



Fire Alarm System Fundamentals

Presented By:

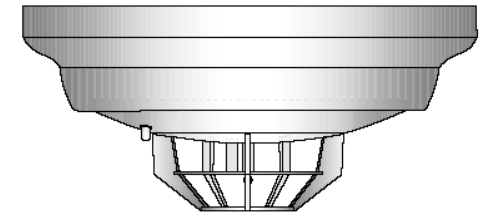
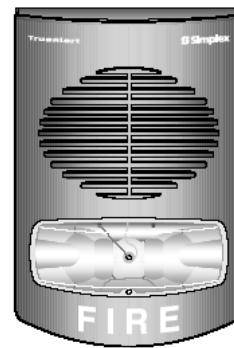
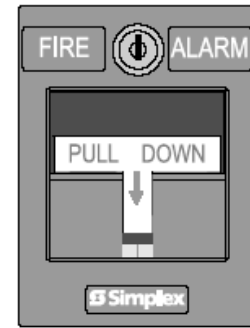
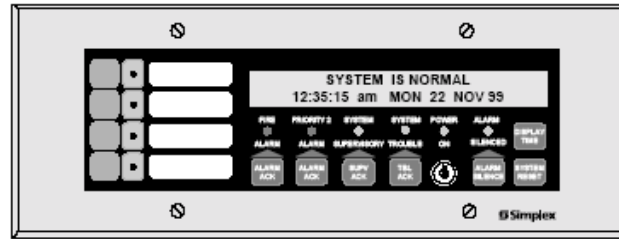
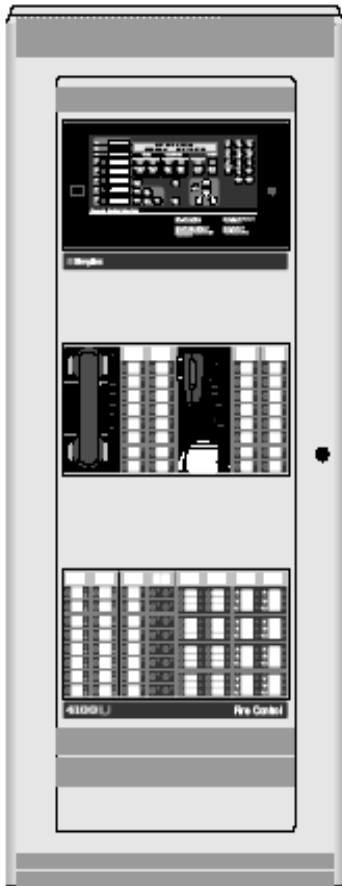
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Overview

- Understanding the Codes
 - Fire Alarm Systems (Manual Vs Automatic)
 - NFPA 5000
 - 2010 NFPA-72 (effective 8/1/2009)
- Selected Design Fundamentals
 - Fire Alarm and Detection
 - System Considerations
 - Survivability
 - Emergency Communication/ Notification
 - Fire Command Center
 - Other Essentials

Understanding the Codes





Fire Alarm and Detection Systems

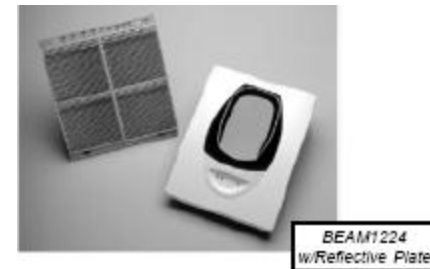
- Designed to initiate early responses to fires
- Includes:
 - Notifying building occupants
 - Summoning responding personnel
 - Activating safety control functions that mitigate a fire hazard
- NFPA/IBC: emphasis is on occupants' notification and evacuation
 - Specific requirements are based upon occupancy type and expected facility conditions
- Where required, system must be installed in accordance with NFPA-72





Fire Alarm and Detection System Types

- Manual
 - Initiating devices or manual fire alarm boxes installed at exits and other locations in a building
 - Actuation by pulling a lever (single action) or pushing or lifting and pulling (double action)
- Automatic
 - Single- and multiple-station smoke alarms
 - System smoke detectors (spot or air sampling)
 - Heat detectors (spot or linear type)
 - Water flow switches
 - Flame Detectors
 - Spark / ember detectors
 - Gas Detection





Manual or Automatic System?

- Determinants:

- Number of occupants
- Capabilities of the occupants
- Characteristics of the building
 - Height, building access, hazard and use



- Automatic fire detection usually required when:

- Detecting fire is essential to the evacuation plan or protection of occupants

- Automatic smoke detection usually required when:

- Occupants are limited in movement and unable to act in self preservation
- Occupants are provided with sleeping accommodations



Where is a fire alarm system required by Code?

- Fire alarm requirements are determined by building use, occupancy type and specific building conditions, as described by NFPA/ IBC
- Occupancy types may be further subdivided
 - Example: High-Hazard Group Occupancy (Group H) has 5 sub-divisions, H-1 through H-5, and H-5 may have fire alarm requirements where the rest do not



Fire Alarm and Detection Systems Requirement in the NFPA 5000/ IBC 2012

**Review of NFPA/ IBC and applicable codes to
determine the requirements for each specific
building, use and situation**



System Designs

Addressable vs. Non-Addressable

Is there really a choice anymore?

Addressable systems make up more than
90% of most manufacturer's fire alarm
systems – with few exceptions



System Designs

Non-Addressable (conventional) Systems / circuits

- Many newer systems have the capabilities to support conventional circuits as well as addressable technology
- All conventional type systems are limited to those with a maximum of 16 – 32 initiating device circuits (commonly referred to as zones)
- Typically , Conventional systems or devices are used when ambient conditions prohibit the use of addressable technology or for smaller (1-4 zone) applications



System Design Considerations

Non-Addressable (conventional) Systems / circuits

- Maximum limit of 30 2-wire smoke detectors per circuit (zone)
- Smoke detectors must be UL listed with the control panel, by the control panel manufacturer
- Identification of the device in alarm is limited to the circuit (zone) – field verification is necessary
- Limited expandability
- Can be installed and serviced by mostly anyone

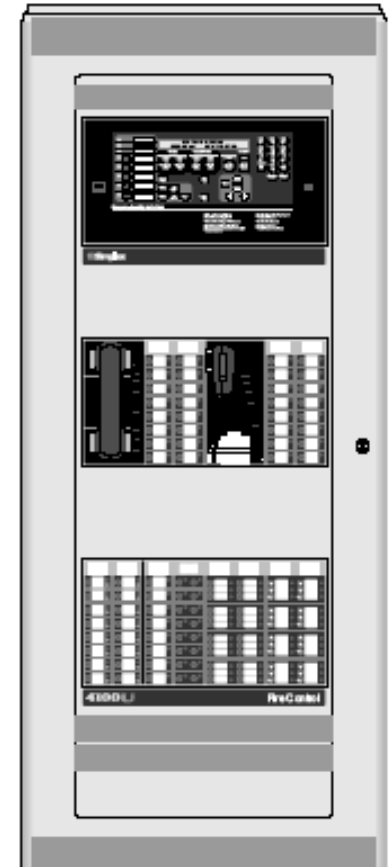
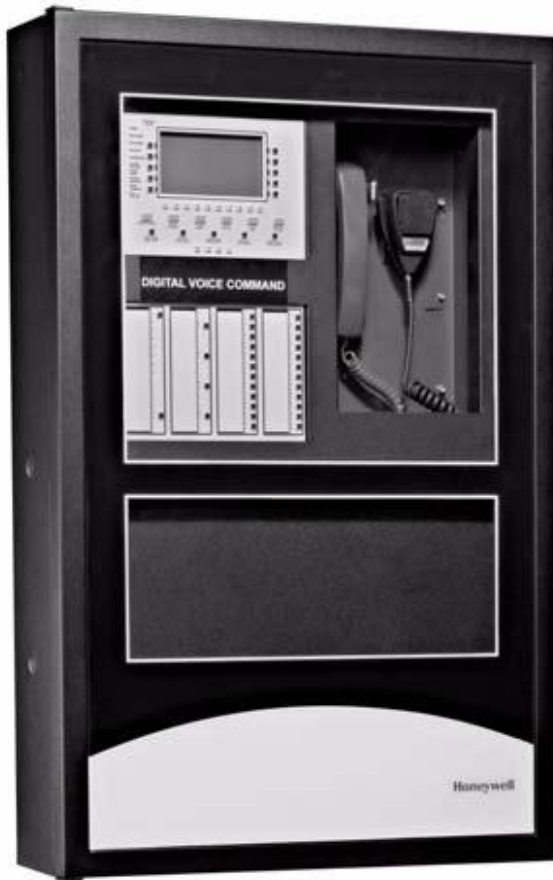


