

Fire Alarm System Fundamentals



Mircom is the largest and oldest privately owned fire alarm and life safety manufacturer in North America and 5th largest overall with 50 years of industry experience. Mircom offers a full line of fire panels from conventional to intelligent FACP's ranging from 6 points of protection to over 500,000. As well, we manufacture a full line of mass notification systems, area of refuge, telephone entry/intercom systems, access control, and nurse call systems.

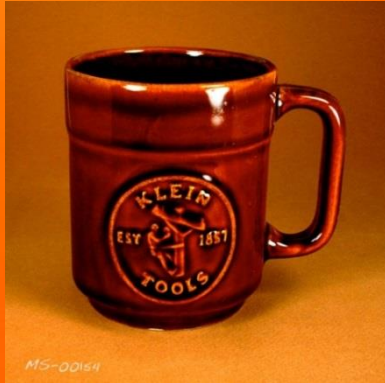
Introduce Yourself

- ✓ Hi, my name is ...
- ✓ My employer is ...
- ✓ I've been in this industry for ...
- ✓ I'm here because ...

Building Emergency Plan



Roster, hot beverages, baños, smokers, lunch, etc.



TRAINING REGISTRY Date: _____

PRINT

Name: _____

Title: _____

Company: _____

Address: _____

City: _____

Province/State: _____

Zip/Postal Code: _____

Phone: _____

Fax: _____

Email: _____



Goals and Objectives

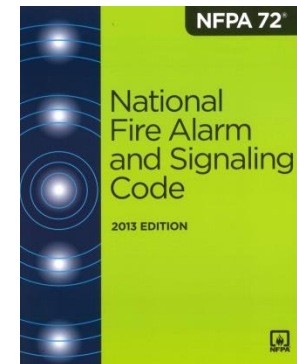
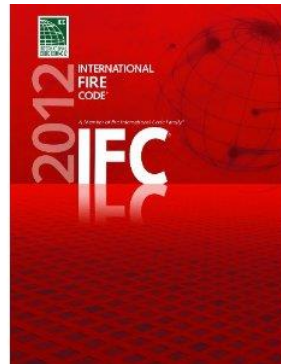
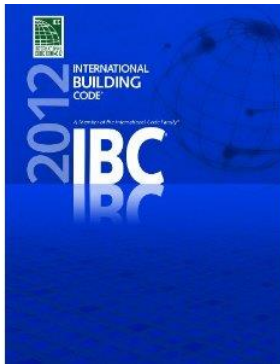
- ✓ To review Basic Fire Alarm Systems, including their purpose, their operation, and their pieces & parts.
- ✓ Attendees must attend the entire seminar to receive a Certificate of Attendance.

Outline

- ❑ 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

Referenced Publications

- ✓ NFPA 72-2013 *National Fire Alarm & Signaling Code*



History

1. The evolution of Codes and Standards

- ✓ Code of Hammurabi (1760 BC);
- ✓ The Rebuilding of London Act (1670);
- ✓ London Building Act (1844);
- ✓ BOCA/ICBO/SBCCI (1915/1922/1941);
- ✓ IBC (2000 to present)
- ✓ NBFU 70 (1883 to present)
- ✓ NBFU 72 (1896 to present)

2. Early alarm and detection

3. Modern addressable analog systems

Codes and Standards

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

Terminology

Approved.

Acceptable to the authority having jurisdiction.

NFPA 72-2013 3.2.1*

Authority Having Jurisdiction (AHJ).

An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

NFPA 72-2013 3.2.2*


Terminology

Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the AHJ and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

NFPA 72-2013 3.2.5*

Terminology

Nationally Recognized Testing Laboratory (NRTL)

<p>Applied Research Laboratories, Inc. (ARL)</p>  <p>Canadian Standards Association (CSA)</p>  <p>NRTL</p>  <p>NRTL/C</p>  <p>US</p>  <p>C US</p> <p><i>Used for products meeting only U.S. standards</i></p> <p><i>Used for products meeting both U.S. and Canadian standards</i></p>  <p><i>Used for gas-fueled products meeting U.S. standards</i></p>	<p>Communication Certification Laboratory, Inc. (CCL)</p>  <p>Curtis-Straus LLC (CSL)</p>  <p>Electrical Reliability Services, Inc. (ERS). Also known as eti Conformity Services and formerly Electro-Test, Inc. (ETI)</p>  <p>Entela, Inc. (ENT)</p>  <p><i>Used for products meeting only U.S. standards</i></p>  <p><i>Used for products meeting both U.S. and Canadian standards</i></p>	<p>FM Global Technologies LLC (FM) Also known as FM Approvals and formerly Factory Mutual Research Corporation</p>  <p>Intertek Testing Services NA, Inc. (ITSNA) Formerly ETL Testing Laboratories, Inc.</p>  <p>Warnock Hersey</p>  <p><i>Used for products meeting only U.S. standards</i></p>  <p>Warnock Hersey</p>  <p><i>Used for products meeting both U.S. and Canadian standards</i></p>	<p>MET Laboratories, Inc. (MET)</p>  <p>NSF International (NSF)</p>  <p>National Technical Systems, Inc. (NTS)</p>  <p>SGS U. S. Testing Company, Inc. (SGSUS) Formerly U.S. Testing Company, Inc.</p>  <p>Southwest Research</p> 	<p>TUV America, Inc. (TUVAM)</p>  <p>TUV Product Services</p>  <p>TUV Rheinland of North America, Inc. (TUV)</p>  <p><i>NRTL previously used but ceased authorizing on or about January 2000.</i></p>  <p><i>Used for products meeting only U.S. standards</i></p>  <p><i>Used for products meeting both U.S. and Canadian standards</i></p>	<p>Underwriters Laboratories Inc. (UL)</p>  <p>UL US</p>  <p>UL US</p>  <p>LISTED</p> <p><i>Used for products meeting only U.S. standards</i></p>  <p>LISTED</p> <p><i>Used for products meeting both U.S. and Canadian standards</i></p>  <p>CLASSIFIED</p>  <p>CLASSIFIED</p> <p><i>Used on products which UL has evaluated for specific properties, a limited range of hazards, or suitability for use under limited or special conditions</i></p> <p>Wyle Laboratories (WL)</p> 
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Terminology

Qualified. A competent and capable person or company that has met the requirements and training for a given field acceptable to the authority having jurisdiction.

NFPA 72-2013 3.3.222*

**Qualified might also mean that the person has knowledge of the installation, construction, or operation of apparatus and the hazards involved.*

Terminology

- ✓ **Device** refers to an input (e.g. automatic fire detector, manual box, waterflow switch, etc.)
- ✓ **Appliance** refers to an output (e.g. horn, bell, chime, strobe, speaker, etc.).
- ✓ **Module** refers to an addressable input or output (e.g. monitor module, control module etc.)

Terminology

- ✓ **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 its fault tolerance or how the circuit will perform during a fault condition, by labeling it Class A, B, C, D, E, or X.

