Fire Alarm Training Manual

POTTER
The Symbol of Protection

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Foreword

The history of fire detection and alarm in the United State dates back to the 1800s with the first standards. Since then the science and technology behind fire detection and alarm continues to improve. The primary purpose for fire detection and alarm is the reduction of loss of life and property from fire.

The modern fire alarm is constantly evolving as the technology around detection and notification expands. However, the basic functions of the fire alarm system remain unchanged. There are two key pieces to every fire alarm system; detection, local notification. Most fire alarm systems also provide off premises reporting to either the fire department or a monitoring company that reports the alarm to the local fire department.

This manual will give a brief overview to the pieces of the fire detection and alarm system. These parts include the symbols used for drafting plans, types of detection, control panels and types of notification. In addition, this manual will discuss the required documentation that is required for the permit, installation and maintenance process.

The core pieces of every fire alarm system are the same. The systems can become quite complex with multiple panels networked together over an entire campus. However the basic parts that make up the most complex system are the same as the most simple. Therefore, by learning the basics it can be built upon to assemble the parts and pieces through training for the large addressable networked systems.

Table of Contents

Glossary/Definitions

Addressable Device: A fire alarm system component with discreet identification that can have its status individually identified, or that is used to individually control other functions.

Air Sampling-Type Detector: A detector that consists of a piping or tubing distribution network from the detector to the areas being protected. A fan in the detector housing draws air from the protected area back to the detector. The air is analyzed for products of combustion

Alarm Signal: A signal indicating an emergency requiring immediate action, such as a signal indicative of a fire.

Alarm Verification: A feature of some automatic fire detection and alarm systems to reduce unwanted alarms. Smoke detectors must report alarm conditions for a minimum period of time, or confirm alarm conditions within a given time period after being reset, to be accepted as a valid alarm initiating signal.

Analog Initiating Device: An initiating device that transmits a signal indicating varying degrees of condition, such as smoke obscuration levels. As contrasted with a conventional initiating device which can only indicate an "on/off" condition

Annunciator: A unit containing two or more indicator lamps, alphanumeric displays, or other equivalent means in which each indication provides status information about a circuit, condition, or location.

Approved: Acceptable to the "authority having jurisdiction".
***Note*:** The National Fire Protection Association does not approve, inspect or certify any installations, procedures, equipment, or materials, nor does it approve or evaluate testing laboratories.

Authority Having Jurisdiction: Organization, office or individual responsible for "approving" equipment, an installation or a procedure.

Automatic Extinguishing System Operation Detector: A device that detects the operation of an extinguishing system by means appropriate to the system employed. Including but not limited to water flow devices.

Automatic Extinguishing System Supervision: Devices that respond to abnormal conditions that could affect the proper operation of an automatic sprinkler system or other fire extinguishing system. Including but not limited to control valves, pressure levels, room temperature, etc.

Automatic Fire Detectors: A device designed to detect the presence of fire or the products of combustion. Including but not limited to heat detectors, flame detectors, smoke detectors.

Auxiliary Fire Alarm System: A system connected to a municipal fire alarm system for transmitting an alarm of fire to the public fire service communication center. Fire alarms from an auxiliary system are received at the public fire service communication center on the same equipment and by the same methods as alarms transmitted manually from municipal fire alarm boxes located on streets.

Breakglass Fire Alarm Box: A fire alarm box in which it is necessary to break a special element in order to operate the box.

Ceiling: The upper surface of a space, regardless of height. Areas with a suspended ceiling would have two ceilings, one visible from the floor and one above the suspended ceiling.

Ceiling Height: The height from the continuous floor of a room to the continuous ceiling of a room or space.

Ceiling Surfaces: Ceiling surfaces referred to in conjunction with the locations of initiating devices are as follows:
A} Beam Construction: Ceilings having solid nonstructural members projecting down from the ceiling surface more than 4 in. and spaced more than 3 ft., center to center.
B} Girders: Girders support beams or joists and run at right angles to the beams or joists. When the top of girders are within 4 in. of the ceiling, they are a factor in determining the number of detectors and are to be considered as beams. When the top of the girder is more than 4 in. from the ceiling, it is not a factor in detector location.

Central Station: A supervising station that is listed for central station service.

Central Station Fire Alarm System: A system or group of systems in which the operations of circuits and devices are transmitted automatically to, recorded in, maintained by, and supervised from a listed central station.

Class A Circuit: Class A refers to an arrangement of monitored initiating device, signaling line, or notification appliance circuits, which would permit a single open or ground on the installation wiring of these circuits from causing loss of the systems intended function.

Class B Circuit: Class B refers to an arrangement of monitored initiating device, signaling line, or notification appliance circuits, which would permit a single open or ground on the installation wiring of these circuits to cause loss of the systems intended function.

Combination Detector: A device that either responds to more than one fire phenomenon or employees more than one operating principle to sense one of these phenomenon. Typical examples are combination smoke/heat detectors or a combination rate of rise and fixed temperature heat detector.

Compatibility Listed: A specific listing process that applies only to two wire devices [such as smoke detectors] designed to operate with certain control equipment.

Digital Alarm Communicator Receiver [DACR]: A system component that will accept and display signals from digital alarm communicator transmitters [DACT] sent over public switched telephone network.

Digital Alarm Communicator System [DACS]: A system in which signals are transmitted from a digital alarm communicator transmitter [DACT] located at the protected premises through the public switched telephone network to a DACR.

Digital Alarm Communicator Transmitter [DACT]: A system component at the protected premises to which initiating devices are connected. The DACT will seize the connected telephone line, dial a pre-selected telephone number to connect to a DACR, and transmit signals indicating a status change of the initiating device.

Display: The visual representation of output data other than printed copy.

Evacuation: The withdrawal of occupants from a building.
***Note*:** Evacuation does not include relocation of occupants within a building.

End Of Line Device: A device such as a resistor or diode placed at the end of a class B circuit to maintain supervision.

End Of Line Relay: A device used to supervise power [usually for 4-wire smoke detectors] and installed within or near the last device on an initiating circuit.

Evacuation Signal: Distinctive signal intended to be recognized by the occupants as requiring evacuation of the building.

Exit Plan: Plan for the emergency evacuation of the premises.

Fire Alarm Control Unit [Panel]: A system component that receives inputs from automatic and manual fire alarm devices and may supply power to detection devices and transponders or
off-premises transmitters. The control unit may also provide transfer of power to the notification appliances and transfer condition of relays or devices connected to the control unit. The fire alarm control unit can be a local unit or a master control unit.

Fire Rating: The classifications indicating in time [hours] the ability of a structure or component to withstand fire conditions.

Fire Safety Functions: Building and fire control functions that are intended to increase the level of life safety for occupants or to control the spread of harmful effects of fire.

Flame Detector: A device that detects the infrared, ultraviolet, or visible radiation caused by fire.

Four Wire Smoke Detector: a smoke detector that has two distinct circuits used in its operation. The first circuit provides resettable power for the detector and the second circuit monitors the contact on the device. These types of devices are not listed for compatibility.

Heat Detector: A device that detects abnormally high temperature or rate of temperature rise.

Initiating Device: A system component that originates transmission of a change of state condition, such as a smoke detector, water flow switch, etc.

Initiating Device Circuit: A circuit to which automatic or manual initiating devices are connected.

Ionization Smoke Detector: A smoke detector that has a small amount of radioactive material which ionizes the air in the sensing chamber, thus rendering it conductive and permitting a current to flow between two charged electrodes. This gives the sensing chamber an effective electrical conductance. When smoke particles enter the sensing chamber they decrease the conductance of the air by attaching themselves to the ions, causing a reduction in mobility. When conductance is reduced to less than a predetermined level, the detector responds.

Level Ceilings: Those ceilings that are actually level or have a slope of less than 1 1/2 in. per foot.

Light Scattering: The action of light being reflected and/or refracted off particles of combustion for detection by a photoelectric smoke detector.

Line Type Detector: A device in which detection is continuous along a path. Examples include projected beam smoke detectors and heat sensitive cable.

Listed: Equipment or materials included in a list published by an organization acceptable to the “authority having jurisdiction” and concerned with product evaluation, that maintains periodic inspection of production of listed equipment or materials and whose listing states either that the equipment or material meets appropriate standards or has been tested and found suitable for use in a specific manner.
Note: The means for identifying listed equipment may vary for each organization concerned with product evaluation, some of which do not recognize as listed unless it is also labeled. The “authority having jurisdiction” should utilize the system employed by the listing organization to identify a listed product.

Local Fire Alarm System: A local system sounding an alarm at the protected premises as the result of the operation of automatic or manual initiating devices.

Manual Station [pull station]: A manually operated device used to initiate an alarm signal.

National Fire Protection Association [NFPA]: Administers the development of and publishes codes, standards, and other materials concerning all phases of fire safety.

Nationally Recognized Testing Laboratory (NRTL) – a laboratory that is recognized by the Occupational Safety and Health Administration as meeting the necessary qualifications specified in the Code of Federal Regulations. Common NRTL in the United States that deal with fire alarm products are FM Approvals, Intertek Testing Services (ETL) and Underwriters Laboratories Inc. (ULI)

Non restorable Initiating Device: A device whose sensing element is designed to be destroyed in the process of operation.

Notification Appliance: A fire alarm system component such as a bell, horn, speaker, strobe, etc. that provides an audible or visible output or both.

Notification Appliance Circuit (NAC): A circuit directly connected to a notification appliance.

Obscuration: A reduction in the atmospheric transparency caused by smoke. Usually expressed in percent per foot.

Particles of Combustion: Substances resulting from the chemical process of a fire.

Photoelectric Smoke Detector: A smoke detector utilizing a light source and a photosensitive sensor so arranged that the rays from the light do not normally shine on the photosensitive sensor. When smoke enters the light path, some of the light reflects off the smoke onto the sensor, causing the detector to respond.

