NFPA®

1964

Standard for Spray Nozzles

2018

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NFPA® 1964

Standard for

Spray Nozzles

2018 Edition

This edition of NFPA 1964, *Standard for Spray Nozzles,* was prepared by the Technical Committee on Fire Hose. It was issued by the Standards Council on November 10, 2017, with an effective date of November 30, 2017, and supersedes all previous editions.

This edition of NFPA 1964 was approved as an American National Standard on November 30, 2017.

Origin and Development of NFPA 1964

The first edition of NFPA 1964 was adopted in 1988 based on a need for a standard that applied to portable adjustable-pattern nozzles for general fire department use and for use on hose attached to standpipes. In the second edition, the text was editorially reworked to make the document more usable, and the details of a few of the test procedures were revised to better reflect how the nozzles are used in the field. The 1998 edition allowed for rating nozzles at other than the traditional 6.9 bar (100 psi); added requirements for marine nozzles; and clarified the testing process, methods, and procedures to improve the understanding of the compliance testing required.

The 2003 edition expanded the document to cover master stream spray nozzles up to 7570 L/min (2000 gpm) in addition to handline spray nozzles. Requirements for marking nozzles were allowed to be in either SI or U.S. units. The pass/fail criteria for some tests were revised to base them on requirements for the nozzle in the standard rather than on results of previous testing. The parenthetical expression "(Shutoff and Tip)" was removed from the title of the standard. The document was completely revised for compliance with the *Manual of Style for NFPA Technical Committee Documents*, and changes were made to improve the clarity of the requirements.

The 2008 edition of this standard was a general update and review by the committee.

The 2013 edition of NFPA 1964 was edited by the Technical Committee to clarify language. The difference between *flow* and *flow rate* in comparison to discharge was made clearer to emphasize the importance of flow and flow rate factors in fire suppression. The committee also transposed measurements to put U.S. units first to reflect the format of other NFPA fire hose standards.

The 2018 edition of NPFA 1964 has many significant changes due to the fact that the committee has chosen to withdraw NFPA 1965. In doing so the committee incorporated the relevant material from 1965 into the applicable areas of NFPA 1964. The goal of this major change was to make it easier for the users of the documents to go to one document for the information on nozzles, whereas before the user would have to go to multiple documents for information on the subject.

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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 size and design of fire hose connections, and the performance, maintenance, and selection of all types of fire hose, couplings, nozzles, and accessory equipment.

Contents

NFPA 1964

Standard for

Spray Nozzles

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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.

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 B. 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 B.

Chapter 1 Administration

Δ **1.1* Scope.** This standard shall cover the requirements for new adjustable-pattern spray nozzles intended for general fire-fighting use, for marine and offshore platform fire-fighting use, for use with fire hoses affixed to standpipe systems, and for fire hose appliances up to and including 6 in. (150 mm) nominal dimension designed for connection to fire hose, fire apparatus, and fire hydrants intended for general fire service use in controlling or conveying water.

1.2 Purpose. The purpose of this standard shall be to provide minimum performance and operational requirements for spray nozzles and fire hose appliances and to specify the design verification tests for spray nozzles and fire hose appliances.

1.3* Application. These requirements shall apply to the following:

(1) Manually operated basic spray, constant gallonage, and constant pressure spray nozzles whether designed as handline nozzles or master stream nozzles
(2) Nozzles that have a rated discharge of 2000 gpm (7570 L/min) or less
(3) Nozzles for use on Class A and Class B fires
(4) Portable valves, including gate valves, ball valves, piston valves, butterfly valves, clappered valves, and pressure relief valves
(5) Portable monitors, ladder pipes, and break-apart monitors
(6) Miscellaneous hose appliances, including wyes, siamese, elbows, water curtains, water thieves, and manifolds

1.4 Equivalency.

N **1.4.1** Nothing in this standard shall 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.

N **1.4.2** Technical documentation shall be submitted to the authority having jurisdiction to demonstrate equivalency.

N **1.4.3** The system, method, or device shall be approved for the intended purpose by the authority having jurisdiction.

1.5* Units of Measurement. In this standard, U.S. values for measurement are followed by an equivalent in metric units. Either set of values can be used, but the same set of values (either U.S. or SI units) shall be used throughout.

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 1963, *Standard for Fire Hose Connections,* 2014 edition.

2.3 Other Publications.

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

ASTM B117, *Standard Practice for Operating Salt Spray (Fog) Apparatus,* 2016.

ASTM D395, *Standard Test Methods for Rubber Property — Compression Set,* 2016.

ASTM D412, *Standard Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers — Tension,* 2016.

ASTM D573, *Standard Test Method for Rubber — Deterioration in an Air Oven,* 2015.

ASTM D2565, *Standard Practice for Xenon Arc Exposure of Plastics Intended for Outdoor Applications,* 2016.

2.3.2 ISO Publications. International Organization for Standardization, ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland.

ISO 9001, *Quality management systems — Requirements,* 2015.

2.3.3 Other Publications.

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

2.4 References for Extracts in Mandatory Sections.

NFPA 1901, *Standard for Automotive Fire Apparatus,* 2016 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 Shall. Indicates a mandatory requirement.

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

N **3.2.5 Standard.** An NFPA Standard, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and that is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions are not to be considered a part of the requirements of a standard and shall be located in an appendix, annex, footnote, informational note, or other means as permitted in the NFPA Manuals of Style. When used in a generic sense, such as in the phrase "standards development process" or "standards development activities," the term "standards" includes all NFPA Standards, including Codes, Standards, Recommended Practices, and Guides.

3.3 General Definitions.

N **3.3.1 Break-Apart Monitor.** See 3.3.10.1.

3.3.2 Control.

3.3.2.1 ***Lever-Type Control.*** A control in which the handle operates along the axis of the nozzle.

3.3.2.2 ***Rotational-Type Control.*** A control that rotates in a plane perpendicular to the axis of the nozzle.

N **3.3.2.3** ***Trigger-Type Lever Control.*** A control that is actuated by a squeezing or pinching movement and features a spring-operated automatic return to the closed position.

N **3.3.3 Fire Hose Appliance.** A piece of hardware (excluding nozzles) generally intended for connection to fire hose to control or convey water.

3.3.4* Flush. A nozzle feature that allows the orifice to be opened so that small debris that could otherwise be trapped in the nozzle, causing pattern disruptions and flow rate variation, can pass through.

3.3.5 Full-Time Swivel. A connection that allows one side of the connection to swivel or rotate in relation to the other side after the connection has been tightened together.

3.3.6* Handline Nozzle. A nozzle with a rated discharge of less than 350 gpm (1325 L/min).

N **3.3.7 Ladder Pipe.** A monitor that attaches to the rungs of a vehicle-mounted aerial ladder.

3.3.8* Master Stream Nozzle. A nozzle with a rated discharge of 350 gpm (1325 L/min) or greater.

N **3.3.9 Maximum Operating Pressure.** The maximum pressure at which the device is designed to be operated.

N **3.3.10 Monitor.** A device designed to hold and direct a nozzle while being fed by one or more hose lines or by rigid piping.

N **3.3.10.1** ***Break-Apart Monitor.*** A monitor that can be converted for use either in stationary mode on a fire apparatus or in portable mode on a separate ground base.

N **3.3.10.2** ***Portable Monitor.*** A monitor that can be lifted from a vehicle-mounted bracket and moved to an operating position on the ground by not more than two people.

N **3.3.11* Nozzle.** A constricting appliance attached to the end of a fire hose or monitor to increase the water velocity and form a stream.

N **3.3.12 Portable Monitor.** See 3.3.10.2.

N **3.3.13 Portable Valve.** See 3.3.20.1.

3.3.14 Pressure.

N **3.3.14.1** ***High Pressure.*** Pump discharge pressure from 500 psi (3500 kPa) to less than 1100 psi (7600 kPa). [**1901,** 2016]

3.3.14.2* ***Normal Pressure.*** Pressure created by forces acting perpendicular to the pipe wall at the point where a pressure tap is made.

3.3.14.3* ***Nozzle Pressure.*** The normal pressure measured at the inlet of the nozzle.

3.3.14.4 ***Rated Pressure.*** The pressure at which a nozzle is designed to operate to produce a specified flow rate.

3.3.14.4.1 ***Maximum Rated Pressure.*** The maximum pressure at which the manufacturer determines it is safe to operate the nozzle.

N **3.3.14.5** ***Ultra-High Pressure.*** Pressure created by forces acting perpendicular to the pipe wall at the point where a pressure tap is made and which is greater than 1100 psi (7600 kPa).

3.3.15 Rated Discharge. The rate(s) at which a nozzle is designed to flow water when operated at its rated pressure.

N **3.3.16 Shutoff Valve.** See 3.3.20.2.

N **3.3.17 Slow-Operating Valve.** See 3.3.20.3.

3.3.18 Spray Nozzle. A nozzle intended for connection to a hose line or monitor to discharge water in either a spray pattern or a straight stream pattern as selected by the operator.

3.3.18.1* ***Basic Spray Nozzle.*** An adjustable-pattern spray nozzle in which the rated discharge is delivered at a designated nozzle pressure and nozzle setting.

