BURGLAR & FIRE ALARM ASSOCIATION OF MICHIGAN

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APPRENTICESHIP PROGRAM

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Period 1
Related Training Instruction (RTI)
Module 1 – Fire Alarm Signaling Systems

Reading material associated with this module:
Chapters 1, 2, and 4
Fire Alarm Signaling Systems, Fourth Edition 2010

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Construction Industry Regulations

This program is based on information contained within the following codes, standards, manuals and handbooks:

- Fire Alarm Signaling Systems, 4th Edition
- NFPA 72 National Fire Alarm and Signaling Code, 2022 Edition
- Michigan Building Code, 2021 Edition
- NFPA 70 National Electrical Code, 2023 Edition
- Ugly's Electrical Reference, 2023 Edition
- American Red Cross First Aid/CPR/AED Participant's Manual
- 29 CFR 1926 OSHA Construction Industry Regulations

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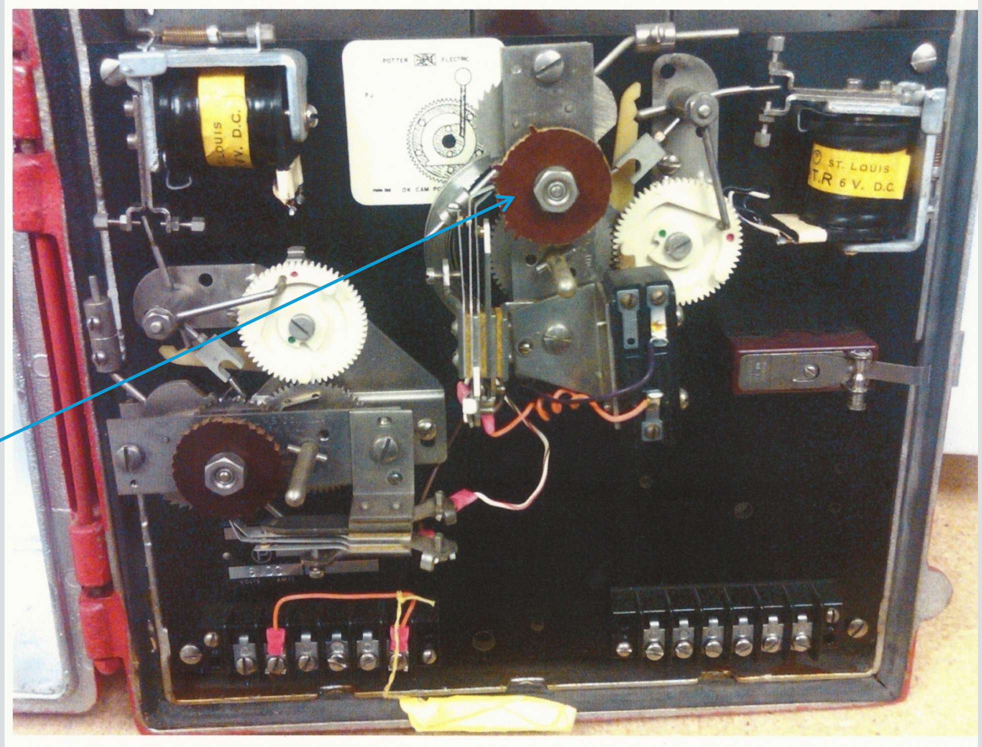
Period 1
Related Training Instruction (RTI)
Module 1 – Fire Alarm Signaling Systems

Note that there may be conflicts between the information provided in Period 1 modules obtained from the Fire Alarm Signaling Systems, 4th Edition vs. the information contained in NFPA 72, National Fire Alarm and Signaling Code, 2022 Edition. We have made every effort to reconcile these differences within the program but, in all cases, the information provided in NFPA 72 is to be considered the authoritative source.

