3.13 Life (Fire) Safety, Fire Prevention, and Fire Protection

Keep fires infrequent and small. Help the occupants get out, the firemen get in, and save the structure

No one can be against fire safety. But, fire safety is not just adding fire protection sprinklers, fire alarms, and fire extinguishers. These desirable and beneficial devices must work with the walls, doors, windows, building structure, HVAC, and electrical components to form a system of fire prevention. Since these components serve other functions as well, their role in the fire prevention system cannot be known by looking alone. The identical material can be part of a fire prevention system in one application but not in another. And materials that look the same may have completely different fire prevention qualities. Relevant information is needed and is discussed below.

The Purpose of Life Safety Measures

Fewer fires, smaller fires, limited smoke

The purpose of life safety measures is to minimize the fire and smoke that can injure people or damage a structure. This is accomplished first by controlling combustion devices, such as furnaces and hot water heaters, so fire from these sources is extraordinarily rare. (Reduction in open flame space heaters over the second half of the twentieth century was one of the largest contributors to decrease in residential fires.) The second approach is to use materials that ideally Do not burn, or if they do burn, burn slowly and make an acceptable amount of noxious smoke. Finally, fire suppression systems keep the fire small, and extinguish it quickly.

Get the occupants out, the firemen in, and save the structure

The overall goals are:

1. To notify and get the occupants out of the structure safely (except where impossible, such as hospitals and prisons—as discussed below)
2. To get the firemen in as safely as possible
3. To provide the firemen adequate direction about the location and nature of the fire.

These goals require Fire-resistant construction for fire and smoke containment, and safe exit ways and notification systems, such as fire alarms.

Occupancy Types, Building and Hazard Fire Ratings

How difficult is the "fire problem"

Occupancy types—the occupants' capacity for self preservation and rescue

The "occupancy type" describes the probable speed and complexity of self-rescue measures that the intended occupants can be expected to take in a fire. The first consideration is mobility. Occupants who can walk normally are best. Occupants who are partially or completely incapable, such as infants, nursing home occupants, and those temporarily incapacitated in healthcare structures, are worst.

The second consideration is whether occupants can and will respond predictably when a fire is identified. This response will vary with mental capacity, and may vary significantly even among normally functioning people. For example, schools are generally considered to require frequent regimented fire drills to achieve the level of awareness that might be considered normal in an office building, which uses few or no fire drills.

The final consideration is the familiarity of the occupants with their surroundings. It is best if all occupants, except the occasional visitor, are completely familiar with all parts of the structure through long-term daily use, as would occur in offices and factories. The other extreme is auditoriums and sports arenas where familiarly with more than a few parts of the structure is unlikely.

Building structure fire ratings

How long can the building withstand a fire before being unsafely damaged?

The fire rating of a structure defines the time materials can resist a fire before deformation is close. (This is well before collapse.) Wood will deform by charring until the reduced size compromises strength. Steel will deform with softening by heat (not melting). And, concrete and masonry will deform by crumbling. Wood will have around a 1/2 hour rating, steel around 1-hour, and concrete up to a 3-hour rating. Addition of fireproofing materials can improve these ratings.

But "around 1-hour" is not information you can take to the bank. The materials, thicknesses, and heights of the entire assembly determine the fire ratings. The components must be UL (Underwriters Laboratories) tested, and the assembly size must be calculated in accordance with building codes. The sizes of the assemblies are determined by long, multi-step calculations by architects and engineers. Common sense alone cannot safely second guess this process. But, the knowledge that these are specifically constructed assemblies where everything has a purpose, aids correct installation and avoids problems in maintenance and renovation.

Hazard types—how flammable are the contents and operations?

The "hazard type" describes the likelihood that the contents and operations will produce a fire. Office, residential, and retail occupancies (uses) strive to have as little hazard as possible, by careful control of combustion devices and selection of less flammable materials. Warehouse hazards can vary by the contents of the warehouse. Less flammable products, such as steel, carry a lower hazard rating than more flammable products, such as wood products or carpet. The highest hazard is in industrial operations that use flammable, corrosive, toxic, or explosive materials.

