Technical Principles and Practices of Fire Prevention

Module Storage

MODULE OBJECTIVES

The students will be able to:

- *Identify the types of storage occupancy.*
- *Identify the major fire and life safety issues in a storage occupancy.*
- *Given examples of potential hazards in storage occupancies, identify concerns and proper solutions.*
- *Given a scenario, describe the requirements for indoor storage of flammable liquids.*
- *Identify the major components of sprinkler systems.*
- *Shown a set of slides for a sprinkler system, evaluate the conditions shown and reference required corrective actions.*

STORAGE OCCUPANCIES

This module deals with the specifics of storage occupancies: buildings or structures used to store or shelter goods, merchandise, products, vehicles, or animals. Storage occupancies may contain various types and amounts of commodities, with varying degrees of hazards. Examples of storage occupancies include warehouses, freight terminals, parking garages, aircraft storage hangars, grain elevators, barns and stables, ministorage facilities, and boat storage facilities. At times these have distinct parts or multiple uses. When storage is incidental to the occupancy, it is classified as part of the main occupancy. An example of this would be a storage room within another occupancy, e.g., public assembly.

(BOCA), (NFPA), Standard, Uniform, and International Codes use the same basic definition: a building or structure used for storage.

TYPES OF STORAGE

In discussing the types of storage, we need to note that the classification depends on the contents stored at the time. This is important, because the contents can and will change; this can affect the classification. Also, certain areas of a storage occupancy used for defined tasks may fall in the industrial classification, thus affecting the overall classification of the occupancy as well as the hazard classification. In this case, the inspector needs to consider a mixed use occupancy classification.

Classifications of Hazard

There are three:

1. Low combustibility; no self-propagating fire can occur.

2. Liable to burn with moderate rapidity.

3. Liable to burn with extreme rapidity or poisonous fumes or explosion.

The major codes use the same basic classifications, with possible difference in terminology and depth of classification. The following matrix shows this comparison.

Levels	BOCA	NFPA	Standard	Uniform	International
Low combustibility; no self-propagating fire can occur	S2	Low	S2	Division 2	S-2
Liable to burn with moderate rapidity	S1	Ordinary	S1	Division 1	S-1
Liable to burn with extreme rapidity or poisonous fumes or explosions	H	High	H	H	H

Questions to Consider

In attempting to determine the classification of hazard for a particular storage occupancy, consider your response to the following questions.

- Do the contents qualify for a low-hazard classification?
- Do the contents qualify for a high-hazard classification?

If the answer to each of these questions is no, then the hazard of contents must be moderate or ordinary classification.

Bottom Line

The bottom line is that very few occupancies qualify as having a low-hazard content, and occupancies containing high-hazard contents are rare. For the purpose of this module, we will concentrate on storage occupancies with ordinary or moderate-hazard contents.

Also consider occupant load in your review of the hazard for a particular storage. In general, the load will be very low, minimal to say the least. But some facilities will have a larger-than-expected work force on the floor. You need to consider this and apply your jurisdiction's applicable life safety requirements.

Standards and Codes Relating to Storage

It is extremely important that you consider your applicable codes. First address the applicable fire prevention code for your jurisdiction. Through this code, you must identify and review the referenced codes that have applicability. There are other codes that you may want to review to learn more about the many considerations within different type storage occupancies.

NFPA 230, *Fire Protection for Storage*.

NFPA 231D, *Standard for Storage of Rubber Tires*.

NFPA 30, *Flammable and Combustible Liquids Code*.

NFPA 30B, *Code for the Manufacture and Storage of Aerosol Products*.

NFPA 13, *Standard for the Installation of Sprinkler Systems*.

NFPA 10, *Standard for Portable Fire Extinguishers*.

NFPA 101, *Life Safety Code*.

BOCA *National Fire Prevention Code*.

Standard Fire Prevention Code.

Uniform Fire Code.

International Fire Code.

These standards are complicated and will require further and continual indepth study.

COMMODITIES

When making an initial determination of the hazards found in storage occupancies, you also must consider the commodities that may be present. This classification will affect the requirements for the automatic fire suppression systems directly. This classification is the level assigned based upon the combination of products, packing material, and container(s).

There are four levels of classification that are listed in NFPA 13 and 230.

Class I--Essentially noncombustible, products on wooden pallets or in corrugated cartons.

Class II--Noncombustible products in slatted wood crates.

Class III--Commodity of wood, paper, natural fiber.

Class IV--Commodity constructed partially or totally of Group B plastics, or consist of free-flowing Group A plastics.

HAZARDS IN STORAGE OCCUPANCIES

Fire hazards for storage center on three main areas: people, use of equipment, and natural causes.

People

In the "people" area, we need to focus on the two causes of fire: deliberate and accidental. Within the deliberate cause, the major problems for storage occupancies are juvenile firesetters, profit-oriented arsonists, or thieves covering up for another crime. The accidental list is fairly lengthy and contains the most common causes within storage occupancies:

- careless use of smoking materials;
- poor housekeeping practices;
- improper storage of idle pallets;
- storage of materials in aisleways;
- improper cutting and welding operations;
- ignition from industrial trucks;
- placing materials too close to heating units or electrical appliances; and
- improper use of equipment.

Equipment

Improper use of equipment includes concerns with wiring of the equipment, proper space for ventilating between pieces of equipment, portability of the equipment, and vehicles. Inspectors need to consider the proper and timely maintenance of equipment.

Storage of Specific Materials

Idle wood or plastic pallets should be piled no more than six feet high. If they are piled higher than the sprinkler system, the pallets must be calculated for a greater discharge density. If no sprinkler system is present, these pallets should be stored outside the facility.

Rubber tires can be stored on their sides directly on the floor, or on their tread; another method is to store them in fixed or portable racks. Tires in storage create a very high fire hazard. Consider here the automatic fire protection system, the venting of the facility, and the ability of fire suppression crews to enter safely to extinguish any fire.

Roll paper may be stored in any fashion: on its side, on end, on pallets, or in racks. The consideration is the configuration of the storage and the capability of the sprinkler system. An additional concern is the weight of the paper when it becomes saturated with water.

Refrigerated storage offers a unique concern with temperatures in the facility. These temperatures may range from 65°F (18.3°C) to -60°F (-51.1°C). Not only the combustibility of the structure itself, but also the additional insulating materials used, are areas of concern in these facilities.

Outdoor storage should take access into account, with driveways at least 15 feet wide and aisles 10 feet wide. There should be adequate fire protection, per the code you are using.

Natural Causes

Natural causes of fire include lightning hits and basic weather-related occurrences. Spontaneous combustion from oily rags also could fall into this group. Window placement and type of material used could present a hazard. A direct southern exposure, with glass that could magnify the sun's rays, may ignite combustibles.

FLAMMABLE AND COMBUSTIBLE LIQUIDS

Flammable and combustible liquids are common in all types of occupancies. The recent shortage of energy sources has caused an increase in the storage of these products in both small and large quantities. Gasoline and fuel oils are the most common and most widely used. The inspector also should keep in mind that some of these liquids are not only flammable, but also are toxic or unstable. These will require particular consideration from the inspector.

The general principles for controlling the fire hazards associated with flammable and combustible liquids are to contain the liquid and vapors, and to minimize the exposure of the liquid to air. Prevention of flammable and combustible liquid fires and explosions may include one or more of the following techniques:

- exclusion of sources of ignition;
- exclusion of air;
- keeping the liquid in closed containers or systems;
- ventilation to prevent the accumulation of vapors within the flammable range; and
- use of an atmosphere of inert gas instead of air.

Here are specific sources of information that relate to flammable and combustible liquids:

- NFPA 321, *Standard on Basic Classification of Flammable and Combustible Liquids*.
- NFPA 325M, *Manual on Fire Hazard Properties of Flammable Liquids, Gases, and Volatile Solids.*
- NFPA 325A, *Flash Point Index of Trade Name Liquids.*
- NFPA 30, *Flammable and Combustible Liquids Code*.
- NFPA 31, *Standard for the Installation of Oil Burning Equipment*.
- NFPA 33, *Standard for Spray Application Using Flammable and Combustible Materials*.
- NFPA 34, *Standard for Dipping and Coating Processes Using Flammable or Combustible Liquids.*

When using these resources, it is very important that the inspectors determine the purpose and scope of the code and the conditions that do not apply to the code. It is impossible for inspectors to remember all the code requirements, but they should become familiar with the basic requirement each code addresses, and know where to look to find the correct, detailed requirements that would apply to the situation noted during the inspection. They should not attempt to memorize the code but simply become familiar with it and learn to reference it properly and quickly for appropriate hazards.

Flammable Liquids

Flammable liquid is a term that designates any substance having a flashpoint below 100°F (37.8°C), having a vapor pressure below 40 psia (pounds per square inch absolute), and a specific fluidity or viscosity (consistency consideration on a scale of water to tar). There are three classes of these liquids as shown in Figure ST-1.

Combustible Liquids

Combustible liquid is a term that designates any liquid having a flashpoint at or above 100°F. The classification also appears in Figure ST-1.

