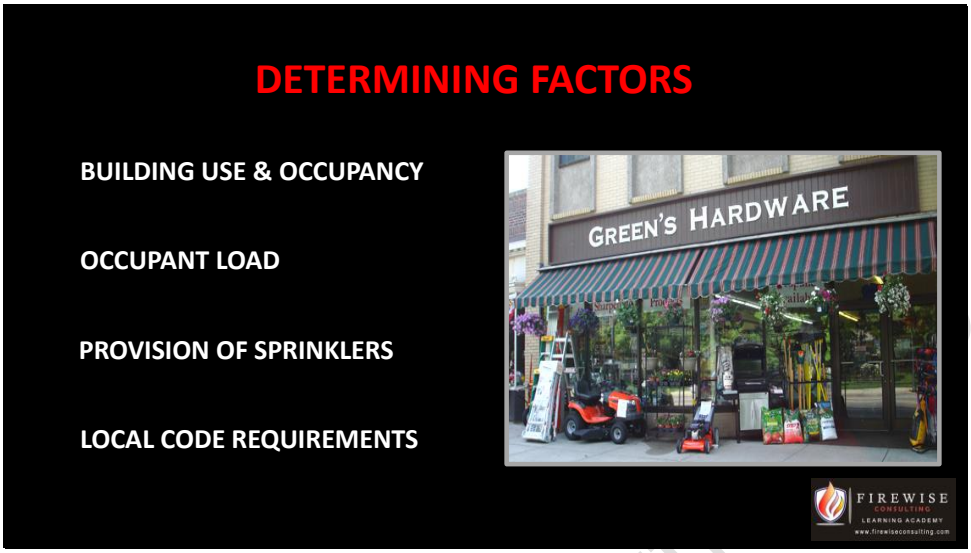
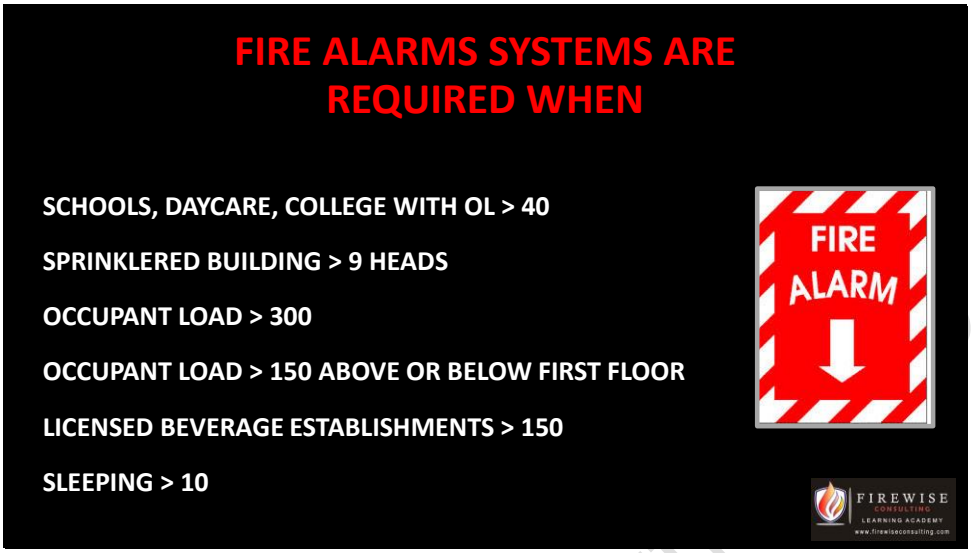
Welcome to Unit 4 Fire Alarm Systems.

A fire alarm system is one of the three most important fire safety measures in a building. As already covered in this program fire separation and adequate exiting are the others. This unit will identify when a fire alarm system is required, the types of systems available, the components that make up the fire alarm system and discuss maintenance and testing requirements.

The main purpose of a fire alarm system is to provide early warning of a fire so the occupants can evacuate safely. The fire alarm system may also be designed to notify the fire department so they can respond in the early stages of the fire.



There are many factors that determine when a fire alarm system is required. These include the type of building and what it is used for, what the total occupant load is, if it has an automatic sprinkler system throughout, what occupancies are in the building and what the local building code requires.



The requirements for fire alarm systems may vary from jurisdiction to jurisdiction but in most cases fire alarm systems are required in every building that is equipped with a sprinkler system that has more than 9 sprinkler heads or buildings that have an occupant load greater than 300. An alarm system is also required in buildings with an occupant load of more than 150 above or below the first story. Schools, daycares and colleges require a system when their occupant load exceeds 40.

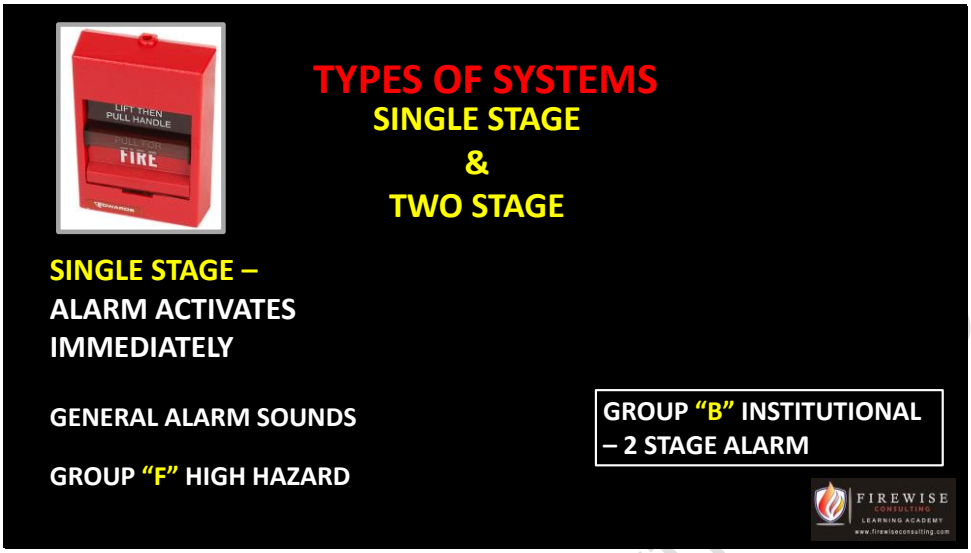
Restaurants and Licensed Beverage Establishments (Pubs) require an alarm system when their occupant loads exceed 150 people.

A fire alarm system is also required when sleeping accommodations are provided for more than 10 people.

A fire alarm system is **not** required in residential buildings like motels where each suite has direct access to an exterior exit facility leading to ground level. Also, a fire alarm system is **not** required if there are not more than 4 dwelling units sharing a common means of egress.