Proprietary Fire Alarm System: An installation of fire alarm systems that serve contiguous and noncontiguous properties under one ownership from a proprietary supervising station located at the protected property.

Rate Of Rise Heat Detector: A device which will respond when the temperature rises at a rate exceeding a predetermined amount [usually about 15 degrees per minute].

Remote Station Fire Alarm System: A system installed in accordance with NFPA 72 to transmit alarm, trouble and supervisory from one or more protected premises to a remote location at which appropriate action is taken.

Restorable Initiating Device: A device whose sensing element is not ordinarily destroyed in the process of operation. Restoration may be manual or automatic.

Shall: In NFPA literature indicates a mandatory requirement.

Should: In NFPA literature indicates a recommendation or that which is requested but not required.

Signaling Line Circuit: A circuit or path between any combination of circuit interfaces, control units, or transmitters over which multiple system input signals or output signals, or both are carried.

Sloping Ceiling: Ceilings having a slope of more than 1 1/2 in. per foot.
A: Sloping - Peaked Type, Ceilings in which the slope is in two directions from the highest point. Curved or domed ceilings may be considered peaked.
B: Sloping - Shed Type, Ceilings in which the high point is at one side with the slope extending toward the opposite side.

Smooth Ceiling: A surface uninterrupted by continuous projections such as solid joists, beams or ducts, extending more than 4 in. below the ceiling surface.

Solid Joist Construction: Ceilings having solid structural or nonstructural members projecting down from the ceiling surface a distance of more than 4 in. and spaced at intervals 3 ft. or less, center to center.

Spot Type Detector: A device whose detecting element is concentrated at a particular location. Examples include certain smoke and heat detectors.

Stratification: An effect that occurs when air containing smoke particles or products of combustion is heated by burning material, rises until it reaches a level where there is no longer a temperature difference between it and the surrounding air.

Story: the portion of a building included between the upper surface of a floor and the upper surface of a floor or roof next above.

Supervision: The ability to detect a fault condition in the installation wiring which would prevent normal operation of the fire alarm system.

Supervisory Signal: A signal indicating an “off normal” condition on the fire suppression system. Examples include, tamper indication, low air pressure and low building temperature.

Thermal Lag: The difference between the operating temperature of a thermal detector and the actual air temperature.

Two-Wire Smoke Detector: A smoke detector that initiates an alarm condition on the same pair of wires that supply power to the detector.

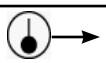
Symbols for Control Panels

Symbol	Description
	Control panel-basic shape
FACP	Fire alarm control panel
FSA	Fire systems annunciator alarm
FAA	Annunciator panel-from NECA 100, symbol 7.006
FTR	Fire alarm transponder or transmitter
ESR	Elevator status/recall
FAC	Fire alarm communicator
FSCP	Fire system control panel
FSCP$_{HL}$	Halon
FSCP$_{CO_2}$	Carbon dioxide
FSCP$_{DC}$	Dry chemical
FSCP$_{FO}$	Foam
FSCP$_{WC}$	Wet chemical
FSCP$_{CA}$	Clean agent
FSCP$_{WM}$	Water mist
FSCP$_{DL}$	Deluge sprinkler
HVA	Control panel for heating, ventilation, air conditioning, exhaust stairwell pressurization, or similar equipment
MIC	Remote MIC for voice evacuation system
EVAC	Voice evacuation panel-from NECA 100, symbol 7.008
FATC	Fire alarm terminal cabinet-from NECA 100, symbol 7.009
FCS	Fire command system
FACU	Fire alarm control unit
SAP	Sprinkler alarm panel
RP	Relay alarm panel
DGP	Data gathering panel
AMP	Amplifier rack

Symbols for Signal Initiating Devices and Switches

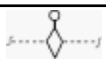
Symbol	Description	Comments
	Manual station	Basic shape
 HL	Manual station-Halon	
 CO_2	Manual station-carbon dioxide	
 DC	Manual station-dry chemical	
 FO	Manual station-foam	
 WC	Manual station-wet chemical	
 P	Manual station-pull station	
 CA	Manual station-clean agent	
 WM	Manual station-water mist	
 DL	Manual station-deluge sprinkler	
 MB	Fire alarm master box	
 DK	Drill key	
 PRE	Preaction system	
	Fire service or emergency telephone station	Basic shape
 A	Fire service or emergency telephone station-accessible	
 J	Fire service or emergency telephone station	
 H	Fire service or emergency telephone station-handset	
	Abort switch	Basic shape
 HL	Abort switch-Halon	
 CO_2	Abort switch-carbon dioxide	
 DC	Abort switch-dry chemical	

Symbols for Signal Initiating Devices and Switches

Symbol	Description	Comments
 FO	Abort switch-foam	
 WC	Abort switch-wet	
 CA	Abort switch-clean agent	
 WM	Abort switch-water mist	
 DL	Abort switch-deluge sprinkler	
 PRE	Abort switch-preaction system	
 EPO	Abort switch-emergency power off	
	Automatic detection and supervisory devices	Basic shape
	Heat detector (thermal detector)	Symbol orientation not to be changed
 R/F	Heat detector-combination rate-of-rise and fixed temperature	
 R/C	Heat detector-rate compensation	
 F	Heat detector-fixed temperature	
 R	Heat detector-rate-of-rise only	
	Heat detector-line-type detector (heat sensitive cable)	
 R	Smoke/heat detector	

***** Symbols are copied from the National Fire Protection Association Standard 170, Standard for Fire Safety and Emergency Symbols

Symbols for Signal Initiating Devices and Switches

Symbol	Description	Comments
	Smoke detector	Symbol orientation not to be changed
 P	Smoke detector-photoelectric products of combustion detector	
 I	Smoke detector-ionization products of combustion detector	
 BT	Smoke detector-beam transmitter	
 BR	Smoke detector-beam receiver	
 ASD	Smoke detector-air sampling	
	Smoke detector for duct	
	Gas detector	
	Flame detector	Indicate ultraviolet (UV), infrared (IR), ultraviolet/infrared (UV/IR), or visible radiation-type detectors; symbol orientation not to be changed
 F	Flame	
 UV	Ultraviolet	
 IR	Infrared	
 UV/IR	Combination ultraviolet/infrared	
 VR	Visible radiation	
	Flow detector/switch	
	Pressure detector/switch	Specify type-water, low air, high air, and so forth; symbol orientation not to be changed
	Lever detector/switch	Symbol orientation not to be changed
	Tamper detector	Alternate term-tamper switch
	Valve with tamper detector/switch	
 VR	Output relay	
 HT	Temperature switch-high temperature	
 LT	Temperature switch-low temperature	

***** Symbols are copied from the National Fire Protection Association Standard 170, Standard for Fire Safety and Emergency Symbols

Symbols for Indicating Appliances

Symbol	Description	Comments
	Mini-horn	
	Gong	
	Water motor alarm (water motor gong)	Shield optional
	Bell-vibrating	
	Bell-vibrating/strobe	
	Bell-single stroke gong	
	Bell-single stroke gong/strobe	
	Bell-trouble	
	Bell chime	
	Horn with light as separate assembly	
	Horn with light as one assembly	
	Rotating beacon to indicate emergency response points	
	Remote alarm indicating and test switch	

Symbols for Related Equipment

Symbol	Description	Comments
	Door holder	
	Addressable input module	
	Addressable output module	

***** Symbols are copied from the National Fire Protection Association Standard 170, Standard for Fire Safety and Emergency Symbols

The Difference Between Codes and Standards

The terms code and standard are often used interchangeably, however each has a very different meaning. Codes are the written rules and regulations that are adopted as law by an Authority Having Jurisdiction for enforcement. These codes are the minimums that must be complied with to provide a reasonable degree of life, health and fire safety. The codes are written based on the standards. Generally, consensus committees produce standards that set the minimum level of how to install a certain type of protection. Standards are focused on one particular system or building component and give guidance on the proper installation, maintenance and testing.

Code:
Codes specify circumstances **WHEN and WHERE** a given type of protection is required. Codes are *MINIMUM* requirements, they can and are encouraged to be exceeded.

Examples of Codes:
NFPA 30 Flammable and Combustible Liquids Code
NFPA 54 National Fuel Gas Code
NFPA 70 National Electrical Code
NFPA 101 Life Safety Code
NFPA 5000 Building Construction and Safety Code
IBC International Building Codes

Standard:
Standards detail **HOW** the protection required by the code is to be achieved.

Examples of Standards:
NFPA 10 Standard for Portable Fire Extinguishers
NFPA 13 Standard for the Installation of Sprinkler Systems
NFPA 14 Standard for the Installation of Standpipes and Hose Systems
NFPA 20 Standard for the Installation of Stationary Pumps for Fire Protection
NFPA 72 National Fire Alarm Code (This is actually a standard even though it is called a code)

NFPA 72 will explain how a fire alarm system is supposed to be installed. It does not determine what type of equipment such as smoke detectors, pull stations, horns, strobes, etc. should be used. That is determined by the adopted building code.

The terms **“Shall”** and **“Should”** are often used.
“Shall” Indicates a mandatory requirement.
“Should” Indicates a recommendation.

Determining Fire Alarm Requirements
The building code or ordinance that is enforced in the particular area usually determines the fire alarm requirements. Most codes will determine the fire alarm & sprinkler requirements based on the occupancy classification of the building.

If NFPA 101 Life Safety Code is the adopted Code being enforced:
Each Occupancy Class will give direction to the extent of the fire alarm system and will refer the authority to Section 9.6 Fire Detection, Alarm and Communications Systems for exact installation requirements. In addition, the Occupancy Class will define the exact level of protection and with refer the authority to Section 9.7 Automatic Sprinklers and Other Extinguishing Equipment for the exact installation requirements.

Section 9.6.1.1
The “General” Provision
Specifies the conditions under which a fire alarm is required in that particular occupancy.

