FIXED PROTECTION FOR OIL AND CHEMICAL PLANTS

INTRODUCTION

Fixed water spray, deluge, foam-water and sprinkler systems are essential parts of overall fire protection systems in oil and chemical plants. Such systems can control and often extinguish fires involving flammable and combustible liquids.

Fixed water spray systems as defined in NFPA 15 use water in a form having a predetermined pattern, particle size, velocity and density discharged from specially designed nozzles.

Deluge sprinkler systems as defined by NFPA 13 are sprinkler systems using open sprinkler heads.

Water spray and deluge systems discharge water through all open nozzles or open sprinkler heads onto the equipment or area to be protected. The deluge or water spray valves are actuated by detection systems. Foam concentrate can be added to a water spray or deluge system to increase its effectiveness on pool fires. Refer to NFPA 16 for additional information. For limited exposures, adequate protection can be provided by closed head sprinkler systems in accordance with NFPA 13. Foam concentrate can be added to such a system in accordance with NFPA 16 to increase its effectiveness.

Fixed water spray systems have also been very successful in cooling equipment and structures exposed to flammable and combustible liquid fires. Adequate cooling will prevent the weakening of metals, collapse of structures, rupture of vessels, damage of insulated power and instrumentation cables, damage to critical process control valves and instrumentation, and will aid in the control of burning material escaping due to failure of rotating equipment such as compressors and pumps. Protecting exposed critical structures and equipment from early failure can be achieved by combining fixed water spray or deluge protection and fireproofing. Fixed water spray systems can also be designed to control pool fires involving flammable or combustible liquids.

Torch fires can occur in facilities handling flammable gases under high pressure. Water spray or deluge systems will generally not be able to sufficiently cool the direct flame impinged spot of equipment or structure to avoid failure. Only fireproofing will provide some protection from torch fires. Water spray or deluge protection can provide adequate cooling for the area surrounding the point of direct flame impingement. Keep in mind that the addition of foam concentrates to a water based system confers no advantage other than on pool fires.

Finely dispersed water, when sprayed into vapor clouds, has shown some vapor dispersion effects. This phenomenon is not discussed in this PRC Guideline.

For additional information on water spray systems refer to NFPA 15 and API 2030. For additional information on deluge sprinkler systems, refer to NFPA 13 and PRC.12.1.1.0.

POSITION

Automatic fixed water spray, deluge, foam-water or sprinkler systems should be provided to protect high-hazard, exposed or easily damaged equipment. Similar protection is needed for high pressure and high temperature pumps, air-cooled heat exchangers and vessels with large quantities of liquids. Such equipment is generally located in open process structures.

Fixed water spray and deluge systems should be designed, built and installed in accordance with NFPA 15 or NFPA 13 and PRC.12.1.1.0 unless otherwise specified in this guide. Fireproofing is generally required in addition to water spray protection as outlined in PRC.2.5.1.

This PRC Guideline does not cover exposure protection for buildings, which is addressed in NFPA 80A.

Area Versus Specific Application

Deluge protection can be applied over the entire hazard area with open sprinkler heads located at various floor levels or fixed water spray systems can be applied specifically on the equipment to be protected. Specific water spray application is preferred because it provides better equipment cooling and reduces the water wasted due to wind and fire draft.

Fixed water spray protection can be difficult to install in multilevel process structures, in congested areas or in areas containing numerous pieces of small equipment. Therefore, deluge protection of an area is an acceptable alternative to specific application.

Area deluge protection may not be able to wet the underside of equipment. Water spray nozzles spraying onto those dry areas can complement the deluge protection. Generally, all high hazard equipment in deluge protected areas may still warrant some specific water spray protection. In other instances, deluge protection complements a water spray system. Both systems can be integrated into one “hybrid” system. “Hybrid” systems are acceptable and should be hydraulically designed with the systems operating simultaneously. Each system type should comply with its NFPA design standard.

Fixed Water Spray Design

Design of fixed water spray protection will depend upon the type of equipment being protected and types of nozzles being used. The recommended water spray densities should be applied uniformly and not depend upon the rundown of water from upper surfaces.

Figure 1 illustrates how the nozzles in a fixed water spray system would be arranged to protect a typical outdoor process unit.

Reactors, Towers and Other Vessels

Vessels, such as accumulators, condensers, towers, receivers, reactors or drums within process unit (battery) limits with large quantities of liquids, require fixed water spray over the entire vessel surface up to a height of 35 ft (10.7 m) from grade, solid flooring or solid decks. A density of 0.35 gpm/ft^2 (14.2 L/min/m^2) is recommended for flammable gas or liquid hazards. A density of 0.25 gpm/ft^2 (10.2 L/min/m^2) can be used for combustible liquid hazards.