Flammable and Combustible Liquids			
Flammable Liquids	**Flashpoint**	**Boiling Point**	**Example**
Class IA	Below 73°F (22.8°C)	Below 100°F	ethyl chloride
Class IB	Below 73°F	At or above 100°F	gasoline
Class IC	At or above 73°F	Below 100°F	butyl alcohol
Combustible Liquids	**Flashpoint**		**Example**
Class II	At or above 100°F but below 140°F (60°C)		kerosene
Class IIIA	At or above 140°F but below 200°F (93.3°C)		fuel oil #6
Class IIIB	At or above 200°F		fish oil

Figure ST-1

Many chemicals are solids at 100°F or above and therefore are classified as solids. When heated, the solids liquefy, giving off flammable vapors, and flashpoints can be determined. When in a liquid state these solids are treated like other liquids with similar flashpoints. These solids include paste waxes and polishes. The flashpoint and amount of liquid in the material will determine the degree of hazard.

The concept behind this classification system is to divide liquids that burn into three categories. In most areas, the indoor temperature could reach 100°F at some time during the year; therefore, all liquids with flashpoints below 100°F are Class I liquids.

In some areas, the ambient temperature could exceed 100°F, so only a moderate degree of heating would be required to heat the liquid to its flashpoint. Based on this, an arbitrary division of 100°F to 140°F exists for liquids with this flashpoint. These are known as Class II liquids.

Liquids with flashpoints above 140°F would require considerable heating from a source other than ambient temperature before ignition could occur. They are Class III liquids. All the model fire codes use this classification except the Standard Fire Prevention Code, which does not separate Class III liquids into Class IIIA and IIIB. It uses a Class III designation and defines it as a liquid with a flashpoint at or above 140°F and below 200°F. In determining fire prevention code requirements, it is important to remember that it is the vapor of a flammable or combustible liquid, rather than the liquid itself, which will burn or explode.

The violence of flammable vapor explosions also varies, depending on the concentration and nature of the vapor, as well as the quantity of the vapor-air mixture and type of enclosure containing the mixture.

Flashpoint, commonly accepted as one of the most important measures of the relative hazard of flammable and combustible liquids, is by no means the only factor for evaluating the hazard. The ignition temperature, flammable range, rate of evaporation, reactivity when contaminated or exposed to heat, density, and rate of diffusion of the vapor also have a bearing. The flashpoint and other factors that determine the relative susceptibility of a flammable or combustible liquid to ignition have comparatively little influence on its burning characteristics after the fire has burned for a short time.

In determining the physical and fire characteristics of a liquid, the following material is helpful:

- NFPA 321, *Standard on Basic Classification of Flammable and Combustible Liquids*.

- NFPA 325M, *Manual on Fire Hazard Properties of Flammable Liquids, Gases, and Volatile Solids*.

Most of the violations concerning flammable and combustible liquids will occur with improper storage. This includes storage of excessive quantities, improper or unsafe storage containers, and improper handling or misuse of the liquid.

Inspection Considerations for Flammable and Combustible Liquids

Permit Requirement

Usually the codes require a permit for the storage, handling, or use of flammable and combustible liquids that exceed a given amount. The permit helps to control who uses, handles, or stores these liquids as well as the location and time of their use, handling, or storage.

Exclusion of Sources of Ignition and Air

- Open flame.

- Lightning strikes.

- Smoking.
- Cutting and welding.
- Hot surfaces.
- Frictional heat.
- Sparks.
- Static electrical discharge.
- Mechanical electrical discharge.
- Liquid and vapor containment--keeping in closed container or system.
- Ventilation of vapor to prevent accumulation within the flammable range.
- Minimize the exposure of the liquid to air through use of an atmosphere of inert gas instead of air.
- Use of explosive-proof fixtures and wiring in good condition.

Ensure that inside storage rooms meet the following special requirements:

- maximum amounts;
- fire-resistive enclosure;
- fixed fire protection system;
- door sill length;
- ventilation; and
- electrical wiring, equipment.

LIFE SAFETY FACTORS IN STORAGE

References

One of the most useful reference documents for inspections in general, as well as for specific occupancies, including storage, is the NFPA's *Inspection Manual*. This book gives an excellent overview of considerations for the inspector. Other references available that relate to storage and storage occupancies include the major fire prevention codes

previously mentioned, and the NFPA Standards developed for identified storage and types of storage.

General topics or considerations for the inspector to consider and then research in more detail:

- occupancy change from last inspection;
- building services;
- emergency lights;
- exit signs;
- fire alarm;
- fire extinguishers;
- fire protection systems;
- fire-resistive construction;
- hazardous areas;
- housekeeping;
- interior finish;
- means of egress;
- vertical openings; and
- operating features.

Before he/she arrives for the inspection, the inspector will have reviewed the file on the particular storage occupancy to note any concerns raised by the previous inspection. The inspector should begin the onsite inspection with a look around the entire outside of the occupancy. Any points of concern should be noted and reviewed later. Once the initial interview has been conducted with a representative of the property, the inspector should note immediately any change of occupancy since the last inspection. With this established, the inspector then would begin a review of the property, starting at either the top or bottom, in a systematic fashion.

Aisles

Aisles are a major consideration in storage occupancies. Aisles should not be less than 44 inches wide, and extend from the floor to the ceiling. Storage pile separation is defined within your specific code; NFPA 230 has some general guidelines. Wall aisles should be at least 24 inches (distance from storage to the wall). Storage should be placed and maintained to retard fire growth. Piled storage should be not more than 50 feet wide, or 25 feet wide if abutting a wall. Main and cross aisles located opposite window or door openings in exterior walls should have a width of at least eight feet. Width and depth, not abutting a wall, are determined per the code by the material and the material handling methods. In high rack, fixed-rack storage obviously is fixed per the design of the system. If

the inspector should notice a concern with the aisles within a facility with fixed racks, it should be noted and researched further.

Access

Access to the facility is essential for emergency services response. Buildings of 12,000 square feet or more should have access to at least two sides. The accesses should be clear of any obstructions or obstacles.

Small Hose Connections

Fire protection within storage occupancies should have, as a minimum, fire extinguishers and small hose connections. These requirements should be addressed further in your code. The Standard Fire Protection Code allows the fire official to omit these small hose connections. Generally though, the small hose connections will meet the requirements of NFPA 230. The hose should be 1-1/2-inch size, with enough hose to reach all portions of the storage area. The nozzles selected will be based on the hydraulic characteristics of the automatic sprinkler system, if present.

Other Considerations

Means of Egress

In considering exits and their paths, you will need to refer to your specific code. In general, at least two separate means of egress should be present. Exit access and travel distance must be at least 44 inches wide and clear of obstructions. These exits should be as remote from each other as possible, and within the distances allowed by the specific code. Smaller storage occupancies may have only one exit, as long as the travel distance is acceptable per the code. As you inspect these means of egress, you must consider the exit access, the exit locations, and the arrangement of the exit discharge. Storage occupancies, because of their nature, may change arrangements within the facility from time to time to permit greater use of the facility. These changes should consider the exit requirements, and the changes must maintain the exit requirements as established by the code.

Means of egress inspections should examine closely any blockage of exitways, travel distances, dead-end corridors or paths, and any security measures that may be in place.

Travel Distances

Travel distances are established per the hazard load; you must refer to your specific code. In general, a low-hazard classification has no limit, whether or not the facility is sprinklered. For an ordinary-hazard classification, nonsprinklered, maximum travel distance is 200 feet; for a sprinklered facility, the distance is doubled to 400 feet. For the high-hazard, nonsprinklered facility allowed travel distance is 75 feet, while for the sprinklered facility it is 100 feet. Dead-end considerations for each hazard classification: low hazard, no limit; for an existing facility of ordinary hazard there is no limit; and for a new sprinklered facility it is 100 feet; a new nonsprinklered facility is 50 feet. High-hazard classification must not have any dead-end considerations.

Doors

Doors within these occupancies may vary depending on their location and your specific code. In general, sliding doors and swinging doors are permitted. These doors should be inspected for proper use and maintenance and for automatic closure devices.

Exit Identification

Exit identification must be present. If the exit is not visible, then the path of travel must be marked such that no point is more than 100 feet from the exit sign. Exit identification must be illuminated. You should check for the proper response of these signs as well as the backup systems that may be present.

Protection of Openings

Another area of consideration with doors is the presence of any conveyor systems that pass through firewalls. These passages must be protected on both sides of the opening.

General Considerations for Storage Occupancies

- The floor loads should be safe. This may be difficult to determine visually. If there is a question, make a note and initiate further research.

- Observe clearance of sprinklers, heat ducts, unit heaters, duct furnaces, flues, radiant space heaters, and lighting fixtures.

- Note any blockage of aisles, doorways, and access to doors and windows.

- Industrial trucks approved for use inside buildings should have fire extinguishers and regular maintenance. If a repair or maintenance area is present, it should be separated from the storage area.

- Closely inspect any hazardous process such as welding and cutting.

- All the building services should be functional and properly maintained. This would include any fire pumps and emergency generators. These should be checked for any debris, trash, dust, and lint.

- The fire alarm and automatic fire protection systems, if required and present, must be maintained and tested (with records so indicating). The inspector should consider an inspection of these systems as part of the storage occupancy inspection.

- Proper rating of interior walls, ceilings, and floor finishes is or may be a difficult consideration during a "routine fire and life safety inspection." The inspector should note any issues and research further.

- Review operating features such as fire drills and the training of employees in emergency procedures.