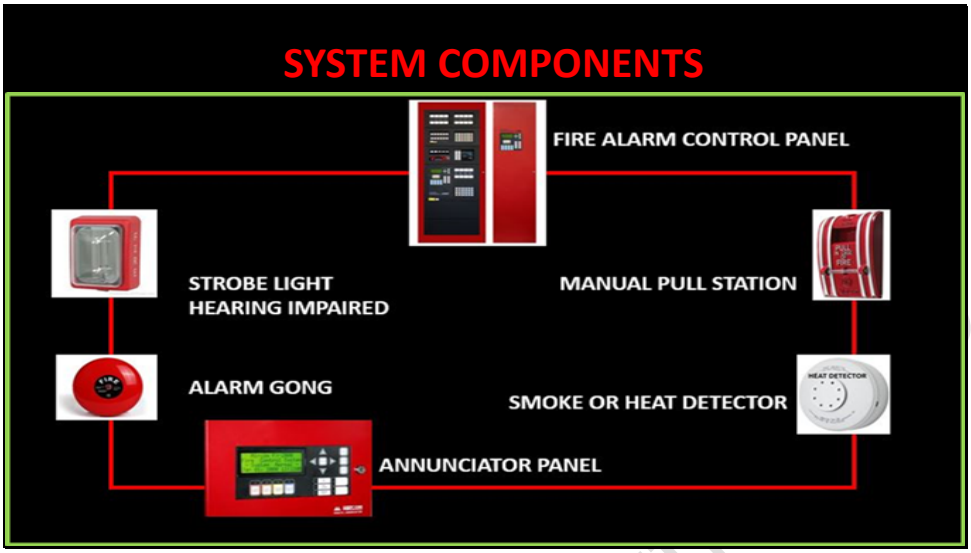
Occupant load calculations are based on two people per bedroom.

A fire alarm system is not required in an apartment building if no more than 4 suites share a common means of egress and the building is not more than 3 stories high.



There are two types of fire alarm systems – Single Stage and Two Stage. The most common is the Single Stage Fire Alarm System, designed so that upon activation of any initiating device like a manual pull station, smoke or heat detector a general evacuation alarm signal sounds on all audible signal appliances throughout the building. All Group F high hazard industrial occupancies are required to have a single stage alarm system. Most Group B institutional occupancies are required to have a two stage alarm system but other occupancies can have either a single or two stage system at the discretion of the owner or designer.

A two stage fire alarm system is designed so that the activation of any alarm initiating device like a manual pull station, smoke or heat detector will cause an alert signal to sound that alerts supervisory staff on duty about the fire emergency. Two-stage alarm systems are normally used if a general alarm would cause undue distress to the occupants, for example in health care facilities. In these facilities the evacuation of the occupants is difficult and could be physically or psychologically harmful. Therefore two-stage alarm systems are used to reduce the possibility of false alarms. Staff are constantly on duty and expected to immediately investigate the source of the alarm and, if a fire exists, to activate the alarm signal. The alarm signal is automatically set off after five minutes if the staff have not already activated it or reset the alarm system.



Fire alarm systems are made up of a number of components that work together.

Typically, a fire alarm system has

- A control panel that is normally located in the electrical room
- An emergency power supply which is usually batteries located inside the control panel
- Alarm initiating devices. These are manual pull stations, heat, smoke or other fire detectors that, when activated, send a signal to the fire alarm control panel.
- An annunciator panel which is normally located near the main entrance to the building where it will be visible to responding firefighters
- Signaling devices that notify occupants and possibly the fire department of the activation of the fire alarm system. These can be audible fire alarm bells and strobe lights to alert the hearing impaired.
- All these components must work together in order for the system to be effective.

The fire alarm panel is usually located in the electrical room of the building and can best be described as the 'brains' of a fire detection and alarm system. The fire control panel receives signals from initiating devices such as pull stations, heat and smoke detectors. It can also send signals to warn occupants about the fire through audible and visible signaling devices, notify the fire department, and control the spread of heat, smoke or fire by activating other fire systems like hold open devices on fire separation doors.

The fire alarm control panel also houses the primary and emergency power supply for the system, but more on that later.

A pull station, when activated, initiates an alarm on a fire alarm system. In its simplest form, the user activates the alarm by pulling the handle down, which completes an electrical circuit and locks the handle in the activated position, sending a signal to the fire alarm control panel.
Older manual stations required a single action or hand motion to activate the alarm but these were subject to unwanted activation by jarring or accidental contact. Early strategies to cope with this problem included requiring the operator to break a pane of glass to release an internal spring-operated mechanism.

Manual pull stations that require two hand motions, such as lift up and pull down, or push in and pull down, have since replaced the break-glass and single-action models in many modern installations.

Where a single stage fire alarm system is installed in a building that is not monitored by an approved monitoring company a sign must be affixed to the wall near each manual station stating that the fire department is to be notified in the event of a fire emergency. The emergency telephone number for the fire department must also be displayed.

After operation some fire alarm pull stations must be restored to the ready position using a special tool or key in order to deactivate the alarm and return the system to normal. Resetting a fire alarm pull station after it has been operated normally requires building personnel or emergency responders to open the station using a key which is often either a hex key or a more traditional key. Opening the station normally causes the handle to go back to its original position allowing the alarm to be reset from the fire alarm control panel after the station has been closed. Responsibility to reset the fire alarm system lies with the building owner or occupant. Most fire departments will not reset the fire alarm or initiating device due to liability concerns.

Firefighters by nature want to help people but they must understand the policies and procedures of their fire department when it comes to resetting fire protection systems and devices.

A smoke detector is a device that senses smoke, typically as an indicator of fire. Smoke detectors are part of a fire alarm system that, when activated, sends a signal to the fire alarm control panel. Smoke alarms on the other hand are a local alarm only and are not connected to the fire alarm system.

