

NFPA® 15

Standard for Water Spray Fixed Systems for Fire Protection

2012 Edition



NFPA, 1 Batterymarch Park, Quincy, MA 02169-7471
An International Codes and Standards Organization



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ISBN: 978-145590090-9 (Print)
ISBN: 978-145590111-1 (PDF)

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NFPA® 15

Standard for

Water Spray Fixed Systems for Fire Protection

2012 Edition

This edition of NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, was prepared by the Technical Committee on Water Spray Fixed Systems and acted on by NFPA at its June Association Technical Meeting held June 12–15, 2011, in Boston, MA. It was issued by the Standards Council on August 11, 2011, with an effective date of August 31, 2011, and supersedes all previous editions.

This edition of NFPA 15 was approved as an American National Standard on August 31, 2011.

Origin and Development of NFPA 15

The *Standard for Water Spray Fixed Systems for Fire Protection*, formerly *Water Spray Nozzles and Extinguishing Systems*, first prepared by the Committee on Manufacturing Hazards, was tentatively adopted in 1939, with final adoption in 1940. Subsequently, this standard was placed under the jurisdiction of the Committee on Special Extinguishing Systems, and a new edition was adopted in 1947. In 1959, the committee organization was further changed to place primary responsibility in the hands of the Committee on Water Spray, under the general supervision of the General Committee on Special Extinguishing Methods. In 1966, the General Committee on Special Extinguishing Methods was discontinued, and the Committee on Water Spray was constituted as an independent committee. Revised editions were presented in 1969, 1973, 1977, 1979, and 1982.

The 1985 edition incorporated several technical changes concerning special piping provisions. The format of the document was also changed to more closely follow the *NFPA Manual of Style*.

Given the limited changes in water spray technology over the past few years, it was apparent that the 1985 edition could be reconfirmed with referenced publications being updated.

The 1996 edition represented a complete reorganization of the standard. Information was rearranged in a more functional and concise format to improve the usability of the document.

Other major changes included a new chapter on high-speed systems, and revised requirements for spray nozzles, piping protection, spacing of pilot sprinklers, discharge densities, and design calculations.

The 2001 edition represented a complete reorganization of the standard to conform to the requirements of the 2000 edition of the *Manual of Style for NFPA Technical Committee Documents*.

The 2007 edition incorporated welding requirements for pipe and fittings and also coordinated requirements for fire department connections with NFPA 13, *Standard for the Installation of Sprinkler Systems*.

The 2012 edition provides updated rules for grooved couplings to comply with changes in the 2010 edition of NFPA 13. Other changes include an expanded section on designing for flammable vapor mitigation and the addition of new contractor's material and test certificates.



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NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on the design, construction, installation, and test of fixed water spray systems for fire protection purposes.



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NFPA 15

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

Changes other than editorial are indicated by a vertical rule beside the paragraph, table, or figure in which the change occurred. These rules are included as an aid to the user in identifying changes from the previous edition. Where one or more complete paragraphs have been deleted, the deletion is indicated by a bullet (•) between the paragraphs that remain.

A reference in brackets [] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, the complete title and edition of the source documents for extracts in mandatory sections of the document are given in Chapter 2 and those for extracts in informational sections are given in Annex C. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

Information on referenced publications can be found in Chapter 2 and Annex C.

Chapter 1 Administration

1.1 Scope.

1.1.1 This standard provides the minimum requirements for the design, installation, and system acceptance testing of water spray fixed systems for fire protection service and the minimum requirements for the periodic testing and maintenance of ultra-high-speed water spray fixed systems.

1.1.2* Water spray fixed systems shall be specifically designed to provide for effective fire control, extinguishment, prevention, or exposure protection.

1.1.3* This standard shall not apply to water spray protection from portable nozzles, sprinkler systems, monitor nozzles, water mist suppression systems, explosion suppression, or other means of application covered by other standards of NFPA.

1.2 Purpose. The purpose of this standard shall be to provide the minimum requirements for water spray fixed systems based on sound engineering principles, test data, and field experience.

1.3 Application.

1.3.1 Water spray is applicable for protection of specific hazards and equipment and shall be permitted to be installed indepen-

dently of, or supplementary to, other forms of fire protection systems or equipment.

1.3.2 Water spray protection is acceptable for the protection of hazards involving each of the following groups:

- (1) Gaseous and liquid flammable materials
- (2) Electrical hazards such as transformers, oil switches, motors, cable trays, and cable runs
- (3) Ordinary combustibles such as paper, wood, and textiles
- (4) Certain hazardous solids such as propellants and pyrotechnics
- (5) Vapor mitigation

1.4 Retroactivity. The provisions of this standard reflect a consensus of what is necessary to provide an acceptable degree of protection from the hazards addressed in this standard at the time the standard was issued.

1.4.1 Unless otherwise specified, the provisions of this standard shall not apply to facilities, equipment, structures, or installations that existed or were approved for construction or installation prior to the effective date of the standard. Where specified, the provisions of this standard shall be retroactive.

1.4.2 In those cases where the authority having jurisdiction determines that the existing situation presents an unacceptable degree of risk, the authority having jurisdiction shall be permitted to apply retroactively any portions of this standard deemed appropriate.

1.4.3 The retroactive requirements of this standard shall be permitted to be modified if their application clearly would be impractical in the judgment of the authority having jurisdiction, and only where it is clearly evident that a reasonable degree of safety is provided.

1.5 Equivalency. Nothing in this standard is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this standard. Technical documentation shall be submitted to the authority having jurisdiction to demonstrate equivalency. The system, method, or device shall be approved for the intended purpose by the authority having jurisdiction.

1.6 Units and Formulas.

1.6.1 Metric units of measurement in this standard are in accordance with the modernized metric system known as the International System of Units (SI). Two units (liter and bar), outside of but recognized by SI, are commonly used in international fire protection. These units are listed in Table 1.6.1, with conversion factors.

Table 1.6.1 Unit Conversions

Name of Unit	Unit Symbol	Conversion Factor
Liter	L	1 gal = 3.785 L
Liter per minute per square meter	(L/min)/m ²	1 gpm/ft ² = 40.746 (L/min)/m ²
Cubic decimeter	dm ³	1 gal = 3.785 dm ³
Pascal	Pa	1 psi = 6894.757 Pa
Bar	bar	1 psi = 0.0689 bar
Bar	bar	1 bar = 10 ⁵ Pa

Note: For additional conversions and information see IEEE/ASTM-SI-10, *Standard Practice for Use of the International System of Units (SI): The Modern Metric System*.

1.6.2 If a value for measurement as given in this standard is followed by an equivalent value in another unit, the first stated shall be regarded as the requirement. A given equivalent value might be approximate.

1.6.3 The conversion procedure for the SI units has been to multiply the quantity by the conversion factor and then to round the result to the appropriate number of significant digits.

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2010 edition.

NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*, 2010 edition.

NFPA 22, *Standard for Water Tanks for Private Fire Protection*, 2008 edition.

NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*, 2010 edition.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 2011 edition.

NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*, 2009 edition.

NFPA 70®, *National Electrical Code*®, 2011 edition.

NFPA 72®, *National Fire Alarm and Signaling Code*, 2010 edition.

NFPA 1963, *Standard for Fire Hose Connections*, 2009 edition.

2.3 Other Publications.

2.3.1 ANSI Publications. American National Standards Institute, Inc., 25 West 43rd Street, 4th Floor, New York, NY 10036.

ANSI/ASME B1.20.1, *Pipe Threads, General Purpose*, 2006.

ANSI B16.1, *Cast Iron Pipe Flanges and Flanged Fittings*, 2005.

ANSI B16.3, *Malleable Iron Threaded Fittings*, 2006.

ANSI B16.4, *Gray Iron Threaded Fittings*, 2006.

ANSI B16.5, *Pipe Flanges and Flanged Fittings*, 2006.

ANSI B16.9, *Factory-Made Wrought Steel Butt Welding Fittings*, 2007.

ANSI B16.11, *Forged Fittings, Socket-Welding and Threaded*, 2009.

ANSI B16.18, *Cast Copper Alloy Solder Joint Pressure Fittings*, 2001.

ANSI B16.22, *Wrought Copper and Copper Alloy Solder Joint Pressure Fittings*, 2001.

ANSI B16.25, *Butt Welding Ends*, 1997.

ANSI B36.10M, *Welded and Seamless Wrought Steel Pipe*, 2004.

ANSI B36.19M, *Stainless Steel Pipe*, 2002.

ANSI C2, *National Electrical Safety Code*, 2007.

2.3.2 ASME Publications. American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990.

Boiler and Pressure Vessel Code (BPVC), Section IX, *Welding and Brazing Qualifications*, 2010.

2.3.3 ASTM Publications. ASTM International, 100 Barr Harbor Drive, Box C700, West Conshohocken, PA 19428-2959.

ASTM A 53, *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless*, 2007.

ASTM A 135, *Standard Specification for Electric-Resistance-Welded Steel Pipe*, 2009.

ASTM A 182, *Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service*, 2009.

ASTM A 234, *Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service*, 2007.

ASTM A 312, *Standard Specification for Seamless Welded and Heavily Cold Worked Austenitic Stainless Steel Pipes*, 2009.

ASTM A 536, *Standard Specification for Ductile Iron Castings*, 2009.

ASTM A 795, *Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use*, 2008.

ASTM B 75, *Standard Specification for Seamless Copper Tube*, 2002.

ASTM B 88, *Standard Specification for Seamless Copper Water Tube*, 2009.

ASTM B 251, *Standard Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube*, 2002.

ASTM D 323, *Standard Test Method for Vapor Pressure of Petroleum Products (Reid Method)*, 2008.

2.3.4 AWS Publications. American Welding Society, 550 N. W. LeJeune Road, Miami, FL 33126.

AWS A5.8, *Specification for Filler Metals for Brazing and Braze Welding*, 2004.

AWS B2.1, *Specification for Welding Procedures and Performance Qualification*, 2009.

AWS B2.2, *Standard for Brazing Procedure and Performance Qualification*, 1991.

2.3.5 IEEE Publications. Institute of Electrical and Electronics Engineers, Three Park Avenue, 17th Floor, New York, NY 10016-5997.

IEEE/ASTM-SI-10, *Standard Practice for Use of the International System of Units (SI): The Modern Metric System*, 2002.

2.3.6 Other Publications. Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2010 edition.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 2011 edition.

NFPA 30, *Flammable and Combustible Liquids Code*, 2012 edition.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary*, 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.4 Shall. Indicates a mandatory requirement.

3.2.5 Should. Indicates a recommendation or that which is advised but not required.

3.3 General Definitions.

3.3.1 Combined System. A system of piping that connects both sprinklers and water spray nozzles in a common fire area, and is supplied by a single riser and system actuation valve.

3.3.2* Combustible Liquid. Any liquid that has a closed-cup flash point at or above 100°F (37.8°C), as determined by the test procedures and apparatus set forth in Section 4.4 of NFPA 30. Combustible liquids are classified according to Section 4.3 of NFPA 30. [30, 2012]

3.3.3 Control of Burning. Application of water spray to equipment or areas where a fire can occur to control the rate of burning and thereby limit the heat release from a fire until the fuel can be eliminated or extinguishment effected.