Outdoor Storage

- Access: driveways--15 feet wide; aisles--10 feet wide.

- Adequate fire protection.

- NFPA 230.

Storage Incidental to Another Occupancy

- Must refer to your adopted building code--generally in the section/chapter on "use or occupancy."

- Will establish parameters for specific storage--based upon classification and amount.

- Will have application for separation and protection.

- Some considerations for all occupancies except dwelling units.

  - Paint shops.

  - Waste and soiled linen collection rooms and chute termination rooms.

  - Waste and soiled linen chute access rooms.

  - Some considerations for assembly, business, educational, certain institutional(s), certain residential(s).

  - Storage rooms more than 50 sq. ft. and less than 100 sq. ft.

  - Storage rooms more than 100 sq. ft.

- Some considerations for detection and correctional.

  - Storage rooms require one-hour rated enclosures with self-closing 3/4-hour latched fire door assemblies, automatic sprinkler protection, or both.

- General.

  - Housekeeping.

  - Trash and debris.

AUTOMATIC SPRINKLERS

Hazard Classification

Three basic hazard categories are used when sprinkler systems are designed and installed per NFPA 13. The classification category is used in the design phase of a sprinkler system. The classification group designations are addressed during the design phase, considering the area/density water supply requirement.

Light hazard occupancies are where the quantity and/or combustibility of contents is low. Examples are

- churches;
- offices;
- clubs;
- institutional;
- educational;
- restaurant seating area; and
- residential.

Ordinary hazard occupancies, Group 1, are where combustibility is low, quantity of combustibles is moderate, stockpiles do not exceed 8 feet. Examples are

- automobile parking and showrooms;
- bakeries;
- canneries;
- beverage manufacturing;
- electronic plants;
- laundries; and
- restaurant service areas.

Ordinary hazard occupancies, Group 2, are where quantity and combustibility of contents are moderate to high, stockpiles do not exceed 12 feet. Examples are

- chemical plants (ordinary);
- cold storage warehouse;
- confectionery products;
- exhibition halls;
- mercantile;
- paper process plants;
- printing and publishing;
- repair garages;
- warehouses (having moderate to higher combustibility of content); and
- wood product assembly.

Extra hazard occupancies, Group 1, are where quantity and combustibility of contents are very high with the probability of rapidly developing fires. Group I are occupancies with little or no flammable or combustible liquids. Examples are

- aircraft hangars;
- plywood and particle board manufacturing;
- sawmills;
- upholstering with plastic foams; and

- textile, picking, blending, and carding.

Extra hazard occupancies, Group 2, are where moderate to substantial amounts of flammable or combustible liquids are present. Examples are

- flammable liquids spraying;
- flow coating;
- mobile home or modular building assemblies where finished enclosure is present and has combustible interiors;
- plastic processing;
- varnish and paint dipping; and
- solvent cleaning.

Special Occupancy Hazards

Other NFPA standards contain sprinkler design criteria for fire control of specific hazards that include

- high-piled combustibles;
- variety of flammable and combustible liquids;
- combustible dusts;
- chemicals;
- aerosols; and
- explosives.

Sprinkler systems that have been designed properly and maintained are highly reliable and provide life safety as well as property protection. Automatic sprinkler systems are the most commonly installed automatic fire suppression systems.

Sprinkler systems have two main purposes: 1) to extinguish unwanted fires, and 2) to control the size of a fire until trained fire suppression crews arrive to extinguish the fire. Either of these results in increased property protection and life safety. When connected to an approved fire alarm system, sprinkler systems provide the added benefit of acting as initiating devices to activate the fire alarm system.

When inspecting existing automatic sprinkler systems it is critical to determine if the protected hazard has changed. That may require a re-evaluation of the systems. These changes would include the following: fire loading/combustibility of the content; arrangements/storage methods; and new hazardous processes. Examples of these changes would be an occupancy that was first used as an office area and then changed to a storage area with 8 feet high combustible storage on pallets. Another example would be a storage warehouse that had 8 feet high palletized

storage changed to rack storage 16 feet high. In both examples the required water supply for the original hazard design would be inadequate for the new use or storage arrangement change. In any case the existing system would have to be re-evaluated and possibly upgraded to meet the new design demand in order to maintain effectiveness.

Types of Automatic Sprinkler Systems

NFPA 13 defines six major types of automatic sprinkler systems.

Wet Pipe

Wet-pipe systems use closed automatic sprinklers attached to a piping system containing water under pressure at all times. The wet-pipe system is the most common type of sprinkler system and generally is the one used, unless there is danger of the water in the pipes freezing, or when other special conditions require one of the other types of systems.

Dry Pipe

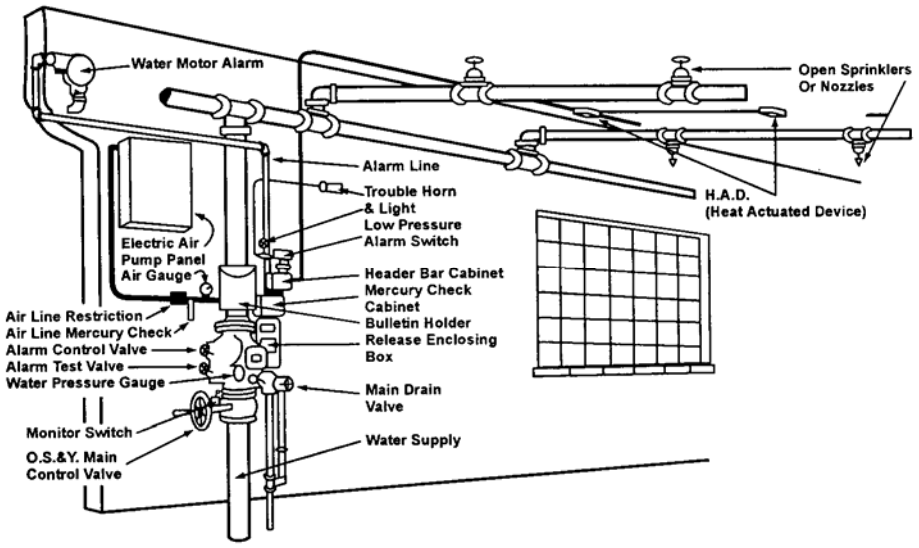
Dry-pipe systems employ closed automatic sprinklers attached to a piping system that contains air or nitrogen under pressure. When a fire occurs and an automatic sprinkler activates, the air or nitrogen is released, reducing the pressure in the system to a point at which the pressure on the water supply side causes the valve to operate, allowing water to flow through the system piping. Dry-pipe systems usually are used only in locations that cannot be heated properly.

Preaction

Preaction systems employ closed automatic sprinklers attached to a piping system containing air, which may or may not be under pressure. When a fire occurs, a fire detecting device such as a smoke or heat detector activates and causes the water control valve to open and water to flow into the pipe system. Thereafter, when an automatic sprinkler activates, water will be available to flow through the sprinkler immediately. Preaction systems are commonly used in areas where there is danger of serious water damage as a result of a damaged automatic sprinkler or broken piping. Electrical equipment rooms, computer rooms, and operating rooms are locations where preaction sprinkler systems have been used.

Deluge

Deluge sprinkler systems employ automatic sprinklers that are open at all times. When a fire occurs, a fire detecting device, usually a heat detector, activates and causes the deluge valve to open. Water then will flow into the piping and discharge through all the open sprinklers. Deluge sprinkler systems are effective in protecting severe hazards, such as flammable liquids, where there is a possibility that the fire could flash ahead of the operation of closed automatic sprinklers (in this example, a rapid detection system would be required).



Deluge System

Combined Dry-Pipe and Preaction

These systems employ the essential features of each system and can operate as either system. Typically the dry-pipe feature serves as a supplemental operation in case of failure of the preaction system. Such systems are effective in areas that are too large for a single dry-pipe system.

Special Types

Special types of systems depart from the requirements of NFPA 13 in such areas as special water supplies and reduced pipe sizes. The systems are

installed according to the instructions that accompany their listing by a testing laboratory.

Basis for Code-Required Automatic Sprinkler Systems

Total Building Protection

The BOCA National Building Code (1999), NFPA 101, *Life Safety Code* (2000), the Uniform Building Code (UBC) (1997), the Standard Building Code (1997), and the International Building Code (2000) do not require automatic suppression systems throughout all buildings. Automatic suppression may be required depending on the floor area and height of the building, the construction, and the occupancy classification. Many States have adopted legislation or regulations that require automatic sprinkler protection throughout certain buildings such as highrises and hospitals.

When required by code, the rationale usually is based on one or more of the following situations:

- The need to limit the potential fire size.
- Unavoidable excessive fuel loads.
- The need for added (sprinkler) protection indicated by fire experience for the type of occupancy.
- The effectiveness of manual fire suppression is questionable (fire department access is limited).
- Openings and accessibility used by the fire department are limited (windowless or below-grade areas).
- The height of the occupied floors is above fire department access with available fire apparatus.
- Added assurance required for life safety, due to fast-developing fires, large numbers of people present (assembly), or people who must be defended in place (hospitals).