Hardware

- ✓ Fire Alarm Control Panel
- ✓ Adder Modules
- ✓ Remote Annunciators
- ✓ Remote Power
- ✓ Circuits and Pathways

Fire Alarm Control Panel

Fire Alarm Control Unit (FACU).

A component of the fire alarm system, provided with primary and secondary power sources, which receives signals from initiating devices or other fire alarm control units, and processes these **signals** to determine part or all of the required fire alarm system output function(s).

NFPA 72-2013 3.3.102*

Signal

A message indicating a **condition**, communicated by electrical, visible, audible, wireless, or other means.

NFPA 72-2013 3.3.257

Condition. A situation, environmental state, or equipment state of a fire alarm or signaling system.

Condition → Signal → Response

NFPA 72-2013 A.3.3.57

Condition → Signal → Response

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

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

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

Condition → Signal → Response

Supervisory Condition. An abnormal condition in connection with the supervision of other systems, processes, or equipment.

Supervisory Signal. A signal that results from the detection of a supervisory condition.

Supervisory Response. The response to the receipt of a supervisory signal.

Condition → Signal → Response

Trouble Signal. A signal that results from the detection of a trouble condition.

Trouble Condition. An abnormal condition in a system due to a fault.

Trouble Response. The response to the receipt of a trouble signal.

Hardware Adder Modules

- ☐ Network Card
- ☐ Conventional, Non-addressable Circuits
- ☐ Loop Adders (SLC)
- ☐ Graphic Driver

Transmitters

Digital Alarm Communicator Systems.

Radio Systems.

NFPA 72-2013 26.6

A.26.6.2.2 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 ...

Remote Annunciators

Distribute Control



Remote Power Supplies

Distribute Power



Secondary Power Supply

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 72-2013 10.6.7.2

Battery-set Size Calculation

3-step Process

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

Step 2: Total alarm load times 5 minutes (15 minutes for EVAC systems) plus;