Chapter 1 - History of Fire Alarm Systems

- In the early **1840's** Samuel Morse invented the telegraph. This led to the first reporting alarm system.
- In **1847** New York began construction of a municipal fire alarm system. This was to "construct a line of telegraph" by setting posts in the ground for communicating alarms of fire from the City Hall to the fire departments.
- The world's first electric municipal fire alarm system, based on Samuel Morse's printing register, was installed by the City of Boston in **1852**. It consisted of 40 miles of wire to connect the central station to 40 signal boxes and 19 bells in churches, schools, and fire engine houses. It transmitted an electric impulse from a code wheel, breaking the circuit, and recording a Morse code dot or dash on the printing register. On April 30, **1852**, within 24 hours of the system being placed in service, a fire alarm was transmitted from what is now Box 1212 for a fire on Causeway Street.

Chapter 1 - History of Fire Alarm Systems



Chapter 1 - History of Fire Alarm Systems

- By **1871**, improvements had been introduced, including spring-driven models of the fire alarm boxes and a “non-interference” pull box design eliminating interference between fire alarm boxes transmitting at the same time.
- Extending the public fire alarm telegraph system to stations throughout a building further saved valuable time in fire department notification. This interior manual fire alarm system was called an Auxiliary Fire Alarm System.
- Private companies were founded to serve the public using commercial central stations in districts of a city to provide messenger service and later electric burglar and fire alarm telegraph service to homes and businesses.

Chapter 1 - History of Fire Alarm Systems

- In **1882**, Chauncey F. McCulloh patented a loop design, known as the McCulloh Loop, to eliminate the challenge that a break or ground in the loop servicing the signal boxes connected to the central station could disable the entire loop causing loss of protection to all central station subscribers. The McCulloh Loop is still in use in some areas to this day, based on this initial patent.
- In **1863**, the electric fire detector was developed. By the early **1870's** remotely monitored fire alarm systems using heat detectors had been developed and, in **1873**, the first private fire alarm company was formed, which exists to this day as AFA Protective Systems in Syosset, NY.
- AFA developed their alarm-monitoring business to include waterflow alarms in addition to their thermostat alarm systems. Building owners who used these combination systems were able to receive insurance credits that equaled the subscriber's fee.

Chapter 1 - History of Fire Alarm Systems

- In the late **1930's**, the first projected-beam photoelectric smoke detector was developed. At about this same time, spot-type photo-electric smoke detectors were developed, which were installed by independent alarm companies for the next 10-15 years.
- During the **1930's,** ionization smoke detector technology was developed in Germany for protection of German munitions plants. After the war, the technology was further refined by the Swiss, and they began marketing ionization detectors in the United States. These original ionization detectors utilized 220VDC for their power source.
- The **1960's** saw the development of improved smoke detection technology. The 24VAC powered detector, the battery-operated ionization detector, and refinement of the photoelectric smoke detector at a more mass-marketable price were among these new developments.
- **1965** saw the development of the first single-station residential smoke detectors, which were AC powered and line-cord-connected photoelectric units.

Chapter 2 – Fire Protection Goals and Fire Signatures

- Proper design of a fire alarm system requires an understanding of fire itself, its by-products or fire signatures, its effects, how it can be detected, and its influence on the installation of a fire alarm system.
- Once the owner of a building decides that they need a fire alarm system, it is the designers' responsibility to choose a fire alarm system that meets the owner's goals. In many cases, the owner will need guidance in this area, so the designer must be able to articulate each fire protection goal.
- Fire protection goals can be:
    - Compliance with local or national building codes
    - Life safety
    - Property protection
    - Mission protection
    - Heritage preservation
    - Environmental protection

Chapter 2 – Fire Protection Goals and Fire Signatures

Aerosol (Smoke) Signatures:

- The process of combustion releases very large numbers of solid and liquid particles into the atmosphere. These particles suspended in air are called aerosols and, when produced by fire, are usually called smoke.
- The particles cover a spectrum of sizes, depending on the combustible materials and age of the smoke. As smoke ages and cools, the particles grow in size. This cooling effect relates to the stratification of smoke during smoldering fires and the declining heat release rate from fire plumes.
- The aerosols can be visible or invisible depending on their size. Visible particles are larger than 0.3 micrometers, while those below 0.3 micrometers are considered invisible. Listed smoke-sensing fire detectors are only tested for response to visible smoke particles.