While many codes do not require automatic suppression systems to be installed, the codes do provide numerous incentives to encourage the installation of sprinkler systems in buildings. Typical incentives include

- increased building area and height;
- increased capacity of exits;

- increased exit travel distances;
- reduced fire resistance of vertical openings;
- elimination of need for enclosure of certain hazardous areas;
- reduced interior finish requirements;
- reduced corridor wall fire resistance and associated hardware, such as rated glazing, fire dampers, and closing devices;
- reduced corridor door fire resistance;
- increased size of areas open to the corridor (hospitals);
- permitted use of atriums;
- reduced requirements for furnishings; and
- reduced standpipe requirements.

It should be noted that some of the modifications require sprinkler protection throughout the entire building, while others apply only to certain portions of the building or to individual rooms or areas.

Special Hazard Protection

While the list may vary among codes, automatic suppression typically is required for specific hazards such as commercial cooking equipment, central laundries, soiled linen rooms, combustible storage rooms, and trash collection rooms. Some codes permit other hazardous areas to be separated by two-hour fire-rated construction, or protected by an automatic suppression system and separated by one-hour fire-rated construction. Such areas include boiler or furnace rooms, paint shops, and maintenance shops. Other hazardous areas either may be separated by one-hour fire-rated construction, or protected with an automatic suppression system.

Automatic Sprinkler System Standards

When a sprinkler system is required by code or desired for trade-offs or other reasons, the following standards are used as installation requirements.

NFPA 13 is the oldest of the sprinkler-design standards in use, having first been published in 1896. Unless allowed by code or by the Authority Having Jurisdiction (AHJ) to use another design standard (see those listed below) NFPA 13 typically is the standard to be used.

NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Mobile Homes*. As the name implies, this standard can be used, as permitted, to design systems for one- and two-

family dwellings, including mobile homes. This document may not be appropriate for use in other types of occupancies.

NFPA 13R, *Standard for the Installation of Sprinkler Systems in Residential Occupancies Up to & Including Four Stories in Height*. This document was produced in an effort to address the gap between NFPA 13 and NFPA 13D. The occupancies for which this design standard is appropriate are indicated by its title.

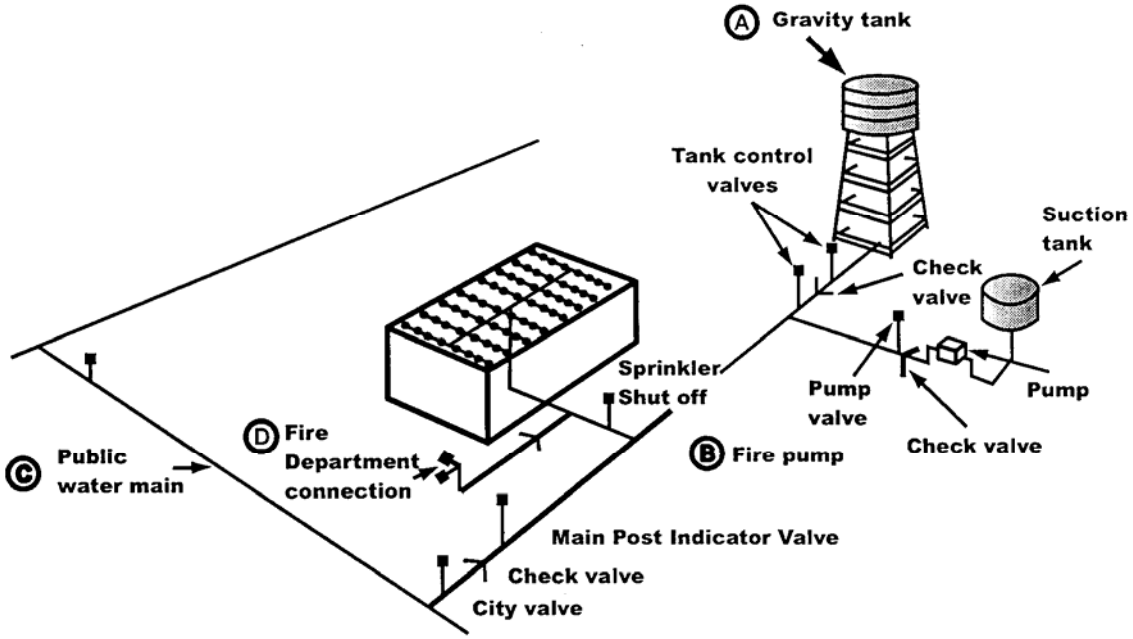
Design of Automatic Sprinkler Systems

Automatic sprinkler systems typically are designed using a hydraulic calculation method which may involve the use of a computer. The designer can enter the general pipe layout and sizes, along with some additional data requirements, and the program will determine the pressure drop through the pipe network. This provides the minimum pressure and flow requirement for the system, which then can be compared to water supply data to determine if the required flow and pressure are available. If excess pressure is available, the system designer can reduce pipe sizes, which will provide a cost savings.

Design of such systems usually is based on a required density to be provided over a specified design area. NFPA 13 provides design criteria for various hazards based on the size of the design area. Sprinkler and branch line spacing also are affected by the hazard classification and the design density. NFPA 13 requires that a nameplate be attached permanently to the base of risers of hydraulically designed systems. The nameplate indicates the location of the system and the basis of the design, including discharge densities and design area size, as well as the gallon-per-minute flow and the residual pressure demand at the base of the riser. Some sprinkler systems, such as residential sprinklers, use a specified number of sprinklers; thus the density is inherently incorporated into the design.

Before the advent of readily available computer programs and cost-effective computer hardware, sprinkler systems typically were designed using the pipe schedule method, which is a simple approach but often more costly to install. This approach uses the concept of the maximum number of heads that may be supplied by a given pipe diameter. The designer then selects pipe sizes, starting at the location most remote from the water supply, until all pipe sizes are determined. The pipe schedules also are based on the classification of the hazard protected. Pipe schedules are allowed for new installations today in a very limited application.

WATER SUPPLY SOURCES



Example of Sprinkler System Water Supply

Generally, at least one automatic water supply is required for an approved sprinkler system. An automatic supply refers to a supply that does not require any human interaction to initiate the flow into the sprinkler system. Additional water supply sources frequently are provided to supplement the primary water supply. The more common components of a water supply include the following.

Public main. Perhaps the most common automatic water supply is the public street main. Here, the sprinkler system is connected through a series of check valves, backflow preventors, underground piping, etc., to the public main.

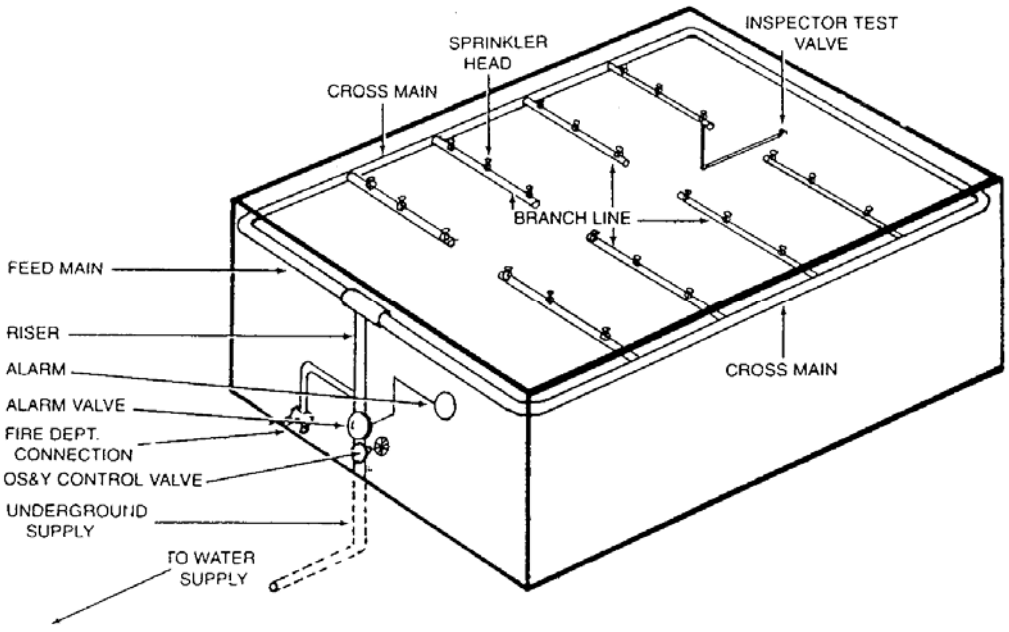
Fire department connection. This is not an automatic source, as it clearly requires human action to initiate the flow. The fire department can flow water into the connection to provide both flow and pressure to the system. Fire department connections usually are a secondary water source that can be used to supplement the primary supply.

Suction tanks with fire pumps. A fire pump takes water at a less-than-required pressure and discharges it so that adequate pressure is available to the sprinkler system. The fire pump can be fed from many sources, including nonpressure sources.