Step 3: A 20% safety margin

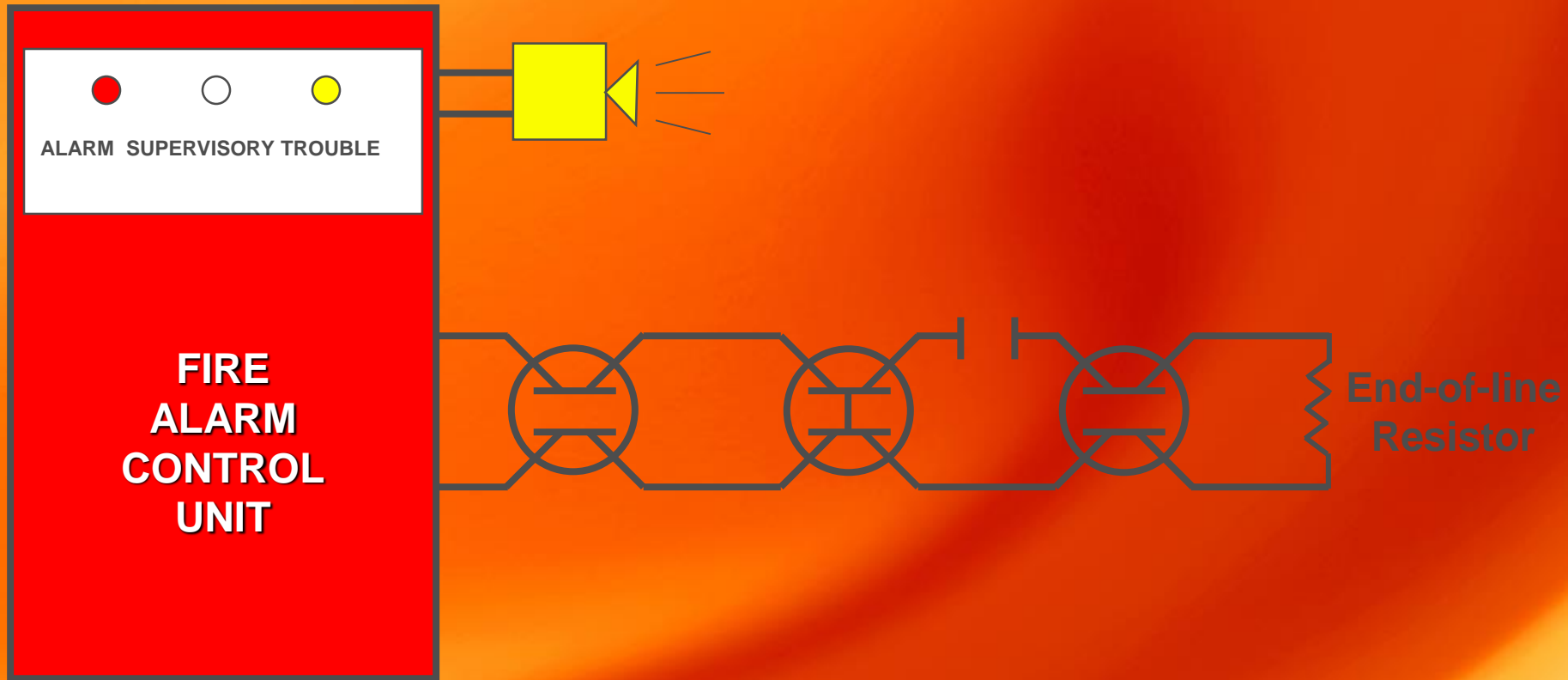
NFPA 72-2013 10.6.7.2

Circuits and Pathways

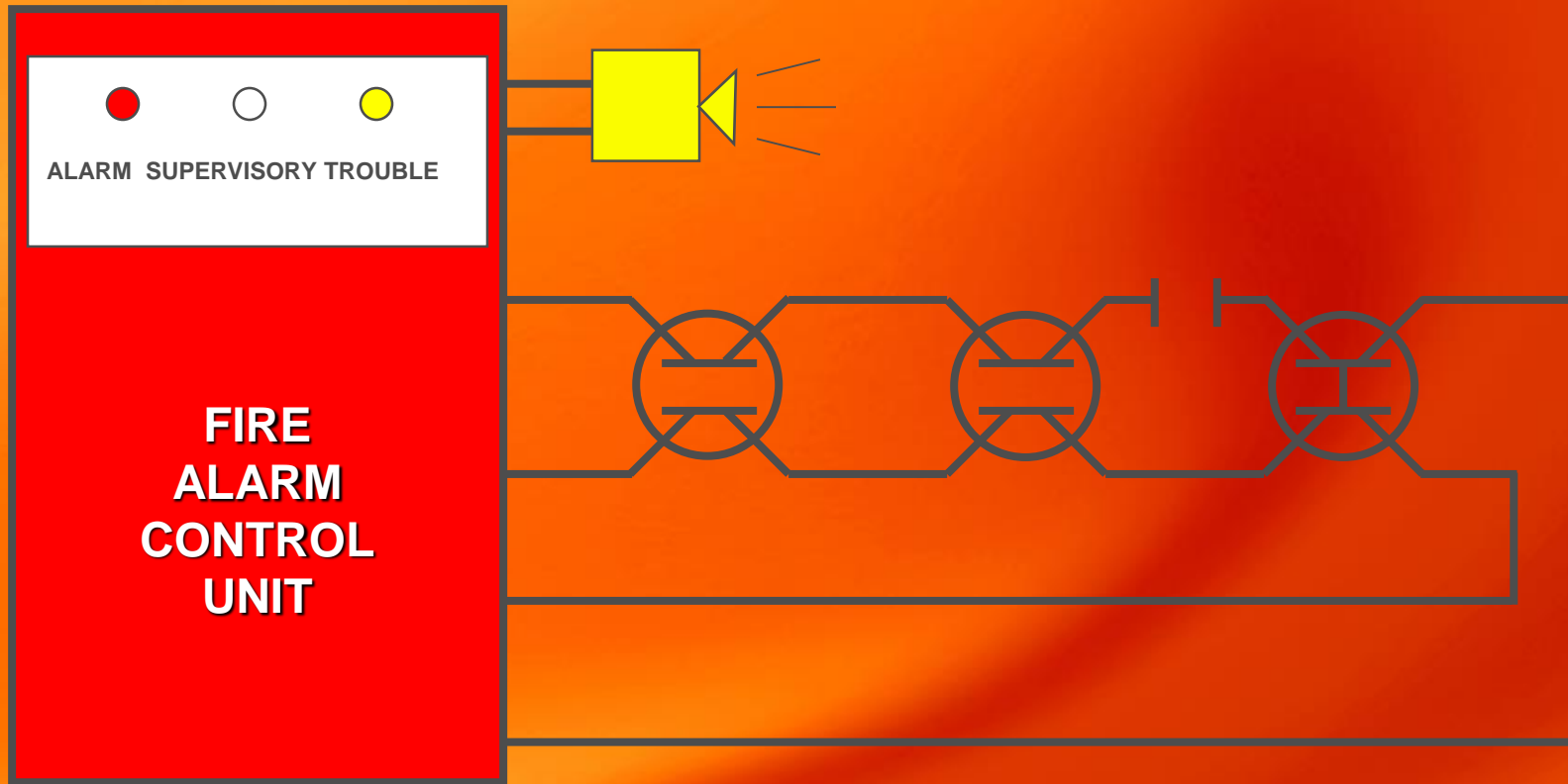
Pathway Class Designations.

Pathways shall be designated as Class A, Class B, Class C, Class D, Class E, or Class X, depending on their performance.

NFPA 72-2013 12.3*



Class B Initiating Device Circuit
alarm and trouble condition



Class A Initiating Device Circuit
