FLAMMABLE AND COMBUSTIBLE LIQUIDS

INTRODUCTION

National Fire Protection Association (NFPA) documents describe a level of fire protection agreed on by persons representing a variety of interests. The guidance in these documents does not reflect unique conditions or special considerations, such as system performance under adverse conditions. Nor does NFPA guidance reflect the increased system reliability that AXA XL Property Risk Consulting recommends for high valued properties.

This AXA XL Risk Consulting Guideline takes a position on provisions of NFPA 30 that AXA XL Risk Consulting believes require clarification or changes. To understand the position, this AXA XL Risk Consulting Guideline must be read with a copy of NFPA 30. The provisions of the NFPA document are not repeated.

POSITION

General

Protect distilled spirits in wooden barrels or casks according to Distilled Spirits Council of the U.S. *Recommended Fire Protection Practices For Distilled Spirits Beverage Facilities* standards. See also PRC.8.1.0.1.

Building Construction

Walls

Provide only noncombustible or fire resistive construction for facilities storing flammable or combustible liquids. Cut off the following areas from each other:

- Manufacturing areas involving operations such as mixing, blending, milling, grinding and filling (other than aerosols);
- Aerosol filling and pressurizing areas;
- Reaction areas, including resin manufacturing, thinning and varnish cooking operations;
- Office and other service areas;
- Warehousing areas storing aerosol products;
- Warehousing areas storing other raw materials, intermediate products or finished products.

Limit the size of cut-off areas storing flammable liquids as follows:

- Flammable or combustible liquids in plastic containers - 25,000 ft^2 (2325 m^2);
- Flammable or combustible liquids in metal containers - 50,000 ft^2 (4650 m^2).

Cut off liquid warehouse storing flammable or combustible liquids, including Class IIIB liquids with a single, 4 h, freestanding fire wall with a 3 ft (1 m) parapet or two independent, 3 h, fire walls with 3 ft (1 m) parapets. Liquid warehouse storing Class IIIB liquids which are not heated above their flash point can be cut off from other occupancies with either a 3 h freestanding fire wall with a 3 ft (1 m) parapet or two independent, 2 h, fire walls with 3 ft (1 m) parapets. Base the fire ratings on ASTM E119, ISO 834-1, AS/NZS 1530.1, EN 1363-1 or equivelant, and have a registered design professional certify the fire wall design. See NFPA 221 and PRC.2.2.1.

Drainage

Drainage is not required for storage in metal containers of 10 gal (38 L) capacity or less.

For storage of containers greater than 10 gal (38 L), design the drainage systems as follows (also see Figure 1):

- Provide trench drains that divide the floor of the storage area into rectangles having areas equal to or less than the design areas of the ceiling sprinkler system. Center drains under racks. Arrange trenches as shown in Figure 2. Particularly note the dimensions of the trenches, and note the solid covering spans ⅔ of the width and the grating spans ⅓ of the width.
- Provide drain pipe connections to the trenches at trapped sumps. Size the drain pipes to carry 150% of the anticipated sprinkler water discharged in the area served by the drain. Use the following equation to calculate the flow to individual drains:

  $F = 1.5 \times D \times A$

- Size the main drain lines connected to the individual trench drains to carry 150% of the estimated sprinkler water to be discharged. Use the following equation to calculate the flow through the main drains:

  $F = 1.5 \times d \times D \times A^{0.5}$

where:

F = Flow in drain pipe (gpm or L/min)

d = distance between trenches (ft or m)

D = Sprinkler design density (gpm/ft^2 or L/min/m^2)

A = Sprinkler design area (ft^2 or m^2)

- Seal existing floor drains that do not terminate in a safe location. Slope the floor toward the drain trenches with a minimum 1% slope. Make the floor highest at fire walls.