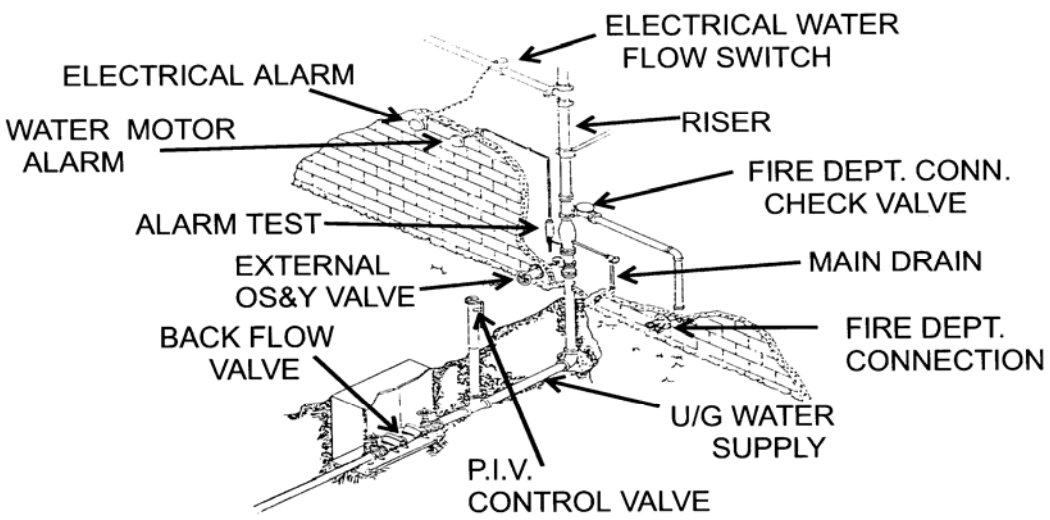
Gravity tanks. A gravity tank serves two functions: it acts as a storage container for the needed water, and its elevation creates pressure. This can be a source of automatic water supply for a sprinkler system.

Pressure tanks. A pressure tank is similar to a gravity tank except that it uses gas pressure to cause the water to flow from the tank under pressure, as opposed to gravity. Generally, an air pump can be used to pressurize such storage tanks adequately.

Major Sprinkler System Components



Components of Riser and Underground



Major Components of a Sprinkler System

- Underground supply--water supply source to the sprinkler system. May have a Post Indicating Valve (PIV) or exterior OS&Y control valve for the system. May also be equipped with a detector check on backflow prevention valve.

- Fire department connection--Allows the fire department to pump into the system to supplement and increase the water flow and pressure to the operating sprinkler heads.

- Fire department connection check valve--prevent water in the system from backfeeding into the exterior fire department connection to prevent freezing.

- Alarm valve--automatically provides an alarm to the water motor alarm when a sprinkler head operates.

- Main drain--proves the ability to drain the system and test whether the water supply source is adequate.

- Alarm test valve--allows the testing of the water motor alarm or electrical alarm.

- Exterior alarm--can be either electrical or mechanical; mounted on exterior of building.

- Riser--main supply from alarm valve to the overhead sprinkler piping that supplies the feed main and cross mains.

- Water flow electrical switch--provides an electrical alarm when a sprinkler head operates on the system side of the switch location.

- Branch line--piping that directly supplies the sprinkler heads.

- Automatic sprinkler heads--are equipped with thermo-sensitive elements that react to heat and activate, discharging water over a specific area of coverage.

- Inspector's test valve--can be found at the most distant part of the system or on the system side of any water flow switch located in the sprinkler piping.

Inspection, Testing, and Maintenance of Automatic Sprinkler Systems

The operational readings and maintenance of automatic sprinkler systems is the responsibility of the property owner. The owner may contract with a sprinkler contractor to conduct the required routine test and maintenance of the system on their behalf.

NFPA Standard 13 references that the inspecting, testing, and maintenance of installed sprinklers shall be conducted in accordance with NFPA 25, *Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*. The required items, activity, and frequency can be found in the Appendix at the end of this module.

A proper inspection of a sprinkler system is based upon an inspector's knowledge of how a system operates and basic installation requirements. The visual inspection of an installed sprinkler system should include the following items:

Exterior of Building

- Fire department connection--is accessible, visible, and can be identified. Hose threads are not damaged and swivel hose coupling operates freely. Hose connections are provided with protective caps. Interior of hose connections are not blocked with debris or other matter, and the clapper is operational. Look for ice accumulation inside connection during cold season.

- Outside PIV or OS&Y valves to system are fully open supervised with lock and chain, or electrically monitored with tamper switches. Multiple control valves are identified as to what part of the building they control.

- Exterior alarm/bell cover intact, unobstructed, and identified as a sprinkler alarm.

Interior of Building

- All water control valves are supervised, in the fully opened position with lock and chain, or electrically monitored with tamper switches. Are not obstructed/freely accessible and are of the indicating type. Each control valve is provided with a sign noting area of the building or system it controls.

- Identification plate provided at sprinkler riser for systems that are of the hydraulically calculated design.

- Cabinet located near riser for stock of spare sprinkler heads with removal wrench.

- Main drain from alarm valve is piped directly to the building exterior and provided with identification sign.

- Alarm test valve provided at alarm valve with identification sign.

- Water pressure gauges at alarm valve indicating pressure on the system.

- Air pressure gauges at alarm valve for dry-type systems indicating pressure of the system.

- Air compressor for dry system appears operational.

- Alarm valve for dry-type systems are located within a heated room or enclosure to prevent freezing.

- No indication of broken or leaking gauges.

- Piping is free of mechanical damage, not leaking, not corroded, not subject to external loads, and supported correctly by hangers. Look for established low points in dry type system and make sure there are drains to allow for drainage.

- Sprinkler heads free of corrosion, check for accumulation of dust, grease, paint, physical damage, and obstruction to spray pattern caused by ceiling fixtures, decorations, display, or partitions. A clearance of at least 18 inches must be maintained by the sprinkler head deflector.

- Fire alarm/detection systems in operation for pre-action and deluge type systems.

Other Considerations

Review of past records related to the inspection, testing, and maintenance of the sprinkler system. If the owner has been providing these services on at least an annual basis they should have records indicating same. Those records at a minimum should indicate that the following tests have been conducted.

- Main drain flow test annually noting both the static and residual pressure readings. Compare previously recorded pressures and look for drop in residual pressure that may indicate a water supply problem.

- All sprinkler water flow alarms have been tested and are operational.

- All dry-type alarm valves have been trip tested at least annually.

- All low point piping drains for dry-type systems have been drained of any water accumulation.

- The test fire alarm and detection systems for pre-action and deluge-type systems are in operation and have tested.

- Sample of standard-type sprinkler heads removed for testing or replaced when they are 50 years old, or 25 years when of the fast-response type head.

- Interior of sprinkler piping has been examined and flushed periodically to remove any obstruction or accumulation of debris, especially for dry-type systems.

Wet-type systems must be protected from freezing temperatures. Building with wet systems must have reliable heat that can maintain a temperature of at least 40ºF during freezing temperatures. Also look out for areas with

broken windows, exterior fans, areas above insulated ceilings, and individual rooms that may not be heated.

Sprinkler systems that have fire pumps and on-site water supply tanks also need special attention. Make sure that the fire pump is operational and has been tested at least annually in accordance with NFPA 20, *Installation of Fire Pumps*. The on-site water supply tank must be kept full and maintained to prevent freezing.

After sprinkler systems have been installed it is not unusual to find areas of the building that become unprotected or obstructed, caused by remodeling, alterations, or additions. The most common causes are the installation of a new suspended ceiling without dropping the sprinkler heads down, moving office wall partitions that create new areas without sprinkler head coverage, or areas too large to be protected by the existing sprinkler heads.

Activity ST.1

Identify Types of Storage

Purpose

To identify the types of storage by contents hazard classification.

Directions

1. View slides and identify types of storage occupancies by their contents hazard classification:

   a. Low.

   b. Moderate.

   c. High.

2. Do you have this classification or type of storage occupancy in your jurisdiction?

   a. Yes.

   b. No.

   c. Not sure.

3. What do you feel may be unique about this type of storage occupancy?

Activity ST.2

Hazards in Storage

Purpose

To identify and list major fire and life safety issues in storage occupancies.

Directions

1. Your group will be assigned two occupancies from the list of storage occupancies identified in Activity ST.1. Develop a list of possible fire and life safety hazards for each assigned occupancy type.

2. With the list of possible fire and life safety hazards, develop recommendation(s) for corrective actions and identify the reference in the applicable code for each corrective action.

3. Select a spokesperson to present your group's report.

Occupancy 1

	Hazards	Corrective Action	Code Reference
1.			
2.			
3.			
4.			

Occupancy 2

	Hazards	Corrective Action	Code Reference
1.			
2.			
3.			
4.			

Activity ST.3

Flammable Liquids

Purpose

Given a request from a property owner as a scenario, make general recommendations with code references for the indoor storage of flammable liquids.

Directions

1. You are asked by a building owner what he/she needs to do to put a storage room for flammable liquids in his/her warehouse. In a letter to the building owner, prepare a list that addresses code requirements for flammable liquid storage.

2. Select a spokesperson to read your group's letter to the class.

Scenario

You have been contacted by A.B. Clone of A.B. Clone Wholesale Confectionery, Inc. Clone has a block warehouse building with a flat roof, no sprinkler system, that is 30' x 60' x 15'. He/She currently wholesales candies, smoking products, and toiletries, to be sold to small convenience stores. He/She would like to stock auto fluids (oil, transmission, brake) for distribution to these same convenience stores. He/She would like to "section off" part of the warehouse for these commodities. All products would be in single quantities of two quarts or less in case lots. Clone proposes to maintain 100 to 150 cases of each (oil--three types, transmission fluid, brake fluid). These cases will total no more than 1,200 gallons of Class IIIB liquids and no more than 600 gallons of Class IIIA liquids.

