FIXED WATER SPRAY SYSTEMS FOR FIRE PROTECTION

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1.0 SCOPE

FM Global has accepted and adopted NFPA Standard 15, *Standard for Water Spray Fixed Systems for Fire Protection*, 2001 Edition.

This data sheet addresses design and installation of fixed water spray systems as it pertains to the conservation and protection of property.

1.1 Changes

May 2010. Replaced all references to Data Sheet 2-8N, *Installation of Sprinkler Systems (NFPA)*, with references to Data Sheet 2-0, *Installation Guidelines for Automatic Sprinklers*.

1.2 Superseded Information

May 2002. All previous information in Data Sheet 4-1N is superseded by this new standard.

2.0 FM GLOBAL INTERPRETATION

2.1 Introduction

Design and install fixed water spray systems for fire protection in accordance with the requirement of NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, 2001 Edition, and the interpretations included in this data sheet.

2.1.1 Shall versus Should

In most, if not all instances, the mandatory *shall*, used in the text of NFPA 15, can be replaced by the more permissive *should*.

2.1.2 Authority Having Jurisdiction

There are many references in the text of NFPA 15 to the authority having jurisdiction (AHJ). Legally this could mean the state fire marshal, local fire department, or some other state or municipal office. In the application of this standard the term Authority Having Jurisdiction refers solely to FM Global unless the legal authority takes precedent.

2.1.3 Listed or Approved

Within the NFPA Standard, the term *"listed"* should be interpreted as equipment *Approved* by FM Approvals and listed in the Approval Guide, an online resource of FM Approvals. FM Approved equipment should be used whenever possible.

Within the NFPA Standard, the term *"approved"* means acceptable to FM Global.

2.1.4 Related NFPA Standards

NFPA 15 contains references to several other NFPA standards. Where FM Global has a corresponding standard to a referenced NFPA document, the FM Global standard takes precedence.

2.2 Comments and Exceptions

2.2.1 Protection

2.2.1.1 Treat "Appendix A" material in NFPA 15 as recommended practice applicable to FM Global insured locations.

2.2.1.2 Use of Water Spray. In addition to the uses and applications provided in NFPA 15, fixed water spray systems may be used to prevent the spread of fire, hot gases and smoke through wall or floor openings. Certain nozzles are specifically Approved for this use at openings in important walls where it is not possible to install automatically closing fire doors. Where fixed water spray systems are used to protect openings, design the system in accordance with FM Global Data Sheet 1-23, *Protection of Openings in Fire Subdivisions*, to discharge directly into the opening at 2.0 to 4.0 gpm/ft^2 (81.5 to 163 mm/min), depending on the height of the opening above the floor level. The use of fixed water spray systems is not considered

equivalent protection or fire cut off as physical barriers. Methods of providing water spray protection for conveyor belt openings are described in Data Sheet 1-23.

2.2.1.3 Automatic vs. Manual Operation. Use automatic systems with control valves locked or supervised in the open position. Manually operated systems can be accepted under limited hazard conditions and where failure to turn on the system would not result in serious consequences. Where manually operated systems become acceptable, use preferentially quick-opening valves of small diameter, instead of OS&Y valves, and provide the system with automatic fire detection and alarm.

2.2.1.4 Pipe having wall thickness conforming with Schedule 10 (10S) can be used in sizes 4, 5 and 6 inches (100, 150 and 200 mm) when joined by welding or Approved joints.

2.2.1.5 The interior of piping used in open-nozzle water spray systems is subject to the same extent of corrosion as the exterior of the pipe. If galvanizing is considered not suitable protection against corrosion on the exterior, similarly it is unsuitable on the interior of the pipe. Do not use galvanized pipe for systems intended for extinguishment, where one obstructed nozzle by scale or other corrosion by-product can result in failure to achieve extinguishment.

2.2.1.6 Design water spray systems to conform to the applicable requirements of the following FM Global Data Sheets and Standards of the National Fire Protection Association.

Table FM-1. FM Global Data Sheets and Standards of the National Fire Protection Association.

Title	*FM Global Data Sheet (NFPA Standard)*
Installation of Sprinkler Systems	Data Sheet 2-0
Installation of Standpipe and Hose Systems	Data Sheet 4-4N (NFPA 14)
Deluge-Foam Sprinkler and Spray Systems	Data Sheet 4-12
Fire Protection Pumps	Data Sheet 3-7
Water Tanks For Private Fire Protection	Data Sheet 3-1 & 3-2 (NFPA 22)
Outside Protection	Data Sheet 3-10 (NFPA 24)
Inspection and System Maintenance	Data Sheet 2-81
National Electrical Code	NFPA 70
National Fire Alarm Code	NFPA 72
Protection From Exposure Fires	Data Sheet 1-20 (NFPA 80A)
Protection of Openings in Fire Subdivisions	Data Sheet 1-23
Cooling Towers	Data Sheet 1-6 (NFPA 214)
Transformers	Data Sheet 5-4
Belt Conveyors	Data Sheet 7-11
Cable Runs and Bus Bars	Data Sheet 5-31
Industrial Ovens and Dryers	Data Sheet 6-9
Fire & Explosion Protection for Flammable Liquid, Flammable Gas & Liquefied Flammable Gas Processing Equipment & Supporting Structures	Data Sheet 7-14

2.2.1.7 For flammable liquid and liquefied flammable gas processing equipment and supporting structures located indoors, design water supply assuming discharge from all nozzles within the building ground floor areas up to 10,000 ft^2 (930 m^2).