There can be multiple hazard types for each occupancy type. Precise determination of the combination of occupancy and hazard types takes knowledge, experience, and calculation. The result makes sense, but cannot be determined by common sense alone.

The physical responses—fire walls, fireproofing, and fire protection systems—required by occupancy and hazard types are specified by building code. These codes are hundreds of pages long and written in language only a lawyer could love. Understanding and applying these rules must be left to the architectural design professional. However, the common sense ideas behind the rules are discussed here to give an understanding of what is being done and why.

For example, a hotel convention center would contain the assembly areas of the convention center, public areas such as the lobby, small meeting rooms, a commercial kitchen, and the residential hotel rooms above—many of which are different occupancies and hazards. Realization of why different construction will be required for each room is helpful. When originally constructing the building, the dividing line between these parts of the building and the fireproofing, fire protection, mechanical, and electrical requirements must be known. These requirements must be considered with even the smallest remodeling project—where moving a single wall or moving or removing a single mechanical or electrical device from one occupancy to another could destroy the continuity of a fire compartment—rendering it useless—with possible disastrous results.

Occupancy type, building and hazard ratings are interactive

All three work together to make a safe building. The occupancy type will limit the choice and specify the dimensions of possible structures. And changes in hazard rating can require changes in building structure or restrict possible occupancies. So all parts of the life safety system must be specified for each project. Common sense, intuition, and rules of thumb alone are not enough.

Fire Control By Limiting the Fire's Fuel and Air

Build with less flammable materials

Use of less flammable materials—steel, concrete, and masonry—has long been normal in industrial structures. Commercial structures, where a more decorative "softer" feel of fabrics and wood is desired, have used more flammable materials. But, improvement in these materials over the last half of the twentieth century has been huge. Fire retarding additives have improved engineered wood products (plywood, particle board, and OSB), and are now stocked in commercial supply houses. Surface-applied flame retarding chemicals can be added to fabrics and solid woods. Improvement in all aspects of synthetic fabrics has made them more Fire-resistant. This reduction in flammability without compromise of material choice or significant cost increase is now the norm in building construction—as well as interior furnishings and window treatments. These improvements lag in residential construction.

Shut off the fuel supply

Wherever a significant volume of pressurized flammable gas or liquid is delivered, this supply is stopped when a fire is sensed. The usual method is to have a fire alarm signal close a powered valve in the fuel supply line. This method is used in industrial fuel handling systems, commercial kitchens, and very large commercial buildings. Few small commercial buildings and fewer residential buildings use this method.

Shut off the air supply

Most commercial structures over about 2,000 sf (with about 2,000 cfm air supply) will automatically shut down the mechanical ventilation blower when fire is sensed. In small commercial buildings without a central fire alarm, this is done by a stand-alone smoke detector in the return air duct. In larger buildings, the central fire alarm system is used. The blower and the combustion source for heating are interlocked—so shutting down the blower also shuts down the flame source. This has a similar effect, but is a poor cousin, to the fuel shutoff described above.

Pressurize compartments to contain smoke

A further measure included in high-rise buildings and similar types of structures to control fire is to mechanically pressurize the space surrounding a fire compartment. This consists of completely shutting off all mechanically supplied air to the space, and mechanically pressuring the air on the other side of the fire compartment. This prevents smoke infiltration into the corridors and adjacent compartments, or the floor above and below, and directs the smoke to the exterior.

Building Compartments—Keeping Fire and Smoke in a Small Box

Compartments to contain fire and smoke

The normal structure is compartmentalized into areas that will contain the fire and smoke originating in an area. The size of the compartment allowed is precisely calculated by a combination of the occupancy and the hazard types as described above. An example of the possible size ranges of the compartments is: warehouses 100,000 sf, retail space in a single-story shopping center 30,000 sf, healthcare occupancy 4,000 sf.

For the highest hazards, where large quantities of highly flammable or explosive materials are contained, a reinforced fire-proof room restrains the blast with heavy reinforcing on all six sides except one small location designed as a point of blast relief. A smoke hatch on the roof, or a wall panel (usually measuring about 3 by 5 feet) that has a weaker connection and will fly out of the wall relieves and directs the smoke or pressure of the explosion to an acceptable location.