Chapter 2 – Fire Protection Goals and Fire Signatures

Energy Release Signatures:

In all stages, fire releases energy into the surrounding atmosphere. This energy release produces several detectable fire signatures.

IR and UV Radiant Energy:

- The earliest energy signature that can be detected from a fire.
- The total infrared (IR) signature has been used in the detection of both smoldering and flaming fires. The disadvantage of the IR signature is the wide range of noise levels from solar and man-made sources.
- Despite a lower signal-to-noise ratio than IR signatures, ultraviolet (UV) signatures have been effectively used for flaming fires.

Chapter 2 – Fire Protection Goals and Fire Signatures

Energy Release Signatures (continued):

Thermal Energy:

- Convected thermal energy from a fire causes an increase in the air temperature of the surrounding environment.
- The time required for release of sufficient energy to produce a significant convected energy signal can vary from less than 1 minute for rapidly developing fires to hours for slowly developing / smoldering deep-seated fires.
- In contrast to aerosol and radiant energy signatures, convected thermal energy signatures often appear well after life-threatening conditions have been reached from excessive aerosol and/or toxic gas concentrations.

Chapter 2 – Fire Protection Goals and Fire Signatures

Gas Signatures:

- During a fire, many changes occur in the gas content of the atmosphere, both in the area of fire origin and in areas far removed from the fire.
- Mostly due to the addition of gases that are not normally present, these changes in atmospheric gas content are termed evolved gas signatures.
- Another gas signature that occurs during a fire is the reduction of oxygen content, termed the oxygen depletion signature.
- Examples of gases that evolve during fires are:
    - Water vapor (H_2O), carbon monoxide (CO), carbon dioxide (CO_2), hydrogen chloride (HCl), hydrogen cyanide (HCN), hydrogen fluoride (HF), hydrogen sulfide (H_2S), ammonia (NH_3) and nitrogen oxides.
    - Carbon monoxide is present in nearly all fires.

Chapter 2 – Fire Protection Goals and Fire Signatures

Fatality Potential for Fire Signatures:

- The primary design objective if building occupants could be exposed to fire signatures is generally to ensure that the conditions will not be harmful to occupants.
  - This can be accomplished by several means:
    - Design the building such that the fire effects will not reach any occupied space.
    - Design it such that the smoke layer elevation will not descend below head height of any occupied space.
    - Design it such that any occupied areas will be evacuated before the smoke layer descends below head height of any occupied space.
    - Conduct an analysis of the hazards in the fire-induced environment to determine whether they create an environment that could be incapacitating to people.
- Fire alarm and signaling systems are a portion of the design approach for achieving these objectives.

Chapter 2 – Fire Protection Goals and Fire Signatures

Fatality Potential for Fire Signatures:

- **Thermal Injury:** Thermal injury can be caused by radiant transfer, i.e., from fires that are remote from an individual, from a hot smoke layer, or by immersion in a heated atmosphere. Burns to the respiratory tract from inhaling hot gases are also possible; however, it is likely that injury from skin burns will occur before respiratory tract burns.
- **Toxicity:** People exposed to toxic gases at a concentration sufficient to cause harm could become incapacitated or unable to continue self-evacuation without becoming injured. Continued exposure could eventually result in death. When developing building designs intended to achieve life safety goals for people exposed to fire products, avoidance of incapacitation is generally the design objective.
    - CO and CO_2 are generally the toxicants of primary concern. Most fire safety analyses will focus on asphyxiating gases (CO, CO_2, and reduced oxygen). Yields of CO and CO_2 are strongly influenced by burning conditions, which are lower in cases where there is sufficient oxygen to completely burn the fuel, and higher in cases of smoldering combustion.