Section 9.6.2
The “Signal Initiation” Provision
Specifies the three means for initiating an alarm: Manual, Automatic and Extinguishing System Operation and the provisions for the activation and location of the initiating devices. It is typical in many occupancy chapters that the “Initiation” provisions call for “Manual means in accordance with 9.6.2”. When referred to Section 9.6, only the applicable portions of chapter 9 apply for that occupancy.

Section 9.6.3
The “Occupant Notification” Provision
Specifies “Occupant Notification shall be provided to alert occupants of a fire or other emergency” and how those signaling requirements are to be met. The building code may refer to the requirements for the use of door holders, smoke and fire dampers. It may require voice evacuation, visible signals, audible signals and may permit or prohibit the use of “Pre-Signal” features. All of the notification and automatic functions fall under the notification portion.

Section 9.6.2.1.0
The "Detection" Provision
Specifies requirements for automatic detection. This section should always be reviewed, even if the building is not required to have a fire alarm system under the general statement for that occupancy class.

There are two types of detection devices automatic and manual. The automatic detection devices include smoke detectors, heat detectors and water flow switches. Any device that will activate the fire alarm panel or directly activate a notification appliance without human intervention is considered automatic. Manual fire detection is generally pull stations that directly activate the fire alarm or suppression system. Manual fire alarm systems require human intervention for the system to operate.

Section 9.6.4
The "Emergency Forces Notification" Provision
The fire alarm system may have requirements to be monitored to provide immediate notification to the fire department or fire brigade of a fire. This section outlines the different types of monitoring stations as outlined by NFPA72.

Section 9.7 "Automatic Sprinklers and Other Extinguishing Equipment"
The occupancy class will dictate the minimum requirement for the installation of fire sprinklers, automatic extinguishing systems, fire extinguishers and standpipes. Section 9.7 will give the appropriate NFPA Standard to follow as well as trade-offs that are allowed.

In addition to the installation requirements, NFPA 101 requires that the fire suppression equipment is inspected, tested and maintained.

Sprinkler System Supervision Includes:
Water Supply Control Valves
Alarm Line Supervision
Fire Pump Status
Water Tank, Levels and Temperature
Low and High Air Pressure on Dry Pipe Systems
Building Temperature

Water supply control valves shall be supervised to obtain a distinctive signal when in an off normal position, within 2 revolutions of the hand wheel, or when the valve has moved one fifth from its normal position.

The switch shall not restore to a normal condition throughout the entire travel of the valve, until it is restored to a fully open position.

A Supervisory signal must be visually or audibly distinctive from both Alarm and Trouble signals.

Water flow **and** supervisory devices **cannot** be connected on the same initiating circuit so that the closing of a valve is annunciated as a "trouble" condition.

Fire Alarm Signals

Alarm - A signal indicating an emergency that requires immediate action, such as a signal indicative of a fire.
1. Automatic water flow device
2. Manual fire alarm station (pull station)
3. Automatic fire detectors (smoke or heat detectors)

Supervisory – A signal indicating the need for action in connection with the supervision of guard tours, the fire suppression systems or equipment, or the maintenance features of related systems.
1. Control valve switch
2. High/low air pressure switch
3. Water tank level and temperature switches
4. Low water pressure for public water supplies
5. Low building temperature switch
6. Alarm line valve position

Trouble - A signal indicating a problem with the fire control panel or associated wiring which may render the system inoperable.
1. Loss of primary power (120VAC)
2. Loss of secondary power (battery)
3. A break in the supervised wiring to an initiating device, indicating appliance or extinguishing agent release device

Types of Systems

Conventional
Conventional fire alarm systems are comprised of initiating and notification zones. The number of initiating zones (initiating

device circuits) defines how large the system can be. The zones are generally a specific function (pull station, water flow switch, etc.) or cover a geographical area for smoke and heat detection. Most conventional zones use a two-wire system with an end of line resistor for supervision.

Conventional zones support two types of devices: dry contact and powered. The dry contact type devices are devices that use a normally open switch that closes on activation and create an alarm. These devices include pull stations, heat detectors, four wire smoke detectors, flow switches and sprinkler supervisory switches. The powered devices on conventional zones use voltage from the panel for power and subsequently must be listed for compatibility. In addition, there are a maximum number of smoke detectors that can be installed on any zone. Most panels are listed with numerous smoke detectors and the exact number of smokes per panel varies with each manufacturer. Powered devices operate on a “Go/No Go” in that they are either normal or they are in alarm condition.

The Annex of NFPA 72 recommends that the coverage area for a single zone does not exceed 20,000 square feet and does not extend beyond a floor of a building. In addition, a maximum of five waterflow switches and a maximum of twenty supervisory switches can be connected to a single zone. The common devices in a system should be grouped together on a zone. A trouble condition on a zone should indicate some sort of wiring or device problem.

Addressable
Addressable fire alarm systems assign each initiating device a discrete and unique identification (address). In addition to the address, the panel will usually have the ability to have a tag to further identify the address (i.e. Address 1, Front Lobby, back door, hallway, etc). Some addressable systems consider each point as a separate zone. Addressable devices are similar to conventional devices in that they are either in alarm or in a normal condition.

Addressable systems utilize a Signaling Line Circuit (SLC) to communicate with detectors, modules and auxiliary devices to complete the system. These types of systems have more versatility and features compared to the conventional systems. Modules and additional circuit boards allow the addressable systems to expand to perform more remote relay functions, dry contact monitoring, remote power control, releasing service and conventional zone monitoring.

The addressable systems also allow for mapping of inputs to outputs. This allows the end-user to control the panel in such a way that specific smoke detectors can control certain output functions.
Addressable fire systems have a number of advantages over conventional systems. The wiring for each zone must return to the panel on conventional systems, whereas the addressable systems use a single pair of wires and connect to all of the initiating devices and control modules on the addressable system. In addition, when a trouble occurs with the addressable system, the information from the panel will help the installer determine where the problem has occurred, if a device is missing or if the wrong type of device is installed. Conversely, the conventional system will show a trouble condition and the zone where the trouble occurred. Also, when a device reaches the alarm level, the conventional system will give the area of alarm, the addressable system will tell what device is in alarm and where that device is located.

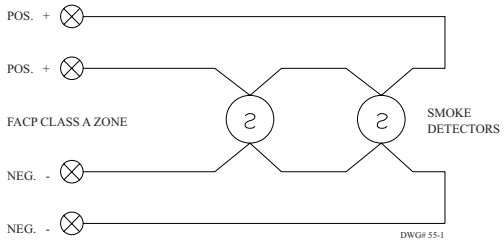
Analog/Addressable
Analog/Addressable systems are wired and have the same advantages of a straight addressable system, but offer additional features that assist in the testing and maintenance of a system. Instead of using a detector that is either in alarm or normal, the Analog/Addressable system uses a sensor for detecting a level of alarm. The panel and the sensors communicate and the panel will determine, based on preprogrammed levels, if the device is normal, dirty or in alarm. The analog systems also use modules for dry contact inputs, power outputs and relays, however these have no analog value to communicate back to the panel, just a normal or off normal. The installer can run reports from the analog system and determine if devices are within sensitivity levels within the listed parameters as required by the testing requirements of NFPA 72.

Annuciators for fire alarm systems are available in one of three variations; LED, LCD and graphic. The LED annunciators are generally simplistic devices that indicate what zone is in alarm, AC power, Trouble conditions and possibly some control features such as Silence and System Reset. The LCD annunciators give a text display indicating the status of the fire alarm system. Most LCD displays also allow for common control functions and usually some programming. The graphic displays are large boards that have a footprint of the entire building usually by floor with LED’s indicating different devices mounted within the building. Annunciators are required by the AHJ to assist the emergency responders in quickly pinpointing the area of alarm and responding to that area to verify whether a fire exists. Some AHJ’s have a preference to which type of and the exact location of where annunciators are to be installed.

Monitoring for Integrity

Since fire alarm systems are used as a life safety and property protection systems they must be designed and installed with a high level of reliability. The reliability of the fire alarm system is built into the panel in the means of operation and the minimum requirements to achieve a listed and recognized product.
The core concept behind the reliability of a fire alarm system is based on monitoring for the integrity of the circuits. This is achieved by the fire alarm control unit supervising each zone, circuit or point. This is accomplished by end of line resistors, end of line relays and two way communications between the panel and devices throughout the building.

Circuit Types
Fire alarm circuits are wired either Class A or Class B and both have advantages and disadvantages. The Class A circuit utilizes a pair of wires to attach to all of the devices and then a pair returns back to the panel. NFPA 72 requires that a minimum distance separates the outgoing and return wires on class A wiring. If a break occurs anywhere in the circuit, every device is still active due to the redundant circuit paths. There are four wires, two supplying power to the front of the circuit and two supplying power from the end of the circuit.

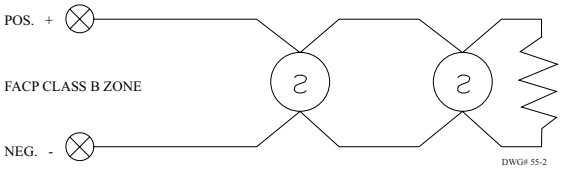


As described earlier, the conventional systems use the end of line resistor to monitor the status of the zones. If a wire is broken or a device removed, the panel detects the lack of the end of line resistor and annunciates a trouble condition. Similarly most notification appliance circuits use an end of line resistor as well. These circuits are monitored for open circuits as well as short circuits. In addition, both circuits are monitored for ground faults or a high amount of resistance to ground potential. A ground can impede the proper operation of a circuit.

Detectors and notification appliances must be wired to ensure supervision of the device. Removal of the detector head or notification appliance must cause a trouble condition on the panel.

Conventional panels send a small amount of power out to the initiating devices and end-of-line resistor. The panel measures the amount of current being consumed. If the current is in the normal or midrange the panel is normal. If the panel detects too little current that is indicative of an open and the panel indicates a trouble condition. If the panel sees too high of a current the panel interrupts that as a short and indicates an alarm condition. Dry contact devices such as pull stations and heat detectors put a direct short on the initiating circuit and put the panel into alarm.