3.3.4 Deflagration. Propagation of a combustion zone at a velocity that is less than the speed of sound in the unreacted medium.

3.3.5 Density. The unit rate of water application to an area or surface expressed in gpm/ft² [(L/min)/m²].

3.3.6 Detection Equipment.

3.3.6.1 Automatic Detection Equipment. Equipment that automatically detects heat, flame, products of combustion, flammable gases, or other conditions likely to produce fire or explosion and cause other automatic actuation of alarm and protection equipment. [25, 2011]

3.3.6.2 Flammable Gas Detection Equipment. Equipment that will automatically detect a percent volume concentration of a flammable gas or vapor relative to a predetermined level.

3.3.7 Detonation. Propagation of a combustion zone at a velocity that is greater than the speed of sound in the unreacted medium.

3.3.8 Electrical Clearance. The air distance between the water spray equipment, including piping and nozzles, and unenclosed or uninsulated live electrical components at other than ground potential.

3.3.9 Exposure Protection. Absorption of heat through application of water spray to structures or equipment exposed to a fire, to limit surface temperature to a level that will minimize damage and prevent failure.

3.3.10* Fire Area. For the purpose of this standard, an area that is physically separated from other areas by space, barriers, walls, or other means in order to contain fire within that area.

3.3.11* Flammable Liquid. Any liquid that has a closed-cup flash point below 100°F (37.8°C), as determined by the test procedures and apparatus set forth in Section 4.4 of NFPA 30, and a Reid vapor pressure that does not exceed an absolute pressure of 40 psi (276 kPa) at 100°F (37.8°C), as determined by ASTM D 323, *Standard Test Method for Vapor Pressure of Petroleum Products (Reid Method)*. Flammable liquids are classified according to Section 4.3 of NFPA 30. [30, 2012]

3.3.12 Impingement. The striking of a protected surface by water droplets issuing directly from a water spray nozzle.

3.3.13 Insulation.

3.3.13.1* Insulated. Refers to equipment, structures, or vessels provided with an encapsulating material that, for the expected duration of fire exposure, will limit steel temperatures to a maximum of 850°F (454°C) for structural members or 650°F (343°C) for vessels. The insulation system shall be: (1) noncombustible and fire retardant; (2) mildew and weather resistant; (3) resistant to the force of hose streams; and (4) secured by fire and corrosion-resistant fastenings.

3.3.13.2 Uninsulated. Refers to equipment, structures, or vessels not provided with an encapsulating material that meets the requirements defined as “insulated.”

3.3.14 Net Rate. The total rate of water discharge density, less water wastage due to factors such as wind effects and inaccuracies in nozzle angles of spray.

3.3.15* Nonabsorbing Ground. Earth or fill that is not readily permeable or absorbent to large quantities of flammable or combustible liquid or water, or both.

3.3.16 Pilot Sprinkler. An automatic sprinkler or thermostatic fixed temperature release device used as a detector to pneumatically or hydraulically release the system actuation valve.

3.3.17 Rundown. The downward travel of water along a surface, caused by the momentum of the water or by gravity.

3.3.18 Ultra-High-Speed Water Spray System. A type of automatic water spray system where water spray is rapidly applied to protect specific hazards where deflagrations are anticipated.

3.3.18.1 Ultra-High-Speed Water Spray System — Area Application. The application of ultra-high-speed water spray over a specific floor area or over the surface area of a specific object.

3.3.18.2 Ultra-High-Speed Water Spray System — Local Application. The application of ultra-high-speed water spray on a specific point or points of ignition, such as cutting, mixing, or grinding operations.

3.3.19 Valve.

3.3.19.1 Deluge Valve. A type of system actuation valve that is opened by the operation of a detection system installed in the same areas as the spray nozzles or by remote manual operation supplying water to all spray nozzles.

3.3.19.2 System Actuation Valve. The main valve that controls the flow of water into the water spray system.

3.3.20 Water Spray. Water in a form having a predetermined pattern, particle size, velocity, and density discharge from specially designed nozzles or devices.



3.3.21 Water Spray Nozzle.

3.3.21.1 Automatic Water Spray Nozzle. A nozzle intended to open automatically by operation of a heat responsive element that maintains the discharge orifice closed by means such as the exertion of force on a cap (button or disc), that when discharging water under pressure, will distribute the water in a specific, directional pattern.

3.3.21.2* Open Water Spray Nozzle. An open water discharge device that, when discharging water under pressure, will distribute the water in a specific, directional pattern.

3.3.22* Water Spray System. An automatic or manually actuated fixed pipe system connected to a water supply and equipped with water spray nozzles designed to provide a specific water discharge and distribution over the protected surfaces or area.

3.3.23* Water Wastage. That discharge from water spray nozzles that does not impinge on the surface being protected.

Chapter 4 General Requirements

4.1* Design Objectives. In general, water spray shall be considered effective for any one of or a combination of the following objectives (*see Chapter 7*):

- (1) Extinguishment of fire
- (2) Control of burning
- (3) Exposure protection
- (4) Prevention of fire

4.2 Special Considerations.

4.2.1 A study shall be made of the physical and chemical properties of the materials for which the water spray protection is being considered to determine the advisability of its use.

4.2.2 The flash point, specific gravity, viscosity, miscibility, and solubility and permeability of the material, temperature of the water spray, and the normal temperature of the hazard to be protected are among the factors that shall be given consideration.

4.2.3* Where water spray can encounter confined materials at a high temperature or with a wide distillation range, the slop-over or frothing hazard shall be evaluated.

4.2.4 Water Soluble Materials.

4.2.4.1 Where protecting water soluble materials, such as alcohol, systems shall be permitted to be designed for extinguishment by control, extinguishment by dilution, or extinguishment by an adequate application rate and coverage.

4.2.4.2 Each water soluble material shall be tested under the conditions of use to determine the applicability of a water spray system, unless design supportive data is available.

4.2.5* Water spray shall not be used for direct application to materials that react with water, such as metallic sodium or calcium carbide, which produce violent reactions or increase hazardous products as a result of heated vapor emission.

4.2.6 Water spray shall not be used for applications involving liquefied gases at cryogenic temperatures (such as liquefied natural gas), which boil violently when heated by water.

4.2.7 An evaluation shall be conducted, given the possibility of damage, distortion, or failure of equipment operating at high temperatures due to water spray application.

4.3* Workmanship. Water spray system design, layout, and installation shall be entrusted to fully experienced and responsible parties only.

4.4 Control of Runoff.

4.4.1* Water discharge from water spray systems shall be controlled or contained to prevent the spread of fire where flammable or combustible liquids are present.

4.4.2 Where flammable or combustible liquids are not present and the potential for water damage to adjacent areas is minimal, water discharged from water spray systems shall not be required to be controlled or contained.

4.4.3* The control or containment system shall utilize any one of the following:

- (1) Curbing and grading
- (2) Underground or enclosed drains
- (3) Open trenches or ditches
- (4) Diking or impoundment
- (5) Any combination of 4.4.3(1) through 4.4.3(4)

4.4.4* Where the protected hazard involves the possible release of flammable or combustible liquids, the drainage system shall be designed to safely handle burning liquids.

4.4.5 Enclosed drain systems shall be fitted with traps or other means to prevent the entrance of flames or burning liquids into the system.

4.4.6 Open trenches and ditches shall be routed so as not to expose fire fighters, critical equipment and piping, other important structures, or property of others.

4.4.7 The control or containment system shall be designed to accommodate the total combined flow from all of the following:

- (1)*All water spray systems intended to operate simultaneously within the fire area (where the actual discharge will exceed the design flow rate, the actual flow rate shall be used)
- (2) Supplemental hose streams and monitor nozzle devices likely to be used during the fire
- (3) The largest anticipated spill or accidental release of process liquids where applicable
- (4) Any normal discharge of process liquids or cooling water into the drainage system
- (5)*Rain water, provided local conditions warrant inclusion

4.4.8* The control or containment system shall be designed to accommodate the total combined flow for the fire's expected duration.

4.4.9 Where approved, the system shall be permitted to be designed to accommodate the total combined flow for a period less than the fire's expected duration.

4.4.10 The water and liquids drained from protected areas shall be collected and treated as required by local regulations.

4.4.11 Hazardous chemicals and contaminated water shall not be discharged to open waterways or onto the property of others.

Chapter 5 System Components

5.1 General.

5.1.1 All component parts shall be coordinated to provide complete systems.

5.1.2 Only listed materials and devices shall be used in the installation of water spray systems.

5.1.2.1 Components that do not affect system operation, such as drain valves and signs, shall not be required to be listed.

5.1.2.2 Only new materials and devices shall be employed in the installation of new water spray systems.

5.1.2.3 The use of reconditioned valves and devices, other than automatic water spray nozzles, as replacement equipment in existing systems shall be permitted.

5.1.3 System components shall be rated for the maximum working pressure to which they are exposed, but not less than 175 psi (12.1 bar).

5.1.4 System components installed outside, or in the presence of a corrosive atmosphere, shall be constructed of materials that will resist corrosion or be suitably protected from corrosion.

5.2 Water Spray Nozzles. Water spray nozzles shall be of a type listed for use in water spray systems with the following discharge characteristics:

- (1) K factor
- (2) Spray patterns at various pressures, distances, and orientation angles
- (3) Uniformity of water distribution over its spray pattern

5.2.1 Water spray nozzles shall be permanently marked with their characteristics according to their listing.

5.2.2 Standard temperature ratings and color code designations of automatic water spray nozzles shall be as required for automatic sprinklers in NFPA 13, *Standard for the Installation of Sprinkler Systems*.

5.2.3 Special Coatings.

5.2.3.1 Listed corrosion-resistant spray nozzles shall be installed in locations where chemicals, moisture, or other corrosive vapors sufficient to cause corrosion of such devices exist.

5.2.3.2 Corrosion-Resistant Coatings.

5.2.3.2.1 Corrosion-resistant coatings shall be applied by the manufacturer of the spray nozzle.

5.2.3.2.2 Any damage to the protective coating occurring at the time of installation shall be repaired immediately, using only the coating of the manufacturer of the spray nozzle in the approved manner so that no part of the spray nozzle will be exposed after installation.

5.2.3.3* Painting.

5.2.3.3.1 Unless applied by the manufacturer, spray nozzles shall not be painted.

5.2.3.3.2 Any spray nozzles that have been painted by other than the manufacturer or after installation shall be replaced with spray nozzles of the same characteristics, including K factor, thermal response (automatic nozzles), and water distribution.

5.2.4 Guards. Automatic water spray nozzles subject to mechanical damage shall be protected with listed guards.

5.2.5* Stock of Spare Automatic Water Spray Nozzles and Pilot Sprinklers.

5.2.5.1 A supply of automatic water spray nozzles and pilot sprinklers shall be maintained on the premises so that any automatic water spray nozzles or pilot sprinklers that have operated or been damaged in any way can be promptly replaced.