3.3.18.2* ***Constant Gallonage Spray Nozzle.*** An adjustable-pattern spray nozzle that discharges a constant discharge rate throughout the range of patterns from a straight stream to a wide spray at a designed nozzle pressure.

3.3.18.3* ***Constant Pressure (Automatic) Spray Nozzle.*** An adjustable-pattern spray nozzle in which the pressure remains relatively constant through a range of discharge rates.

3.3.18.4* ***Constant/Select Gallonage Spray Nozzle.*** A constant discharge rate spray nozzle with a feature that allows manual adjustment of the orifice to effect a predetermined discharge rate while the nozzle is flowing.

3.3.19 Standpipe System. An arrangement of piping, valves, hose connections, and allied equipment installed in a building or structure such that, when supplied with adequate water, allows attached hose lines to be used to extinguish a fire.

N **3.3.20 Valve.**

N **3.3.20.1** ***Portable Valve.*** A fire hose appliance that includes at least one valve and has fire hose connections on both inlet(s) and outlet(s).

N **3.3.20.2*** ***Shutoff Valve.*** A valve whose primary function is to operate in either a fully shutoff or a fully open condition.

N **3.3.20.3** ***Slow-Operating Valve.*** A valve that has a mechanism to prevent movement of the flow-regulating element from the fully closed position to the fully opened position or vice versa in less than 3 seconds. [**1901,** 2016]

Chapter 4 Operational Design Requirements

4.1 Flow Rate Performance.

4.1.1* The nozzle rating shall be expressed as a rated discharge at a rated pressure [e.g., 60 gpm at 100 psi (225 L/min at 6.9 bar)].

4.1.2 Basic spray nozzles shall flow no less than the rated discharge and no more than 10 percent over the rated discharge at the rated pressure when tested in accordance with Section 6.1.

4.1.3 Constant gallonage spray nozzles shall flow no less than the rated discharge at the rated pressure and no more than 10 percent over the rated discharge at the rated pressure when tested in accordance with Section 6.1.

4.1.4 Constant/select gallonage spray nozzles shall meet the requirements of 4.1.3 at each predetermined discharge rate.

4.1.5 Constant pressure (automatic) spray nozzles shall maintain their rated pressure ±15 psi (±1 bar) throughout the rated discharge range when tested in accordance with Section 6.1.

4.2 Discharge Pattern.

4.2.1 Spray nozzles shall be capable of developing discharge patterns varying from straight stream to at least 100 degrees spray angle.

4.2.2 The straight stream pattern setting shall provide a cohesive jet capable of delivering 90 percent of the rated discharge within a circle 12 in. (305 mm) in diameter at a distance of 10 ft (3 m) from the nozzle if the nozzle's rated discharge is less than 350 gpm (1325 L/min), and within a circle 15 in. (381 mm) in diameter at a distance of 10 ft (3 m) from the nozzle if the nozzle's rated discharge is 350 gpm (1325 L/min) or greater.

4.2.3* Spray pattern settings shall provide a full and uniform spray pattern.

4.3* Spray Nozzle Controls.

4.3.1 If the spray nozzle is designed to be used on a handline, the nozzle shall have a water discharge control capable of functions ranging from full discharge to complete shutoff of the nozzle discharge. This control device shall be permitted to be a permanently mounted valve or a break-apart shutoff butt assembly.

4.3.2 Nozzles equipped with a lever-operated shutoff handle shall be in the closed position when the handle is closest to the discharge end of the nozzle.

4.3.3 Nozzles equipped with a linear-acting pattern control lever or handle shall be in the straight stream position when the handle is closest to the discharge end of the nozzle.

4.3.4 Rotational controls shall traverse from a wide angle spray pattern to narrow spray, to straight stream, and to shutoff position on nozzles so equipped, in a clockwise manner, when viewed from the rear of the nozzle.

4.3.5 Trigger-type lever controls shall be in the open position when squeezed and the closed position when released.

4.3.6 Lever-type controls shall require a force of no more than 16 lbf (71.2 N) and no less than 3 lbf (13.4 N) to open or close the shutoff or to adjust the stream pattern when tested in accordance with 6.3.1.

4.3.7 For rotational-type controls, the operational force required to change the pattern setting and change the flow rate, as well as to just close (without discharge), to fully close, to just open (leak), and to fully open the valve, shall not exceed 40 lbf (178 N) and shall not be less than 3 lbf (13.4 N) when tested in accordance with 6.3.2 and 6.3.4.

4.3.8* All controls for nozzle functions such as pattern selection, flush, flow rate adjustments, and shutoff shall operate with a force not greater than 25 percent over the maximum allowed at 100 psi (6.9 bar) after the entire nozzle has been subjected to a pressure of the higher of either 300 psi (20.7 bar) or one and one-half times the maximum rated pressure for 3 minutes.

4.3.9 Full-Time Swivel.

4.3.9.1 Nozzles equipped with a full-time swivel shall require a minimum force of 10 lbf (44.5 N) to rotate the nozzle when tested in accordance with 6.3.3.

4.3.9.2 Nozzles equipped with both rotational pattern controls and a full-time swivel shall have the force required to rotate the full-time swivel at least 1 lbf (4.5 N) greater than the force required to rotate the pattern control, as defined in 4.3.7.

4.4 Threads. All spray nozzles, shutoffs, and tips shall be manufactured with National Hose (NH) thread conforming to NFPA 1963, unless otherwise designated by the AHJ.

4.5 Flushing. All spray nozzles shall be designed to clear or flush the size of debris specified in Table 4.5 from the nozzle without shutting off the water to the hose. This flushing shall be permitted to be accomplished either through the full open nozzle position or through a flush feature of the nozzle.

4.5.1 Nozzles shall be tested in accordance with Section 6.2 to verify compliance with Section 4.5.

4.5.2 Nozzles equipped with a flush feature shall have a separate control or detent, or require increased force to indicate to the fire fighter when the flush feature is being engaged.

***N* 4.6 Fire Hose Appliance Characteristics.**

***N* 4.6.1* Maximum Operating Pressure.** The maximum operating pressure shall be a minimum of 200 psi (13.8 bar).

***N* 4.6.2 Appliance Connectors.**

***N* 4.6.2.1** All fire hose couplings on the appliance shall meet the requirements of NFPA 1963.

N* 4.6.2.2 All fire hose connectors on an appliance shall conform to NFPA 1963. If the hose threads or connectors used by the fire department do not conform to NFPA 1963, the authority having jurisdiction shall be permitted to designate the hose threads or connectors that shall be used.

***N* 4.6.2.3** If the hose connector(s) on the appliance is equipped with a full-time swivel, the force required to rotate the swivel shall not exceed 30 lbf (133.4 N) when tested in accordance with Section 6.1.

***N* 4.6.3 Manually Operated Shutoff Valves.**

***N* 4.6.3.1** Shutoff valves or appliances equipped with a lever-operated handle shall indicate the closed position when the handle is perpendicular to the hose line it is controlling.

***N* 4.6.3.2** If an appliance has more than two valves with lever-operated handles, the two outside handles shall indicate their closed position as described in 4.6.3.1.

***N* 4.6.3.2.1** If the design of the appliance does not permit the intervening handle(s) to indicate the closed position perpendicular to the hose, it shall be permitted to indicate the closed position when the handle(s) is at the 2 o'clock position when viewed from the single hose connection side.

***N* 4.6.3.2.2** Any valve arranged as permitted in 4.6.3.2.1 shall be permanently marked to indicate the open and closed positions.

***N* 4.6.3.3** Shutoff valves equipped with a U-shaped handle shall indicate the closed position when the handle is closer to the discharge end of the valve.

Table 4.5 Size of Debris Nozzle Must Clear

Rated Discharge		Size of Steel Ball	
gpm	L/min	in.	mm
<60	<230	1/8	3.18
60–150	230–570	3/16	4.76
>150	>570	1/4	6.35

***N* 4.6.3.4** Operating a shutoff valve shall require a force of no more than 40 lbf (180 N) and no less than 3 lbf (13 N) to open or close the valve when tested in accordance with Section 6.2.

***N* 4.6.3.5** Any 3 in. (76 mm) or larger shutoff valve on an appliance shall be a slow-operating valve.

***N* 4.6.4* Relief Valves.** If the appliance has a relief valve, the relief valve shall meet the requirements of 4.6.4.1 through 4.6.4.4.

***N* 4.6.4.1** The relief valve shall be on the intake side of the shutoff valve.

***N* 4.6.4.2** The relief valve shall relieve to atmosphere.

***N* 4.6.4.3** The relief valve shall be field adjustable.

***N* 4.6.4.4** The manufacturer shall mark the range of pressure adjustment on the relief valve.

***N* 4.6.5 Portable Monitors.**

N* 4.6.5.1 A portable monitor, except a portable ladder pipe, shall have an attachment for at least one tiedown.

***N* 4.6.5.2** Portable ladder pipes shall have rung attachment mechanisms with multiple motion-locking devices.

***N* 4.6.5.3** The monitor shall be provided with stops to prevent it from being lowered to an angle of discharge or rotated to a point where the monitor becomes unstable.

***N* 4.6.5.4** A locking method shall be provided that will hold the elevation of the monitor in any position allowed by the manufacturer.

***N* 4.6.5.5** A locking method shall be provided that will hold the rotation of the monitor in any position allowed by the manufacturer.

