BURGLAR & FIRE ALARM ASSOCIATION OF MICHIGAN

ESTABLISHED 1981

APPRENTICESHIP PROGRAM

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Period 1
Related Training Instruction (RTI)
Module 4 – Fire Alarm Signaling Systems

Reading material associated with this module:
Chapters 7, 8, and 9
Fire Alarm Signaling Systems, Fourth Edition 2010

Chapter 7 – Signal Transmission Methods and Processing

Introduction:

- The three methods of fire alarm signaling circuits (pathways) are:
  - Hard-wiring with copper wire and cable
  - Radio frequency (RF), also known as wireless
  - Optical fiber
- The circuits connect alarm-initiating devices to the FACU and other locations that require notification of a fire.
- Methods of transmission, compatibility of initiating devices, signal verification, and false alarms will also be covered in this section.
- Copper wire is the oldest method of carrying a signal from one component of a fire alarm system to another.

Chapter 7 – Signal Transmission Methods and Processing

Introduction (continued):

- Wireless transmission is often used to transmit signals in proprietary supervising station alarm systems, central station service alarm systems, remote supervising station alarm systems, and public emergency alarm reporting systems.
- Wireless transmission can also transmit alarm signals from initiating devices to the fire alarm control unit.
- Optical fiber signaling circuit requirements are addressed in Article 770 of the National Electrical Code (NEC).

Chapter 7 – Signal Transmission Methods and Processing

Wire Transmission:

- Conventional circuits utilize normally open devices on a circuit that terminates with an end of line resistor, sometimes referred to as a two-wire or Class B initiating device circuit (IDC).
- Circuits that originate and terminate at the control unit are referred to as a four-wire or Class A initiating device circuit.
- Smoke detectors can be two-wire, where their operating power is drawn from the initiating device circuit, or four-wire, where separate power is supplied to the smoke detector. A two-wire smoke detector in an alarm condition may prevent other two-wire smoke detectors on the circuit from getting enough power to operate.
- Four-wire smoke detectors should be configured with a power source capable of supporting all detectors in alarm at the same time. This is important when relays in the smoke detector base are relied upon to close fire doors or fire shutters.

Chapter 7 – Signal Transmission Methods and Processing

Addressable Detectors:

- Addressable devices draw their operating power from the signaling line circuit (SLC) and have a unique address that is set at the detector and is communicated to the control unit. When the control unit polls the addressable device, the device transmits its status. When a device fails to respond to a poll from the control unit, a trouble signal is generated.
- Analog detectors send real time environmental data to the control unit, and the control unit makes the decision to go into an alarm condition. Some control units can also combine data from adjacent detectors to help make the alarm decision.

Chapter 7 – Signal Transmission Methods and Processing

Multiplexing / Active Multiplexing:

- Multiplexing is a technology that allows multiple signals on the same path. An addressable device on a signaling line circuit is one example of multiplexing. Multiple wireless transmitters on the same radio frequency are another example of multiplexing. Multiplexing can be either *active* or *passive*.
- Active multiplexing is the transmission of status signals from an addressable device to a central control or receiving unit upon command, enabling identification of each addressable device responding to the command.
- Active multiplexing can be utilized at the protected premises between devices and the control unit and can also be utilized between a supervising station and the protected premises.

Chapter 7 – Signal Transmission Methods and Processing

Multiplexing / Active Multiplexing (continued):

- Passive multiplexing removes the command to transmit and permits transmitters to report at any time. Coded initiating devices, where the initiating device includes a code wheel that imposes a coded output on the notification appliance output, are an example of passive multiplexing.

Chapter 7 – Signal Transmission Methods and Processing

Wireless Transmission:

- Wireless transmission is used both for communication between protected premises and the supervising station, and for communications between initiating devices and/or indicating devices and the control unit. In both cases, transmission is carried on an FCC assigned frequency.
- Wireless communications between the supervision station and protected premises may be one-way RF or two-way RF, permitting the supervising station to poll or control the protected premises transmitter.
- Wireless communications between the initiating and/or indicating devices and the control unit are typically one-way, utilizing low power transmitters powered with a dry cell battery.