Compartments for safe occupant exit and fireman entrance

These compartments are constructed by using fire-rated walls, ceilings, and floors to build a six-sided box around the compartment. The materials used are typically noncombustible concrete, steel, masonry, and gypsum drywall. Using Underwriters Laboratories (UL) tested assemblies when building these assemblies, you must use exactly the components specified in the test. For example, if the test specifies 1/2" drywall, then using 5/8" drywall, even though it would seem to be better, is a failure. Floor, ceiling, and wall assemblies will commonly have fire ratings of one to three hours. Four hours is possible, in some cases, from a single assembly.

The fire rating describes the time it will take for a fire of a specified temperature (about 1,200−1,500°F) burning on one side of the wall to increase the temperature on the other a specified amount, or cause the wall to distort by a specified dimension, or collapse. If the fire-rated walls perform within these limits, the corridor formed by these walls will permit safe travel—by the occupants going out and the firemen coming in.

Fireproofing (ratings) to maximize the structure's resistance time

All of the structural components of a building—floors, columns, beams, walls, and roofs—can be, but are not always, fireproofed to maintain their necessary strength. Fire will damage wood by surface charring and then burning, steel by heating until the structure bends and buckles, and concrete will crumble. In all cases, structural failure occurs long before complete combustion or melting.

Fireproofing includes surrounding the structural component with Fire-resistant construction, such as masonry, concrete, drywall, or a sprayed-on insulating material. Less common are intumescent materials that expand when heated to provide a thicker insulating layer. Again, 1–3 hour fire ratings are common, and a 4-hour rating is possible with a single layer of fireproofing material.

The fire compartments for exit and the fireproofing for the basic structure are made of the same materials. They may even be close and touch, or may even occasionally be the same. They are both working for fire safety, but in different ways—and this distinction must always be remembered. For example, if a column is enclosed in a fire-rated wall, this wall is also serving as the fire rating for the column structure. If the wall is later removed, separate fireproofing must be added to the column. Or, if the occupancy of an existing building is changed, fireproofing of the entire structure may have to be upgraded. This is a complete system, not just a stack of bricks!

Making Fire Barriers Complete and Continuous

Fire stopping the penetrations—seal all small holes

The fire and smoke compartments must be continuous—without gaps, breaks, or penetrations. So, when multiple penetrations occur, such as pipes, conduit, and ducts, each and every one must be sealed so that the hole surrounding the penetration achieves the same fire rating as the overall wall. This is done by fire stopping caulks, putties, insulations, and related sheet metal assemblies. These again are all UL-tested assemblies that must be installed in accordance with the directions. Common sense and intuition does not preclude knowledge here—if it isn't tested and labeled Do not use it.

Fire stopping is not a small task. For occupancies such as a healthcare facility with huge amounts of piping and conduit, the cost of the fire stopping can exceed the cost of the wall. Scheduling the fire stopping construction early, when accessibility is greatest, is the best opportunity for cost reduction.

Fire dampers in HVAC ductwork—seal these large holes too

For HVAC ductwork penetrations, the interior of the ductwork area must also be considered. Usually, for one-hour walls, the exterior of the ductwork is considered sufficient fire barrier, and no additional measures are needed on the interior. For fire ratings greater than one hour, a fire damper must be installed inside the duct where it penetrates the wall. A fire damper is a piece of sheet metal that closes to make the wall barrier continuous. This damper can be activated by a fusible link (melted by fire) or a motor activated by a fire alarm signal. (Note: This damper then becomes a mechanically serviceable part and access panels must be installed in the area of the fire damper for service. Include this space in design and layout.)

Doors—close, latch, and stop the smoke and fire

Doors and frames in a fire-rated wall must have a similar fire rating as the surrounding wall. Usually the fire rating is just a little less than the wall—a one-hour wall may require 45-minute doors, a two-hour wall may require 90-minute doors. The exact requirements are specified by code and must be tested and labeled. The doors must also be self-closing and latching (so they cannot be pushed open by air, fire or smoke pressures). If these self-closing doors must usually be held open for convenience, the hold-open device must be connected to a fire alarm activated release device that closes the door automatically in a fire.