Chapter 2 – Fire Protection Goals and Fire Signatures

Fatality Potential for Fire Signatures (continued):

- **Toxicity :** Following are examples of common items that release toxic materials during a fire.
  - Hydrogen chloride is associated with burning plastics, such as electrical wiring insulation, PVC, and textiles and treated materials that contain chlorine. Hydrogen chloride is a highly corrosive and irritating gas even at low concentrations.
  - Hydrogen cyanide is associated with combustion of polyurethane foam, nylon (clothing and carpets), wool, and silk. Hydrogen chloride is a systemic asphyxiant, whereas it interferes with the body's ability to use oxygen, potentially leading to organ damage and death.
  - Hydrogen sulfide is associated with combustion of wool, rubber, and certain plastics. It is highly flammable and can also form an explosive mixture in air. Its exposure effects include respiratory irritation, unconsciousness, and death. Its toxicity is comparable to CO.

Chapter 2 – Fire Protection Goals and Fire Signatures

Fatality Potential for Fire Signatures (continued):

- **Visibility:**
  - The fire environment can also influence human behavior by causing a reduction in visibility. Although not in itself a cause of physiological harm, reduction in visibility can hinder egress and limit actions of occupants. In most cases, visibility thresholds are the failure points reached first. Reduced visibility can impact human behavior by decreasing the following:
    - The likelihood that people will move through an egress route.
    - Movement speeds in egress routes.
    - Wayfinding ability, decreasing the likelihood that people will be able to find their way to an exit, particularly when the way is unfamiliar.

Chapter 2 – Fire Protection Goals and Fire Signatures

Transport of Fire Signatures:

- A fire detector is a device that can sense one or more fire signatures. The threshold (sensitivity) must be exceeded before the detector signals an alarm. The detector can only respond to the level of the sensed parameter present at its location; specifically, regardless of the amount of matter or energy being released by the fire, only that which reaches the detector can be sensed. The mechanisms associated with the transport of matter and energy from the fire to the detector are critical to detector response.
- Flaming combustion is the easiest to detect because it produces all the signatures to which detectors are sensitive (aerosols, heat, and radiant energy) and the rate of heat release from the combustion is generally sufficient to rapidly transport the particulate to the detector area.
- Smoldering fires, in contrast, are low-energy fires that require special attention to detector location and are only adequately protected utilizing smoke detectors. Delays can occur because the limited quantity of heat liberated provides little of the buoyancy needed to drive the smoke to the detector location. The smoke also moves slowly and is subject to other influences (heating, ventilation, and air conditioning).

Chapter 2 – Fire Protection Goals and Fire Signatures

Transport of Fire Signatures (continued):

- Detectors that respond to infrared or ultraviolet flame radiation, the energy transport occurs at the speed of light. The only potential interference with this transport process is blockage of the signal by a physical object.
- IR detectors will still respond to reflected light from wall surfaces, although reaction will be delayed because energy dissipates in the surface reflection process.
- UV detectors, however, do not respond to reflected energy and must be within the direct line-of-sight of the flame to provide a response.
- Video-based smoke and flame detection systems use video cameras and computer-based image analysis to detect flames or smoke. Video-based fire detection systems can also provide images for security surveillance use only through output connections provided specifically for that purpose by the video system manufacturer.

Chapter 2 – Fire Protection Goals and Fire Signatures

Transport of Fire Signatures (continued):

- Heat detectors are the slowest responding of fire detectors, because the temperature of the fire gases is reduced by the mixing of cool air into the fire plume and by heat transfer to surfaces. When the fire plume first reaches the ceiling ad begins to spread outward, as much as 90 percent of the energy contained in the layer can be lost to the ceiling.
- Losses are a significant factor for other detectors as well. Examples such as:
    - Smoke detectors - ceiling configuration (obstructions and slope) effects and smoke concentration reduction from dilution as clean air is being entrained into the plume.
    - UV/IR flame detectors – radiated energy decreases in intensity with the square of the distance between the radiating source and the detector.
- The characteristics of various fire signatures, with their potential to cause serious fire injury or death, are important considerations in fire alarm system design.