The most common installation is Class B utilizing two wires that connect to each device and an end-of-line resistor for wiring supervision. Unlike Class A circuits, Class B circuits will not fully operate when a wire break occurs. Every device down stream of the break will be unavailable until the wire problem is corrected. The panel will, however indicate a trouble signal.



The Signaling Line Circuits (SLC) in addressable systems have additional devices that can isolate short circuits so the loop will still fully operate. These types of installations are generally required in government installations, some hospitals and some schools. These systems are more expensive to install and may require additional equipment, however there is greater redundancy built into the system.

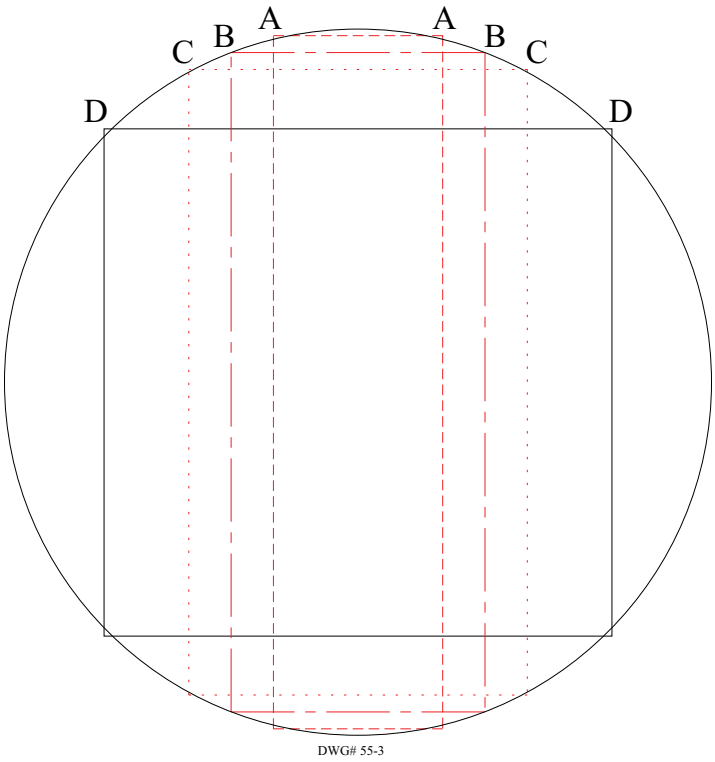
Initiating Devices

Smoke Detector Placement
Detector placement is critical to early warning functions. In order to provide an effective early warning of a developing fire situation, smoke detectors should be installed in all areas of the protected premises. The location, quantity and zoning of detectors should be engineered to provide maximum life safety.

Defining the smoke chamber
The continuous, smoke resistant perimeter boundary of a room or area to be protected between the upper surface of the floor and the lower surface of the ceiling. The smoke barrier does not have to be a solid structure from floor to ceiling. A solid structure that extends 18” or more from the ceiling would constitute a smoke barrier.
Open “grid” material is considered solid when:
* The openings are less than 1/4” in the least dimension
* The thickness of the material exceeds the least dimension
* The openings constitute less than 70% of the area of the perforated material

For areas with smooth and flat ceilings that are ten feet in height or lower:

- A spacing of 30 feet shall be permitted as a guide for smoke detector placement. Smoke detectors do not have a listed spacing.
- All points on the ceiling shall have a detector within a distance equal to .7 times the selected spacing.
- Spot type detectors shall be located on the ceiling not less than four inches from a side wall or, if mounted on a side wall, between four and twelve inches down from the ceiling to the top of the detector.
- The distance between detectors shall not exceed their selected spacing. There shall be detectors within one-half the selected spacing, measured at right angles, from any side wall.
- Detectors shall not be recessed mounted unless specifically listed for recess mounting.
- Spot type smoke detectors must be a minimum 36” from air diffusers, and may not be in a direct airflow exceeding their air velocity, regardless of distance.
- Detectors shall be supported independently of their attachment to circuit conductors.
- Spot type detectors should be mounted at least 6’ from florescent lights.
- Except in cases where “stratification” is expected, detectors shall never be mounted more than 12” below ceiling level.



DWG# 55-3

Rectangles
A = 10’ x 41’
B = 15’ x 39’
C = 20’ x 37’
D = 30’ x 30’

If 30 feet is used as a guide, any square that will fit inside of a circle with a 21foot radius could be covered with a single smoke detector.

Note that an area 10ft. by 41ft. can be covered by one smoke detector using 30ft. spacing.

Smooth Ceiling Spacing - Spot type Smoke Detectors

Spacing of 30 feet may be used as a guide, consult manufacturers instructions.
NFPA72, 2007 5.7.3.2.3.1

Solid Joist and Beam Construction

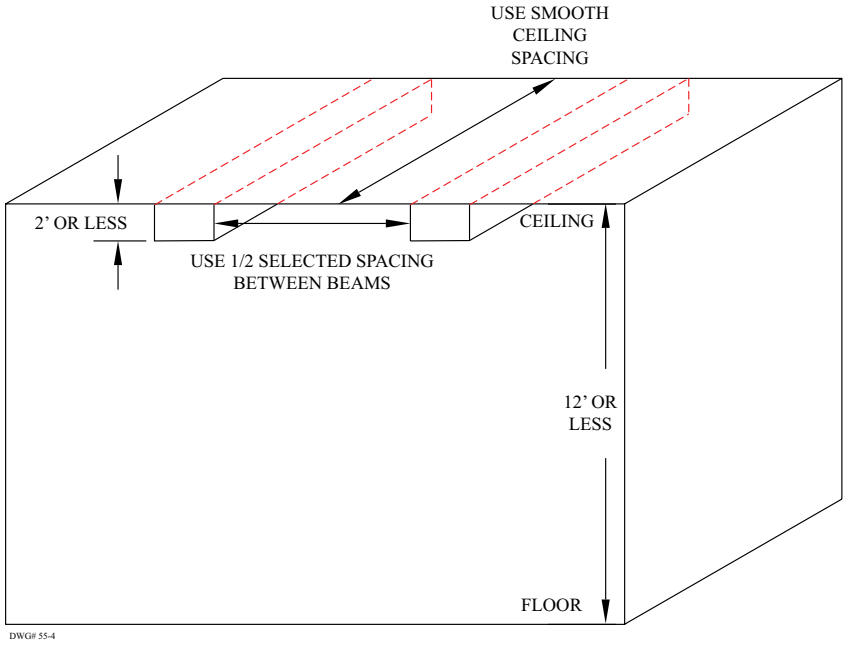
Solid joists shall be considered equivalent to beams for smoke detector placement.
NFPA72 2007, 5.7.3.2.4.1

Flat Ceilings

A. For ceiling heights of 12 feet or less and beam depths of 2 feet or less:
Use smooth ceiling spacings running in the direction of the beams, and 1/2 the smooth ceiling spacing for the direction perpendicular to the beams. Spot type detectors may be installed either on the ceiling or on the bottom of the beams. NFPA 72 2007, 5.7.3.2.4.3

B. For ceilings higher than 12 feet or beams extending down more than 2 feet, spot type detectors shall be located on the ceiling in every beam pocket.
NFPA 72 2007, 5.7.3.2.4.2
See NFPA72 2007, 5.7.3.2.4.3 for sloped ceilings with beams.

Beamed Ceilings



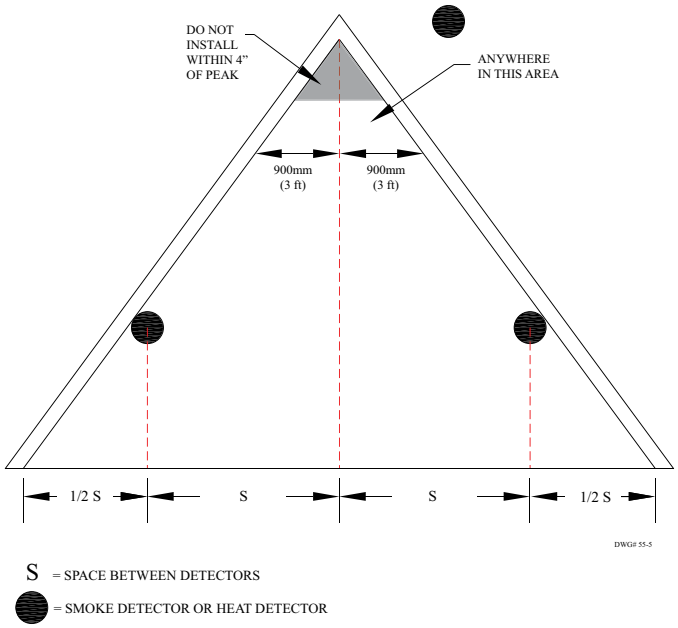
Sloped/Peaked Ceilings

Sloped Ceiling - Having a slope of more than 1.5 inches per foot
Peaked Ceiling - Having a slope of more than 1.5 inches per foot in two directions from it's highest point. May include domed or curved ceilings.

To determine if a ceiling is sloped or peaked:
Divide the difference between the height of the low wall and the highest point of the ceiling in inches by the width of the building in feet. If the answer is 1.5 or less, the ceiling is considered flat.(Highest point of ceiling in inches) minus (top of low wall in inches) divided by (width of building in feet)

Smoke and heat detector placement on sloped ceilings:
Make all measurements parallel to the floor, not along the ceiling.
Locate the point on the ceiling which is 3 ft. from the high sidewall. Locate the first detector anywhere within that three feet, except the four inches nearest the wall. The remaining detectors shall be located in the remaining ares on the basis of the horizontal projection of the ceiling, spaced in accordance with the type of construction.

Smoke and heat detector placement on peaked ceilings:
Measure three feet horizontally from the peak in both directions. Follow the guidelines for sloped ceilings.