System Designs

Addressable systems and Circuits

- Small to large building applications
- Signaling Line Circuits can extend across several building zones
- 66 – 250 addressable devices per circuit (depending on manufacturer)
- May be networked with other panels of the SAME manufacturer to create a larger or distributed system
- New requirement to limit failure to 50 devices

Fire Alarm System Designs





System Designs

Panel Distribution and Configurations

Banked or Distributed

What is the Difference?



Panel Distribution and Configuration

Banked Systems

- **When all control panel equipment is in the same room (FCC Room or other designated location)**
- **Typically controlled with one CPU**
- **Requires considerable more wire and labor to install**
- **Lower Head-end (control) equipment cost**
- **Single point of failure can affect entire system**



Panel Distribution and Configuration

Distributed Systems

- **When the equipment is strategically located throughout the building or campus**
- **A CPU at each panel location**
- **Requires considerable less wire and labor to install**
- **Higher Head-end (control) equipment cost / More reliable**
- **Less overall wire and wire installation costs**
- **Distributed panels can operate independently (degrade mode)**



Panel Distribution and Configuration

Distributed Systems – Distribution

- **Locate panels every 3 – 5 floor in a high-rise (serve the floor the panel is located on and evenly above and below)**
- **For ease of service, remote panels should be provided with displays (not always provided – must be requested)**
- **Class “A” / Style 7 wiring between panels provides improved reliability (optional)**



Panel Distribution and Configuration

Distributed Systems – Distribution

- Be cognoscente of survivability requirements



Survivability

- **Pathway Survivability Level 2, 3 and 4 (2007)**
 - (1) A 2-hour fire rated circuit integrity (CI) cable
 - (2) A 2-hour fire rated cable system (electrical circuit protective system)
 - (3) A 2-hour fire rated enclosure
 - (4)*Performance alternatives approved by the authority having jurisdiction
 - (5) Buildings fully protected by an automatic sprinkler system installed in accordance with NFPA 13, Standard for the Installation of Sprinkler Systems, and with the interconnecting wiring or cables used for the operation of notification appliances installed in metal raceways and in accordance with Article 760 of NFPA 70



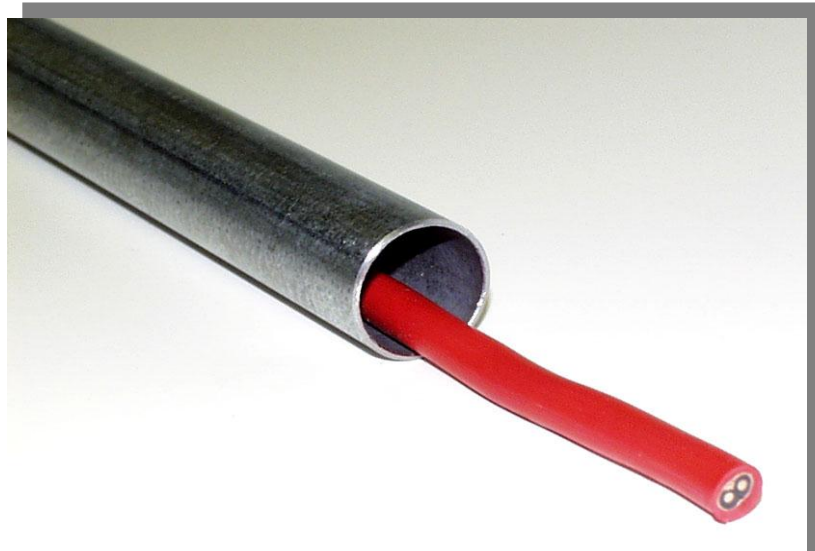
Survivability

- **Pathway Survivability Level 2, 3 and 4 (2010 and 2013)**
 - (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



Types of CI Cable

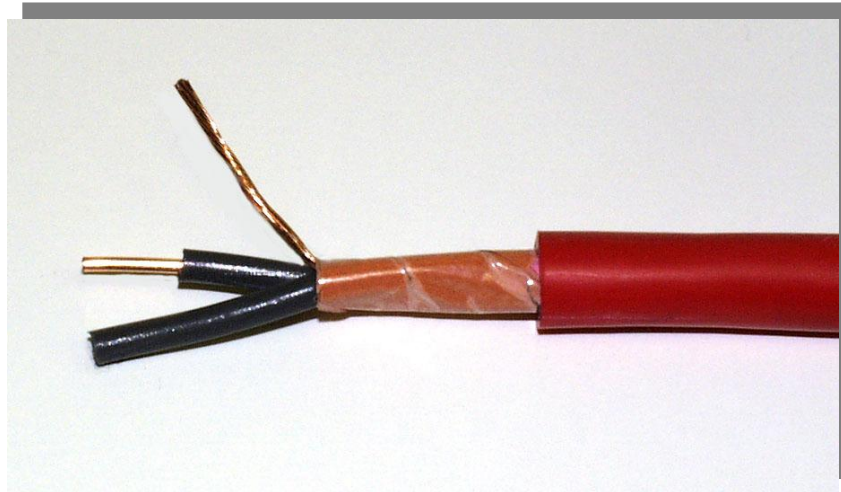
- CIC - Requires Strict Compliance to the Installation Criteria for the CIC Electrical Circuit Protective Systems.