2.2.1.8 Provide automatic starting water supplies, i.e., water supplies which are available to the system without the need for manual operation of valves or pumps, and which are as reliable as the supplies used for automatic sprinkler systems. In very large systems (2000 gpm or higher) supplied principally by pumps, provide additional or reserve capacity so that the system can function effectively in case one of the water supply pumps is out of service for repair or maintenance.

2.2.1.9 Where water spray systems are used for protection of remotely located transformers, provide water supply (pressure tanks or other source of supply in accordance with NFPA 15) with at least 60 minute duration, in accordance with Data Sheet 5-4, *Transformers*.

2.2.1.10 Density and Application. Provide a minimum nozzle discharge pressure of at least 20 psi (138 kPa) (1.4 bar) so that the system can maintain a good distribution pattern. Outdoor installations with nozzles less than ½ in. (12 mm) nominal diameter provide 30 psi (207 kPa) (2.2 bar) for proper discharge pattern and

spray protection against moderately intense wind. Outdoor systems with nozzles ½ in (12 mm) and larger require at least 20 psi (138 kPa) (1.4 bar) discharge pressure for proper discharge pattern against moderately intense wind.

For indoor installations, 20 psi (138 kPa) (1.4 bar) discharge pressure is adequate for spray nozzles properly located over open tanks containing high flashpoint liquids, such as quench oil. For liquids similar to Kerosene, 30 to 100 psi (207 to 689 kPa) (2.1 to 6.9 bar) discharge pressure is required, depending upon the spacing and the discharge characteristics of the nozzle.

2.2.1.11 Open Tank Protection. For protection of dip tanks, flow coaters and roll coaters use the recommendations in Data Sheet 7-9, *Dip Tanks, Flow Coaters and Roll Coaters*, in addition to requirements of NFPA 15.

Fixed water-spray systems designed in accordance with NFPA 15 are suitable for protection of fires in open tanks of flammable liquids with flash points above 140°F (60°C) (hazards equivalent to or less than kerosene, quench oil and transil oil). The design should be based on spacing and discharge pressure as specified for the particular nozzles in Table FM-2.

Arrange nozzles to provide an adequate amount of water at sufficient velocity to penetrate through fire and updraft and contact the liquid surface without creating excessive turbulence. An example of the arrangement of nozzles and piping for open tank protection is given in Figure FM-1.

To protect against spread of fire from boilover, extend spray-nozzle protection a distance of 10 to 20 ft (3 to 6 m) beyond tanks containing liquids that are or may become heated to 212°F (100°C) or above in production operations.