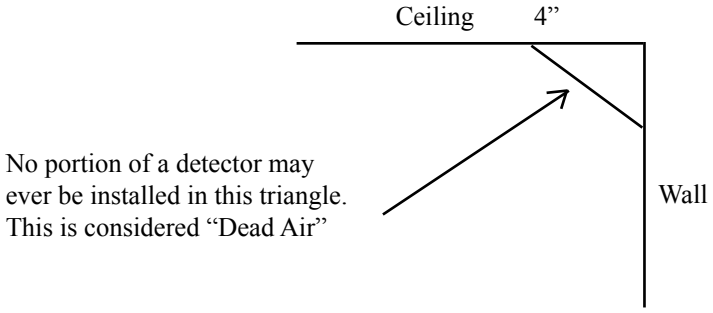
Raised Floors and Suspended Ceilings

Spaces between raised floors and above suspended ceilings shall be treated as separate rooms for smoke detector spacing purposes. Detectors installed beneath raised floors or above suspended ceilings used for environmental air, shall not be used in lieu of providing detection within the room. NFPA 72 2007, 5.7.3.7

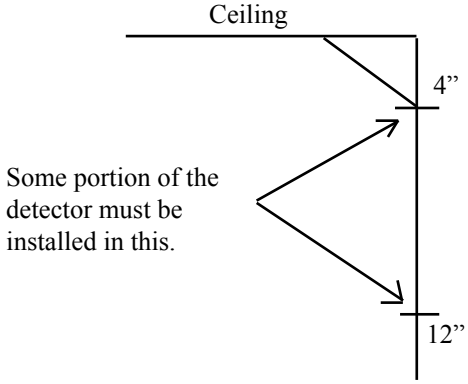
To minimize dust collection, smoke detectors, where installed under raised floors, detectors shall only be mounted in an orientation in which they been listed. NFPA 72 2007, 5.7.3.2.2

Detectors shall not be installed until after the construction cleanup of all trades is complete and final.
Exception: Where required by the authority having jurisdiction for protection during construction. Detectors that have been installed during construction and found to have a sensitivity outside the listed and marked sensitivity range shall be cleaned or replaced in accordance with Chapter 10 at completion of construction. NFPA 72 2007, 5.7.1.11

Smoke detectors can be installed on the ceiling or wall. When installed on a ceiling, no portion of the detector may be within 4" of a sidewall.



When installed on a wall, no portion of the detector mey be installed within 4" of the ceiling. Some portion of the detector must be within 4"-12" of the ceiling.



Residential Smoke Detector Requirements

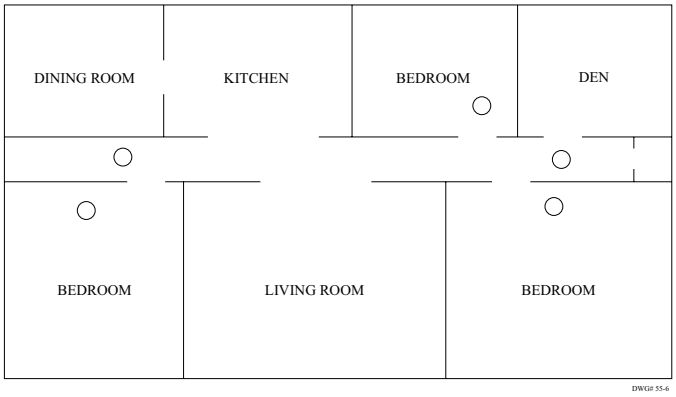
Smoke detectors are required in all residential occupancies. Over 80% of all fire deaths occur in residential occupancies. All residential occupancies need a minimum of a single station smoke detector on each floor of the building. At a minimum these devices are to battery operated, however it is preferred that they are powered from line voltage and have a battery back up. The problem with the batteries is that the reliability of the device relies on intervention of the homeowner/occupant.

In new construction, smoke detectors are required on all levels of the home, in each bedroom and within ten feet of each bedroom door. High ceilings with a slope greater than 1 foot in 8 feet must have a detector installed in the high side of the room. This includes vaulted and cathedral type ceilings. Garages, crawl spaces and unfinished attics are exempt from smoke detector requirements due to the high probability of false alarms. The detectors are not listed to operate in these types of environments. Smoke detectors installed in basement should be installed in close proximity to the stairs due to the fact that smoke has a tendency to travel upward. The smoke detectors are required to have primary power from line voltage and required to have a battery back up. The batteries still have to be changed and are recommended to be changed twice a year. Smoke detectors in new residential occupancies are required to be interconnected so that when one sounds, all of the devices sound.

Some installation errors reduce the reliability of smoke detectors due to frequent false and nuisance alarms. Smoke detectors installed in or near kitchens, garages and bathrooms often false alarm due to fluctuations in the environment. Smoke detectors can not tell the difference between engine exhaust and smoke from a fire. In addition, smoke detectors in kitchens will detect the by-products of cooking and will activate unintentionally. Similarly, steam from bathrooms will set detectors in hallways off. In addition, if smoke detectors are installed in areas where the temperature is too low or too high, the device will not operate as intended. Smoke detectors installed to close to air diffusers and HVAC vents will cause unwanted alarms due to dirt entering the detector.

A majority of the smoke detectors installed in residential occupancies utilize the ionization chamber method of smoke detection. In some cases these devices have been found to not have response times that are deemed acceptable. Because of this, some states and local jurisdictions have adopted codes that require either a photoelectric smoke detector or dual technology device that utilizes a photoelectric and ionization principle smoke detection.

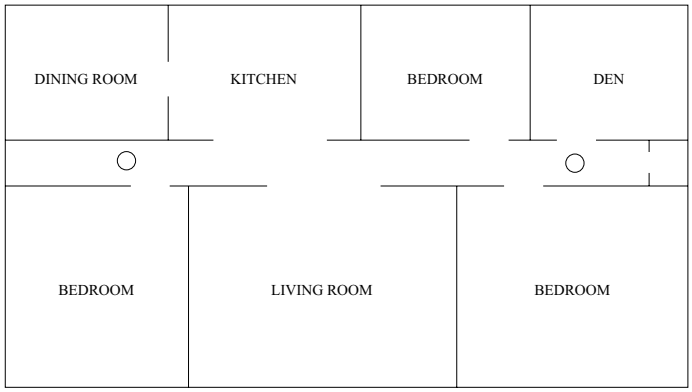
Smoke Detectors Locations New Construction
Smoke Detectors are required in every bedroom and outside of the bedroom in the immediate vicinity. If the bedrooms are separated a detector must be installed outside of each area of the home that has bedrooms.



◯ = SMOKE DETECTOR LOCATION

Smoke Detector Location in Existing Homes

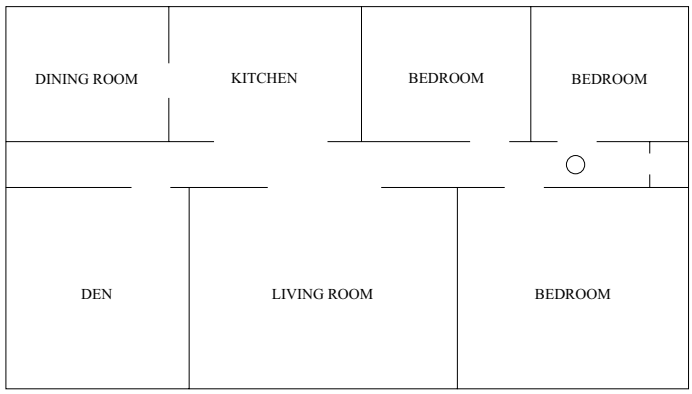
Smoke Detectors should be installed outside of the bedrooms in the immediate vicinity of the bedrooms. When all of the bedrooms are located in one area, one detector is sufficient. If the bedrooms are separated, multiple detectors are required. In addition, at least one detector shall be installed per floor.



◯ = SMOKE DETECTOR LOCATION

Smoke Detector Locations in Existing Homes

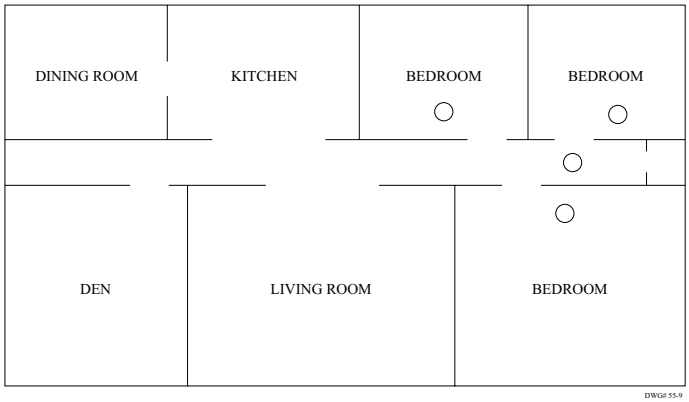
In the drawing below, all of the bedrooms are in the same vicinity therefore only one detector is required in the immediate vicinity.



◯ = SMOKE DETECTOR LOCATION

Smoke Detectors Locations in New Construction

Smoke detectors are required to be installed in the immediate vicinity of the bedrooms. When all of the bedrooms are located in one area, one detector is sufficient in addition to one detector in each bedroom.



◯ = SMOKE DETECTOR LOCATION

Heat Detectors

1. Heat detectors are **not considered life safety equipment**, they are for property protection only.
2. Heat detectors should be installed where conditions are not favorable for smoke detectors such as kitchens, garages, attics, boiler rooms, etc.
3. The maximum ceiling temperature in the area where the heat detector is installed must be 20 degrees or more below the operating temperature of the heat detector.