Chapter 2 – Fire Protection Goals and Fire Signatures

Limitations of Fire Alarm Systems:

- The fire alarm system user and designer must consider the chosen detectors' response capabilities and potential limitations of the design imposed by the building configuration.
- Although the following is not an all-inclusive list, these items must be considered for their effects on the detection and operation of the fire alarm system:
  - Ceiling shape, surface, and height
  - Air flow
  - Ceiling obstructions
  - Ambient environment (temperature, humidity)
  - Detector type
  - Water supply
  - Fire department response time
  - Fire department capabilities
  - Occupancy
  - Egress design
  - Construction type
  - Capabilities of occupants (mobility, hearing, etc.)
  - Ambient noise levels

Chapter 4 – Fire Alarm Systems Overview

Description of a Fire Alarm System:

- A system intended to indicate and warn of abnormal conditions, summon appropriate aid, and control occupant facilities to protect life. A fire alarm system either manually or automatically links the sensing of a fire condition with the notification of people within and outside the building that action should be taken to respond to a fire condition.

Basic components of a fire alarm system:

- Alarm initiating device circuits (such as waterflow alarm detectors, automatic fire detectors, and manual fire alarm stations).
- Notification appliances such as bells, horns, speakers, and strobes.
- Control panel with primary and secondary power and off-premises communication capability.

Chapter 4 – Fire Alarm Systems Overview

Types of Fire Alarm Systems:

Fire alarm systems are classified as to the type of functions they are expected to perform.

- Protected-premises fire alarm system (local)
- Auxiliary alarm system
- Remote supervising station alarm system
- Central station service alarm system
- Proprietary supervising station alarm system
- In-building fire emergency voice/alarm communications system
- Two-way in-building emergency communications system
- In-building mass notification system (MNS)

Chapter 4 – Fire Alarm Systems Overview

Protected-Premises Fire Alarm System (Local):

- Types include building fire alarm system, dedicated function fire alarm system, or releasing fire alarm system.
- Supervised system that serves the needs of the building, providing occupant notification for evacuation, or supervision or operation of specific building fire safety functions.
- A protected premises fire alarm system does not automatically relay alarms to a fire department; instead, someone must notify the fire department when an alarm occurs.
- When a building fire alarm system is not required, the installation of a dedicated function fire alarm system or a releasing fire alarm system does not trigger requirements that would normally be associated with a building fire alarm system.

Chapter 4 – Fire Alarm Systems Overview

Protected-Premises Fire Alarm System (Local) Power Requirements:

- A protected-premises fire alarm system must be powered by a primary (main) power supply and a secondary (standby power supply). A stored-energy emergency power supply system (SEPSS / ESS / UPS) system could also be utilized for primary and secondary power if it meets specific requirements.
- Primary power is normally supplied from commercial power and light service. An engine-driven generator can also provide power to the system. Failure of the primary power supply is required to cause a trouble condition at the fire alarm control unit.
- The fire alarm system is normally connected to a dedicated branch circuit that is mechanically protected and identified as “FIRE ALARM CIRCUIT”.
- The secondary power supply must be capable of operating the system under normal load for 24 hours and subsequently operate the system in alarm for an additional 5 minutes.

Chapter 4 – Fire Alarm Systems Overview

Protected-Premises Fire Alarm System (continued):

- Automatic fire detection
- Manual fire alarm
- Sprinkler system waterflow alarm and supervisory service
- Smoke control
- Fire/smoke door control
- Elevator recall
- Air-handling systems (HVAC) detection and control

- All devices, appliances, and controls utilized as part of a protected-premises fire alarm system must be listed for their intended use by a testing agency acceptable to the authority having jurisdiction.
- Use of the standard audible emergency evacuation signal is required by NFPA 72 when building evacuation is needed.