Interior windows are part of the fire barrier too

Windows in a fire-rated wall must similarly be fire rated. The frames are fire rated in the same way as doorframes described above, but the size of a glass is usually limited to about 3 feet square. The glass can be wire glass—where small wires are embedded in the center of the glass. Wire glass is intended to withstand moderate heat, then shatter when cooled by the stream of a fire hose, but still remain in place. (Wire glass is not security glass.)

Specially formulated heat-resistant glass can be used. But, it is slightly discolored, wavy, and not completely clear, and about 20 times the cost of wire glass. Finally, larger fire-rated wire glass openings are possible with a "water curtain." Here, fire alarm-activated sprinklers located on both sides of the glass saturate and cool the glass. This solution is usually found where cost is of little concern.

Fire Exit Corridors From and Between Compartments

Get the occupants out, or suitably contain them in "safe compartments"

Upon notification of a fire, if the occupants are physically able and mentally alert as occurs in most situations, the occupants will exit through the fire corridors down the fire stairs to the exterior of the building and to safety.

However, if all of these conditions are not met, such as in a hospital, nursing home, institution for the mentally ill, or a prison, it is physically impossible to have the staff evacuate the immobile residents fast enough, or to have some undesirable residents on the streets. In these cases, the fire and smoke compartments serve to make safe that part of the building. The staff and the residents stay in the event of a fire, and the fire corridors are not used for immediate evacuation of the occupants.

The second case requires more fireproof materials and more fire prevention systems. However, if one were to attempt to remodel this more hazardous type of occupancy into a less hazardous office occupancy, these fire corridors would have to be added—which might be unfeasible. More demanding occupancy and hazard requirements mean different, but not necessarily universally better, measures are needed.

The basic understanding described above is necessary to understand wet fire protection systems, sprinklers, and fire alarm systems. The building of compartments, fire protection sprinklers, and fire alarms are all using the same theories—to achieve the same goals—and you cannot understand the purpose of one, without understanding the purpose and use of the others.

Get the firemen in

Fire-rated corridors between fire-rated compartments permit the firemen to gain safe access to evacuate occupants, and fight the fire. The corridors exist for these reasons in all occupancies. Proper fire rating of the structure is critical for the safety of the firemen during fire fighting operations.

Fire Protection Sprinklers

Fire protection sprinklers keep fires small and short

The purpose of fire protection sprinklers is to sense fire and spray water on it so it stays small, local, and is quickly extinguished. (In industrial applications, where water cannot extinguish chemical fires, foam and other chemicals can be used.)

Where the water comes from—water service of the required volume and pressure

It is feasible to mechanically pump the water from surface water such as lakes or rivers, but the most common source is the city water mains. The size of the water line required for fire protection is far larger than the size of the water line typically required for domestic plumbing. For example, if a 1" water line is adequate for plumbing, a 4" water line might be required for fire protection. The number of fire protection sprinkler heads (which are related to the area of the building, plus the pressure required to reach the highest point) and their probability of discharge determine the size of the line.

The pressure that is available at the water main is determined by placing pressure meters on the closest and the adjacent fire hydrants near the point of connection. Then the fire hydrants are opened and fully discharged, and the initial pressure and flow and the drop over a period of about 10 minutes is measured. These tests are witnessed by the fire department and then recorded as the accepted pressure available at the main at that point. It is common that the city pressure will be adequate for a single story, and sometimes up to a three-story-building.

If greater pressure is required, a fire pump must be added. This fire pump boosts the water pressure and must be powered by a separate electrical service independent from the building electrical service. The entire service entrance conduit is concrete encased, and typically dyed red. The separate service is required, because in a fire, a fireman will first shut off electrical power to the building, to allow safe fighting of the fire—but the fire pump must continue working.