***N* 4.6.5.6** Any shutoff valves incorporated in a monitor shall meet the requirements of 4.6.3.

***N* 4.6.5.7** All swivel hose connections 3½ in. (90 mm) or larger shall have a full-time swivel.

***N* 4.6.5.8 Force to Operate.**

***N* 4.6.5.8.1** The force to rotate a monitor shall be not less than 3 lbf (13 N) nor more than 40 lbf (180 N) when measured as defined in Section 6.7.

***N* 4.6.5.8.2** The force to elevate the stream of a monitor shall be not more than 40 lbf (180 N) when measured as defined in Section 6.8.

***N* 4.6.5.9** The monitor shall be capable of operation through all positions of elevation and rotation allowed by the manufacturer without any movement of the monitor's feet when tested in accordance with Section 6.9.

4.7 Leakage. Nozzles equipped with a shutoff shall be pressurized to 800 psi (55.2 bar) or one and one-half times the rated pressure, whichever is higher, after all air has been bled from the nozzle and the shutoff has been closed.

4.7.1 The pressure shall be held for 3 minutes and the leakage, if any, shall be measured.

4.7.2 The maximum leakage allowed through the discharge orifice shall be 12 drops per minute (½ ml/min).

4.7.3 Leakage through any part of the nozzle other than the discharge orifice shall not be permitted.

N 4.8 Leakage — Fire Hose Appliances.

N 4.8.1 If the appliance is equipped with a shutoff valve on the discharge side of the appliance, the appliance shall not develop in excess of 12 drops/min (½ mL/min) through the discharge orifice of the valve when tested in accordance with Section 6.3.

N 4.8.2 There shall be no leakage through any part of the appliance other than the discharge orifice of a shutoff valve on the discharge side of the appliance when tested in accordance with Section 6.3.

4.9 Rough-Handling Tests for Handline Nozzles.

4.9.1 Handline nozzles shall be capable of continued operation after being subjected to the rough-handling tests in Section 6.9.

4.9.2 The nozzle shall not deform or break beyond the point where it affects the operational use of the nozzle as defined in the requirements of this standard.

4.9.3 All nozzle functions such as pattern selection, flush, flow rate adjustment, and shutoff shall operate as described in Section 4.3. The operating force shall not increase more than 10 percent from that allowed before the test.

4.9.4 Following performance of the test in 4.9.3, samples shall again be subjected to the leakage test defined in Section 4.7. The leakage shall not increase by more than 10 percent from that allowed before the test.

4.10 Rough-Handling Tests for Master Stream Nozzles.

4.10.1 Master stream nozzles shall be capable of continued operation after being subjected to the rough-handling tests in Section 6.10. This requirement shall not apply to flange-mounted nozzles.

4.10.2 The nozzle shall not deform or break beyond the point where it affects the operational use of the nozzle as defined in the requirements of this standard.

4.10.3 All nozzle functions such as pattern selection, flush, flow rate adjustment, and shutoff shall operate as described in Section 4.3. The operating force shall not increase more than 10 percent from that allowed before the test.

N 4.11 Rough-Handling Tests for Fire Hose Appliances.

N 4.11.1 Section 4.6 shall not apply to portable monitors.

N 4.11.2 The appliance shall be capable of operation after being subjected to the rough usage tests in Section 6.6.

N 4.11.3 Any operating force shall not increase more than 10 percent from that allowed before the test.

N 4.11.4 Following performance of the test to confirm compliance with 4.11.3, the test sample shall again be subjected to the leakage test defined in Section 6.3.

N 4.11.5 The leakage shall not increase by more than 10 percent from that allowed before the test.

N 4.12 Rough-Handling Tests for Portable Monitors.

N 4.12.1 The monitor shall remain operational and not leak or come apart after being subjected to the rough usage test described in Section 6.10.

N 4.12.2 Any operating force shall not increase by more than 10 percent from that allowed before the test.

N 4.12.3 Following performance of the test to confirm compliance with 4.12.2, the test sample shall again be subjected to the leakage test described in Section 6.3.

N 4.12.4 The leakage shall not increase by more than 10 percent from that allowed before the test.

4.13 Handholds, Handgrips, and Ladder Hooks.

4.13.1 Dual handholds, single handgrips, or ladder hooks provided on handline nozzles shall support a 300 lbf (1335 N) nozzle reaction force when tested in accordance with Section 6.17.

4.13.2 If more than one feature is provided on the same nozzle, each feature shall be tested separately.

4.13.3 Test samples that distort or develop cracks or broken sections shall be considered as having failed to meet the test criteria.

N 4.14 Connections for Large-Stream Devices.

N 4.14.1* Primary Inlet. At least one inlet connection on each fire department large-stream device equipped with multiple primary inlets (other than devices piped permanently to a pump) shall be fitted with at least one female swivel connection, which shall have 2.5–7.5 NH standard thread as shown in Figure 4.14.1(a) and Figure 4.14.1(b). An adapter shall be permitted to be provided to meet this intent.

N 4.14.2* Subsequent Connections and Nozzles.

N 4.14.2.1 The discharge end of large-stream devices designed to flow from 400 gpm to 1250 gpm (1600 L/min to 5000 L/min) shall have the 2.5–7.5 NH thread for attaching straight-tip nozzle tips or spray nozzles.

N 4.14.2.1.1 If stacked straight-tip nozzles are used, one of the tips shall have the 1.5–9 NH thread as shown in Figure 4.14.1(a).

N 4.14.2.1.2 Straight-tip nozzles and spray nozzles designed to flow from 400 gpm to 1250 gpm (1600 L/min and 5000 L/min) shall have 2.5–7.5 NH thread on their inlet.

N 4.14.2.2 The discharge end of large-stream devices designed to flow more than 1250 gpm (5000 L/min) but less than 3000 gpm (12,000 L/min) shall have the 3.5–6 NH thread for attaching straight-tip nozzles or spray nozzles.

N 4.14.2.2.1 A 3.5–6 NH female × 2.5–7.5 NH male reducer fitting or a stacked tip having the male 2.5–7.5 NH thread as an integral component as shown in Figure 4.14.1(b) shall be provided.

N 4.14.2.2.2 Straight-tip nozzles and spray nozzles designed to flow more than 1250 gpm (5000 L/min) but less than 3000 gpm (12,000 L/min) shall have 3.5–6 NH thread on their inlet.

N 4.14.2.3 Subsequent connections, straight-tip nozzles, and spray nozzles on large-stream devices designed to flow 3000 gpm (12,000 L/min) or more shall have an NH standard thread consistent with the nominal inlet or outlet size.

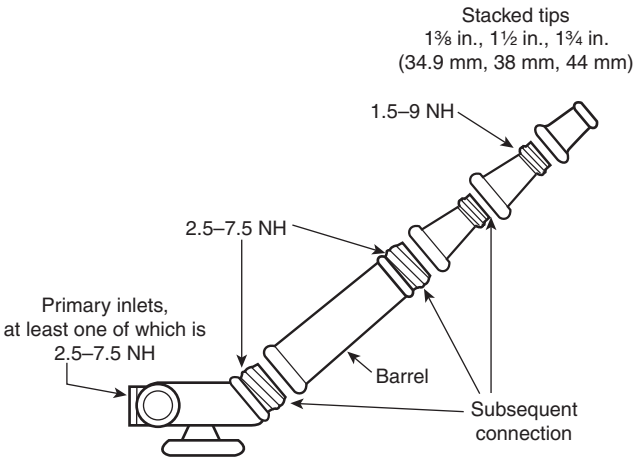

FIGURE 4.14.1(a) Large-Stream Device Rated from 400 gpm to 1250 gpm (1600 L/min to 5000 L/gpm).

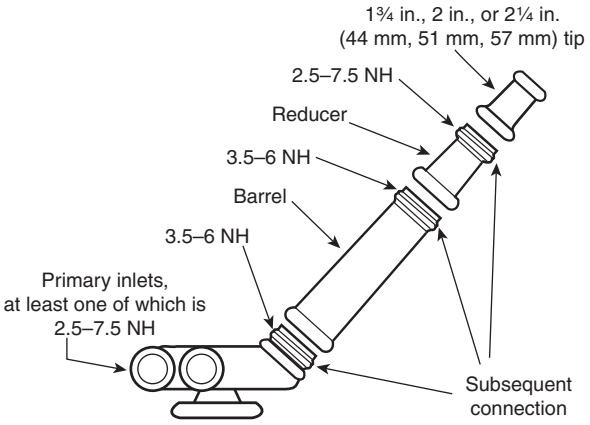

FIGURE 4.14.1(b) Large-Stream Device Rated More Than 1250 gpm (5000 L/min) but Less Than 3000 gpm (12,000 L/min).

4.15 Markings.

4.15.1 Each nozzle shall be permanently identified with the following information using figures and letters not less than $\frac{3}{16}$ in. (4.8 mm) in height:

(1) Name of manufacturer
(2) Unique product or model designation
(3) All other markings required by this standard

4.15.2 All markings of pressure or flow shall be permitted to be in either U.S. or SI units.

4.15.3 Each spray nozzle shall be marked with the rated pressure of the nozzle.

4.15.4 Each spray nozzle shall be marked with the flow rate at positions of straight stream and full spray.

4.15.4.1 Select gallonage nozzles shall be marked to indicate the flow rate at each setting.

4.15.4.2 Constant pressure (automatic) nozzles shall be marked with the minimum and maximum flow rate.

4.15.5 Nozzles equipped with a flush feature shall indicate the flush operating position with the word "FLUSH."

4.15.6 Adjustable-pattern nozzles shall be marked to indicate straight stream and spray pattern settings, or arrows shall indicate the direction of adjustments for straight stream or spray pattern.