5.2.5.2 These automatic water spray nozzles and pilot sprinklers shall correspond to the types and temperature ratings of the automatic water spray nozzles and pilot sprinklers on the property.

5.2.5.3 The automatic water spray nozzles and pilot sprinklers shall be kept in a cabinet where the ambient storage temperature does not exceed 100°F (38°C).

5.2.5.4 Where required by the manufacturer, a special automatic water spray nozzle and/or pilot sprinkler wrench shall be provided to be used in the removal and installation of automatic water spray nozzles and pilot sprinklers.

5.2.5.5 The stock of spare automatic water spray nozzles and pilot sprinklers shall include as a minimum 1 of each type of automatic water spray nozzle and pilot sprinkler present on the property and shall in no case be less than the following total quantities based on the total number of automatic water spray nozzles and pilot sprinklers on the property:

- (1) For properties with fewer than 300 automatic water spray nozzles or pilot sprinklers, not fewer than 6 automatic water spray nozzles or pilot sprinklers
- (2) For properties with 300 to 1000 automatic water spray nozzles or pilot sprinklers, not fewer than 12 automatic water spray nozzles or pilot sprinklers
- (3) For properties with over 1000 automatic water spray nozzles or pilot sprinklers, not fewer than 24 automatic water spray nozzles or pilot sprinklers

5.3 Pipe and Tube.

5.3.1 Pipe or tube used in water spray systems shall meet or exceed one of the standards in Table 5.3.1 or be in accordance with 5.3.4. In addition, steel pipe shall be in accordance with 5.3.2 and 5.3.3, and copper tube shall be in accordance with 5.3.4.

Table 5.3.1 Pipe or Tube Specifications

Materials and Dimensions	Standard
Ferrous Piping (Welded and Seamless)	
Stainless Steel Pipe	ANSI B36.19M
Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipes	ASTM A 312
Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use*	ASTM A 795
Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless*	ASTM A 53
Welded and Seamless Wrought Steel Pipe	ANSI B36.10M
Standard Specification for Electric-Resistance-Welded Steel Pipe	ASTM A 135
Copper Tube (Drawn, Seamless)	
Standard Specification for Seamless Copper Tube*	ASTM B 75
Standard Specification for Seamless Copper Water Tube*	ASTM B 88
Standard Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube	ASTM B 251
Specification for Filler Metals for Brazing and Braze Welding (Classification BCuP-3 or BCuP-4)	AWS A5.8

*Denotes pipe or tubing suitable for bending according to ASTM standards.



5.3.2* Where steel pipe listed in Table 5.3.1 is used and joined by welding or by roll-grooved pipe and fittings, the minimum nominal wall thickness for pressures up to 300 psi (20.7 bar) shall be in accordance with Schedule 10 for pipe sizes up to 5 in. (127 mm); 0.134 in. (3.40 mm) for 6 in. (152 mm) pipe; and 0.188 in. (4.78 mm) for 8 in. and 10 in. (203 mm and 254 mm) pipe.

5.3.2.1 Pressure limitations and wall thickness for steel pipe listed in accordance with 5.3.5 shall be in accordance with the listing requirements.

5.3.3 Where steel pipe listed in Table 5.3.1 is joined by threaded fittings or by fittings used with pipe having cut grooves, the minimum wall thickness shall be in accordance with Schedule 30 [in pipe sizes 8 in. (203 mm) and larger] or Schedule 40 [in pipe sizes less than 8 in. (203 mm)] for pressures up to 300 psi (20.7 bar).

5.3.4 Copper tube shall be permitted in water-filled water spray systems where system pressures do not exceed 175 psi (12.1 bar). Copper tube specified in the standards listed in Table 5.3.1 shall have wall thicknesses of Type K, L, or M.

5.3.5* Other types of pipe or tube investigated for suitability in automatic water spray installations and listed for this service, including but not limited to steel differing from that provided in Table 5.3.1, shall be permitted where installed in accordance with their listing limitations, including installation instructions. Bending of pipe shall be permitted as allowed by the listing.

5.3.6 Steel Piping.

5.3.6.1 Steel pipe used in manual and open systems shall be galvanized on its internal and external surfaces in accordance with Table 5.3.1.

5.3.6.2 The threaded ends of galvanized pipe shall be protected against corrosion.

5.3.6.3 Water-filled steel piping shall be permitted to be black steel.

5.3.6.4 Stainless steel pipe shall not be required to be galvanized.

5.3.7 Corrosion Protection. Where no other piping material will provide the required corrosion resistance for a particular corrosive application, listed coated pipe or an approved corrosion resistance system applied to piping shall be permitted.

5.3.8 Minimum Pipe Size. The minimum pipe size shall be 1 in. (25 mm) for steel and galvanized steel, and ¾ in. (19 mm) for copper and stainless steel.

5.3.9 Pipe Bending.

5.3.9.1 Bending of steel piping of wall thickness equal to or greater than Schedule 10 and Types K and L copper tube shall be permitted where bends are made with no kinks, ripples, distortions, reductions in internal diameter, or any noticeable deviations from round.

5.3.9.2 For Schedule 40 steel piping and Types K and L copper tubing, the minimum radius of bend shall be 6 pipe diameters for pipe sizes 2 in. (51 mm) and smaller, and 5 pipe diameters for pipe sizes 2½ in. (64 mm) and larger.

5.3.9.3 For all other types of steel pipe, the minimum radius of bend shall be 12 pipe diameters for all pipe sizes.

5.3.10 Pipe Identification.

5.3.10.1* All pipe, including specially listed pipe allowed by 5.3.5, shall be marked along its length by the manufacturer in such a way as to properly identify the type of pipe.

5.3.10.2 The marking shall be visible on every piece of pipe over 2 ft (610 mm) long.

5.4 Fittings.

5.4.1 Fittings used in water systems shall meet or exceed the standards in Table 5.4.1.

Table 5.4.1 Fittings Materials and Dimensions

Materials and Dimensions	Standard
Cast Iron	
Gray Iron Threaded Fittings, Class 125 and 250	ANSI B16.4
Cast Iron Pipe Flanges and Flanged Fittings	ANSI B16.1
Malleable Iron	
Malleable Iron Threaded Fittings, Class 150 and 300	ANSI B16.3
Steel	
Factory-Made Wrought Steel Butt Welding Fittings	ANSI B16.9
Butt Welding Ends	ANSI B16.25
Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures	ASTM A 234
Pipe Flanges and Flanged Fittings	ANSI B16.5
Forged Fittings, Socket-Welding and Threaded	ANSI B16.11
Copper	
Wrought Copper and Copper Alloy Solder Joint Pressure Fittings	ANSI B16.22
Cast Copper Alloy Solder Joint Pressure Fittings	ANSI B16.18
Ductile Iron	
Standard Specification for Ductile Iron Castings	ASTM A 536
Stainless Steel	
Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service	ASTM A 182

5.4.2 In dry sections of the piping exposed to possible fire or in self-supporting systems, ferrous fittings shall be of steel, malleable iron, or ductile iron.

5.4.3 Galvanized fittings shall be used where galvanized pipe is used.

5.4.4 Other types of fittings investigated for suitability in water spray system installations and listed for this service, including but not limited to fiberglass and steel differing from that provided in Table 5.4.1, shall be permitted when installed in accordance with their listing limitations, including installation instructions.

5.4.5 Fittings shall be extra heavy pattern where pressures exceed 175 psi (12 bar).

5.4.6 Standard weight pattern malleable iron fittings 6 in. (150 mm) in size or smaller shall be permitted where pressures do not exceed 300 psi (20.7 bar).

5.4.7 Listed fittings shall be permitted for system pressures up to the limits specified in their listings.

5.4.8 Couplings and Unions.

5.4.8.1 Screwed unions shall not be used on pipe larger than 2 in. (50 mm).

5.4.8.2 Couplings and unions of other than screwed type shall be of types listed specifically for use in water spray or sprinkler systems.

5.4.9 Reducers and Bushings.

5.4.9.1 A one-piece reducing fitting shall be used wherever a change is made in the size of pipe.

5.4.9.2 Hexagonal or face bushings shall be permitted for use in reducing the size of openings of fittings where standard fittings of the required size and material are not available from the manufacturer.

5.4.10* Rubber-gasketed fittings shall be permitted to be used to connect pipe in fire-exposed areas where the water spray system is automatically controlled.

5.4.11 Fire-exposed areas where rubber-gasketed fittings are located shall be protected by automatic water spray systems or other approved means.

5.5 Joining of Pipe and Fittings.

5.5.1 Threaded Pipe and Fittings.

5.5.1.1 All threaded pipe and fittings shall have threads cut in accordance with ANSI/ASME B1.20.1, *Pipe Threads, General Purpose*.

5.5.1.2* Steel pipe with wall thicknesses less than Schedule 30 [in pipe sizes 8 in. (200 mm) and larger] or Schedule 40 [in pipe sizes less than 8 in. (200 mm)] shall not be joined by threaded fittings.

5.5.1.3 Where wall thicknesses are less than those required in 5.5.1.2, pipes shall be permitted to be threaded where the threaded assembly is investigated and listed for this service.

5.5.1.4 Joint compound or tape shall be applied only to male threads.

5.5.2* Welded Pipe and Fittings.

5.5.2.1 General. Welding shall be permitted as a means of joining water spray system piping in accordance with 5.5.2.2 through 5.5.2.6.

5.5.2.2 Fabrication.

5.5.2.2.1 Field welding shall be permitted provided that the requirements of 5.5.2 through 5.5.2.5 are met.

5.5.2.2.2 When welding in the field, safe welding and cutting practices shall be followed in accordance with NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*.

5.5.2.2.3 Welding shall not be performed where there is impingement of rain, snow, sleet, or high wind on the weld area of the pipe product.

5.5.2.2.4 Torch cutting and welding shall not be permitted as a means of modifying or repairing water spray systems.

5.5.2.2.5 Where longitudinal earthquake braces are provided, tabs welded to pipe for longitudinal earthquake braces shall be permitted.

5.5.2.2.6 Where welded piping is to be galvanized, pipe shall be fabricated into spooled sections and shall be galvanized after fabrication.

5.5.2.3 Fittings.

5.5.2.3.1 Welded fittings used to join pipe shall be listed fabricated fittings or manufactured in accordance with Table 5.4.1.

5.5.2.3.2 Manufactured fittings joined in conformance with a qualified welding procedure as set forth in this section shall be permitted to be an acceptable product under this standard, provided that materials and wall thickness are compatible with other sections of this standard.

5.5.2.3.3 Fittings shall not be required where pipe ends are butt-welded in accordance with the requirements of 5.5.2.4.3.

5.5.2.3.4 When reducing the pipe size in a run of piping, a reducing fitting designed for that purpose shall be used.

5.5.2.4 Welding Requirements.

5.5.2.4.1* Welds between pipe and welding outlet fittings shall be permitted to be attached by full penetration, partial penetration, or fillet welds.

5.5.2.4.2* The minimum throat thickness shall be not less than the thickness of the pipe, the thickness of the welding fitting, or $\frac{3}{16}$ in. (5 mm), whichever is least.