Heat Detectors Only

Buildings with a ceiling height of 10 feet to 30 feet the heat detector spacing shall be reduced:

Above	Up To	Precent of Listed Spacing
0	10	100%
10	12	91%
12	14	84%
14	16	77%
16	18	71%
18	20	64%
20	22	58%
22	24	52%
24	26	46%
26	28	40%
28	30	34%

Ceiling Height

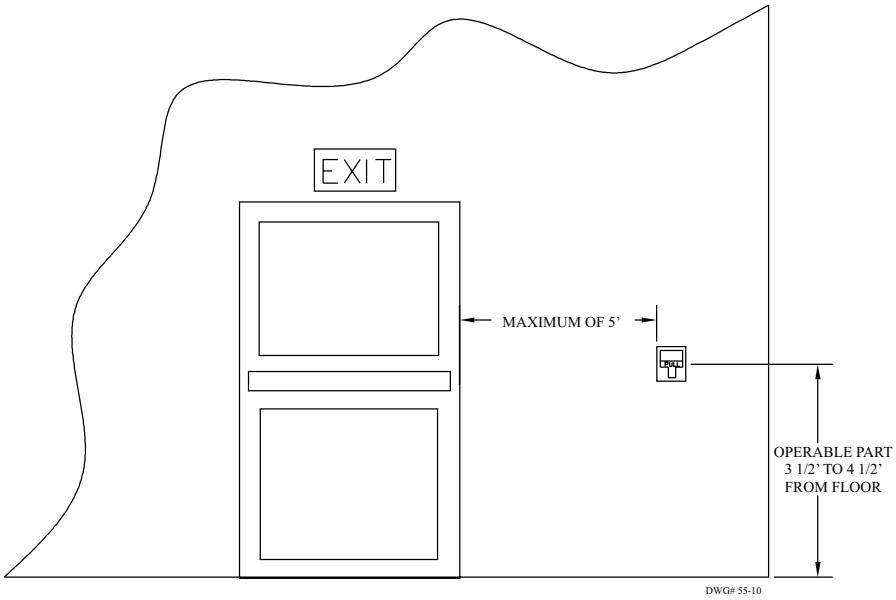
Heat Detector Selection Guide (from NFPA 72)			
Temp Classification	Temp Rating Range °F	Max Ceiling Temp °F	Color Code
Low*	100 - 134	20 Below**	Uncolored
Ordinary	135 - 174	100	Uncolored
Intermediate	175 - 249	150	White
High	250 - 324	225	Blue
Extra High	325 - 399	300	Red
Very Extra High	400 - 499	375	Green
Ultra High	500 - 575	475	Orange

* Intended only for installation in controlled areas. Units shall be marked to indicate maximum ambient installation temperature
** Maximum ceiling temperature has to be 20 degrees Fahrenheit or more below the detector rated temperature.
Note: The difference between the detectors rated temperature and the maximum ambient ceiling temperature should be as small as possible to minimize response time.

Manual Alarm Stations

The building code sets the requirements for where pull stations are required, how to install them and the stipulations for installing. A minimum of one manual station or pull station is required to be installed anytime a fire alarm or monitored sprinkler system is installed. The pull station must be installed where indicated by the Authority Having Jurisdiction. In addition, the pull station must be designed and installed to meet the American's with Disabilities Act where applicable.

Pull stations must be installed according to NFPA 72, the National Fire Alarm Code. The building codes will indicate the exact requirements for the location of pull stations within a building. The operable part of the pull station must be mounted between 3.5 feet and 4.5 feet from the floor. In addition, the device must be securely mounted to prevent damage and false activation. The pull station must be conspicuously located and contrasted so they are easy to locate. Pull stations should be located within 5 feet of each egress on each floor. In addition, there should not be more than 200 feet of travel distance between pull stations when required throughout a building.



Manual pull stations are the only fire alarm devices required to be red in color. These devices are only to be used as a manual fire alarm initiation device or suppression system activation device. These devices are required to be marked with the word "FIRE" to indicate the purpose of the manual station. Other manual stations are available for ancillary building functions such as emergency notification, egress stations in access control systems, nurse calls as well as many other specialized applications. These applications cannot use a standard fire alarm pull station. Most manual station manufactures can provide the specialized devices for the specific applications.

In addition to only using fire alarm pull stations for fire alarm systems, the manual station need to be listed with the area being installed. If a pull station is installed in an outdoor or wet environment, the device must be tested and listed for that application. In addition, special hazard manual stations are manufactured for intrinsically safe environments.

Pull stations are available in a number of configurations that prevent accidental operation. Most pull stations are the single action type in which a single pull down activates the device. These types are very prone to malicious and accidental activation. Most pull stations are available in a dual action model that requires two actions to activate, usually a push then pull or a lift and pull. These types are less susceptible to accidental activation. Break glass stations or covers are other options that are also available to eliminate the malicious and accidental alarms. The covers offer a large number of options including horns and seals. In addition, the weatherproof covers allow a regular pull stations to be installed in areas that ordinarily would not be suitable. If a pull station is installed outdoors, it must be listed for outdoor operation and temperature limits.

Notification

Audible and Visual Notification Appliances

The building code, AHJ or other governing code or standard determines the requirements for occupant notification. This notification could be audible only, visual only or both. Once the notification requirement is determined by the appropriate source, the required equipment shall be installed in accordance with the enforced version of NFPA 72.

Generally, notification is considered as horns, bells and strobes. However, notification also includes voice evacuation systems, alarm printers, annunciators, textual displays and graphic displays. The standard dictates where and how these devices are installed. Building codes call for the installation of voice evacuation systems. Insurance providers and certifying entities will usually require the alarm printers. Authorities Having Jurisdiction will require the annunciators and graphic displays. Often, the graphic displays are located near the front entrance to the building and provide a complete view of the building with alarm points. Usually, remote annunciators will be located near the entrance where the emergency forces will enter the building. Some authorities require that the annunciators utilize light emitting diodes (LEDs) and other will allow liquid crystal displays (LCDs).

Almost all installations require the use of audible signals through horns, bells or chimes. However, some cases exist that require visual indicators. Visual indicators are accomplished through the use of flashing strobe lights. In some instances, a rotating beacon is used for outdoor installations for warning on large industrial and commercial complexes. When the notification appliances are required, calculations must be performed to ensure that the panel's notification circuit will power all of the devices. In addition, the standby batteries must be of sufficient size to power the panel in both a standby and alarm condition. Refer to the fire alarm control panel installation instructions for further guidance on notification circuits.

Audible Notification

Audible notification has historically been used as a notification of fire. The early notification consisted primarily of bells or sirens. An advantages of audible devices is that they have a low power draw therefore a circuit can have numerous devices connected to it. In order for audible devices to alert the building occupants, the device must be loud enough to be heard. The level of loudness is a measurement of sound pressure and that measurement is decibels or 1/10 bell. The decibels are expressed as dBA. This measurement of decibels has been adjusted to account for the manner in which the human ear perceives different frequencies in particular the way high-pitched (high frequency) sounds are heard better than low-pitched (low frequency) sounds. The A weighting adjustment corrects for this so that the loudness at different frequencies can be heard. Most audible devices indicate the sound pressure level at ten feet (XdB at 10 ft).

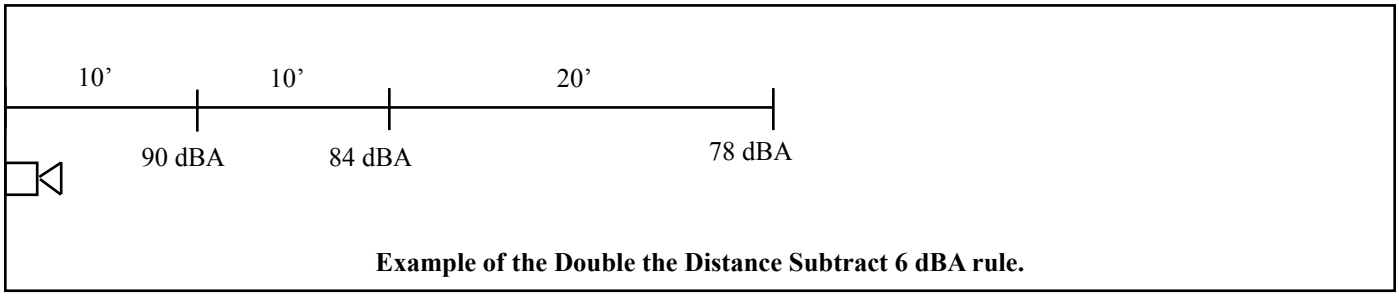
The sound level is required to be at least 15 dBA above the average or normal sound level or 5 dBA above the maximum sound level that lasts at least one minute. This measurement is required to be 5 feet (1.5 M) off of the floor. The measurement in sleeping areas is required to be measured at the pillow level. The Average Ambient Sounds levels are given below and only considered a guide. Each installation is individual and will require specific evaluation.

Location	Average Sound Level (dba)
Business Occupancies	55
Educational Occupancies	45
Industrial Occupancies	80
Institutional Occupancies	50
Mercantile Occupancies	40
Mechanical Rooms	85
Piers and Water Surrounded Structures	40
Places of Assembly	55
Residential Occupancies	35
Storage Occupancies	30
Thoroughfares, high density urban	70
Thoroughfares, medium density urban	55
Thoroughfares, rural and suburban	40
Tower Occupancies	35
Underground Structures and Windowless	40
Vehicles and Vessels	50

In some instances, audible devices are ineffective or are inappropriate. If the ambient sound in a building is above 105 dB, the building must have visible notification. The standard allows the audible notification in noisy areas if the ambient sound level can be reduced (i.e. NightClub). The total sound pressure produced by the audible devices must not exceed 120 dB, as permanent hearing damage may occur. Restrooms and elevators are examples where audible devices would be inappropriate. The sound level could cause disorientation delaying the egress time. In elevators, the people inside have no where exit until the car stops and the doors open. Also, stairwells are inappropriate since theses devices are in the path of egress. An audible device would be an unnecessary annoyance.

Audible notification devices must be mounted in such an arrangement that can be heard by the building's occupants. Generally, devices are mounted on the walls, however devices are now listed for installation on ceilings as well. When ceiling heights allow and other installations are otherwise not permitted, wall-mounted devices are required to be mounted so that the top of the device is at least 6 inches below the ceiling and the top is at least 90 inches above the finished floor level.