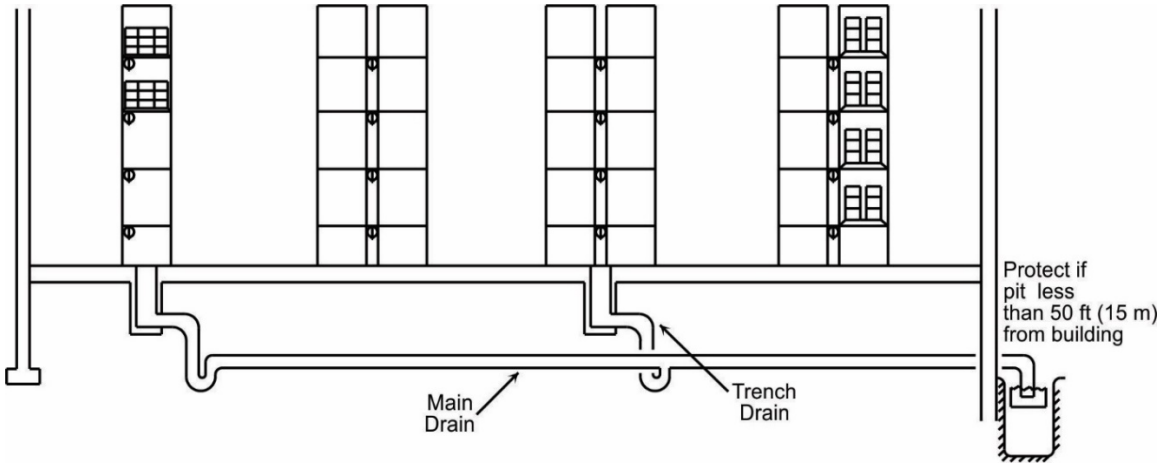

Figure 1. General Scheme for Liquids Warehouse Drainage.

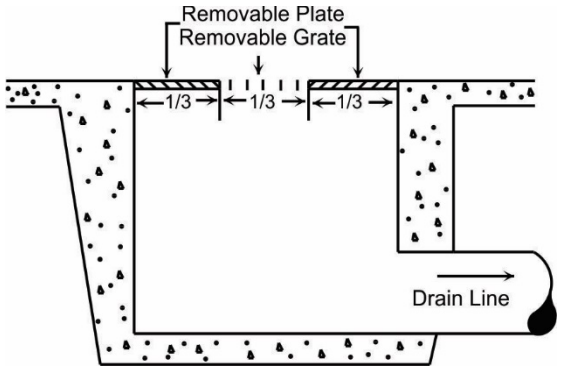

Figure 2. Details Of Drainage Trench Design.

Design walls to prevent the flow of liquids outside the liquid storage area. Prevent the flow of liquids through door openings by one of the following methods:

- Use conveyors to transfer most stock. Protect conveyor openings with double, 3 h, fire doors and conveyor breaks.
- Provide a curb at least 6 in. (15 cm) high at the doorway. To allow vehicle traffic, ramp the curb.
- Provide a 3 ft (1 m) wide drainage trench on the liquid spill side of the door (both sides if applicable); arrange the trench as shown in Figure 3; and connect the trench to the drainage system. Pipe the drainage trenches on opposite sides of a doorway separately to the drainage system by installing independent trapped connections.

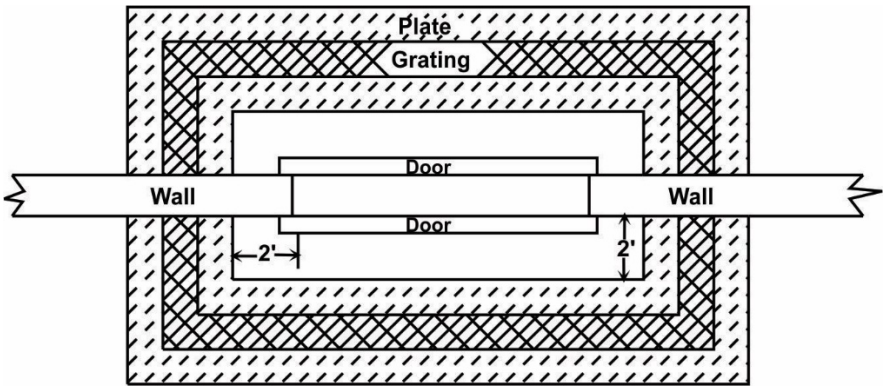

Figure 3. Arrangement Of Trench Drains To Protect Fire Openings (1 ft = 0.305 m).
Note that the trenches do not pass through or under the wall and are drained independently.