5.5.2.4.3* Circumferential butt joints shall be cut, beveled, and fit so that full penetration is achievable. Full penetration welding shall not be required.

5.5.2.4.4 Where slip-on flanges are welded to pipe with a single fillet weld, the weld shall be on the hub side of the flange, and the minimum throat weld thickness shall not be less than 1.25 times the pipe wall thickness or the hub thickness, whichever is less.

5.5.2.4.5 Face welds on the internal face of the flange shall be permitted as a water seal in addition to the hub weld required in 5.5.2.4.4.

5.5.2.4.6 Tabs for longitudinal earthquake bracing shall have minimum throat weld thickness not less than 1.25 times the pipe wall thickness and welded on both sides of the longest dimension.

5.5.2.4.7 Where welding is performed, the following shall apply:

- (1) Holes cut in piping for outlets shall be cut to the full inside diameter of fittings prior to welding in place of the fittings.
- (2) Discs shall be retrieved.
- (3) Openings cut into piping shall be smooth bore, and all internal slag and welding residue shall be removed.
- (4) Fittings shall not penetrate the internal diameter of the piping.
- (5) Steel plates shall not be welded to the ends of piping or fitting.
- (6) Fittings shall not be modified.
- (7) Nuts, clips, eye rods, angle brackets, or other fasteners shall not be welded to pipe or fittings, except as permitted in 5.5.2.2.5 and 5.5.2.4.6.
- (8) Completed welds shall be free from cracks, incomplete fusion, surface porosity greater than $\frac{1}{16}$ in. (1.5 mm) diameter, and undercut deeper than 25 percent of the wall thickness or $\frac{1}{32}$ in. (0.8 mm).
- (9) Completed circumferential butt weld reinforcements shall not exceed $\frac{3}{32}$ in. (2.4 mm).



5.5.2.5 Qualifications.

5.5.2.5.1 A welding procedure shall be prepared and qualified by the contractor or fabricator before any welding is done.

5.5.2.5.2 Qualification of the welding procedure to be used and the performance of all welders and welding operators shall be required and shall meet or exceed the requirements of American Welding Society Standard AWS B2.1, *Specification for Welding Procedures and Performance Qualification*; ASME Section IX, *Welding and Brazing Qualifications*; or other applicable qualification standard as required by the AHJ, except as permitted by 5.5.2.5.4.

5.5.2.5.3 Successful procedure qualification of complete joint penetration groove welds shall qualify partial joint penetration (groove/fillet) welds and fillet welds in accordance with the provisions of this standard.

5.5.2.5.4 Welding procedures qualified under standards recognized by previous editions of this standard shall be permitted to be continued in use.

5.5.2.5.5 Contractors or fabricators shall be responsible for all welding they produce.

5.5.2.5.6 Each contractor or fabricator shall have available to the authority having jurisdiction an established written quality assurance procedure ensuring compliance with the requirements of 5.5.2.5.

5.5.2.6 Records.

5.5.2.6.1 Welders or welding machine operators shall, upon completion of each welded pipe, place their identifiable mark or label onto each piece adjacent to a weld.

5.5.2.6.2 Contractors or fabricators shall maintain certified records of the procedures used and the welders or welding machine operators employed by them, along with their welding identification, which shall be available to the authority having jurisdiction.

5.5.2.6.3 Records shall show the date and the results of procedure and performance qualifications and shall be available to the authority having jurisdiction.

5.5.3 Groove Joining Methods.

5.5.3.1* Pipe joined with grooved couplings shall be joined by a listed combination of couplings, gaskets, and groove dimensions.

5.5.3.2* Grooved connections of fittings and valves, and grooves cut or rolled on pipe shall, be dimensionally compatible with the couplings.

5.5.3.3 Grooved couplings, including gaskets used on preaction and deluge systems, shall be listed for dry pipe service.

5.5.4* Brazed Joints.

5.5.4.1* Joints for the connection of copper tube shall be brazed using the brazing material in Table 5.3.1.

5.5.4.2 Field brazing shall be permitted.

5.5.4.3 Safe brazing practices shall be followed in accordance with NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*.

5.5.4.4 Brazing methods shall comply with all of the requirements of AWS B2.2, *Standard for Brazing Procedure and Performance Qualification*.

5.5.4.5 Fittings used to join copper tube shall be manufactured in accordance with Table 5.4.1 or shall be listed as mechanically formed/extruded connection systems.

5.5.4.6 No brazing shall be performed if there is impingement of rain, snow, sleet, or high wind on the braze area of the tube product.

5.5.4.7 Brazing shall be performed in accordance with the following:

- (1) Fittings and branch connections shall not penetrate the internal diameter of the tubing.
- (2) Copper plates shall not be brazed to the ends of tubing or fittings.
- (3) Fittings shall not be modified.
- (4) Nuts, clips, eye rods, angle brackets, or other fasteners shall not be brazed to tube or fittings.

5.5.4.8 Where the tube size in a run of tubing is being reduced, a reducing fitting designed for that purpose shall be used.

5.5.4.9 Qualifications.

5.5.4.9.1 A brazing procedure shall be prepared and qualified by the contractor or fabricator before any brazing is done.

5.5.4.9.2 Qualification of the brazing procedure to be used and performance of all brazers and brazing operators shall be required and shall meet or exceed the requirements of AWS B2.2, *Standard for Brazing Procedure and Performance Qualification*.

5.5.4.9.3 Contractors or fabricators shall be responsible for all brazing they produce.

5.5.4.9.4 Each contractor or fabricator shall have available to the authority having jurisdiction an established written quality assurance procedure ensuring compliance with the requirements of 5.5.4.7.

5.5.4.9.5 Records.

5.5.4.9.5.1 Contractors and fabricators shall maintain certified records of the brazing procedures used and the brazers and brazing operators employed by them.

5.5.4.9.5.2 Records shall show the date and the results of procedure and performance qualification, and shall be available to the authority having jurisdiction.

5.5.5 Other Types. Other joining methods investigated for suitability in water spray sprinkler installations and listed for this service shall be permitted where installed in accordance with their listing limitations, including installation instructions.

5.5.6 End Treatment.

5.5.6.1 Pipe ends shall have burrs and fins removed after cutting.

5.5.6.2 Pipe used with listed fittings and its end treatment shall be in accordance with the fitting manufacturer's installation instructions and the fitting's listing.

5.6 Hangers.

5.6.1 General. The types of hangers used shall be in accordance with the requirements of NFPA 13, *Standard for the Installation of Sprinkler Systems*.

5.6.2 Hangers used outdoors or in locations where corrosive conditions exist shall be galvanized, suitably coated, or fabricated from corrosion-resistive materials.

5.7 Valves.

5.7.1 Control Valves.

5.7.1.1 All valves controlling connections to water supplies and to supply pipes to water spray nozzles shall be listed indicating valves.

5.7.1.2 Listed underground gate valves equipped with listed indicator posts shall be permitted in underground applications.

5.7.1.3 Where approved, replacement or installation of a nonindicating valve, such as a T-wrench-operated roadway box, shall be permitted to be installed.

5.7.1.4 Control valves shall not close in less than 5 seconds when operated at maximum possible speed from the fully open position.

5.7.1.5 Wafer-type valves with components that extend beyond the valve body shall be installed in a manner that does not interfere with the operation of any system components.

5.7.2 System Actuation Valves.

5.7.2.1* System actuation valves shall be listed.

5.7.2.2* Accessories used to operate the actuation valve shall be listed and compatible.

5.7.2.3* System actuation valves shall be provided with manual means of actuation independent of the automatic release system and detection devices.

5.7.2.4 Alarm check valves shall not require an independent means of activation.

5.7.2.5 Manual controls of actuation valves shall not require a pull of more than 40 lbf (178 N) or a movement of more than 14 in. (356 mm) to secure operation.

5.7.3 Drain Valves and Test Valves. Drain valves and test valves shall be approved.

5.7.4 Identification of Valves.

5.7.4.1 All control, drain, and test connection valves shall be provided with permanently marked weatherproof metal or rigid plastic identification signs.

5.7.4.2 The identification sign shall be secured with corrosion-resistant wire, chain, or other approved means.

5.8 Pressure Gauges. Required pressure gauges shall be listed and shall have a maximum limit not less than twice the normal working pressure where installed.

5.9 Strainers.

5.9.1* Pipeline strainers shall be specifically listed for use in water supply connections.

5.9.2 Strainers shall be capable of removing from the water all solids of sufficient size to obstruct the spray nozzles [normally $\frac{1}{8}$ in. (3.2 mm) perforations are suitable].

5.9.3 Pipeline strainer designs shall incorporate a flushing connection.

5.9.4 Individual or integral strainers for spray nozzles, where required, shall be capable of removing from the water all solids of sufficient size to obstruct the spray nozzle they serve.

5.10 Fire Department Connections.

5.10.1 Unless the requirements of 5.10.1.1, 5.10.1.2, or 5.10.1.3 are met, the fire department connection(s) shall consist of two $2\frac{1}{2}$ in. (65 mm) connections using NH internal threaded swivel fitting(s) with "2.5–7.5 NH standard thread," as specified in NFPA 1963, *Standard for Fire Hose Connections*. [13:6.8.1]

5.10.1.1* Where local fire department connections do not conform to NFPA 1963, *Standard for Fire Hose Connections*, the authority having jurisdiction shall be permitted to designate the connection to be used. [13:6.8.1.1]

5.10.1.2 The use of threadless couplings shall be permitted where required by the authority having jurisdiction and where listed for such use. [13:6.8.1.2]

5.10.1.3 A single-outlet fire department connection shall be acceptable where piped to a 3 in. (76 mm) or smaller riser. [13:6.8.1.3]

5.10.2 Fire department connections shall be equipped with approved plugs or caps, properly secured and arranged for easy removal by fire departments. [13:6.8.2]

5.10.3 Fire department connections shall be of an approved type. [13:6.8.3]

5.10.4 Connections shall be equipped with approved plugs or caps.

5.11 Alarms.

5.11.1 Waterflow alarm apparatus shall be listed for this service.

5.11.2 An alarm unit shall include a listed mechanical alarm or horn or a listed electric device, bell, speaker, horn, or siren.

5.11.3* Outdoor water-motor-operated or electrically operated bells shall be protected from the weather and shall be provided with guards.

5.11.4 All piping to water-motor-operated devices shall be galvanized steel, brass, copper, or other approved metallic corrosion-resistant material of not less than $\frac{3}{4}$ in. (20 mm) nominal pipe size.

5.11.5 Piping between the water spray system and a pressure-actuated alarm-initiating device shall be galvanized steel, brass, copper, or other approved metallic corrosion-resistant material of not less than $\frac{3}{8}$ in. (10 mm) nominal pipe size.

5.11.6 Drains from alarm devices shall be sized and arranged to prevent water overflow at the drain connection when system drains are open wide and under system pressure.

5.11.7 Electrical alarm devices used outdoors shall be listed for this purpose.

5.11.8 Electrical fittings and devices listed for use in hazardous locations shall be used where required by NFPA 70, *National Electrical Code*.