The level of sound made by the audible device is reduced as the distance from the source is increased. As a rule of thumb, double the distance from the source and the sound pressure (dB) drops by 6dB. Double the distance again and the sound pressure is decreased another 6 dB. When the sound must travel through walls and doors the sound loss may be more than 6 dB.



Example of the Double the Distance Subtract 6 dBA rule.

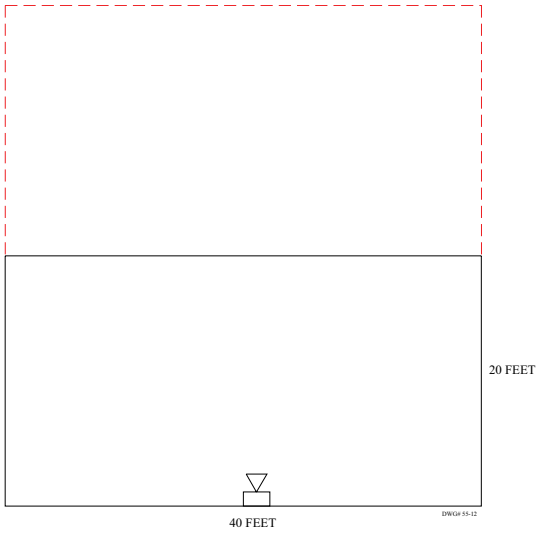
Visual Notification

The requirement for visual notification appliances comes from the applicable building code. The Americans with Disabilities Act (ADA) also requires strobes in certain instances. Strobe requirements of the ADA apply to new construction of or renovations to portions of buildings open to the general public. Likewise strobes are required by the ADA in portions of any building accessible to a hearing impaired person. In commercial facilities, strobes would be located in areas accessible to the public and to occupants of the facility who may have a hearing disability. Areas such as conference rooms, restrooms, hallways, routes of tours & the private office of someone with a hearing disability are examples. If no employees have hearing disabilities and the facility is not open to the public, no strobes would be required. When strobes are required, the installation, operation and location requirements are the same for ADA and the NFPA. The ADA is enforced through litigation. For more information on the ADA, contact: http://www.access-board.gov/ada-aba/commrept.htm#702

Candela Information

Visual appliances are installed in one of two orientations, wall mount and ceiling mount. Flashing strobes are listed for a particular orientation and are required to be installed in that orientation. Wall mount strobes cannot be mounted on ceilings for visual notification.Most often the strobes are used in a wall mount configuration. These devices may have a split candela rating depending on the angle in which the viewer is looking at the device. For example, a 15/75-candela strobe has a 15-candela rating when looking at the device from a 90-degree angle. The same device has a 75-candela rating when looking straight at the device. Wall mount strobes are required to be mount between 80 and 96 inches from the finished floor level. The spacing requirements for the visual devices are based on the tables in NFPA 72. The spacing is based on the square area covered by a single device. The area of notification is determined when the device that entirely covers that area is used. In the example below, the room is 40 feet wide by 20 feet deep. The room would be required to have a minimum of a single 60-candela strobe or two 30-candela strobes on the shorter sidewalls opposite of each other.

40 x 40 feet Strobe Requirement



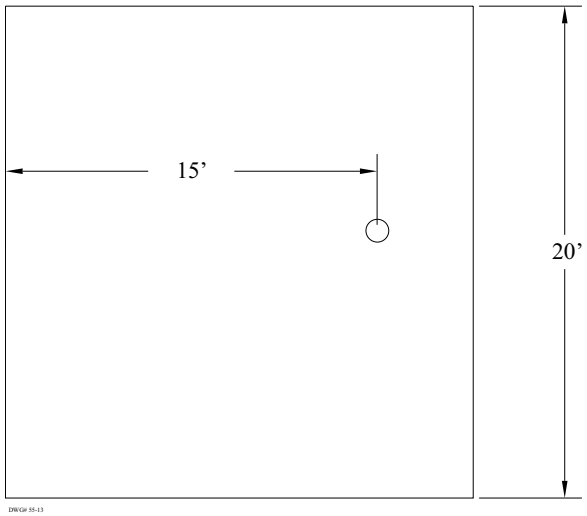
When visual devices are mounted on the walls, the strobe configuration is either a single device per area, two devices per area, or four devices per area. NFPA 72 has tables that define the minimum required light output. Generally, the largest room area covered by a single wall mounted device is 70 feet by 70 feet.

Ceiling mounted visual devices are available as multiple candela rated. These strobes are a specific candela but have various settings depending on the minimum required light output. In addition to the room size, the installer must be cognizant of the ceiling height when installing ceiling mounted strobes. The maximum ceiling height of any ceiling mounted strobe is 30 feet. If the ceiling height exceeds 30 feet, the visual devices must be suspended or wall mount strobes must be used. The maximum room area covered by a ceiling mounted strobe is 50 feet by 50 feet. In addition, the strobe must be mounted in the center of the room to achieve the light levels as specified in the tables in NFPA 72. If the strobe is not mounted in the center of the room, the distance from the strobe to the farthest wall is measured, then doubled to determine the room size for the strobe to be used. In the example below, the strobe is set off center by five feet. Therefore, the farthest wall is 15 feet, that doubled is 30 feet so the strobe must be at least that which would be used in a 30 feet x 30 feet room.

The light intensity of a strobe device is measured in candela (cd). The strobe devices listed for evacuation have specific light output requirements that must be complied with for the listing. Power is applied to these devices and the light output is measured to ensure the proper light output. The minimum light directly in front of the device is 15 cd. Manufacturers design the devices with various options and light output settings. For example the Potter SH-1224 has six selectable settings of 15, 35, 60, 75, 90 or 110 cd. These various settings each have a specific use depending on the room size and number of visual devices per room.

Double the longest distance to determine the maximum room size.

30 Feet x 30 Feet would be the minimum room size used.



Room Spacing for Ceiling-Mounted Visible Appliances

Maximum Room Size		Maximum Ceiling Height		Minimum Required Light Output (Effective Density); One Light (cd)
m	ft	m		ft
6.1 x 6.1	20 x 20	3.05	10	15
9.14 x 9.14	30 x 30	3.05	10	30
12.2 x 12.2	40 x 40	3.05	10	60
15.2 x 15.2	50 x 50	3.05	10	95
6.1 x 6.1	20 x 20	6.1	20	30
9.14 x 9.14	30 x 30	6.1	20	45
12.2 x 12.2	40 x 40	6.1	20	80
15.2 x 15.2	50 x 50	6.1	20	115
6.1 x 6.1	20 x 20	9.14	30	55
9.14 x 9.14	30 x 30	9.14	30	75
12.2 x 12.2	40 x 40	9.14	30	115
15.2 x 15.2	50 x 50	9.14	30	150

Where required, visual devices must be installed in the corridors of a building for visual notification. The corridor must be less than 20 feet wide. If the corridor is wider than 20 feet then the requirements for the room spacing must be applied. The minimum candela rating for the visual devices mounted in corridors is 15 cd. The strobes must be mounted within 15 feet of the end of the corridor and cannot be spaced more than 100 feet apart on center. The visual devices may be mounted either on the wall or the ceiling. They must be mounted in accordance with NFPA 72 for the proper height and placement. In addition, if there are any interruptions in the corridor such as fire doors, partitions or changes in elevation the areas are to be viewed as separate areas.

An installer must be concerned with how visual devices, strobes in particular, are installed with respect to how many strobes are in a field of view or room when activated. When more than two strobes are in the field of vision the strobes must be synchronized to flash at the same time. Some people are prone to photosensitive epileptic seizures when exposed to random flashing lights and synchronization of flashes prevent the seizure.

Room Spacing for Wall Mounted Visible Appliances (per NFPA 72) Minimum Required Light Output (Effective Intensity, cd)			
Max Room size	One Light per Room	Two Lights per Room (Located on Opposite Walls)	Four Lights per Room (One Light per Wall)
20 x 20	15	NA	NA
28 x 28	30	Unknown	Unknown
30 x 30	34	15	NA
40 x 40	60	30	15
45 x 45	75	Unknown	Unknown
50 x 50	94	60	30
54 x 54	110	Unknown	Unknown
60 x 60	135	95	30
70 x 70	184	95	60
80 x 80	240	135	60
90 x 90	304	185	95
100 x 100	375	240	95
110 x 110	455	240	135
120 x 120	540	305	135
130 x 130	635	375	185
NA = Not Allowable			

Notification Voltage Drop

When installing notification devices the installer must be aware of the operating voltage of the devices and ensure that the voltage supplied is within the listing of the device. Failure to make the appropriate calculations could result in the notification circuits to not operate. The installer must know the voltage of the system, the total current available per circuit, the number of devices that need to be connected, the current draw of each device, the minimum device operating voltage, the length of the wire run and the wire size. Commercial fire alarm control panels are generally required to operate at 20.4 volts (85% of 24 volts) on battery back up. Failing to consider the minimum operating voltage or the characteristics of the devices connected to the system may cause the system not to operate as intended.

Notification voltage drop calculations are used to determine if the power at the last notification device is sufficient to power the last device. The voltage drop is a result of the added resistance from the wire as the length of the wire run increases. The most simplistic way of calculating the voltage drop is to use a computer program. Numerous sources are available with these calculators, refer to the Automatic Fire Alarm Associations web site at www.afaa.org for an example.

The most accurate way to manually calculate the voltage drop is to start with a panel voltage of 20.4 volts (85% of the nominal 24 volts). That is the minimum voltage at which the fire panel is required to operate. This voltage would be worse case after the panel is operating on battery power for an extended period of time. Calculate the wire resistance from the fire panel to the first appliance and multiply that by the current draw of all appliances. Subtract that number from 20.4. That will be the available voltage at that the first appliance. Make sure that number is larger than the lowest operating voltage of the appliance. Calculate the wire resistance to the next appliance, multiply that by the current draw of the remaining appliances and subtract that number from the voltage at the previous appliance. Continue for all appliances on the NAC circuit. Make sure the voltage at the last appliance is within the operating range of the appliance.