Chapter 4 – Fire Alarm Systems Overview

Auxiliary Alarm System:

- A type of protected-premises fire alarm system that transmits alarm signals using a municipal coded fire alarm box connected to the municipal fire headquarters. These systems utilize the same equipment and transmission lines that are used for the publicly accessible alarm boxes (street boxes).
- Two types of auxiliary systems are recognized in NFPA 72:
  - Local-energy type
  - Shunt type
- The local-energy type is electrically isolated from the municipal alarm system and has its own power supply.
- The shunt type system is electrically connected to the municipal fire alarm system and is an integral part of that system.
- Shunt type systems can only be used fore manual fire alarm and waterflow alarm service only.
- Automatic detection is not permitted on shunt type systems.

Chapter 4 – Fire Alarm Systems Overview

Remote Supervising Station Alarm Systems:

- Supervised systems in one or more protected facilities that transmit alarm, trouble or supervisory signals to a facility providing remote supervising station service.
- Remote supervising stations are attended by trained personnel 24 hours per day (in most cases at a fire department or municipal communications center).
- Properties under the same or different ownership can be protected by a remote supervising station.
- Remote supervising station service differs from central station service primarily in that central station personnel are mainly responsible for furnishing and maintaining supervised signaling service and the central station is a privately owned, for-profit operation.
- Secondary power must be capable of operating the system for 24 hours in normal condition followed by 5 minutes in alarm.

Chapter 4 – Fire Alarm Systems Overview

Central Station Service Alarm System:

- Supervised systems or groups of systems where the operation of circuits and devices are transmitted automatically to, recorded in, maintained by, and supervised from a listed central station that has competent and experienced servers and operators who, upon receipt of a signal, take such actions as required by code. Such service is to be controlled and operated by a person, firm, or corporation whose business is the furnishing, maintaining, or monitoring of supervised alarm systems.
- The scope of central station service includes all of the following elements:
  - Installation of alarm transmitters
  - Alarm, guard, supervisory, and trouble signal monitoring
  - Retransmission
  - Associated record keeping and reporting
  - Testing and maintenance
  - Runner service

Chapter 4 – Fire Alarm Systems Overview

Proprietary Supervising Station Service Alarm System:

- A protected-premises fire alarm system that serves properties under single ownership, that provides emergency building monitoring and control services from a central supervising station at the protected property, similar to a central station, but operated by the owner of the protected property.
- Proprietary control units are required to transmit alarm, supervisory, and trouble signals to the supervising station. Fire alarms must be transmitted promptly, and preferably, automatically. Two-way telephone communication should also be established between the supervising station and the municipal communications center. The control unit at the supervising station must have a secondary (standby) power supply capable of operating the system for 24 hours under normal traffic conditions. Since operators are constantly on duty, 24 hours of standby power is sufficient.
- The supervising station must be constantly attended by minimum of two staff members responsible for monitoring signals and operating the system. Personnel must be competent and adequately trained.
- The supervising station must be located in a separate fire-resistive building or in a fire-resistive enclosed room that is entirely separate from hazardous operations in the facility.

Chapter 4 – Fire Alarm Systems Overview

Communication Methods:

- The communication methods addressed in NFPA 72 for transmitting signals from protected premises to a supervising station include the following:
  - Performance-based technologies: These technologies include equipment such as IP and GSM communicators as well as legacy technologies that, for the most part are no longer being installed, but may exist in some installations, and newly developed communications methods that can meet the performance requirements. Existing systems utilizing legacy technologies are acceptable because all of these technologies still meet the performance-based requirements.
  - Digital alarm communicator system (DACS): These systems use a digital alarm communicator transmitter (DACT) at the protected premises, and a digital alarm communicator receiver (DACR) at the supervising station.
  - The third communications classification includes radio systems. The radio classification is divided into two types of radios. Two-way radio frequency (RF) multiplex systems and one-way private radio alarm systems, which are more common.

Chapter 4 – Fire Alarm Systems Overview

Communication Methods:

- The most commonly used communication method is the DACS. A system employing a DACT shall employ a single telephone line (number) and one of the following transmission means:
  - One-way private radio alarm system.
  - Two-way RF multiplex system.
  - Transmission means complying with the requirements for a performance-based technology detailed in NFPA 72.
  - A second telephone line (number) meeting the requirements of NFPA 72.