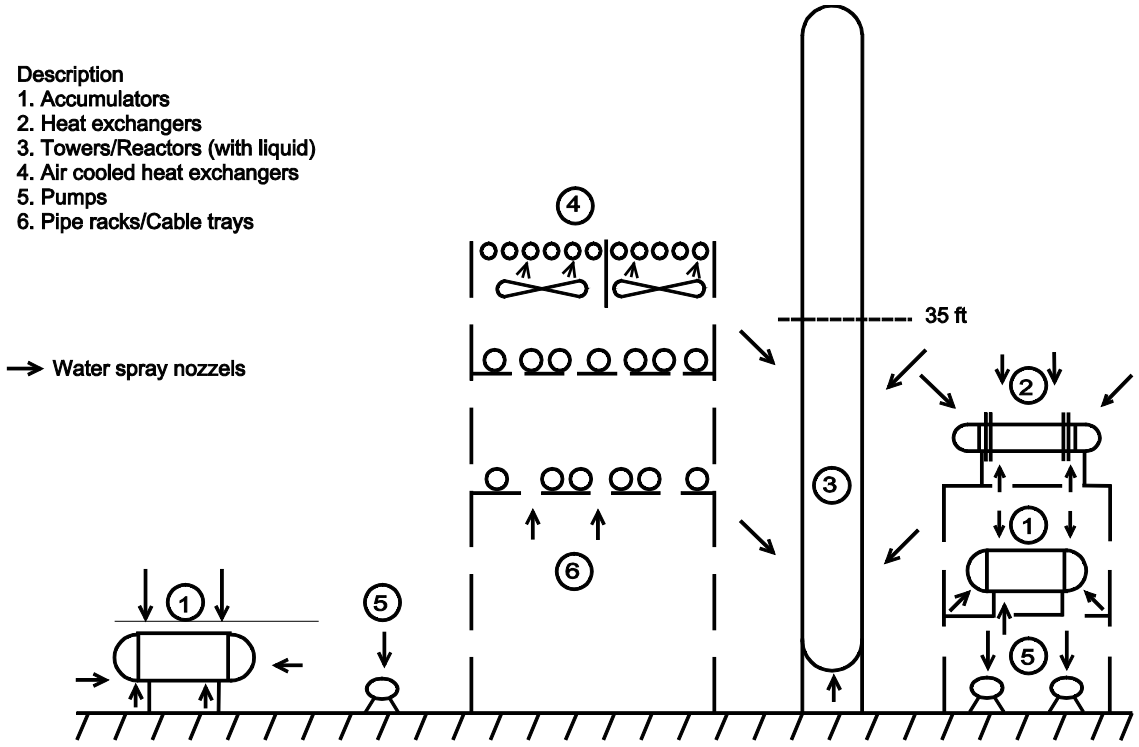

Figure 1. Equipment To Be Covered By Waterspray In An Outdoor Process Unit.

Pumps

A fixed water spray system providing a density of 0.50 gpm/ft^2 (20.4 L/min/m^2) over the protected area is recommended for pumps handling flammable or combustible liquids and when the pumps:

- Expose other equipment.
- Operate at pressures in excess of 500 psig (34.5 bar).
- Operate at temperatures in excess of 500°F (260°C) or operating above the product autoignition temperature.
- Handle liquefied flammable gases.

Pumps without shaft seals, such as canned pumps, do not require water spray protection.

Pumps or other devices that handle flammable liquids or gases shall have the shafts, seals, and other critical parts enveloped by directed water spray at a net rate of not less than 20.4 (L/min)/m² [0.50 gpm/ft²] of projected surface area of the equipment.

Compressors and Turbines

Bearings and governors of compressors and turbines require fixed water spray providing 0.5 gpm/ft^2 (10.2 L/min/m^2) over the projected surface area of the equipment. Provide water spray protection to cover critical parts of gas compressor including the shafts, seals, inter-stage cooling vessels, the suction and discharge valves and the electric motor. The lubricating and hydraulic oil reservoirs as well as the oil handling equipment require similar protection if they expose the turbine or compressor. Additional information can be found in NFPA 850, PRC.17.12 and PRC.17.12.1.