5.12 Detection Systems.

5.12.1 Automatic detection equipment, release devices, and system accessories shall be listed for the intended use.

5.12.2 The detection systems shall be automatically supervised in accordance with NFPA 72, *National Fire Alarm and Signaling Code*.

Chapter 6 Installation Requirements

6.1 Basic Requirements.

6.1.1 Hazardous Locations. Components of the electrical portions of water spray systems that are installed in classified locations as defined in Article 500 of NFPA 70, *National Electrical Code*, shall be listed for such use.



6.1.2* Electrical Clearances.

6.1.2.1 All system components shall be located so as to maintain minimum electrical clearances from live parts.

6.1.2.2 The electrical clearances in Table 6.1.2.2 shall apply to altitudes of 1000 m (3300 ft) or less.

Table 6.1.2.2 Electrical Clearance from Water Spray Equipment to Live Uninsulated Electrical Components

Nominal System Voltage (kV)	Maximum System Voltage (kV)	Design BIL (kV)	Minimum* Clearance	
			in.	mm
To 13.8	14.5	110	7	178
23.0	24.3	150	10	254
34.5	36.5	200	13	330
46.0	48.3	250	17	432
69.0	72.5	350	25	635
115.0	121.0	550	42	1067
138.0	145.0	650	50	1270
161.0	169.0	750	58	1473
230.0	242.0	900	76	1930
		1050	84	2134
345.0	362.0	1050	84	2134
		1300	104	2642
500.0	550.0	1500	124	3150
		1800	144	3658
765.0	800.0	2050	167	4242

Note: BIL values are expressed as kilovolts (kV), the number being the crest value of the full wave impulse test that the electrical equipment is designed to withstand. For BIL values that are not listed in the table, clearances can be found by interpolation.

*For voltages up to 161 kV, the clearances are taken from NFPA 70, *National Electrical Code*. For voltages 230 kV and above, the clearances are taken from Table 124 of ANSI C2, *National Electrical Safety Code*.

6.1.2.3 At altitudes in excess of 1000 m (3300 ft), the electrical clearance shall be increased at the rate of 1 percent for each 100 m (330 ft) increase in altitude above 1000 m (3300 ft).

6.1.3 Where the design BIL is not available and where nominal voltage is used for the design criterion, the highest minimum clearance listed for this group shall be used.

6.2 Water Spray Nozzles.

6.2.1* Selection.

6.2.1.1 Open water spray nozzles shall be used.

6.2.1.2 Automatic nozzles shall be permitted where positioned and located so as to provide satisfactory performance with respect to activation time and distribution.

6.2.1.3 The selection of the type and size of spray nozzles shall be made with proper consideration given to such factors as discharge characteristics, physical character of the hazard involved, ambient conditions, material likely to be burning, and the design objectives of the system.

6.2.1.4 Where acceptable to the authority having jurisdiction, sprinklers shall be permitted to be used in water spray systems and installed in positions other than anticipated by their listing to achieve specific results where special situations require.

6.2.2 Temperature Rating. The temperature rating for automatic nozzles shall be based on the maximum ambient temperature and determined in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*.

6.2.3 Water spray nozzles shall be permitted to be placed in any position, within their listing limitations, necessary to obtain proper coverage of the protected area.

6.2.4 The positioning of water spray nozzles shall include an evaluation of all the following factors:

- (1) The shape and size of the area to be protected
- (2) The nozzle design and characteristics of the water spray pattern to be produced
- (3) The effect of wind and fire draft on very small drop sizes or on large drop sizes with little initial velocity
- (4) The potential to miss the target surface and increase water wastage
- (5) The effects of nozzle orientation on coverage characteristics
- (6) The potential for mechanical damage

6.3 Piping Installation.

6.3.1 Valves.

6.3.1.1 Water Supply Control Valves. Each system shall be provided with a control valve located so as to be accessible during a fire in the area the system protects, or any adjacent areas, or, in the case of systems installed for fire prevention, during the existence of the contingency for which the system is installed.

6.3.1.2 Valve Supervision. Valves controlling the water supply to water spray systems shall be supervised in the normally open position by one of the following methods:

- (1) Central station, proprietary, or remote station alarm service
- (2) Local alarm service that will cause the sounding of an audible signal at a constantly attended point
- (3) Locking valves open
- (4) Sealing of valves and approved weekly recorded inspection where valves are located within fenced enclosures under the control of the owner

6.3.1.3 Underground gate valves with roadway boxes shall not be required to be supervised.

6.3.1.4 Location of System Actuation Valves.

6.3.1.4.1 System actuation valves shall be as close to the hazard protected as accessibility during the emergency will permit.

6.3.1.4.2 The location of system actuation valves shall include an evaluation of all the following factors:

- (1) Radiant heat from exposing fire
- (2) Potential for explosions
- (3) The location and arrangement of drainage facilities including dikes, trenches, and impounding basins
- (4) Potential for freezing and mechanical damage
- (5) Accessibility
- (6) System discharge time

6.3.2 Pipe Support.

6.3.2.1 System piping shall be supported to maintain its integrity under fire conditions.

6.3.2.2 Piping shall be supported from steel or concrete structural members or pipe stands.

6.3.2.2.1* Pipe stands used to support piping shall be in accordance with Table 6.3.2.2.1 to determine maximum heights for pipe stands supporting various diameters of looped piping.

Table 6.3.2.2.1 Maximum Pipe Stand Heights

Diameter of Pipe	Pipe Stand Diameter				
	1½ in.	2 in.	2½ in.	3 in.	4 in.
1½ in.	10 ft	14 ft	18 ft	28 ft	30 ft
2 in.	8 ft	12 ft	16 ft	26 ft	30 ft
2½ in.	6 ft	10 ft	14 ft	24 ft	30 ft
3 in.	—	8 ft	12 ft	22 ft	30 ft
>3 in.	—	—	—	—	10 ft

Note: For SI units, 1 in. = 25.4 mm; 1 ft = 0.305 m.

6.3.2.2.2* Distance between pipe stands exceeding those in Table 6.3.2.2.2 shall be permitted where a 45-degree diagonal is attached between the pipe stand and the loop piping. (See Figure A.6.3.2.2.2.) For piping of other than Schedule 40, pipe stand shall be spaced in accordance with the hanger references of NFPA 13, *Standard for the Installation of Sprinkler Systems*.

Table 6.3.2.2.2 Pipe Stand Distance

Loop Size		Distance Between Pipe Stands	
in.	mm	ft	mm
1	25	10	3048
1½	40	12	3658
2	50	14	4267
2½–8	65–200	15	4572

6.3.2.2.3 Pipe stands shall be constructed of Schedule 40 threaded pipe, malleable iron flange base, and shall have a threaded cap top.

6.3.2.2.4* Pipe stands shall be anchored to a concrete pier or footing with either expansion shields, bolts for concrete, or cast-in-place J hooks.

6.3.2.2.5* Piping shall be attached to the pipe stand with U-bolts or equivalent attachment.

6.3.2.3 Piping support shall be permitted to be attached directly to vessels or other equipment, provided the equipment is capable of supporting the system and the design is certified by a registered professional engineer.

6.3.2.4 Tapping and drilling of load-bearing structural elements shall be permitted only where the design of the structural members takes the drilling or tapping into account, where the design includes the additional loads created by the water spray system, and where the design is certified by a registered professional engineer.

6.3.2.5 Where welding of supports directly to vessels or equipment is necessary, it shall be done in a safe manner in conformance with the provisions of all safety, structural, and fire codes and standards.

6.3.2.6* Hangers shall be installed and located in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*.

6.3.2.7* Where the pipe support methods outlined in this standard or NFPA 13, *Standard for the Installation of Sprinkler Systems*, cannot be used, water spray system piping shall be supported in a manner equivalent to the performance requirements of this standard or NFPA 13 and the design certified by a registered professional engineer.

6.3.2.8 Piping shall be supported and braced to restrict movement due to nozzle reaction and water surges so that system performance and integrity is maintained.

6.3.3 Piping Drainage.

6.3.3.1 All water spray system pipe and fittings shall be installed so that the system can be drained.

6.3.3.2 Drains shall discharge to a safe location, and drain valves, where provided, shall be accessible.

6.3.3.3 Drains shall not be directly interconnected with any sewer systems.

6.3.3.4 The drain discharge shall conform to any health or water department regulations.

6.3.3.5 Means shall be provided to verify water flow through the drain.

6.3.3.6* Each system shall be provided with drain connections for system risers, mains, and actuation valves.

6.3.3.7 Drain connections shall be sized as shown in Table 6.3.3.7.

Table 6.3.3.7 Drain Size

Riser or Main Size (in.)	Size of Drain Connection (in.)
Up to 2	¾ or larger
2½, 3, 3½	1¼ or larger
4 and larger	2 only

Note: For SI units, 1 in. = 25.4 mm.

6.3.3.8 Auxiliary Drains.

6.3.3.8.1 Auxiliary drains shall be provided where a change in piping direction prevents drainage of system piping through either the main drain valve or open water spray nozzles.

6.3.3.8.2 The sizing of auxiliary drains for water spray systems shall be in accordance with Table 6.3.3.8.2.

Table 6.3.3.8.2 Minimum Auxiliary Drain Size for Trapped Water Spray Piping

Volume of Trapped Piping		Drain Size (in.)
gal	L	
< 5	< 18.9	½
5 to 50	18.9 to 189.3	¾
> 50	> 189.3	1.0

Note: For SI units, 1 gal = 3.8 L; 1 in. = 25.4 mm.



6.3.4 Protection Against Freezing.

6.3.4.1 Where used, valve rooms shall be lighted and heated.

6.3.4.2 The source of heat shall be of a permanently installed type and shall be capable of maintaining a room temperature at a minimum of 40°F (4°C).

6.3.4.3 Where water-filled supply pipes, risers, system risers, or feed mains pass through open areas, cold rooms, passageways, or other areas exposed to freezing, the pipe shall be protected against freezing by insulating coverings, frostproof casing, or other means capable of maintaining a minimum temperature of 40°F (4°C).

6.3.4.4 Unheated areas shall be permitted to be protected by antifreeze systems in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, if acceptable to the authority having jurisdiction.

6.3.5 Protection Against Damage Where Subject to Earthquakes. Protection of piping against damage where subject to earthquakes shall be in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*.

6.3.6* Protection of Piping Against Damage Where Explosion Potential Exists. Where water spray systems are installed in areas having an explosion potential, they shall be installed in a manner that will minimize damage to the piping and system control and actuation valves.

6.4 System Attachments.

6.4.1 Alarms.

6.4.1.1 All automatic water spray systems shall be provided with a local alarm.

6.4.1.2 Any flow from a single automatic nozzle of the smallest orifice size installed on the system or flow from any group of nonautomatic nozzles shall result in an audible alarm on the premises within 90 seconds after flow begins.

6.4.1.3 Where a separate detection system is used to activate the water spray system, the alarm shall be actuated independently of system water flow to indicate operation of the detection system.