Chapter 7 – Signal Transmission Methods and Processing

Optical Fiber Transmission:

- Optical fiber transmission is typically utilized to carry data between fire alarm control panels and remote annunciators. The National Electrical Code (NEC), Article 770 addresses installation requirements for fiber optic cable and raceways.
- Advantages of optical fiber transmission include high bandwidth, low signal loss, small size, light weight, noise immunity, and transparency. It is also non-interfering and highly secure.

Chapter 7 – Signal Transmission Methods and Processing

Signal Transmission Compatibility:

- Compatibility, the ability of equipment produced by one manufacturer to operate properly with that of another manufacturer is critical to signal transmission in a fire alarm system.
- Device compatibility is an important consideration when utilizing two-wire smoke detectors. The detectors must be evaluated by a testing laboratory to make sure they function properly with the proposed control unit. Fire alarm control units have lists, known as compatibility lists, of detectors that have been tested to work with the control unit.
- NFPA 72 requires that all devices and appliances that receive their power from the initiating device circuit (IDC) or signaling line circuit (SLC) of a control unit must be listed for use with that control unit.
- This requirement does not apply to notification appliance circuits.

Chapter 8 – Fire Alarm Notification

Introduction:

- The intent of fire alarm notification is to notify the occupants of the building of an alarm condition. In most circumstances, the intent is to have the occupants evacuate the building. In some occupancies such as hospitals, occupants may relocate within the building instead of evacuating the building.
- Various types of audible and visible signals as well as an in-building fire emergency voice/alarm communications system can be used as a notification method.

Chapter 8 – Fire Alarm Notification

Notification Methods:

- Notification is accomplished primarily through audible and visible signaling devices. Audible devices may include bells, horns, electronic sounders and fire alarm speakers. Visible devices are typically strobes, used as a stand-alone device or in combination with an audible device.
- To ensure that audible notification appliance signals are clearly heard, it is required that they have a minimum sound level of at least 15dB above the average ambient sound level or 5dB above the maximum sound level over a duration of at least 60 seconds (whichever is greater).
- Sleeping areas must meet the same requirements as above, or have a sound level of at least 75dBA, whichever is greater, measured at the pillow level.
- If any barrier, such as a door, curtain, or retractable partition, is located between the notification appliance and the pillow, the sound pressure level must be measured with the barrier in place.

Chapter 8 – Fire Alarm Notification

Notification Methods (continued):

- Where audible appliances are provided to produce signaling for sleeping areas, they must produce a low-frequency alarm signal that complies with the following:
  - The alarm signal must be a square wave or provide equivalent awakening ability.
  - The wave must have a fundamental frequency of 520Hz +/- 10 percent.
- The recommended signal for evacuation is a Code 3 temporal signal. This consists of a signal that is ON for ½ second, OFF for ½ second, ON for ½ second, OFF for ½ second, ON for ½ second, then OFF for 1.5 seconds, then the cycle is repeated. This pattern can be imposed on bells, horns, tones, and other forms of audible signaling.
- This signal shall be repeated until the fire alarm is manually silenced or reset by authorized personnel or emergency personnel.
- The signal may be automatically silenced where approved by the authority having jurisdiction based on an emergency plan, but no less than 180 seconds (3 minutes) after the signal was initiated.

Chapter 8 – Fire Alarm Notification

Notification Methods (continued):

- Supervisory signals should also be distinctive in sound from other signals and used only to indicate a supervisory condition. Fire alarm signals should take precedence over all other signals except where permitted for emergency mass notification signals.
- Trouble signals should be distinctive from fire alarm signals and indicated by the operation of a sounding appliance. The trouble signal should be located in an area where it is likely to be heard, as designated by the authority having jurisdiction.
- Signals at the control unit are permitted to have the same characteristics for all alerting functions, including alarm, trouble, and supervisory, provided that the distinction between signals is by other appropriate means such as visible annunciation.

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Classification of Notification Signals:

- Fire alarm notification signals are classified as:
  - Coded
  - Non-coded
  - Textual
- Notification appliances also operate in either the public or private modes
- Coded signals provide information through the number of strokes on a bell, the number of flashes on a visible appliance, or the number of activations on a horn or buzzer.
- Non-coded signals simply activate. They are either ON or OFF. The operation of a non-coded appliance may be continuous or interrupted at a continuous uniform rate. The Code 3 evacuation signal is considered a non-coded signal.
- Textual signals convey information. A voice message over a fire alarm speaker is an example of a textual message. A text display showing the location of an activated device is another example of a textual signal.