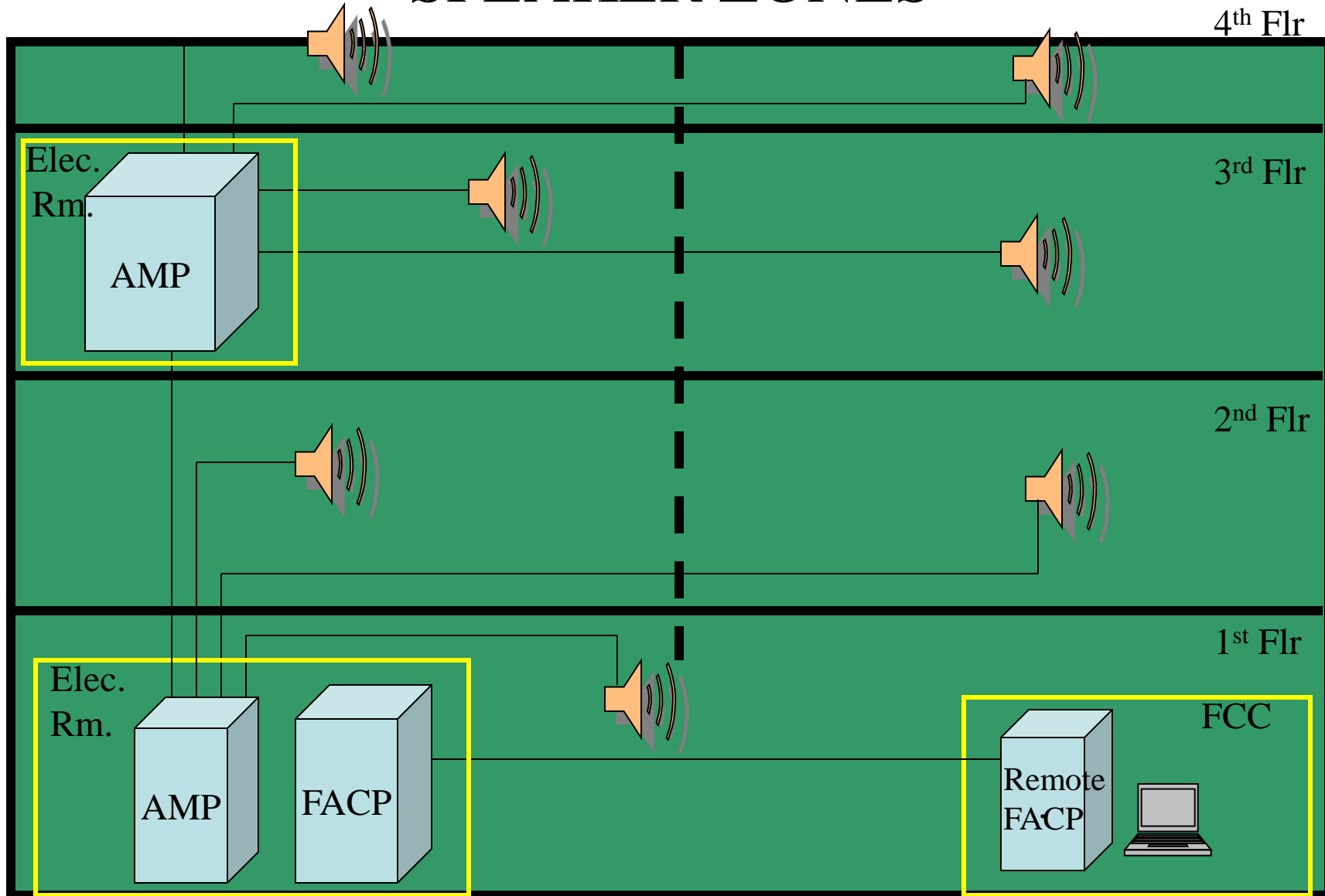


Types of CI Cable

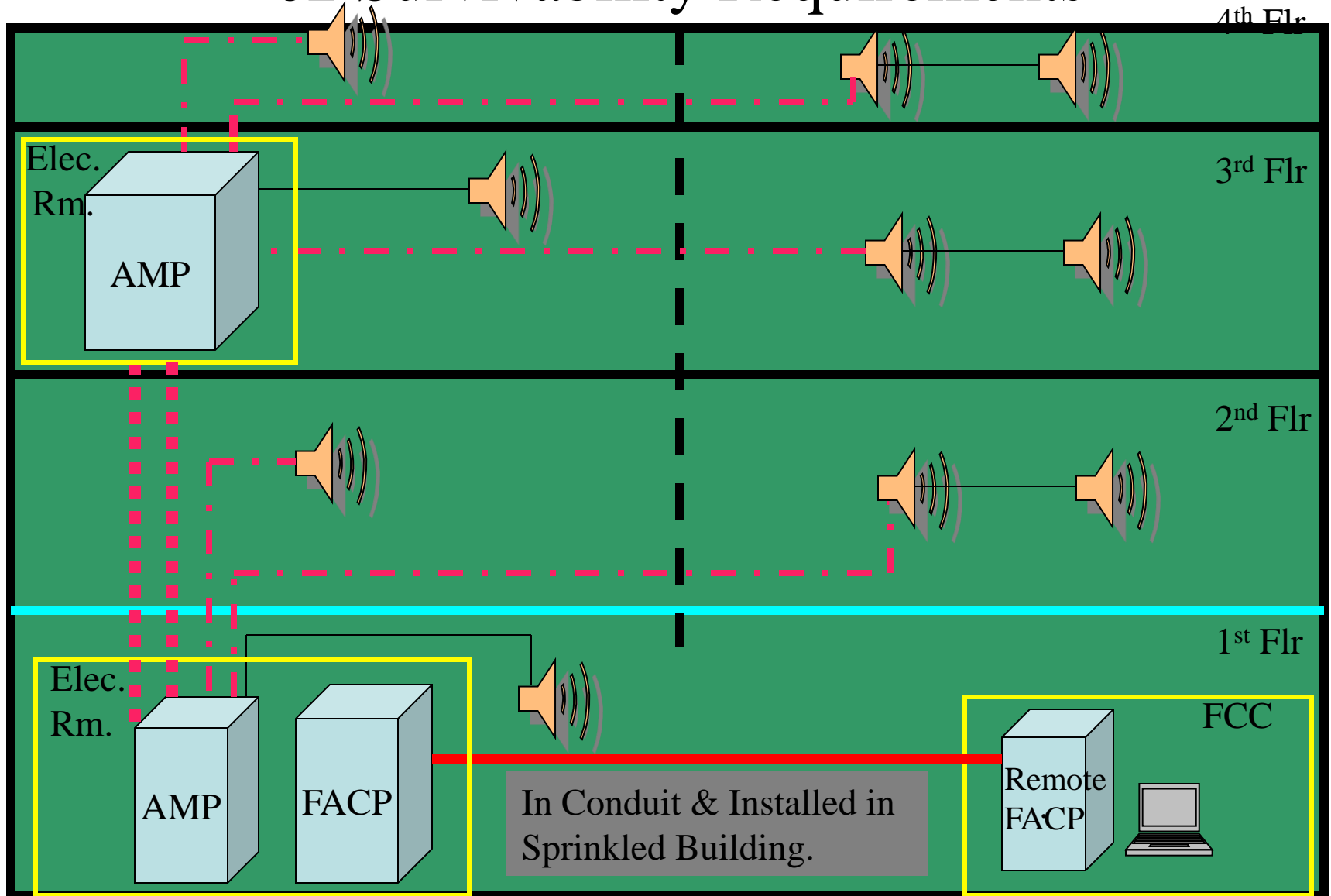
- CI – Follow NEC 760 applicable criteria for Power-Limited Fire Alarm Circuits.



