiating control of fans, dampers, doors, and other equipment shall be classified in the following manner:

- (1) Area detectors that are installed in the related smoke compartments
- (2) Detectors that are installed in the air duct systems
- (3) Video image smoke detection that is installed in related smoke compartments

# Smoke Detectors for Control of Smoke Spread

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# Emergency Control Functions

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Emergency control function interface devices shall be located within 3 ft (1 m) of the component controlling the emergency control function. **NFPA 72-2016 21.2.4\***

... The location of the emergency control function interface device within 3 ft (0.9 m) applies to the point of interface and not to remotely located equipment.

**NFPA 72-2016 A.21.2.4**

# Emergency Control Functions

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## Question #6

Imagine an air handler on the rooftop used to pressurize a stairwell.

Where do we connect it to the FACP?

- 1) At the AHU on the rooftop
- 2) In the 1<sup>st</sup> floor motor control center

# In Conclusion ...

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“The building code doesn’t allow a  
LEGO chimney on a Lincoln Log cabin.”