alarm and trouble condition

Compatibility

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 72-2013 10.3.3

This requirement does not apply to notification appliance circuits.

NFPA 72-2013 A.10.3.3

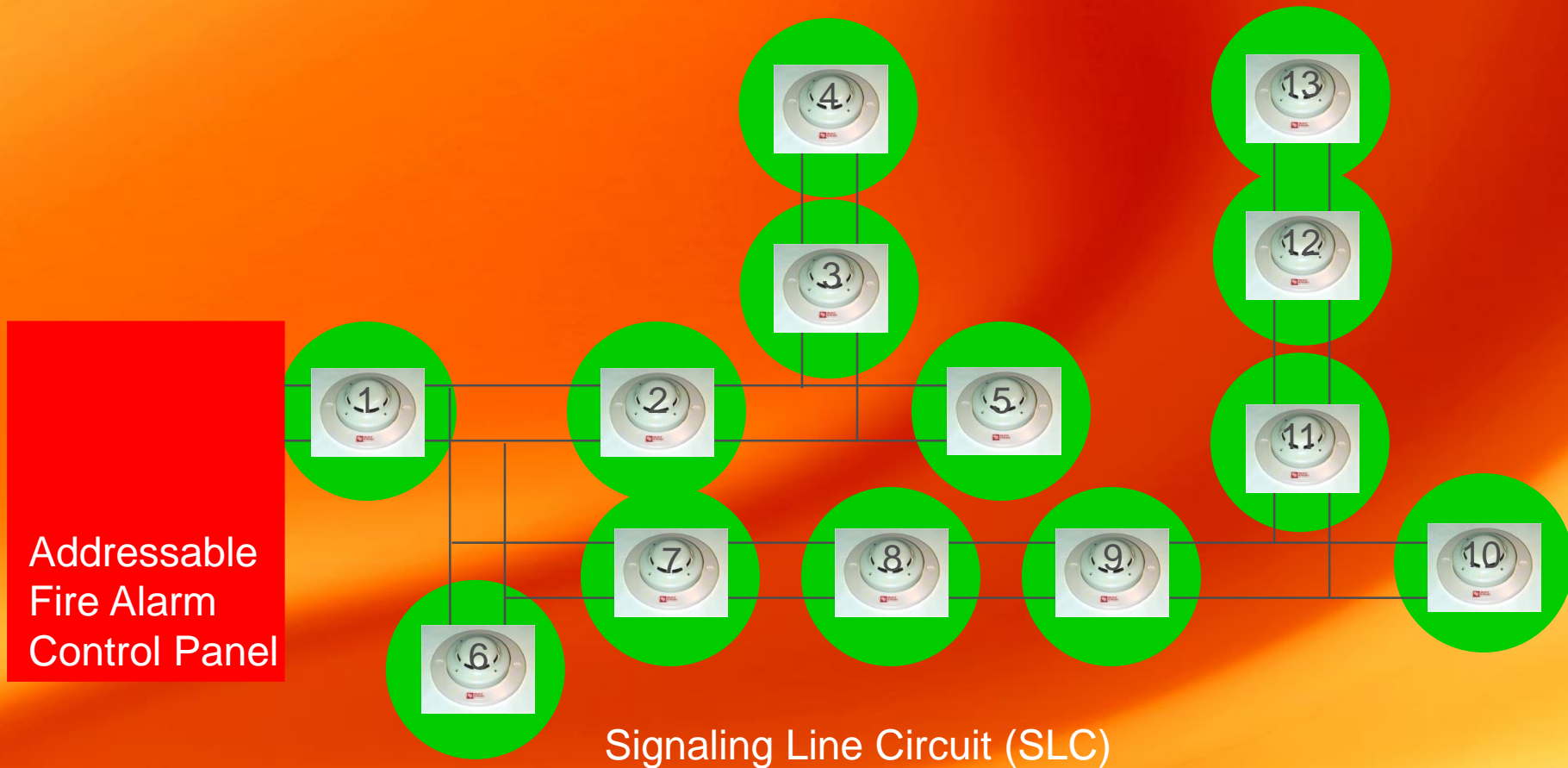
Addressable Device

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 72-2013 3.3.8

Devices are polled and changes in condition are reported; alarm, supervisory, and trouble.