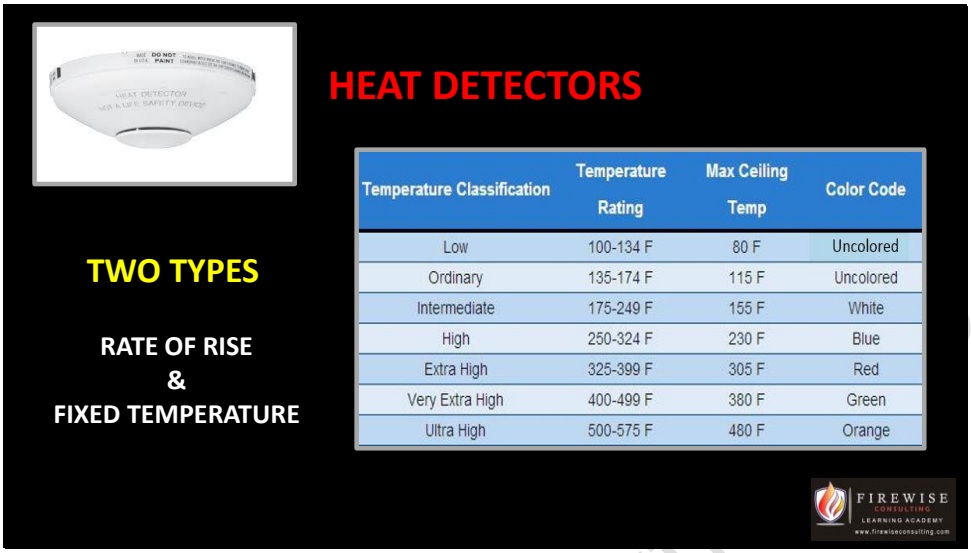
Smoke detectors react much faster to fire than heat detectors so they are required to be installed in certain locations by local building and fire codes.

When residential buildings like hotels, apartments and condominiums are equipped with fire alarm systems smoke detectors must be installed in public corridors, exit stair shafts and in the elevator room.

In institutional occupancies like homes for the aged and care facilities smoke detectors are required in each sleeping room and each corridor serving as part of a means of egress. They are also required in each room in a contained use area like a jail and corridors serving those rooms.

In assembly occupancies like churches, community halls, restaurants and licensed beverage establishments smoke detectors are not required as part of the fire alarm system.

Smoke detectors and smoke alarms seldom fail but can if they accumulate dust on their sensors. If the owner wants to clean the smoke detector or their smoke alarm they may clean the outer case and plastic cover, using a brush for the dry dust and dirt. Compressed air can also be used to blow dust away from the detector. The detector case can also be cleaned with a cloth dampened with a solution of dish washing liquid but the interior of the unit must be kept dry. They can also vacuum the exterior of the smoke detector with a vacuum cleaner brush attachment to remove dust. If the smoke detector continues to cause problems they should have it replaced by a qualified technician.



Temperature Classification	Temperature Rating	Max Ceiling Temp	Color Code
Low	100-134 F	80 F	Uncolored
Ordinary	135-174 F	115 F	Uncolored
Intermediate	175-249 F	155 F	White
High	250-324 F	230 F	Blue
Extra High	325-399 F	305 F	Red
Very Extra High	400-499 F	380 F	Green
Ultra High	500-575 F	480 F	Orange

Heat detectors are designed to go off when a certain temperature is reached or when the temperature in a room rises quickly. There are two types of heat detectors - Rate of Rise and Fixed Temperature.

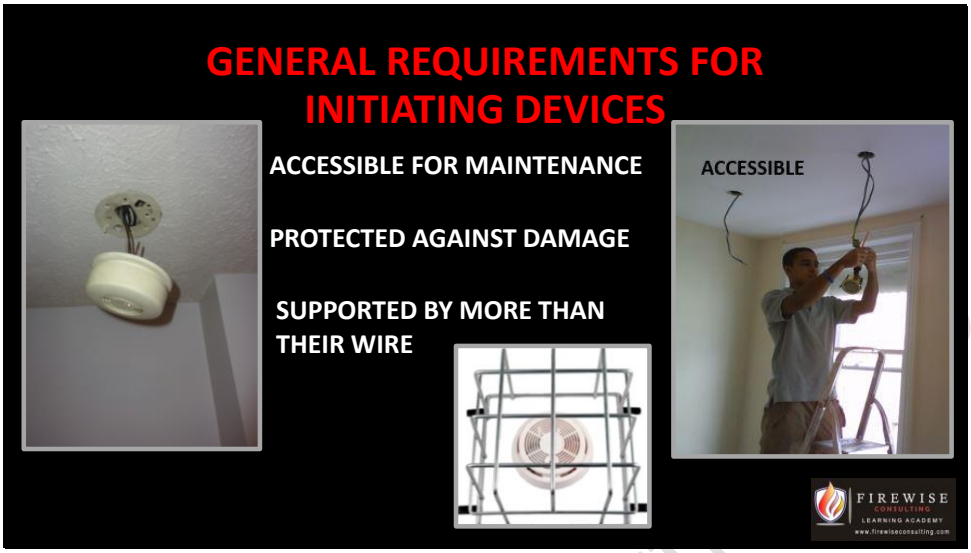
The Rate of Rise heat detector identifies a sudden rise in temperature triggering the activation of the fire alarm system. These detectors are particularly useful if a fire grows rapidly or explosively. If the temperature in the room rises quickly a signal will be sent to the fire alarm control panel and the alarm will be triggered. Rate of Rise heat detectors can be set to detect different rates of temperature change, depending on what is required for the situation. These detectors work well in cold areas.

Fixed Temperature heat detectors initiate the alarm when a certain temperature in the room is reached. A metal component in the heat detector melts at a certain temperature, causing the alarm to sound. The melting temperature varies depending on the area to be protected. Most manufacturers mark the operating temperature of the detector on the unit or color code the detectors for the maximum expected ceiling temperature. If false alarms occur the wrong temperature detector may have been installed.

This type of fire safety device is most useful in warning against slowly developing fires. The most common type of fixed temperature heat detectors use a fusible

link that melts when a pre-determined temperature is reached allowing a spring held under pressure to release completing an electrical circuit to actuate an alarm.

A heat detector is not designed to be used as the only fire warning system in a building. The vast majority of fires are detected more quickly with smoke detectors than with heat detectors. A combination of the two types of devices can provide the most reliable fire warning system.



The general requirements for all types of initiating devices include:

- Initiating devices should only be installed in accessible locations where the can easily be maintained.
- They must be protected if they are exposed to mechanical damage. They can be protected with a mechanical guard but the guard must be approved for use with the detector.
- Detectors must be supported by another means besides their own wires meaning they have to be properly attached to the wall or ceiling with a mounting bracket and cannot be left dangling.