SPEAKER ZONES



02 Survivability Requirements





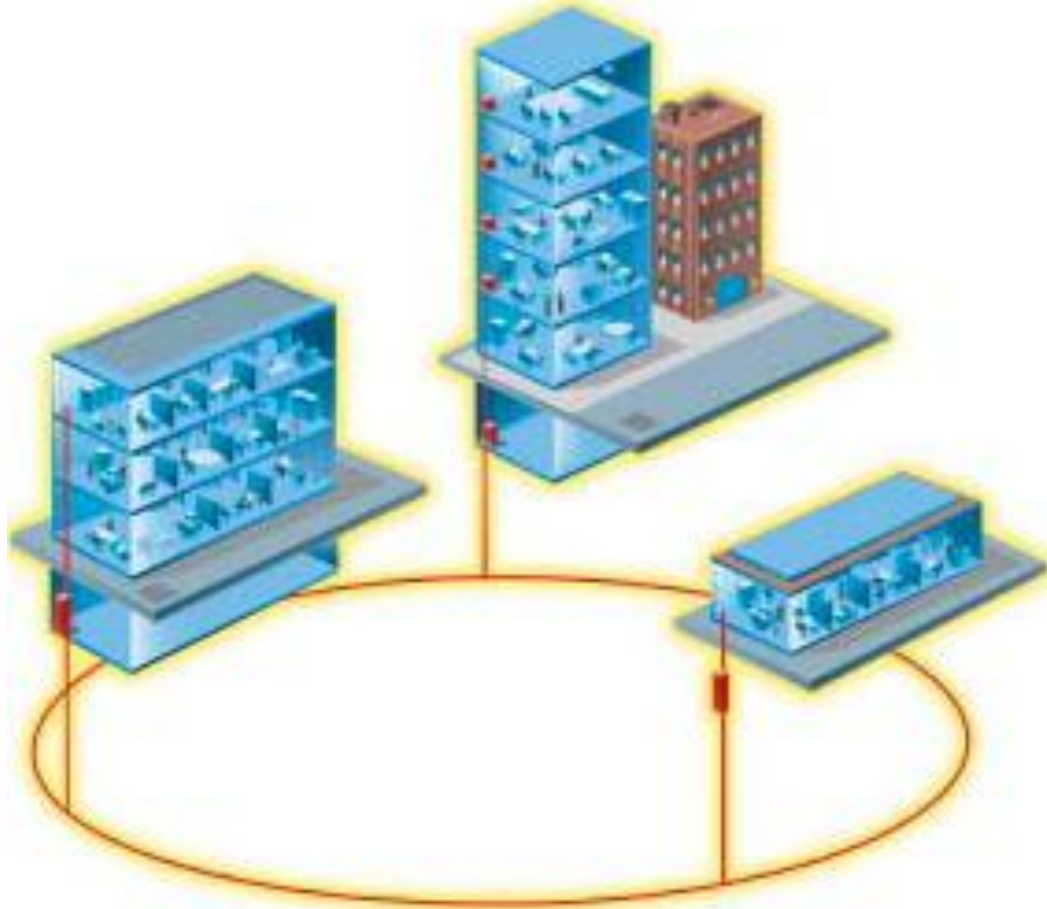
SURVIVABILITY

- **NFPA 72, 24.4.1.8:**

Applies **only** to Partial Evacuation or Occupant Relocation Systems (Selective Egress).

- Single notification appliance circuit shall not serve more than one notification zone.
- Failure of equipment or a fault on one or more conductors, shall not result in functional loss.

Panel Distribution and Configuration





Sub-Panel Distribution

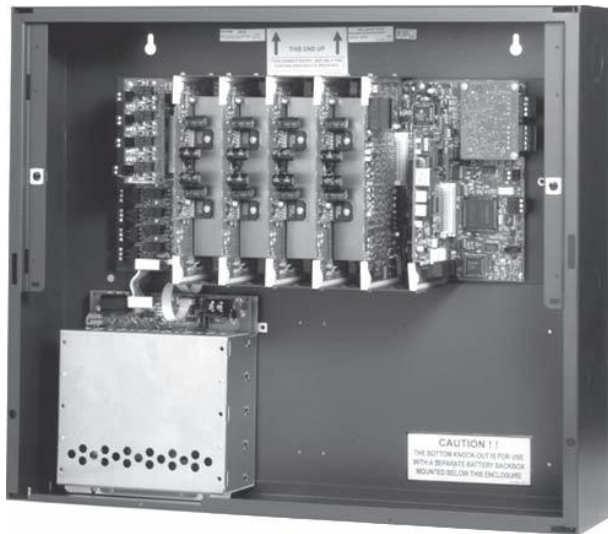
- Sub-panels maybe referred to as remote booster power supplies or slave transponders
- Typically not an intelligent component of the system
- Rely on signals from other equipment or panels to operate



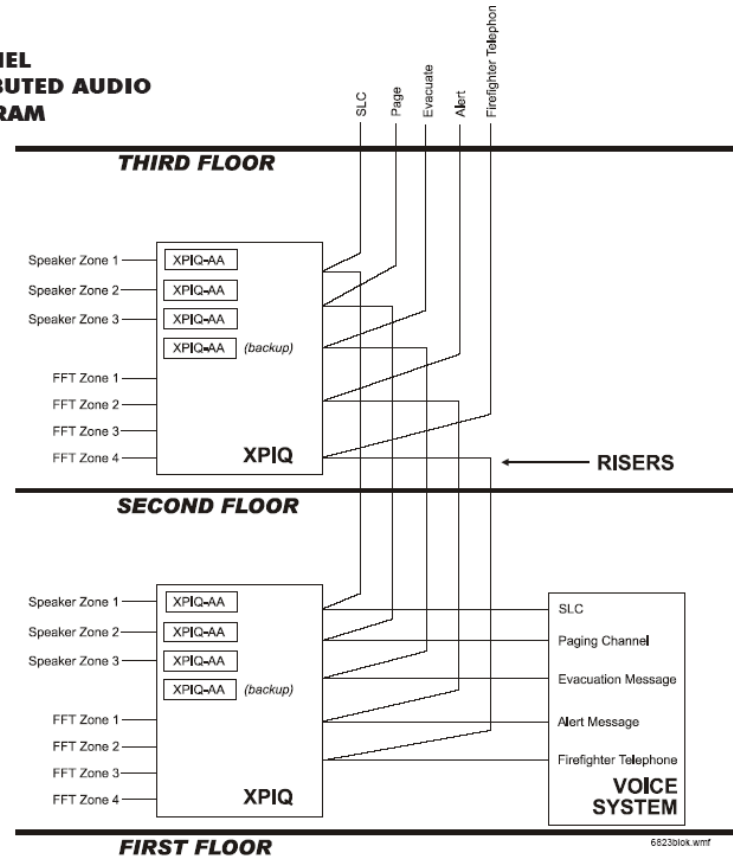
Sub-Panel Distribution

- Vertically – located on each floor and segregated circuits for the common areas from the tenant or residential areas of the floor
- Horizontally – Spaced at intervals near the extent of notification appliance circuits
- Sub panels may be configured with initiating device circuits, notification appliance circuits, auxiliary relays, signaling line circuits, power supplies, amplifiers, etc.

Sub-Panel Distribution



**FOUR-CHANNEL
XPIQ DISTRIBUTED AUDIO
BLOCK DIAGRAM**





System Designs

Voice Systems vs Non-Voice Emergency Communication Systems

Where are they required?

Assembly Occupancies > 1000

High-rise Buildings >75ft

Malls and Special Amusement Bldg.

refers to NFPA-72

for design requirements



Emergency Communication Systems

NFPA-72 – 2010 / 2013 editions

- **23.9.1* In-Building Fire Emergency Voice/Alarm Communications.** In-building fire emergency voice/alarm communications shall meet the requirements of Chapter 24.
- **24.4 One-Way Emergency Communications Systems.**
 - Messages shall be developed for each scenario developed in the emergency response plan.
 - A message template shall be developed for each message required
 - For an evacuation message, a tone in accordance with 18.4.2 shall be used with a minimum of two cycles receding and following the voice message.
 - Test messages shall clearly state the phrase “This is a test.”



Emergency Communication Systems

NFPA-72 – 2010 / 2013 editions

- **24.4.2.1 Automatic Response.**
- The in-building fire emergency voice/alarm communications system shall be used to provide an automatic response to the receipt of a signal indicative of a fire alarm or other emergency.
- When the monitoring location is constantly attended by trained operators, and operator acknowledgment of receipt of a fire alarm or other emergency signal is received within 30 seconds, automatic response shall not be required.
- If acceptable to the authority having jurisdiction, the system shall permit the application of an automatic evacuation signal to one or more evacuation signaling zones and, at the same time, shall permit manual voice paging to the other evacuation signaling zones selectively or in any combination.