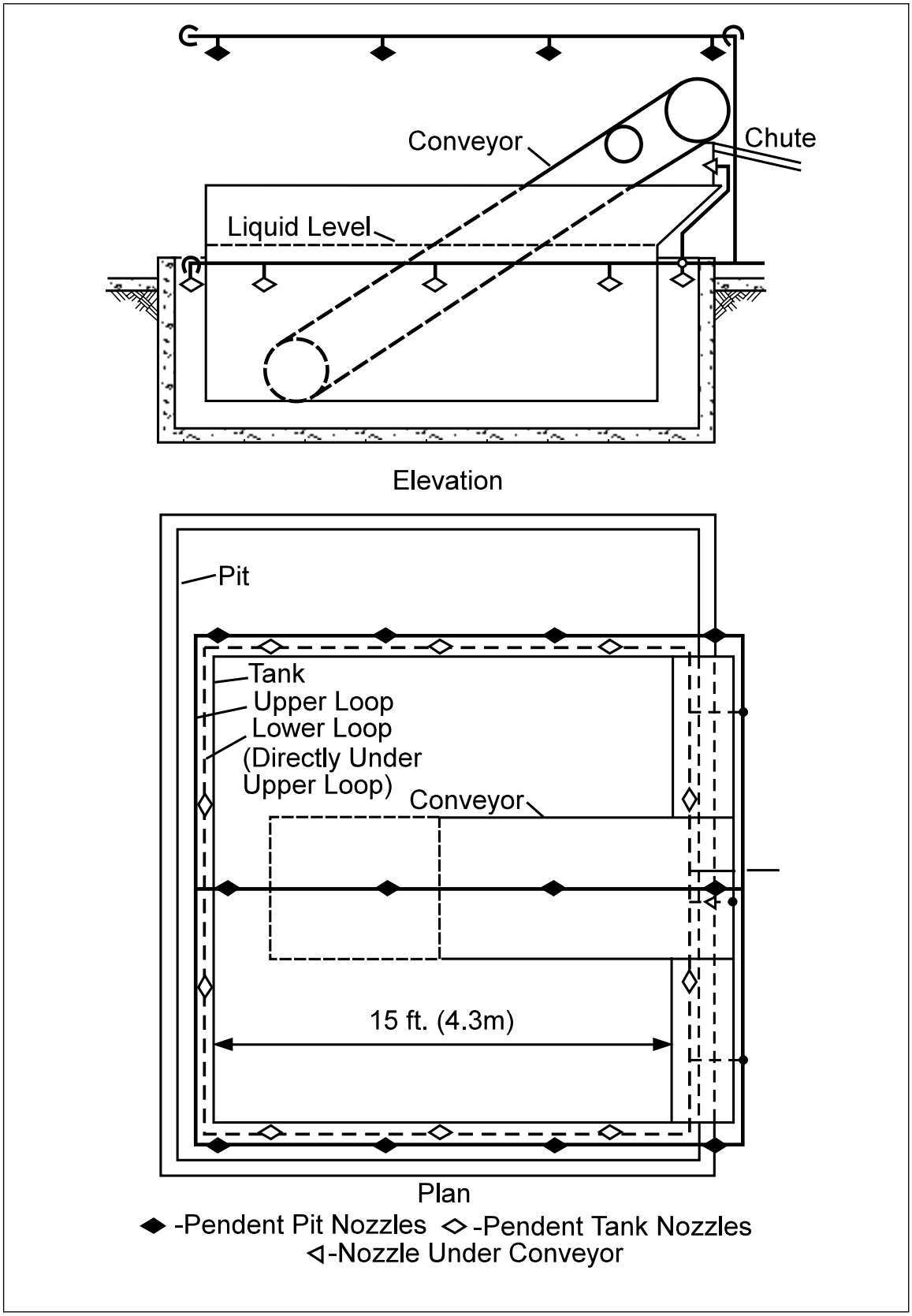


Fig. FM-1. Nozzle and piping arrangement for open tank of flammable liquids.

Table FM-2. Nozzle Location, Size, and Discharge Pressures for Open Tank Protection.

Nominal orifice size and discharge rate at 50 psi (3.4 bar)	Cone angle of spray, °	Recommended distance, Nozzle to hazard, ft (m)			Spacing, ft (m), and discharge pressure to extinguish, psi (bar)*					
		Indoors		Outdoors	For liquids similar to kerosene			For liquids similar to quench and transil oil		
		Minimum	Maximum	Maximum	*4 3 4 (1.2 3 1.2) spacing*	*6 3 6 (1.8 3 1.8) spacing*	*8 3 8 (2.4 3 2.4) spacing*	*4 3 4 (1.2 3 1.2) spacing*	*6 3 6 (1.8 3 1.8) spacing*	*8 3 8 (2.4 3 2.4) spacing*
½ in. (12.7 mm)	160-180	5 (1.5) 6 (1.8) 7 (2.1) 9 (2.7)	14 (4.3) 14 (4.3) 16 (4.9) 18 (5.5)	7 (2.1) 7 (2.1) 8 (2.4) 12 (3.7)		35 (2.4) 45 (3.1) 60 (4.1) 75 (5.2)	40 (2.8) 50 (3.4) 65 (4.5) 75 (5.2)		20 (1.4) 20 (1.4) 30 (2.1) 30 (2.1)	20 (1.4) 20 (1.4) 30 (2.1) 30 (2.1)
37-42 gpm	125-140									
(140-159 dm^3/min)	90-110									
	60-80									
⅜ in. (9.5 mm)	160-180	4 (1.2) 5 (1.5) 6 (1.8) 8 (2.4)	12 (3.7) 13 (4.0) 14 (4.3) 16 (4.9)	6 (1.8) 6.5 (2.0) 7 (2.1) 11 (3.4)	30 (2.1) 40 (2.8) 50 (3.4) 65 (4.5)	40 (2.8) 50 (3.4) 65 (4.5) 75 (5.2)	50 (3.4) 50 (3.4) 75 (5.2) 90 (6.2)	20 (1.4) 20 (1.4) 20 (1.4) 30 (2.1)	20 (1.4) 20 (1.4) 30 (2.1) 30 (2.1)	20 (1.4) 20 (1.4) 30 (2.1) 30 (2.1)
20-24 gpm	125-140									
(76-91 dm^3/min)	90-110									
	60-80									
¼ in. (6.4 mm)	160-180	2 (0.6) 3 (0.9) 5 (1.5) 6 (1.8)	8 (2.4) 8 (2.4) 10 (3.0) 12 (3.7)	4 (1.2) 4 (1.2) 5 (1.5) 8 (2.4)	40 (2.8) 50 (3.4) 75 (5.2) 90 (6.2)	60 (4.1) 70 (4.8) 80 (5.6)	75 (5.2) 90 (6.2)	20 (1.4) 30 (2.1) 30 (2.1) 30 (2.1)	30 (2.1) 30 (2.1) 30 (2.1)	30 (2.1) 30 (2.1)
8-12 gpm	125-140									
(30-45 dm^3/min)	90-110									
	60-80									