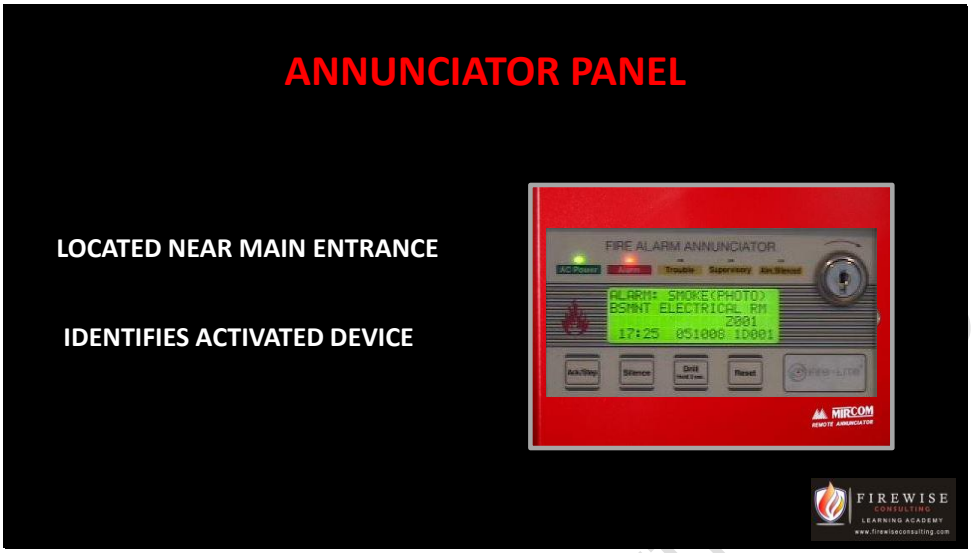
In addition to smoke and heat detectors there are also flame detectors. They are normally found in industrial applications and they detect the presence of light. They work well with hydrocarbon fires which have a tendency to emit ultraviolet and infrared light frequency wave lengths.

In some cases building and fire codes call for Fire Detectors to be installed as part of the fire alarm system. Fire detectors can be heat, smoke or flame detectors but the code does not specify which is needed. Normally heat detectors will be chosen because they are usually much less expense that smoke or fire detectors but it is the owners choice which to install.

If a fire alarm system is required in a building that is not sprinklered, fire detectors must be installed in:

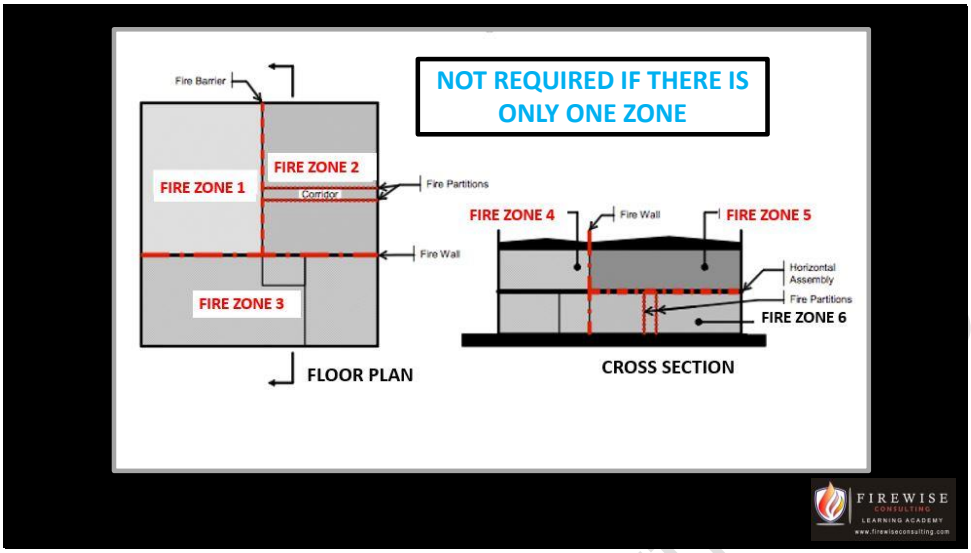
Storage rooms not within dwelling units,
Service rooms not within dwelling units,
Janitors' rooms,
Rooms in which hazardous substances are to be used or stored
Elevator and dumbwaiter shafts, and
Laundry rooms in buildings of residential occupancy, but not those within dwelling units.

Fire detectors are not required in floor areas that are sprinklered because the sprinkler head acts as a heat detector.



A fire alarm Annunciator Panel is a small keypad or LCD screen or collection of lights normally located near the main building entrance where the Fire Department can easily find it. They are typically small boxes that have an LCD screen, and a few buttons or a group of lights with floor numbers or zones beside each light. The lights indicate if the system is operating normally or a trouble condition exists and if an initiating device has activated and where that initiating device is located. The fire department and building management use the annunciator to quickly pinpoint the location where the device activated.

The Fire Alarm Control Panel, which is the brains of the fire alarm system, is typically hidden in an out-of-the-way electrical room or other places that the Fire Department may have difficulty finding. When the Fire Department arrives, they need to know where and why the fire alarm system activated as soon as possible. Instead of hunting for the control panel the Fire Department can look at the annunciator on a wall beside the main entrance and quickly establish what is going on.



Fire alarm systems are usually divided into zones and the annunciator panel indicates in which zone the problem has occurred. The zones should be each floor level in buildings more than one story in height, each fire compartment and each shaft required to have a smoke detector.
An annunciator need not be provided if only one zone is required.
Fire alarm annunciators generally beep when there is an alarm, or something is wrong with the fire alarm system. There may also be a pair of indicator lights on the annunciator specifically for the purpose of quickly differentiating between alarms and system troubles. A technician familiar with the fire alarm system should be called immediately when the system is beeping because it may be inoperable.

Fire alarm evacuation signals generally consist of a fire alarm gong or bell combined with visual strobe lights for the hearing impaired and are located in all common areas of the building.

Fire alarm gongs or bells have a standardized audible tone to avoid confusion with other signals and should be clearly heard throughout the building. The bells should be in the 65 decibel to 120 decibel range at 10 feet from the device.

One problem many buildings face is that the sound is too loud in parts of the building but barely audible in other parts. This can be overcome by installing a larger number of lesser rated audible appliances. Instead of trying to cover large areas with a few, relatively high powered audible appliances, the use of a greater number of lower powered appliances may overcome the problem.