N **4.16 Markings — Fire Hose Appliances.**

N **4.16.1** Each fire hose appliance shall be permanently identified with the following information using numerals and letters not less than $\frac{3}{16}$ in. (4.8 mm) in height:

(1) Name of manufacturer
(2) Unique product or model designation
(3) Maximum operating pressure
(4) For monitors, maximum rated flow

N **4.16.2** The information on the maximum operating pressure shall be visible to the operator when the appliance is in its normal operating position.

N **4.16.3** The rated flow of the portable monitor shall be near the marking of the maximum operating pressure.

4.17 Handline Nozzles for Use in Marine and Offshore Platform Applications. Handline spray nozzles intended for firefighting use by personnel aboard ships and offshore platforms, and for other marine applications, shall meet the requirements of this section.

4.17.1 The nozzle shall comply with all of the requirements of this standard.

4.17.2 The nozzle shall maintain constant gallonage during pattern change and use a lever-type shutoff.

4.17.3 The nozzle shall be constructed of materials having inherent resistance to corrosion, or of materials that are coated, finished, or otherwise protected such that the material withstands unprotected outdoor exposure including the following:

(1) Prolonged sunlight
(2) Continuous salt air
(3) Saltwater residue

4.17.4 Nozzles shall be marked "Flush With Fresh Water After Each Use."

4.17.5 Salt Spray Resistance.

4.17.5.1 Nozzles on Vessels on Saltwater Routes.

4.17.5.1.1 When nozzles are tested for corrosion resistance in accordance with Section 5.3 and Section 6.14, they shall be subject to 720 hours of exposure to the salt spray with the nozzle shutoff valve in the open position in order to allow salt spray infiltration.

4.17.5.1.2 Nozzles shall be permanently marked "Marine."

4.17.5.2 Nozzles on Vessels with Routes Limited to Lakes and Other Bodies of Fresh Water. Nozzles shall be permanently marked "Marine — Fresh Water Only."

4.17.6* Nozzle Rating.

4.17.6.1 Nozzle for 1½ in. or 1¾ in. (38 mm or 45 mm) Hose.

4.17.6.1.1 Each marine nozzle for use with 1½ in. or 1¾ in. (38 mm or 45 mm) hose shall be permanently marked with the rated pressure or pressure range.

4.17.6.1.2 The rated pressure shall be the minimum nozzle pressure necessary to separately accomplish all of the requirements of 4.17.6.1.2.1 through 4.17.6.1.2.3.

4.17.6.1.2.1 The spray pattern shall be adequately developed to meet the performance requirement of 4.2.3.

4.17.6.1.2.2 The straight stream shall have a minimum effective reach of 55 ft (17 m).

4.17.6.1.2.3 The nozzle shall be capable of flowing 90 gpm (340 L/min) at its rated pressure.

4.17.6.2 Nozzle for 2½ in. (65 mm) Hose.

4.17.6.2.1 Each marine nozzle for use with 2½ in. (65 mm) hose shall be permanently marked with the rated pressure or pressure range.

4.17.6.2.2 The rated pressure shall be the minimum nozzle pressure necessary to separately accomplish all of the requirements of 4.17.6.2.2.1 through 4.17.6.2.2.3.

4.17.6.2.2.1 The spray pattern shall be adequately developed to meet the performance requirement of 4.2.3.

4.17.6.2.2.2 The straight stream shall have a minimum effective reach of 65 ft (20 m).

4.17.6.2.2.3 The nozzle shall be capable of flowing 225 gpm (852 L/min) at its rated pressure.

4.17.7 Marine nozzles shall be listed and marked to identify the listing organization.

4.17.7.1 Nozzles manufactured to comply with this standard under a process certified to ISO 9001, *Quality management systems—Requirements,* by a marine classification society or other organization acceptable to the AHJ shall not be required to meet 4.17.7.

4.17.7.2* Nozzles manufactured under a quality control program approved by the AHJ shall not be required to meet 4.17.7.

4.17.8 Each nozzle shall be tested by the manufacturer for flow calibration, pattern, and leakage to ensure compliance with the manufacturer's specifications.

Chapter 5 Construction Materials

5.1 Hydrostatic Strength.

5.1.1 Nozzles shall be designed to withstand a hydrostatic pressure of 900 psi (62 bar) or three times the maximum rated pressure, whichever is higher.

5.1.2 The hydrostatic strength shall be confirmed by testing in accordance with Section 6.6.

5.2 High- and Low-Temperature Exposure. The dry nozzle and appliance shall be capable of operation and there shall be no cracks or broken sections after it has been tested to a high temperature of 135°F (57°C) and then to a low temperature of –25°F (–32°C) in accordance with Section 6.15.

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5.3* Corrosion Exposure.

N **5.3.1** After the corrosion exposure, the nozzle shall then be tested for any leakage in accordance with Section 4.7.

Δ **5.3.2** All nozzles and appliances shall be capable of operation after they have been subjected to a salt spray test in accordance with Section 6.16.

Δ **5.3.3** If the appliance has a valve(s), operating forces and leakage shall not increase by more than 10 percent from that allowed before the test.

5.4 Ultraviolet Light and Water Exposure of Nonmetallic Nozzle Components.

5.4.1 Exposed nonmetallic parts on a nozzle shall not crack or craze when subjected to ultraviolet light and water.

5.4.2 If the nozzle has exposed nonmetallic parts, it shall be tested as described in Section 6.15.

5.4.3 At the conclusion of the test, the nozzle shall be inspected for cracking or crazing, the presence of which indicates failure of the test.

5.4.4 All functions such as pattern selection, flush, flow rate adjustment, and shutoff shall continue to meet the requirements in Section 4.3.

5.5 Aging Exposure of Nonmetallic Nozzle Components.

5.5.1 A nozzle with nonmetallic components, other than rubber gaskets where a nozzle connects to a hose line, shall be subjected to the air-oven aging test as described in Section 6.16.

5.5.2 The nozzle shall then meet the rough usage requirements in Section 4.9 for handline nozzles or Section 4.10 for master stream nozzles.

5.5.3 The appliance shall then be subjected to a rough usage test in accordance with Section 6.6 if the appliance is not a portable monitor or in accordance with Section 6.10 if the appliance is a portable monitor.

5.6 Moist Ammonia–Air Stress Cracking. Nozzles or components made from copper alloys containing more than 15 percent zinc shall withstand exposure to a moist ammonia–air mixture without developing stress cracks when tested in accordance with Section 6.18.

5.7 Rubber Sealing Materials.

5.7.1 A rubber material or synthetic elastomer used to form a seal shall have the properties described in 5.7.1.1 through 5.7.1.4 in the as-received condition.

5.7.1.1* Silicone rubber shall have a tensile strength of not less than 500 psi (3.4 MPa) and at least 100 percent ultimate elongation, determined in accordance with Section 6.19.

5.7.1.2 Material other than silicone rubber shall have a tensile strength of not less than 1500 psi (10.3 MPa) and at least 200 percent ultimate elongation, determined in accordance with Section 6.19.

5.7.1.3 The rubber material or synthetic elastomer shall have a tensile set of not more than 19 percent, determined in accordance with 6.19.1.

5.7.1.4 Compression Sets.

N **5.7.1.4.1** For nozzles, the rubber material or synthetic elastomer shall have a compression set of not more than 15 percent, determined in accordance with Section 6.20.

N **5.7.1.4.2** For appliances, a compression set of the material shall not be more than 25 percent, determined in accordance with Section 6.20.

5.7.2 The rubber material or synthetic elastomer shall have not less than 80 percent of the as-received tensile strength and not less than 50 percent of the as-received ultimate elongation after it has been through the accelerated aging test in accordance with Section 6.21.

Chapter 6 Test Methods

6.1 Flow Rate Test.

6.1.1 Test Equipment — Nozzles.

6.1.1.1 Pressure gauges connected to a piezometer ring shall be used to measure the water pressure at the nozzle inlet.

6.1.1.2 When testing nozzles equipped with a 1½ in. (38 mm) connection at a discharge rate of 250 gpm (946 L/min) and higher, the pressure gauge shall be mounted on a 2½ in. (65 mm) waterway.

6.1.1.2.1 A tapered adaptor shall be used between the 2½ in. (65 mm) waterway and the 1½ in. (38 mm) inlet to the nozzle.

6.1.1.2.2 The maximum included angle of the adaptor shall be 30 degrees.

6.1.2 Test Procedure — Nozzles.

6.1.2.1 The nozzle shall be mounted such that the discharge rate through the nozzle and pressure at the inlet to the nozzle can be measured.

6.1.2.2 With the shutoff fully open, the inlet pressure shall be adjusted to the rated pressure, ±2 percent.

6.1.2.3 Basic spray nozzles shall be tested and flow rate measurement taken in both straight stream and wide angle spray pattern settings after the nozzle pressure has been adjusted as specified in 6.1.2.2 for each of the pattern settings.