Fired Heaters

Exposed or exposing heaters, liquid fuel fired heaters or heaters, which heat flammable or combustible liquids, require water spray under the heater as well as on the exterior sides. A density of 0.25 gpm/ft^2 (10.2 L/min/m^2) is recommended. Extend protection to cover expansion or surge vessels containing more than 500 gal (130 L) of fluid or if the system is operating above the fluid autoignition temperature.

Piping and Pipe racks

Exposed piping in major pipe racks should be protected as follows:

- **Pipe racks not deeper than 3 ft (0.9 m)**: 0.25 gpm/ft^2 (10.2 L/min/m^2) onto the underside of the lower level piping.
- **Pipe racks deeper than 3 ft (0.9 m)**: 0.25 gpm/ft^2 (10.2 L/min/m^2) onto the underside of piping at 3 ft (0.9 m) intervals.

Where space is inadequate and sprinkler piping can not be installed below the rack, spray nozzles are permitted to be applied at the top of the piping on racks.

An alternative is to protect pipe racks in accordance with NFPA 15 and is summarized as follows:

- **Single level pipe racks**: 0.25 gpm/ft^2 (10.2 L/min/m^2) onto the underside of the piping.
- **Two level pipe racks**: 0.20 gpm/ft^2 (8.2 L/min/m^2) onto the underside of the lower level and 0.15 gpm/ft^2 (6.1 L/min/m^2) onto the underside of the upper level.
- **Three, four or five level pipe racks**: 0.20 gpm/ft^2 (8.2 L/min/m^2) onto the underside of the lower level and 0.15 gpm/ft^2 (6.1 L/min/m^2) onto the underside of alternate levels and the upper level.
- **Six or more level pipe racks**: 0.20 gpm/ft^2 (8.2 L/min/m^2) onto the underside of the lower level and 0.10 gpm/ft^2 (4.1 L/min/m^2) onto the underside of alternate levels and the upper level.

Cable Trays

The following recommendations provide exposure protection of cable trays that are exposed by pumps or other equipment:

- Where cables are exposed and no shielding or fireproofing is provided, provide fixed water spray located under and above the tray with the spray directed onto the tray. A density of 0.30 gpm/ft^2 (12.2 L/min/m^2) is recommended.
- Where exposed cable trays are provided with a bottom shield that extend at least 6 in. (150mm) beyond the side rail of the tray or rack, provide fixed water spray with a density of 0.25 gpm/ft^2 (10.2 L/min/m^2) onto the upper part of the tray.
- Where cable trays are fully enclosed into a 30 min UL 1709 fire rated enclosure, water spray for exposure protection is not required.

When fire protection for cables in trays is warranted due to the fire hazard created by the cables themselves, then protection should be provided in accordance with NFPA 850, PRC.17.12, and PRC.17.12.1.

Air Cooled Heat Exchangers

Exposed air cooled heat exchangers require a fixed water spray system located immediately underneath the exchanger. Protection is also needed for the exposing equipment (e.g. pumps). The spray nozzles should be installed below the cooling tubes and directed upwards. A density of 0.25 gpm/ft^2 (10.2 L/min/m^2) is recommended.

Electric Motors

Exposed large motors driving critical equipment should be protected by a water spray system providing a density of 0.25 gpm/ft^2 (10.2 L/min/m^2).

Cooling Towers

When combustible cooling towers are critical for production, they should be protected in accordance with NFPA 214.

Transformers

Protect oil-filled transformers critical for production by a system designed to provide water spray impingement on all exposed exterior surfaces at a density of 0.25 gpm/ft^2 (10.2 L/min/m^2). Refer to NFPA 850, PRC.17.12, PRC.17.12.1 and PRC.5.9.2 for additional information.

Conveyor Belts

Refer to PRC.9.3.1.

Atmospheric Storage Tanks

A fixed system that applies water directly on the sides of tanks is very effective for cooling tank shells exposed to fires and for maintaining the integrity of shells during foam application and pump-out operations. For floating roof tanks, the water should be applied directly under the wind girders. A water density of 3 gpm/ft^2 (37.2 L/min/m^2) of shell circumference is recommended. Design the system so water is distributed evenly along the circumference of the tank. Shell cooling is recommended in the following cases:

- For tanks in excess of 300,000 bbl (47,700 m^3) containing flammable or combustible liquids.
- For tanks in excess of 10,000 bbl (1590 m^3) containing flammable liquids and located within one tank diameter of another exposing tank.