Emergency Communication System

Single or Multi-Channel Voice

- Single Channel – One message throughout building
- Multi-channel – Different messages simultaneously to different parts of the facility

Selective Evacuation or General Alarm

- Selective Evacuation – Minimum Standard / Floor of alarm / above and below
- General Alarm – Evacuation tone and message to entire facility

Intelligibility vs. Audibility

- The tone is measured for audibility / the message for intelligibility
- Intelligibility measure by STI or CIS Scale – refer to annex of NFPA-72
- Simple rule – Clearly hear without echo or overlap from adjacent zone



Emergency Communication System

NFPA-72 (2013 edition)

- **The following requirements shall be met for layout and design:**
 - (1) The loudspeaker layout of the system shall be designed to ensure intelligibility and audibility.
 - (2) Intelligibility shall first be determined by ensuring that all areas in the building have the required level of audibility.
- System design shall incorporate designation of acoustically distinguishable spaces (ADS) within the occupiable areas as required in Chapter 18.
- Audibility shall be required in all areas in accordance with Chapter 18.



Emergency Communication System

FACTS AND MYTHS

Back up amplifiers are required by NFPA-72
Recommended under A10.19.2.1

MYTH

When doing relocation announcements –audible and visible notification appliances within the stairwell are on separate circuits from the notification appliances on the floor, for manual paging only

FACT – 24.4.2.8.4

A “Slow Whoop” tone may be used as an alert signal prior to and after the automatic message

MYTH – 24.4.1.3



Emergency Communication System

Non-Voice Systems

- Public Mode – 15dBA above ambient
- Private Mode – 10 dBA above ambient
- Sleeping areas – 75 dBA at the pillow
- Maximum dBA output of a device – 110dBA at the minimum hearing distance
- When the ambient noise is greater than 105dBA – Visual notification shall be used
- Ambient noise is measured over a period of time when people are present or 24-hours



Sound Levels

Average Ambient Sound Level According to Location

Location	dBA	Location	dBA
Business Occupancies	55	Storage Occupancies	30
Educational Occupancies	45	Thoroughfares, high density urban	70
Industrial Occupancies	80	Thoroughfares, medium density urban	55
Institutional Occupancies	50	Thoroughfares, rural & suburban	40
Mercantile Occupancies	40	Tower Occupancies	35
Piers & Water Surrounded Structures	40	Underground Structures	40
Places Of Assembly	55	Vehicles & Vessels	50
Residential Occupancies	35	Mechanical Rooms	85

NFPA 72 (2013 Edition) A.18.4.3 Underground structures includes windowless buildings. This was a change in 2002.



Audio Appliance Locations

- **Wall-mounted appliances shall have their tops above the finished floors at heights of not less than 90 in. and below the finished ceilings at heights of not less than 6 in. (18.4.8.1.6.1)**



Emergency Communication System

Visible Notification



FACILITIES AFFECTED BY ADA

- ADA covers places of “Public Accommodation” and breaks these down into 12 categories:
 - **Places of Exhibition or Entertainment**
 - **Stations Used For Public Transportation**
 - **Establishments Serving Food or Drink**
 - **Places of Exercise or Recreation**
 - **Sales or Rental Establishments**
 - **Social Service Center Establishments**
 - **Places of Lodging**
 - **Places of Recreation**
 - **Places of Education**
 - **Places of Public Gathering**
 - **Places of Public Display**
 - **Service Establishments**
- In effect for all new construction, and anytime the existing fire alarm system receives an upgrade* or is replaced.



NFPA 72 & ADA REQUIREMENTS

- Lamp
 - Xenon strobe or equivalent.
 - Color to be clear or nominal white.
- Intensity
 - 75 Candela (Listed to UL 1638)
 - 15/75 Candela Strobes?
- Spacing
 - No place in any room or space required to have a visual signal shall be more than 50' from the signal.
- Flash Rate
 - Minimum - 1hz, Maximum - 3hz.
- Mounting
 - 80" above floor or 6" below ceiling whichever is less.
(Wall Mount)



EQUVALENT FACILITATION

- **ADAAG Currently Allows: (2010 edition)**
 - **702 Fire Alarm Systems**
 - **702.1 General.** Fire alarm systems shall have permanently installed audible and visible alarms complying with NFPA 72 (1999 or 2002 edition) (incorporated by reference, see “Referenced Standards” in Chapter 1), except that the maximum allowable sound level of audible notification appliances complying with section 4-3.2.1 of NFPA 72 (1999 edition) shall have a sound level no more than 110 dB at the minimum hearing distance from the audible appliance. In addition, alarms in guest rooms required to provide communication features shall comply with sections 4-3 and 4-4 of NFPA 72 (1999 edition) or sections 7.4 and 7.5 of NFPA 72 (2002 edition).**EXCEPTION:** Fire alarm systems in medical care facilities shall be permitted to be provided in accordance with industry practice.



Visible Appliance Locations

- Corridors $\leq 20'$ – Maximum 15' from the end of a corridor, minimum 15cd, no more than 100' apart
- If ceiling heights exceed 30', appliance must be lowered below 30'
- Wall mount – entire lens 80" – 96" above finished floor
- Sleeping areas – if $\geq 24''$ to the ceiling 177cd / if $\leq 24''$ to the ceiling 110cd
- Public Restrooms not Private (hotel guestroom restrooms are considered private)
- Meeting rooms and common workspaces (two or more people)
- Areas accessible to the general public
- Large Assembly Spaces – Break down into small section and use room size tables
- Synchronization – when more than 2 are visible
- Line of sight / field of view – 135 degrees
- Performance based alternatives

Table 18.5.5.4.1 (a) Wall Mounted Visible Appliances

Maximum Room Size		Minimum Required Light Output [Effective Intensity (cd)]	
		One Light per Room	Four Lights per Room (One Light per Wall)
ft	m		
20 × 20	6.10 × 6.10	15	NA
28 × 28	8.53 × 8.53	30	NA
30 × 30	9.14 × 9.14	34	NA
40 × 40	12.2 × 12.2	60	15
45 × 45	13.7 × 13.7	75	19
50 × 50	15.2 × 15.2	94	30
54 × 54	16.5 × 16.5	110	30
55 × 55	16.8 × 16.8	115	30
60 × 60	18.3 × 18.3	135	30
63 × 63	19.2 × 19.2	150	37
68 × 68	20.7 × 20.7	177	43
70 × 70	21.3 × 21.3	184	60
80 × 80	24.4 × 24.4	240	60
90 × 90	27.4 × 27.4	304	95
100 × 100	30.5 × 30.5	375	95
110 × 110	33.5 × 33.5	455	135
120 × 120	36.6 × 36.6	540	135
130 × 130	39.6 × 39.6	635	185

NA: Not allowable.

Table 18.5.5.4.1 (b) Ceiling Mounted Visible Appliances

Maximum Room Size		Maximum Lens Height*		Minimum Required Light Output (Effective Intensity); One Light (cd)
ft	m	ft	m	
20 × 20	6.1 × 6.1	10	3.0	15
30 × 30	9.1 × 9.1	10	3.0	30
40 × 40	12.2 × 12.2	10	3.0	60
44 × 44	13.4 × 13.4	10	3.0	75
20 × 20	6.1 × 6.1	20	6.1	30
30 × 30	9.1 × 9.1	20	6.1	45
44 × 44	13.4 × 13.4	20	6.1	75
46 × 46	14.0 × 14.0	20	6.1	80
20 × 20	6.1 × 6.1	30	9.1	55
30 × 30	9.1 × 9.1	30	9.1	75
50 × 50	15.2 × 15.2	30	9.1	95
53 × 53	16.2 × 16.2	30	9.1	110
55 × 55	16.8 × 16.8	30	9.1	115
59 × 59	18.0 × 18.0	30	9.1	135
63 × 63	19.2 × 19.2	30	9.1	150
68 × 68	20.7 × 20.7	30	9.1	177
70 × 70	21.3 × 21.3	30	9.1	185



Fire Alarm Essentials

- Alarm notification appliances in I-1 and R-1(907.5.2.3.3)