*1 bar = 100 kPa

2.2.1.12 Exposure Protection of Transformers. For exposure protection of transformers use the recommendations in Data Sheet 5-4, *Transformers*, in addition to requirements of NFPA 15.

Weatherproof any indoor-type transformers and associated electrical devices protected by water spray. This is needed to prevent electrical breakdown, unless individual transformers are in separate curbed and drained areas with baffles extending from the ceiling to below the lowest spray nozzles and a separate spray system is provided at each transformer. Use carbon dioxide (or other applicable gaseous suppression systems) instead of fixed water spray systems where transformers have openings in the top (as some used with electric-arc furnaces) and/or where it is impractical to make the transformers watertight.

Water-spray systems using nozzles of various patterns are suitable for protection of oil-filled transformers and for exposure protection of adjacent transformers and associated equipment (Fig. FM-2). Large transformers are more easily protected by large-capacity nozzles because their greater discharge and range permit simpler piping arrangements. Also, the large-capacity nozzles better overcome the effects of wind currents (Fig. FM-3). To extinguish fire in transil oil flowing over a transformer case, over cooling radiators, and the surrounding pit area locate and direct nozzles to cover the entire surface with water spray.

2.2.1.13 Protection of Cable Trays and Cable Runs. For protection of cable trays and cable runs use the recommendations in Data Sheet 5-31, *Cables and Bus Bars*, in addition to requirements of NFPA 15.

2.2.1.14 Protection of Belt Conveyors. For protection of conveyor belts use the recommendations in Data Sheet 7-11, *Belt Conveyors*, in addition to requirements of NFPA 15.

2.2.1.15 Protection of Cooling Towers. For protection of Cooling Towers use the recommendations in FM Global Loss Prevention Data Sheet 1-6, *Cooling Towers*, in addition to requirements of NFPA 15.

2.2.1.16 Protection of Ovens & Dryers. Spray nozzles with a flat fan-shaped discharge are suitable for horizontal multipass dryers handling large sheets of combustible stock, such as wallboard, where space limitations and the arrangement of racks and rolls would interfere with proper spacing and distribution of automatic sprinklers. This spray nozzle discharges a small quantity of water over a large horizontal area. For further details on fire protection in ovens and dryers refer to Data Sheet 6-9, *Industrial Ovens and Dryers*.