The water system protecting large tank shells should be divided into two, three or four independent sections. Separating the water application system into independent sections becomes desirable when exposure protection from an adjacent burning tank is required. Under these circumstances, cooling water would be applied only to the portion of the tank, which is directly exposed, thereby reducing the water demand. Therefore, manual water application systems are preferred in this case. Each water/spray section should be from separate connections to fire water mains. Distinctively marked manual control valves for these connections should be located outside the dikes and be readily accessible.

Pressure Storage Vessels

Fixed water spray systems are recommended for horizontal and vertical pressure vessels containing flammable materials and should provide a density of 0.35 gpm/ft^2 (14.2 L/min/m^2) over the entire surface. Spheres and spheroids should be protected with the same design. Water-weir systems or other systems utilizing water rundown only are not recommended.

Cryogenic and Low Temperature Storage Tanks

Fixed water spray providing a density of 0.25 gpm/ft^2 (10.2 L/min/m^2) is required over any exposed combustible foam insulation of cryogenic or low temperature storage tanks storing flammable materials. The water spray may be manually actuated. In lieu of water spray, fireproofing can be applied over the exposed combustible foam insulation.

See Table 1 for a summary of these densities.

TABLE 1
Summary of Densities in gpm/ft²

	Water Spray Flammable Liquid	Water Spray Combustible Liquids	Foam-Water Spray Flammable or Combustible Liquids
Reactors, Towers, Other Vessels	0.35	0.25	0.25
Pumps	0.50	0.50	0.50
Turbines, Compressors	0.50	0.25	0.25
Fired Heaters	0.25	0.25	0.25
Pipe Racks	0.25	0.25	0.25
Cable Trays			
No Shielding	0.30	0.30	0.30
With Shielding	0.25	0.25	0.25
Air Cooled Heat Exchangers	0.25	0.25	0.25
Motors	0.25	0.25	0.25
Transformers	N/A	0.25	0.25
Tank Storage	3 gpm per ft of shell circumference	3 gpm per ft of shell circumference	N/A
Pressure	0.35	0.35	N/A
Cryogenic/Low Temperature	0.25	0.25	N/A

SI Units: 1 gpm/ft² = 40.7 L/min/m²
For specifics refer to the individual descriptions in this section.

Deluge Sprinkler System Design

The following deluge sprinkler densities are recommended:

- 0.25 gpm/ft² (10.2 L/min/m²) over the protected area for fires involving combustible liquids.
- 0.35 gpm/ft² (14.2 L/min/m²) over the protected area for fires involving flammable gases or liquids. Where deluge foam-water sprinkler systems are provided to protect against flammable liquid hazards, the required density can be reduced to 0.25 gpm/ft² (10.2 L/min/m²).

The deluge protection should be provided up to 35 ft (10.7 m) above any flammable or combustible liquid pooling area, except in indoor process structures.

In addition to the area deluge protection, deluge or water spray protection is required under the following circumstances:

- Protect fire prone equipment, such as pumps handling flammable or combustible materials, with water spray protection aimed at the equipment.
- Protected equipment and other obstructions exceeding 4 ft (1.2 m) in width or diameter by additional deluge sprinklers or nozzles spraying onto the dry underside areas.

Outdoor Multi-Level Process Structures

In multi-level structures with open floor grating, a density of 0.25 gpm/ft² (10.2 L/min/m²) can be used in the upper levels. The lower level deluge sprinkler density should be 0.35 gpm/ft² (14.2 L/min/m²) or 0.25 gpm/ft² (10.2 L/min/m²) depending on whether the fuel present is flammable or combustible.

In multi-level structures with solid flooring, deluge protection should be provided at all levels. The recommended densities will depend on whether the fuel present is a flammable or combustible.

Indoor Process Structures

In indoor process structures, e.g. inside buildings, deluge sprinkler systems located at the ceiling will be designed on an area basis. The protection should extend to the entire structure and should not be limited to 35 ft (10.7 m) above any flammable or combustible liquid pooling area. Specific high hazard equipment may be protected by additional water spray nozzles.

Indoor multi-level process structures with open floor grating can be protected by closed head systems in lieu of deluge systems provided the following conditions are met:

- For flammable liquid service, the roof density should be 0.35 gpm/ft^2 (14.2 L/min/m^2). For combustible liquids (or water miscible flammable liquids), the density can be reduced to 0.30 gpm/ft^2 (12.2 L/min/m^2).
- All intermediate levels for flammable liquids service should be protected with a density of 0.25 gpm/ft^2 (10.2 L/min/m^2). If for combustible liquid (or water miscible flammable liquid) service, the density can be reduced to 0.15 gpm/ft^2 (6.1 L/min/m^2).
- For flammable liquid service, the bottom level should be protected with a density of 0.35 gpm/ft^2 14.2 L/min/m^2). For combustible liquid (or water miscible flammable liquid) service, the bottom level should be protected with a density of 0.30 gpm/ft^2 (12.2 L/min/m^2).
- The bottom level should be a separate system utilizing AFFF. The calculated duration of the concentrated supply should be at least 20 min.