NUMBER OF SLEEPING UNITS	SLEEPING ACCOMMODATIONS WITH VISIBLE ALARMS
6 to 25	2
26 to 50	4
51 to 75	7
76 to 100	9
101 to 150	12
151 to 200	14
201 to 300	17
301 to 400	20
401 to 500	22
501 to 1,000	5% of total
1,001 and over	50 plus 3 for each 100 over 1,000



Fire Phones and Fire Pumps

Fire Phones (Firemen's two-way communications)

- NFPA-72 – 1 jack per floor, 1 per exit stairway and Fire Pump Room
- IBC - ...Including elevators, elevator lobbies and emergency and standby power rooms. (907.2.13.2) (Replaced with Radio System per 510)

Fire Pump Monitoring

(when not in an occupied space)

- Electric Fire Pump – Pump or motor running, loss of phase, phase reversal and controller connected to alternate source (NFPA-20)
- Diesel Fire Pump – Engine is running, Controller Main Switch is off or in manual, trouble on the controller or engine (can be one or two signals) and low fuel



Auxiliary Systems

Auxiliary Systems

- **Elevator Recall – 3 relays (Primary / Alternate / Fire Hat)**
- **Elevator Shunt Trip (activates on heat or non-delayed waterflow)**
- **Smoke Control System Interfaces**
- **HVAC Systems**
- **Door Unlocking**
- **Door Release (allow doors to be closed – normally held open)**
- **Damper Closure**

Supervision – Required to the point of the control relay / relay within 3' of equipment

Non-Supervised – When failure of relay causes auxiliary systems to go to a “Fail-safe” condition



Fire Command Center

As defined by IBC – 911

- **1-hour fire barrier construction in accordance with section 706 or horizontally constructed in accordance with section 711 or both.**
- **Minimum size – 200 square feet**
- **Minimum dimension – 10 feet (you do the math – 20 X 10)**
- **Shall comply with NFPA-72**
- **Shall include....**



Fire Command Center

As defined by IBC – 911

Shall include....

- **The emergency voice alarm communication system**
- **The fire department communications unit**
- **The fire detection and alarm system annunciator unit**
- **Elevator position annunciator**
- **Status indicators and control for air handling systems**
- **Smoke control panel as required by section 909**
- **Control for unlocking stairway door simultaneously**
- **Sprinkler valve and waterflow detector displays**
- **Emergency and stand-by power status indicators**
- **Telephone for Fire Department use with controlled access**
- **Fire pump status indicators**
- **Worktable**
- **Generator supervision devices (manual start and transfer)**
- **Schematic building floor plans, including fire protection systems, means of egress, fire department access and fire fighting equipment**



Fire Alarm Essentials



- **Manual fire alarm boxes (907.4)**

- **Location**

- Manual fire alarm boxes shall be located not more than 5 feet from the entrance to each exit. - *See also NFPA-72*
 - Additional manual fire alarm boxes shall be located so that travel distance to the nearest box does not exceed 200 feet - *See also NFPA-72*

- **Height**

- The height of the manual fire alarm boxes shall be a minimum of 42 inches and a maximum of 48 inches measured vertically, from the floor level to the activating handle or lever of the box.
 - NFPA-72 defines this as the operable part of the manual fire alarm box - *See NFPA-72*

- **Color**

- Manual fire alarm boxes shall be red in color. *NFPA is Silent*

Fire Alarm Essentials

- **Manual fire alarm boxes (907.4) – cont.**

- **Signs**

- Where fire alarm systems are not monitored by a supervising station, an approved permanent sign that reads: **WHEN ALARM SOUNDS—CALL FIRE DEPARTMENT** shall be installed adjacent to each manual fire alarm box. Unless noted on the manual fire alarm box by the manufacturer

- **Protective covers**

- The building official is authorized to require installation of listed manual fire alarm box protective covers to prevent malicious false alarms or protection from physical damage.
 - Transparent or red in color with a transparent face
 - Each cover shall include proper operating instructions.
 - A protective cover that emits a local alarm signal shall not be installed unless approved.
 - Covers manufactured by STI – *Stopper II series*





Fire Alarm Essentials

- **Zones (907.6.3)**
 - Each floor shall be zoned separately, not exceed 22,500 sq. ft.
 - The length of any zone shall not exceed 300 ft. in any direction
 - Automatic sprinkler system zones shall not exceed the area permitted by NFPA 13.
- **Zoning indicator panel (907.6.3.1 and 907.6.3.2) / Alarm Annunciation (NFPA-72, 4.4.6.1)**
 - Visible annunciation by indicator lamp, alphanumeric display, printout or other approved means
 - The visual zone indication shall lock in until the system is reset and shall not be canceled by the operation of an audible alarm-silencing switch.
 - High-rise buildings, zone by floor / by device type where provided for; Smoke detector, Sprinkler water-flow device, Manual fire alarm boxes, other approved types of automatic fire detection devices or suppression systems

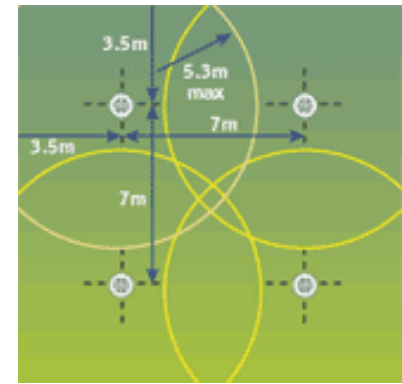


Fire Alarm Essentials



- **Fire safety functions (907.10) – cont.**
- **Detector Coverage *NFPA-72, 17.5.3.1***
 - Total (Complete) Coverage
 - Rooms, halls, storage areas, basements, attics, lofts, spaces above suspended ceilings, closets elevator shafts enclosed stairways, dumb waiters, shafts and chutes
 - If inaccessible areas contain combustibles, must be made accessible
 - May not be required in combustible blind spaces (17.5.3.1.2)
 - May not be required below open grid ceilings (17.5.3.1.3)
 - May not be required in concealed, accessible spaces above suspended ceilings used as a return air plenum (17.5.3.1.4)
 - May not be required beneath open loading docks or platforms (17.5.3.1.5)

Fire Alarm Essentials



- **Detector Coverage *NFPA-72, 17.5.3.2***
 - Partial Coverage
 - Where codes, standards, laws or AHJ require protection of selected areas only.
 - Nonrequired Coverage
 - When not required by codes, standards, laws or AHJ
 - Shall meet all the requirements of NFPA-72
 - Except the prescriptive spacing criteria.
 - When achieving specific fire safety objectives, additional detectors not necessary to achieve the object are not required.



Fire Alarm Essentials



- **Duct smoke detectors 907.3.1**
 - Connected to the building's fire alarm control panel when a fire alarm system is provided.
 - Activation of a duct smoke detector shall initiate a visible and audible supervisory signal at a constantly attended location
 - Not required to be a supervisory signal if activating building alarm notification appliances
 - Not to be used as a substitute for open area detection
- **Access (907.6.4)**
 - Access shall be provided to each fire alarm device and notification appliance for periodic inspection, maintenance and testing.
- **Fire-extinguishing systems (904.3.5)**
 - Shall be connected to the building fire alarm system, when a fire alarm system is required.
 - Alarm or Supervisory Signal (NFPA-72, 17.13)
 - Off normal conditions to report as a supervisory signal



Fire Alarm Essentials

- **Power supply (907.6.2)**

- The primary and secondary power supply for the fire alarm system shall be provided in accordance with NFPA 72.
- Exception: Backup power for single-station and multiple-station smoke alarms as required in Section 907.2.11.4.