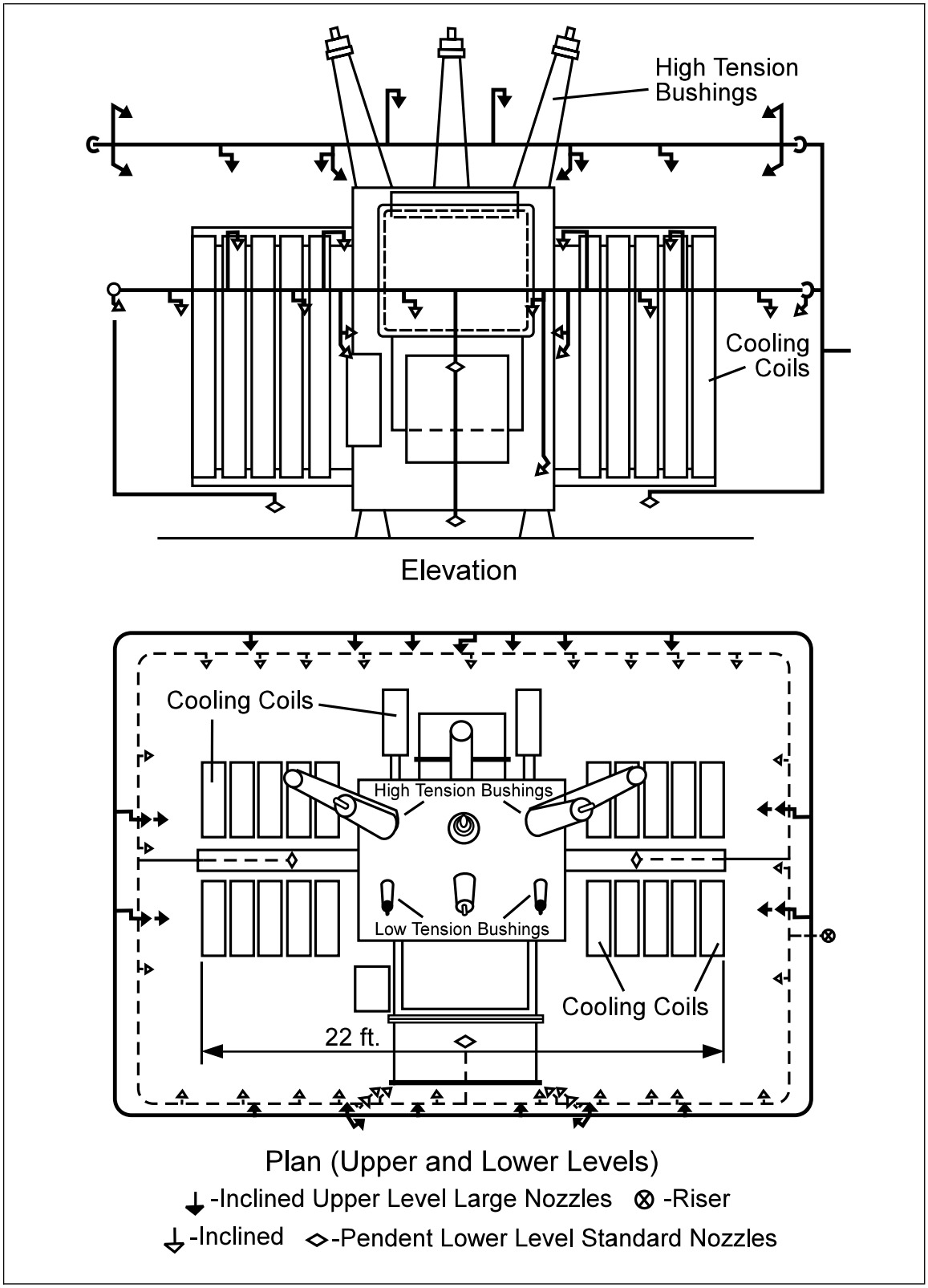


Fig. FM-2. Nozzle and piping arrangement for transformer, using nozzles of ordinary capacity. Upper-level nozzle piping shown by full line, lower-level by dash line. Both levels same distance from transformer.