Activity ST.4

Life Safety Factors in Storage

Purpose

Given the applicable code, a storage occupancy description and floor plan, the number and size of the exits, and the exit separation, identify potential fire and life safety hazards.

Directions

1. You will work in four small groups.

2. Each group will be given a scenario from which it will list the potential fire and life safety hazards.

3. Your group will identify the potential hazard, corrective action, and code reference.

4. Each group will select a spokesperson to deliver the group's report.

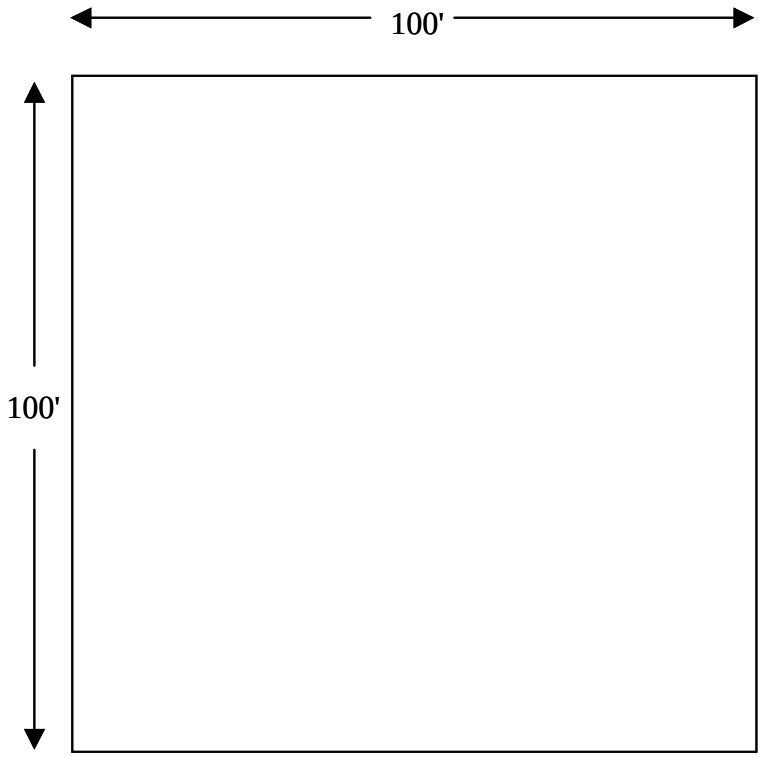
Potential Hazard	Corrective Action	Code Reference

Scenario 1

Acme Moving and Storage

Description

This is a storage building for a moving company. It is a block building with a flat roof. It is heated, and measures 100' x 100', with a 20' ceiling height. The building has a wet-pipe sprinkler system. All storage is in shipping crates that measure 4' x 4' x 6'. These crates are stacked two high.

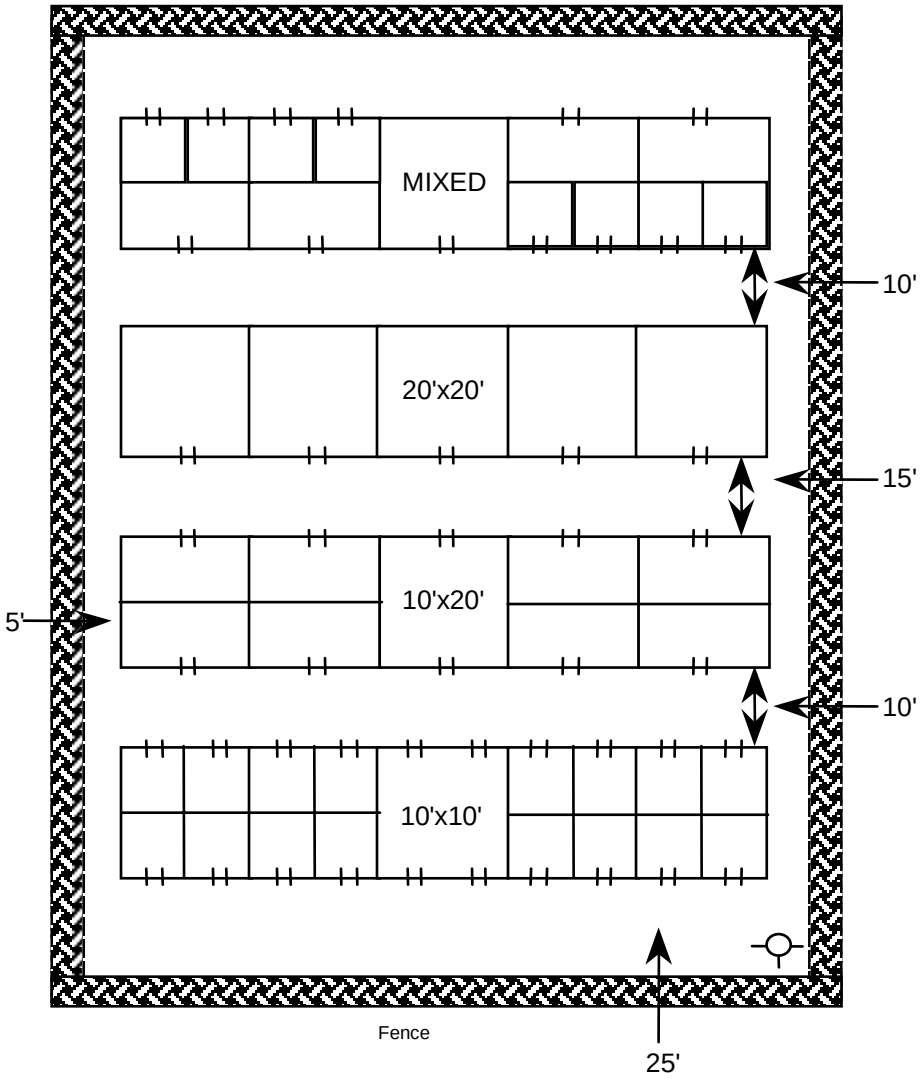


Scenario 2

Store Yourself, Inc.

Description

This is a typical "self-storage" rental facility. It consists of four separate buildings (each 20' x 100' x 12') with block construction with metal roofs. No sprinkler systems are present. Each rental cube has one eight-foot overhead door. Cube sizes available are 10' x 10', 10' x 20', and 20' x 20'. Each cube is individually leased, with the leasee having sole access.