6.1.2.4 Constant gallonage spray nozzles shall be tested and the flow rate shall be monitored through the full range of pattern selection.

6.1.2.5 Constant/select gallonage spray nozzles shall be tested at each discrete flow rate selection.

6.1.2.5.1 The nozzle pressure shall be adjusted as specified in 6.1.2.2 for each discrete flow rate selection.

6.1.2.5.2 The flow rate shall be monitored through the entire range of pattern selection.

6.1.2.6 Constant pressure (automatic) spray nozzles shall be tested on the same equipment specified in 6.1.1.

6.1.2.6.1 The flow rate shall be increased to the minimum rated discharge and the pressure at this flow rate shall be recorded.

6.1.2.6.2 The flow rate and nozzle pressure shall be monitored through the entire range of pattern selection from straight stream to wide angle spray, and any deviation greater than 2 percent in flow rate or pressure shall be recorded.

6.1.2.6.3 The discharge rate shall continue to be slowly increased to the maximum rated discharge and the minimum and maximum pressures throughout the discharge range shall be recorded.

6.1.2.6.4 At the maximum discharge rate, the flow rate and the pressure shall be monitored through the entire range of pattern selection from straight stream to wide angle spray and any deviation greater than 2 percent in flow rate or pressure shall be recorded.

6.2 Flush Test — Nozzles.

6.2.1 Nozzles shall be held in the vertical position, discharge end down, with the nozzle in either the fully open or flush position.

6.2.2 The appropriate size steel ball shall pass through the nozzle without changes in the control position.

6.2.2.1 For nozzles with discharge rates up to 60 gpm (230 L/min), a ⅛ in. (3.18 mm) steel ball shall be used.

6.2.2.2 For nozzles with discharge rates of 60 gpm to 150 gpm (230 L/min to 570 L/min), a $\frac{3}{16}$ in. (4.76 mm) steel ball shall be used.

6.2.2.3 For nozzles with discharge rates greater than 150 gpm (570 L/min), a ¼ in. (6.35 mm) steel ball shall be used.

6.3 Control Tests.

6.3.1 Lever-Type Controls — Nozzles.

6.3.1.1 The nozzle shall be mounted in the closed position with an inlet pressure of 100 psi (6.9 bar).

6.3.1.1.1 A dynamometer, which records the maximum force reading, shall be attached to the lever or handle where it is designed to be held during operation.

6.3.1.1.2 The shutoff or pattern selection lever or handle shall be moved from the fully closed to fully open position for the full range of pattern adjustment and the maximum force recorded.

6.3.1.1.3 The inlet pressure shall be adjusted to 100 psi (6.9 bar) while in the full discharge position.

6.3.1.1.4 The dynamometer shall be used to measure the maximum force to move the lever through the full range of positions.

6.3.1.1.5 The maximum force required in both directions shall be recorded.

6.3.1.2 The nozzle shall be mounted without any pressure applied to it and the controlling lever shall be placed in the closed or full forward position.

6.3.1.2.1 The dynamometer shall be used to measure the force required to move the lever from the full forward position.

6.3.1.2.2 The force required to move the lever shall be recorded.

6.3.2 Rotational Pattern Control — Nozzles.

6.3.2.1 Nozzles equipped with rotational pattern control shall be mounted on a rigid device, and the force required to rotate the pattern sleeve shall be measured while water is discharging at 100 psi (6.9 bar).

6.3.2.2 A length of twine or string, not to exceed $^{3}/_{32}$ in. (2.9 mm) in diameter, shall be wrapped around the nozzle at the point where the nozzle normally would be held while rotating the pattern sleeve.

6.3.2.2.1 The string shall be of sufficient length to wrap around the nozzle at least six times.

6.3.2.2.2 The first two turns shall overlap the starting end of the string, and the balance of the turns shall not overlap any other turn.

6.3.2.3 A force gauge, which records the maximum force reading, shall be attached to a loop in the free end of the string.

6.3.2.4 The pattern sleeve shall be rotated by pulling the force gauge perpendicular to the center axis of the nozzle such that, as the pattern sleeve rotates, the string will unwind so that the force always remains tangential to the pattern sleeve.

6.3.2.5 The pattern sleeve shall be rotated from the straight stream position to the wide spray position, and vice versa. If the nozzle is equipped with detents for the pattern settings, this test shall commence with the pattern sleeve in the straight stream and wide spray detent.

6.3.3 Full-Time Swivel — Nozzle.

6.3.3.1 Nozzles equipped with a full-time swivel shall be tested while water is discharging at the rated pressure of the nozzle.

6.3.3.2 A length of twine or string, not to exceed $^{3}/_{32}$ in. (2.9 mm) in diameter, shall be wrapped around the nozzle at the point where the nozzle normally would be held while rotating the pattern sleeve.

6.3.3.3 The pattern sleeve of the nozzle shall be rotated to the end of its travel in the wide spray direction.

6.3.3.4 The force shall be applied tangentially with a dynamometer to determine the force required to rotate the nozzle, and this force shall be recorded.

6.3.4 Twist Shutoff — Nozzles.

6.3.4.1 A nozzle with a twist shutoff shall be mounted on a device equipped with a relief valve, or other means, to maintain 100 psi (6.9 bar) in both the closed position and the fully open position while flowing the rated discharge.

6.3.4.2 The test shall start with the nozzle in the closed position.

6.3.4.3 The force gauge shall be used to twist the shutoff to the fully open position, following the method outlined in 6.3.2.2 through 6.3.2.4.

6.3.4.4 The windings on the pattern sleeve shall be reversed, and the force gauge used as described in 6.3.2.4 to rotate the shutoff from the fully open to the fully closed position.

6.3.4.5 In the fully closed position, any leakage shall be measured and shall not exceed that allowed by 4.7.2.

N **6.3.5 Test of Handles on Manually Operated Shutoff Valves/Appliances.**

N **6.3.5.1** The appliance or the valve used with the appliance shall be mounted in a device capable of holding the appliance or valve stationary.

N **6.3.5.2** A dynamometer, which records the maximum force reading, shall be attached to the outermost point of the handle.

N **6.3.5.3** With the valve in the closed position, an inlet gauge pressure of 100 psi (6.9 bar) shall be applied to the valve.

N **6.3.5.4** The dynamometer shall be used to measure the force to move the handle from the fully closed position to the fully open position, and the maximum force shall be recorded.

N **6.3.5.5** The inlet pressure shall be adjusted to a gauge pressure of 100 psi (6.9 bar) while the valve is in the fully open position.

N **6.3.5.5.1** If the outlet of the valve is 1 in. (25.4 mm) or less, the flow shall be whatever flow rate is achieved with the inlet pressure at 100 psi (6.9 bar).

N **6.3.5.5.2** If the outlet of the valve is greater than 1 in. (25.4 mm), the flow shall be at least 250 gpm (946 L/min) with the inlet pressure at 100 psi (6.9 bar). A nozzle or restricting orifice shall be permitted to be used downstream of the valve to regulate the flow.

N **6.3.5.6** The dynamometer shall be used to measure the force to move the handle from the fully open position to the fully closed position, then back to the fully open position.

N **6.3.5.7** The maximum force measured in both directions shall be recorded.

N **6.3.5.8** The valve shall be fully closed without any inlet pressure on the valve.

N **6.3.5.9** The dynamometer shall be used to measure the force to move the handle from the fully closed position to the fully open position.

N **6.3.5.10** The maximum force measured in both directions shall be recorded.

N **6.4 Leakage Test — Appliances.**

N **6.4.1** The appliance shall be connected to a source of water.

N **6.4.2** If the appliance is equipped with a shutoff valve on the discharge side of the appliance, the valve shall be closed and all the air bled out.

N **6.4.3** If the appliance is not equipped with a shutoff valve on the discharge side of the appliance, the discharge side of the appliance shall be capped and all the air bled out.

N **6.4.4** The appliance shall be pressurized to a gauge pressure of 800 psi (55.2 bar) or 1½ times the maximum operating pressure, whichever is higher, and held for a period of 1 minute.

N **6.4.5** The leakage, if any, shall be measured.

N **6.5 Full-Time Swivel — Appliances.**

N **6.5.1** An appliance equipped with a full-time swivel on the hose connection shall be tested while it is dry.

N **6.5.2** The appliance shall be mounted in a device capable of holding the appliance stationary.

N **6.5.3** The coupling shall have a hook or other device added in a manner that will allow an attached dynamometer to apply force tangentially.

N **6.5.4** The force required to rotate the coupling shall be applied tangentially with a dynamometer, which records the maximum force reading.

N **6.5.5** The force shall be recorded.

6.6 Hydrostatic Test.

6.6.1 Hydrostatic Pressure.

N **6.6.1.1** The nozzle or appliance shall be mounted in a closed position on a device capable of exerting a hydrostatic pressure of 900 psi (62 bar) or three times the maximum rated pressure, whichever is higher.

N **6.6.1.2** Test caps capable of withstanding the required hydrostatic pressure shall be attached to the appliance openings, and all valves shall be placed in the fully open position.

6.6.2 All air shall be bled out of the system.

6.6.3 The pressure gauge shall be increased by 50 psi (3.5 bar) increments and held for 30 seconds at each pressure up to the maximum pressure for which the nozzle is being tested.