Separate fire protection sprinkler water to protect the potable water purity

The water in the fire protection piping may stand stagnant for years. Some rust from the interior of the pipes, the oil from the pipe cutting thread, and bacteria will foul this water. When draining down an existing fire protection system, 6"-8" of drain water in a bucket will obscure the bottom. Although this is of little concern if sprayed on a fire, it is of great concern if mixed with water intended for plumbing use inside the building.

A very common approach is to use the large fire protection line from the city main to the building for domestic water. This ensures continuous water flow through the fire protection line to prevent stagnation. The water going to domestic plumbing and the fire protection are then separated in the building by double back-check valves that prevent the fire protection water from siphoning back into the domestic systems if pressure drops at the main. The goal, although difficult to achieve, is to have no more than 6' of dead end piping for any domestic water system. Although this is the most common arrangement, some city water and fire departments require separate fire and domestic water mains from the street to building.

Two other supervisory components are added to this service entrance to signal system shutdown or water flow caused by sprinkler activation. One is a tamper switch, which sends an electrical signal to the fire alarm system if any valve is closed that prevents water flow to the fire protection system. The second is a flow switch that is a small flat piece of metal inserted into the piping which is pushed aside by water flow and sends an electrical signal to the fire alarm system. These signals must be sent back to the fire department, as described in fire alarm systems below.

The final component is the fire department connection, which is an exterior male connection onto which the fire department can attach a hose and mechanically pressurize the system from the pumps on the fire trucks. This is used in the event that the fire pump fails, or the pressure in the building fire lines is inadequate to supply the fire protection sprinklers. These are typically called Siamese connections and are two-headed fixtures on the exterior of the building located conveniently for fire truck access.

Distribution of the Fire Protection Sprinkler Water

Risers (vertical)

The sprinkler water distribution rises vertically through the building in pipe risers. These are vertical pipes located in an area most useful to the firemen, typically the stairwells. Fire hose connections, and sometimes fire hoses, are located on each floor so the firemen can fight the fire in that location. The firemen are assumed to have a maximum of 150' of hose, so if the fire risers are more than 150' apart, additional fire hose cabinets must be added. And, the 150' distance is actually physically measured by rolling out the fire hose and seeing if it reaches the most remote point. So corridors and obstructions must be taken into consideration. Some small remodeling projects can require large fire protection changes to maintain the maximum 150' distance.

Mains and branches (horizontal)

From the risers, a grid work of mains (larger pipes) and branches (smaller pipes) cover each floor area. This grid work may be, but is not always, zoned with 2–4 zones per floor, somewhat corresponding to fire compartments. But there will be more fire compartments then fire protection zones.

The purpose of the zoning is first to send a signal that identifies the location of the sprinkler discharge and fire. The other purpose is to limit the time of maintenance or renovation operations, to minimize cost and maximize safety. When a sprinkler head must be replaced, all water must be drained from the system. Draining and refilling an entire multi-story building can take 8–16 hours. And, no fire protection for the building will be working during this time.

Activating Fire Protection Sprinkler Heads

Fusible links and fire alarms are used

Wet pipe systems—common for most occupancies

With a wet system, all pipes are continuously filled with pressurized water. Each head consists of a diffuser to spread out water spray, a fusible link, and a restraining disk that holds the water back. When a fire melts the fusible link, the disk falls away, and water sprays on the diffuser (typically a star-shaped piece of metal on the bottom of the fire protection head) and spreads an even pattern of water droplets below. Only the activated heads will spray water, so water damage from a single head discharge may not be great. This is the most common type of system, and will be used unless low temperature or high hazards require other systems.

Dry pipe systems—when pipes must be protected from freezing

Dry pipe systems work similarly as the wet systems with one exception. In areas subject to freezing, the piping cannot be continuously filled with water. It is instead filled with pressurized air or nitrogen. When a sprinkler head opens, the pressure drops and a valve near the service entrance fills all the pipes with water and the activated sprinkler heads discharge. Dry systems are usually used in the attic spaces of sloped roof structures in cold climates (e.g. nursing homes, banquet halls, and country clubs). A dry pipe system in the attic is in addition to the wet system in the floor below, so cost and maintenance complexity increases.