SLC Supervision



Analog Initiating Device (Sensor)

An initiating device that transmits a signal indicating varying degrees of condition as contrasted with a conventional initiating device, which can only indicate an on-off condition.

NFPA 72-2013 3.3.132.1

Analog Addressable System

Certain systems are able to upwardly adjust sensor alarm threshold automatically to avoid a nuisance alarm resulting from hostile environments.

This type of system will identify the affected detector when the limit of compensation is reached.

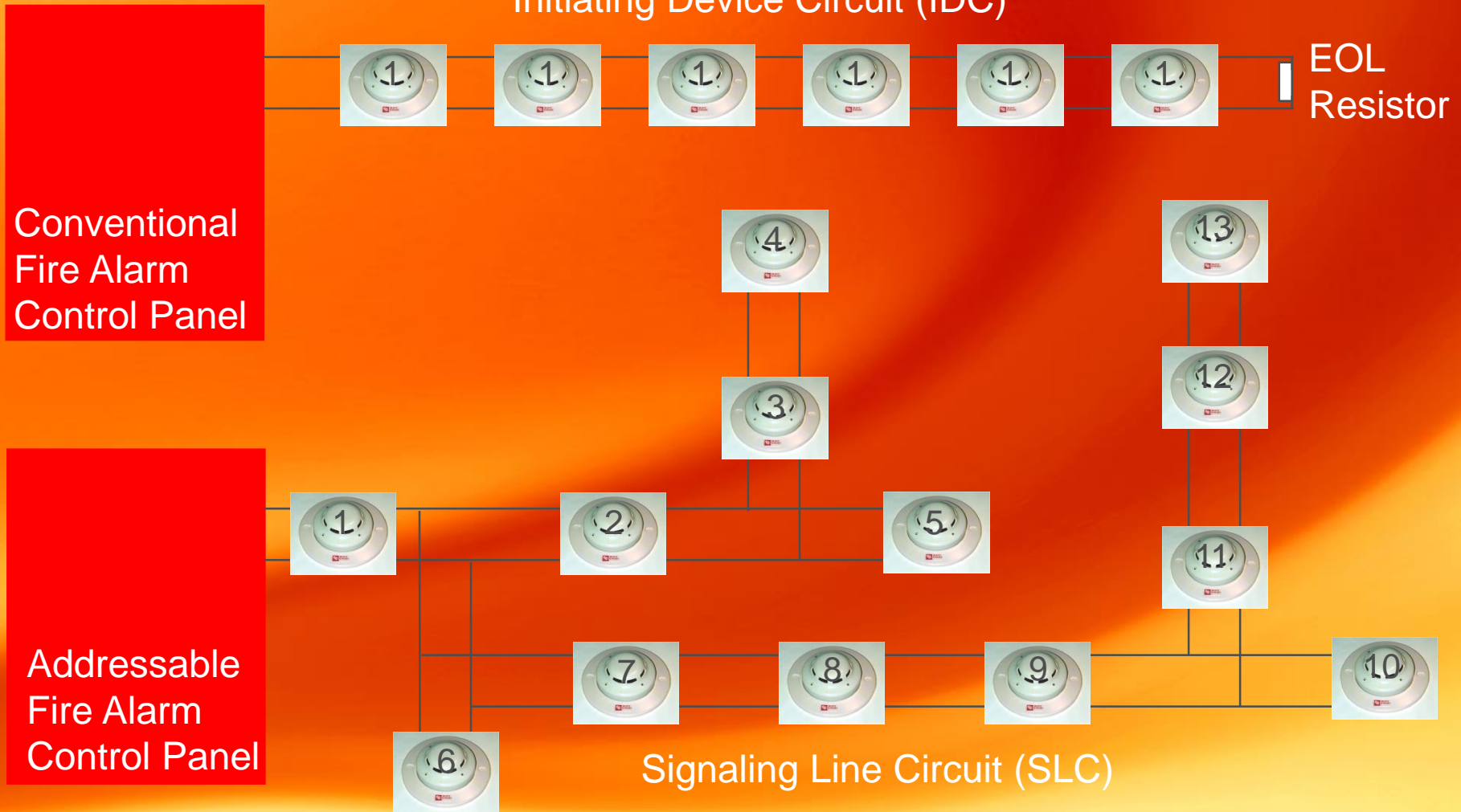
NFPA 72-2013 23.8.5.4.2

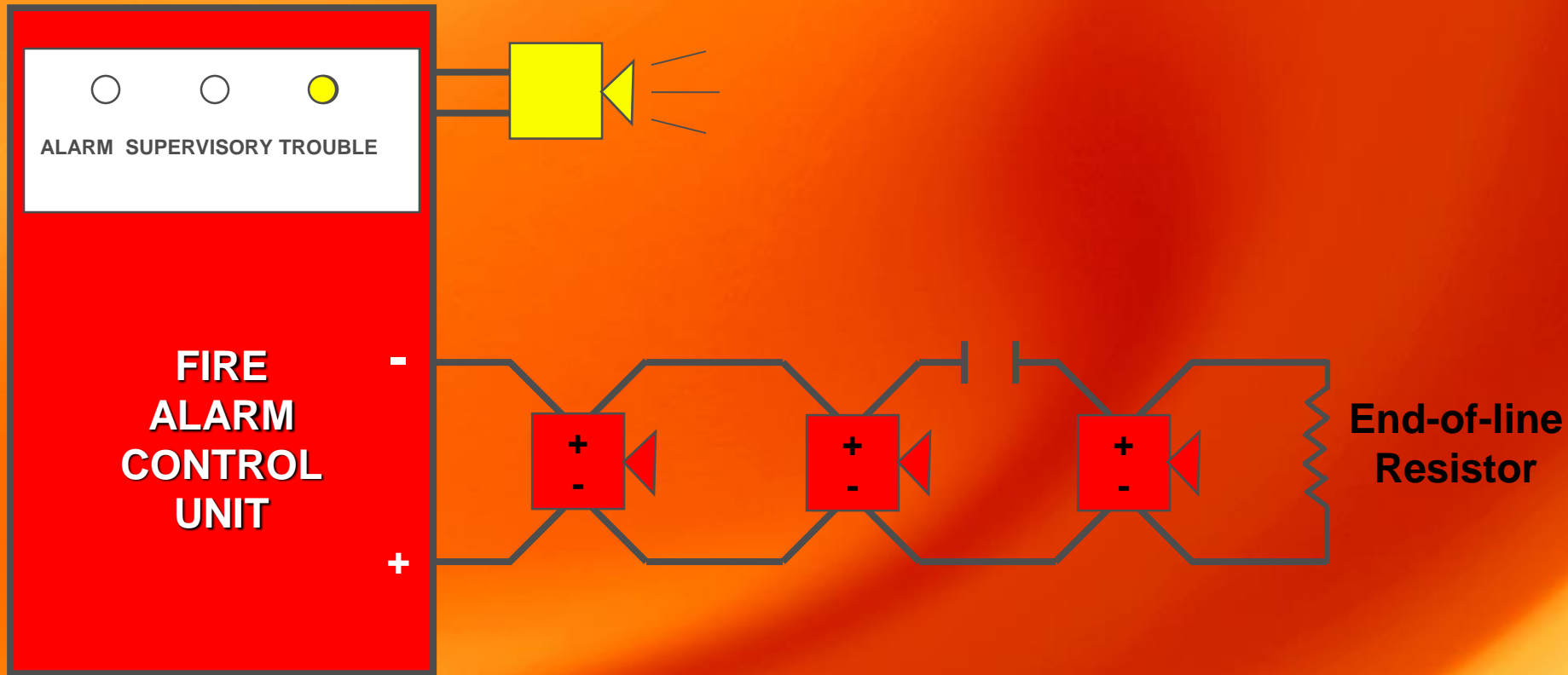
Analog Addressable System



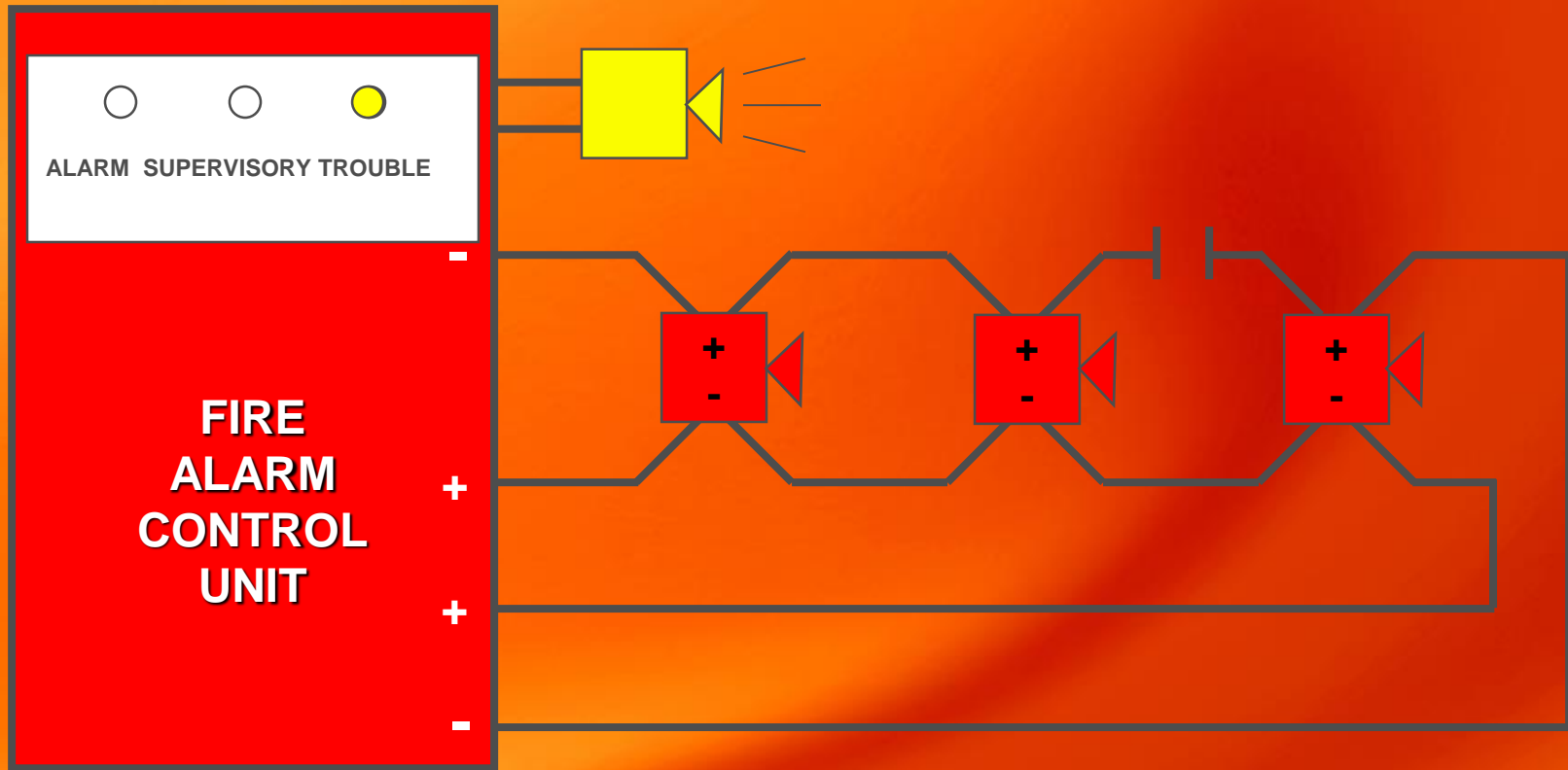
Conventional vs. Addressable

Initiating Device Circuit (IDC)