Δ **6.6.4** This maximum pressure shall be held for 1 minute without rupture.

6.6.5 Leakage shall not be permitted through any part of the nozzle other than the discharge orifice.

6.6.6 Increase in leakage through the discharge orifice of nozzles shall be permitted beyond that allowed in Section 4.7.

N **6.6.7** Operating forces and leakage shall not increase by more than 10 percent from that allowed before the test.

6.7 High-Temperature Tests.

6.7.1 The nozzle or appliance shall be conditioned to 135°F (57°C) for 24 hours prior to the test.

Δ **6.7.2** Immediately after being removed from the heating chamber, the nozzle or appliance shall be tested for proper function of all adjustments and controls.

N **6.7.3** Binding of any function, such as pattern selection, flush, flow rate adjustment, or shutoff, shall not be permitted.

6.8 Low-Temperature Tests.

6.8.1 A dry nozzle or appliance shall be conditioned to –25°F (–32°C) for 24 hours prior to the test.

Δ **6.8.2** Immediately after being removed from the cooling chamber, the nozzle or appliance shall be tested for proper function of all adjustments and controls.

N **6.8.3** Binding of any function, such as pattern selection, flush, flow rate adjustment, or shutoff, shall not be permitted.

6.8.4 Within 3 minutes after being removed from the cooling chamber, the nozzle or appliance other than portable monitors, shall be subjected to the rough-handling tests identified in Section 6.9 for handline nozzles or Section 6.10 for master stream nozzles.

N **6.8.5** Portable monitors shall be tested in accordance with Section 6.9.

6.9 Rough-Handling Tests — Handline Nozzles. Each nozzle shall be subject to the three tests in 6.9.1 through 6.9.3.

6.9.1 Test One.

6.9.1.1 The nozzle shall be attached to a length of hose at least 10 ft (3 m) long.

6.9.1.2 With the hose uncharged, the nozzle shall be dropped from a height of 6 ft (2 m) onto a concrete surface so that it impacts directly or squarely on the discharge end.

6.9.2 Test Two.

6.9.2.1 The nozzle shall be attached to a length of hose at least 10 ft (3 m) long.

6.9.2.2 With the hose uncharged, the nozzle shall be dropped twice from a height of 6 ft (2 m) onto a concrete surface so that the points of impact are on two different sides of the nozzle.

6.9.2.2.1 For nozzles equipped with a shutoff handle or lever, one of the points of impact shall be directly on that handle or lever while in the closed position.

6.9.2.2.2 For nozzles equipped with a handhold, handgrip, or ladder hook, one of the points of impact shall be on the handhold, handgrip, or ladder hook.

6.9.3 Test Three.

6.9.3.1 The nozzle shall be attached to a length of hose at least 10 ft (3 m) long.

6.9.3.2 With the nozzle shut off and the hose line charged with water to a pressure of 100 psi (6.9 bar), the nozzle shall be dropped twice from a height of 6 ft (2 m) onto a concrete surface so that the points of impact are on two different sides of the nozzle.

6.9.3.2.1 For nozzles equipped with a shutoff handle or lever, one of the points of impact shall be directly on that handle or lever while in the closed position.

6.9.3.2.2 For nozzles equipped with a handhold, handgrip, or ladder hook, one of the points of impact shall be on the handhold, handgrip, or ladder hook.

6.10 Rough-Handling Test — Master Stream Nozzles.

6.10.1 A plug shall be attached to the nozzle's threaded connection to protect the threads.

6.10.2 If the nozzle weighs less than 10 lb (4.54 kg), it shall be dropped four times from a height of 6 ft (2 m) onto a concrete surface so that it impacts directly or squarely once on its discharge end, at least once on each of two sides, and once on the plugged end.

6.10.3 If the nozzle weighs 10 lb (4.54 kg) or more, it shall be dropped four times from a height of 3 ft (1 m) onto a concrete surface so that it impacts directly or squarely once on its discharge end, at least once on each of two sides, and once on the plugged end.

N **6.10.4 Rough-Handling Test — Appliances.**

N **6.10.4.1** A cap shall be attached to each male threaded connection on the appliance to protect the exposed threads.

N **6.10.4.2** If the appliance weighs less than 10 lb (4.54 kg), the appliance shall be dropped from a height of 6 ft (2 m) onto a concrete surface so that it impacts directly or squarely on each side and on the top and the bottom (a minimum of six drops).

N **6.10.4.3** If the appliance weighs 10 lb (4.54 kg) or more, the appliance shall be dropped from a height of 3 ft (1 m) onto a concrete surface so that it impacts directly or squarely on each side and on the top and the bottom (a minimum of six drops).

N **6.10.5 Rough Usage Test for Portable Monitors.**

N **6.10.5.1** The assembled monitor shall have caps and plugs installed to protect any threaded connection.

N **6.10.5.2** The legs shall be extended and the monitor shall be dropped from a height of 3 ft (1 m) onto a concrete surface so that it impacts directly on a support leg.

N **6.10.5.3** The monitor shall continue to be dropped from a height of 3 ft (1 m) onto a concrete surface until it has been dropped on each supporting leg.

N **6.10.5.4** The monitor shall then be dropped from the same height onto the discharge end and the intake end of the appliance.

N **6.10.5.5** If the monitor is of a break-apart design, it shall be disassembled and each piece dropped on the break-apart point.

N **6.10.5.6** Following these drops, the monitor shall be inspected to be sure that it will still rotate and elevate and that all components are still attached and operational as designed by the manufacturer.

N **6.10.5.7** The monitor shall be flow tested and shall remain operational and not leak or come apart.

N **6.11 Force-to-Rotate Test — Monitors.**

N **6.11.1** The monitor shall be mounted in a device capable of holding its base stationary. A dynamometer, which records the maximum force reading, shall be attached to the monitor where a person would normally grab the monitor to rotate it.

N **6.11.2** The monitor shall be flowing water at its maximum rate of flow at a nozzle discharge pressure of 100 psi (6.9 bar) through a smooth bore tip.

N **6.11.3** The dynamometer shall be used to measure the force when the monitor is rotated first in one direction and then in the other direction. The maximum force in both directions shall be recorded.

N **6.12 Force-to-Elevate Test — Monitors.**

N **6.12.1** The monitor shall be mounted in a device capable of holding its base stationary. A dynamometer shall be attached to the monitor where a person would normally grab the monitor to elevate it.

N **6.12.2** The monitor shall be flowing water at its maximum flow rate at a nozzle discharge pressure of 100 psi (690 kPa) through a smooth bore tip.

N **6.12.3** The dynamometer shall be used to measure the force when the monitor is elevated from its lowest position to its maximum elevation. The maximum force shall be recorded.

N **6.13 Stability Test for Portable Monitors.**

N **6.13.1 Test Setup.**

N **6.13.1.1** The monitor shall be set up in accordance with the manufacturer's instructions on a concrete surface with a broom finish.

N **6.13.1.2** The position of the feet shall be marked on the surface so that any movement can be detected.

N **6.13.1.3** The monitor shall be attached to a secure tiedown point with an attachment that has approximately 6 in. (150 mm) of slack.

N **6.13.1.4** The attachment shall have a rated strength of at least twice the maximum test reaction force.

N **6.13.1.5** The hose supplying the monitor shall be charged and any slack removed from the hose.

N **6.13.1.6** The monitor shall be equipped with a smooth bore nozzle that is capable of flowing the rated flow of the monitor at 100 psi (6.9 bar) discharge pressure.

N **6.13.1.7** The monitor shall be positioned to discharge the stream at the maximum elevation position.

N **6.13.2 Test Procedure.**

N **6.13.2.1** A water flow shall be established at a nozzle discharge pressure of 150 psi (10.4 bar).

N **6.13.2.2** The monitor shall then be operated through all positions of elevation and rotation allowed by the manufacturer.

N **6.13.2.3** The monitor shall be operated for a minimum of 3 minutes.

N **6.13.2.4*** Any movement of the monitor feet relative to the concrete surface of more than 1½ in. (38 mm) shall constitute failure of this test, and the water supply shall be immediately shut down and the test discontinued.

6.14 Salt Spray Test. Test samples shall be supported vertically and exposed to salt spray (fog) for 120 hours, following the procedures specified by ASTM B117, *Standard Practice for Operating Salt Spray (Fog) Apparatus*.

6.15 Ultraviolet Light and Water Test.

6.15.1 Sample nozzles and appliances shall be exposed to ultraviolet light and water for 720 hours.

6.15.1.1 They shall be inspected for cracking and crazing after 360 hours.

6.15.1.2 If no cracking or crazing is apparent, the exposure shall continue for the full 720 hours.

N **6.15.2 Carbon-Arc Lamp Source.**

6.15.2.1 Ultraviolet light shall be obtained from two stationary enclosed carbon-arc lamps.

6.15.2.2 The arc of each lamp shall be formed between two vertical carbon electrodes, ½ in. (12.7 mm) in diameter, located at the center of a revolving vertical metal cylinder 31 in. (787 mm) in diameter and 17¾ in. (451 mm) in height.

6.15.2.3 Each arc shall be enclosed with a number 9200 PX clear Pyrex™ glass globe.

6.15.2.4 The test components shall be mounted vertically on the inside of the metal cylinder and revolved continuously around the stationary arcing lamps at 1 rpm.