Preaction systems—a dry pipe system with faster response

The preaction system is similar to the dry system except the signal to fill the pipe with water is provided by an electrical device, such as a smoke or fire detector rather than a drop in pressure at the head. (The system acts faster—before a sprinkler head is opened.) This system is used where higher hazards exist.

Deluge systems—fast response and complete saturation

In contrast to the three systems described above, there are no fusible links or restraining disks with a deluge system. All heads in a deluge system are always open. And the piping is not pressurized with air or nitrogen nor filled with water. When a signal is sent from a device such as a fire or smoke detector, the entire system is pressurized with water and all sprinkler heads in the system discharge at once. This is typically used where highly flammable materials are stored. The water damage to contents is large.

Halon—when you can not or won't use water

Water is partially or completely ineffective in fighting some chemical fires. The most common application is the exhaust hood over the fryer and stove in a commercial kitchen. Here the chemical Halon is used, which is a gas that can suppress fire, but can be breathed by people in small quantities and for the short times needed to suppress the fire. A small canister (about 10" wide and about 1'-3' high) is located next to the hood. Heads are placed over the hood and can either be activated by a fire alarm signal, or manually by hitting the panic switch near the canister.

Water must be avoided for electronics, such as computer rooms or phone switches, where even a little water will completely destroy the equipment. The activating devices can be far more sensitive—using smoke, heat, and light sensing. The contents are not water damaged, but at a cost. A Halon refill charge for a 20-foot by 30-foot room can equal five weeks' wages.

Chemical suppression systems for flammable or explosive contents

For some chemical fires, water has no effect and can even make a fire worse. In this case, pressurized foam discharge suppression systems are used. The cost and clean up are considerable.

Multiple systems in one structure

A single structure may include multiple types of wet fire protection systems. The most common example is an unheated roof structure above a single-story building, which would require both a wet and a dry system. Further, very early response systems, such as "a water curtain" (fire protection sprinklers sprayed on glass areas to increase their fire rating) may be needed. And rack storage in a warehouse can require a sprinkler grid on each rack. Further, fast response sprinklers for flammable liquid storage may also be needed.

Location of Fire Protection Sprinkler Heads

What must be protected—where main lines must be located

Every horizontal level in the building where a fire can originate or spread—including crawl spaces, floors above ceiling spaces, attics, or roof structures—may require a fire protection system. If the vertical heights between horizontal assemblies are small and all materials are noncombustible, such as a drop ceiling in a commercial office building, sprinklers may not be required in the above ceiling space. Reducing the size of fire compartments and using fire-proof materials can also remove the requirement for attic fire protection sprinklers in sloped roof structures.

These few examples show typical ways fire protection rules are applied—to show these rules are founded on sound principles. The specific determination of where fire protection sprinklers are required, is determined by calculations in the building codes determined by occupancy type, hazard type, size of the building, and materials of the building, and can be further altered by local fire department regulations. (These calculations are about as interesting as filling out income tax forms, and unfortunately, just as necessary.)

But realization that the entire system of fire compartments and protection systems are related is useful. Raising a roofline "just a little" can more than double the cost of a fire protection system. Moving a fire compartment "just a few feet" can make the whole system fail. The need for design by competent architects and engineers, and installation by educated construction personnel is obvious.

Warehouse shelves can greatly increase requirements

One special case that is frequently encountered and deserves mention is rack storage in a warehouse. Here, the spacing of the racks and the combustibility of the materials to be stored can require that each and every level of every rack have a separate branch line with heads. This should be noted because changing racks or changing the hazard of stored material in an existing building can trigger this more burdensome requirement. Since racks are generally installed after completion of the building, and fire protection sprinklers are contractor designed after contract award, they can be missed in the original building design. Missing such a large quantity of fire protection heads can mean the entire service entrance mains and distribution for the system are undersized, and will have to be torn out and completely replaced!