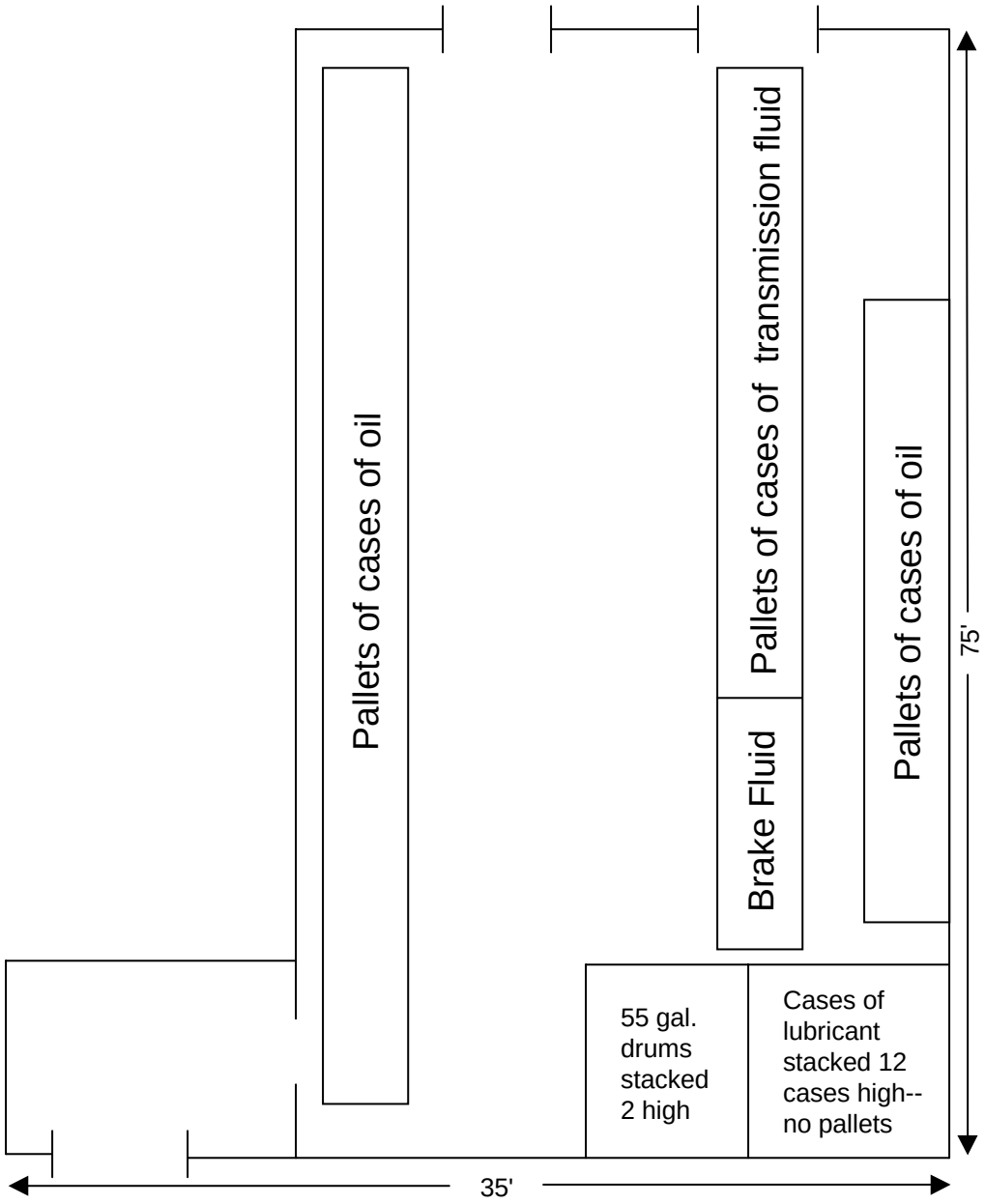


Scenario 3

Petro Storage Company

Description

This is a wood-frame structure, 35' x 75', with a composite shingle roof. The structure is not sprinklered and appears to have been an old church, converted to a warehouse. Storage is primarily cases of motor oil and automotive lubricants. The structure is single story, with a high vaulted ceiling. There are large windows on two sides of the structure. There is a loading dock and two eight-foot garage doors on one end. There is a basement (not used) with an exterior entrance only. The interior entrance to the basement has been closed off.

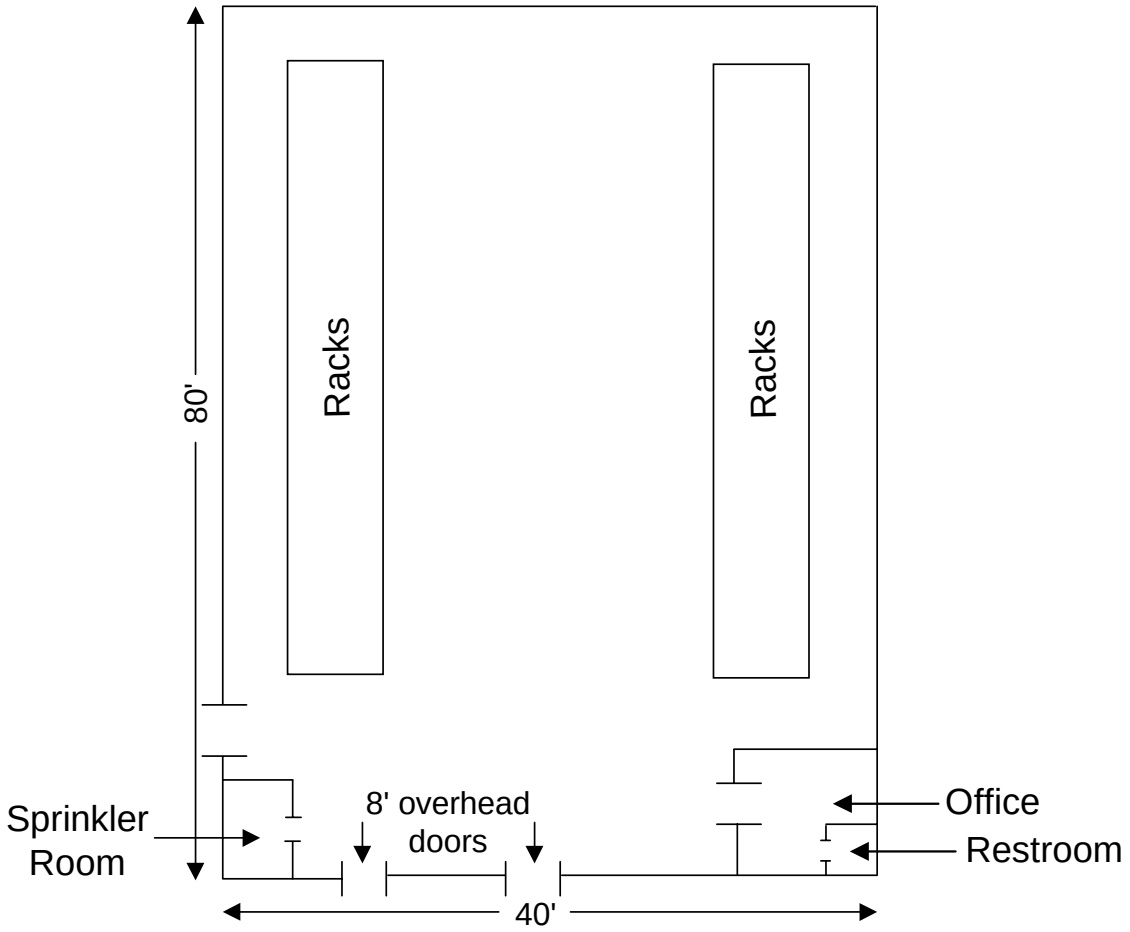


Scenario 4

Quality Spice Company

Description

This is a steel structure with a steel roof. The structure is 40' x 80' x 24'. It is equipped with a dry-pipe sprinkler system; the building is not heated. There is a small office with a bathroom. A wall space heater is in the office area. All storage is on pallets: cases of product stacked eight feet high and sealed in plastic. The structure is fashioned with two double-row racks, not exceeding 25 feet. There are no in-rack sprinklers. There are two eight-foot garage doors leading to a small loading dock. There is one additional 36-inch door.



Activity ST.5

Sprinkler System Operational Readiness

Purpose

Given information about a system, using the following slides, list the conditions found and the corrective actions required in accordance with NFPA 25.

Directions

1. Given information about a system, and using the following slides, note what conditions you observe from each slide.

2. After you have completed your review, determine, using NFPA Standard 25, what specific reference sections relate to each slide and the corrective action required.

3. Complete the work individually, and discuss the results of each slide as a large group.

Concerns Observed	Reference Section NFPA 25	Corrective Action
1.		
2.		
3.		
4.		
5.		
6.		
7.		

Activity ST.6

Report Preparation

Purpose

To formulate code-based findings from an inspection into a properly formatted report document.

Directions

1. Working individually and using the code applicable to your jurisdiction, review the attached inspection scenario.

2. Using the attached inspection report form or an inspection report form from your jurisdiction, complete the form, citing the hazards identified in the scenario.

3. Be sure to cite specific code references.

4. You have 60 minutes to complete this activity.

Storage Scenario

On Tuesday, July 25, 1995, the weather was warm with low humidity (85°F); I inspected the ACME Moving and Storage Company. Upon arrival, I met with the manager, Mr. R.B. Jones. He works for ACME Moving and Storage Company and can be contacted during the day at 333-444-1111. He also was employed by ACME during the last departmental inspection of this facility.

The facility itself is a concrete block building (200' x 100' x 24') with a flat roof. The facility is sprinklered with a dry system. The facility is heated with several large gas-fired heaters suspended from the ceiling. Part of this facility, approximately 50' x 50', houses an office area, restroom, and sprinkler/utility room. There are approximately four employees present at any given time. The facility is used for the storage, generally short-term, of households in the process of moving. Additionally, some large shipping crates are stored. All storage is in nonsprinklered racks, with the racks no greater than three feet, generally six feet each.

An inspection was fairly easy to conduct, as the facility had minimum areas to view. I went through the small administrative area first, followed by the restroom, sprinkler/utility room, and then the main storage area. The following items were noted.

- There were piles of wood pallets stored inside the facility, approximately ten feet high.

- One exitway and door were blocked by storage in the aisleway.

- In the southwest corner, storage was piled very high, above the sprinkler heads.

- The portable extinguisher located near the restroom was found to be reading "discharged," and the inspection card indicated that it was last checked in June of 1993.

- In the corner near one of the loading dock doors, a large amount of trash (packing debris) was piled into a 5' x 10' area. It appeared to have been there for several days.

- No "No Smoking" signs were observed. Several employees were smoking as they walked through the facility.