6.4.1.4 Water flow alarms shall be installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*.

6.4.1.5 Electrically operated alarm attachments shall be installed in accordance with NFPA 72, *National Fire Alarm and Signaling Code*.

6.4.1.6 Water spray system water flow alarm systems that are not a part of a required protective signaling system shall not be required to be supervised, but shall be installed in accordance with Article 760 of NFPA 70, *National Electrical Code*.

6.4.2 Remote Manual Actuation.

6.4.2.1 At least one manual actuation device independent of the manual actuation device at the system actuation valve shall be installed for all automatic systems.

6.4.2.2 Where the manual release at the systems actuation valve meets the requirements of 6.4.2.1, a separate remote manual activation device shall not be required.

6.4.2.3 Systems that protect normally unoccupied areas shall not require a separate manual activation means.

6.4.2.4 Remote manual actuation devices shall be located so as to be conspicuous, unobstructed, and accessible during an emergency.

6.4.2.5 Remote manual actuation devices shall be identified with a permanently marked weatherproof metal or rigid plastic sign identifying the system(s) controlled.

6.4.2.6 The operable part of each remote manual actuation device shall be not less than 3½ ft (1.1 m) and not more than 4½ ft (1.37 m) above grade or floor level.

6.4.3* Fire Department Connections.

6.4.3.1* One or more fire department connections shall be provided as described in this subsection.

6.4.3.2 Fire department connections shall not be required for the following installations:

- (1) Systems located in remote areas that are inaccessible for fire department support shall not require a fire department connection.
- (2) Large-capacity systems exceeding the pumping capacity of the fire department shall not require a fire department connection.
- (3) Ultra-high-speed water spray systems shall not require a fire department connection.

6.4.3.3 The number of outlets and size of the outlets and piping in the fire department connection shall be sufficient to supply the water spray system demand.

6.4.3.4 The arrangement and other installation features of fire department connections shall be in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*.

6.4.4 Gauges.

6.4.4.1 Pressure gauges shall be installed as follows:

- (1) Below the system actuation valve
- (2) Above and below alarm check valves
- (3) On the air or water supply to pilot lines

6.4.4.2 Pressure gauges shall be installed so as to permit removal.

6.4.4.3 Pressure gauges shall be located where they will not be subject to freezing.

6.4.4.4 Provisions shall be made for test gauges at or near the highest or most remote nozzle on each separate section of the system.

6.4.4.5 At least one gauge connection shall be provided at or near the nozzle calculated as having the least pressure under normal flow conditions.

6.4.5 Alarm Test Connection for Wet Pipe Systems. An alarm test connection shall be provided for all wet pipe systems in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*.

6.4.6 Strainers.

6.4.6.1* Main pipeline strainers shall be provided for all systems utilizing nozzles with waterways less than ¾ in. (9.5 mm) and for any system where the water is likely to contain obstructive material.

6.4.6.2 Mainline pipeline strainers shall be installed so as to be accessible for flushing or cleaning.

6.4.6.3 Individual or integral strainers shall be provided at each nozzle where waterways smaller than $\frac{3}{16}$ in. (5 mm) are used.

6.5 Automatic Detection Equipment.

6.5.1 Protection.

6.5.1.1 Corrosion Protection. Detection equipment installed outdoors or in the presence of possible corrosive vapors or atmospheres shall be protected from corrosion by suitable materials of construction or by suitable protection coatings applied by the equipment manufacturer.

6.5.1.2 Protective Canopy. Detection equipment requiring protection from the weather shall be provided with a canopy, hood, or other suitable protection.

6.5.1.3* Mechanical Damage. Detection equipment shall be located so as to be protected from mechanical damage.

6.5.1.4 Mounting. Detectors shall, in all cases, be supported independently of their attachment to wires or tubing.

6.5.1.5 Pilot Sprinklers. Pilot-type automatic sprinklers shall be permitted to be supported by their piping or tubing.

6.5.2 Selection, Location, and Spacing of Detectors.

6.5.2.1 The selection, location, and spacing of automatic fire detectors for the actuation of fixed water spray systems shall meet or exceed the applicable requirements of *NFPA 72, National Fire Alarm and Signaling Code*, and be consistent with the following:

- (1) Data obtained from field experience
- (2) Tests
- (3) Engineering surveys
- (4) Manufacturer's recommendations
- (5) Detectors' listing criteria
- (6) Nature of the hazard being protected
- (7) Both normal and abnormal air velocities
- (8) Range of anticipated temperatures
- (9) Maximum expected rates of temperature change under nonfire conditions
- (10) Number and height of structural levels
- (11) Effects of precipitation (rain and snow)
- (12) Presence and magnitude of electromagnetic interference
- (13) Presence of obstructions that might retard or mitigate timely detection
- (14) Other conditions that might affect the efficacy of the fire detection employed

6.5.2.2 Detectors shall be located so as to promptly respond to a fire, flammable gas release, or other design condition.

6.5.2.2.1 The detection system shall be capable of detecting a fire up to the elevation of the highest level of protected equipment surface.

6.5.2.2.2 Detectors shall be located so that no portion of the hazard being protected extends beyond the perimeter line of detectors.

6.5.2.3* Outdoor Detector Spacing.

6.5.2.3.1 Where located out of doors or in the open, the spacing of fixed temperature or rate-of-rise detectors shall be reduced by at least 50 percent from the listed spacings under smooth ceilings.

6.5.2.3.2 Where testing has demonstrated acceptable performance at other spacings, those spacings shall be permitted.

6.5.2.3.3 Pilot sprinklers spaced in accordance with 6.5.2.4 shall not require reduced spacing.

6.5.2.3.4 Where specific guidance is provided in the listing, detectors specifically listed for outdoor installation shall be installed in accordance with the listing requirements.

6.5.2.4 Pilot-Type Sprinklers.

6.5.2.4.1 The temperature rating of pilot-type sprinklers shall be selected in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*.

6.5.2.4.2 Where located under a ceiling, pilot sprinklers shall be positioned in accordance with the requirements for automatic sprinklers in NFPA 13, *Standard for the Installation of Sprinkler Systems*.

6.5.2.4.3 Maximum horizontal spacing for indoor locations shall not exceed 12 ft (3.7 m).

6.5.2.4.4 The obstruction to water distribution rules for automatic sprinklers shall not be required to be followed where pilot sprinklers are used.

6.5.2.4.5 Pilot sprinklers shall be permitted to be spaced more than 22 in. (559 mm) below a ceiling or deck where the maximum spacing between pilot sprinklers is 10 ft (3 m) or less.

6.5.2.4.6 Other maximum horizontal pilot sprinkler spacings differing from those required in 6.5.2.4.2 and 6.5.2.4.3 shall be permitted where they are installed in accordance with their listing.

6.5.2.4.7 Pilot sprinklers located outdoors, such as in open process structures, shall be spaced such that the elevation of a single level of pilot sprinklers and between additional levels of pilot sprinklers shall not exceed 17 ft (5.2 m).

6.5.2.4.8 The horizontal distance between pilot sprinklers installed outdoors shall not exceed 8 ft (2.5 m).

6.5.2.4.9 The horizontal distance between pilot sprinklers installed outdoors on a given level shall be permitted to be increased to 10 ft (3 m) where the elevation of the first level does not exceed 15 ft (4.6 m), the distance between additional levels does not exceed 12 ft (3.7 m), and the pilot sprinklers are staggered vertically.

6.5.2.4.10 Other vertical pilot sprinkler spacings differing from those required in 6.5.2.4.7 and 6.5.2.4.8 shall be permitted where installed in accordance with their listing.

6.5.2.5 Special Situations.

6.5.2.5.1 Open-Sided Buildings.

6.5.2.5.1.1 Detectors located in open-sided buildings shall follow the indoor spacing rules.

6.5.2.5.1.2 A line of detectors in accordance with the outdoor detector spacing rules shall be located along the open sides of open-sided buildings.

6.5.2.5.2 Under Open Gratings. Detectors located under open gratings shall be spaced in accordance with 6.5.2.3.

6.5.2.6 Two or More Systems. Where there are two or more adjacent water spray systems in one area controlled by separate detection systems, the detectors on each system shall be spaced independently as if the dividing line between the systems were a wall or draft curtain.

6.5.2.7* Flammable Gas Detectors.

6.5.2.7.1 Flammable gas detectors shall be located with consideration for the density of the flammable gas and its temperature and proximity to equipment where leakage is more likely to occur.

6.5.2.7.2 Access for testing, calibration, and maintenance of flammable gas detectors shall be provided.

6.5.2.8 Radiant Energy-Sensing Fire Detectors. Radiant energy-sensing fire detectors shall be spaced and located in accordance with their listings and manufacturer's recommendations.

6.5.3 Arrangement and Supervision of Systems.

6.5.3.1 Electrical Systems.

6.5.3.1.1 Water spray systems that depend on electric thermostats, relay circuits, flammable gas detectors, or other similar equipment shall be so arranged that such equipment is normally energized or completely supervised in a manner that will result in positive notifications of an abnormal condition in accordance with *NFPA 72, National Fire Alarm and Signaling Code*, unless failure of the detection system results in the operation of the water spray system.

6.5.3.1.2 Supervision shall include, but not be limited to, the tripping device, solenoid valve, and any connecting wiring.

6.5.3.2 Pneumatic and Hydraulic Systems. Pneumatically and hydraulically operated systems shall be supervised in a manner such that failure will result in positive notification of the abnormal condition, unless the failure results in operation of the water spray system.

7.1.10 Size of System and Water Demand.

7.1.10.1* A single system shall not protect more than one fire area.

7.1.10.2* The number of systems expected to operate simultaneously shall be determined by evaluating the following factors:

- (1) Possible flow of burning liquids between areas before or during operation of the water spray systems
- (2) Possible flow of hot gases between fire areas that could actuate adjoining systems, thereby increasing demand
- (3) Flammable gas detection set to automatically actuate systems
- (4) Manual operation of multiple systems
- (5) Other factors that would result in operation of systems outside of the primary fire area

7.1.10.3 The hydraulically designed discharge rate for a single system or multiple systems designed to operate simultaneously shall not exceed the available water supply. (See 9.2.1.)

7.2 Extinguishment.

7.2.1 General.

7.2.1.1 Design Objective. Systems shall be designed so that extinguishment shall be accomplished and all protected surfaces shall be cooled to prevent flashback occurring after the system is shut off.

7.2.1.2* Extinguishment Methods. Extinguishment of fires by water spray shall be accomplished by one or a combination of the following methods:

- (1) Surface cooling
- (2) Smothering by produced steam
- (3) Emulsification
- (4) Dilution
- (5) Other factors

7.2.1.3* Design Density. A general range of water spray application rates that shall apply to most ordinary combustible solids or liquids shall be from 0.15 gpm/ft² to 0.50 gpm/ft² [6.1 (L/min)/m² to 20.4 (L/min)/m²] of protected surface.

7.2.1.3.1 The specific design density for extinguishment shall be based on test data or knowledge concerning conditions similar to those that will apply in the actual installation.