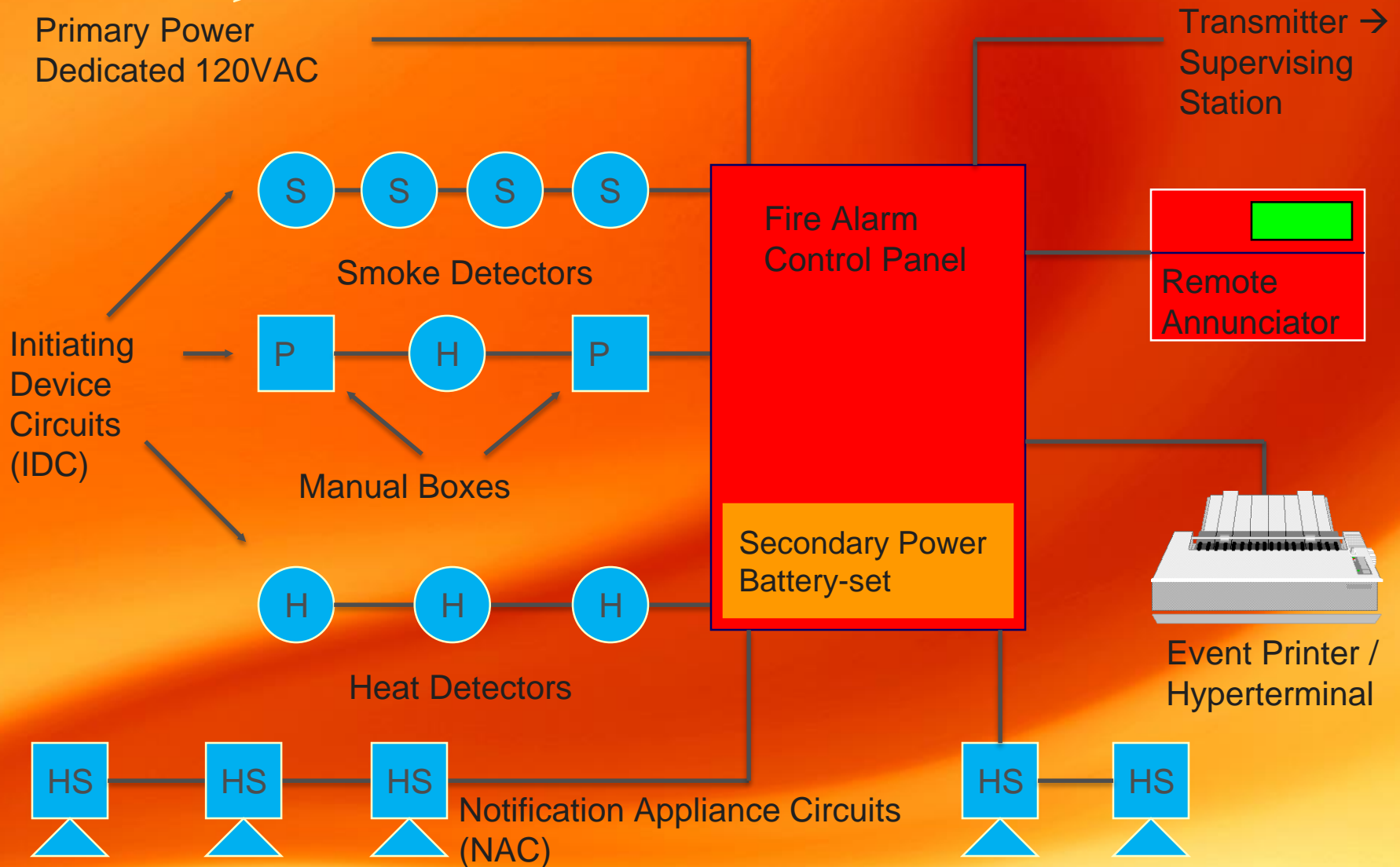


Class B Notification Appliance Circuit
trouble condition



Class A Notification Appliance Circuit
trouble condition

Bringing it all Together



Fire Alarm System Wiring Methods

Fire alarm systems are unique. Circuits are either supervised, redundant, or both.

Therefore, their wiring methods are a bit different than that for light, power, and other limited-energy electrical systems. Install IAW NFPA 70, Article 760.

NFPA 72-2013 12.2.4.3

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

NFPA 70-2011 Chapter 3

I. General Requirements

300.1 Scope.

(A) All Wiring Installations.

This article covers wiring methods for all wiring installations unless modified by other articles.