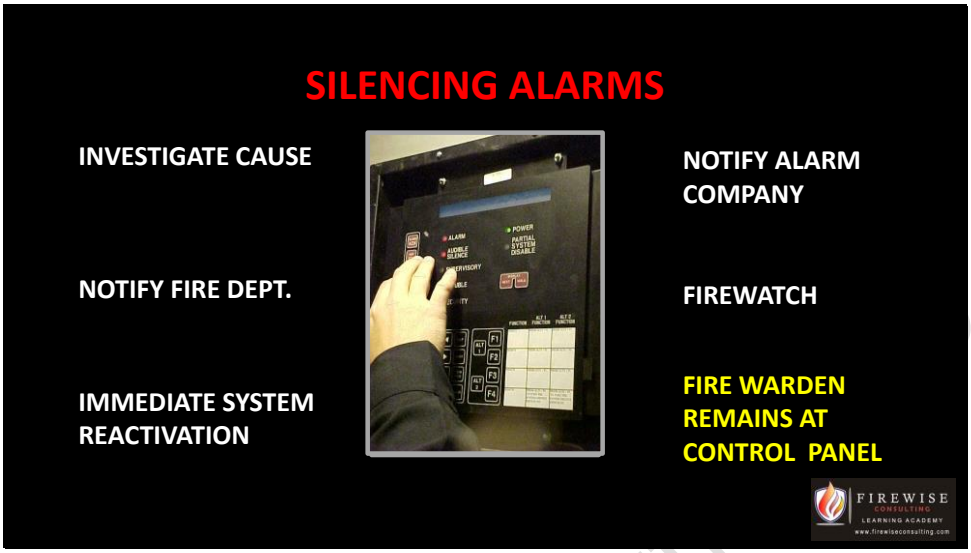
Visual signal devices must be installed in addition to audible devices in buildings intended for use by persons with a hearing impairment. Visual signals are also required in assembly occupancies where loud music is played, in any floor area in which the ambient noise level is more than 87 dBA, and in any floor area in which the occupants use ear protection devices.

Strobe lights range between 15 to 1,000 candela and should flash white or red incandescent lights at one second intervals.

With the aging population some existing fire alarm systems may have to be retrofitted to include visual signals or replaced.

Generally speaking fire alarm activation signals must be automatically relayed to the fire department when:

An assembly occupancy building has an occupant load more than 300
The building has an automatic sprinkler system
Or the fire alarm is a two stage system.



All buildings equipped with a fire alarm system need to have a Fire Safety Plan. Part of the Fire Safety Plan should include instructions on measures to be taken if the fire alarm is inoperable for any reason including breakdown, maintenance, or periodic inspection.

The building owner/manager may silence the fire alarm on the conditions that:
•an investigation of the area of fire alarm activation is concurrently taking place
•notification of the fire department is not affected or delayed
•the system can be immediately put back into full alarm mode where it is determined a fire or hazardous condition is present
•notification is given to any third party such as the alarm maintenance company
•a fire watch procedure is in place and can be implemented immediately

Building owners/managers or fire wardens who silenced the alarm must remain at the fire alarm control panel or annunciator panel until the fire department arrives and they have provided all necessary information to the Fire Department Incident Commander.

The Building owners/managers or fire wardens must assist the Incident Commander in identifying the cause, nature and origin of fire alarm activation. The operation of the fire alarm systems can be compromised because of accidental damage, building renovation or alteration, new construction and/or routine or emergency maintenance. When system shutdown is planned ahead of time at least 24 hours' notice should be given to the occupants of the building and the fire department. Depending on the use of the building and duration of the shutdown an approved fire watch may be required based upon a risk analysis.

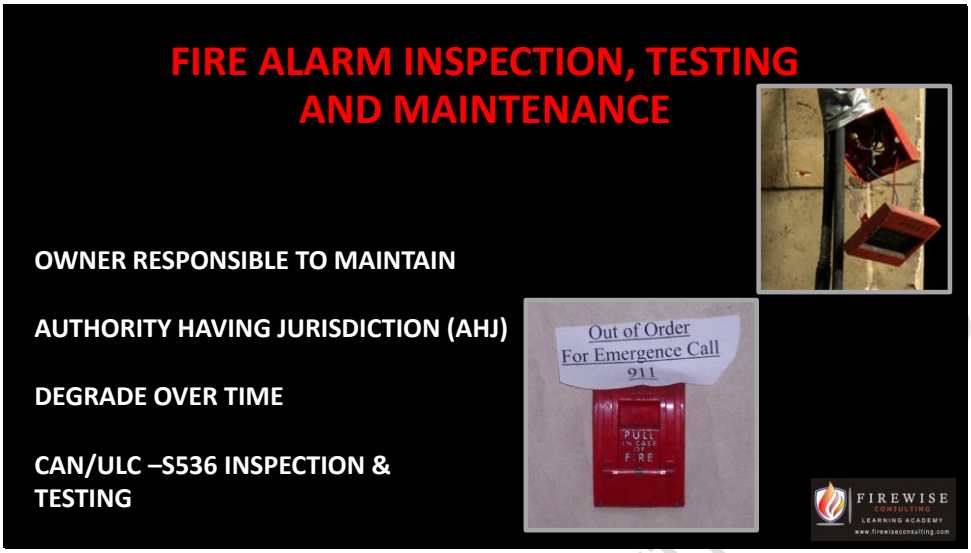
If the system is to be out of service for more than 4 hours signs should be posted in conspicuous locations and the main entrance to warn occupants that the fire alarm system is temporarily out of service and to call 911 if smoke or fire is noticed. If the building is equipped with a public address system an announcement should be made advising of the impairment and repeated every two hours until the system is operational.

As soon as the system is restored to full operation and tested the fire department should be notified, all signs removed and an announcement advising occupants that the system is operational should be made

The fire department can require a fire watch anytime a fire protection system is out of service. Usually they do this when the system will inoperable for more than 4 hours in a 24-hour period. It is the responsibility of the owner/occupant to provide the fire watch.

The procedures for a Fire Watch should be documented and include:

- The person assigned to perform the fire watch has no other duties
- They must initiate a warning to occupants and notify the fire department when necessary
- They must have portable fire extinguishing equipment available and be trained to use it
- They must try to extinguish a fire but only when it is very small
- The must make sure that no hot work and/or other tasks that create sparks or an open flame take place in the area



The owner is responsible to maintain the fire alarm system in operational condition at all times. The system must be inspected and tested in conformance with CAN/ULC-S536, "Inspection and Testing of Fire Alarm Systems" by a person acceptable to the authority having jurisdiction. Authority having jurisdiction means the governmental body responsible for the enforcement of any code.

Fire alarm systems are expected to help protect people, property, and assets. But it is hard to tell if they're fully operational just by looking at them. As with other electronics, components can degrade over time and compromise the system's operation. Dust, dirt, and other contaminants can cause problems with smoke detectors. Such things as vandalism, remodeling, and improper maintenance procedures can also damage fire protection equipment. The good news is that with proper testing, inspection, and maintenance fire alarm systems can be kept at optimum operating performance. In addition to ensuring protection, keeping your system in good condition reduces emergency repairs and false alarms.

Systems under five years old should require little effort to maintain.
Systems between five and ten years old may experience some component breakdown caused by normal wear, but this should be identified by the maintenance and inspection program.
Systems between ten and fifteen years old can still provide appropriate life-safety response but need close attention. Even with proper maintenance it's likely that failure of some components will occur. Owners should develop a replacement plan.
Systems over 15 years of age may be beyond their life expectancy. These systems may continue to work satisfactorily if properly maintained, but need continuous testing and inspection by trained specialists to ensure their reliability in an emergency.