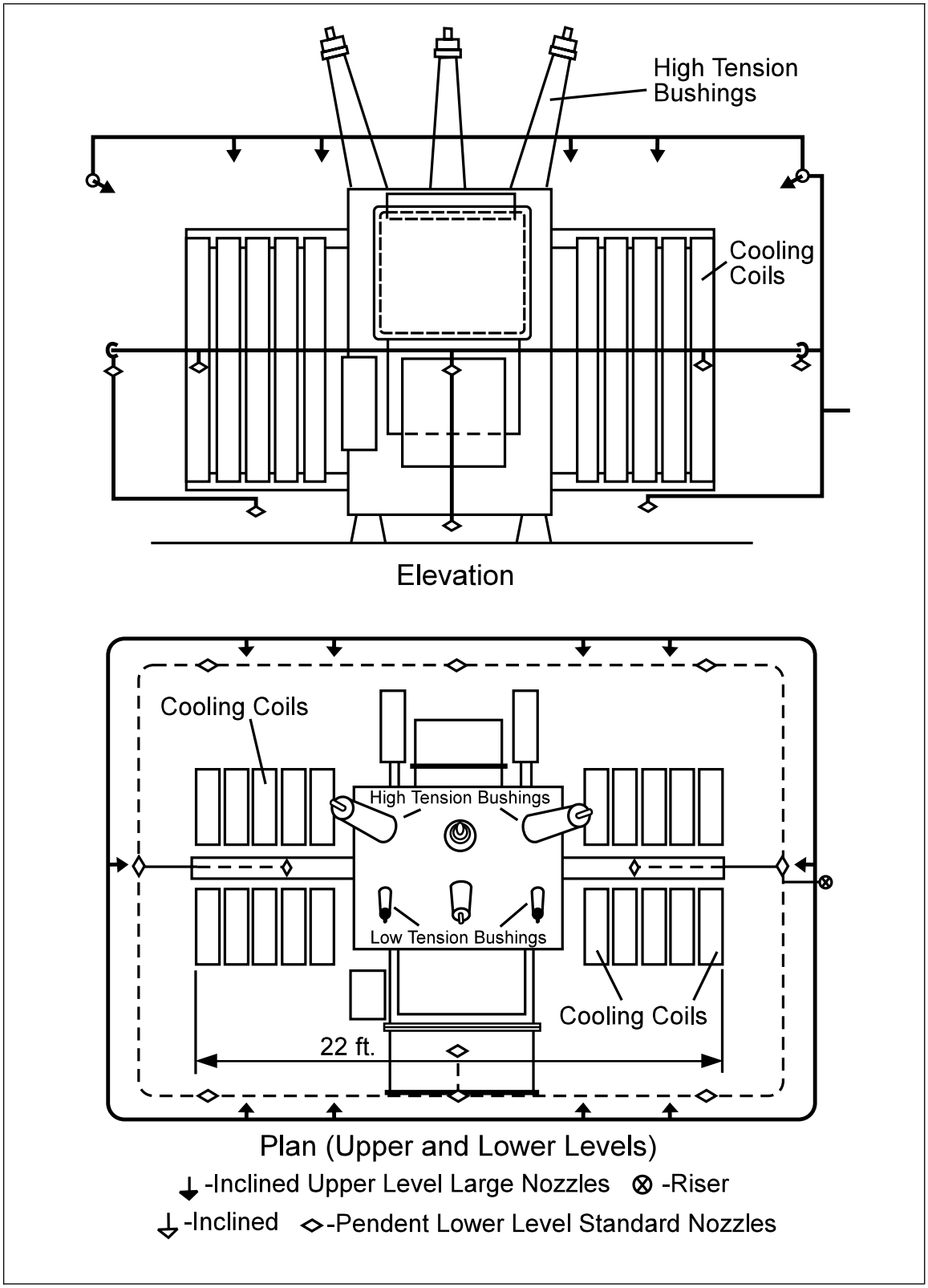


Fig. FM-3. Nozzle and piping arrangement for transformer, using large-capacity nozzles. Upper-level nozzle piping shown by line, lower level by dash line. Both levels same distance from transformer.

2.2.1.17 Protection of Engine Test Cells. Solid-cone, narrow-angle spray nozzles are suitable for test cells for jet engines and other highspeed, high-fuel-demand engines, where it is necessary to project the spray through rapidly moving air and to provide for rapid absorption of heat liberated by the burning fuel. Spilled flammable liquid acquires little depth, and water spray successfully prevents damage to cells and test structures.

2.2.1.18 Protection of Chemical Process Areas. Protect chemical process areas and other flammable material processing areas in accordance with Data Sheet 7-14, *Fire & Explosion Protection for Flammable Liquid, Flammable Gas & Liquefied Flammable Gas Processing Equipment & Supporting Structures*.

2.2.2 Operation and Maintenance

2.2.2.1 Water Discharge Test. Protect indoor transformers or other equipment subject to water damage prior to conducting any operating tests of water spray systems.

2.2.2.2 Check drainage at flammable-liquid tanks, curbed areas, and pits, preferably by waterflow test, to determine if there is adequate carrying capacity.

2.2.2.3 Acceptance Tests: Conduct acceptance tests in accordance with NFPA 15.

a) Make a visual examination to determine if the system is in good mechanical condition. Look for weaknesses such as inadequate piping supports, obstructions to spray distribution, nozzles plugged or improperly located or directed, and need for protection against external loading and corrosion.

b) Make certain all valves are in properly closed or open position.

2.2.2.4 Conduct annual waterflow test in all water spray systems. Where flow tests are not practical, conduct operational tests of at least the automatic-control valves and of all initiating devices (such as heat or other detectors) installed.

3.0 SUPPORT FOR RECOMMENDATIONS

Fixed water-spray systems are recommended in certain FM Global Data Sheets for protection of hazards where special occupancy conditions require more than ordinary sprinkler protection to provide adequate fire control and extinguishment. Fixed water spray systems are also used for localized protection of hazards such as vessels, open and roofed tanks, cable trays, transformers, belt conveyors and other special hazards. Water-spray systems can also be applied as active protection of certain structures against exposure fires.

The nozzles are specially designed to break up a solid stream into small particles of varying size. The smaller the droplets, the more effective their cooling action because of their proportionally greater surface area and resultant higher rate of heat absorption. For outdoor or other installations subject to field drafts or wind currents, fine spray may be carried away and is not usually satisfactory.