- NFPA – 72 10.5
 - Two independent and reliable sources
 - Monitored at the point of connection for presence of voltage
 - Dedicated branch circuits that are mechanically protected
 - Secondary power supply
 - Storage battery dedicated to the fire alarm system
 - An automatic starting engine driven generator serving the dedicated branch circuit **AND** storage batteries dedicated to the fire alarm system with 4-hours of capacity





Device Placement Rules

- Smoke Detectors
- Heat Detectors
- Manual Fire Alarm Box
- Audible / Visible Notification



Spacing & Installation General Rules

The location and spacing of smoke detectors result from engineering evaluation based on the guidelines detailed in NFPA 72 and engineering judgment. Some of the conditions included in the evaluation are the following:

1. Ceiling shape and surface
2. Ceiling height
3. Configuration of contents in the area to be protected
4. Burning characteristics of the combustible materials present
5. Ventilation
6. Ambient environment
7. Early Warning



Smoke Detector Spacing

NFPA 72 – 17.7.3.2.3.1 Spot Type Smoke Detectors

17.7.3.2.3.1* In the absence of specific performance-based design criteria, smoke detectors shall be permitted to be located using 9.1 m (30 ft) spacing.



Smoke Detector Spacing

- **Spacing and Location**
 - 30 foot Guide
 - Modifications to Guide
 - Ceiling Configuration and Height
 - $H < 12'$, $D < 1' = \frac{1}{2} R$ Perpendicular
 - $H > 12'$, $D > 1' =$ Each Beam Pocket
 - Sloped Ceilings
 - Air Movement
 - Air Changes
 - Effect of Grills (Supply and Return)



Spacing & Installation General Rules

(1) For ceilings with beam depths of less than 10 percent of the ceiling height ($0.1 H$), smooth ceiling spacing shall be permitted. Spot-type smoke detectors shall be permitted to be located on ceilings or on the bottom of beams.



Spacing & Installation General Rules

(2) For ceilings with beam depths equal to or greater than 10 percent of the ceiling height ($0.1 H$), the following shall apply:

(a) Where beam spacing is equal to or greater than 40 percent of the ceiling height ($0.4 H$), spot-type detectors shall be located on the ceiling in each beam pocket.

(b) Where beam spacing is less than 40 percent of the ceiling height ($0.4 H$), the following shall be permitted for spot detectors:

- i. Smooth ceiling spacing in the direction parallel to the beams and at one-half smooth ceiling spacing in the direction perpendicular to the beams
- ii. Location of detectors either on the ceiling or on the bottom of the beams



Spacing & Installation General Rules

(3)*For beam pockets formed by intersecting beams, including waffle or pan-type ceilings, the following shall apply:

(a) For beam depths less than 10 percent of the ceiling height ($0.1 H$), spacing shall be in accordance with 17.7.3.2.4.2(1).

(b) For beam depths greater than or equal to 10 percent of the ceiling height ($0.1 H$), spacing shall be in accordance with 17.7.3.2.4.2(2).



Spacing & Installation General Rules

(4)*For corridors 15ft (4.6 m) in width or less having ceiling beams or solid joists perpendicular to the corridor length, the following shall apply:

(a) Smooth ceiling spacing shall be permitted.

(b) Location of spot-type smoke detectors on ceilings, sidewalls, or the bottom of beams or solid joists



Spacing & Installation General Rules

(5) For rooms of 900 ft² (84 m²) or less, the following shall be permitted:

(a) Use of smooth ceiling spacing

(b) Location of spot-type smoke detectors on ceilings or on the bottom of beams



Smoke Detector Spacing

- **Special Spacing Problems**
 - Uneven ceilings or ceilings crossed by joists or beams.
 - Sloped or Peaked ceilings.
 - High ceilings.
 - High storage racks.
 - Partitions.
 - Stratification.
 - Uninsulated roofs.



Other Smoke Detector Spacing

- Smoke detectors installed within 21' of the centerline of elevator doors for elevator recall
- Area smoke detectors can be used for control of dampers and doors
- When area smoke detection is used in corridors, smoke detectors are not required within 5' of smoke door assemblies provided that any corridor smoke detector causes the smoke doors to release
- Smoke detectors required for the protection of panels when panels are located in unattended areas – this includes remote booster power supplies
- Smoke detectors installed within 10 ft of an entrance to a smoke proof enclosure for mechanically ventilated and pressurized enclosures (NFPA-101, section 7.2.3.10 2000 and 2006 editions)

Other Smoke Detector Spacing

NFPA-72 (2010) A17.7.5.4.2.2

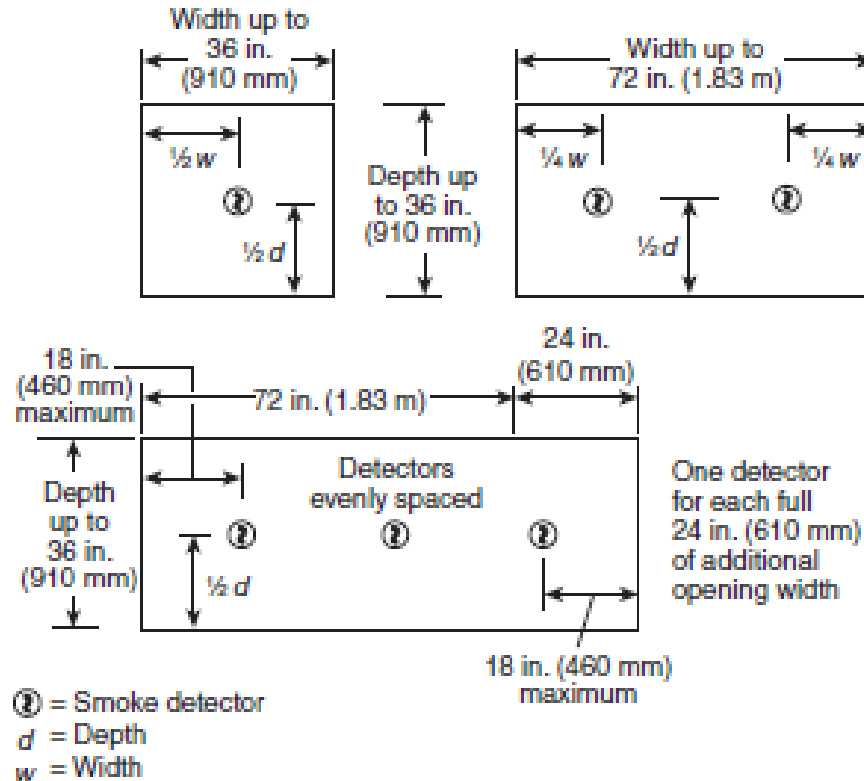


FIGURE A.17.7.5.4.2.2(a) Location of a Smoke Detector(s) in Return Air System Openings for Selective Operation of Equipment.



Other Smoke Detector Spacing IBC 717.3.3.2

- Smoke Detectors for Damper Actuation
 - Within 5' damper
 - On either side of a smoke barrier door opening
 - 5' horizontally of a damper
 - Within a corridor
 - Area detection in all areas serviced by the mechanical (HVAC) system



Spacing & Installation General Rules

Spot Type Smoke & Heat Detectors Located on Ceiling Surface*

- Not > 12 in. down from ceiling surface
- Not < 4 in. from side walls
- Not on sidewalls between 4 in. and 12 in. down from the ceiling surface
- Not Recessed
- All points on the ceiling shall have a detector within a distance equal to 0.7 times the listed (or selected) spacing

**Exceptions for solid joist construction, beam construction and high ceilings. Reference NFPA 72 for specific location and spacing details.*



Spacing & Installation General Rules

Smoke Detectors for Door Release NFPA-72 (2010) 17.7.5.6.5.3.