Accurate and detailed records of routine checks, inspection, testing and maintenance of the fire protection equipment and systems in the building are required. These records must be retained for a period of two years and be presented to the fire department representative upon request. Some fire departments also require the records to be submitted to them annually.

A “check” means a visual observation to ensure the device or system is in place and is not obviously damaged or obstructed.

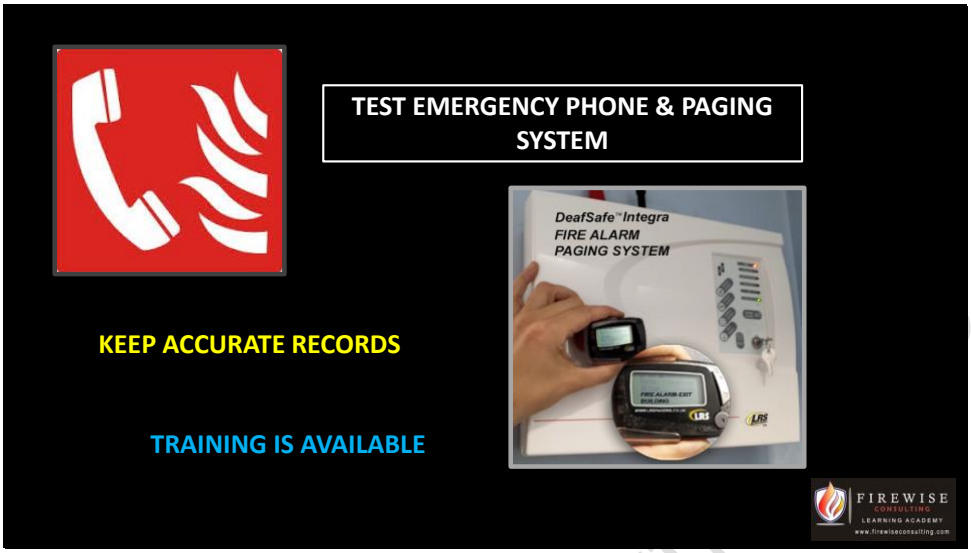
An “inspection” means a physical examination to determine that the device or system will perform in accordance with its intended function.

A “test” means actual operation of a device or system to ensure that it will perform in accordance with its intended function.

A visual check should be made every day to make sure the annunciator panel or the fire alarm control panel indicates normal operation. Any fault indicated must be recorded and receive immediate attention. Check the principle and remote trouble lights for trouble indication and make sure the AC power-on light indicates normal operation. Most jurisdictions do not require the daily check to be recorded.

Once a month a more detailed inspection of the fire alarm system is required. The person conducting the monthly inspection must:

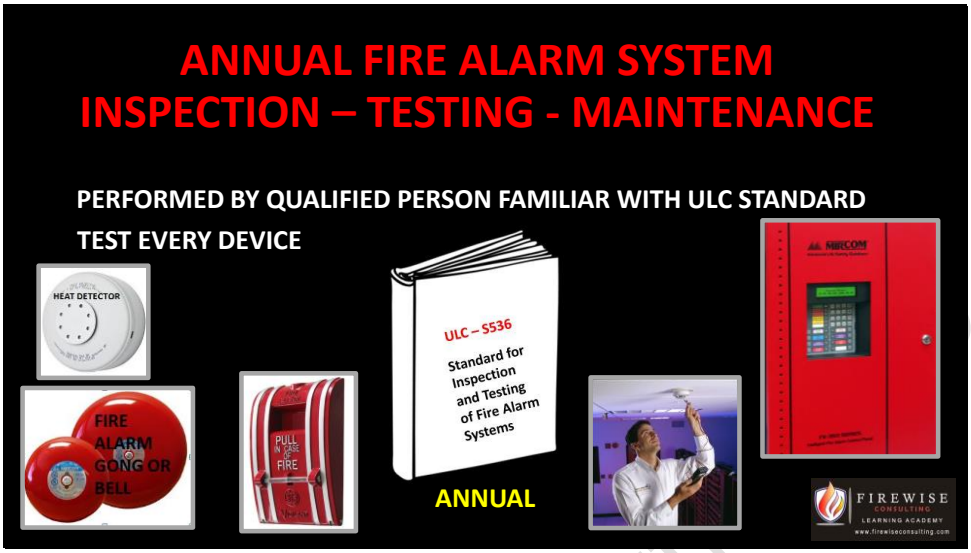
Confirm the system power lamp is illuminated
Test one initiating device on a rotating basis to ensure it sets off the audible and visual signaling devices
Confirm the annunciator indicates the correct zone where the initiating device was activated
Visually inspect the standby power batteries to make sure the terminals are clean, tight and lubricated
Test the system's "trouble indicator"



Test one emergency telephone if the system is so equipped
Test paging capability to one zone
Record the inspection in the maintenance log book.

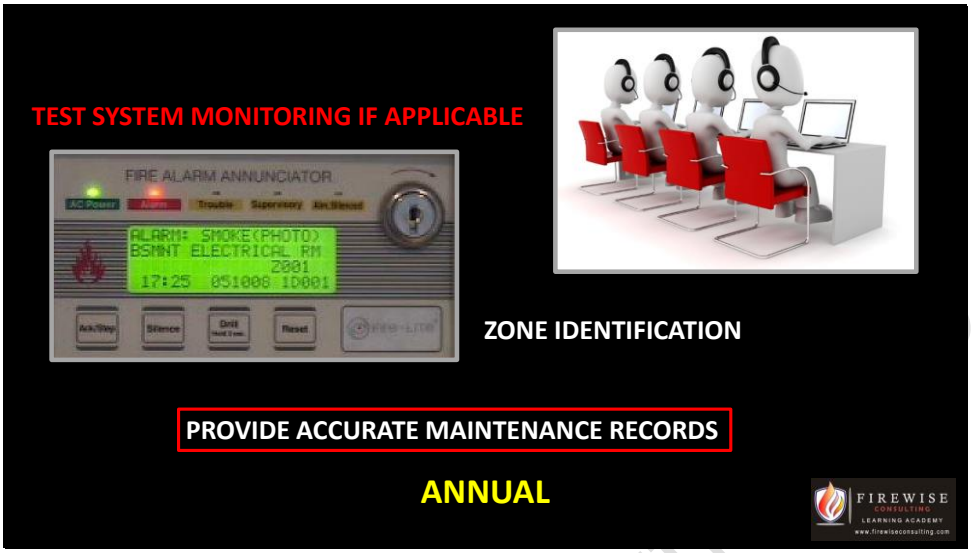
The monthly inspection does not need to be performed during the month when an annual test is conducted.