6.15.2.5 A system of nozzles shall be provided so that during each operating cycle, the samples shall be exposed to the light and to water spray for 3 minutes and to only the light for 17 minutes (total 20 minutes).

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6.15.2.6 The air temperature within the revolving cylinder of the apparatus during the test shall be 145°F ± 9°F (63°C ± 5°C).

N **6.15.3 Xenon-Arc Lamp Source.**

N **6.15.3.1** The ultraviolet light exposure shall be obtained in accordance with ASTM D2565, *Standard Practice for Xenon Arc Exposure of Plastics Intended for Outdoor Applications*.

N **6.15.3.2** The source of radiation shall be a 6500 W, water-cooled xenon-arc lamp with borosilicate inner and outer optical filters.

N **6.15.3.3** The wattage to the lamp shall be controlled automatically to provide spectral irradiance of 0.0325 W/ft^2 (0.35 W/m^2) at 0.000014 in. (340 nm).

N **6.15.3.4** The samples shall be mounted vertically on the inside of a 38 in. (97 cm) diameter cylinder, facing the arc, and the cylinder shall be rotated about the arc at 1 rpm.

N **6.15.3.5** During each operating cycle of 120 minutes, each sample shall be exposed to light for 102 minutes and to light and water spray for 18 minutes.

N **6.15.3.6** The black-panel temperature during the dry portion of the light-on cycle shall be regulated to 145°F ± 9°F (63°C ± 5°C).

N **6.15.3.7** At the conclusion of the test, the components shall be inspected for cracking or crazing.

6.16 Air-Oven Aging Tests.

N **6.16.1** Samples of the nozzles shall be subjected to air-oven aging for 180 days at 158°F (70°C) and then allowed to cool at least 24 hours in air at 74°F (23°C) at 50 percent relative humidity.

N **6.16.2** A sample appliance(s) shall be subjected to air-oven aging for 180 days at 212°F (100°C) and then allowed to cool at least 24 hours in air at 74°F (23°C) at 50 percent relative humidity.

6.17 Handholds, Handgrips, and Ladder Hooks — Nozzles. The sample nozzle shall be mounted in a fixture to simulate intended use and a force of 300 lbf (1335 N) shall be applied to the nozzle for 5 minutes to simulate the nozzle reaction force.

6.18 Moist Ammonia–Air Stress Cracking Test.

6.18.1 Each test sample shall be subjected to the physical stresses normally imposed on or within the sample as the result of assembly with other components or a coupling.

6.18.1.1 Such stresses shall be applied to the sample prior to the test and maintained during the test.

6.18.1.2 Each sample shall be connected to an appropriate male coupling, or mating coupling for appliances, and tightened to the minimum torque necessary to produce a leaktight assembly.

6.18.2 The sample shall be degreased and supported by an inert tray in a glass chamber with a glass cover 1.5 in. (38.1 mm) above an aqueous ammonia solution.

6.18.2.1 An aqueous ammonia solution having a specific gravity of 0.94 shall be maintained in the glass chamber at a volume of approximately 0.16 gal/ft^3 (21.2 L/m^3) of chamber capacity.

6.18.2.2 The moist ammonia–air mixture in the chamber shall be maintained at atmospheric pressure and at a temperature of 93°F (34°C).

6.18.2.3 The sample shall be left in its set position and continuously exposed to the moist ammonia–air mixture for 10 days.

6.18.3 At the conclusion of the exposure, the sample shall show no evidence of cracking when examined using 25× magnification.

6.19 Tensile Strength, Ultimate Elongation, and Tensile Set Tests.

Δ 6.19.1 Tensile strength, ultimate elongation, and tensile set shall be determined in accordance with Method A in ASTM D412, *Standard Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers—Tension*, except that, for tensile set determinations, the elongation shall be maintained for only 3 minutes, and the tensile set shall be measured 3 minutes after release of the specimen.

6.19.2 The elongation of a specimen for a tensile set determination shall be such that the 1 in. (25 mm) spacing of the benchmarks increases to 3 in. (76 mm).

6.19.3 If a specimen breaks outside the benchmarks, or if either the measured tensile strength or ultimate elongation of the specimen is less than the required value, an additional specimen shall be tested, and those results shall be considered final.

6.19.4 Results of tests for specimens that break in the curved portion just outside the benchmarks shall be permitted to be accepted if the measured strength and elongation values are within the minimum requirements.

6.20 Compression Set Test.

Δ 6.20.1 Type I specimens of the material shall be prepared and the test conducted in accordance with Method B in ASTM D395, *Standard Test Methods for Rubber Property—Compression Set*.

6.20.2 The specimens shall be exposed for 22 hours at 70°F ± 2°F (21°C ± 1°C).

6.21 Accelerated Aging Test.

6.21.1 Specimens shall be prepared in the same manner as for tensile strength and ultimate elongation tests, except that benchmarks spaced 1 in. (25 mm) apart shall be stamped on the specimens after the test exposure.

6.21.2 Specimens shall be tested at 212°F (100°C) for 70 hours in accordance with ASTM D573, *Standard Test Method for Rubber—Deterioration in an Air Oven*.

Chapter 7 Compliance Testing

7.1* Certification. Performance of the nozzle and appliance to the requirements of this standard shall be certified by a testing laboratory or by the manufacturer.

7.2 Sample Selection.

7.2.1 A minimum of one nozzle or one completely assembled appliance shall pass each required test.

7.2.2* Multiple nozzles or appliances shall be permitted to be used during the testing process.

7.2.2.1 The same nozzle or appliance equipped with a shutoff valve(s) that is initially used to evaluate the requirements of Section 4.3 shall be used for the rough-handling evaluation *(see Section 4.9 and Section 4.10)*.

Δ **7.2.2.2** The same nozzle or appliance that is used to test the high-temperature exposure shall be used to test the low-temperature exposure *(see Section 5.2)* with the high-temperature exposure evaluation done first.

7.2.3 Any nozzle or nozzle components and appliance or appliance components that have been subjected to the destructive tests to prove compliance with the requirements of this standard shall be considered unsuitable for in-service use.

7.3 Test Results.

7.3.1 The test results shall be kept on file by the manufacturer.

7.3.2 Copies shall be provided when requested by the purchaser.

7.4 Design Changes. Any changes to the design of the nozzle or appliance or in the materials of construction shall be cause for retesting.

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

Δ **A.1.1** While nozzles meeting the requirements of this standard are designed to be used in fire suppression, including hose lines on standpipe systems, the nozzles cannot be expected to provide satisfactory performance if adequate water pressure and volume are not available. Pressures available in standpipe systems are often controlled by pressure-reducing devices. Fire departments planning to use spray nozzles with standpipe systems should ensure the standpipe system can supply the necessary pressure and volume.

The inspection and care of in-service nozzles is covered by NFPA 1962.

The purchasers should specify any desired conformance testing or required certification to this standard at the time they order the nozzle or appliance.

N **A.1.3** Adapters, reducers, caps, and plugs are covered by NFPA 1963. Spray nozzles with built-in shutoff valves, spray nozzle tips, and spray nozzles with break-apart shutoff valves are covered by NFPA 1964. Foam-making equipment, such as eductors, nozzles, and foam aspiration equipment, is covered by UL 162, *Standard for Foam Equipment and Liquid Concentrates*.

Δ **A.1.5** Metric units of measurement in this standard are in accordance with the modernized metric system known as the International System of Units (SI). The liter unit is outside of, but recognized by, SI and commonly is used in international fire protection. Table A.1.5(a) provides the conversion factors that can be used where more precision is desired. Table A.1.5(b) provides a list of abbreviations for units of measure.

Δ **A.3.2.1 Approved.** The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

Δ **A.3.2.2 Authority Having Jurisdiction (AHJ).** The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building

Δ **Table A.1.5(a) Conversion Factors**

U.S. to SI	SI to U.S.
1 psi = 6.895 kPa	1 kPa = 0.145 psi
1 psi = 0.0690 bar	1 bar = 14.492 psi
1 lb = 0.454 kg	1 kg = 2.205 lb
1 in. = 25.40 mm	1 mm = 0.039 in.
1 ft = 0.305 m	1 m = 3.281 ft
1 gal = 3.785 L	1 L = 0.2642 gal
1 lbf = 4.45 N	1 N = 0.2248 lbf
1 psi = 0.006 MPa	1 MPa = 145 psi

Δ **Table A.1.5(b) Abbreviations for Units of Measure**

Abbreviation	Unit
ft	foot/feet
ft^2	square foot/feet
ft^3	cubic foot/feet
in.	inch(es)
kg	kilogram(s)
kPa	kilopascal(s)
lb	pound(s)
MPa	megapascal(s)
m	meter(s)
mm	millimeter(s)
m^2	square meter(s)
m^3	cubic meter(s)
psi	pound(s) per square inch

official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

Δ **A.3.3.4 Flush.** When the flush feature is engaged, the nozzle pressure will drop and pattern will deteriorate. In fire fighting, caution should be exercised when the flush feature is engaged.

Δ **A.3.3.6 Handline Nozzle.** Handline nozzles are normally used on hose lines that can be advanced and maneuvered by fire-fighting personnel while the nozzles are flowing.