Chapter 4 – Fire Alarm Systems Overview

Communication Methods:

- The following requirements apply to all combinations of transmission methods indicated in the previous slide:
  - The means for supervising each channel shall be in a manner approved for the method of transmission employed.
  - If a signal has not been processed over the subject channel in the previous 6 hours, a test signal shall be processed.
  - The failure of either channel shall send a trouble signal on the other channel within 4 minutes.
  - When one transmission channel has failed, all status change signals shall be sent over the other channel.
  - The primary channel shall be capable of delivering an indication to the DACT that the message has been received by the supervising station.

Chapter 4 – Fire Alarm Systems Overview

Communication Methods:

- The following requirements apply to all combinations of transmission methods indicated in the previous slide (continued):
  - Unless the primary channel is known to have failed, the first attempt to send a status change signal shall use the primary channel.
  - Simultaneous transmission over both channels shall be permitted.
  - Failure of telephone lines (numbers) shall be annunciated locally.

Chapter 4 – Fire Alarm Systems Overview

DACT Transmission Means:

- The following requirements shall apply to all DACTs:
  - A DACT shall be connected to two separate means of transmission at the protected premises so that a single point of failure on one means of transmission shall not affect the second means of transmission.
  - The DACT shall be capable of selecting the operable means of transmission in the event of failure of the other means. The following requirements apply to all combinations of transmission methods indicated in the previous slide (continued):
  - Upon the receipt of a signal, the central station will immediately retransmit to the public fire department and the appropriate authorities. The central station will dispatch someone to the premise when equipment must be reset manually.
  - Central station systems require secondary power that will operate the system for 24 hours.

Chapter 4 – Fire Alarm Systems Overview

In-Building Fire Emergency Voice/Alarm Communications System:

- The purpose of emergency voice is to provide transmission of information and instructions pertaining to a fire emergency to building occupants and the fire department. This system also allows communication with those persons remaining in the building.
- This system can be used to partially evacuate a building in emergency conditions while permitting some occupants to remain in safe areas. This system must be used when the emergency plan includes anything other than the immediate and total evacuation of the building.
- The system supplements a protected-premises, auxiliary, remote supervising station, central station service, or proprietary supervising station alarm system.
- Its standby power supply must operate the entire system for a fire or other emergency condition without primary power for 24 hours and then be capable of intermittently operating the system in alarm condition for 15 minutes.

Chapter 4 – Fire Alarm Systems Overview

In-Building Fire Emergency Voice/Alarm Communications System (continued):

- Due to the emergency nature of a voice/alarm communication system, special requirements in NFPA 72 cover the survivability of the system so that fire damage to one notification zone will not result in the loss of communication to another.
- Designers, authorities having jurisdiction, and installers should also ensure that circuits controlling notification appliance circuits and equipment that are common to more than one evacuation signaling zone be designed and installed such that the fire will not disable these circuits as well.
- There are two basic types of in-building fire emergency voice/alarm communication systems:
    - A stand-alone manually controlled system, with tone or voice signals that can be selected and distributed by the operator.
    - A system integrated into a fire alarm system, with voice or tone signals that can be selected and distributed manually or automatically.

Chapter 4 – Fire Alarm Systems Overview

In-Building Fire Emergency Voice/Alarm Communications System (continued):

- The system consists of speakers located throughout the building connected to and controlled from the fire alarm communications console located in an area of the building designated as a fire command center.
- Voice messages can be provided to individual areas or the entire building with specific instructions to the occupants regarding the type of emergency and how to respond.
- The system can also be used during fire-fighting operations for communication with fire-fighters.
- A one-way system permits emergency personnel to give voice instructions on either a selective or all-call basis using a microphone and loudspeaker system. Occupants can be instructed to evacuate or relocate to non-fire areas of the building and wait for further instructions from the fire department.