Spacing of fire protection sprinkler heads

Maximum and minimum head spacings and clearances

Spacing of fire protection heads for a light hazard occupancy should be no more that 15' on center with no head more than 7'6" from a wall. The heads can also be no closer than 4' apart and no closer than 4" from the wall. The minimum dimension is required because closer spacing can cause one head to discharge onto an adjacent head—keeping it cool and preventing it from activating when it really should. Personal property, cabinets, millwork, furniture, and equipment cannot be placed any closer than 18" from a sprinkler head (obstructing the water flow from an activated sprinkler head would prevent the needed coverage).

These rules are specified in NFPA13 (National Fire Protection Association) and are meant for construction personnel, so are written in plain language. (The building codes, which are not in plain language, determine if fire protection sprinklers are required, and the NFPA codes describe how to install them.) These are the basic rules of thumb for spacing. For more hazardous occupancies, the 15' spacing can decrease to 10', with a corresponding reduction in some of the other dimensions. For special cases, such as step decorative ceilings (atriums), there are further rules about minimum and maximum spacing. The exceptions are about 100 pages long. Careful engineering is required for each project, but knowing minimums, maximums, and clearances helps you to understand what can and should be done and why.

The fire protection sprinkler bonus—requirements eased, problems solved

The addition of fire protection sprinklers allows a reduction in other requirements. Fire compartment size can be increased, dead end exit corridors lengthened, and lower fire ratings used. Older buildings or a changed occupancy can have so many life safety deficiencies that a complete gut is the apparent economical way to achieve conformance. But addition of fire protection sprinklers can erase many deficiencies and make corrections minimal or nonexistent.

Fire Alarm Systems—Early Warning for Prompt Action

Fire alarm systems detect the presence of smoke and fire and transmit a signal to a responsible person for necessary action. They do not themselves suppress the fire. But, they can send a signal to devices that aid in suppressing the fire.

Sensing Devices in Commercial Applications

Smoke detectors

A smoke detector is typically installed at a ceiling location and can also be installed at above ceiling locations. In addition, a smoke detector can be installed in the return air stream near a mechanical unit for most mechanicals supplying over 2,000 cfm. (These duct detectors can be used to shut down the unit itself—even if no fire alarm system exists in the building.)

Heat detectors

Heat detectors can be installed on the ceiling, or above ceiling locations, and signal in the same way as a smoke detector. A smoke detector can sense smoke from even a very small fire that is not yet producing much heat. A heat detector can sense conditions that will soon produce a fire, even if a fire has not yet started.

Light, gas, and liquid detectors

Chemical sensors in the air, or systems that sense the presence of a liquid by differential electrical current at a floor line, or light sensitive devices that detect rapid variation in light produced by a fire, can be used in industrial applications—but are not typically residential or commercial applications. These devices have faster, more sensitive responses, but higher costs, and more false alarms.

Pull stations (switches people can activate)

Pull stations are a manual switch device typically located near an exit way or stairwell. An occupant, upon sensing a fire, can pull the switch and send a signal.

Tamper, flow, and trouble alarms

As discussed above in wet fire protection sprinkler systems, a tamper or flow switch can send a signal to the fire control panel. Another signal can be sent if a system is in "trouble," meaning that there is a mechanical or electrical malfunction in the system that requires attention—similar to the warning lights on the dashboard of a car. A tamper-and- flow signal can signal an alarm or activate a device, but a trouble light will not.

Fire Alarm Zoning and Notification

Locate the fire for faster response

The building fire alarm zones will be similar to the fire compartments discussed above, though less complete and less detailed. The fire department can be sent an alarm in two ways:

1. The fire control panel located near the entrance of the building will identify the location and nature of the device that sent the signal. This information helps the firemen fight the fire faster and safely.
2. A signal is also sent via telephone lines—either to an emergency response network or directly to the fire department, depending on the municipality. This will typically identify that there is a problem, but will not provide as much detail as the fire control panel.

Hard-wired "point to point" vs. addressable systems—both lower cost and increase precision

Before computers, the fire alarm devices had wires from the sensing device to a central collecting system down to the fire control panel, then back to actuate a device. Every device that sent a signal had a continuous wire to the device it activated—lots of wires. This made extensive zoning technically difficult, and made the diagnosis of any trouble in the system a time-consuming process of tracing wires.