  Any use of solid floor sections in any of the intermediate levels will require that the protection immediately above and below that section be raised to equal the densities at the roof and the bottom level. AFFF should be added to the system above the solid floor.
- Because of the open floor construction, design calculations should assume that all heads within the process structure will open.

Process buildings handling limited amounts of flammable or combustible liquids may be protected by a wet pipe sprinkler system in lieu of a deluge system. The sprinkler design should be based on an Extra Hazard Group 2 occupancy in accordance with NFPA 13 and PRC.12.1.1.0. Protection guidelines for storage facilities handling combustible or flammable liquids in portable containers are addressed in PRC.8.1.0.

The area selected for sprinkler hydraulic calculation purposes should reflect the maximum credible spill area taking into account the following criteria:

- The size of the spill should be based on the contents of the largest vessel or train of vessels connected together. This should include liquid hold-up in piping. The existence of shut-off valves should not be considered unless they are automatic or remotely manually activated.
- Assume the spill will spread to cover 50 ft^2 (12.2 m^2) for every gal (3.8 L) of liquid unless prevented in some fashion.
- Curbing may be assumed to limit the spread of the spill provided the area enclosed and the height of the curbing are sufficient to contain the volume of the contemplated spill.
- Drain trenches will also limit the spill area provided the retention volume of the trench and the rate of drainage is sufficient to prevent the contemplated spill from exceeding the given area.
- The hydraulically calculated design area of the sprinkler system should extend 20 ft (6 m) beyond the limits of the spill area. If the limit of the spill area is determined by the presence of a wall, then the sprinkler system design area can also terminate at that point.
- Provided it is installed utilizing the same area coverage criteria as described above, a foam water sprinkler system may be substituted utilizing Extra Hazard Group I design densities.

See Table 2 for a summary of these densities.

TABLE 2
Multiple Level Process Structures in gpm/ft²

	Water Only Flammable Liquids	Water Only Combustible Liquids See Note 1	Foam-Water Systems Flammable or Combustible Liquids
(Deluge) Open Grating Floors			
Top Level	0.25	0.25	0.25
Intermediate	0.25	0.25	0.25
Bottom Level	0.35	0.25	0.25
Solid Floors All Levels	0.35	0.25	0.25
(Closed Head) Indoor Structures Open Grating Floors			
Top Level	0.35	0.30	N/A
Intermediate	0.25	0.15	N/A
Bottom Level	N/A	N/A	Fl. Liq. 0.35 Comb. Liq. 0.30
Solid Floors	N/A	N/A	Fl. Liq. 0.35 Comb. Liq. 0.30

SI Units: 1 gpm/ft² = 40.7 L/min/m²
NOTE 1: This includes also water miscible flammable liquids.

Loading Racks

A fixed water spray or deluge system is recommended for truck and rail car loading racks. See PRC.9.2.1.1.

Piers and Wharfs

Additional water spray or deluge protection could be required for a pier or wharf**,** which is combustible or potentially exposed by spills, ships or barges. Specific protection over pumps or other equipment, such as slop tanks, may be needed.

DISCUSSION

Water Spray or Deluge and Fireproofing

Water spray or deluge protection should be provided in addition to the fireproofing required in PRC.2.5.1. Water spray or deluge systems are not a substitute for fireproofing as the system can be rendered inoperative by an explosion or impairment.

Fireproofed structural supports, columns or vessels may not require water spray or deluge protection on these columns or vessels if both of the following conditions are met:

- The vessel or structure is fully fireproofed (totally covered).
- The fireproofing material has a 2½ hour rating by UL 1709 or the insulation meets the DOT/AAR Torch Fire Test.

To meet the DOT/AAR Torch Fire Test, insulation or fireproofing should limit the container wall temperature to 800°F (427°C) for at least 50 min while being subjected to a torch delivering 70,000 Btu/hr/ft² (795,000 kJ/hr/m²). The test is conducted on insulation applied to a 4 ft × 4 ft (1.2 m × 1.2 m) steel plate. The insulation should also be subjected to a hose stream test. At this time, there are no products listed by a nationally recognized testing laboratory with a follow-up service that meets the DOT/AAR Torch Fire testing criteria.