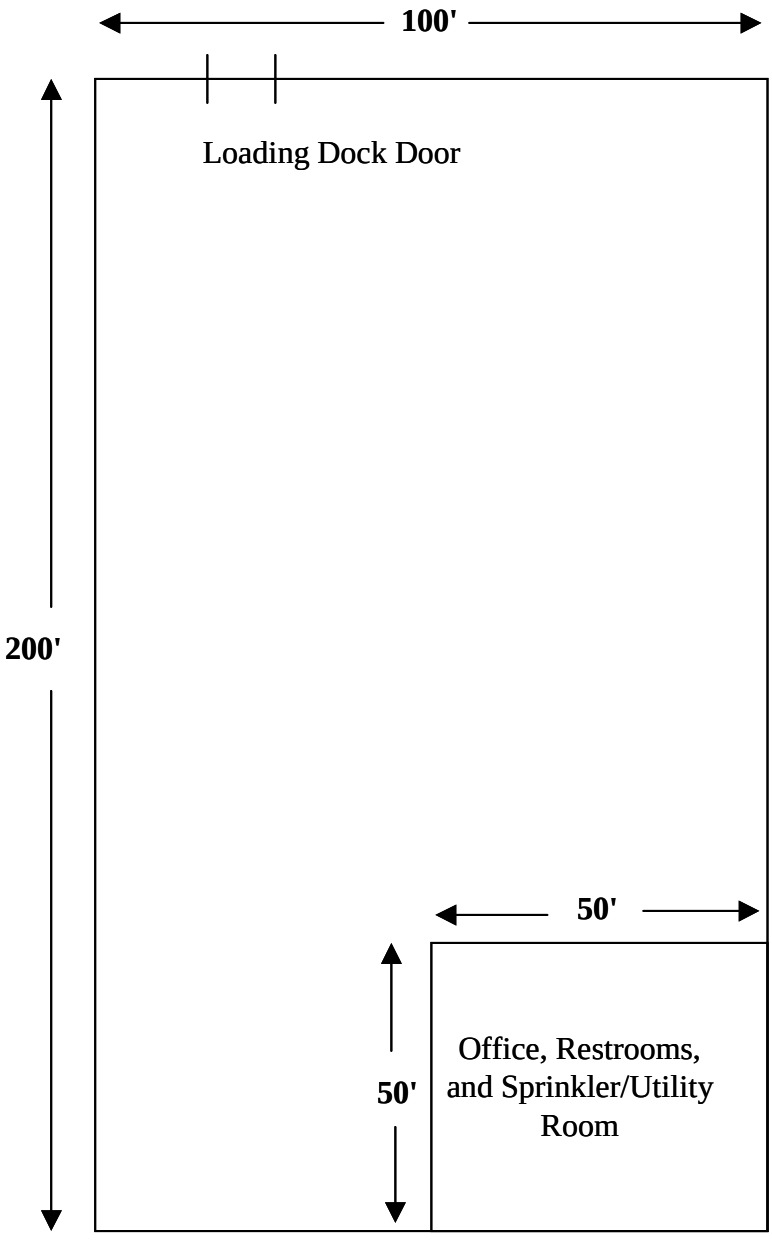
- I requested to review the sprinkler system maintenance log. The manager could not present such a document.

- One aisle leading to an exit was about five feet.

I reviewed the above items with Mr. Jones and advised him that a reinspection will take place on September 25, 1995.

Storage Floor Plan

ACME MOVING & STORAGE



FIRE-SAFETY SURVEY REPORT

FIRE PREVENTION…
FOR YOUR SAFETY

Building _____ Owner/Mgr. _____
Address _____ Phone _____
_____ Type of Occupancy _____

☐ New Occupant

The _____ Fire Department has conducted a fire safety survey of your property. The knowledge gained through this survey will enable the Fire Department to attack and extinguish fire that might occur in the building quickly and efficiently.

During this inspection, conditions affecting fire safety throughout the premises were also noted. It is requested that the items listed below be given your immediate attention in the interest of fire safety.

FIRE HAZARDS FOUND TO EXIST: ☐ NONE OBSERVED THIS INSPECTION

☐ Fire Extinguishers	☐ Housekeeping	☐ Flammable Liquids	☐ Electrical
☐ Trash	☐ Utilities	☐ Fire Protection Equip.	☐ Fire Lanes
☐ Exits	☐ Fire & Smoke Doors	☐ No Smoking Signs	☐ Other

_____

_____

_____

_____

_____

_____

_____

_____

_____

If at any time questions regarding fire safety arise, do not hesitate to contact the Fire Department at _____. For an emergency call _____ . In case of fire in your building, call the FIRE EMERGENCY NUMBER.

_____	_____	_____
Property Representative	*Reporting Officer*	*Date*

Reinspection Due _____ Made By _____ Date _____ Notified FM # _____

WHITE – Owner/Manager
YELLOW – Station File
PINK – Fire Marshal

FIRE HAZARDS CORRECTED # _____
FIRE HAZARDS NOT CORRECTED # _____

10/75

Notice of Violation Page _____ of _____

Building _____ Date _____

Address _____ Owner/Mgr. _____

_____ _____

PROPERTY REPRESENTATIVE REPORTING OFFICER

WHITE – Owner/Manager
YELLOW – Station File
PINK – Fire Marshal

FIRE HAZARDS CORRECTED _____
FIRE HAZARDS NOT CORRECTED _____

8-72

APPENDIX A

INSPECTION, TESTING OF SPRINKLER SYSTEMS FROM NFPA STANDARD 25

Sprinkler Systems
Summary of Minimum Inspection, Testing, and Maintenance

Item	Activity	Frequency	Section Number
Gauges (dry, pre-action deluge systems)	Inspection	Weekly/Monthly	2-2.4.2
Control Valves	Inspection	Weekly/Monthly	See Table 9-1
Alarm Devices	Inspection	Monthly	2-2.6
Gauges (wet pipe systems)	Inspection	Monthly	2-2.4.1
Hydraulic Name-plate	Inspection	Quarterly	2-2.7
Buildings	Inspection	Annually (prior to freezing weather)	2-2.5
Hanger/Seismic Bracing	Inspection	Annually	2-2.3
Piping	Inspection	Annually	2-2.2
Sprinklers	Inspection	Annually	2-2.1.1
Fire Department Connections	Inspection		See Table 9-1
Valves (all types)	Inspection		See Table 9-1
Alarm Devices	Test	Quarterly	2-3.3
Main Drain	Test	Quarterly	Table 9-1
Antifreeze Solution	Test	Annually	2-3.4
Gauges	Test	5 years	2-3.2
Sprinklers-- High Temp.	Test	5 years	2-3.1.1 Exception 3
Sprinklers-- Fast Response	Test	20 years and every 10 years thereafter	2-3.1.1 Exception 2
Sprinkler	Test	50 years and every 10 years thereafter	2-3.1.1
Valves (all types)	Maintenance	Annually or as needed	See Table 9-1
Obstruction Investigation	Maintenance	5 years or as needed	2-4.3

Valves and Fire Department Connections

Minimum Inspection, Testing and Maintenance Frequency

Component	Activity	Frequency	Section Number
Control Valve			
Sealed	Inspection	Weekly	9-3.3.1
Locked	Inspection	Monthly	9-3.3.1, Exception 1
Tamper Switch	Inspection	Monthly	9-3.3.1, Exception 1
Alarm Valve			
Exterior	Inspection	Monthly	9-4.1.1
Interior	Inspection	5 Years	9-4.1.2
Strainers, Filters, Orifices	Inspection	5 Years	9-4.1.2
Check Valve			
Interior	Inspection	5 Years	9-4.2.1
Preaction/Deluge Valve			
Enclosure (during cold weather)	Inspection	Daily/Weekly	9-4.3.1
Exterior	Inspection	Weekly	9-4.3.1, Exception
Interior	Inspection	Yearly/5Years	9-4.3.1.3
Strainers, Filters, Orifices	Inspection	5 Years	9-4.3.1.4
Dry Pipe/Quick Opening Devices			
Enclosure (during cold weather)	Inspection	Daily/Weekly	9-4.4.1.1
Exterior	Inspection	Weekly	9-4.4.1, Exception
Interior	Inspection	Annually	9-4.4.1.4
Strainers, Filters, Orifices	Inspection	5 Years	9-4.4.1.5
Pressure Regulating & Relief Valves			
Sprinkler Systems	Inspection	Monthly	9-5.1.1
Hose Connection	Inspection	Monthly	9-5.2.1
Hose Rack	Inspection	Monthly	9-5.3.1
Fire Pump			
Casing Relief Valve	Inspection	Weekly	9-5.4.1, 9-5.4.1.1
Pressure Relief Valve	Inspection	Weekly	9-5.4.2, 9-5.4.2.1
Backflow Prevention Assemblies			
Reduced Pressure	Inspection	Weekly	9-6.1.2
Reduced Pressure Detector	Inspection	Weekly	9-6.1.2
Fire Department Connections	Inspection	Monthly	9-7
Main Drain	Test	Quarterly	9-2.6
Waterflow Alarm	Test	Quarterly	9-2.7
Control Valve			
Position	Test	Quarterly	9-3.4.1
Operation	Test	Annually	9-3.4.2
Preaction/Deluge Valve			
Priming Water	Test	Quarterly	9-4.3.2.1
Low Pressure Alarms	Test	Quarterly	9-4.3.2.10
Full Flow	Test	Annually	9-4.3.2.2
Dry Pipe Valves/Quick Opening Devices			
Priming Water	Test	Quarterly	9-4.4.2.1
Low Air Pressure Alarm	Test	Quarterly	9-4.4.2.6
Quick Opening Devices	Test	Semiannually	9-4.4.2.4
Trip Test	Test	Yearly	9-4.4.2.2
Full Flow Trip Test	Test	3 Years	9-4.4.2.2.1
Pressure Regulating & Relief Valves			
Sprinkler System	Test	Annually	9-5.1.2
Circulation Relief	Test	Yearly	9-5.4.1.2
Pressure Relief Valve	Test	Yearly	9-5.4.2.2
Hose Connection	Test	5 Years	9-5.2.2
Hose Rack	Test	5 Years	9-5.3.2
Backflow Prevention Assemblies	Test	Yearly	9-6.2
Control Valve	Maintenance	Yearly	9-3.5
Preaction/Deluge Valve	Maintenance	Yearly	9-4.3.3.2
Dry Pipe Valve/Quick Opening Device	Maintenance	Yearly	9-4.4.3.2