Most alarm maintenance companies will conduct the monthly inspection for the building but some are also willing to train on-site staff to perform this inspection.



An annual in-depth test of the entire fire alarm system is required and must be performed by a qualified person acceptable to the authority having jurisdiction. The person performing the annual test and inspection should be familiar with the ULC Standard CAN/ULC-S536. They should also have completed formal training or have sufficient experience acceptable to the authority having jurisdiction. All aspects of the system must be tested including:

An overall system check to ensure proper installation and examine any changes, alterations, additions or damage.
Access to, and functioning of, every connected device such as heat detectors, smoke detectors, pull stations and signaling devices. This includes devices in all common areas as well as any device inside dwelling units.
All auxiliary and ancillary functions and connections.
Internal fire alarm control panel.



Functioning of fire system monitoring, to ensure the monitoring company is receiving required trouble and alarm signals.
Alarm zone annunciation and operation of all remote annunciators, which inform the fire department or on-site staff where the device has been activated.
Functioning of EVAC (evacuation) system, including voice communication and paging systems, firefighters' phones and related equipment.
Documentation detailing the operational readiness of the system for review by fire department inspectors.

Some jurisdictions require the annual test documentation be sent to them.

Preparation is the key to effectively responding to emergencies. Fire drills help building owners, property management and others responsible for fire safety within a building to:

Conduct fire emergency response training for supervisory staff and others;
Determine the competency level of supervisory staff to respond in a timely manner and carry out their duties;
Determine occupant's response to the fire alarm activation
Assess the ongoing effectiveness of the emergency procedures; and
Comply with the requirement for conducting fire drills.

Fire Drills should be done:
Monthly in day-care centers and care and detention occupancies
In schools 3 times in each of the fall and spring school terms;
In high buildings every 3 months;
Every 6 months in laboratories where flammable and combustible liquids are used or handled; and
In all other buildings, fire drills shall be held once during each 12-month period.

Many fire officials consider an actual fire incident or accidental activation of the fire alarm system as a required fire drill, provided a thorough analysis of the incident occurs. It is important to analyze these types of incidents because they provide an excellent opportunity to assess the emergency procedures and preparedness of staff and occupants involved in an actual incident.

Fire drill procedures are part of the building's Fire Safety Plan which should be developed in cooperation with the fire department. When developing the fire drill procedures, consider the following factors to ensure the fire drills are relevant:

The building's use and associated fire hazards;

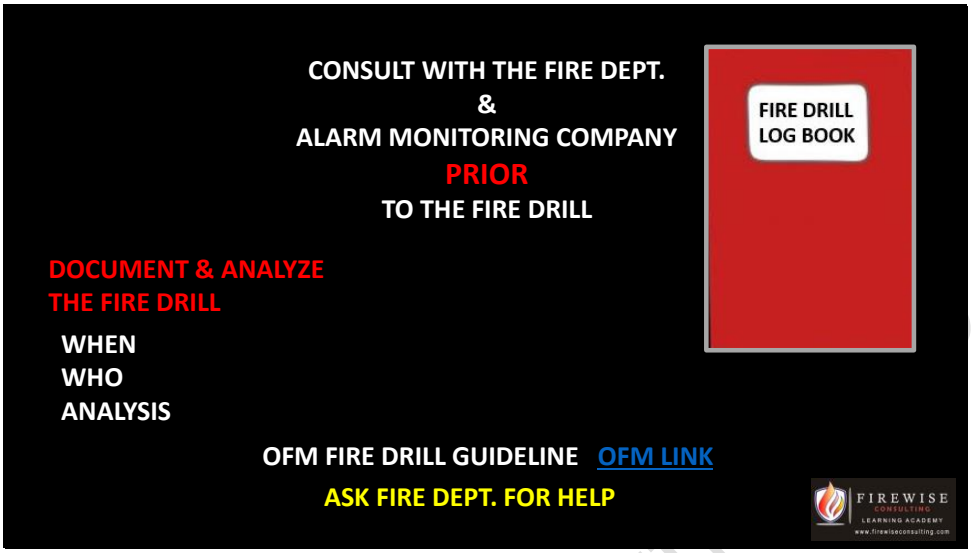
The safety features provided in the building;

The desirable degree of participation of occupants other than supervisory staff;

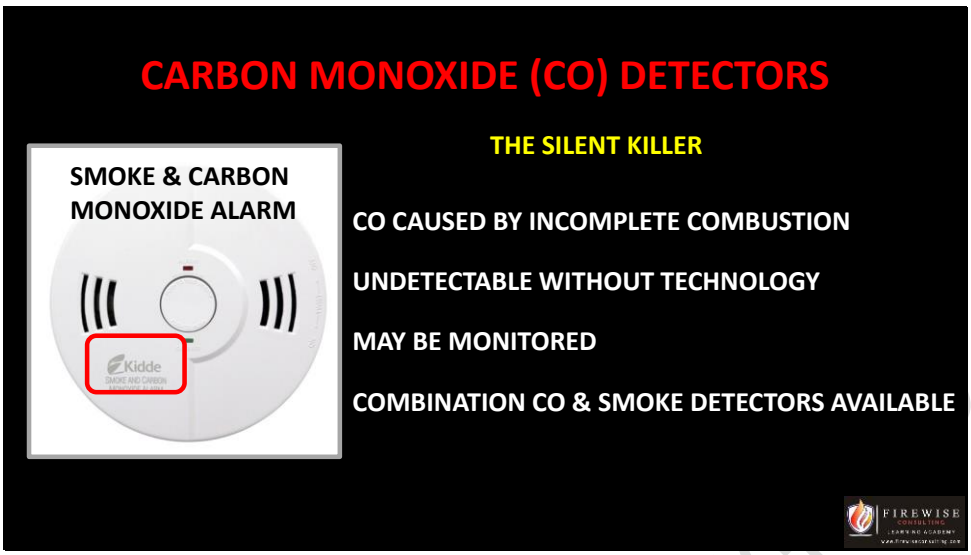
The testing and operation of the emergency systems installed in buildings

In buildings where the occupants live or work they should be encouraged to participate in fire drills. Occupant involvement provides opportunities to assess their preparedness to respond. Occupant participation also provides opportunities to use and become familiar with the primary and alternate evacuation routes, identify areas of refuge (where applicable), and become more aware of the building's emergency procedures that apply to them.

In a residential building or a building of mixed-use where multiple types of businesses are located, it is appropriate to notify the building occupants in advance of the date and time of the drill. In other buildings, such as a care and treatment facility it may be more appropriate to conduct unannounced drills, because in this environment, most employees are considered supervisory staff and are delegated with fire emergency responsibilities requiring assessment.