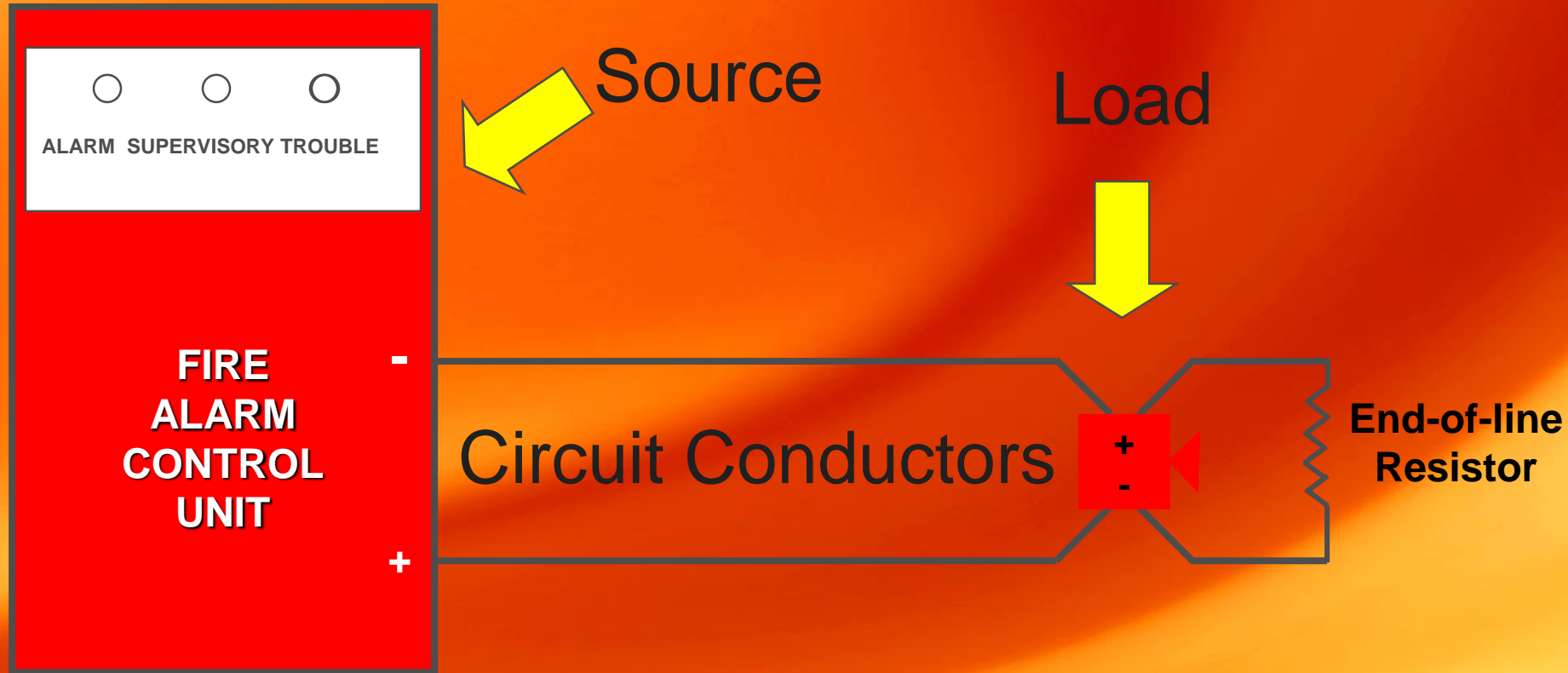
Voltage Drop

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 72-2013 10.3.5

Circuit Fundamentals



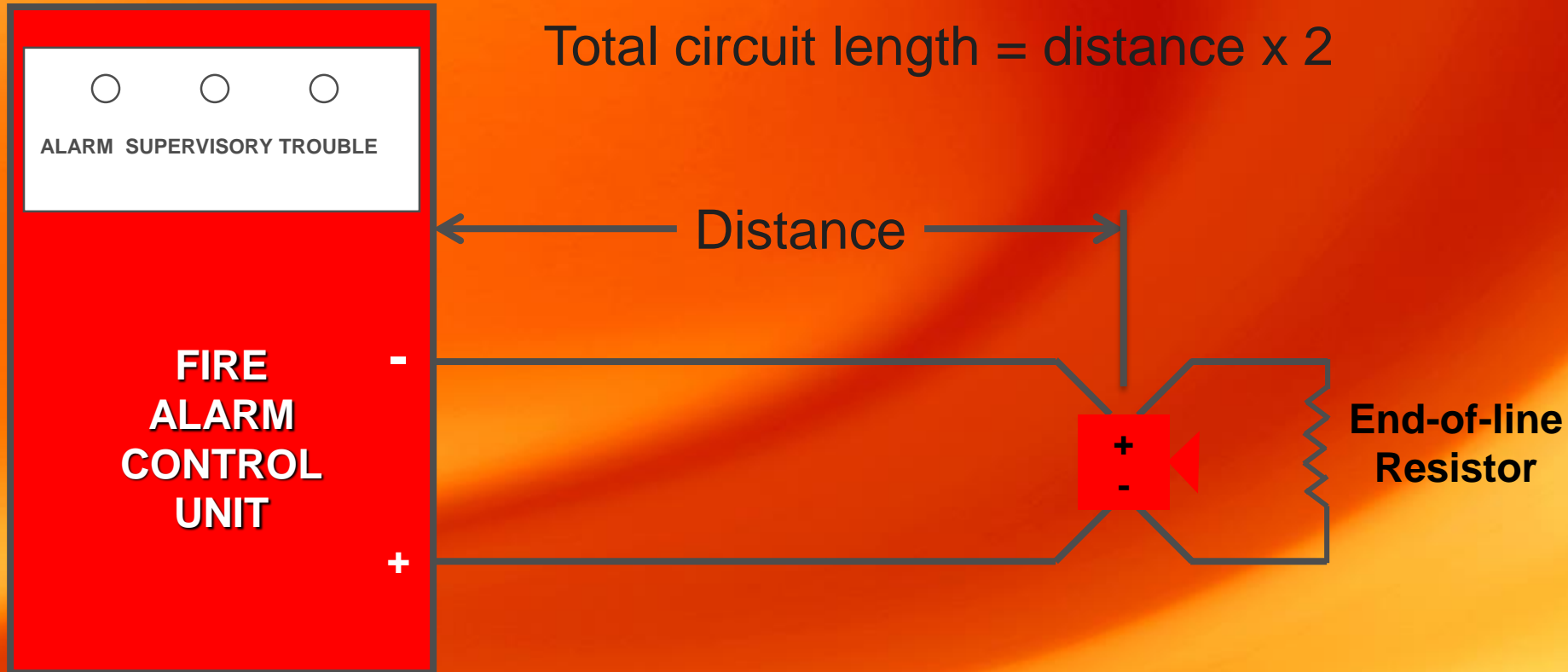
Voltage Drop

- ✓ Is a function of current and resistance.
- ✓ Resistance is a function of conductor length and size.

AWG	DC Resistance $\Omega/1000'$
10	1.24
12	1.98
14	3.07
16	4.89
18	7.77

NFPA 70-2011, Chapter 9, Table 8 Conductor Properties

End-of-line Method



Devices

Automatic;

- ✓ Smoke, heat, flame, gas, waterflow

Manual

- ✓ Boxes; single action, double action

Supervisory Signal

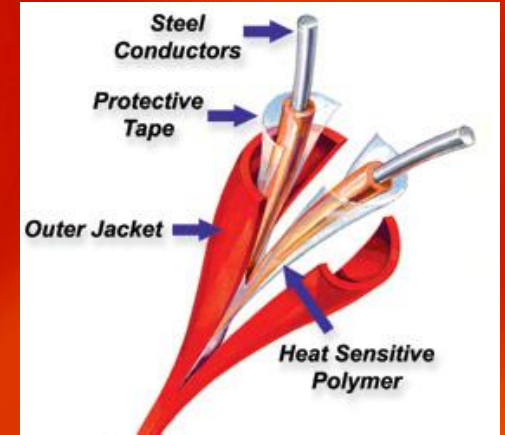
- ✓ Valve Position, Air Pressure, Fire Pump

Addressable Modules

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

Heat-Sensing Fire Detectors

NFPA 72-2013 17.6



Smoke-Sensing Fire Detectors



NFPA 72-2013 17.7



Radiant Energy-Sensing Fire Detectors



NFPA 72-2013 17.8

Gas Detection



NFPA 72-2013 17.10

Manually Actuated Alarm-Initiating Devices



Manually Actuated Alarm-Initiating Devices

- ✓ Each manual fire alarm box shall be securely mounted.
- ✓ The operable part of each manual fire alarm box shall be not less than 42 in. and not more than 48 in. above floor level.
- ✓ Manual fire alarm boxes shall be installed so that they are conspicuous, unobstructed, and accessible.



Fire Extinguisher Electronic Monitoring Device



NFPA 72-2013 17.15

Supervisory Signal-Initiating Devices



NFPA 72-2013 17.16

Notification Appliances



NFPA 72-2013 18.1



Public Mode Audible Requirements

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

- ✓ 15 dBA above average ambient or;
- ✓ 5 dBA above maximum (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 72-2013 18.4.3.1*

Average Ambient Sound Level

Business Occupancies.....	55 dBA
Education Occupancies.....	45 dBA
Industrial Occupancies.....	80 dBA
Institutional Occupancies.....	50 dBA
Mercantile Occupancies.....	40 dBA
Piers & Water Surrounded Structures.....	40 dBA
Places of Assembly.....	55 dBA
Residential Occupancies.....	35 dBA

NFPA 72-2013 Table A.18.4.3

Sleeping Area Requirements

Where audible appliances provide signals for sleeping areas, they shall have a sound level of at least 15 dB above the average ambient sound level or 5 dB above the maximum sound level having a duration of at least 60 seconds or a sound level of at least 75 dBA, whichever is greater, measured at the pillow on the A-weighted scale (dBA).

NFPA 72-2010 18.4.5.1

Visible Notification Appliance



NFPA 72-2013 18.5

Visible Signaling Requirements

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.
- (3) More than two visible notification appliances or groups of synchronized appliances in the same room or adjacent space within the field of view that flash in synchronization.