Electrical

Where Class I liquids are dispensed or where Class II or Class III liquids are dispensed at temperatures at or above their flash points, install electrical equipment and wiring, listed by a nationally recognized testing laboratory and rated for Class I, Division 1 hazardous (classified) locations. See NFPA 497 for information on the extent of classified areas. See NFPA 70 and PRC.5.12.0.1 for further information.

Sprinkler Protection

Arrange and protect all liquids process, handling, transfer, and storage facilities. Pay close attention to the storage height and building height limitations and the conditions where special drainage is needed.

Storage of flammable or combustible liquid products in 2 oz (56 gm) or smaller containers in cardboard cartons are considered: (See PRC.12.1.1.0.)

- A Class IV commodity if the container is glass.
- A Group A plastic if the container is plastic.

Protect all areas having adequate drainage to a remote location with either water or foam-water sprinkler systems. Protect areas with inadequate drainage or with containment in place with foam-water sprinklers only.

Use the sprinkler designs in NFPA 30 with the following modifications:

- Some tables do not address multiple row racks. For those cases, compartmentalize the racks by installing additional vertical barriers at each rack upright.
- Use **only** high temperature heads at the ceiling. These were the only ones tested.

When using closed head foam-water systems, preprime the piping with foam solution to make foam immediately available when a sprinkler operates. Arrange each system to have at least 20 min of foam concentrate, based on the required design flow rate. Install in accordance with NFPA 16 and PRC.12.3.1.1.

Monitor all automatic fire protection systems by guards or alarm systems. See NFPA 72 and PRC.11.0.1.

Storage Arrangements

Store ordinary combustible commodities in separate fire areas from flammable and combustible liquids.

Use only wooden pallets for the storage of container of liquids. The use of plastic pallets to store liquids has not beed tested.

Do not mix Class I, II or IIIA liquids with other commodities. Store Class IIIB liquids in general storage only if arranged and protected in accordance with the tables in NFPA 30 section 16.5

Process Facilities, Dispensing, Handling, Transfer, and Use of Liquids

Apply the spacing guidelines in PRC.2.5.2 to buildings containing operations involving the use and handling of flammable or combustible liquids.

Provide deflagration relief in all rooms handling Class I liquids or liquids at temperatures above their flash points. See NFPA 68 for details.

Design containment or remote impounding to hold 2 h of both automatic and manual fire protection water discharge or 110% of the volume of the largest product tank, whichever is greater.

In dispensing areas, in addition to the normal ventilation rate of 1 cfm/ft^2 (1 m^3/min/3 m^2), provide an emergency ventilation rate of 3 cfm/ft^2 (1 m^3/min/m^2).

Storage of Liquids in Tanks

Vents

Equip **all** vents on tanks storing Class I liquids with flame arrestors listed by a nationally recognized testing laboratory.

Provide flame arrestors even for liquids which tend to polymerize, coagulate, freeze, crystallize, condense, corrode, plug, or otherwise tend to obstruct the flame arrestors. Instead, address these problems by an appropriate means, such as:

- Installing redundant flame arrestors in parallel with three way valves so that one arrestor is always in service on each vent while the other is being inspected and cleaned. Adjust the frequency of such inspections and cleaning to prevent impairment of the working arrestor.
- Installing heat tracing to prevent freezing
- Installing corrossion proof flame arrestors
- Using liquid seal flame traps

- Inerting the tank

Provide all aboveground tanks, regardless of location or class of liquid with the overfill prevention equipment and procedures.