Deluge Foam-Water Sprinkler and Foam-Water Spray Systems

Deluge foam-water sprinkler and foam-water spray systems are preferred to “regular” water spray or deluge systems where a flammable or combustible liquid pool fire is expected. This is particularly true in areas with poor drainage. The foam coverage will greatly reduce the exposing fire therefore allowing a reduction in the water spray or deluge densities.

The recommended water spray density can be reduced to 0.25 gpm/ft^2 (10.2 L/min/m^2) for the protection of process vessels, drums, towers and reactors when automatic fixed foam-water spray protection is provided.

Where deluge foam-water sprinkler systems are provided to protect against flammable liquid hazards, the required density is 0.25 gpm/ft^2 (10.2 L/min/m^2) instead of 0.35 gpm/ft^2 (14.2 L/min/m^2).

Foam systems should be designed for a minimum 20 min supply and designed in accordance with NFPA 16.

NFPA 16 recommends a density of 0.16 gpm/ft^2 (6.5 L/min/m^2) over the entire area. This is a minimum density for extinguishment in ideal conditions and would not be sufficient for three-dimensional fires. Should the foam fail to extinguish the fire before the supply of foam runs out, the remaining water spray or deluge density (without foam) would be inadequate to cool the exposed structures and equipment. By increasing the foam system density to 0.25 gpm/ft^2 (10.2 L/min/m^2), the cooling effect from the water spray or deluge system should be sufficient even if the foam injection failed or the foam supply is depleted.

Although automatic fixed foam-water systems (water spray or deluge) are preferred, alternate system configuration could be used. An automatic water spray or deluge system can be combined with a manual foam injection system. Such a combined system requires the same hardware as a fully automatic foam-water spray or deluge foam-water system. The only difference is that the valve controlling the foam is manually operated from a remote, constantly attended location such as a control room. The foam tank and injection system are part of the fixed installation. Manual foam injection in automatic water spray or deluge systems should use the water densities recommended for non-foam systems.

Detection and Actuation

For plant process areas, water spray or deluge systems control valves should be arranged to operate without delay by **ALL** of the following detection systems:

- **Fire detectors**: Dry-pilot head and pneumatic rate-of-rise heat actuated devices (HADs) are the major types encountered. Dry-pilot head detection systems using 165°F (74°C) rated ½ in. sprinkler heads are recommended unless high operating temperatures are encountered. Pneumatic rate-of-rise HADs can also be used but are generally more difficult to maintain. Where detectors are not directly located under solid surfaces, heat collectors should be provided above the detectors. Other types of detection systems could include ultraviolet or infrared flame detectors, or thermostatic cable heat detectors. All detectors should be listed by a nationally recognized testing laboratory.
- **Combustible gas detectors**: Where a flammable vapor or gas hazard exists, diffusion-head-type gas detectors should be installed. Gas detectors should be arranged to sound an alarm at 25% of the lower explosive limit (LEL) and trip the water spray or deluge system at 50% of the LEL or when two cross-zoned gas detectors measure concentrations reaching 25% of the LEL. Special cases could require different alarm settings for the detectors.
- **Remote-manual-control stations**: Manual actuators should be readily accessible and unexposed by the area being protected.

There are many advantages to actuating the water spray or deluge system as soon as a flammable vapor or gas is detected and before it ignites:

- Sprayed water acts as an air mover, helping to drive the vapors from under structures and away from equipment. If the vapors were to remain trapped, the cloud would be partly confined, increasing the chances for a vapor cloud explosion.
- Sprayed water will wet down critical and highly vulnerable electric wiring, and instrumentation leads, thus protecting them from damage should the cloud ignite in a flash fire.
- Sprayed water will increase the relative air humidity therefore reducing the probability of a static discharge igniting the vapor cloud.
- Sprayed water wets equipment and could reduce the probability of a mechanical spark developing and igniting the cloud.
- Some gases or vapors may be water soluble and spraying water will dilute the cloud.

Explosion Protection

Water spray or deluge systems are subject to damage due to an explosion. To limit damage to such systems and therefore reduce the potential for impairment, use the following design guidelines:

- Deluge valves should be remotely located (at least 50 ft) from the area to be protected or located within a blast resistant valve house or behind a blast wall.
- Piping should run underground whenever possible. Risers should rise aboveground behind a protecting steel column or other structural element, other piping should be located behind structural elements providing shielding from explosion overpressures and flying debris.
- Feed mains and cross-mains should be located as far as possible from reactors, high-hazard process vessels and high-pressure operating equipment.
- The number of deluge valves manifolded together should be strictly limited to no more than three (3).
- Fire water mains should be buried and accessible post indicator isolation valves provided.