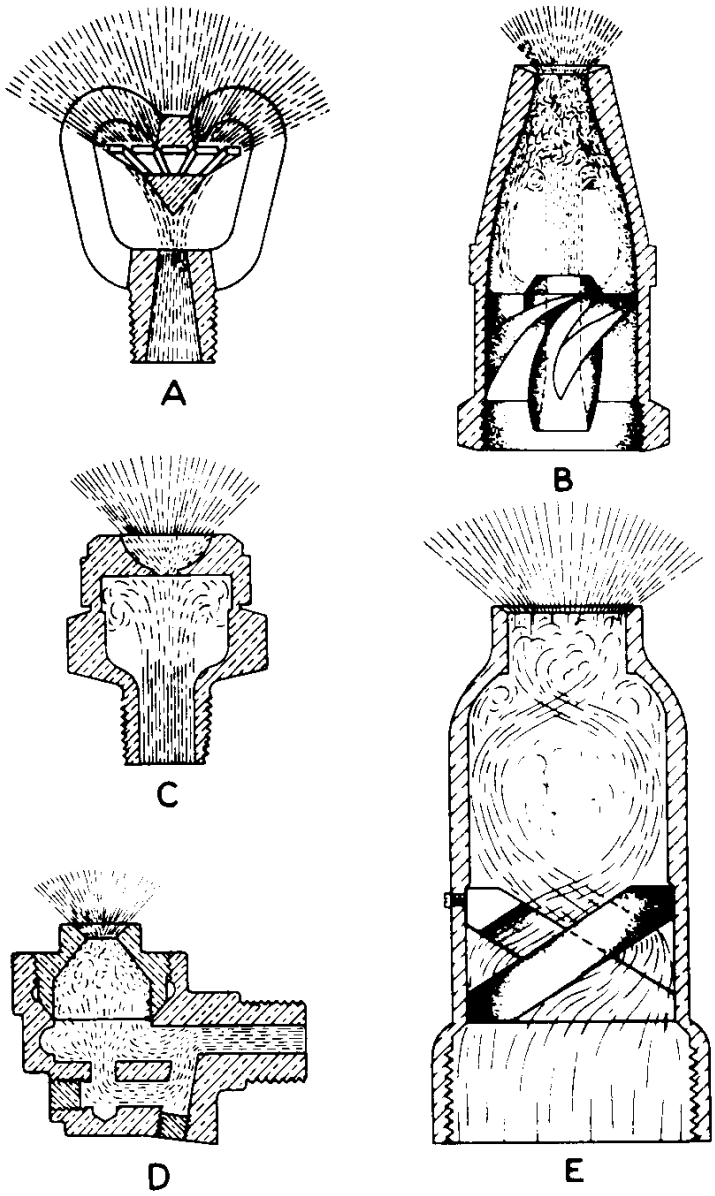
The spray is produced by impingement and dispersion of straight or spiral streams in various ways (Fig. FM-4). Patterns include solid cone or umbrella shapes and flat fan shapes (Fig. FM-5). Most spray patterns start as a cone having an included angle of 60 to 180%, depending on nozzle design. The velocity and range of the spray vary with the discharge and with the angle of the cone.

Water spray extinguishes fire by cooling, smothering, emulsifying or diluting of flammable liquids or by a combination of these factors.

Cooling action results to some extent from absorption of heat by the water particles but mostly from the conversion of water to steam. When converted into steam, 1 lb (0.45 kg) of water at 60°F (16°C) absorbs 1150 Btu. When the surface of the burning material is cooled to a point where flammable vapors are no longer evolved, the fire is extinguished.

Smothering action is obtained when the water spray is converted to steam by the heat of the fire, expanding its volume approximately 1,750 times. Steam thus generated, enveloping the fire area, excludes oxygen and helps to extinguish the fire.

Emulsification is obtained by mechanical agitation of water with oil or other non-water-soluble liquids so that droplets of both materials become closely interspersed. Such an emulsion is produced by the action of water spray striking the surface of certain flammable liquids, rendering the liquid surface nonflammable. With



A. Straight stream impinging on an exterior-toothed deflector
B. Straight stream impinging on spiral streams
C. Straight stream discharging through a square orifice, forming a fan-shaped pattern
D. Two straight streams swirled in an upper and lower spiral chamber and discharging through a common orifice
E. Spiral streams impinging on each other and dispersing (large-capacity nozzle)

Fig. FM-4. Typical water-spray nozzles for fixed systems, illustrating various methods of producing spray.