Take the prescribed reductions in emergency vent sizing only for properly arranged passive protection such as drainage or insulation. Such reductions are acceptable because passive systems are much less susceptible to failure.

Separation Distances

Do not use the tank separation distances in NFPA 30. Separate tanks or tank farms from other structures and buildings by distances listed in Tables 1 and 2 of PRC.2.5.2. The spacing given by NFPA is inadequate to protect nearby structures or buildings from a tank fire.

Do not use the building separation distances in NFPA 30. Separate storage tanks from each other by distances listed in Table 3 of PRC.2.5.2. AXA XL Risk Consulting considers the spacing given by NFPA to be inadequate to protect nearby tanks from a tank fire.

Do not reduce emergency vent sizes for vessels with active protection, such as water spray or foam-water spray. Emergency venting is only needed when such active systems fail, so no credit should be given for such protection when designing emergency venting.

Drainage, Impounding, and Diking

Properly arranged drainage consists of sloped pads and large open trenches. Covered sumps or trenches can be plugged by debris. See PRC.2.5.3.

Properly arranged insulation consists of fireproofing materials listed by a nationally recognized testing laboratory and applied according to manufacturer's instructions to give a rating of 2½ h per UL 1709. See PRC.2.5.1.

Remote impounding is preferred over diking. Slope the ground away from tanks with a grade of at least 2%. Provide remote impounding with capacity at least equal to the volume of the single largest tank plus the fire protection water or 110% of the single largest tank, whichever is greater. See PRC.14.1.1.1 for details on calculating the fire protection water quantity.

If impounding is not possible, provide diking to contain the volume of the largest single tank plus the fire protection water or 110% of the single largest tank, whichever is greater. See PRC.14.1.1.1. Do not include the volumes occupied by tanks within the diked area as available for containment. Provide spacing between the tank shell and the base of the dike at least equal to the difference between the top of the dike and the maximum liquid level in the tank plus the equivalent differential head pressure (if any) in the tank vapor space.

Install only one tank per diked area or provide each tank with automatically activated fire safe shut off valves on all external tank openings below the highest possible liquid level. Place the valves as close to the tank shell as possible.

See PRC.2.5.3 for additional information.

Storage Tank Buildings

Location

Locate storage tank buildings at least 100 ft (30 m) from buildings without fire rated exterior walls or from open structures lacking fireproofing on the load bearing members. Locate storage tanks buildings at least 50 ft (15 m) from buildings with 2 h fire rated exterior walls or from structures with 2 h fire rated fireproofing on the structural members. If separation distances are less than 50 ft (15 m), increase fire resistance ratings of walls or fireproofing to 4 h.

Do not use the building separation distances in NFPA 30. Separate storage tank buildings from other structures and buildings by distances listed in Tables 1 and 2 of PRC.2.5.2. The spacing given by NFPA is inadequate to protect nearby structures or buildings from a tank fire.

Sprinkler Protection

Install ceiling sprinkler systems in all building areas occupied by tanks containing flammable or combustible liquids. If the tank storage area is equipped with proper drainage to a remote location, install water or foam-water sprinkler systems. If drainage is inadequate or a containment-in-place scheme is used, install only foam-water sprinkler systems.

For water only systems, design for 0.60 gpm/ft^2 (24.4 L/min/m^2) over any, including the hydraulically most remote, 5000 ft^2 (465 m^2) using 286 F (141°C) rated sprinklers. For foam-water systems, design for 0.30 gpm/ft^2 (12.2 L/min/m^2) over any, including the hydraulically most remote 3000 ft^2 (279 m^2) using 286 F (141°C) rated sprinklers. Size the foam concentrate supply for a design duration of 20 min. See NFPA 16 and PRC.12.3.1.1.