These recommendations are shown in Figures 2, 3 and 4.

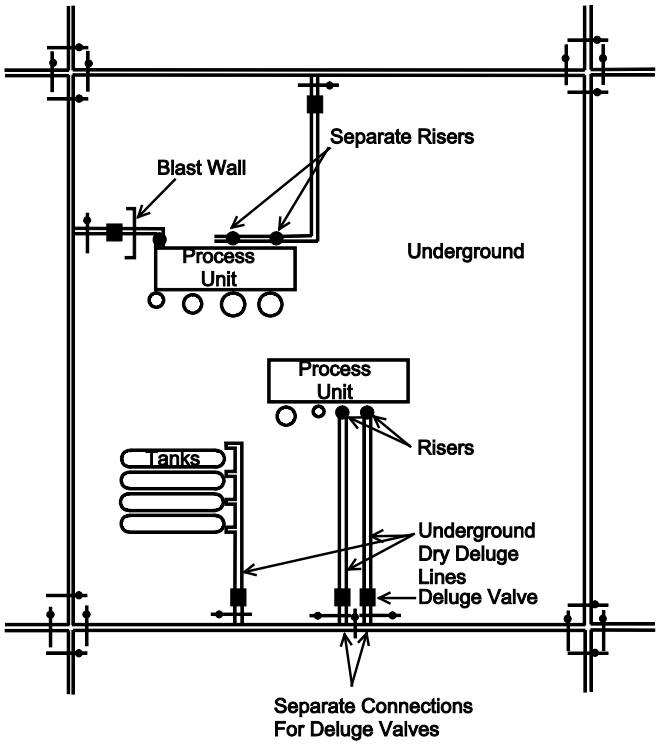

Figure 2. Explosion Protection Of Water Spray Or Deluge Piping. (Plan View)

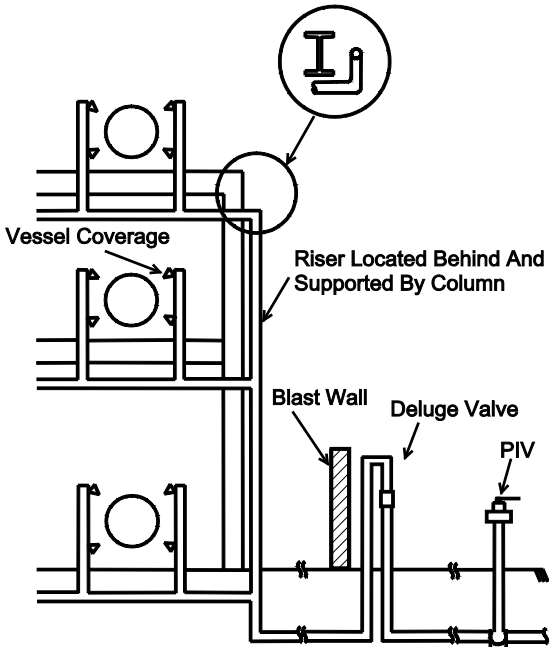

Figure 3. Explosion Protection Of Water Spray Or Deluge Piping. (Elevation)

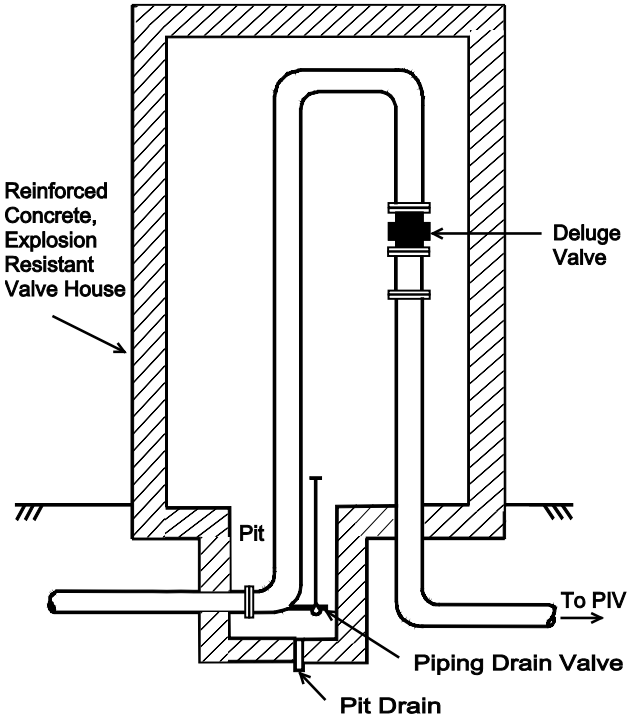

Figure 4. Explosion Protection Of Deluge Valve House.