Δ **A.3.3.8 Master Stream Nozzle.** Master stream nozzles are normally used with monitors that can be supplied by either hose lines or fixed piping.

N **A.3.3.11 Nozzle.** A nozzle can be equipped with a shutoff and can be designed to produce a straight stream, a spray pattern, or both.

Δ **A.3.3.14.2 Normal Pressure.** Normal pressure is measured with a ring gauge or piezometer ring attached to the base of a nozzle.

Δ **A.3.3.14.3 Nozzle Pressure.** Pressure without discharge is known as static pressure. Pressure is measured in pounds per square inch (psi) or bars.

Δ **A.3.3.18.1 Basic Spray Nozzle.** Due to its basic design, as the pattern changes from straight stream to wide spray, the discharge rate will vary. The nozzle pressure will also be affected. These variations are caused by changes in the orifice size to affect pattern adjustment.

Δ **A.3.3.18.2 Constant Gallonage Spray Nozzle.** Constant gallonage is accomplished by maintaining a constant orifice size during discharge pattern adjustment.

Δ **A.3.3.18.3 Constant Pressure (Automatic) Spray Nozzle.** The constant pressure provides the velocity for an effective stream reach at various discharge rates. This constant pressure is accomplished by means of a pressure-activated self-adjusting orifice baffle.

Δ **A.3.3.18.4 Constant/Select Gallonage Spray Nozzle.** Because these are constant gallonage nozzles, the discharge rate remains constant throughout the range of pattern selection from straight stream to wide spray.

N **A.3.3.20.2 Shutoff Valve.** Some shutoff valves have a secondary capability to operate and hold their position between the fully open and fully closed positions. The purchaser should specify that the valve be designed with that capability if it is required for operations.

Δ **A.4.1.1** Spray nozzles have traditionally been rated at 100 psi (6.9 bar). Lower rating pressures affect the stream's reach and the characteristics of spray patterns. The purchaser should ensure that the performance of a nozzle meets his or her needs and expectations.

Δ **A.4.2.3** Nozzles should be tested and visually inspected for full and uniform wide spray patterns as follows.

With the nozzle discharging horizontally 3 ft (1 m) above grade level, it should be set to discharge at its rated pressure and adjusted to the setting where it creates the largest-diameter pattern. The spray issuing from the nozzle should be conically or parabolically enlarging (referred to as the cone), and the center should be permitted to be either hollow or filled with spray.

The circumference of the spray should appear full and uniform. The entire circumference should be visually inspected for persistently weak or hollow areas. The spray sheet at the surface of the cone should not have hollow or weak areas larger than 1 in. (25 mm) wide as measured at a location 2 ft (0.61 m) from the center of the nozzle along the spray sheet (measured along the spray angle from the axis of the nozzle).

The thickness of the sheet of spray at the surface of the cone should be inspected by hand around its entire circumference. The sheet thickness should be at least 2 in. (51 mm) at a distance of 2 ft (0.61 m) from the center of the nozzle along the spray sheet (measured along the spray angle from the axis of the nozzle).

The cone should be visually inspected for flat spots, lobes, or spray ejected outside the general shape of the cone. Discontinuities of the cone shape should not exceed 2 in. (51 mm) when measured at a location 2 ft (0.61 m) from the center of the nozzle along the spray sheet (measured along the spray angle from the axis of the nozzle).

Δ **A.4.3** In order for a fire fighter to be effective in combating a fire, the fire fighter should be able to open and shut off the nozzle and make adjustments to the flow rate and pattern without excessive exertion. Conversely, the controls should not be so loose as to be accidentally altered in normal handling.

This section is not intended to limit intentional self-operated or limiting control features, such as discharge-limiting "dead man" controls designed to reduce or shut off the water discharge when force is released from the control, or to limit pattern overtravel or limiting twist controls incorporated by design for special purposes.

Δ **A.4.3.8** If a master stream nozzle is equipped with a shutoff, it should be of a slow-operating type (i.e., it has a mechanism to prevent movement of the flow-regulating element from the fully closed position to the fully opened position or vice versa in less than 3 seconds).

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N **A.4.6.1** The appliance and the hose with which it is used should be carefully matched. All components of the system need to be rated at or above the maximum operating pressure. The use of appliances rated for use with a lower service test pressure hose could result in catastrophic failure. The friction loss through the appliance can vary, depending on the design of the appliance and the amount of water flowing through the appliance. It is suggested that the manufacturer or the authority having jurisdiction conduct tests to determine what the friction loss is through the appliance at various flows so the pump operator can account for that loss when determining the pump pressure required.

N **A.4.6.2.2** The committee recognizes that different types of hose connections and hose threads might be used in different countries. It is extremely important for fireground operations involving multiple jurisdictions to use a common type of thread or hose connection. Each country should make an effort to standardize thread types. Since 1905, there has been an effort

in the United States to standardize hose threads. NFPA 1963 provides criteria for the American National Fire Connection Screw Thread. The goal of NFPA 1963 is to develop uniformity of fire hose coupling threads and to achieve interconnectability of fire hose.

N **A.4.6.4** Users of hose-connected appliances should always be careful to avoid situations that create water hammer. Training should stress the need to open and close valves slowly. Relief valves will not operate in time to avoid damage to an appliance from a water hammer.

N **A.4.6.5.1** It is important that portable monitors be tied down during use. The nozzle reaction on a portable monitor is directly opposite the direction of the stream. The nozzle reaction from a 2 in. (51 mm) smooth bore tip at a nozzle pressure of 100 psi (6.9 bar) is 600 lbf (2670 N).

N **A.4.14.1** Fire department large-stream devices with a single large-diameter input are designed to rely on the positioning of the hose for part of the device's stability. The manufacturer's instructions for use should be carefully followed for all large-stream devices. A device designed with a single hose-line inlet system is different from a device designed with a multiline inlet system, and trying to supply one device with adapters and fittings from different size hose can create a dangerous situation.

N **A.4.14.2** A flow of 400 gpm (1600 L/min) is the maximum normally obtained with a handline nozzle using a standard 1¼ in. (32 mm) straight-tip nozzle. A flow of 1250 gpm (5000 L/min) is the maximum normally obtained with a portable turret nozzle using a 2 in. (51 mm) straight-tip nozzle.

Δ **A.4.17.6** This standard does not dictate the operating pressure of the nozzle. Marine fire main systems have traditionally been designed to provide a minimum 50 psi (3.45 bar) nozzle pressure. However, vessel designers could design fire main systems for pressures in excess of 50 psi (3.45 bar) depending on the type of vessel and the nature of the vessel's fire risks. Caution should be exercised to ensure a match between the minimum nozzle rating and the actual fire main system performance. It is possible for two virtually identical marine nozzles to have operating pressures that are vastly different. For example, a marine nozzle for a tank ship could have a rating of 100 psi (6.9 bar) and not perform properly if installed on a dinner cruiser with a fire main pressure of 50 psi (3.45 bar). Nozzles should be rated for a pressure equal to or less than the actual pressure available when required streams are flowing. It is recognized that a nozzle could have a good pattern over a wide range of pressures and thus an allowance is made for the nozzle to have a rated pressure range rather than a single rated pressure.

Δ **A.4.17.7.2** While control of the initial quality of a nozzle can be reasonably assured through the manufacturing process, in-service readiness of any nozzle is primarily the responsibility of the owner. Nozzles should be inspected, tested, and maintained in accordance with NFPA 1962.

Δ **A.5.3** The purpose of the salt spray test is to ensure nozzles will perform under normal exposure to mild corrosive conditions such as those found in the atmosphere near oceans or caused by chemicals used to treat road surfaces in icy conditions. If a nozzle is expected to be exposed to corrosive conditions on a long-term basis, or to be used where strong corrosives are present, the purchaser should ensure the nozzle is designed for such exposure.

Δ **A.5.7.1.1** Silicone rubber is rubber having polyorganosiloxane as its characteristic constituent.

N **A.6.13.2.4** It is extremely important that, as the monitor is operated through all its positions, any change in stream direction be done slowly so that there are not sudden changes in force on the monitor.

Δ **A.7.1** When acceptance tests are desired on delivery, they should include the following items:

(1) Nozzle discharge performance as defined in Section 4.1
(2) Discharge patterns as defined in Section 4.2
(3) Field evaluation of the controls only as defined in Section 4.3
(4) Confirmation of the threads as defined in Section 4.4
(5) Confirmation of markings as defined in Section 4.15

Δ **A.7.2.2** It is not the intent of this standard to restrict the testing to a single nozzle that has to pass all tests. Multiple nozzles can be used to facilitate simultaneous testing.

Annex B Informational References

B.1 Referenced Publications. The documents or portions thereof listed in this annex are referenced within the informational sections of this standard and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.

B.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 1962, *Standard for the Care, Use, Inspection, Service Testing, and Replacement of Fire Hose, Couplings, Nozzles, and Fire Hose Appliances*, 2018 edition.
NFPA 1963, *Standard for Fire Hose Connections*, 2014 edition.

B.1.2 Other Publications.

N **B.1.2.1 UL Publications.** Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

UL 162, *Standard for Foam Equipment and Liquid Concentrates*, 2015.

B.2 Informational References. (Reserved)

B.3 References for Extracts in Informational Sections. (Reserved)

Index