7.2.2 Cable Trays and Cable Runs.

7.2.2.1* Where insulated wire and cable or nonmetallic tubing is to be protected by an automatic water spray (open nozzle) system designed for extinguishment of fire that originates within the cable or tube, the system shall be hydraulically designed to impinge water directly on each tray or group of cables or tubes at a net rate of 0.15 gpm/ft² [6.1 (L/min)/m²] on the projected plane containing the cable or tubing tray or run.

7.2.2.2 Cable trays and cable runs shall be permitted to be protected by other water spray densities and methods of application where verified by tests and where acceptable to the authority having jurisdiction.

7.2.2.3* Automatic detection devices shall detect smoldering or slow-to-develop flames.

7.2.2.4 Where it is likely that spills of flammable liquids or molten materials will expose cables, nonmetallic tubing, and tray supports, the design of protection systems shall be in accordance with that specified for exposure protection. (See 7.4.3.8.)

Chapter 7 Design Objectives

7.1 System Design.

7.1.1 Systems shall be arranged for automatic operation with supplementary manual tripping means provided.

7.1.2 Manual operation shall be permitted where automatic operation of the system presents a hazard to personnel.

7.1.3 Manual operation of the system shall be permitted where a system is isolated and attended by trained personnel at all times.

7.1.4 Systems shall be designed to accomplish at least one of the design objectives defined in Section 4.1 and in accordance with Sections 7.2 through 7.5, as applicable.

7.1.5 Systems shall be permitted to have other design objectives requiring different protection where approved by the authority having jurisdiction.

7.1.6* The system and water supplies shall be designed to admit water into the piping and to discharge effective water spray from all open nozzles without delay.

7.1.7 The design shall ensure that the nozzle spray patterns meet or overlap.

7.1.8 Nozzle spacing (vertically or horizontally) shall not exceed 10 ft (3 m).

7.1.9 Nozzles shall be permitted to exceed the spacing requirements of 7.1.8 where listed for spacing exceeding 10 ft (3 m).

7.2.3 Belt Conveyors.

7.2.3.1 General.

7.2.3.1.1 Open nozzles shall be located to direct water spray onto the surfaces to extinguish fire in hydraulic oil, the belt, the contents on the belt, or the drive unit.

7.2.3.1.2 Water spray impingement on structural elements shall provide exposure protection against radiant heat or impinging flame.

7.2.3.1.3 Interlocks shall be provided between the detection system and the machinery to shut down belt conveyor operation, including upstream feed. (See Sections 6.5 and 7.7.)

7.2.3.1.4 The water supply shall be capable of supplying both the design flow rate and 250 gpm (946 L/min) for hose streams for a minimum duration of 1 hour.

7.2.3.2* Drive Unit.

7.2.3.2.1 The water spray system shall be installed to protect the drive rolls, the take-up rolls, the power units, and the hydraulic-oil unit.

7.2.3.2.2 The net rate of water application for the drive unit shall be not less than 0.25 gpm/ft^2 [10.2 (L/min)/m^2] of roll and belt.

7.2.3.3 Conveyor Belt.

7.2.3.3.1* The water spray system shall be installed to automatically wet the top belt, its contents, and the bottom return belt.

7.2.3.3.2 Discharge patterns of water spray nozzles shall envelop, at a net rate of not less than 0.25 gpm/ft^2 [10.2 (L/min)/m^2], the top and bottom belt surface area, conveyor surfaces where combustible materials are likely to accumulate, the structural parts, and the idler rolls supporting the belt.

7.2.3.3.3 Water spray system protection for belt conveyors shall accomplish either of the following:

- (1) Extend onto transfer belts, transfer equipment, and transfer building
- (2) Interlock in such a manner that the water spray system protecting the feeding belt will automatically actuate the water spray system protecting the first segment of the downstream equipment

7.3 Control of Burning.

7.3.1 General.

7.3.1.1* A system for the control of burning shall operate as intended until there has been time for the burning material to be consumed, for steps to be taken to shut off the flow of leaking material, or until the burning material can be otherwise extinguished.

7.3.1.2 Nozzles shall be positioned to impinge water directly on the areas of the source of fire and where spills are likely to spread or accumulate.

7.3.1.3 The water application rate shall be at a net rate of not less than 0.50 gpm/ft^2 [20.4 (L/min)/m^2] of protected area.

7.3.2* Pumps, Compressors, and Related Equipment. 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 0.50 gpm/ft^2 [20.4 (L/min)/m^2] of projected surface area of the equipment.

7.3.3 Flammable and Combustible Liquid Pool Fires. Water spray systems designed to control pool fires resulting from a flammable or combustible liquid spill fire shall be designed to apply a net rate of not less than 0.30 gpm/ft^2 [12.2 (L/min)/m^2] of protected area.

7.3.3.1 Subsection 7.3.3 shall apply to the control of pool fires resulting from a flammable or combustible liquid spill.

7.3.3.2 The water spray system shall be designed to apply a net rate of not less than 0.30 gpm/ft^2 [12.2 (L/min)/m^2] of protected area.

7.4 Exposure Protection.

7.4.1* General. A system for exposure protection shall operate as intended for the anticipated duration of the exposure fire.

7.4.2* Vessels.

7.4.2.1 Water spray shall be applied to vessel surfaces (including top and bottom surfaces of vertical vessels) at a net rate of not less than 0.25 gpm/ft^2 [10.2 (L/min)/m^2] of exposed surface.

7.4.2.2* Where rundown is contemplated, the distance between nozzles at different levels or elevations, protecting vertical or inclined surfaces, shall not exceed 12 ft (3.7 m) as measured along the surface.

7.4.2.3* The horizontal distance between nozzles shall be such that spray patterns meet or overlap at the protected surface.

7.4.2.4 Spherical or horizontal cylindrical surfaces below the vessel equator shall not be considered wettable from rundown.

7.4.2.5 Where projections (manhole flanges, pipe flanges, support brackets, relief valves, etc.) will obstruct water spray coverage, including rundown on vertical surfaces, additional nozzles shall be installed around the projections to maintain the wetting pattern that otherwise would be seriously interrupted.

7.4.2.6 All uninsulated vessel skirts and any uninsulated steel saddles greater than 12 in. (305 mm) high at the lowest point shall have water spray applied on one exposed (uninsulated) side, at a net rate of not less than 0.25 gpm/ft^2 [10.2 (L/min)/m^2].

7.4.3 Structures and Miscellaneous Equipment.

7.4.3.1* Horizontal Structural Steel. Horizontal, stressed (primary) structural steel members shall be protected by nozzles and piping of such size and arrangement to discharge a net rate of not less than 0.10 gpm/ft^2 [4.1 (L/min)/m^2] over the wetted area, as per Figure 7.4.3.1.

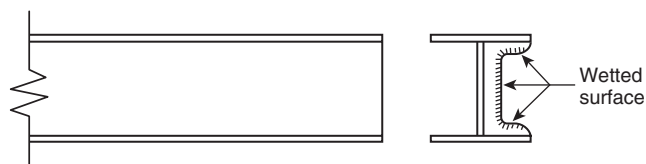


FIGURE 7.4.3.1 Wetted Surface of a Structural Member (a beam or column).

7.4.3.2 Horizontal structural steel that has been encased in fire-resistant insulating material to provide a level of fire resistance acceptable to the authority having jurisdiction shall not require water spray protection.

7.4.3.3 Alternative Engineering Analysis for Horizontal Structural Steel. Horizontal structural steel shall not require water spray exposure protection where all of the following are met:

- (1) Horizontal structural steel shall be analyzed and determined, through calculations certified by a registered professional engineer, to withstand the worst-case postulated fire.
- (2) Calculations shall verify that the temperature of the steel members does not exceed that which would compromise structural integrity.
- (3) The calculation methodology shall be approved and acceptable to the authority having jurisdiction.

7.4.3.4* Vertical Structural Steel. Vertical structural steel members shall be protected by nozzles and piping of such size and arrangement as to discharge a net rate of not less than 0.25 gpm/ft² [10.2 (L/min)/m²] over the wetted area. (See Figure 7.4.3.1.)

7.4.3.5 Vertical structural steel that has been encased in fire-resistant insulating material to provide a level of fire resistance acceptable to the authority having jurisdiction shall not require water spray protection.

7.4.3.6 Alternative Engineering Analysis for Vertical Structural Steel. Vertical structural steel shall not require water spray exposure protection where all of the following are met:

- (1) Vertical structural steel shall be analyzed and determined, through calculations certified by a registered professional engineer, to withstand the worst-case postulated fire.
- (2) Calculations shall verify that the temperature of the steel members does not exceed that which would compromise structural integrity.
- (3) The calculation methodology shall be approved and acceptable to the authority having jurisdiction.

7.4.3.7 Metal Pipe, Tubing, and Conduit.

7.4.3.7.1 Water spray intended to protect metal pipe, tubing, and conduit in racks shall be directed toward the underside of the pipes, tubes, and conduit.

7.4.3.7.2 Water spray protection shall be permitted to be applied to the top of pipes on racks where water spray piping cannot be installed below the rack due to the potential of physical damage or where space is inadequate for proper installation.

7.4.3.7.3 The levels protected and the densities required shall be in accordance with Table 7.4.3.7.3.

Table 7.4.3.7.3 Protection of Metal Pipe, Tubing, and Conduit

Number of Rack Levels	Plan View Density at Lowest Level		Plan View Density at Upper Level(s)*		Levels Requiring Nozzles
	gpm/ft ²	(L/min)/m ²	gpm/ft ²	(L/min)/m ²	
1	0.25	10.2	N/A	N/A	All
2	0.20	8.2	0.15	6.1	All
3, 4, or 5	0.20	8.2	0.15	6.1	Alternate
6 or more	0.20	8.2	0.10	4.1	Alternate

*The table values contemplate exposure from a spill fire.

7.4.3.7.4 Water spray shall be applied to the underside of the top level even if located immediately above a protected level.

7.4.3.7.5 Nozzles shall be selected and positioned such that spray patterns meet or overlap at the protected surface for the entire width of the rack.

7.4.3.7.6 Nozzles shall be positioned no more than 2½ ft (0.8 m) below the bottom of the level being protected.

7.4.3.7.7 Where the rack horizontal support members create an obstruction to the spray pattern, nozzles shall be spaced within the bays.

7.4.3.7.8 Vertical structural supports shall be protected in accordance with 7.4.3.4.

7.4.3.7.9 Vertically stacked piping shall be protected by water spray directed at one side (vertical plane) of the piping at a net rate of not less than 0.15 gpm/ft² [6.1 (L/min)/m²].

7.4.3.8 Cable Trays and Cable Runs.

7.4.3.8.1 Where insulated wire, cable, or nonmetallic tubing in open trays or runs is to be protected by water spray from a spill fire exposure, a net rate of not less than 0.30 gpm/ft² [12.2 (L/min)/m²] of projected horizontal or vertical plane area containing the cables or tubes shall be provided.

7.4.3.8.2 Water spray nozzles shall be arranged to supply water at this rate both over and under (or to the front and rear of) cable or tubing runs and to the racks and supports.