Fire alarm systems are now "addressable" systems—essentially a computer. Each sensing or activating device, such as smoke detectors and heat detectors, contains a chip with a serial number. The fire control panel is a computer. When a device activates, it sends a signal to the computer, the computer sends directions as required—such as turn on lights and bells and close fire dampers. Because the computer understands the location of all the chips from the serial numbers, a more compact wiring system with fewer wires—a "back bone" carrying multiple signals on one wire—can be used. Individual wires from each device to the fire control panel are no longer necessary.

This makes the system far more economical to install, easier to maintain, and provides precise information on the location of a fire. The fire control panel can know the exact location of the smoke or heat detector that went off. Further, if a device must be replaced or relocated, the computer can be temporarily told that the particular device no longer exists. The maintenance procedure can be performed on this device and even if the procedures send a signal to the fire control panel, the signal will be ignored. The rest of the fire alarm systems will stay in operation throughout this procedure.

Devices activate to seal compartments

As described above, the fire alarm signal can activate the preaction and deluge fire protection systems, as well as the Halon systems for computer or electronics rooms. The system can also activate shutdowns of all mechanical blowers and pumps, closing of fire dampers, and closing of any doors held open by magnetic hold-opens. With these actions, the fire compartments are ensured and the mechanical system correctly evacuates air or pressurizes the surrounding compartments.

Monitoring of the fire alarm system—get fast help from afar

Fire alarm systems are electrically powered and work on electronic components. Therefore, continuous acceptable power is required, but this will be absent in a fire. Therefore, fire alarm systems must be powered—in the case of most commercial applications—by battery backup systems. These are typically calculated for the worst case occurring—the building must maintain the system in full operation for from 24- 72 hours depending on the occupancy type and municipality. For some applications, such as hospitals that have a second critical source of power, (an independent source of power from an entirely different power company grid) this critical power can also be used.

Fire Extinguishers—Local Use to Assist Exit, Not Fight a Fire

The function of fire extinguishers is for an occupant to temporarily suppress a fire in his local area, so he can exit to the outside. It is not intended as a fire-fighting tool. A typical fire extinguisher can be fully discharged in seconds and has limited capacity.

Fire extinguishers are typically rated by the source of the combustible material on fire as A, B, and C. These typically use a dry chemical, which discharges under pressure. They cover everything with a white powder that can take some effort to clean up. The alternative is a Halon fire extinguisher, which does not suffer from the same defect, but it is more expensive to use.

The required spacing of fire extinguishers in light-hazard occupancy requires that an occupant be no more the 75' from a fire extinguisher. So, in a long corridor fire extinguishers could be placed at 150' on center. In addition, there is also a requirement that the occupant can readily see the fire extinguishers. This will decrease the spacing, because of bends and corners, so that this requirement can be met.

At one time A, B, and C fire extinguishers were installed in different locations with the C type typically being a water-based system. This practice has faded. Now, except for the locations requiring Halon fire extinguishers, ABC fire extinguishers are at all locations so the possibility of error by misplacement is eliminated.

Summary

The goal of fire prevention is to keep a fire from starting at all. If it starts, make sure it burns slowly and in a controlled fashion, and keep it within manageable compartments. This way the people either get out, or if that is not possible, are suitably contained within safe compartments. Finally, the firemen come in to evacuate the residents and fight the fire.

Use of less flammable materials and minimizing flame sources is the first step in preventing fires. Stopping the supply of fuel and air to the fire is next.

Construction of building compartments keeps the fire and smoke local and assists occupant exit, and firemen entrance. Protecting the building structure with fireproofing materials makes the building safer for the firemen and minimizes permanent damage. Fire protection sprinkler systems and fire alarms all work together using the same principles to achieve the same goal. Understanding that all of these components, which are usually thought of separately, are part of a system makes correct installation of the components more understandable and likely.

In addition, understanding the relationship of components such as fire walls, fire stopping, and fire dampers gets all parts of the fire barrier installed at the same time, which increases productivity and decreases cost. This simultaneous increase in safety, productivity, and reduction in cost enhances project success.