NFPA 72-2013 18.5.5.4.2

Visible Signaling Requirements

1. Wall-mounted appliance location

- ✓ The entire lens 80" - 96" above the finished floor (except sleeping areas)

2. Ceiling-mounted appliances

- ✓ Within 30' of the finished floor

3. Sleeping areas

- ✓ 177cd within 2' of ceiling
- ✓ 110cd more than 2' below ceiling

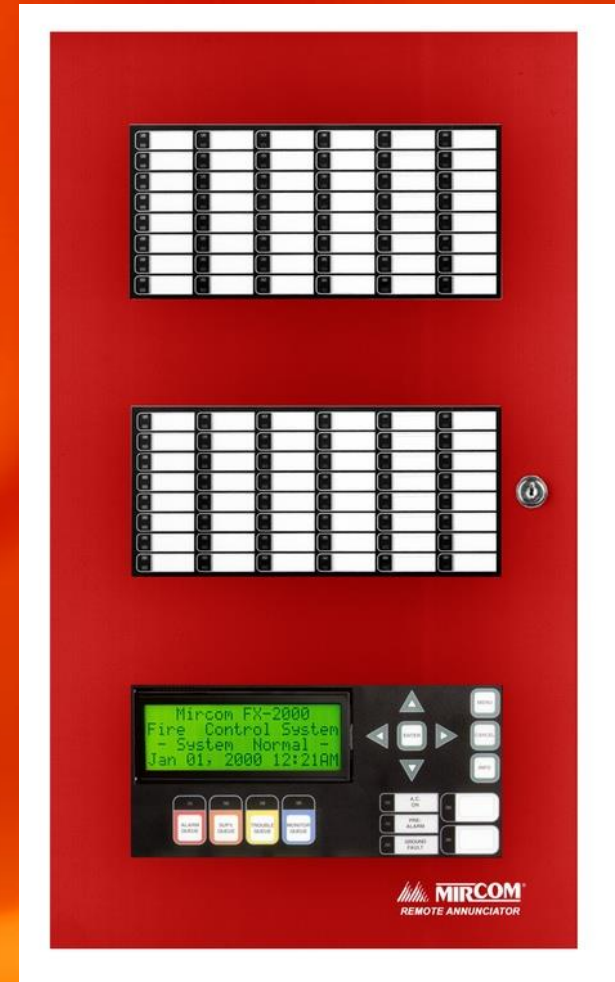
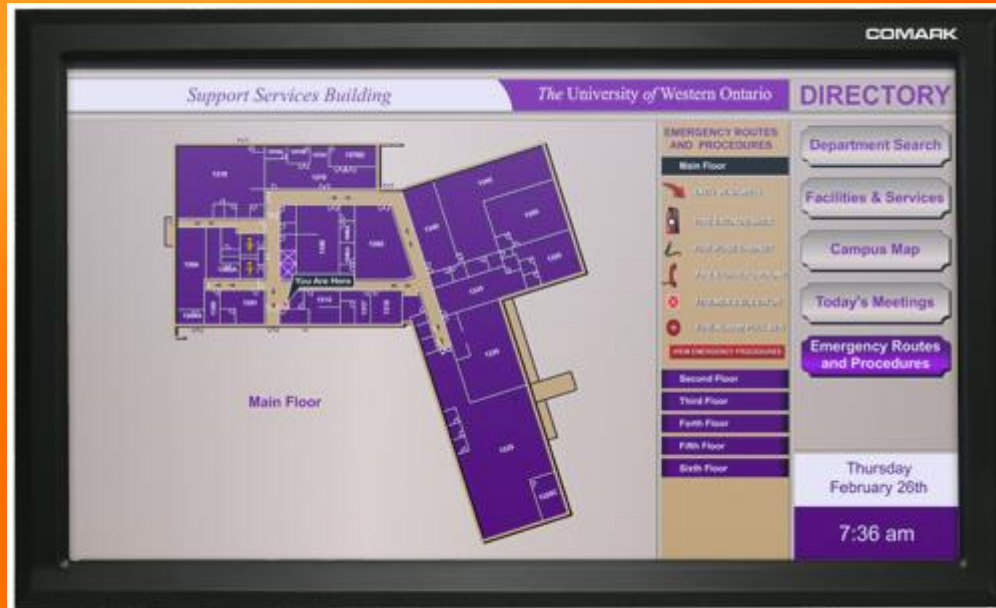
NFPA 72-2013 18.5

Textual Audible Appliance



NFPA 72-2013 18.8

Annunciator Formats



Emergency Communication System (ECS)

- ✓ 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.

Survivability

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

NFPA 72-2013 24.3.6.4.1

Survivability

Pathway survivability Level 2 shall consist of one or more of the following:

- (1) 2-hour fire-rated circuit integrity (CI) cable
- (2) 2-hour fire-rated cable system [electrical circuit protective system(s)]
- (3) 2-hour fire-rated enclosure or protected area
- (4) 2-hour performance alternatives approved by the authority having jurisdiction

NFPA 72-2013 12.4.3

Survivability

Pathway survivability Level 3 shall consist of pathways in buildings that are fully protected by an automatic sprinkler system in accordance with NFPA 13, and one or more of the following:

- (1) 2-hour fire-rated circuit integrity (CI) cable
- (2) 2-hour fire-rated cable system [electrical circuit protective system(s)]
- (3) 2-hour fire-rated enclosure or protected area
- (4) 2-hour performance alternatives approved by the authority having jurisdiction

NFPA 72-2013 12.4.4

Balanced Fire Protection

- Alarm and Detection
 - ✓ To provide occupant early warning
- Sprinkler System
 - ✓ To suppress and extinguish
- Fire and Smoke Barriers
 - ✓ To provide tenability

NFPA 72-2013 21.1

Emergency Control Function Interfaces

- ✓ 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

Emergency Control Functions and Interfaces

- Maintain Path of Egress
- Maintain Areas of Refuge
- Provide Clear Approach for Firefighters
- Minimize Fire and Smoke Damage



Elevator Recall for Firefighters' Service

When sprinklers are installed in elevator pits, install automatic fire detection to initiate elevator recall IAW ASME A17.1 2.27.3.2.1(c)

- (1) Where sprinklers are located above the lowest level of recall, locate the fire detection device at hoistway top.
- (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 21.3.14 [Satisfy ASME A17.1].

NFPA 72-2013 21.3.7*

Elevator Code

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

Smoke detectors shall not be installed in unsprinklered elevator hoistways unless they are installed to activate the elevator hoistway smoke relief equipment.

NFPA 72-2013 21.3.6

If ambient conditions prohibit installation of automatic smoke detection, other automatic fire detection shall be permitted.

NFPA 72-2010 21.3.9*

Smoke Control Systems

Smoke control, as required by the building code, is intended to:

1. Limit the spread of smoke
2. Direct the smoke out of the building

NFPA 92A *Smoke Control Systems Standard*

NFPA 92B *Smoke Management Systems Standard*

Smoke Control Methods

Natural

- ✓ The use of windows, panels and/or hatches so that smoke will flow directly to the outside.

Mechanical

- ✓ The use of building HVAC equipment to exhaust smoke and bring in outside air.

Smoke Detectors for Control of Smoke Spread

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

NFPA 72-2013 17.7.5*

Smoke Detectors for Control of Smoke Spread



Emergency Control Functions

Emergency control function interface devices shall be located within 3 ft (1 m) of the component controlling the emergency control function.

NFPA 72-2013 21.2.4*

Exit Marking Audible Notification Systems



NFPA 72-2013 21.10

Discussion Questions

- What NFPA chapter governs commercial fire alarm systems?
- What NFPA chapter governs fire alarm electrical circuits and wiring?
- What NFPA chapter governs the standard for Smoke Control Systems?
- *Bonus* What IBC chapter governs commercial fire protection systems?

In Conclusion ...