Piping Specifications

The type of piping and fittings used can greatly influence the explosion resistance of a piping installation. The following extra material and design specifications are recommended:

- All water spray piping 2½ in. (63 mm) or larger should be welded or utilize welded flanged fittings.
- All welded pipes and fittings should be hot dipped and galvanized after fabrication.

- All piping from ½ in. – 4 in. (15 mm – 100 mm) in size should be galvanized steel: ASTM A53, ASTM A795 or API-5L, type F (furnace-butt welded, continuous welded) or better (type E or S), schedule 40 or standard weight or better. Type F piping is not intended for flanging.
- All piping larger than 4 in. (100 mm) should be galvanized steel: ASTM A53; ASTM A795; API-5L, Type E (electric-resistance welded) or type S (seamless), grade B, standard weight. ASTM A795 piping should not be used for sizes larger than 6 in. (150 mm).
- Screwed fittings should be Class 150 screwed galvanized malleable iron, standard weight type designed in accordance with ASME B.16.3.
- Welded fittings should be standard weight seamless steel: ASTM A234 grade WPB, galvanized after fabrication and designed in accordance with ASME B16.9 or ASME B16.25.
- Flanges should be Class 150 raised face, slip-on welding or welding neck type, bored to match welding fitting and designed in accordance to ANSI B.16.5. The materials used should be steel ASTM A105 or ASTM A181 galvanized after fabrication.
- Gaskets should be standard flat ring ⅛ in. (3 mm) thick rubber.

Installation Considerations

Piping Supports

Water spray or deluge piping can either be built on self supporting structures or supported on the structure or equipment it is protecting. Major water spray piping should be anchored to fireproofed structural members. There are definite advantages to providing supports welded on vessels. However this type of support system must be a part of the original design; vessels or equipment must, be in accordance with the ASME Boiler and Pressure Vessel Code, Section VIII Division 1 or 2. Often, **post-weld stress relief** will be required after attachment of the supports. Ensure compliance with all applicable boiler and pressure vessel codes.

Open Spray Nozzles and Deluge Sprinkler Heads

The selection of the appropriate type of spray nozzle will depend on the area to be protected, spray angle, spray velocity, type of foam used (if any) and distance between nozzle and equipment. Preferably, minimum ½ in. (15 mm) nominal orifice spray nozzles or spray heads should be used, as smaller orifice heads are more likely to be plugged.

For deluge sprinkler systems, minimum ½ in. (15 mm) nominal orifice sprinkler heads should be used.

A minimum end pressure of 15 psi (1 bar) is recommended, but depending on the manufacturer some nozzles or systems may require higher pressures. All heads and nozzles should be listed by a nationally recognized testing laboratory.

Water Quality

Clogging and plugging of spray nozzles or sprinkler heads is a common problem in water spray or deluge systems. Clean, filtered water should supply such systems. When raw water sources must be used, strainers with removable screens or baskets should be installed in the water feeds. Sea water can create corrosion problems in fire water systems and around stainless steel pressure equipment. Its use as a water source is not recommended unless appropriate metallurgy is used.

Fire Water Demands

Simultaneous operation of water spray or deluge systems should be considered when designing systems. In a liquid spill fire situation, water spray or deluge systems in the incident area and direct surroundings, as well as systems located near the burning spill drainage path, should be expected to operate. In a flammable gas or vapor release, gas detectors would trip systems within the vapor cloud. The water demand generated by multiple systems trip should be hydraulically balanced and calculated. Estimation of the fire water demands for oil and chemical plants is discussed in PRC.14.1.1.1. The fire water supply should be able to meet such a demand. Additional information can be found in PRC.14.0.1.

Where large fire water systems are provided, fire pumps can be automatically started upon tripping of the deluge valves. Interlocking the fire pumps to the deluge valves will avoid a pressure drop in the water supply especially when automatic fire pumps are remotely located from the protected area. Such arrangement will very quickly boost the available pressure for the deluge or water spray systems. See NFPA 20 and PRC.14.2.1 for additional information.