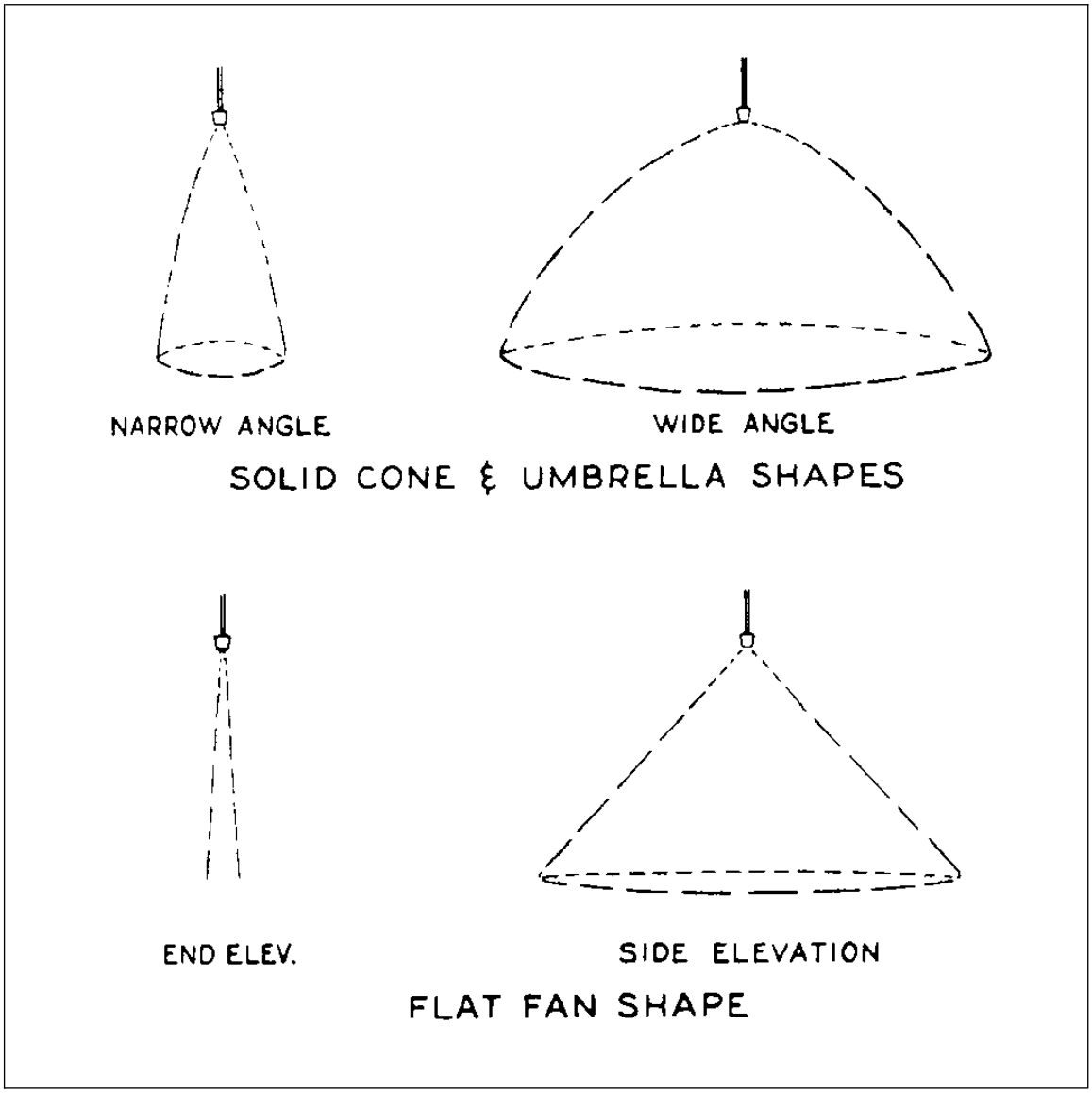


Fig. FM-5. Typical nozzle-discharge patterns.

liquids of low viscosity, emulsification is probably temporary, existing only during the application of the spray. With materials of higher viscosity, the emulsion will last longer and provide some protection against re-flashing.

Dilution of water-soluble liquids is usually a minor factor in extinguishing a fire because of the high degree of dilution required.

4.0 REFERENCES

4.1 FM Global

Data Sheet 2-0, *Installation Guidelines for Automatic Sprinklers*.
Data Sheet 2-8, *Earthquake Protection for Water-Based Fire Protection Systems*.
Data Sheet 3-2, *Water Tanks for Fire Protection*.
Data Sheet 3-7, *Fire Protection Pumps*.
Data Sheet 4-12, *Foam-Water Sprinkler Systems*
Data Sheet 6-9, *Industrial Ovens and Dryers*.

4.2 NFPA Standards

NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, 2001 Edition.

APPENDIX A GLOSSARY OF TERMS

Approved: references to *"*approved*"* in this data sheet mean the product and services have satisfied the criteria for FM Approval. Refer to *Approval Guide*, a publication of FM Approvals, for a complete listing of products and services that are FM Approved.

APPENDIX B DOCUMENT REVISION HISTORY

May 2010. Replaced all references to Data Sheet 2-8N, *Installation of Sprinkler Systems (NFPA)*, with references to Data Sheet 2-0, *Installation Guidelines for Automatic Sprinklers*.

May 2002. This edition of Data Sheet 4-1N supersedes the September 1998 edition and establishes Data Sheet 4-1N as a new and independent document to NFPA 15.

The 1973 version of Data Sheet 4-1N was updated in 1979, to include the NFPA 15 1977 edition. The 1979 version of Data Sheet 4-1N was again revised in 1998. The 1998 revision was an editorial one where the document was reformatted in accordance with the new structure for data sheets.

Data Sheet 4-1N was created in 1973, including the exact text of NFPA 15 1973 edition, appendix material, and the applicable FM Global comments in bold letters.