Containment

Size the containment or remote impounding to equal the sum of the volume of the largest tank plus the designed fixed and manual fire protection system discharge or 110% of the volume of the largest tank, whichever is greater. See PRC.14.1.1.1. Remote impoundment is preferred over containment under or around the tanks. If containment is chosen, the sprinkler systems should be of the foam-water type.

Vents

Do not reduce vent sizing when active protection is provided. Reductions for properly arranged passive protection are permissible.

Provide automatic closing, heat activated valves listed by a nationally recognized testing laboratory on every tank connection through which liquid can flow by gravity. Install the valve as close as possible to the shell of tank.

Outdoor Storage

Do not reduce separation distances based on liquid quantities. Modify the separation distances with the following:

- Maintain a minimum distance between piles or racks of 8 ft (2.4 m).
- Maintain a minimum distance of 50 ft (15 m) between all outdoor liquids storage and other outdoor storage, structures and buildings.

Management Programs

Control smoking, cutting, welding and other hot work in all facilities. Remove flammable and combustible liquids from the areas of hot work operation, or if such materials cannot be removed, provide continuous combustible vapor detectors. Vapors from a spill or leak remote from the hot work area can be detected before ignition occurs. Follow other procedures outlined in *OVERVIEW* (PRC.1.0.1).

DISCUSSION

Remember, these tables are based on specific tests. Given the severity of the hazard posed by flammable or combustible liquids fires, no deviation from these tables should be allowed unless confirmed by a full scale fire test.

Testing has shown that storage of metal containers less than or equal to 10 gal (38 L), protected in accordance with NFPA 30 section 16.4.1, does not need special drainage to prevent the flow of burning liquids outside of the fire area. No testing, however, has been done with containers greater than 10 gal (38 L). Therefore, exempt protected storage of flammable or combustible liquids stored in metal containers of 10 gal (38 L) capacity or less from “special drainage” requirements.

Always keep in mind the difference between containment and drainage. Containment prevents the escape of liquid from a given area while drainage moves liquids to a safe location.

Consider the following points during the design:

- Sealing the walls and installing curbs or drain trenches at openings prevents the spread of burning liquids outside the storage area, but it does not stop such a spread inside the storage area. Total fire involvement within the storage area is therefore possible.
- Sprinkler system design flow rates and durations must be included in the drainage and containment design. If drain trenches are used at wall openings, they must be sized to handle the maximum designed sprinkler system discharge flow rate without allowing any liquid to carry over into other areas.
- If curbs are used at wall openings, then they must be of sufficient height to retain the maximum designed sprinkler system discharge for the expected duration.
- Environmental regulations may apply to spill or runoff facilities. If the effluent handling system is designed to remove spills and fire protection water runoff to the outside of the building, provide adequately sized and protected retention ponds or basins. Size retention ponds according to the type of extinguishing agent used (water only or foam-water). If water is the only agent, more water will generally be required than foam-water agent. Protect retention ponds less than 50 ft (15 m) from important facilities by providing fixed low expansion foam extinguishing systems in accordance with NFPA 11.
- If an underground tank is used for impoundment, do not locate it under an important building or structure. An explosive mix may form in the vapor space during a fire situation. This could lead to an explosion.

The minimum spacing between the tank shell and the base of the dike is intended to prevent liquid from surging over the top of the dike due to a sudden tank shell failure. The higher the tank liquid level and the more differential pressure (if any) in the vapor space, the stronger the liquid surge will be. Thus greater dike height or greater spacing will be needed.

The fire testing performed on the various storage configurations used to derive the requirements of this code used substaintially constructed wood pallets.

Like hot work controls, control of smoking is vital in a facility storing flammable and combustible liquids. A small leak might be easily cleaned up before ignition occurs, but if smoking is allowed, ignition becomes more likely. Part of the task involves periodically surveying the facility and making sure that areas where smoking is prohibited or permitted are clearly marked and there are no signs of the regulations being violated.