The alternative to calculating voltage drop from device to device is to use the lump sum method. The calculations are performed as though all the appliances are installed at the end of the wire run. This method produces a rather large safety factor. Although this is a more conservative method, it may result in unnecessary, extra power supplies that will drive up the cost of the installation.

As a general rule it is advisable to keep the voltage drop on a NAC to 2.5 volts or less.

Ohm's Law = $\frac{E}{(I)(R)}$ Voltage drop can be calculated by $E_d = I_t \times R1$

Where: E_d = Voltage drop, I_t = Total Current (of the Notification Appliance), R1 = Resistance (of the wire)

Wire Resistance

AWG#	Ohm's per 1000 feet
12	1.6
14	2.5
16	4.0
18	6.4
20	10.0
22	16.0

Battery Standby Calculations

The fire alarm system is required to have a secondary power source. Most often this is accomplished through the use of battery back up. In order for the batteries to power the panel for a given time and still have enough capacity to power the system in alarm requires the batteries to be properly sized for the given standby and alarm power loads. The battery calculations need to consider all power requirements of the system. In addition, the standard requires that the batteries be derated to provide a safety margin.

Most fire alarm equipment has a stand-by (Non-alarm State) and alarm current draw. Generally, the alarm condition of the device is higher than the standby current draw. The total current draw is calculated in a number of steps and the final current draw is in amp hours. First, the totals of each initiating device types are totaled and multiplied by the standby current. Then all of the standby currents including the panel, all of the initiating devices, remote annunciators and any other auxiliary currents are added together in amps. Then, all of the alarm currents are added together in amps. The standby current is then multiplied by the number of standby hours required. The alarm current is then multiplied by the number of minutes in alarm expressed in hours (for example 5 minutes divided by 60 minutes per hour equals 0.084). The amp hour of the standby current (usually much larger) and the amp hour of the alarm current are added together and multiplied by 1.2. This final number is the minimum required amp hour rating that must be used to achieve the amount of standby and alarm current necessary.

[(Standby Amps) * (# of hours of Standby)] +[(Alarm Amps) * (% of hours in Alarm)] = Total Current
Total Current (in Amp Hours) * 1.2 (safety factor) = Minimum Battery Size Required ***(See example on following page)***

Fire alarm systems are usually either 12 volt or 24 volt. The batteries are rated at 12 volts and then have an amp hour rating. The standard amp hour rating is 4, 7, 8, 12, 18, 26, 28, 33 and 55. The 24-volt DC systems use two 12 VDC batteries wired in series to provide the needed voltage and maintain the same amp rating. The 12 VDC systems use a single battery, but can wire two batteries in parallel to double the amp hour rating.

Sample Current Draw Spreadsheet

Power Requirements (All Currents are in Miliamperes)							
Model Number	Description	Quantity		Standby	Total Standby	Alarm	Total Alarm
PFC-9000	Main chassis (12 amp)	1	x	230	= 230	380	= 380
SLA-127P	Single loop adder		x	35	=	50	=
DLA-254P	Dual loop adder		x	35	=	50	=
ZA-9008	4 zone NAC card		x	80	=	100	=
IDC-9004	4 zone NAC card		x	35	=	150	=
ARM-9008	8 relay circuit module		x	25	=	150	=
UDACT-9100	Dialer module		x	45	=	120	=
PR-5000	City tie module		x	35	=	300	=
2 Wire smoke detectors			x		=	*0.090	=
4 Wire smoke detectors			x		=		=
APS	Photoelectric smoke sensor		x	.390	=	.390	=
AHD	Heat sensor		x	.350	=	.350	=
AIS	Ionization smoke sensor		x	.350	=	.350	=
ADSD-P	Duct detector		x	2	=	8	=
ADSD-R	Duct detector with relay		x	10	=	55	=
FRCM-2/-4	Fast response contact module		x	.550	=	30	=
SOM-4	Supervised output module		x	.220	=	300	=
PSCI	Short circuit isolator		x	.270	=		= 10
DRM	Dual realy module		x	.150	=	150	=
Alarm LED current for analog devices						135	= 135
Signal load (bells, horns, strobes)			x				=
Auxiliary power supply for remote annunciators. Add 150mA for each RA-LCD and RA-LED32. Add 50mA for each RA-LED48 annunciator.					=		=
Total currents (add above currents) then multiply to convert to Amperes **Standby**					x.001 **(A)**	**Alarm**	x.001 **(B)**

Current Requirement: Standby (**A**) _____ Amps. Alarm (**B**)_____ Amps.

Battery Capacity Requirement:

([Standby (**A**) _____] X [(24 or 60 Hours) ___]**)** + **(**[Alarm (**B**) _____] X [%Alarm in Hr.] _____**)** = (**C**)

_____AH

X1.20

Total Standby Power _____ AH

* Assuming three Initiating Circuits in alarm.

% Use **0.084** for five minutes of alarm or **0.5** for thirty minutes of alarm as a multiplier figure.

See Appendix C, for other available smoke detectors.

Electronic version available at www.pottersignal.com

Required Documentation
When fire alarm systems are installed, the appropriate documentation must be submitted to the AHJ. The complete system should be submitted including building dimensions to scale with partition walls, duct work and separation barriers. In addition, a point by point initiating device detail submitted, detector placement, notification device placement, voltage drop calculations, battery calculations, manuals and manufacturers cut sheets should be submitted for approval. When the system is complete, an as-built drawing should be provided to at least the property owner and a Record of Completion should be provided to at least the AHJ.

On the newer systems, the installers use computers to program the panels. The configuration of the building should be given to the building owner and remain on site. This is so that the panel can be reconfigured to the exact way it was built if a catastrophic failure occurred in the panel. In addition, the system should be 100% tested anytime a change in the software is made to ensure that the system is operating as intended.

An Example of a Record of Completion is shown in NFPA 72, 2007, figure 4.5.2.1.

Record of Completion

Name of Protected Property:_____
Address:_____
Rep. of Protected Prop. (Name/Phone):_____
Authority Having Jurisdiction:_____
Address/Phone Number:_____

1. Type(s) of System or Service
_____NFPA 72, Chapter 3 Local
If alarm is transmitted to location(s) off premises list where received:
_____
_____NFPA 72, Chapter 3 Emergency Voice/Alarm Service
Quantity of voice/alarm channels: ___ Single: _____ Multiple: _____
Quantity of speakers installed: _____ Quantity of speaker zones:_____
Quantity of telephones or telephones jacks included in system:_____
_____NFPA 72, Chapter 4 Auxilliary
Indicate type of connection:
Local energy:_____ Shunt: _____ Parallel telephone:_____
Location and telephone number for receipt of signals:
_____
_____NFPA 72, Chapter 5 Remote Station
Alarm:_____
Supervisory:_____
_____NFPA 72, Chapter 5 Proprietary
If alarms are retransmitted to public fire service communications center or others, indicate location and telephone number of the organization receiving alarm:
_____
Indicate how alarm is retransmitted:
_____
_____NFPA 72, Chapter 5 Central Station
The Prime Contractor:
_____
Central Station Location:
_____
Means of transmission of signals from the protected premises to the central station:
_____McCulloh _____Multiplex _____One-Way Radio
_____ Digital Alarm Communicator _____Two-Way Radio
_____ Others
Means of transmission of alarms to the public fire service communications center:
(a) _____
(b) _____
Systems Location:_____

System Installation and Troubleshooting Tips

Read and Understand All Instructions Before Proceeding.
Follow the manufacturers instructions.
Never connect or disconnect wiring or circuit boards with any power applied!
Test the panel completely before bringing it to the job site. This will eliminate the possibility of installing a defective panel.
Perform power calculations to determine if system power supply and wiring are sufficient.
Perform battery calculations to determine proper battery size.
Fire circuits cannot be run in the same raceway, cable or conduit as high voltage circuits
When not in conduit, fire circuits should not be strapped to high voltage conduit, as electrical “noise” can interfere with the fire circuits.
Prepare a carefully laid out drawing of the complete system, including wiring hookup. A copy of this drawing should be secured in the panel cabinet.
Locate the panel for convenience and serviceability.
Carefully remove the panel and any associated modules from the cabinet.
Mount the cabinet and complete all conduit connections.
Pull all system wiring through conduit, tag and mark wires.
Install panel and any associated modules in cabinet.
Check integrity of field wiring.

Before making any external circuit connections:

1. Power up the panel using only the end of line devices. The panel should be in a normal condition.
2. Power down
3. Connect one circuit
4. Power up, panel should be in a normal condition
5. Repeat steps 2-4 until installation is complete

Problem	Possible Cause/Solution
Ground fault	A wire on one of the initiating or indicating circuits is touching ground. Disconnect the wires from each zone one at a time until the ground fault goes away. The problem will be on that wire. Check for corrosion on the batteries. Battery acid can eat through the paint and cause ground faults.
Trouble on initiating zone	Remove the wires from the zone and place the end of line resistor across the zone terminals. If the problem clears, it is in the wiring. If it doesn’t clear, there is a problem with the panel. If 2-wire smoke detectors are used, make sure the detector and base have been listed for use with the panel.
Trouble on indicating zone	Same as for initiating zone. On some panels, the polarity marked on the indicating circuits is for a normal condition, polarity will reverse in an alarm condition. On these panels, the red wire from the indicating appliance connects to the negative terminal and the black wire connects to the positive terminal. It will look backwards but when the panel goes into alarm it will be correct. Make sure the indicating appliances do not draw more power than the circuit can supply.
Low AC	Check the AC voltage, it must be above 102VAC.
Low battery	Check the batteries under load. Most panels will show low battery at 23VDC.

Look for blown fuses and circuit breakers that may have tripped. Look for diagnostic LED’s that may provide information.

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