7.4.3.8.3 Flame Shield Use.

7.4.3.8.3.1 Where flame shields equivalent to ¼ in. (1.6 mm) thick steel plate are mounted below cable or tubing runs, the water density requirements shall be permitted to be reduced to a net rate of not less than 0.15 gpm/ft² [6.1 (L/min)/m²] over the upper surface of the cable or rack.

7.4.3.8.3.2 The steel plate or equivalent flame shield shall be wide enough to extend at least 6 in. (152 mm) beyond the side rails of the tray or rack in order to deflect flames or heat emanating from spills below cable or conduit runs.

7.4.3.8.4 Where other water spray nozzles are arranged to extinguish, control, or cool exposing liquid surfaces, the water spray density shall be permitted to be reduced to a net rate of not less than 0.15 gpm/ft² [6.1 (L/min)/m²] over the upper surface, front, or back of the cable or tubing tray or run.

7.4.4 Transformers.

7.4.4.1* Transformer protection shall provide complete water spray impingement on all exposed exterior surfaces.

7.4.4.2 Where there is insufficient space to install water spray nozzles underneath transformers such that the water spray cannot directly impinge upon the bottom surfaces, it shall be permitted to protect the surfaces underneath the transformer by horizontal projection or by nozzles directed to cool the area below the transformer projections.

7.4.4.3 Application and Protection.

7.4.4.3.1 The water shall be applied at a net rate not less than 0.25 gpm/ft² [10.2 (L/min)/m²] of projected area of rectangular prism envelope for the transformer and its appurtenances, and not less than 0.15 gpm/ft² [6.1 (L/min)/m²] on the expected nonabsorbing ground surface area of exposure.

7.4.4.3.2 The water shall be applied at a net rate of not less than 0.15 gpm/ft² [6.1 (L/min)/m²] on the expected nonabsorbing ground surface area of exposure.

7.4.4.3.3 Water spray application as specified in 7.4.4.3.1 and 7.4.4.3.2 shall be provided for special configurations, conservator tanks, pumps, and so forth.

7.4.4.3.4 Where transformer components create spaces greater than 12 in. (305 mm) in width, the surfaces shall be individually protected.

7.4.4.3.5 Where there is insufficient clearance to achieve direct impingement, it shall be permitted to protect the surfaces underneath the transformer by horizontal projection or by nozzles directed to cool the area below the transformer projections.

7.4.4.3.6 The water supply shall be capable of supplying both the design flow rate and 250 gpm (946 L/min) for hose streams for a minimum duration of 1 hour.

7.4.4.4 Water spray piping shall not be routed across the top of the transformer tank or across the face of the transformer cabinet.

7.4.4.5 Piping shall be permitted to be routed across the top of the transformer tank or across the face of the transformer cabinet, where impingement cannot be accomplished with any other configuration and the required distance from live electrical components is maintained. (See 6.1.2.)

7.4.4.6 Nozzles shall be positioned such that the water spray does not envelop energized bushings or lightning arresters by direct impingement.

7.4.4.7 Direct impingement of water spray on energized bushings and/or lightning arresters shall be permitted only when authorized by the manufacturer or manufacturer's literature and the owner.

7.5* Flammable Vapor Mitigation.

7.5.1* Design for Vapor Mitigation.

7.5.2 The water spray system shall be designed to operate within the necessary time and shall discharge water for the duration needed to dissolve, dilute, disperse, or cool the flammable vapors, gases, or hazardous materials.

7.5.3 The duration of the release of the flammable materials shall be included in the determination of the water spray duration time.

7.5.4 The minimum net rate of application shall be based on field experience with the product or on actual test data.

7.5.5 The design area of the water spray system shall cover the entire area of any potential spill anticipated, such as the area of a containment dike, pit, and so forth.

7.5.6 Nozzles of the water spray system shall be located to cover all potential leak points, such as fill and discharge connections, relief valves, flexible connections, flanges, pumps, valves, vessels, and so forth.

7.5.7 The water spray system shall be activated automatically by gas/vapor detection in accordance with 6.5.2.7 and manually from both the system area and remotely, such as from a control room.

7.5.7.1* It shall be permitted to have the vapor mitigation system activated by both gas/vapor detection and another detection system, such as flame or heat detection, but the gas/vapor detection system shall be capable of activating the water spray system alone.

7.5.8 Notification of Personnel. Personnel shall be notified upon receipt of any detection signal in accordance with *NFPA 72, National Fire Alarm and Signaling Code*.

7.5.9 Fire Risk Analysis. A fire risk analysis shall be conducted that considers the following additional items in the design of the water spray system for vapor mitigation:

- (1) Importance to continuity of operation
- (2) Size, type, location, and construction of equipment
- (3) Physical properties of the chemicals involved
- (4) Water supply
- (5) Value of equipment
- (6) Climate
- (7) Water delivery time
- (8) Environment
- (9) Access for fire fighting
- (10) Projected flammable liquid or material spill pattern
- (11) Potential for flammable vapor release
- (12) Proximity of personnel to hazard area
- (13) Protection of system actuation valve from fire and explosion
- (14) Blast containment and pressure relief
- (15) Protection of electrical circuits, including explosion-proof equipment
- (16) Potential for fire spread beyond hazard area
- (17) Required replacement time for process equipment
- (18) Potential for business interruption
- (19) Notification of personnel upon vapor detection

7.6 Combined Systems.

7.6.1* General.

7.6.1.1 The sprinkler system portion of combined systems shall be designed and installed in accordance with *NFPA 13, Standard for the Installation of Sprinkler Systems*.

7.6.1.2 The water spray portion of any combined system shall be designed and installed in accordance with this standard.

7.6.2* Design.

7.6.2.1 The system demand shall include the simultaneous hydraulic demand from all sprinklers and water spray nozzles on the system.

7.6.2.2 The water spray component of the combined demand shall not reduce the minimum required sprinkler discharge density.

7.7 Automatic Detection Equipment.

7.7.1* General. Detection systems providing an actuation signal to fixed water spray systems shall be designed in accordance with *NFPA 72, National Fire Alarm and Signaling Code*.

7.7.2 The spacing, location, and position of detectors shall be in accordance with 6.5.2.

7.7.3* The following shall be evaluated when selecting and adjusting detection equipment:

- (1) Normally changing conditions
- (2) Non-fire temperature changes

7.7.4* Response Time.

7.7.4.1 The detection system shall be designed to cause actuation of the system actuation valve to operate without delay.

7.7.4.2 Where ambient conditions exist that cause false system operations, detection systems shall be permitted to include delays that would override these conditions.



Chapter 8 Plans and Hydraulic Calculations

8.1 General.

8.1.1* Hydraulic calculations shall be conducted as part of the design of the piping system to determine that the required pressure and flow is available at each nozzle.

8.1.2* Minimum operating pressure of any nozzle protecting outdoor hazards shall be 20 psi (1.4 bar).

8.1.3 Nozzles protecting interior hazards shall have minimum operating pressures in accordance with their listing.

8.1.4* Except where permitted by 8.1.5, correction for velocity pressure shall be included in the calculations.

8.1.5* The calculations shall be permitted to ignore velocity pressure corrections where the velocity pressure does not exceed 5 percent of the total pressure at each junction point.

8.2 Working Plans.

8.2.1 General.

8.2.1.1 Working plans shall be submitted to the authority having jurisdiction before any equipment is installed or remodeled.

8.2.1.2 Deviation from approved plans shall require permission of the authority having jurisdiction.

8.2.1.3 Working plans, including elevations, shall be drawn to an indicated scale, show all essential details, and include the following pertinent data as a minimum:

- (1) The dates of initial submission and revisions.
- (2) The name of the owner and occupant.
- (3) The name and address of the contractor and layout technician.
- (4) The location, including the street address.
- (5) The point of the compass.
- (6) The full height cross section.
- (7) The structural features.
- (8) The relative elevations of nozzles, junction points, and supply or reference points.
- (9) Full information concerning water supplies, including such items as pumps, underground mains, earthquake protection, and flow test results.
- (10) The make, type, size, location, position, and direction of spray nozzles.
- (11) The make, type, model, and size of the system actuation valve, control valve, or special system valve. The method of control valve supervision shall be indicated on the plans.
- (12) The type and location of alarm devices to be provided.
- (13) The type and location of the control panel.
- (14) The number of each size and type of spray nozzles on each system.
- (15) The type of pipe and schedule of wall thickness, lengths of pipe, and whether center to center or cutting lengths are shown.
- (16) The size and type of all fittings; the dimensions and locations of shop-welded sections.
- (17) The sensing devices for detection, including the type, arrangement, and location.
- (18) The hydraulic reference points shown on the plan shall correspond to comparable reference points on the hydraulic calculation sheets.
- (19) The calculated system demand at a reference point.

- (20) The total designed water demand with the number of systems designed to operate simultaneously at a reference point, preferably the source of supply, including hose streams and other fire protection equipment.
- (21) The density requirements and hazard surface calculation, where applicable.
- (22) The design objective of the system.
- (23) The make, type, and location of hangers, supports, sleeves, sway bracing, and inserts.
- (24) All control and check valves, strainers, drain pipes, and test pipes.
- (25) A graphic representation of the scale used on all plans.
- (26) The weight or class, lining, and size of underground pipe, and the depth that the top of the pipe is to be laid below grade.
- (27) Provisions for flushing underground pipe.
- (28) Accurate and complete layout of the hazard to be protected.

8.2.1.4 The working plan submittal shall include manufacturer's installation instructions for any specially listed equipment, including descriptions, applications, and limitations for any nozzles, devices, piping, fittings, supports, and bracing materials.

8.2.1.5 Where the equipment to be installed is an addition or change to an existing system, details of the existing system shall be indicated on the working plans to allow for review of the design and supporting hydraulic calculations.

8.3* Hydraulic Calculations.

8.3.1 Hydraulic calculations shall be prepared on forms that include a summary sheet, detailed worksheet, and a graph sheet.

8.3.2 Summary Sheet. The summary sheet [for sample summary sheet, see Figure B.1(a)] shall contain all of the following information where applicable:

- (1) The date
- (2) The location
- (3) The name of the owner and occupant
- (4) The building or plant number
- (5) A description of the hazard
- (6) The name and address of the contractor and calculator
- (7) The name of the authority having jurisdiction
- (8) The design purpose
- (9) The rates of the water application (density) and applied areas in gpm/ft² [L/min)/m²]
- (10) The total system water requirements as calculated, including allowance for hose streams
- (11) The total designed water demand with number of systems designed to operate simultaneously at a reference point, preferably the source of supply, including hose streams and other fire protection equipment
- (12) Water supply information

8.3.3 Detailed Worksheets. Detailed worksheets or computer printout sheets [for sample worksheet, see Figure B.1(b)] shall contain all of the following information:

- (1) Sheet number, date, job number, and identification of calculations covered
- (2) Description of discharge constant (K) (or provide the discharge curve or tabulation) for each nozzle type
- (3) Hydraulic reference points
- (4) Flow in gpm (L/min)
- (5) Pipe size in in. (mm)
- (6) Pipe lengths, center to center of fittings (or cut lengths) in ft (m)