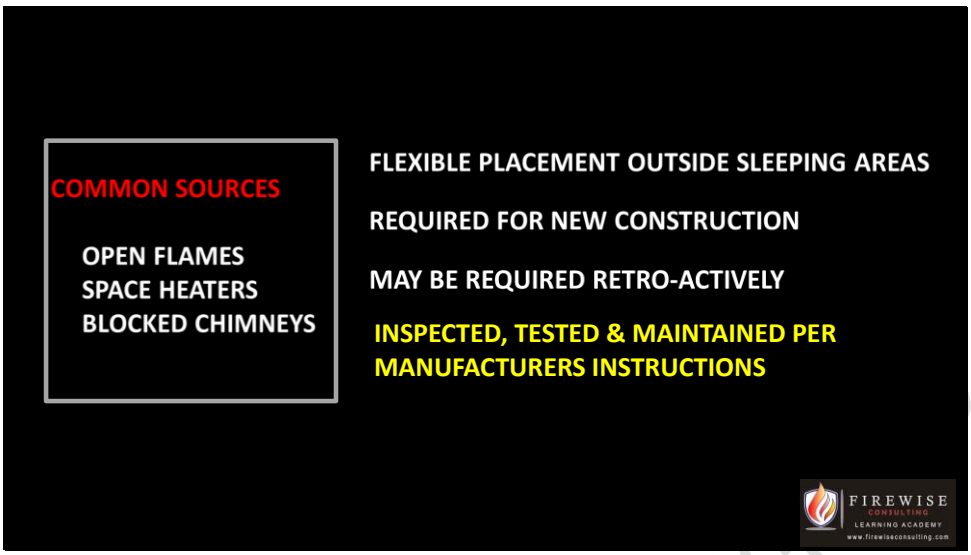


Encourage building owners or managers to consult with the fire department and alarm monitoring company, if the system is monitored, prior to conducting any fire drill. Fire drill documentation should be retained for a period of at least 24 months after the drill. The documentation should identify the date of the drill, persons participating and an analysis of the fire drill. Building owners can contact the fire department for more information. The Ontario Fire Marshal's Office has a good informational guide that can be obtained online.



Carbon Monoxide is a colorless, tasteless and odorless compound produced by incomplete combustion. It is often referred to as the "silent killer" because it is undetectable without using detection technology. Elevated levels of CO are dangerous to humans depending on the amount present and length of exposure. CO detectors are designed to measure CO levels over time and sound an alarm before dangerous levels accumulate giving people adequate warning to safely ventilate the area or evacuate. Some system-connected detectors also alert a monitoring service that can dispatch emergency services if necessary.

While CO detectors do not serve as smoke detectors and vice versa, dual smoke/CO detectors are available. Smoke alarms and smoke detectors react to detect smoke generated by flaming or smoldering fires, whereas CO detectors detect and warn people about dangerous CO buildup caused, for example, by a malfunctioning fuel-burning device.



Some common sources of CO include open flames, space heaters, water heaters, blocked chimneys or running a car inside a garage.CO detectors can be placed near the ceiling or near the floor because CO is very close to the same density as air.

According to NFPA 720 carbon monoxide detectors should be centrally located outside of each separate sleeping area in the immediate vicinity of the bedrooms," and each detector "shall be located on the wall, ceiling or other location as specified in the installation instructions that accompany the unit."

CO detectors are required by the Building Code for new construction and retroactively in some jurisdictions. Ontario for example recently passed legislation that requires carbon monoxide alarms in all residential homes so other Provinces can be expected to follow suit.

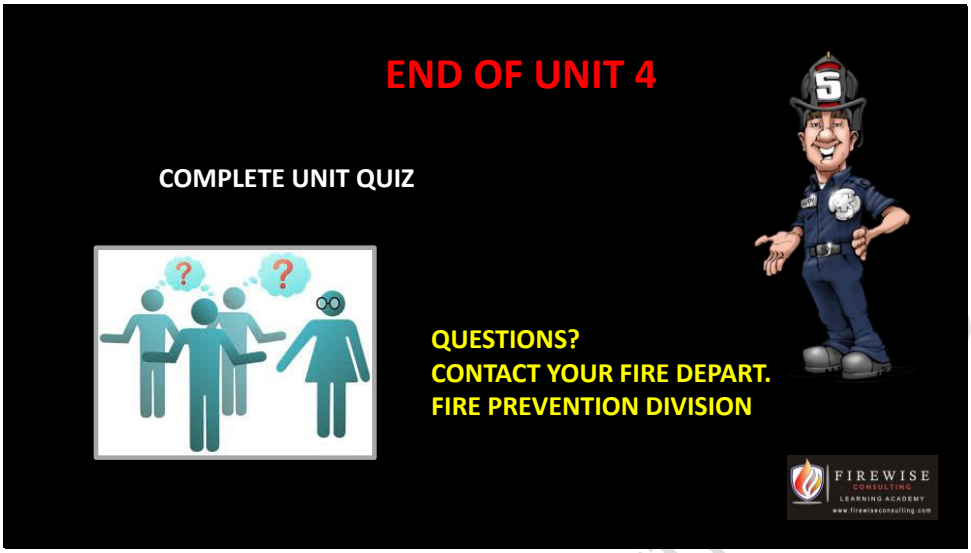
If CO detection is installed as part of a code requirement or voluntarily it must be inspected tested and maintained in conformance with the manufacturer's instructions.

Be prepared to answer questions about CO detection by knowing what policies are in place in your jurisdiction by discussing this with your fire prevention specialist or the building inspector for your jurisdiction.

In this unit we discussed:
That fire alarm systems are required based on the size, use and occupancy classification of the building.
The differences between single stage and two stage systems. Single stage systems react immediately to an initiating device while two stage systems initially send an alert signal.

The components that make up the fire alarm system including the control panel, annunciators, initiating devices and signaling devices.
Cleaning of smoke detectors and smoke alarms
Types of detectors including heat, smoke and flame
Audibility of alarms and signals to the fire department
Who is responsible for silencing and resetting alarms?
The requirements for a firewatch if the system is going to be out of service for an extended period of time
The inspection, testing and maintenance requirements for fire alarm systems and their life expectancy.
fire drills which are part of the Fire Safety Plan for the building
AND
Detection of CO “They silent killer”

We also discussed Carbon Dioxide detectors because the building code requires them for new construction and many jurisdictions require CO detectors to be installed retroactively in specific occupancies like single family dwellings with attached garages and other places that use fossil fuels.



Congratulations that is the end of Unit 4 which dealt with fire alarm systems. You are now ready to move on to Unit 5 which deals with portable fire extinguishers but first please complete the Unit Quiz. If you have any questions now is a good time to contact your local fire department fire prevention division.