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Classification of Notification Signals:

- Private mode signals are designed to notify only the persons necessary to carry out emergency action, such as notifying a fire brigade in an industrial occupancy.
- Public mode signals are designed to notify all occupants of the facility of the need to evacuate or take other appropriate action.
- The total sound pressure level produced by a combination of ambient sound and all audible notification appliances operating must not exceed 110 decibels (dBA) at the minimum hearing distance.
- If ambient sound pressure levels exceed 105dBA, visible notification appliances must be used.

Chapter 8 – Fire Alarm Notification

Classification of Notification Signals:

- Public mode audible notification should be designed to be 15dBA above the average ambient sound level or 5dBA above the maximum sound level having a duration of at least 60 seconds, whichever is greater.
- Private mode audible notification should be designed to be 10dBA above the average ambient sound level or 5dBA above the maximum sound level having a duration of at least 60 seconds, whichever is greater.

Chapter 8 – Fire Alarm Notification

Physically or Mentally Challenged Individuals:

- The Americans with Disabilities Act of 1990 (ADA) requires fire alarm systems to provide both audible and visible signaling appliances, so the visually impaired and the hearing impaired are equally aware of the fire alarm signal. ADA is civil rights legislation, whereas failure of the fire alarm system to notify an impaired person is considered a form of discrimination.
- ADA permits "equivalent facilitation", which allows using a means equal to, or better than, ADA specific requirements to achieve the required performance.
- The requirements of NFPA 72 with respect to visible notification have been accepted as "equivalent facilitation" since the 2005 edition of the *Americans with Disabilities Act Accessibility Guidelines (ADAAG)*.
- *The Americans with Disabilities Act and Architectural Barriers Act Accessibility Guidelines (ADA-ABA-AG)* specifically references NFPA 72.

Chapter 8 – Fire Alarm Notification

Notification Appliance Types:

- Audible notification appliances may be:
  - Bells, generally in 6”, 8”, or 10” sizes.
  - Horns, either electromechanical or electronic.
  - Chimes, which are normally only used in heath care occupancies.
  - Buzzers, which are normally used for trouble signals.
  - Sirens.
  - Speakers, either connected to a remote tone generator and audio amplifier, or the integral type, with the tone generator, amplifier, and speaker contained in a single unit.

Chapter 8 – Fire Alarm Notification

Emergency Controls:

- Emergency controls (fire safety functions) may include:
  - Elevator recall functions.
  - Release of automatic door closers.
  - Stair pressurization and other mechanical air handling features.
  - Smoke dampers in smoke barriers.
  - Automatic shutdown of air handling units.
  - Stair door unlocking to permit entry from the stair to any floor during an alarm condition.
  - Special locking arrangements.
  - Automatic fire-extinguishing equipment.

Chapter 9 – Fire Alarm System Installation

Introduction:

The proper installation of a fire alarm system is a prime factor in subsequent system efficiency, reliability and correct operation. Installation also affects any nonrequired applications of the system. The following items should all be considered in the installation process:

- Equipment must be listed for its intended purpose.
- Adequate power supplies for system operation and notification appliances must be provided.
- Initiation devices and circuit wiring.
- Notification appliances and circuit wiring.

Chapter 9 – Fire Alarm System Installation

Installation of Automatic Fire Detectors:

- Detectors should be protected where subject to mechanical damage. A mechanical guard used to protect a detector should be listed for that purpose.
- They must be supported independently of their attachment to the circuit conductors.
- They must be provided with duplicate terminals or leads for wiring supervision.
- Wiring must not be looped around terminals; wires must be cut and each end attached.
- Detectors should not be recessed in any way into the mounting surface unless they have been tested and listed for such recessed mounting.

Chapter 9 – Fire Alarm System Installation

Installation of Automatic Fire Detectors (continued):

- The design of the detection device layout must account for the following factors that affect detector response to fire:
  - Ceiling shape and surface.
  - Ceiling height.
  - Configuration of contents in the protected area.
  - Combustion characteristics and probable equivalence ratio of the anticipated fires involving the fuel loads in the protected area.
  - Compartment ventilation.
  - Ambient temperature, pressure, altitude, humidity, and atmosphere.