Chapter 4 – Fire Alarm Systems Overview

Two-Way In-Building Wired Emergency Services Communications System:

- A two-way wired emergency services communications system utilizing telephone or intercom techniques permits communication between fire service personnel while they investigating or fighting a fire in the building. These are normally telephones located at each floor in fire stairwells to allow reliable communication with the fire command station.

Two-Way Radio Communications Enhancement Systems:

- Public safety radio systems are commonly employed by fire departments and other emergency services for communications within buildings. Two-way radio communications enhancement systems are utilized to provide additional signal amplification to overcome the operational difficulties in buildings where concrete and steel construction can interfere with the radios.
- The system consists of antennae and repeaters (often called bi-directional amplifier systems) at strategic locations, enhancing the public safety radios.

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Chapter 4 – Fire Alarm Systems Overview

Signal Processing:

- Signal processing is the link between a signal input and a system response. A fire alarm control panel is typically subject to numerous, varied signal inputs with outputs varying widely, depending on the application of the alarm system.
- In its simplest form, such as for a protected-premises or household fire alarm system, a fire alarm signal will energize the output signals.
- A more complex system could have several output responses for various inputs, i.e. audible/visual signal activation, door release, elevator recall, or fire department notification.
- The processing and matching of inputs and outputs can be controlled through fixed electronic circuitry or controlled by software programming.

Chapter 4 – Fire Alarm Systems Overview

Types of Signals Processed:

- ***Manual Fire Alarm Signals:*** Manual fire alarm signals are normally initiated from manual fire alarm boxes which could be located throughout the protected premises or from a single manual pull box at a specific location. Outputs associated with manual fire alarm signals vary based on the type of fire alarm system and could include any of the following:
  - Activate evacuation signals, including audible, visual, or voice/tone messages.
  - Transmission of signals to a remote location for fire department interpretation and response.
  - Various other interfaces for auxiliary functions.
- Manual signal initiation is not normally part of a household fire alarm system. Because most fires occur while the occupants of the household are sleeping, initiation from automatic detection is the only necessary function of the fire alarm system.

Chapter 4 – Fire Alarm Systems Overview

Types of Signals Processed:

- ***Automatic Fire Alarm Signals:*** Automatic alarms are normally initiated by smoke, heat, sprinkler waterflow switches, or other suppression system alarm-monitoring devices.
- The nature of automatic alarm signal generation and processing depends on the type of fire alarm system used and could include evacuation signals, transmission of signals, and various other interfaces.
- ***Guard's Tour Supervisory Service:*** Guard's tour service is a supervisory service signal typically initiated through mechanical key-operated or bar-coded tour stations. The purpose of this service is to track the activation of all stations within a tour route by a guard, both in the correct order and within a specific time frame. The fire alarm system tracks this information and provides exception and delinquency reporting.
- Guard's tour supervisory signals are not transmitted to the public fire department.

Chapter 4 – Fire Alarm Systems Overview

Types of Signals Processed:

- ***Sprinkler System Waterflow Alarm and Supervisory Signal Service:*** This signal service must be able to interpret the type of system signal and the particular element that has operated. Additionally, the supervisory service must identify restoration of the element to its normal position.
- Waterflow supervisory signals may consist of one or more of the following:
  - Gate valve supervision
  - Pressure supervision
  - Water level supervision
  - Water temperature supervision
  - Pump supervision

Chapter 4 – Fire Alarm Systems Overview

Types of Signals Processed:

- ***Trouble Signals:*** These are considered conditions that inhibit alarm transmission or annunciation. Many functions and/or circuits are monitored for integrity against loss of capability. In some cases, automatic or manual control of various system functions permits emergency operation under faults that could debilitate the entire fire alarm system.
- Following are common trouble signal examples:
  - Loss of primary (main) power
  - Loss of initiating circuits such as an open conductor
  - Loss of notification appliance circuits
  - Signaling line circuit conditions such as an open or ground

END OF PERIOD 1 - MODULE 1