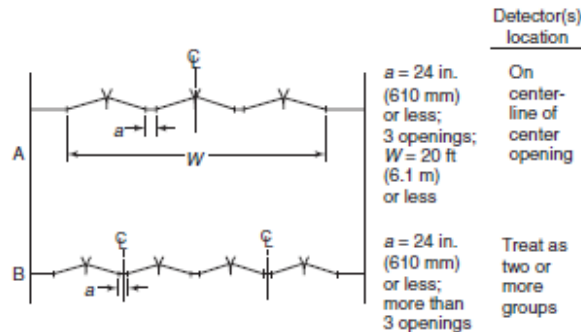


FIGURE 17.7.5.6.5.3(B) Detector Location Requirements for Group Doorways.

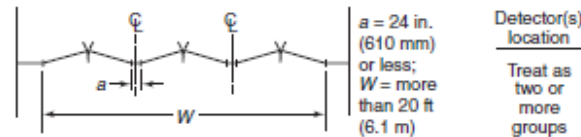


FIGURE 17.7.5.6.5.3(C) Detector Location Requirements for Group Doorways over 20 ft (6.1 m) in Width.

Depth of wall section above door	Door frame mounted	Ceiling or wall mounted
d	Smoke detector listed for frame mounting or as part of closer assembly	Smoke detector ceiling or wall mounted
0-24 in. (0-610 mm) on both sides of doorway	<p>A</p> <p>Detector or detector closer mounted on either side</p>	<p>B</p> <p>One ceiling-mounted detector on either side or one wall-mounted detector on each side</p>
Over 24 in. (610 mm) on one side only	<p>C</p> <p>Detector or detector closer mounted on higher side</p>	<p>D</p> <p>One ceiling-mounted detector on higher side or one wall-mounted detector on each side</p>
Over 24 in. (610 mm) on both sides	<p>E</p> <p>Detector or detector closer mounted on either side</p>	<p>F</p> <p>Two detectors required</p>
Over 60 in. (1.52 m)	G Might require additional detectors	

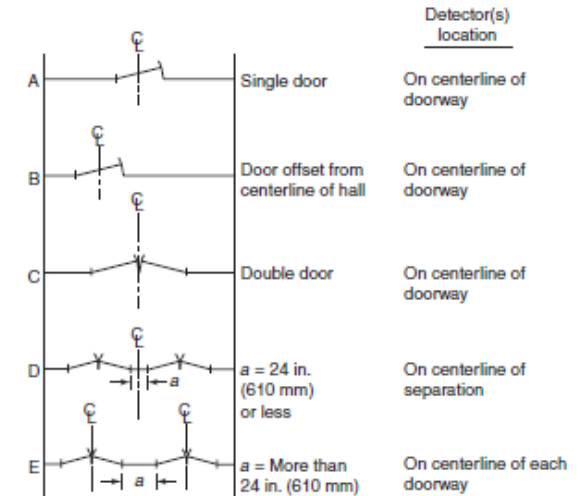


FIGURE 17.7.5.6.5.3(A) Detector Location Requirements for Single and Double Doors.

FIGURE 17.7.5.6.5.1(A) Detector Location Requirements for Wall Sections.



Heat Detectors

- Modification to Selected Spacing
 - Ceiling Height
 - Reduced Spacing for Ceilings above 10 feet
 - Ambient Conditions
 - Plume and Ceiling Jet Consideration (see Annex A)
 - Ceiling Configuration
 - Beams and Joists
 - Sloped Ceilings
 - Atriums
 - Annex B



Manual Fire Alarm Boxes

17.4.4 The operable part of each manual fire alarm box shall be not less than 42 in. (1.07 m) and not more than 48 in. (1.22 m) above floor level.

17.14.5 Manual fire alarm boxes shall be installed so that they are conspicuous, unobstructed, and accessible.

17.14.6 Manual fire alarm boxes shall be located within 60 in. (1.52 m) of the exit doorway opening at each exit on each floor

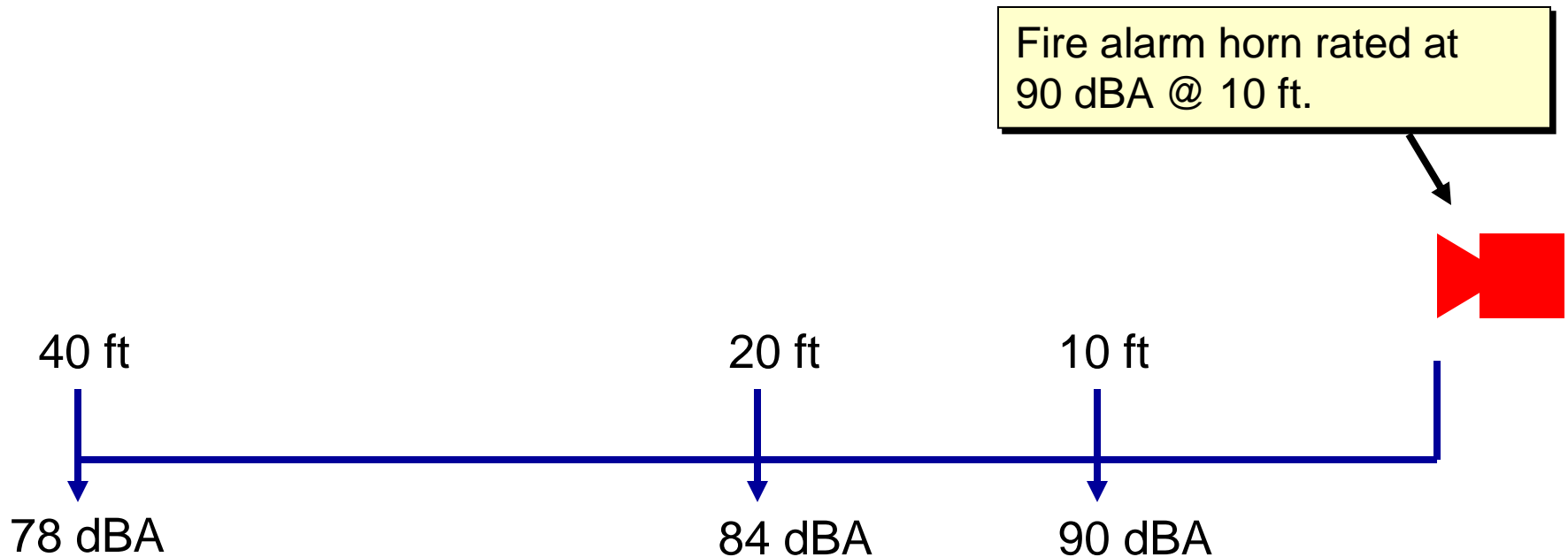
▪
17.14.7 Manual fire alarm boxes shall be mounted on both sides of grouped openings over 40ft (12.2 m) in width, and within 60 in. (1.52 m) of each side of the opening.

17.14.8* Additional manual fire alarm boxes shall be provided so that the travel distance to the nearest fire alarm box will not be in excess of 200ft (61.0 m), measured horizontally on the same floor.



Sound Loss “Rule Of Thumb”

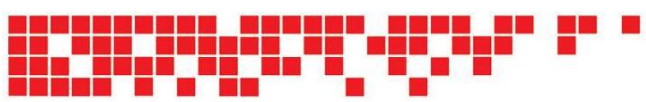
- Each time the distance doubles to the sound source you incur a 6 dBA loss.





Sound Loss Barriers

- **Typical sound loss at 1000 hertz.**
 - Non-insulated Stud Wall 41 dBA
 - Open Doorway 4 dBA
 - Typical Interior Door 11 dBA
 - Typical Fire Rated Door 20 dBA
 - Typical Door With Gasket 24 dBA



EXAMPLES OF FA PITFALLS



















Thank you!

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