Chapter 9 – Fire Alarm System Installation

Installation of Automatic Fire Detectors (continued):

- Total coverage provides detection in all accessible spaces, including all rooms, basements, attics, and spaces above suspended ceilings.
- Partial coverage detection can be provided at common areas and work-spaces, such as corridors, lobbies, storage rooms, equipment rooms, tenantless spaces, smoke barrier openings, and above control equipment.
- Selective coverage is to address a specific hazard only.

Chapter 9 – Fire Alarm System Installation

Special Applications for Automatic Fire Detectors:

- Detectors should only be installed in an orientation they have been listed to (ceiling mount or wall mount). This is a particular concern when installing detectors under raised floors. The detector should not be mounted upside down attached to the floor.
- Smoke detectors in HVAC systems are intended to prevent the recirculation of smoke within a building and typically shut down the HVAC unit when smoke is detected. They are not intended to provide smoke detection for the entire area. Their intent is to stop the HVAC if it is transporting smoke from one area to another.
- Smoke detectors in HVAC systems are subject to dilution from air from other areas, and they only are functional when the HVAC unit is running and moving air through the duct work.

Chapter 9 – Fire Alarm System Installation

Special Applications for Automatic Fire Detectors (continued):

- The Michigan Mechanical Code requires duct smoke detectors to be installed on the return side of all HVAC units greater than 2,000 cfm. There are two exceptions to the requirement for duct smoke detectors:
  - *Exception:* Smoke detectors are not required where the HVAC system cannot move smoke beyond the space in which it was generated. This is typical of many roof top units in large spaces, where there is minimal duct work attached to the RTU. Since the unit cannot move smoke from one space to another, it is exempt from duct smoke detector requirements.
  - *Exception:* Smoke detectors are not required in the return air system where all portions of the building served by the AHU are protected by area smoke detectors connected to a fire alarm system, and the smoke detection system shuts down the AHU.

Chapter 9 – Fire Alarm System Installation

Special Applications for Automatic Fire Detectors (continued):

- Detectors for AHU's may be open area detectors located in return air openings, or they may be in duct detector housings which attach to the outside of the ductwork and use a sampling tube to draw air out of the ductwork and across the detector. Detectors shall be listed for the air velocities present.

Chapter 9 – Fire Alarm System Installation

- **Special Applications for Automatic Fire Detectors (continued):**
  - When smoke detectors are required to close doors to prevent smoke from traveling from one side of the door to the other, detectors used exclusively for smoke door release service shall be located and spaced in accordance with NFPA 72-2022, Section 17.7.6.6. Important items required for the installation are:
    - The height of the wall from the top of the door to the ceiling.
    - Whether the ceiling height is the same on both sides of the door.
    - Whether the intent is to detect smoke flowing just one way, or both ways through the door opening.

Chapter 9 – Fire Alarm System Installation

Installation and Wiring for Fire Alarm System Circuits:

- Fire alarm circuits may be power limited or non-power limited. The equipment that powers the circuit (normally the FACP) must identify those circuits that are power limited circuits. If not identified as a power limited circuit, it is a non-power limited circuit.
- Non-power limited fire alarm circuits must be provided with overcurrent protection (usually a circuit breaker or fuse).
- NPLFA (non-power limited fire alarm) circuits can only share a raceway, cable or enclosure with AC power circuits when they are both connected to the same equipment.
- NPLFA circuit conductors can be as small as 18AWG for single conductors and multi-conductor cables.
- NPLFA circuit conductors shall be solid or stranded copper.

Chapter 9 – Fire Alarm System Installation

Installation and Wiring for Fire Alarm System Circuits (continued):

- PLFA (power limited fire alarm) circuit conductors can be as small as 18AWG for single conductors and 26AWG for multi-conductor cables.
- PLFA circuit conductors shall be solid or stranded copper.
- Circuit conductors for both NPLFA and PLFA may be installed in raceway systems or may be installed using cables listed for either NPLFA or PLFA use.

END OF PERIOD 1 - MODULE 4